

Fermilab Plan for the Future

Greg Bock

12th International Workshop on Accelerator Alignment

September 10-14, 2012

Fermilab, Batavia, U.S.A

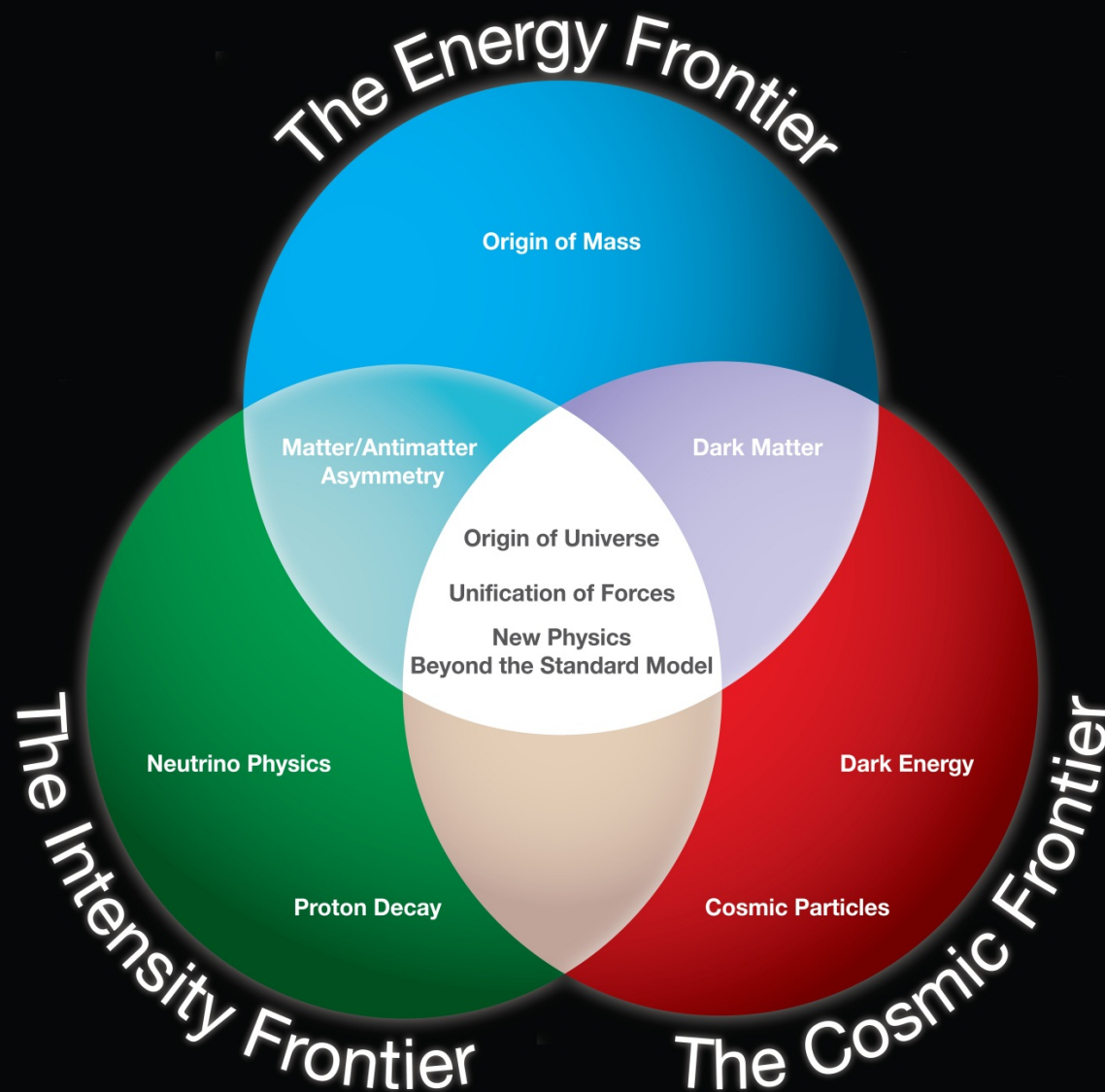
Outline

Welcome to Fermilab

Plans for this Decade

Plans for the Next Decade

Frontiers of Particle Physics



The big questions

Where does mass come from?

Why is matter dominant?

What are the neutrino masses and what do they say?

Where are the heavy neutrino partners?

Why are there three families of quarks and leptons?

Do the forces unify?

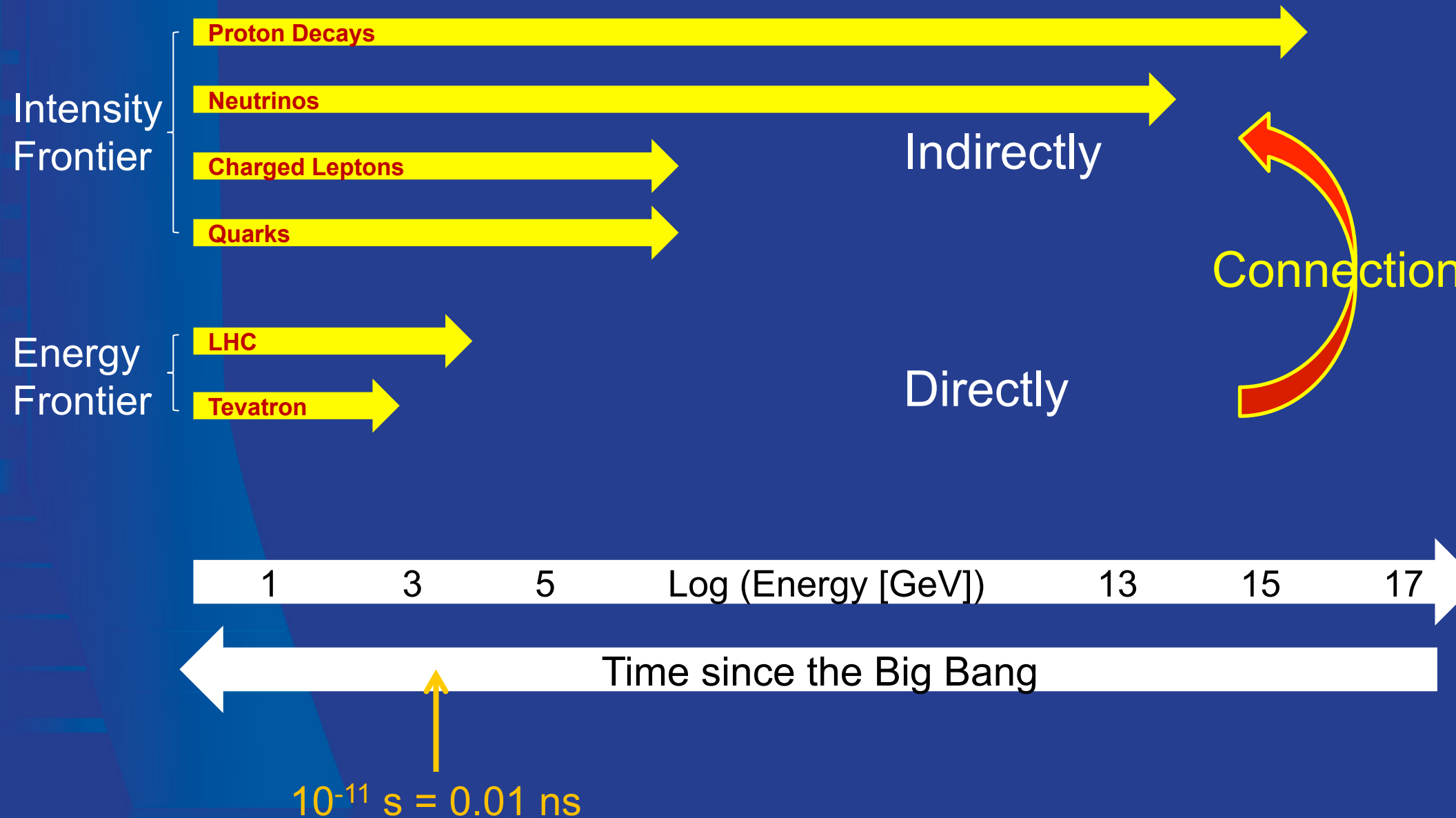
Does nature use supersymmetry or other new symmetries?

Are there extra dimensions of space?

What is dark matter?

