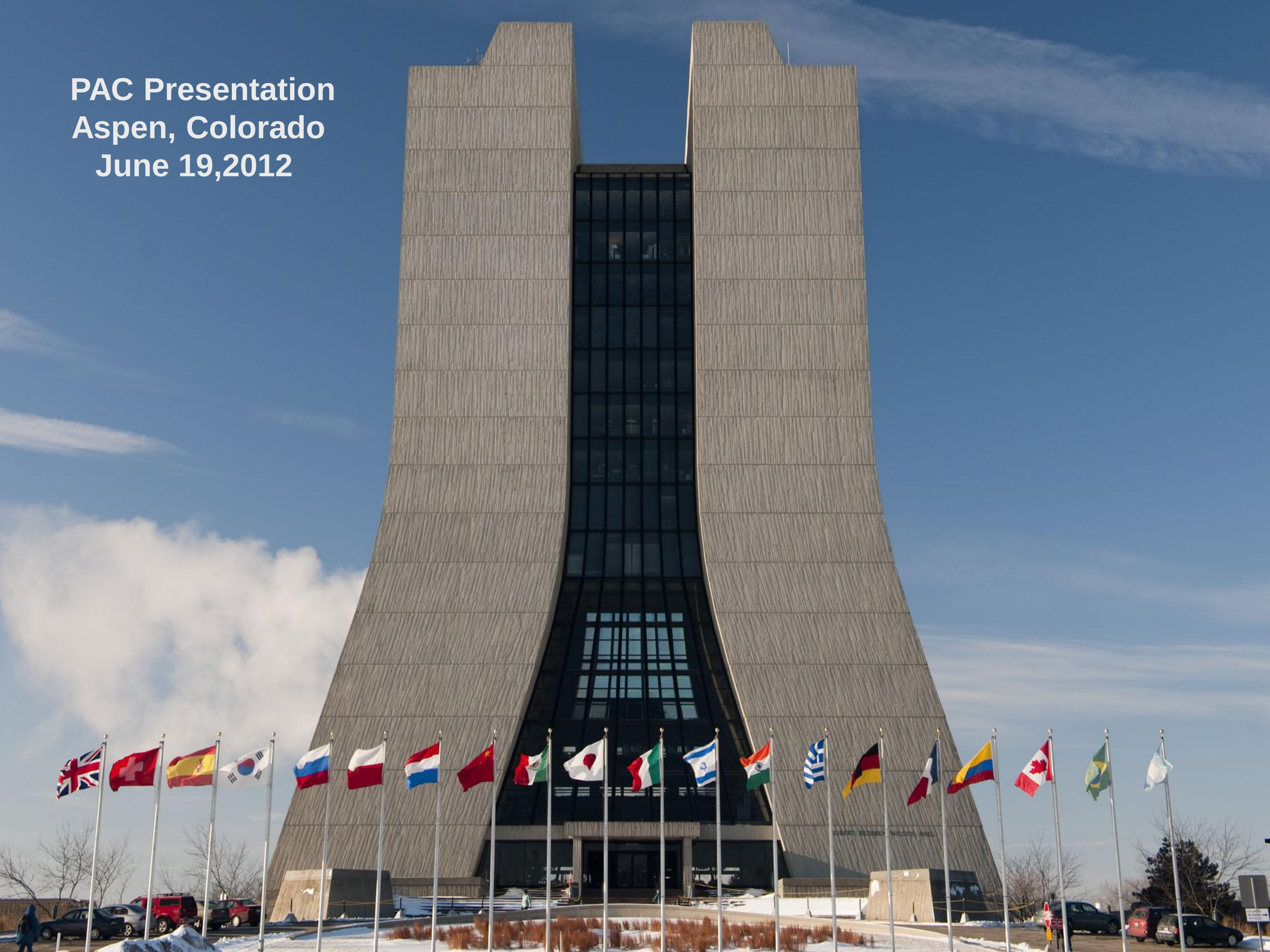
PAC Presentation
Aspen, Colorado
June 19,2012



Outline

- This presentation follows closely our presentation to DOE on June 6th regarding Fermilab plans:
  - General comments on the program goals and the strategy to achieve them
  - The restructuring of LBNE
  - How recent results affect strategy
  - The planned program through 2020
  - The planned program beyond 2020
  - Management and operations that sustain the future of Fermilab

The strategy for Fermilab

- We have a compelling program that maintains Fermilab and the US as a leader in in the world of particle physics --- and now fits a leaner budget profile
- Leadership includes working with the community and DOE to achieve that program, providing the facilities to pursue fundamental discoveries and attracting international partners
- Leadership must take place in the context of a global field

Intensity Frontier Workshop, Washington DC

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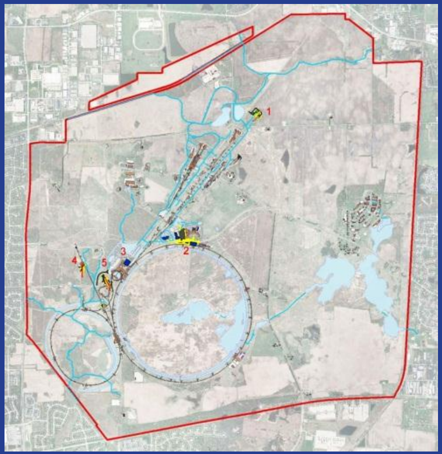
Other planning for Fermilab

- We pay major attention to other important planning issues: human resources, site development, project management, operational improvements throughout -- but all of these will be for naught if we do not get the strategy right. This presentation is heavily weighted towards the strategic issues that determine the future of Fermilab and HEP in the US



Site planning

Community Advisory Board

Employee Advisory Group

Infrastructure

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Criteria for a sustainable strategy

- Drives world-leading physics
- Is supported by the HEP community
- Continually produces scientific results
- Attracts international participation
- Is resilient relative to instability in the US system
- Is resilient relative to new discoveries
- Has the full support of the Office of Science
- Is affordable (the definition of affordability varies with time, up and down)

Strategy: practical matters

- We have worked hard to design a strategy that:
  - Fits the likely budgetary constraints
  - Builds on getting the greatest returns from existing investments in our current accelerators and detectors
  - Sets the platform for future initiatives
  - Sets the trajectory for Fermilab and the US program to be leaders at the Intensity Frontier
- We enjoy DOE support to achieve these broad goals. DOE support includes: running the existing facilities, completing ongoing projects like DES and NOvA, building new projects like Mu2e and Muon g-2 and setting the path towards long term achievements with LBNE and Project X
- We lead this presentation with the reconfiguration of LBNE

The restructuring of LBNE

- Dr. Brinkman's letter: LBNE as currently designed is not affordable; requested phased approach and/or alternatives with physics at every stage
- We have carried out a major re-planning effort with the involvement of the community (many leaders); all major stakeholders; open process with all documentation on the web
- Held community workshop

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Organization of the effort

Steering Committee: Developed viable options, prepared the report

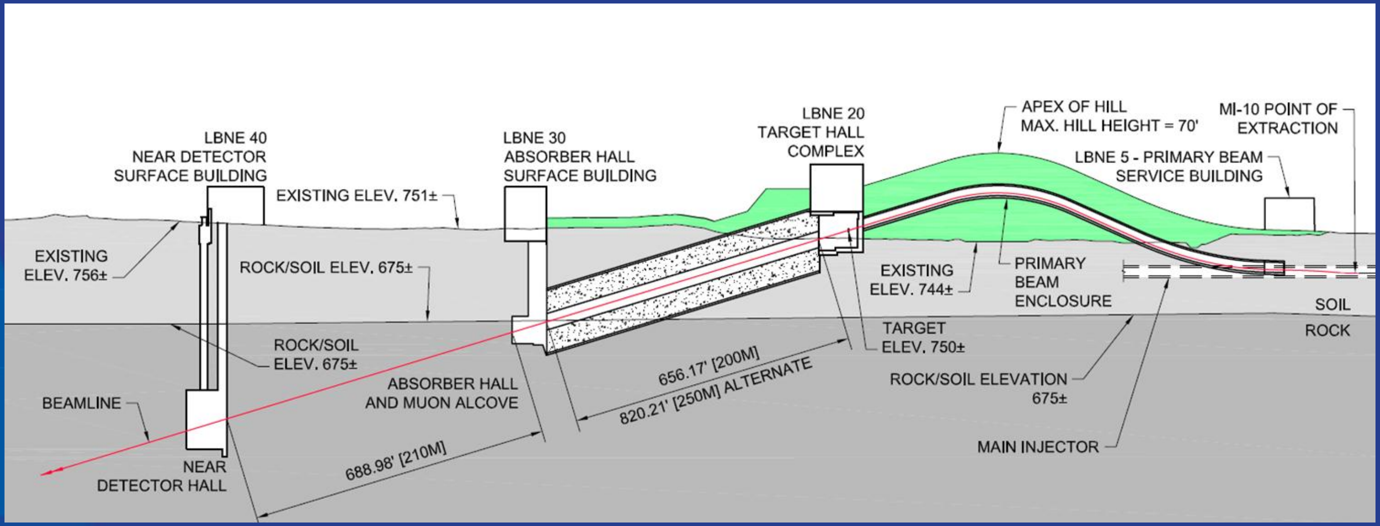
- **Physics Working Group:** Analyzed physics reach with common assumptions
- **Engineering/cost Working Group:** Developed cost with common methodology

Issues for LBNE Phase 1

- Main issues:
  - What compromises to make in the physics for Phase 1 in order to make it affordable
  - What long-term physics limitations are imposed by the different options for Phase 1
- The fundamental practical choice:
  - Do we use the existing beamline to NuMI or do we develop a new beamline to Homestake?

A beamline is a significant investment

- Extraction and transport from the Main Injector to target
- Target hall allows repairs in high-radiation environment
- Focusing horns for secondary particles
- Large underground decay pipe (675m for NuMI and 200m for Homestake), with aquifer protection to higher levels than NuMI beamline



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Issues for LBNE Phase 1

- Using the existing NuMI beamline saves the cost of a new beamline and allows funding a more ambitious detector in Phase 1 (allows either a very large detector on the surface or a smaller detector at depth) -- but permanently limits the future physics reach for neutrino physics. How significant is this?

- Developing a new beamline to Homestake requires the investment of substantial resources that, within limited budgets, reduces the scale of the Phase 1 detector -- but preserves the ability to develop the full physics potential in the long term. Is the Phase 1 physics reach "good enough" to justify the first phase and attract partners?

Reconfiguration Process

- A large number of options were considered, with full study of the physics reach and corresponding engineering/cost studies
- We worked within a guideline of trying not to exceed about $700M to $800M for LBNE Phase 1 (including escalation and contingency), fully aware that it will be easier to get going with lower costs
- At the end, three options were considered viable, each with at least one strength greater than the others. One of the three options was strongly favored by the Steering Committee, but is also the most costly
- To understand how we arrived to a favored option we need to discuss some physics

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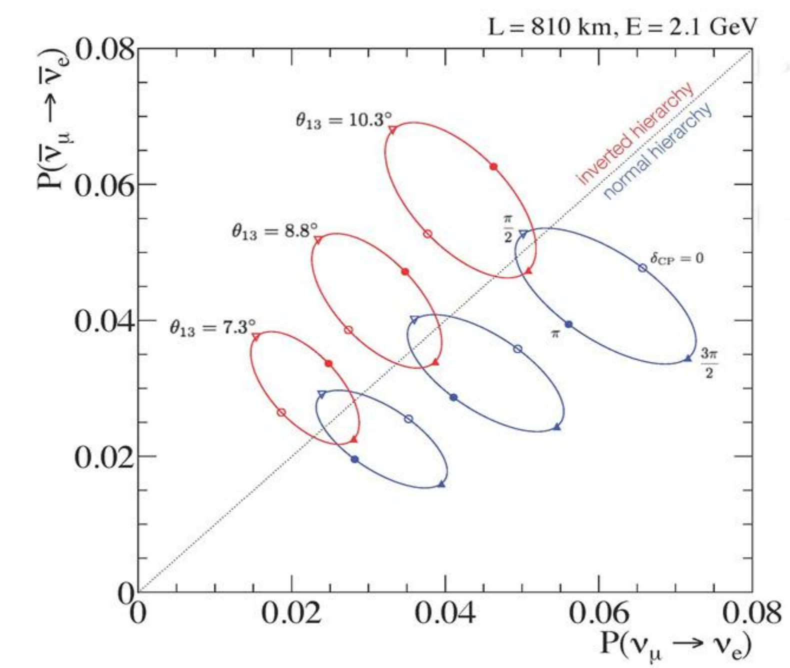
What does a large θ_{13} mean?