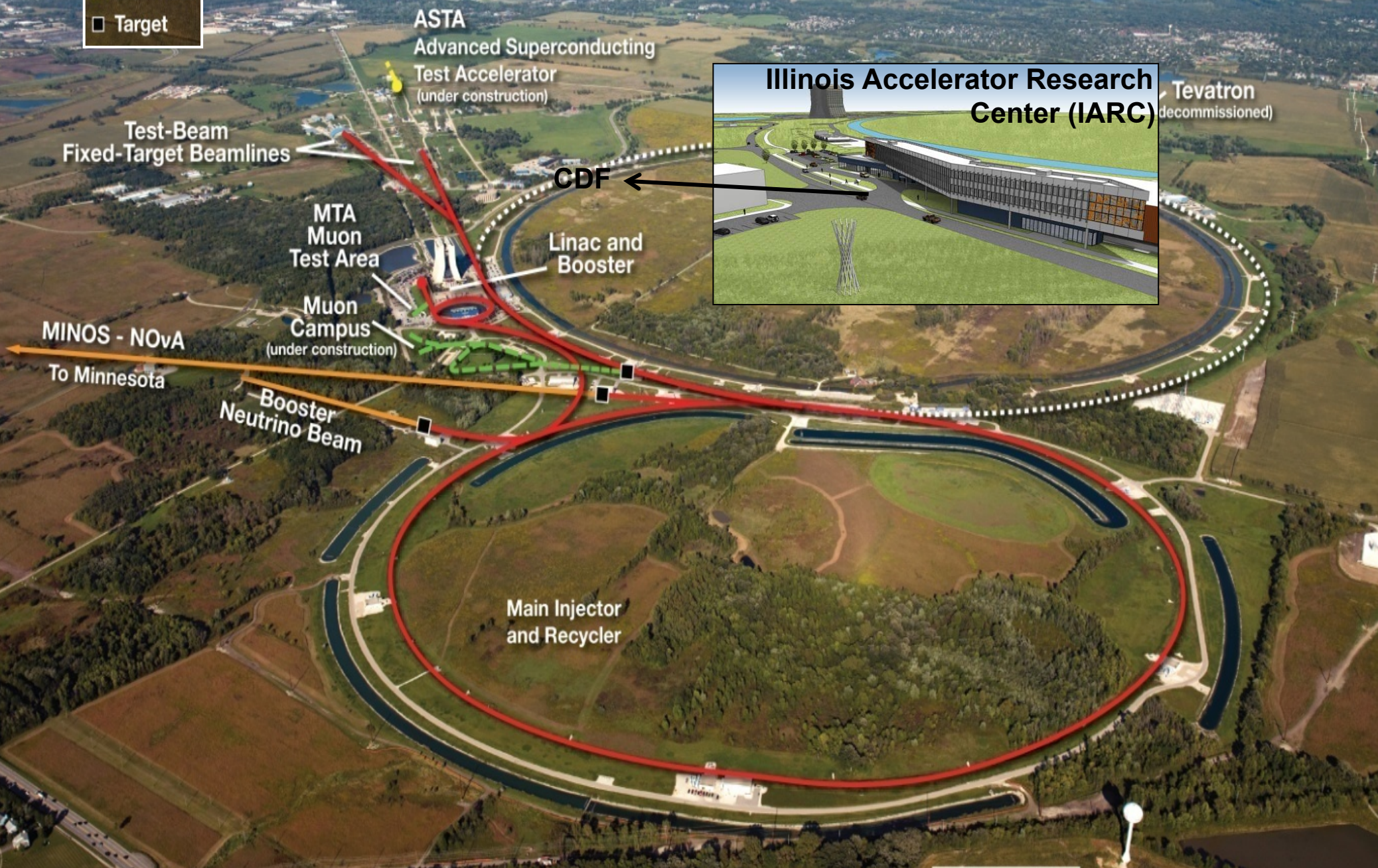
What is dark energy?