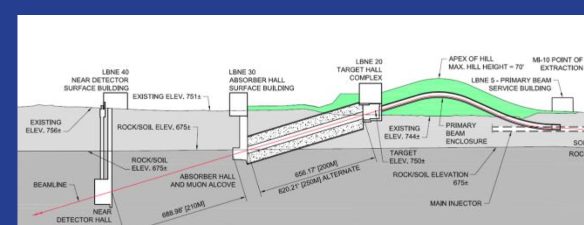
- For values of $\sin^2 2\theta_{13}$, >0.02 the measurement of δ_{CP} is largely independent of $\sin^2 2\theta_{13}$
- A large $\sin^2 2\theta_{13}$ helps the measurement of the mass hierarchy at baselines shorter than Homestake – but not over the full range of δ_{CP}
- A large $\sin^2 2\theta_{13}$ allows mass hierarchy measurement across the full range of δ_{CP} with a smaller detector at Homestake



Neutrino oscillations in NOVA

Three options with different strengths

- 1. The existing NuMI beamline in the “low-energy configuration” with a **30 kton** LAr-TPC **surface detector** 14 mrad off-axis at Ash River (**810 km**)
- 2. The existing NuMI beamline in the “low-energy configuration” with a **15 kton** LAr-TPC **underground (2300 ft) detector** on-axis at the Soudan mine (**735 km**)
- 3. The new LBNE beamline in the low-energy configuration on-axis with a **10 kton** LAr-TPC **surface detector** at Homestake in South Dakota (**1,300 km**)



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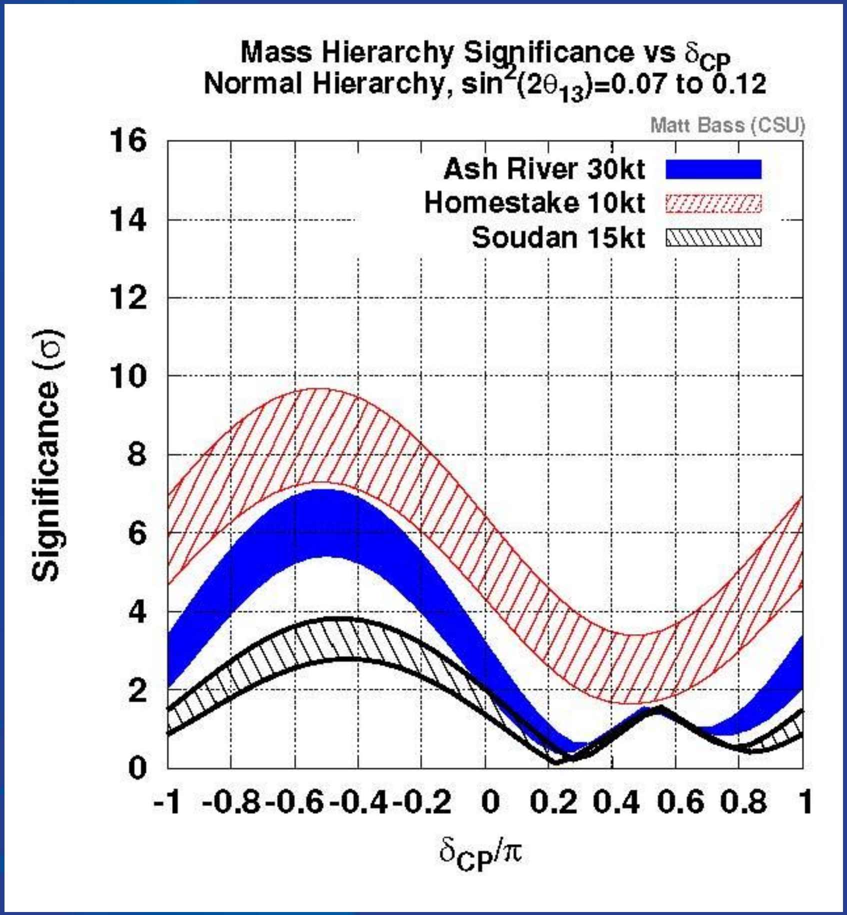
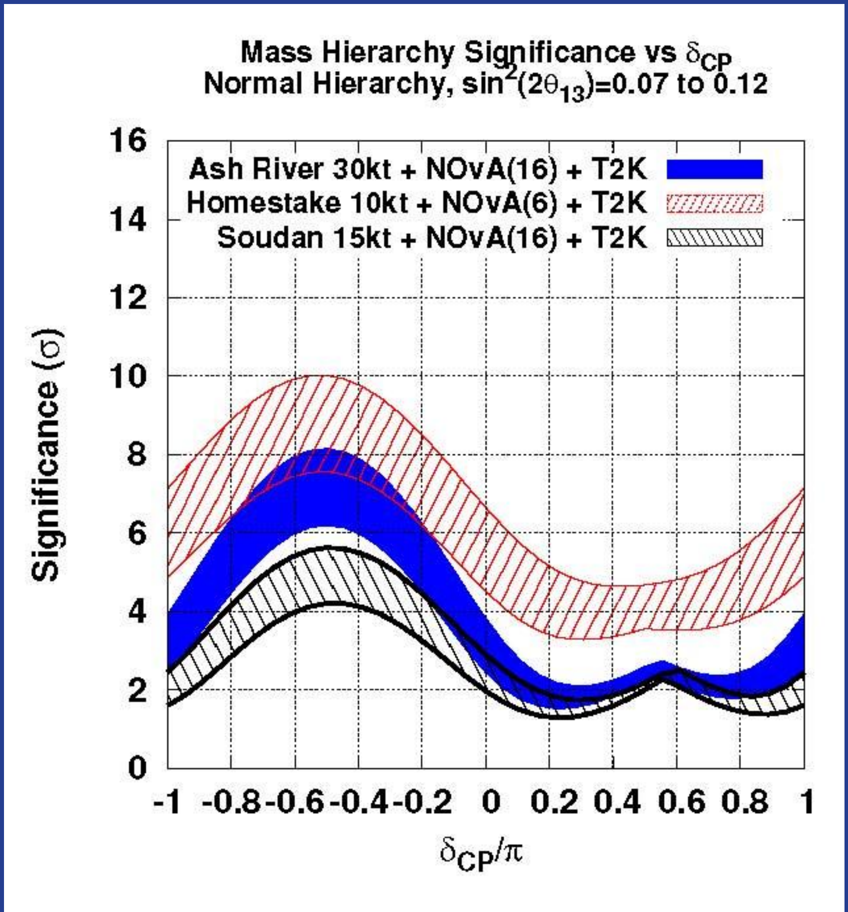
Three options with different strengths

	Ash River	Soudan	Homestake
Baseline	810 km	735 km	1300 km
Detector Mass	30 kt	15 kt	10 kt
Detector position	Surface	Underground 2300 ft	Surface
Beamline	Existing NuMI	Existing NuMI	New

Mass hierarchy reach

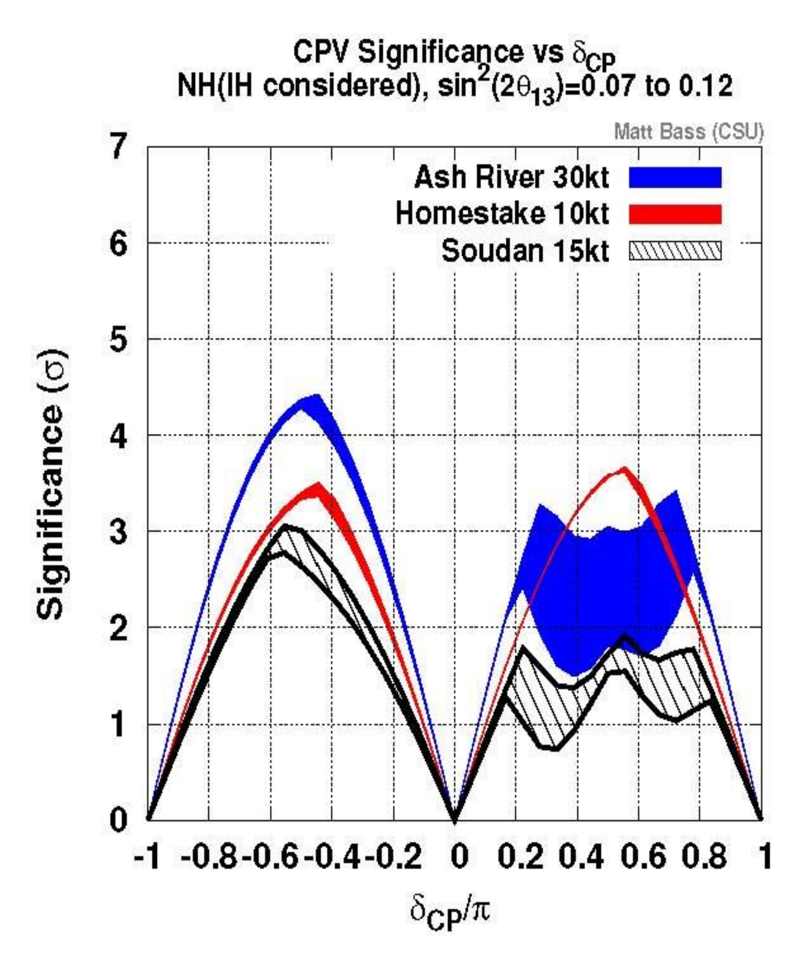


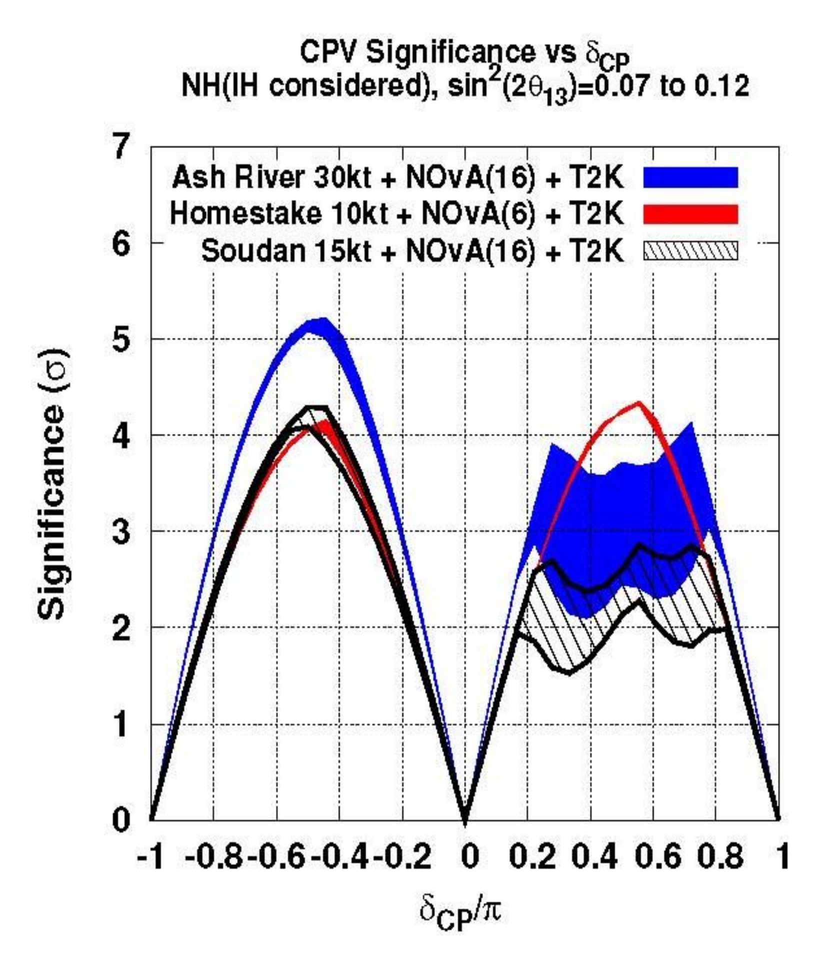


Mass hierarchy reach

- The oscillation effects due to δ_{CP} and the matter effect (mass hierarchy) can both go in the same direction in which case the mass hierarchy is easier to determine or in opposite directions in which case it is harder to determine
- Adding other baselines (e.g., T2K) to either Homestake or NuMI directions helps the weak part of the δ_{CP} range
- Distance makes a big difference. At a sufficiently long distance the effects of δ_{CP} and the matter effect do not overlap within the measurement precision
- A smaller detector towards Homestake does substantially better than larger detectors in the NuMI direction

Reach in CP violation





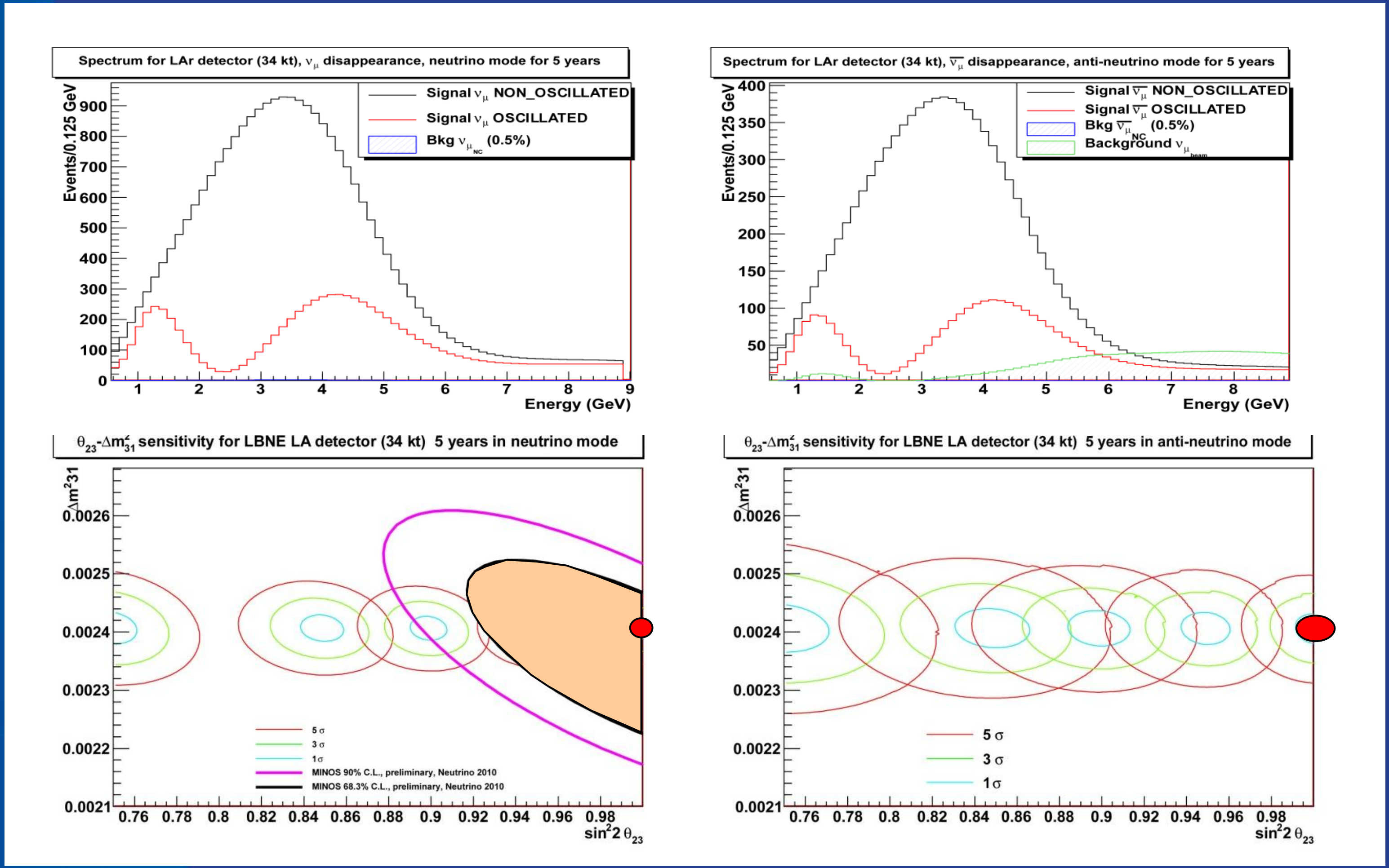
Reach in CP violation

- The larger tonnage at Ash River relative to Homestake and Soudan makes the Ash River option the best for CP violation in one half the delta space. If the mass hierarchy is resolved with the help of other experiments, then it is the Phase 1 option with the highest reach in δ_{CP}
- The Homestake option with the lowest mass of the three options does reasonably well for the full range of δ_{CP} for the Phase 1 experiment
- Soudan has a a more limited reach in δ_{CP} due to the shortest baseline and more limited tonnage than Ash River. It has the advantage of starting deep underground physics (proton decay, SN collapse) early.