The strategy and experimental reach

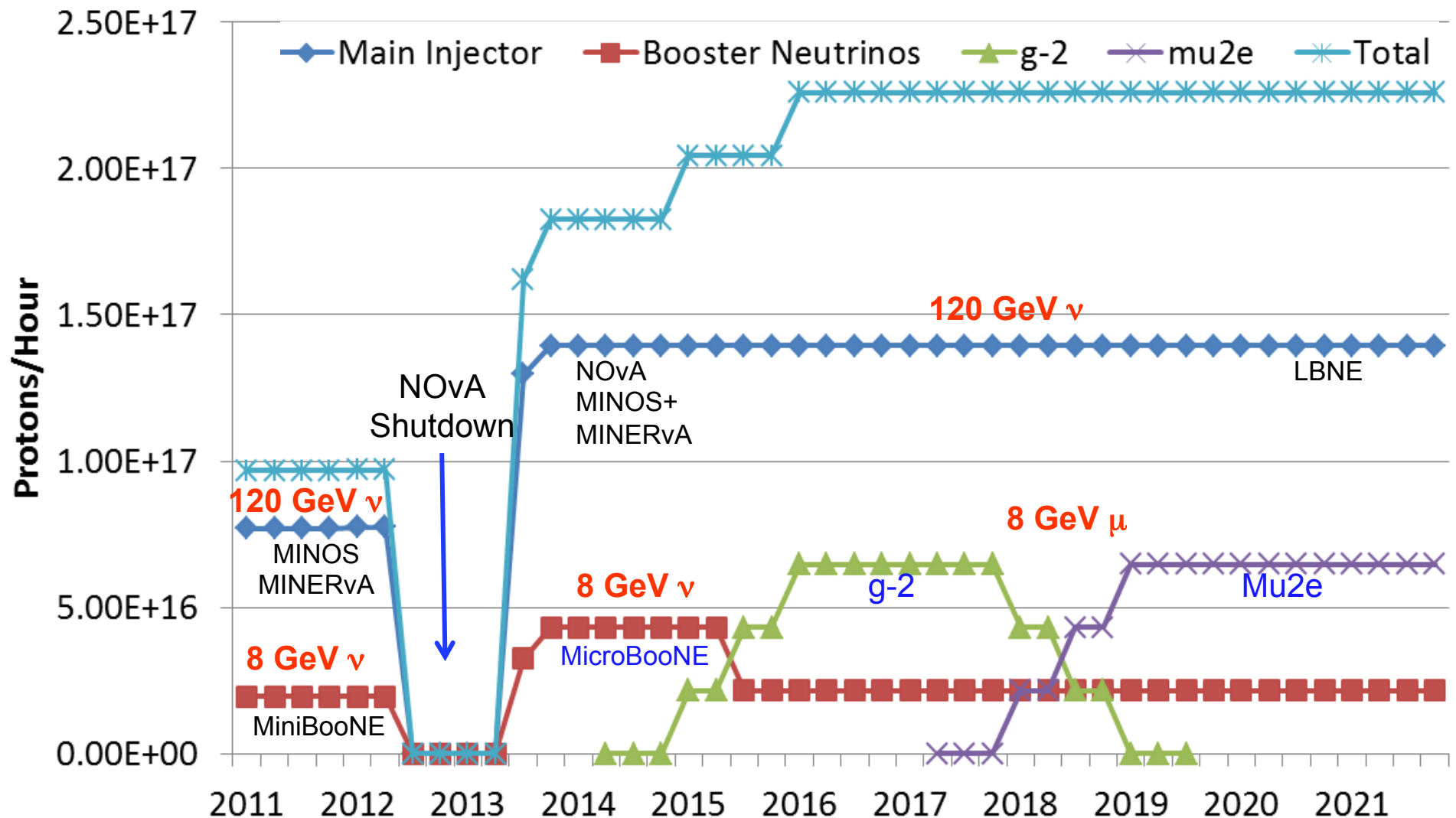


The program through 2020

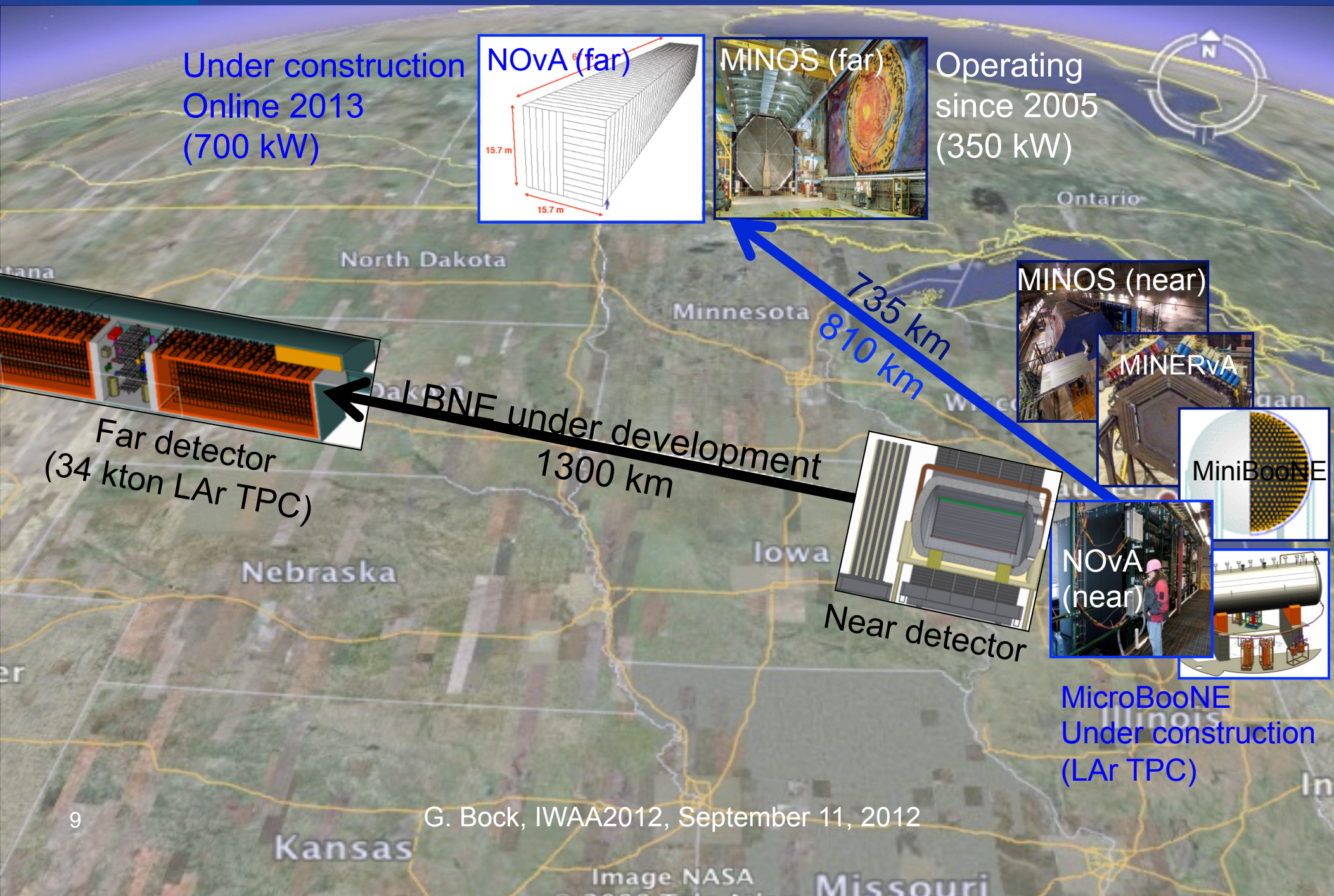
Fermilab Accelerator Complex 2012



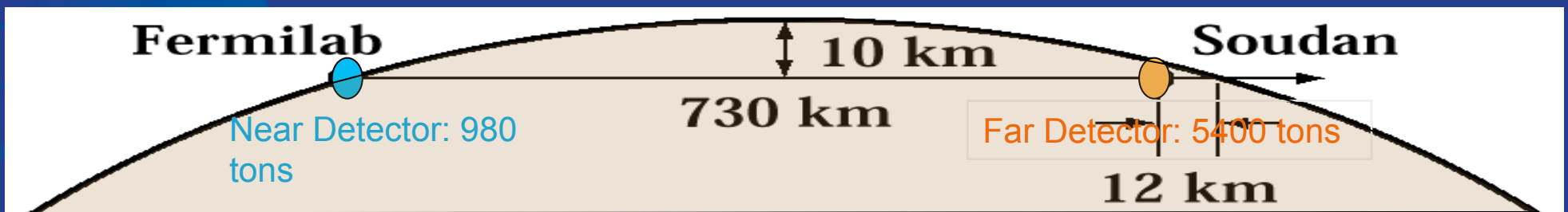
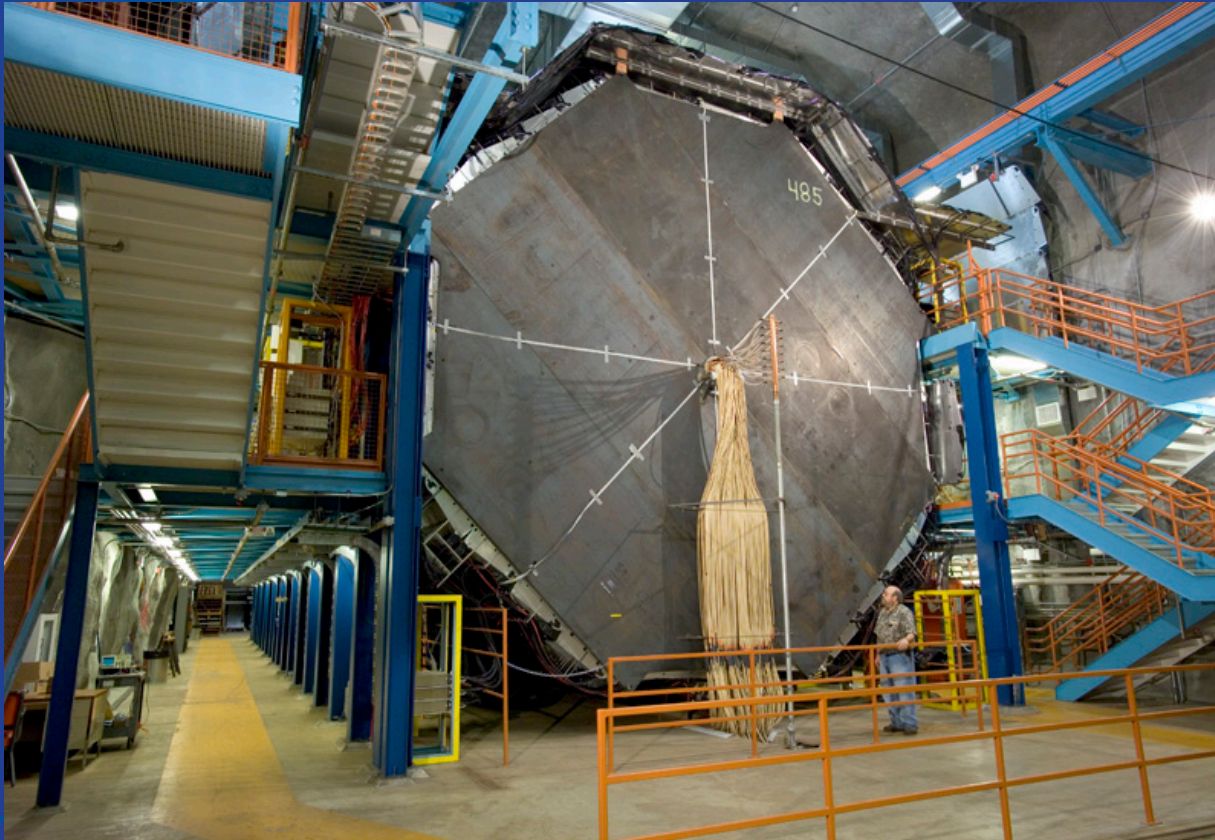
(more than) Doubling the output of our accelerators



Neutrino program

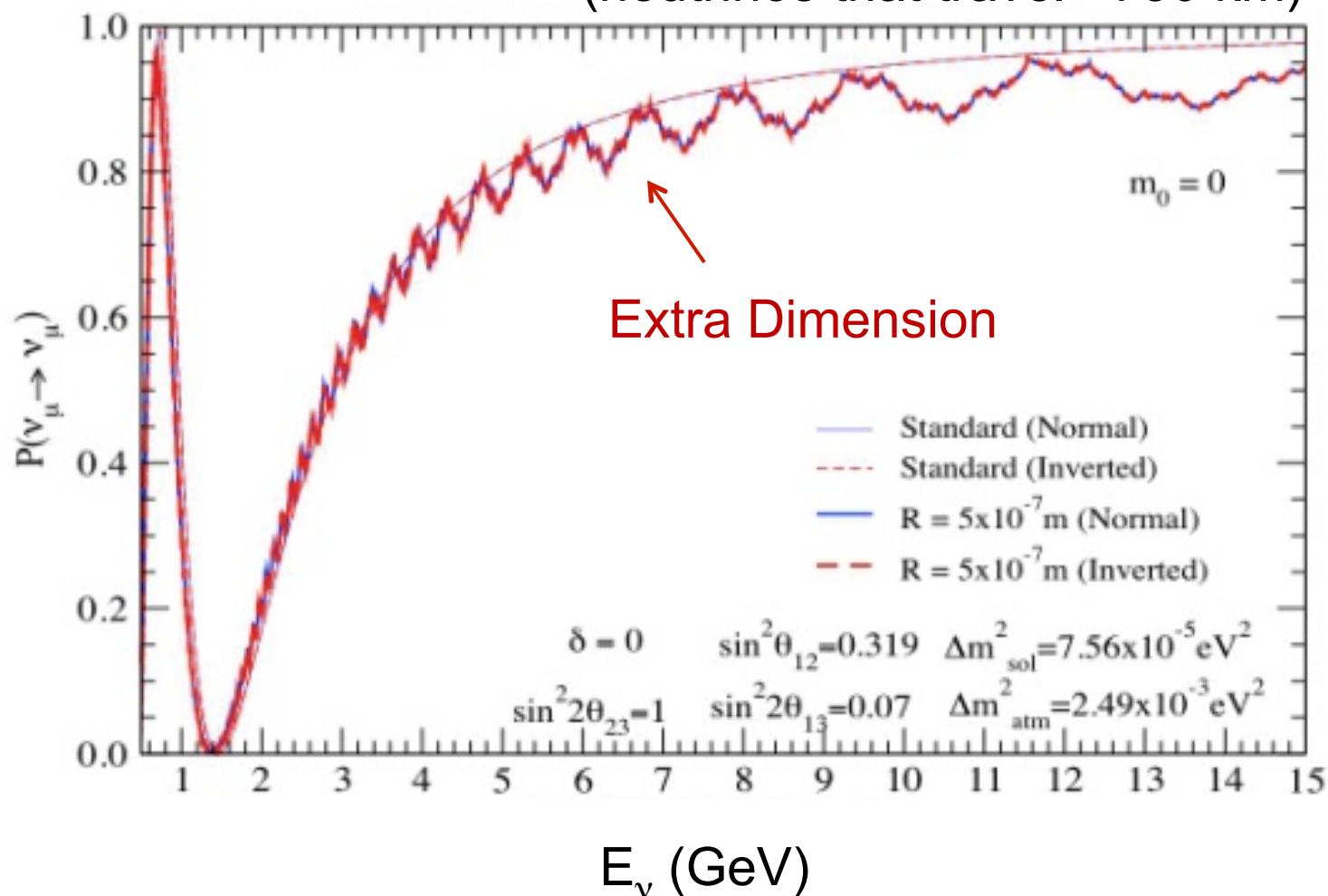


Minos and Minos +



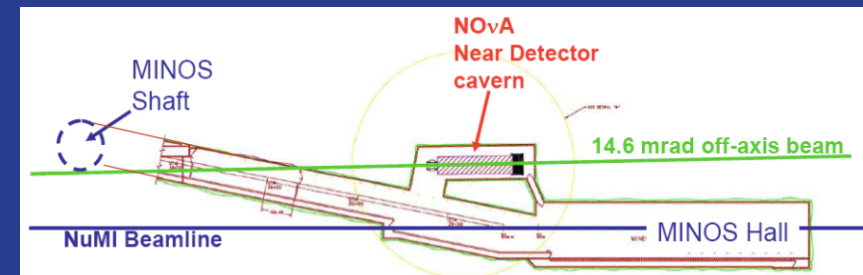
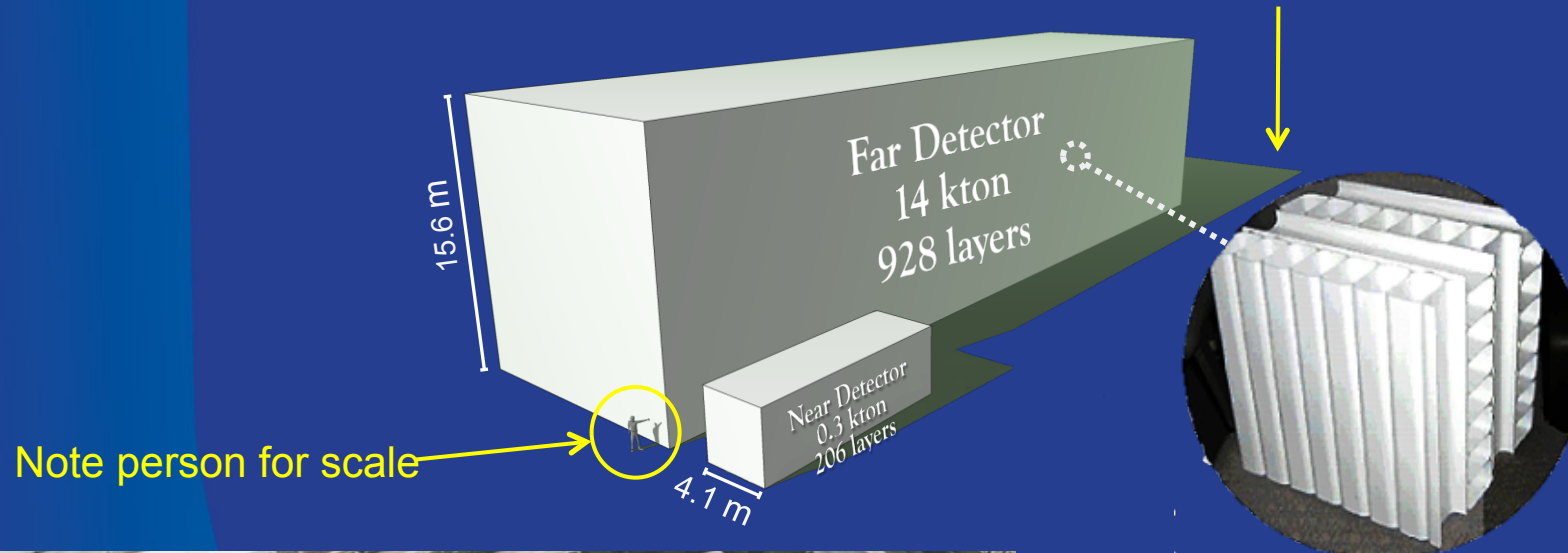
Exploring **unknown unknowns** in neutrino oscillation

Machado, Nunokawa, Funchal
(neutrinos that travel ~ 750 km)



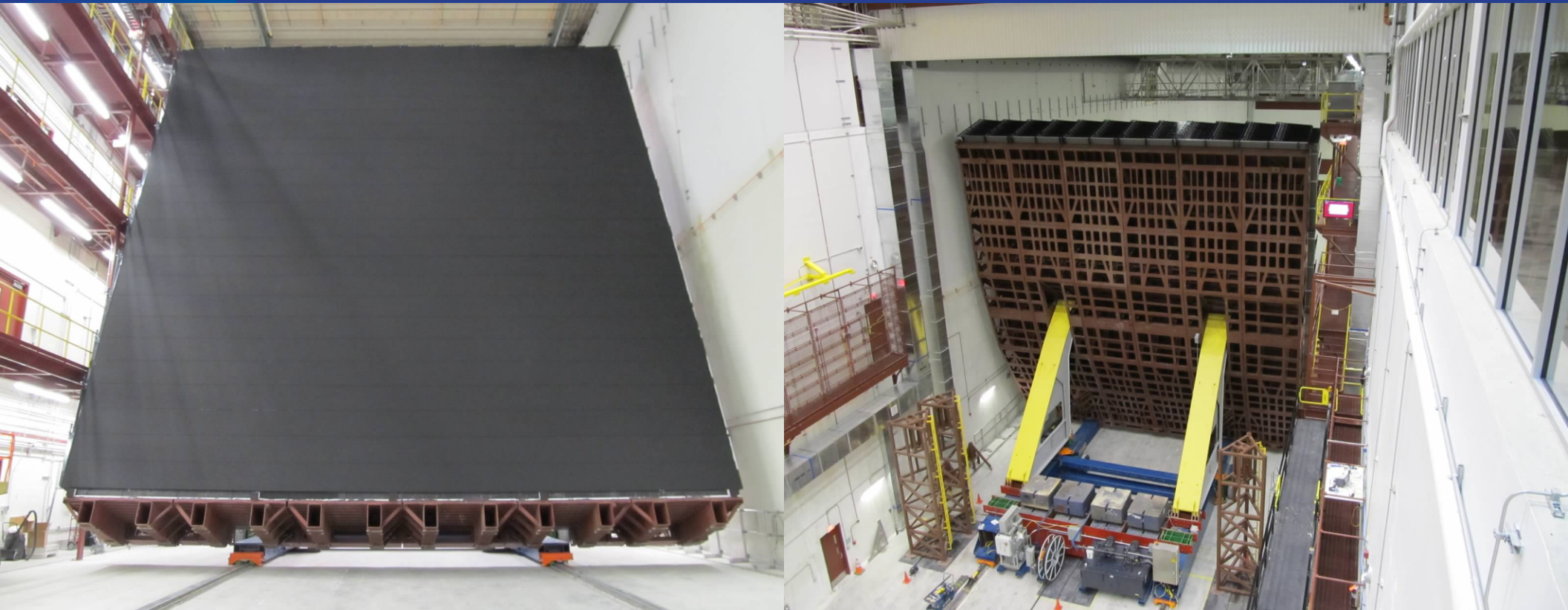
NOvA Near and Far Detectors

- 14 kt Scintillator / PVC (64% / 36%) Far Detector
- 0.33 kt Scintillator / PVC Near Detector at Fermilab
- Identical construction: Alternating X & Y layers of PVC cells