Beyond measuring parameters…

- Beyond the measurement of the missing parameters of the 3x3 mixing matrix, LBNE in the Homestake direction gives us the best sensitivity to new physics
- The beam energy spectrum and baseline are optimal for the exploration of the full oscillation phenomena, so it is a first stage of a long program
- LBNE in the Homestake direction is the one option capable of ultimately exploiting the full power of Project X due to fundamental limitations of the NuMI beam (total power and tritium mitigation)
- Reconfiguration studies confirm the validity of the initial choice of Homestake by previous studies (P5, NRC, Intensity Frontier Workshop)

Example of long-term capabilities



LBNE compared to the state of present measurements. Stringent measurement of whether $\sin^2 2\theta_{23}$ is maximal possibly indicating new symmetry?

Summary: 30 kton at Ash River

Pros	• Best Phase 1 CP-violation sensitivity in combination with NOvA and T2K results for the current value of θ_{13}. The sensitivity would be enhanced if the mass ordering were known from other experiments. • Excellent (3σ) mass ordering reach in nearly half of the δ_{CP} range.

Cons	• Narrow-band beam does not allow measurement of oscillatory signature.
	• Shorter baseline risks fundamental ambiguities in interpreting results.
	• Sensitivity decreases if θ_{13} is smaller than the current experimental value.
	• Cosmic ray backgrounds: impact and mitigation need to be determined.
	• Only accelerator-based physics.
	• Limited Phase 2 path:
	  ○ Beam limited to 1.1 MW (Project X Stage 1).
	  ○ Phase 2 could be a 15-20 kton underground (2,340 ft) detector at Soudan.

Summary: 15 kton at Soudan (2300ft)

Pros	• Broadest Phase 1 physics program: ○ Accelerator-based physics including good (2σ) mass ordering and good CP-violation reach in half of the δ_{CP} range. CP-violation reach would be enhanced if the mass ordering were known from other experiments. ○ Non-accelerator physics including proton decay, atmospheric neutrinos, and supernovae neutrinos. • Cosmic ray background risks mitigated by underground location.
Cons	• Mismatch between beam spectrum and shorter baseline does not allow full measurement of oscillatory signature. • Shorter baseline risks fundamental ambiguities in interpreting results. This risk is greater than for the Ash River option. • Sensitivity decreases if θ_{13} is smaller than the current experimental value. • Limited Phase 2 path: ○ Beam limited to 1.1 MW (Project X Stage 1). ○ Phase 2 could be a 30 kton surface detector at Ash River or an additional 25-30 kton underground (2,340 ft) detector at Soudan.

Summary: 10 kton at Homestake

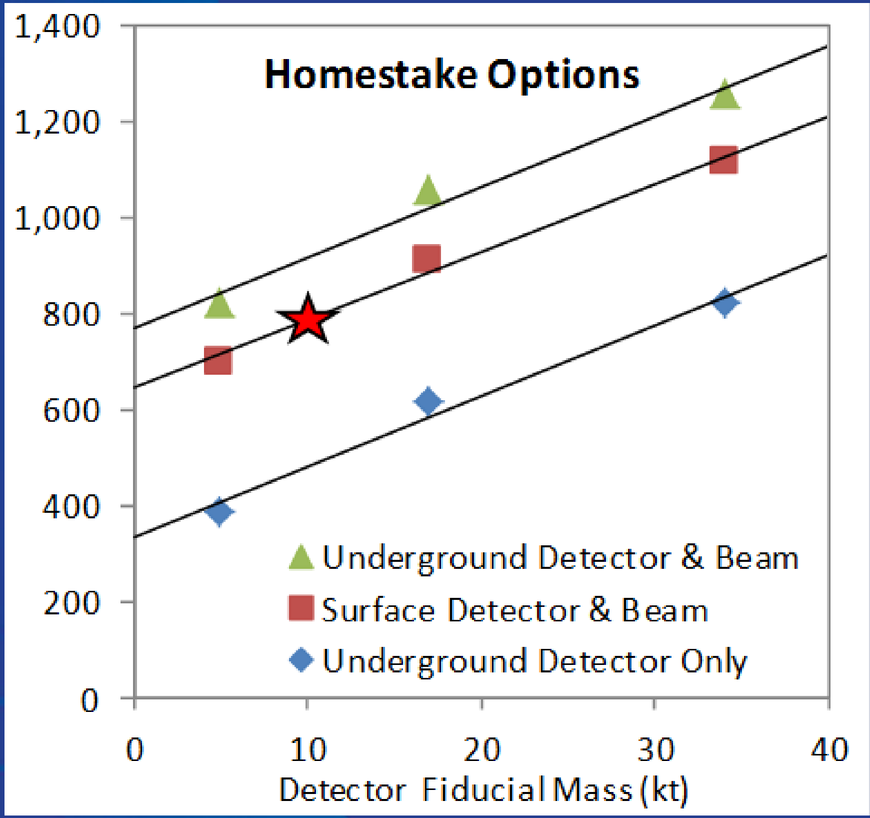
- Excellent (3σ) mass ordering reach in the full δ_{CP} range.
- Good CP violation reach: not dependent on *a priori* knowledge of the mass ordering.
- Longer baseline and broad-band beam allow explicit reconstruction of oscillations in the energy spectrum: self-consistent standard neutrino measurements; best sensitivity to Standard Model tests and non-standard neutrino physics.
- Clear Phase 2 path: a 20 – 25 kton underground (4850 ft) detector at the Homestake mine. This covers the full capability of the original LBNE physics program.
- Takes full advantage of Project X beam power increases.

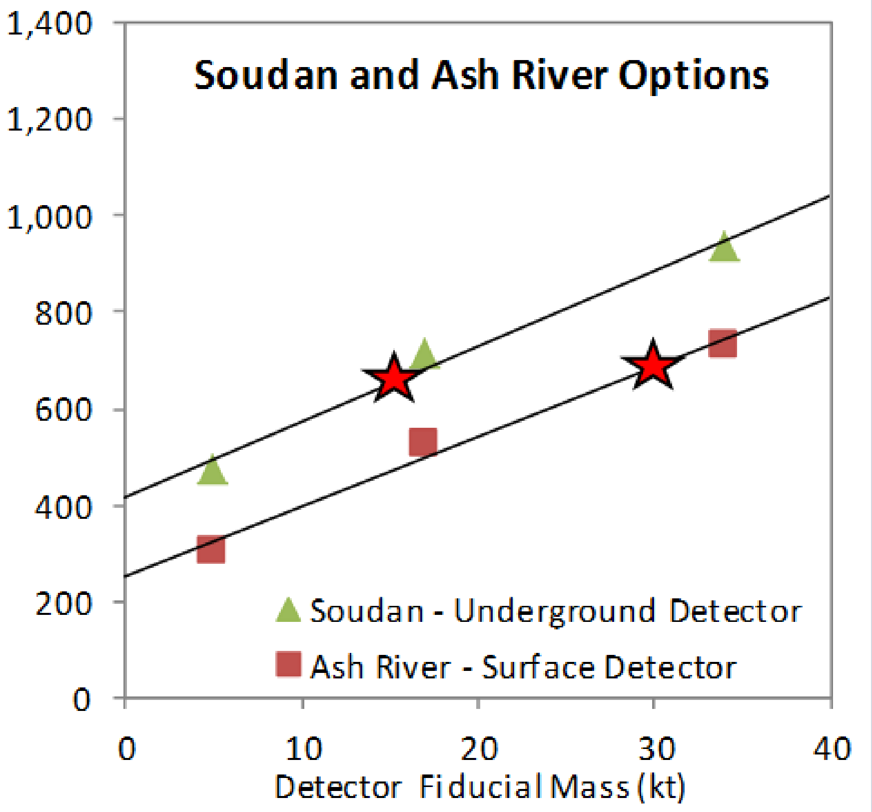
- Cosmic ray backgrounds: impact and mitigation need to be determined.
- Only accelerator-based physics. Proton decay, supernova neutrino and atmospheric neutrino research are delayed to Phase 2.
- ~10% more expensive than the other two options: cost evaluations and value engineering exercises in progress.

Engineering/cost studies

- Scrubbed previous costs, did value engineering and reduced scope wherever possible consistent with the particular option. In the case of the Homestake direction, near detector would be built later or by collaborators
- Cost for previously estimated items maintained – overall cost reduced by eliminating requirements and/or items
- Significant cost savings achieved both for the beamline and for the conventional facilities at the detector site
- Comparative work at Homestake and Soudan was very helpful. There is experience with excavation and operations both at Homestake and at Soudan

Cost curves for different choices





Phased approach and alternatives

- Ideally we would like a detector that exploits both the long baseline of Homestake and operates underground. It requires a new beamline and development of the underground; it does not fit the cost guidelines (at Homestake +$135M to go underground for 10 kton detector)
- The option of Homestake on the surface offers strengths in the neutrino arena and has the best long-term prospects for a phased approach. Because the Phase 1 detector is small, international partners may be interested in adding additional mass.
- The Soudan option offers underground physics from the start; the mass is reduced relative to Ash River in order to fund the development of the underground

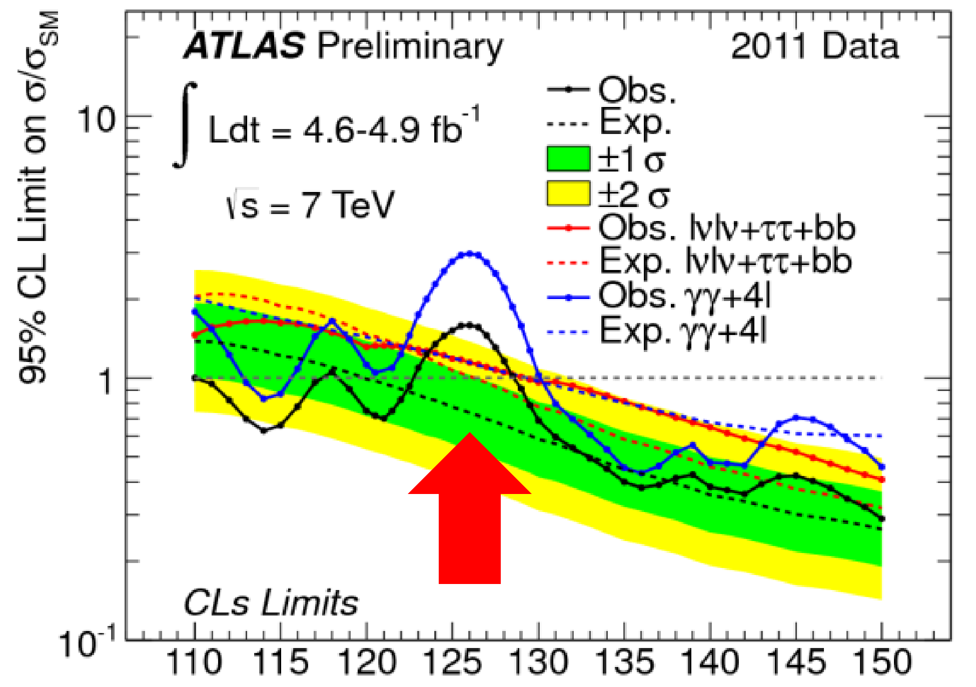
Phased approach and alternatives

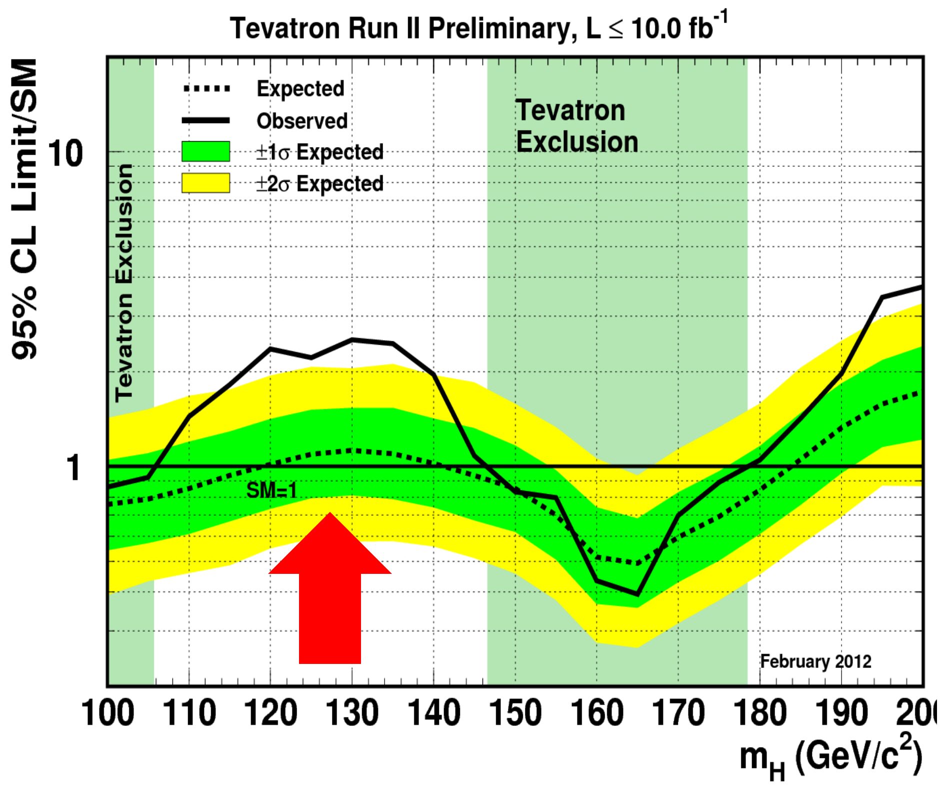
- Ash River would bring the largest detector early with the highest CP reach of any of the options in Phase 1, but in the long term it has neither the ideal baseline nor is it underground. Because we would be building only a detector, cost control can be achieved by scaling the mass back gracefully
- Of these viable options, the Steering Committee and the laboratory favor building 10 ktons on the surface at Homestake, provided the somewhat higher costs of this option could be handled (10%). The long-range physics potential may bring more partners than other options
- We are ready to discuss these issues and options in more detail with the Office of Science, select a path and integrate it into the ongoing project critical decisions