Plan view 300 ft underground

07Sep2012: Pivoting the first block to vertical for its trip down the Detector Hall to the far end



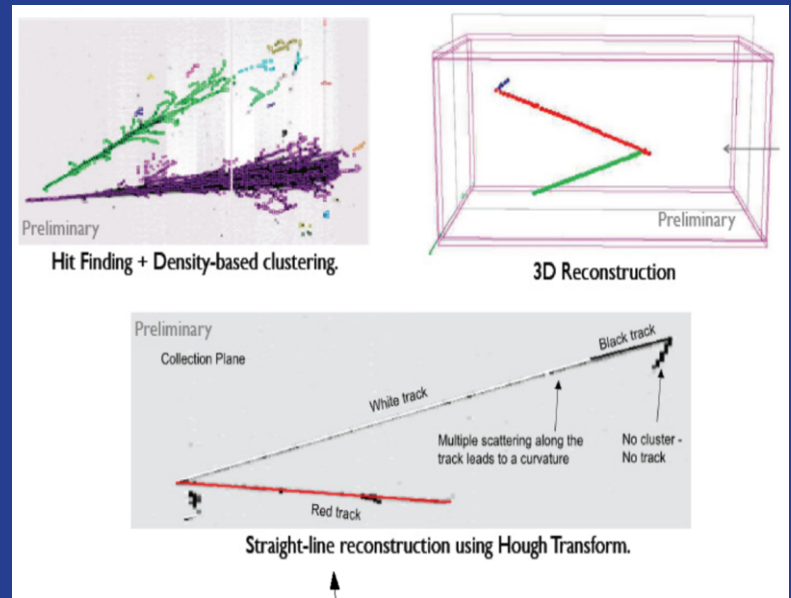
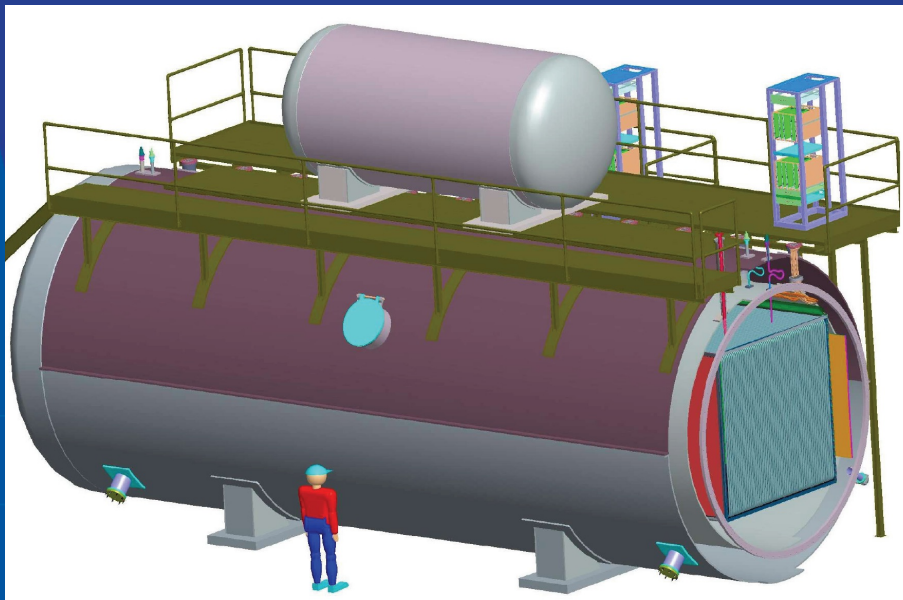
- Front view

Back view

J. Cooper, Fermilab Annual S&T Review, Sept 5-7, 2012

MicroBooNE

- Follow excess in MicroBooNE data. Critical to determine is it electrons or photons?
- Use Liquid Argon TPC: physics + further development of the technology

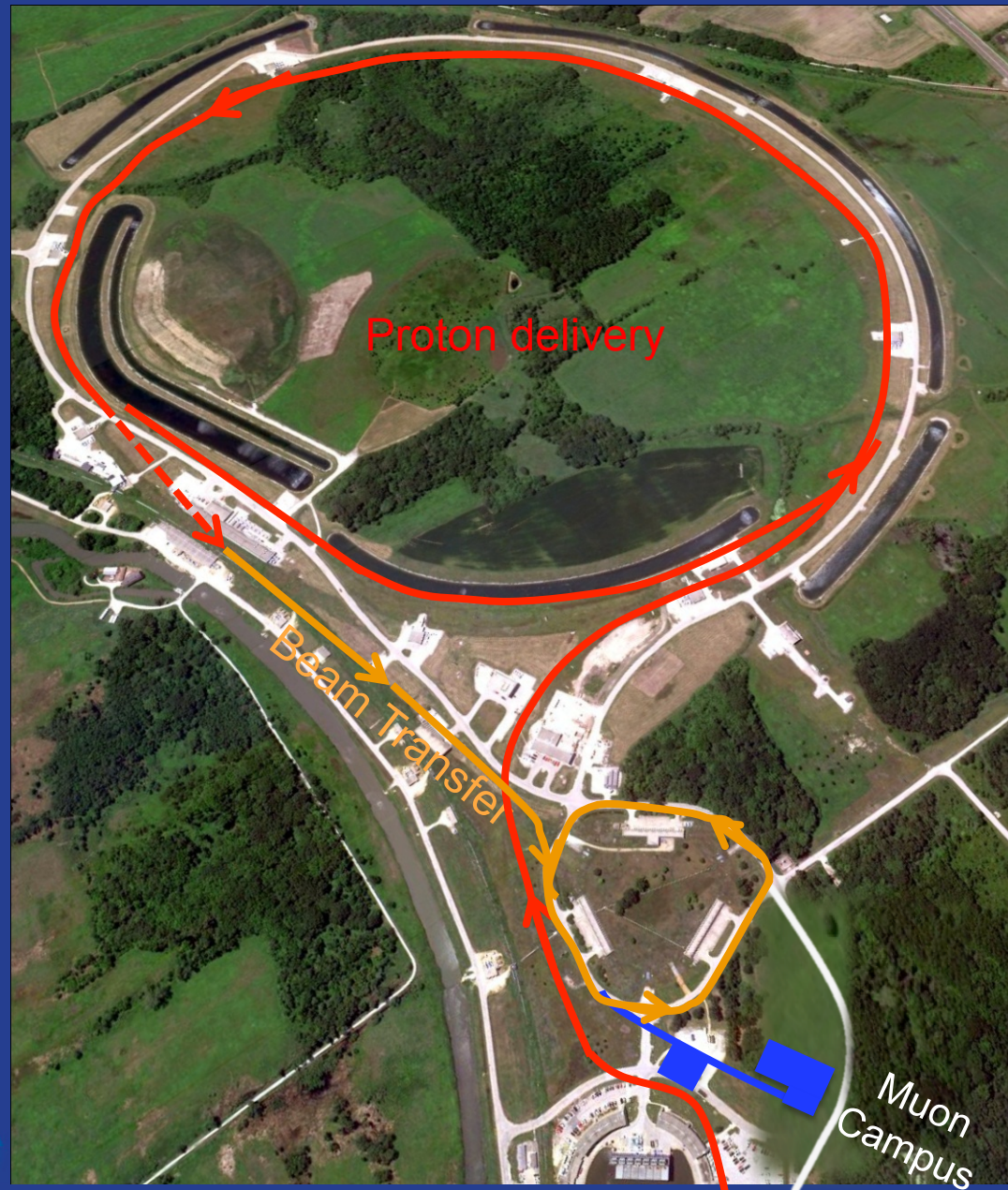


Neutrino experiments and their physics goals in the next ten years

We strive to run 45-50 weeks/ year

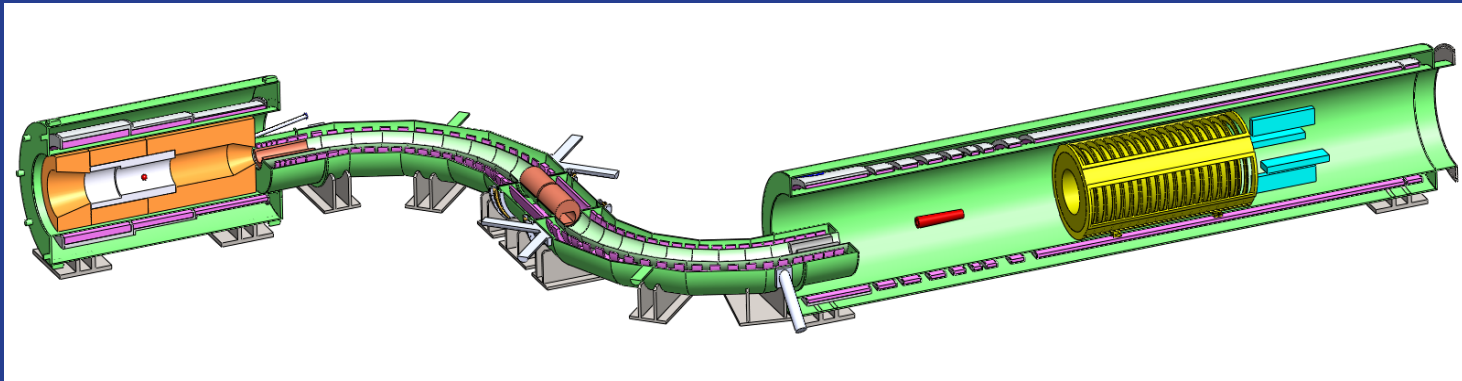
Physics goal	2011		2013		2015		2017		2019		2021
Search for CP violation											
Determine mass hierarchy					NOvA						
Sterile neutrino sector											
Appearance		MiniBooNE	MicroBooNE								
Disappearance			MINOS+								
Establish framework											
Precision mass difference		MINOS									
Neutrino interaction rates with nuclei		MINERvA									
Confirm θ_{13} through appearance			NOvA								

Intensity Frontier at Fermilab: Muon Campus



Muon Experiments

Mu2e experimental rate sensitivity: $10^{-16} - 10^{-17}$



Muon g-2



Intensity Frontier at Fermilab

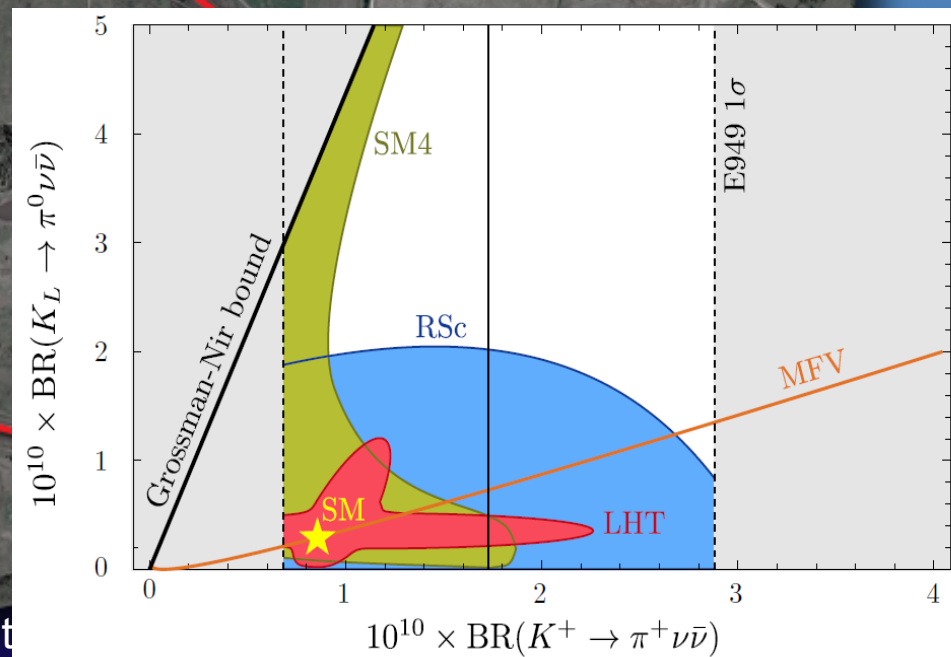
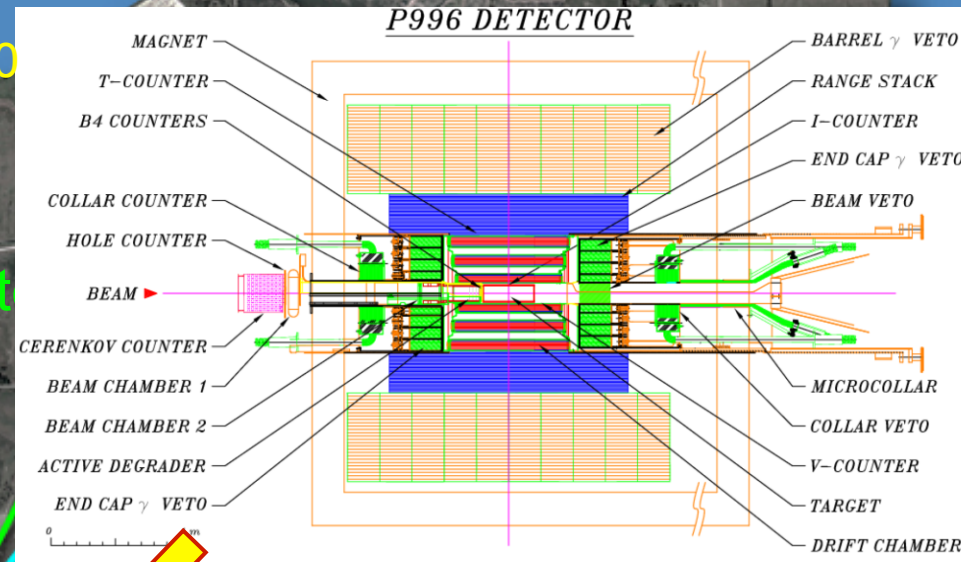
Kaon beam (if an opportunity arises)

$$K^+ \rightarrow \pi^+ \nu \bar{\nu} \text{ rate in SM} \sim 10^{-10}$$

neutrino
beams

muon
beams

Main Injector
Recycler

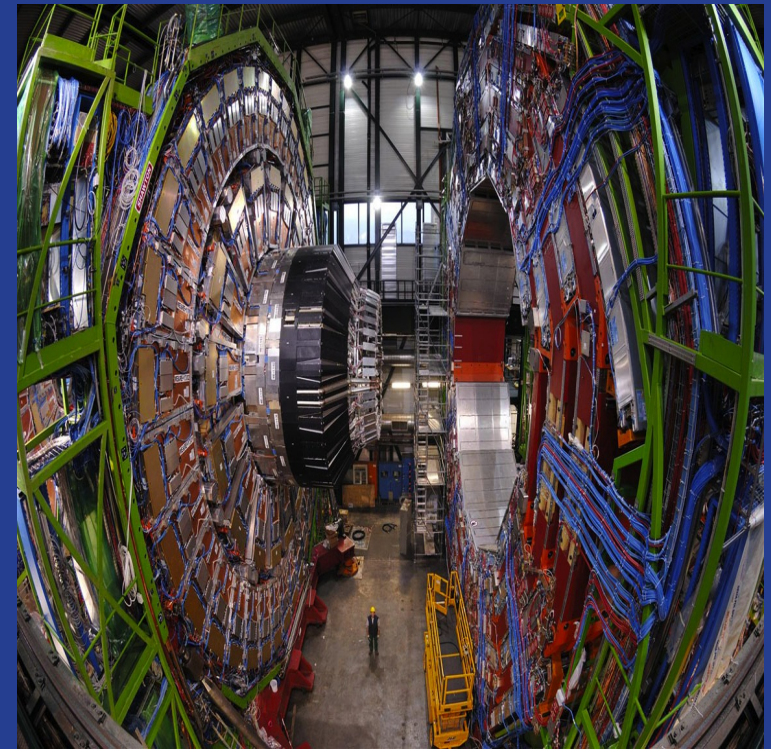


Energy Frontier at Fermilab



Energy Frontier

- The principal activity for the foreseeable future is exploitation of the LHC
 - Operations, physics analysis
 - Support U.S. LHC community
 - High luminosity upgrades for both accelerator and detector
- The biggest unknown is what follows the LHC?: ILC ? CLIC ? Muon Collider ? Energy doubler ?