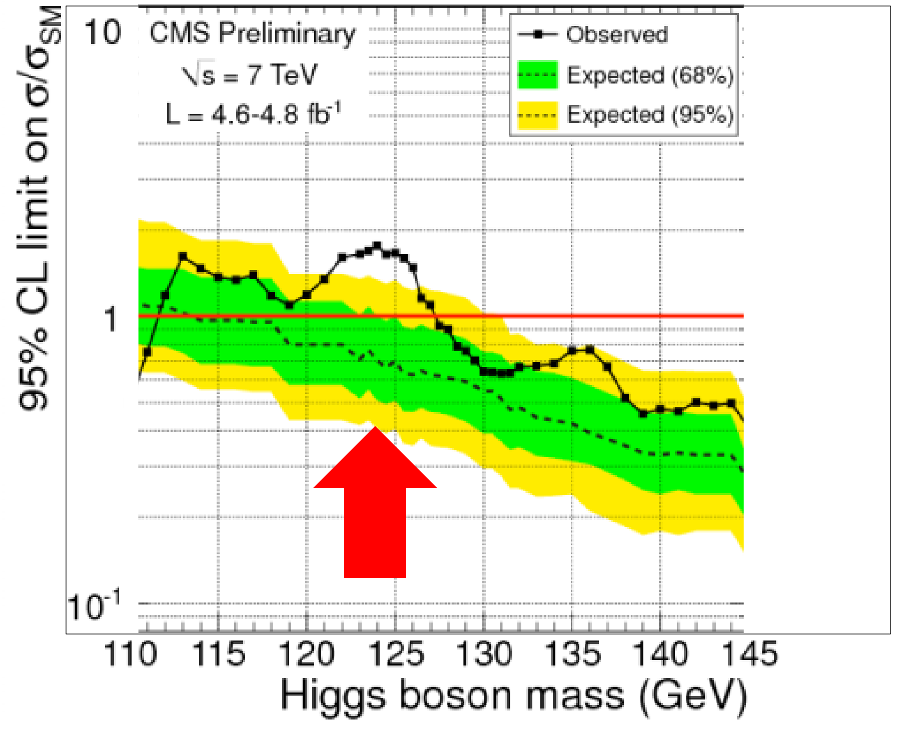
Further phases of LBNE

- Further phases of LBNE can add mass to the detector, or go underground to extend the breadth of the program, depending on: a) the particular Phase 1 chosen, b) financial resources and physics results at the time when the choice needs to be made
- Importantly, we have broken up Project X in several phases as well so that phases in Project X can be intercalated with further phases of LBNE
- In particular, the first phase of Project X at approximately 1/3 the total cost would boost particles at 1 GeV by a factor of 100, and neutrino beams at high energies by 60-70%

Recent results: LHC places many limits implying mass scale for new physics is high; LHC and Tevatron see hints for the Higgs (is it there?)

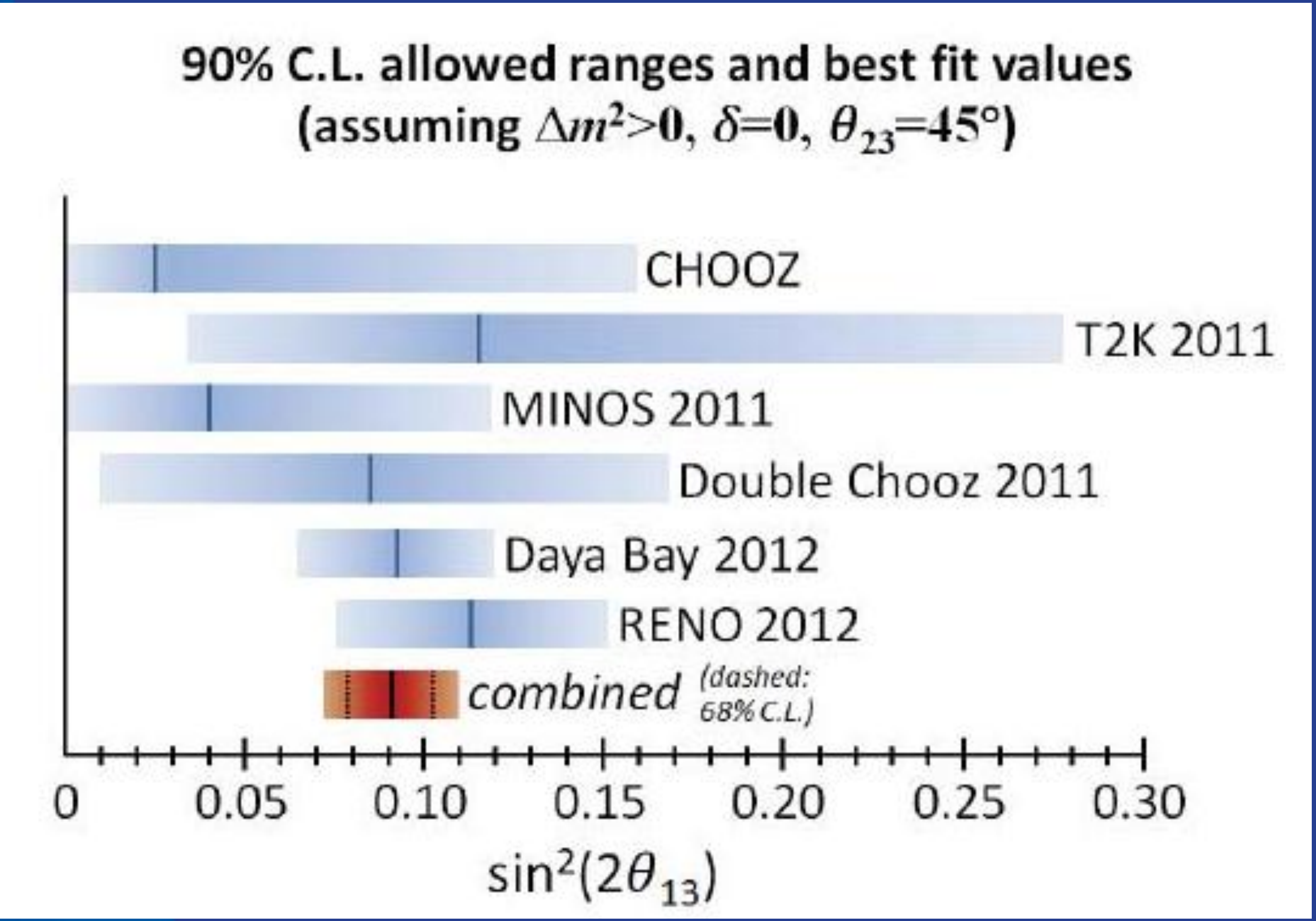






Recently: $\sin^2 2\theta_{13}$ measured (March 2012)

Ryan Patterson (Pre Kyoto mtg.)



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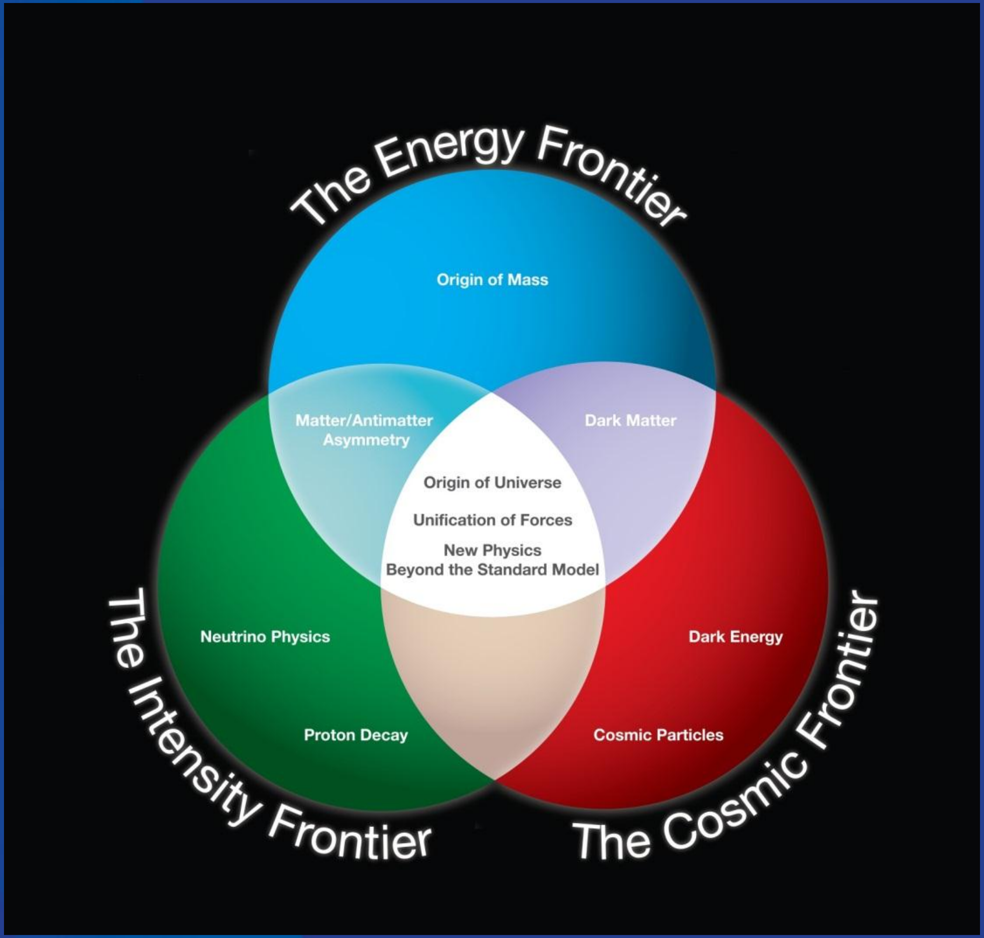
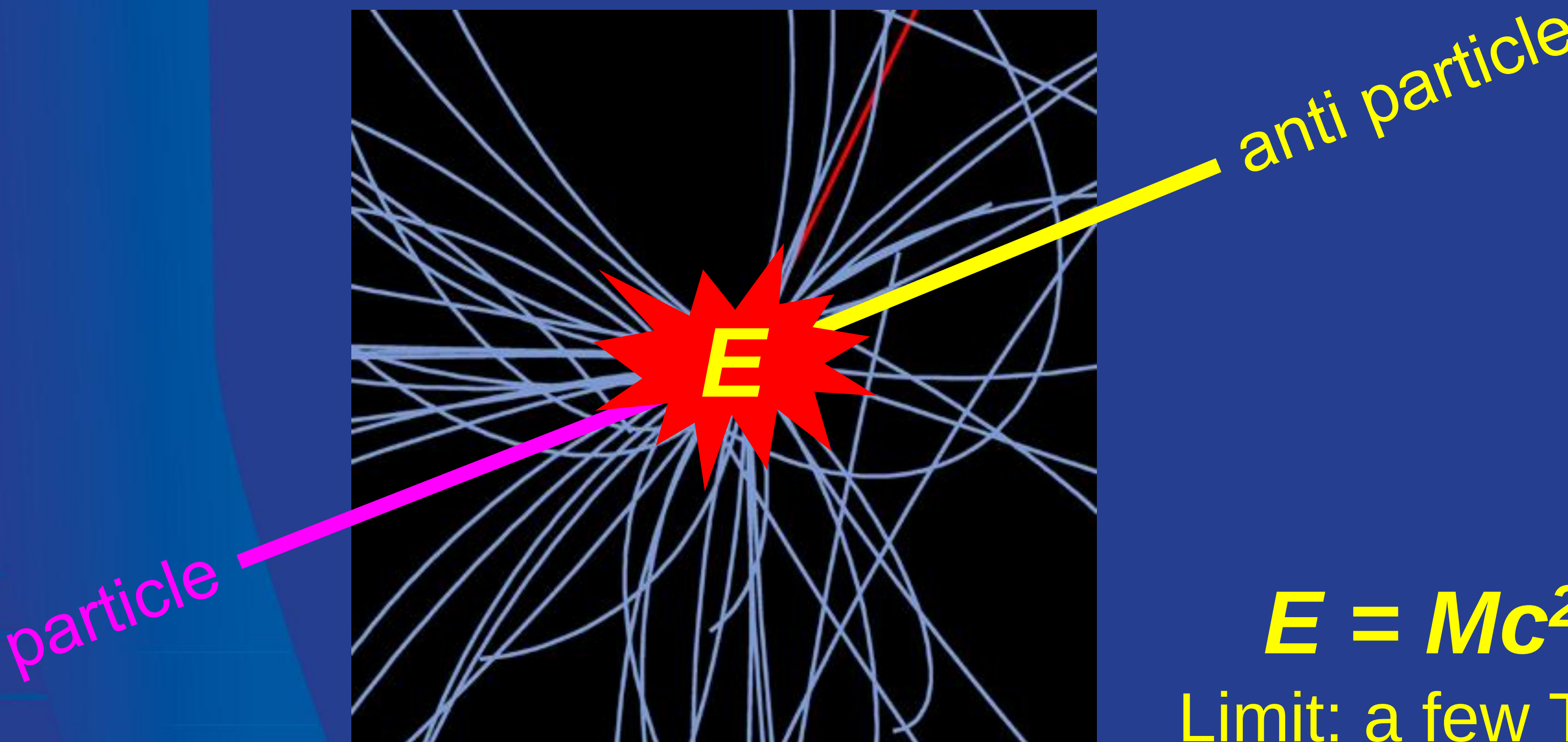
Recent results and US strategy



Recent results on θ_{13} and the LHC further validate the strategy we are pursuing:

- The gate for great neutrino physics is now wide open
- The absence of low-energy structures at LHC (other than possibly the Higgs) → must use indirect intensity frontier methods
- If there are new structures they are likely to be at higher energies → a boost to muon collider R&D

Energy Frontier



$$E = Mc^2$$

Limit: a few TeV

Intensity Frontier

Discover the nature of massive known & NEW particles indirectly by intense beams of charged leptons and quarks

Quantum Fluctuation

High-intensity

particle beam

Top

W, Z

….