Muon Accelerator Program

Cosmic Frontier at Fermilab

Dark Matter Detector

Dark Matter
Particle

Detector

CDMS

DarkSide

COUPP

Detectors in underground facilities

Dark Energy Camera

DES

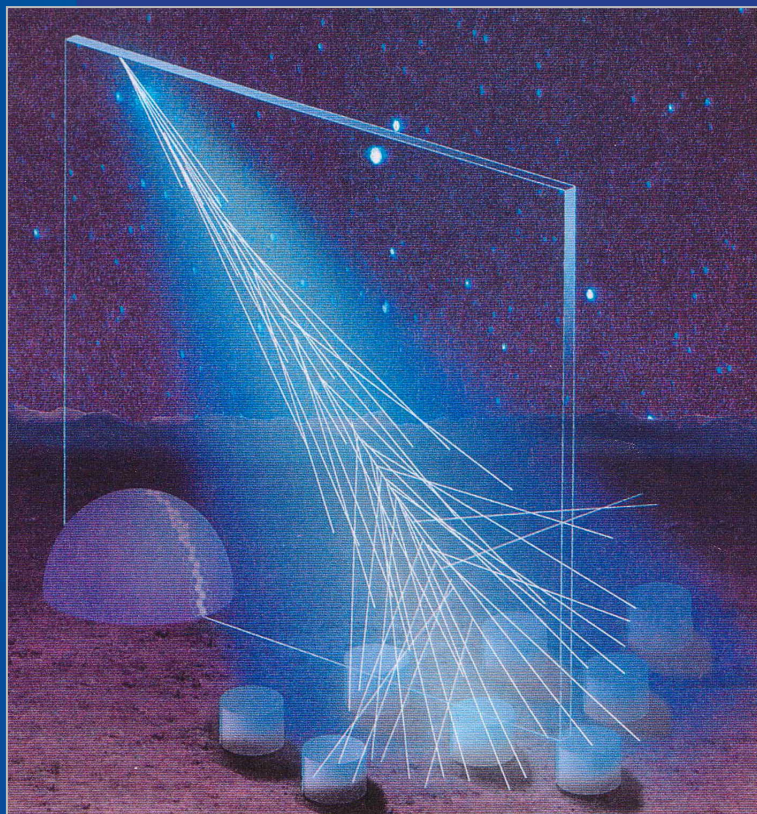
570-Megapixel
digital camera

Fermilab

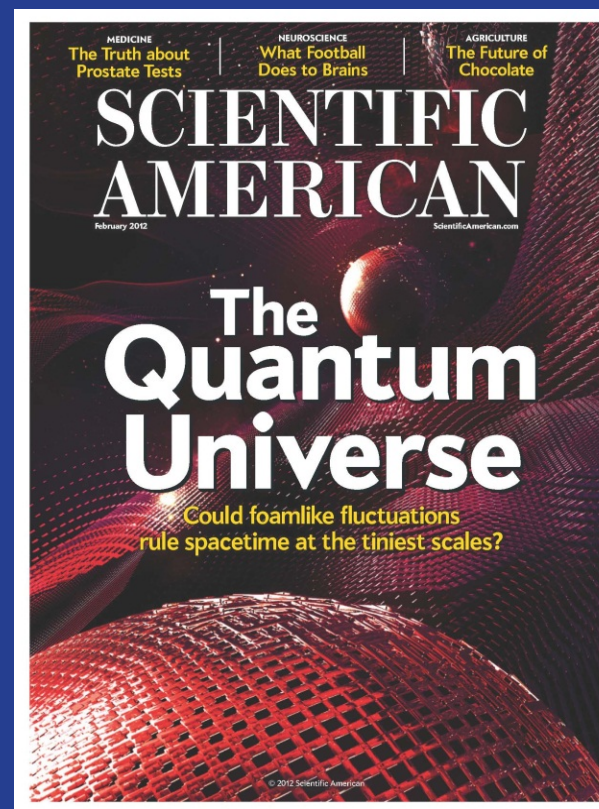
Chile

Cosmic Frontier at Fermilab

Exploring
Highest-Energy Cosmic-Ray Particles
(Auger)



Exploring
Quantum Space-time
(Fermilab Holometer)



Accelerator stewardship: IARC



Funding from the State of Illinois for new building; reconditioning of CDF assembly hall and provision of utilities thanks to DOE. IARC to act as a) portal to Fermilab accelerator facilities b) collaborative space for universities and industries c) training ground for accelerator technologists