NEW

Rate for rare transition

Uncertainty Principle

$$E = Mc^2$$

Limit ~10^4 TeV

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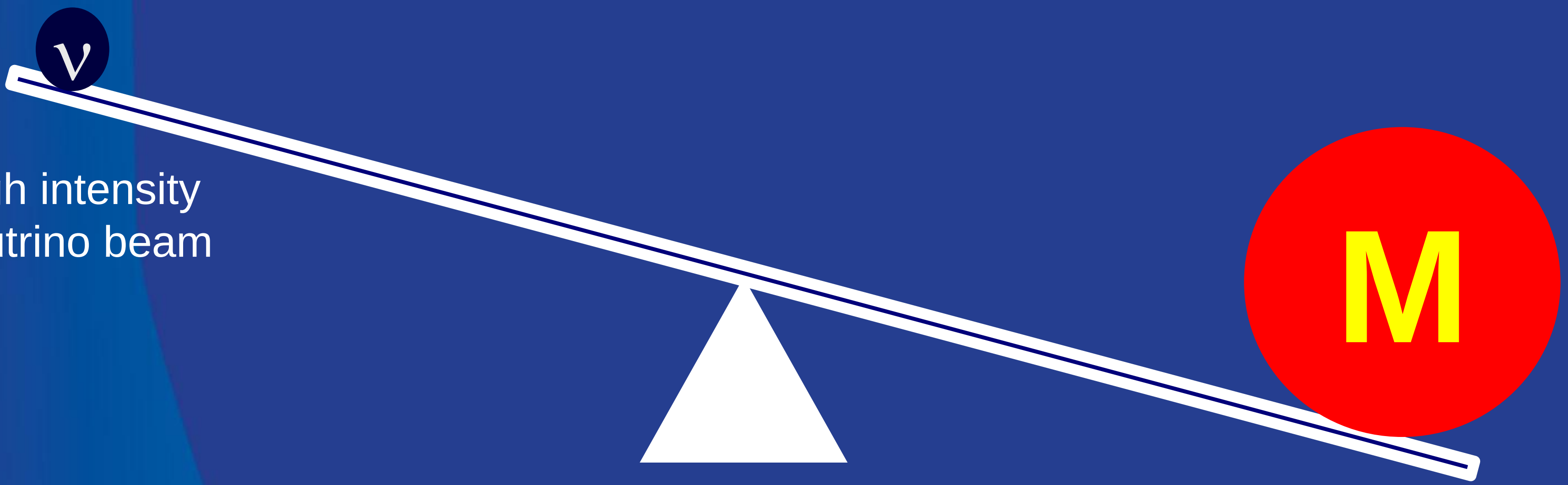
Intensity Frontier

Probe even more massive NEW particles and dark sector particles by intense neutrino beams



high intensity neutrino beam

Seesaw

$m_\nu \times m_N \sim (m_{quark})^2$

$E = Mc^2$

Probing~10^{12} TeV

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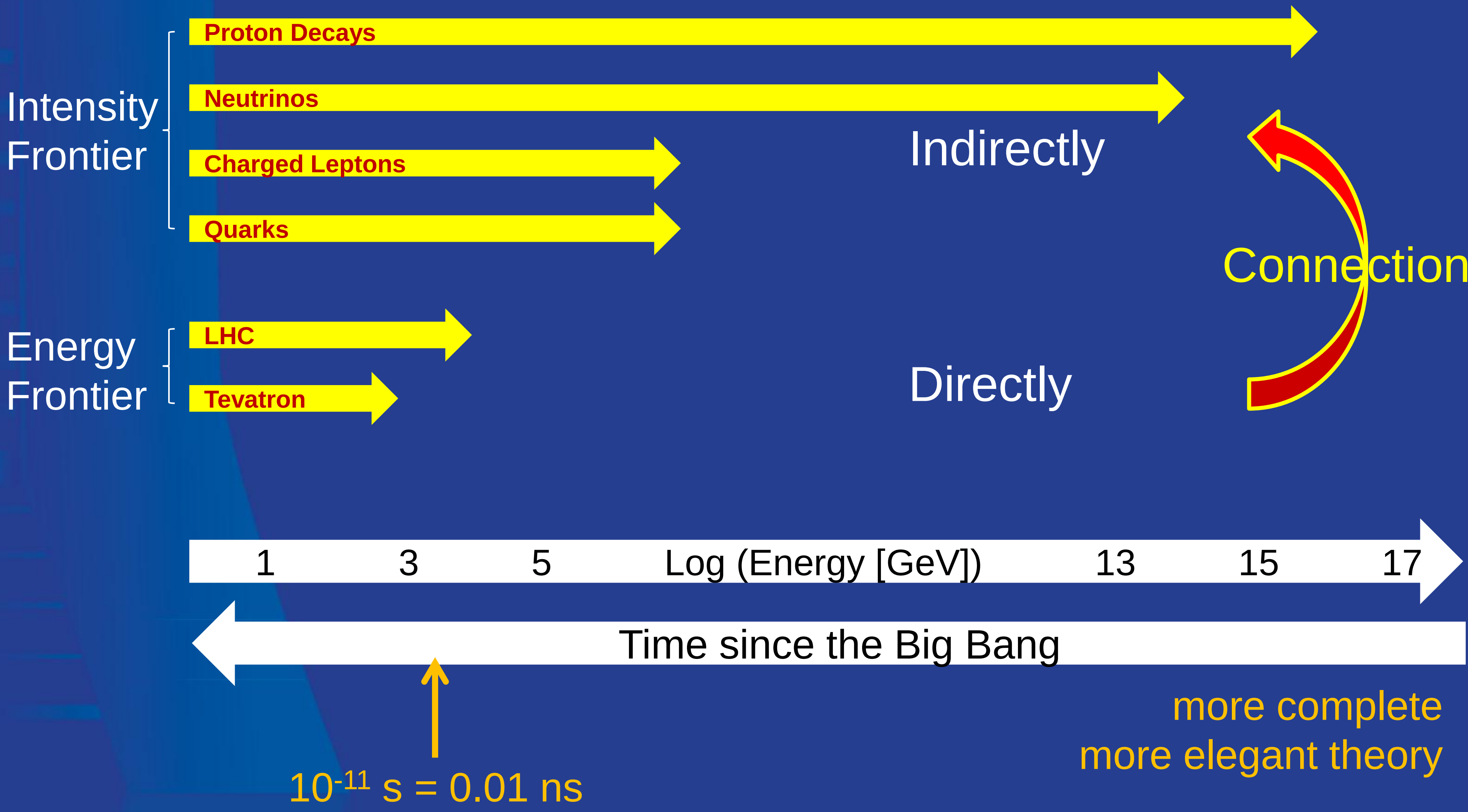
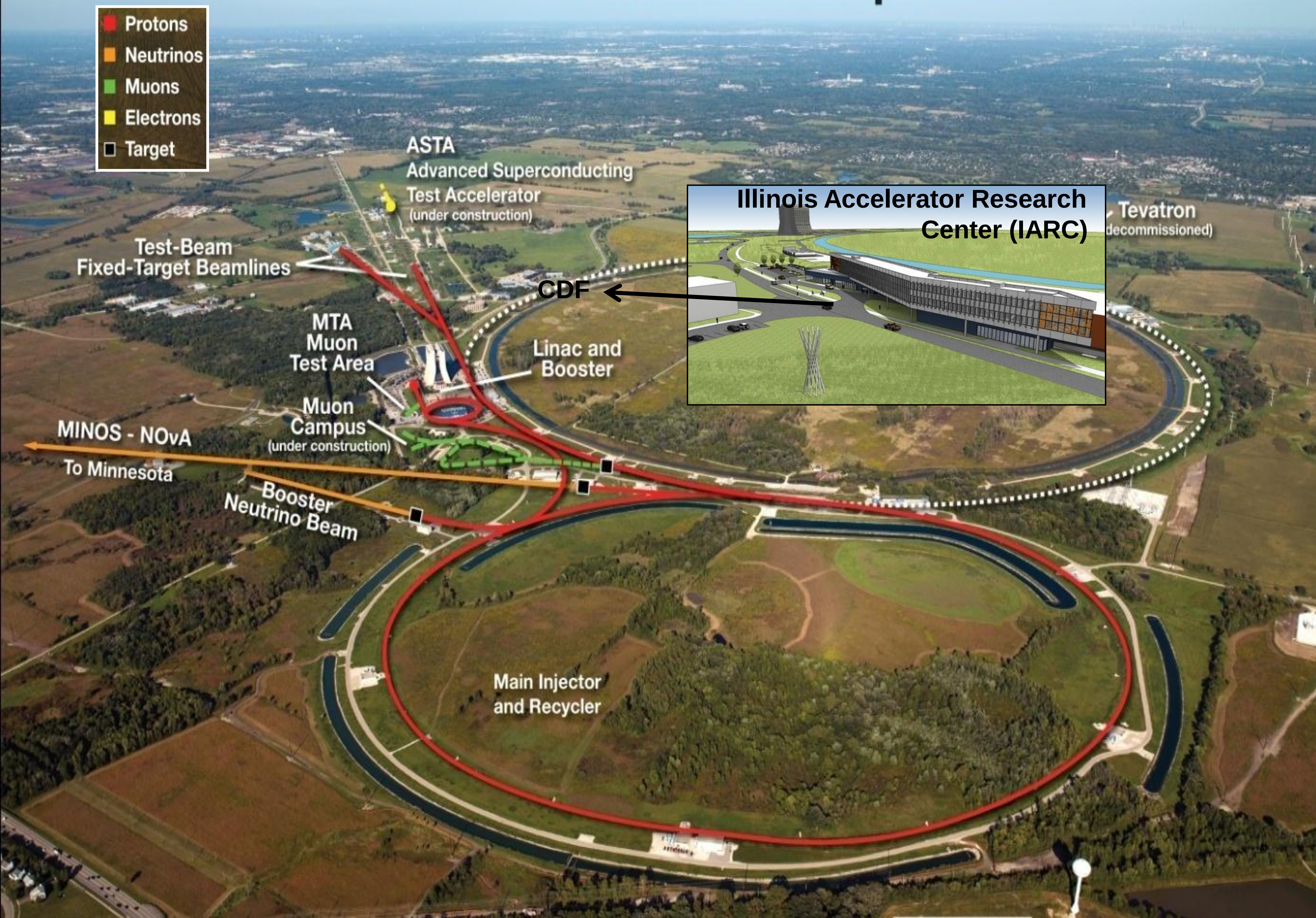
The strategy and experimental reach



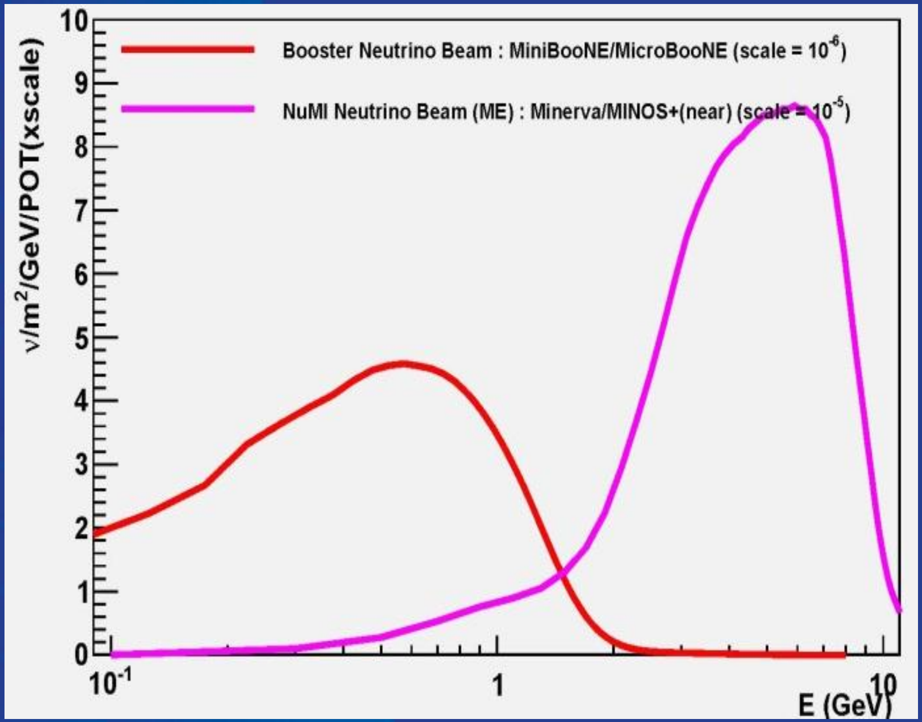
The program through 2020

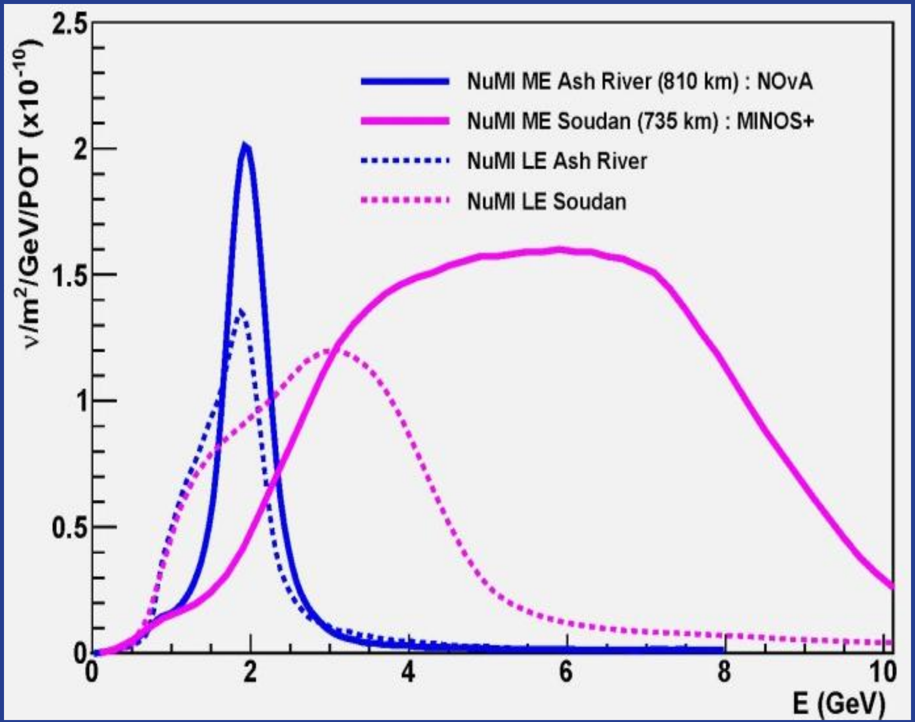
Fermilab Accelerator Complex 2012



Neutrino beams

Diverse and intense beams: Unmatched in the world





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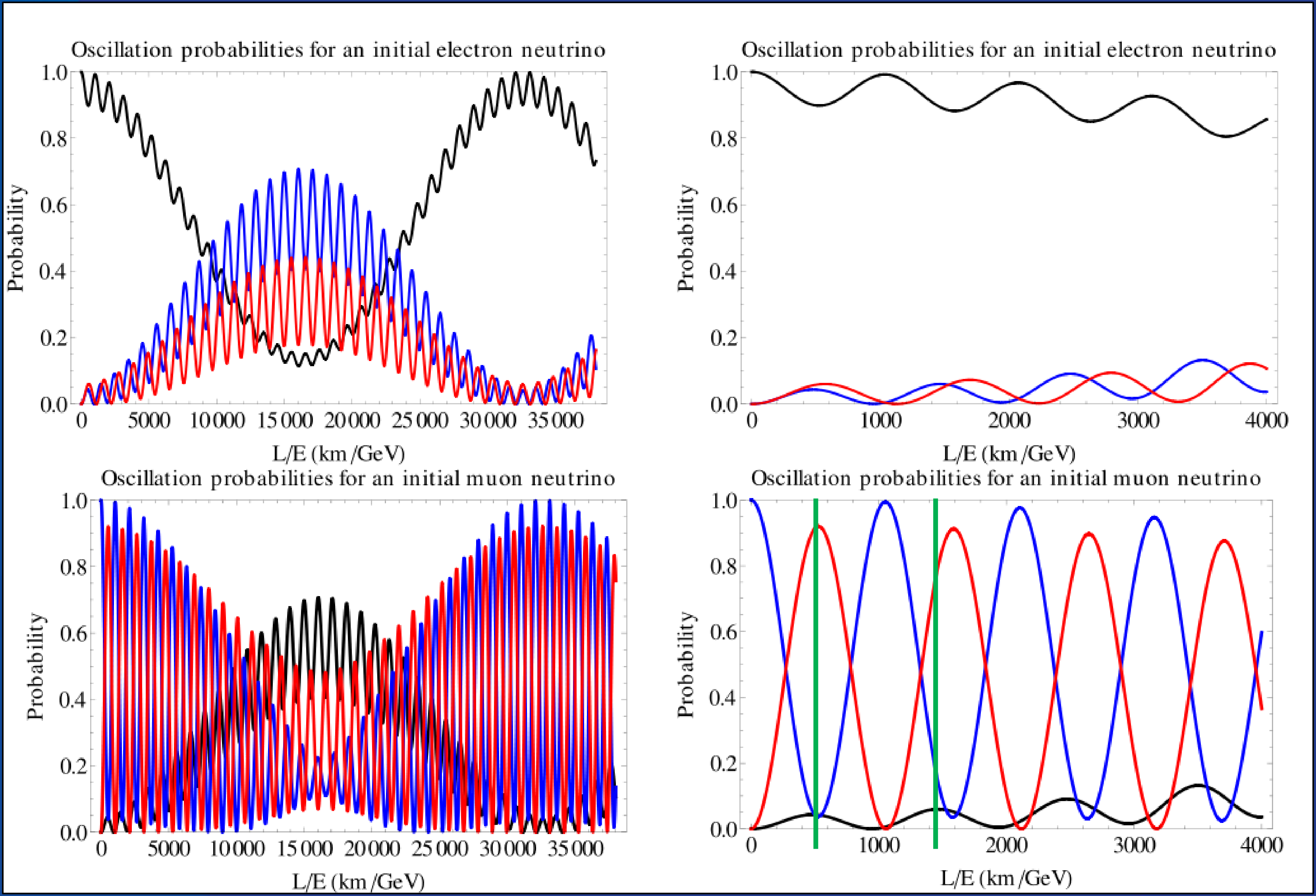
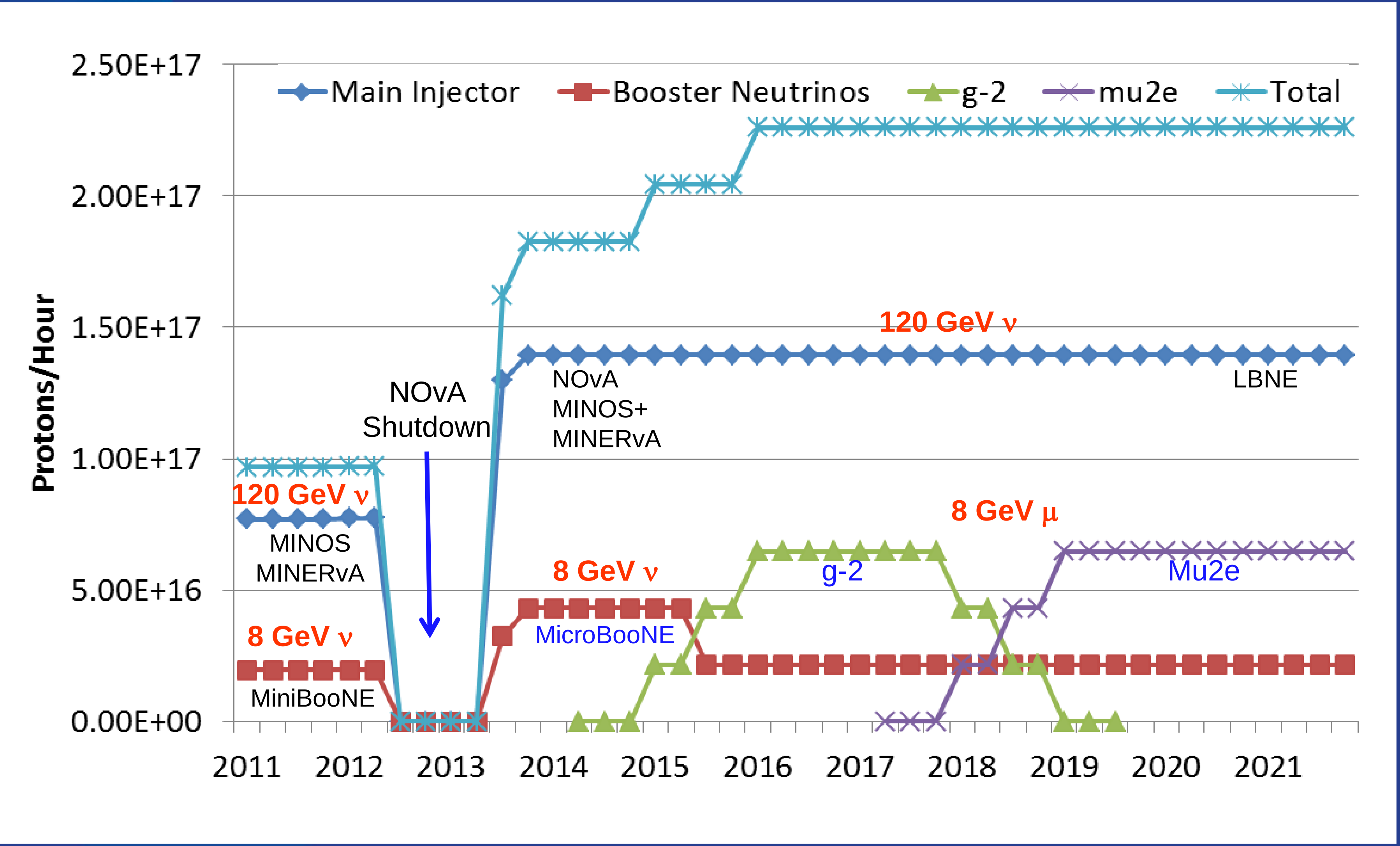
Neutrino oscillations



NOvA accelerator upgrade and Proton Improvement Plan



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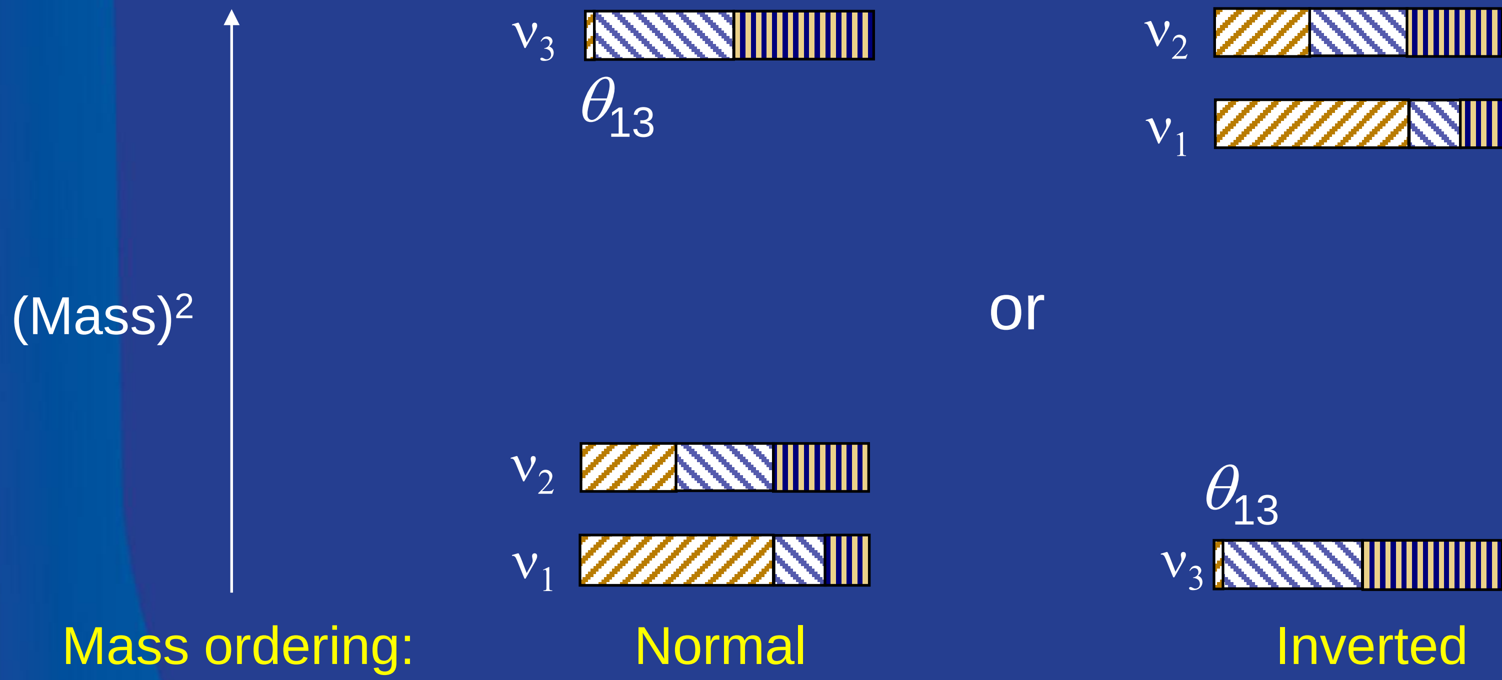
Neutrinos: known unknowns