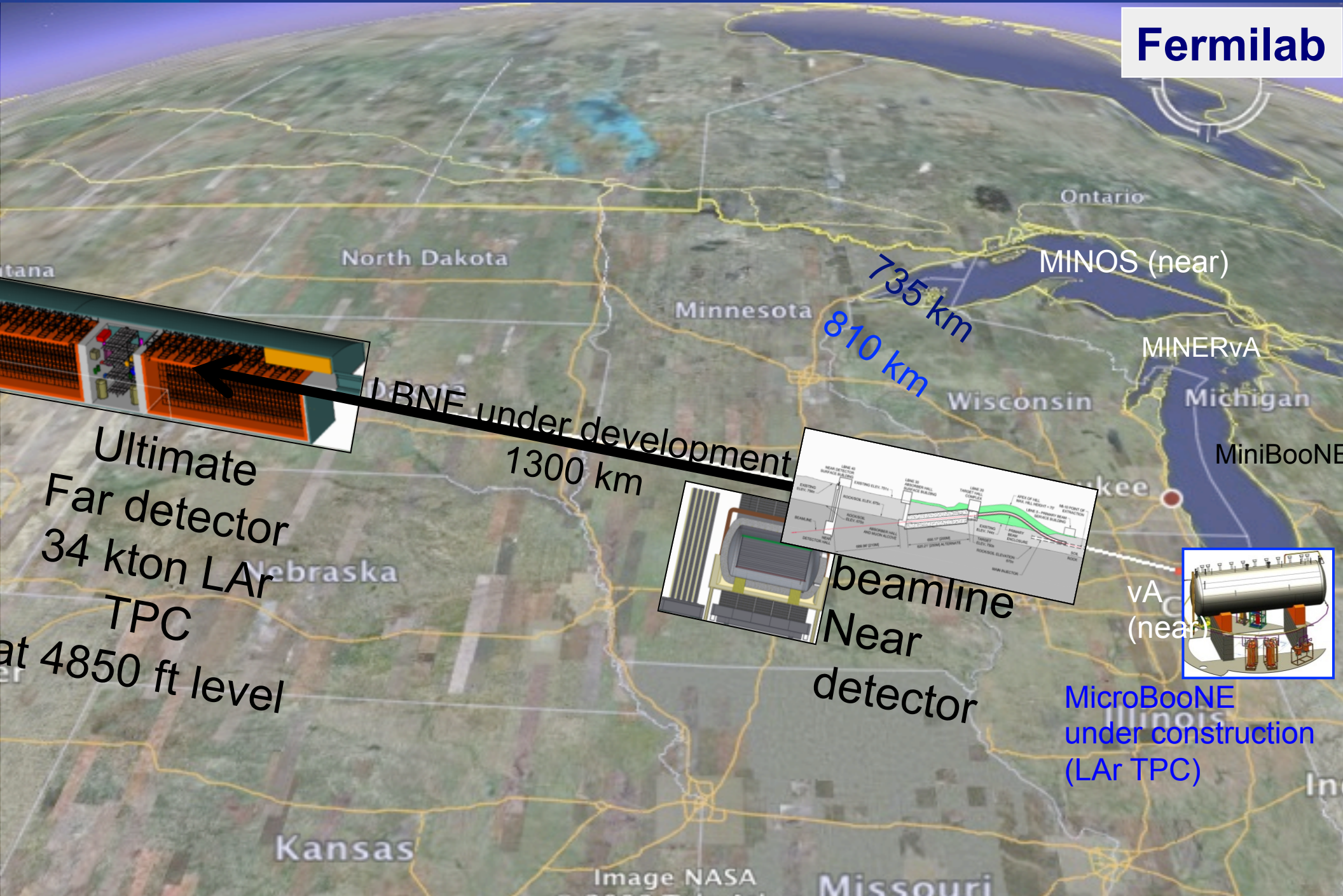
R&D this decade: SCRF and Project X



The program after 2020

Intensity Frontier Accelerators: Neutrino Beams

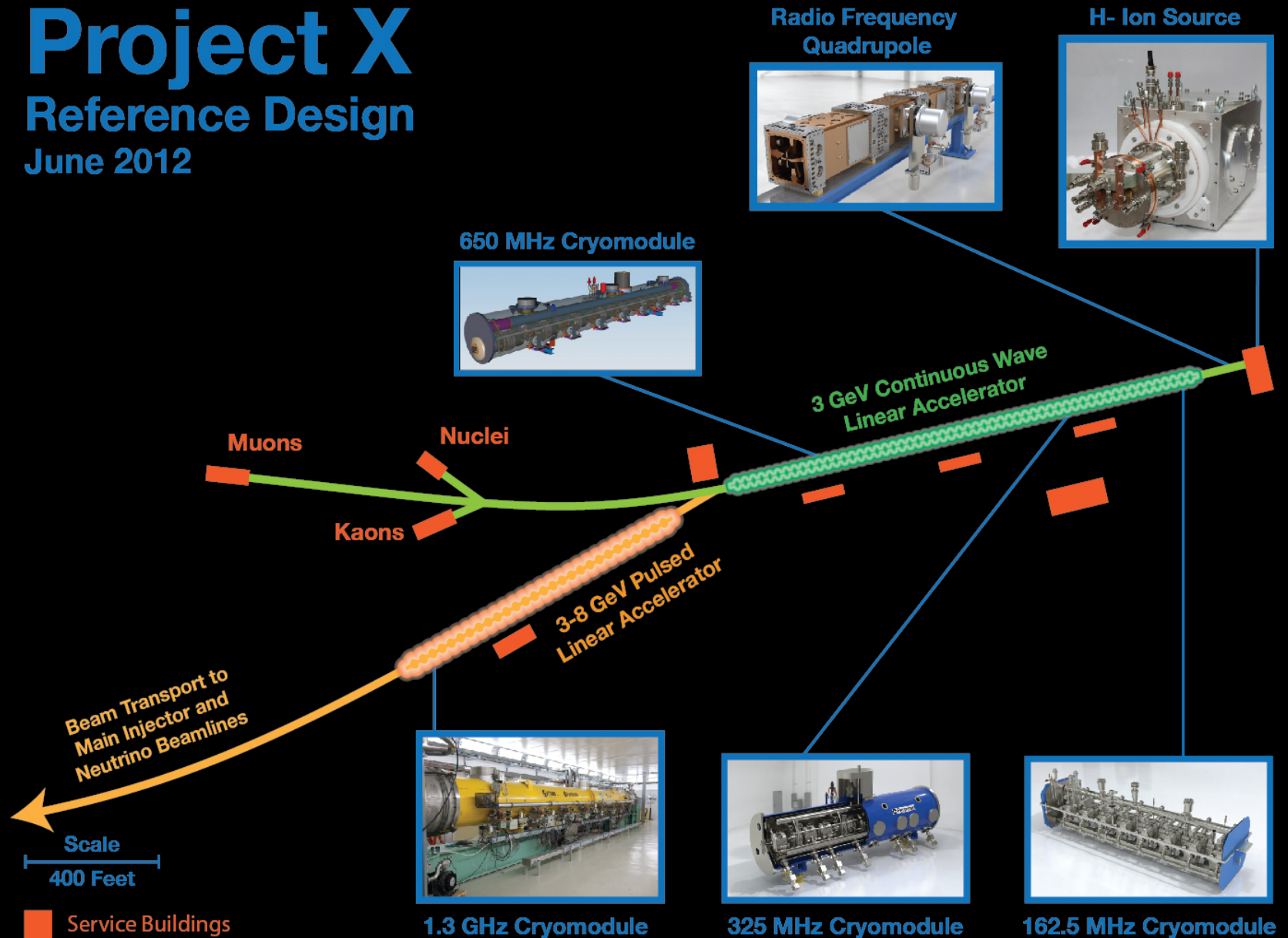
Fermilab



Project X

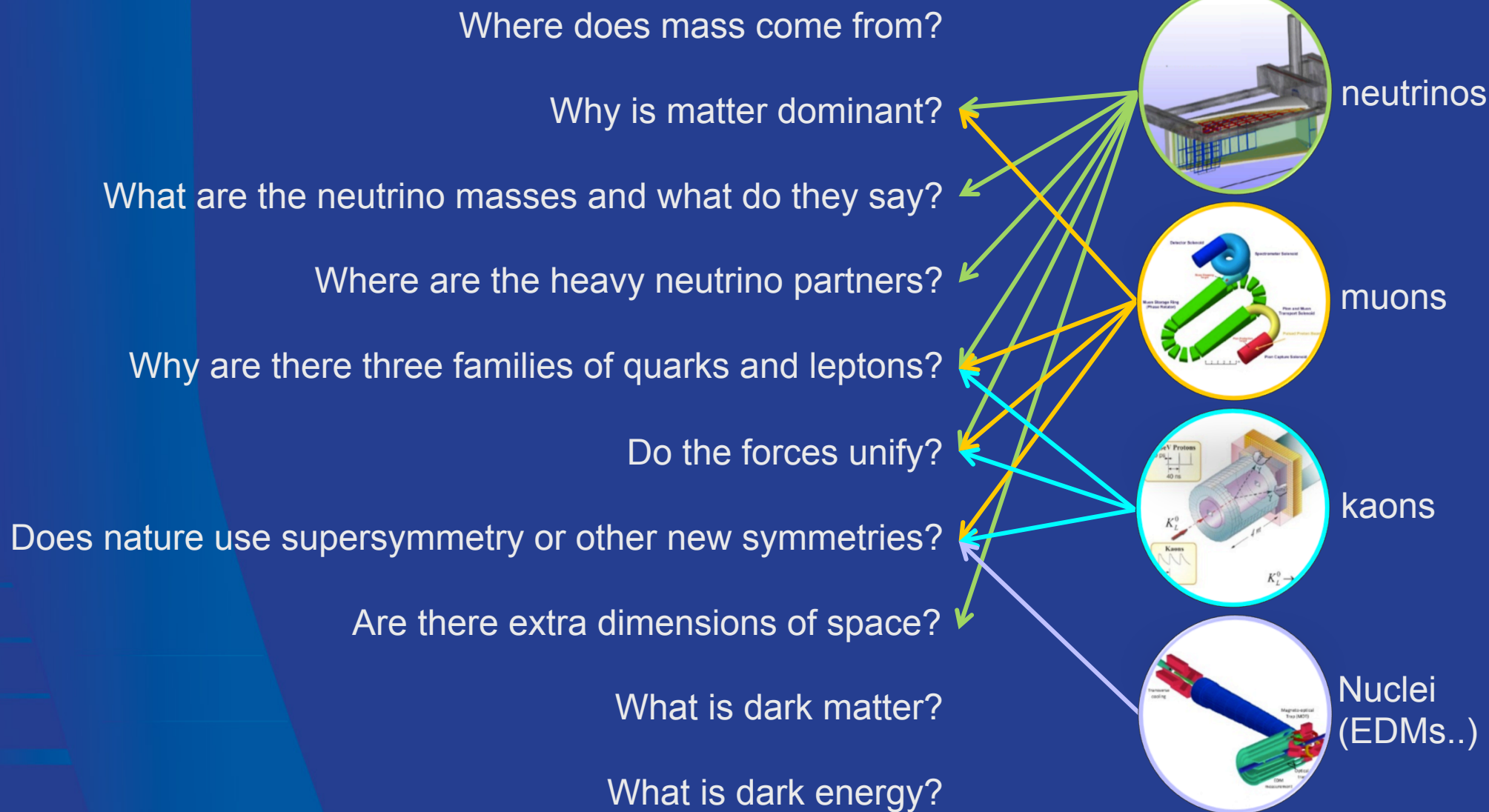
Reference Design

June 2012



Argonne National Laboratory • Brookhaven National Laboratory • Fermi National Accelerator Laboratory • Lawrence Berkeley National Laboratory
 Pacific Northwest National Laboratory • Oak Ridge National Laboratory / SNS • SLAC National Accelerator Laboratory • Thomas Jefferson National Accelerator Facility
 Bhabha Atomic Research Center • Raja Ramanna Center of Advanced Technology • Variable Energy Cyclotron Center • Inter University Accelerator Center

Project X and the big questions



Significant international participation on current projects

Collaboration on Project X R&D with India. Now extended to the Fermilab experimental program. Major in-kind contributions possible for Project X and LBNE

Opportunities for European groups: described on paper submitted to the European Strategy planning exercise

Multiple international workshops

Imperative: increasing trust that we will carry out program planned in the US



Long Term Vision

- The leading facilities in the world at the Intensity Frontier for neutrinos and rare processes – an essential complement to the LHC
- A path towards major contributions to future facilities at the Energy Frontier
- Major contributions to resolving the mysteries of dark matter and dark energy

AGAIN, WELCOME AND ENJOY THE WORKSHOP!