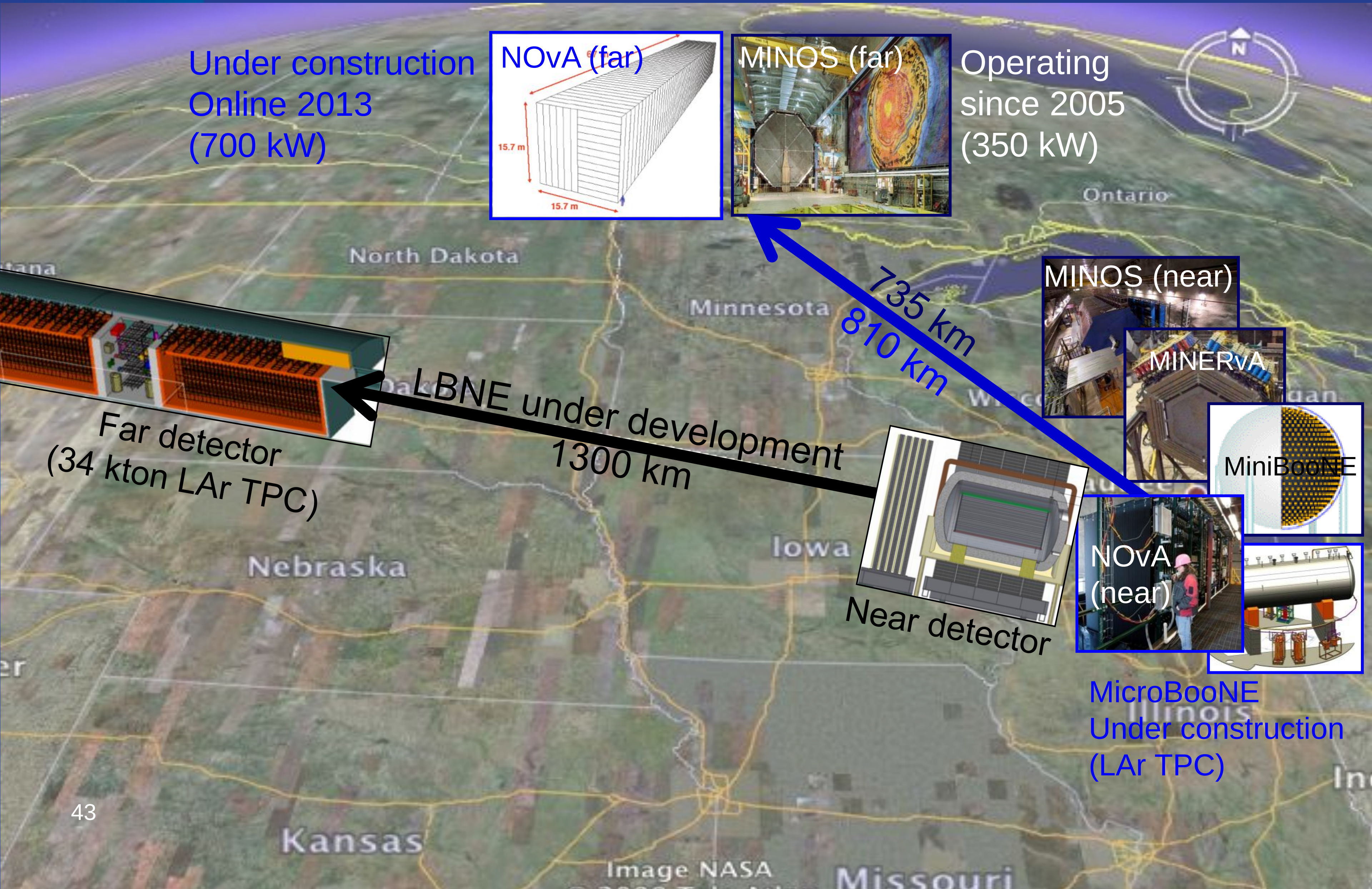


$\nu = \bar{\nu}$?

Matter – Antimatter Asymmetry

unknown unknowns

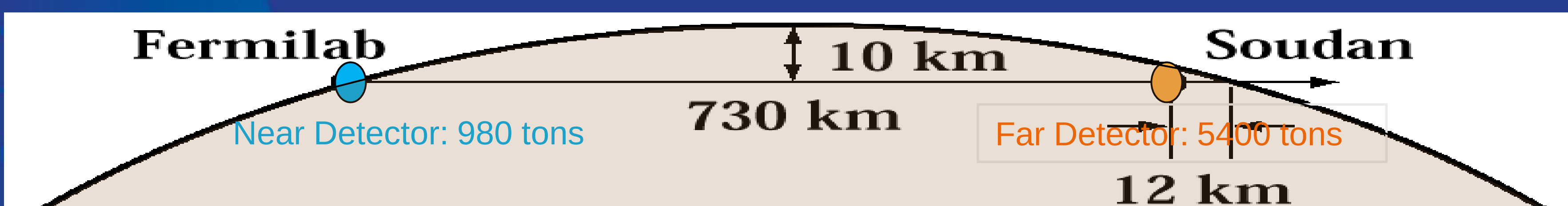
Neutrino program



Why multiple neutrino experiments?

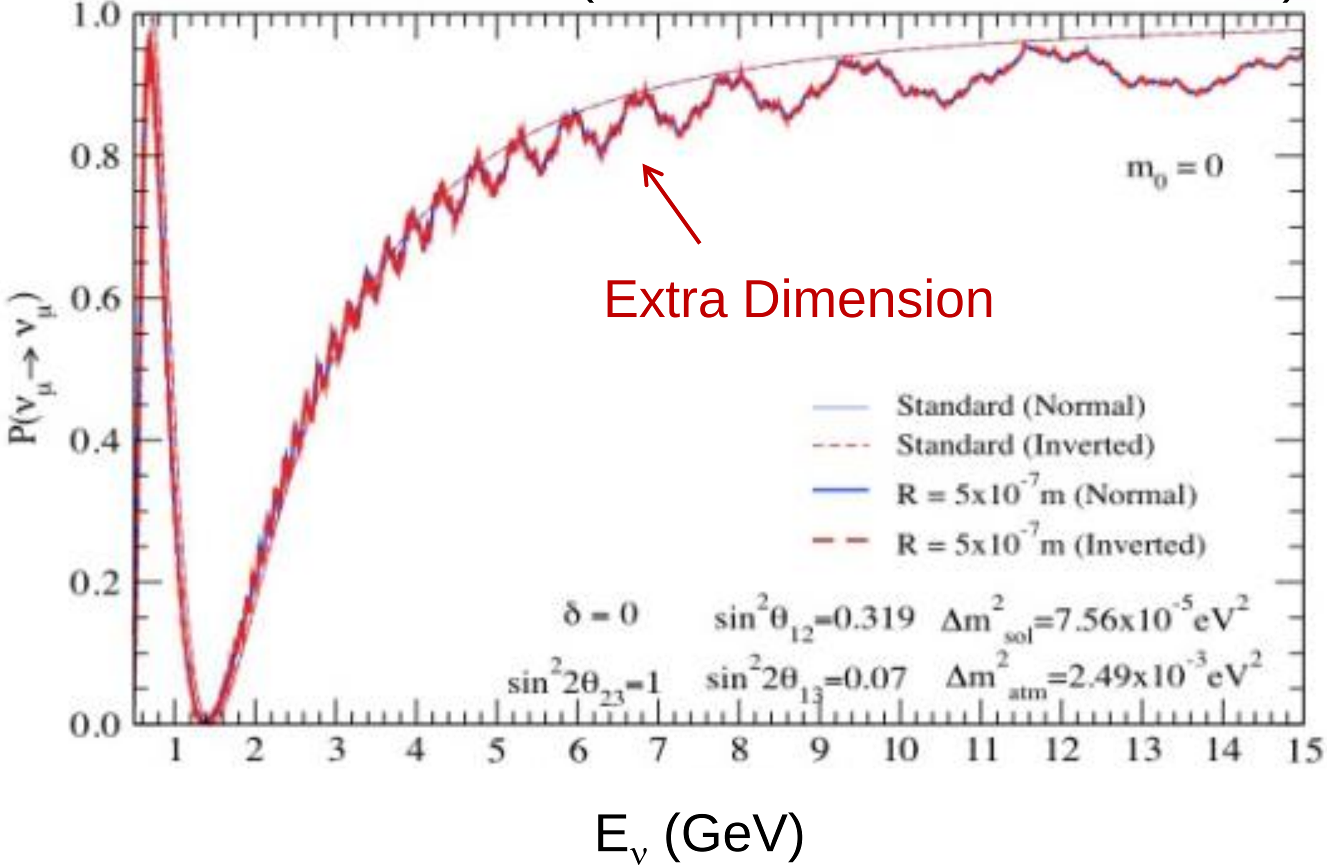
- Different aspects of neutrino physics drive different experiments; each limited by having to operate at one distance and one energy. Beams not used up!!
  - Long baseline:
    - MINOS (disapearance; broad energy spectrum, on-axis; high rate)
    - NOVA (electron appearance, off-axis, narrow energy spectrum; low rate)
    - LBNE (appearance and disappearance; on-axis high rate, best positioned to add second oscillation maximum)
  - Short baseline
    - MINERvA: cross sections different nuclei
    - MiniBOONE and MicroBOONE: anomalies

How do we study neutrinos? Beams

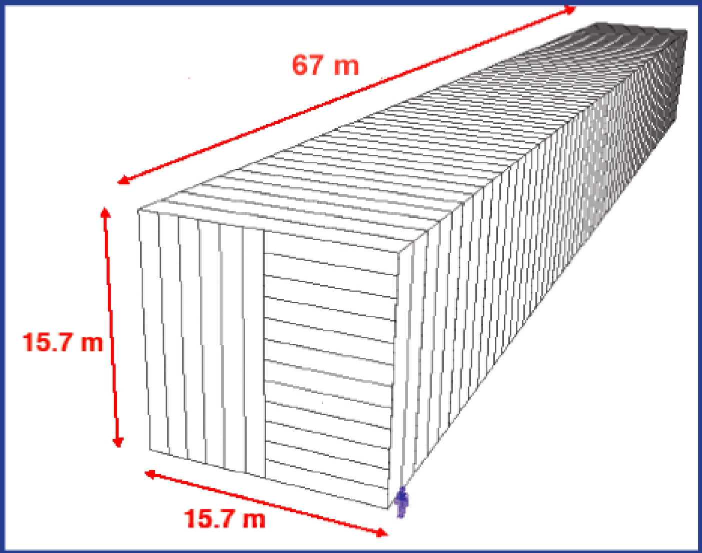


Exploring unknown unknowns in neutrino oscillation

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



NOvA pictures



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NOvA prototype pivoter

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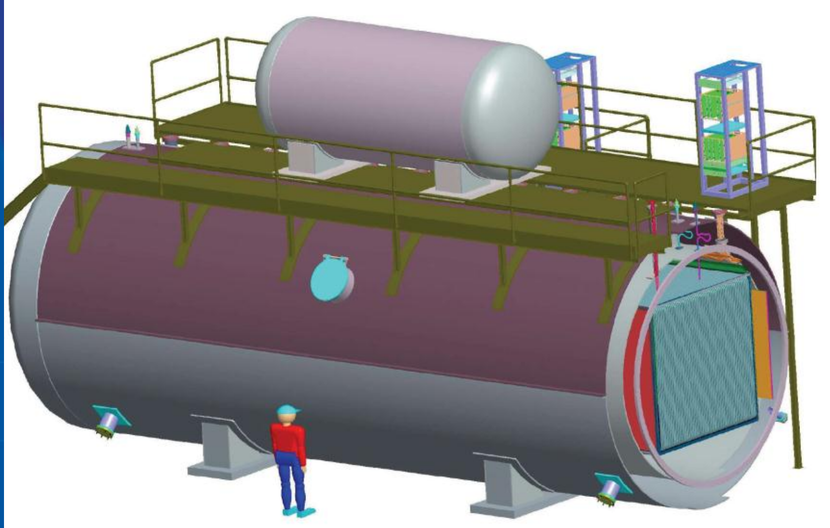
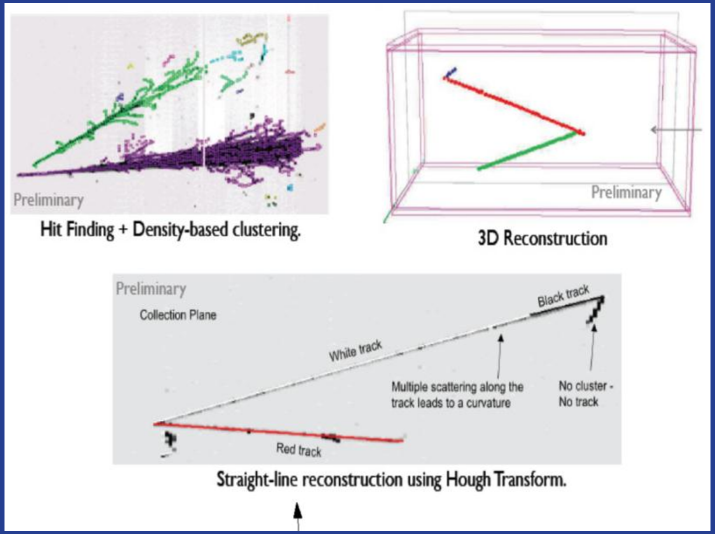
MicroBooNE

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

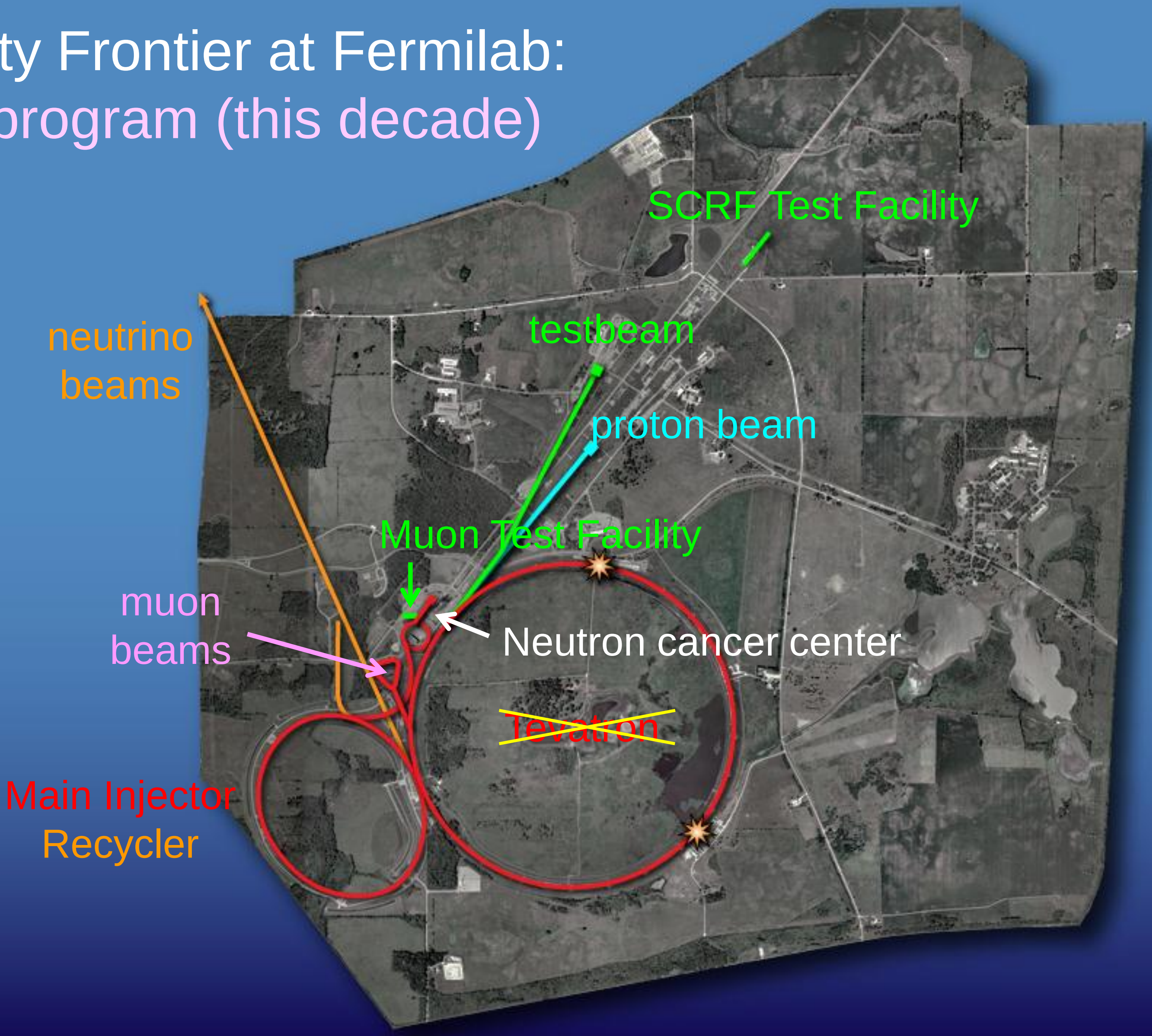




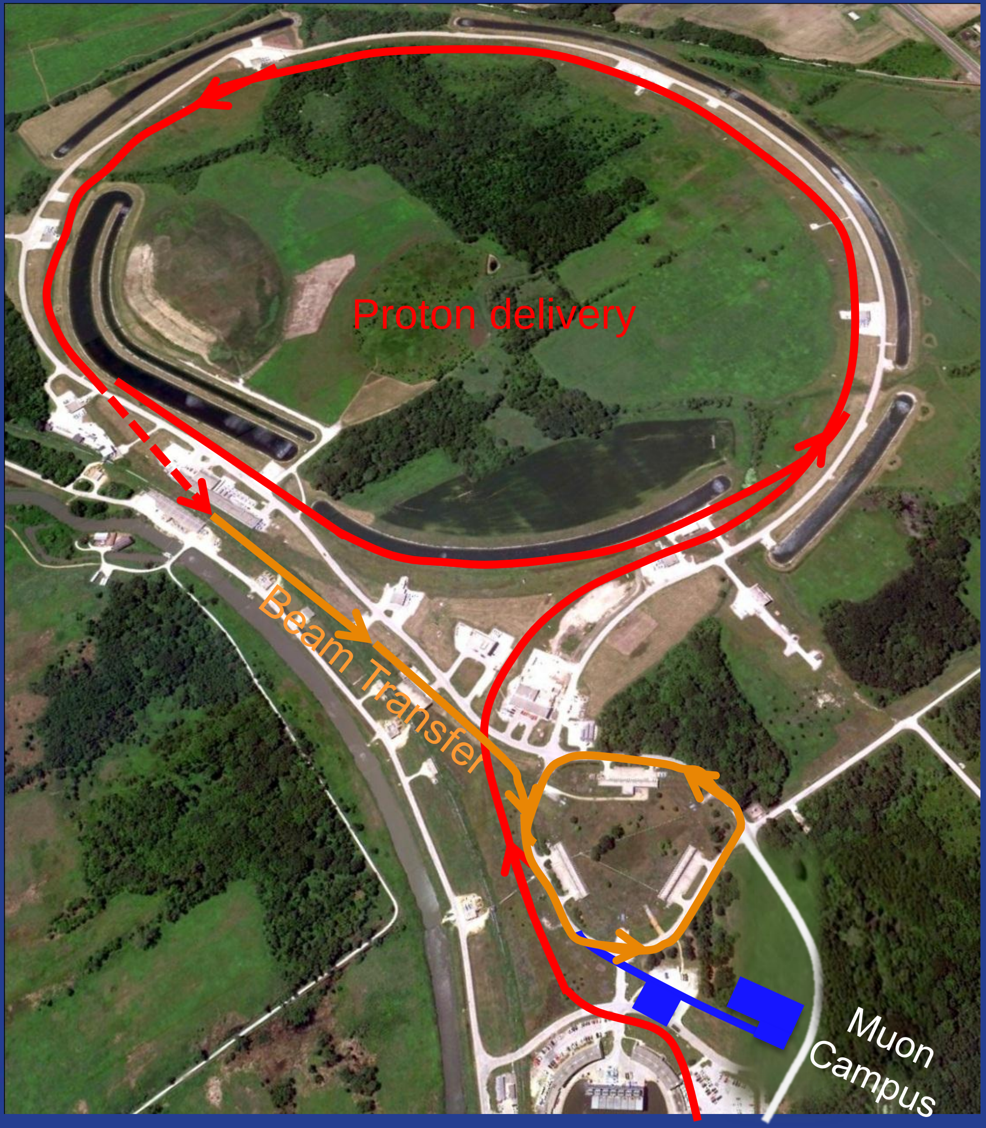
Neutrino experiments and their physics goals in the next ten years

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 program (this decade)



Intensity Frontier at Fermilab: Muon Campus



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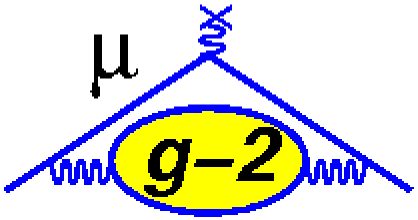
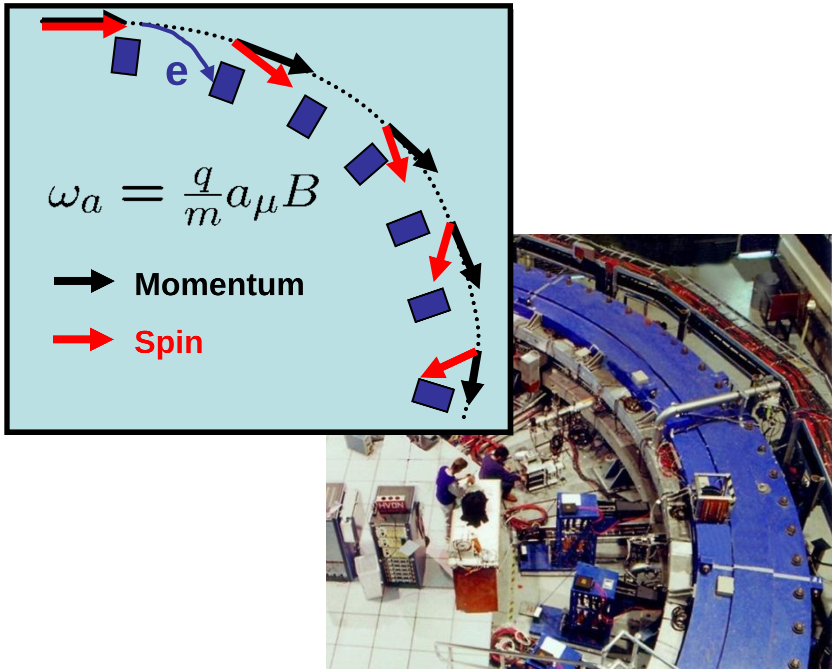
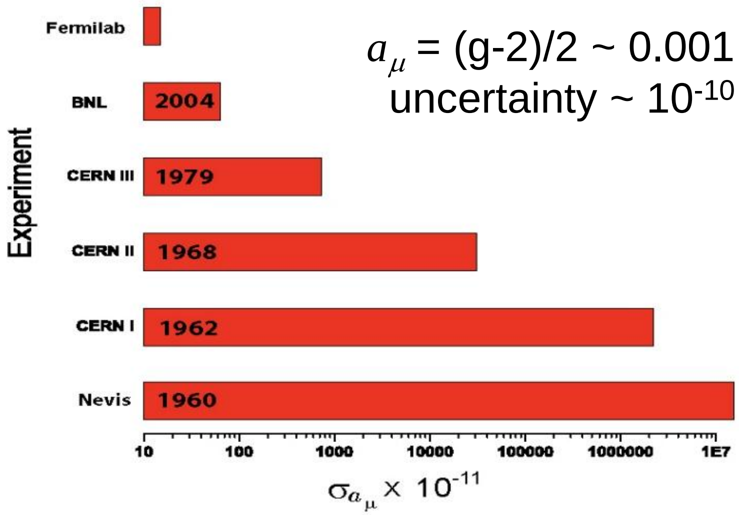
Intensity Frontier at Fermilab: Muon g-2

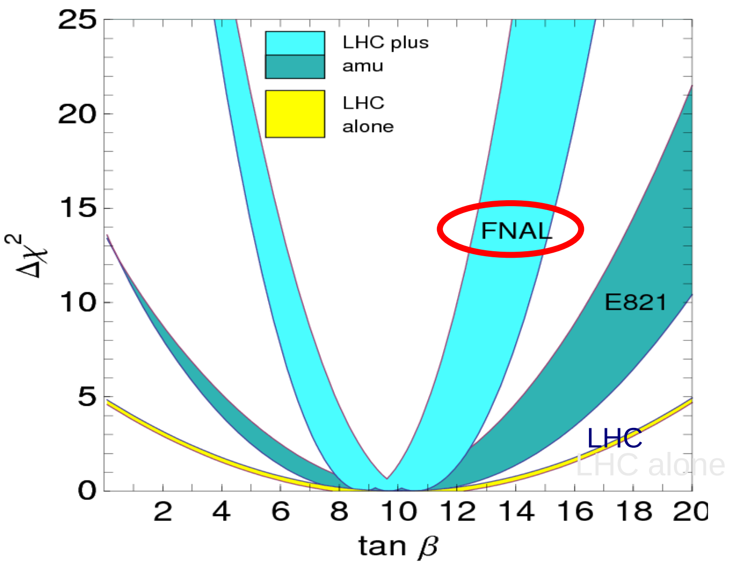
Anomalous magnetic moment





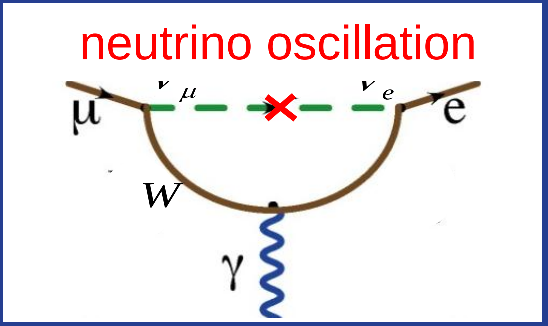
a_μ = (g-2)/2 ~ 0.001
uncertainty ~ 10^{-10}





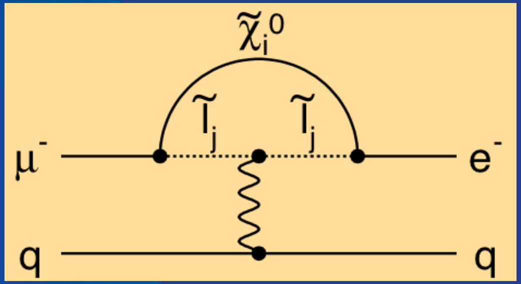
Intensity Frontier at Fermilab: $\mu \rightarrow$ e conversion

- Negligible rate in the SM: $< 10^{-54}$

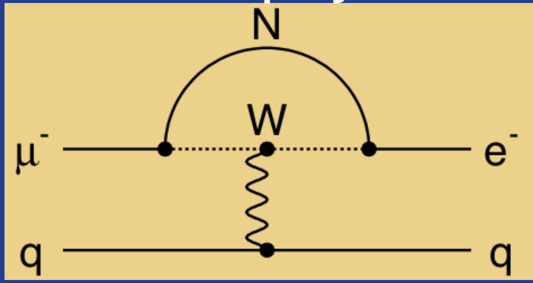


- Measurable rate with new physics contributions: $\sim 10^{-15}$

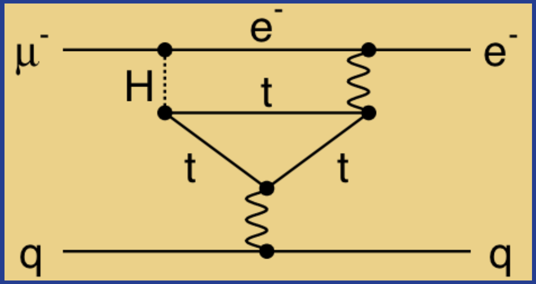
Loops



Supersymmetry

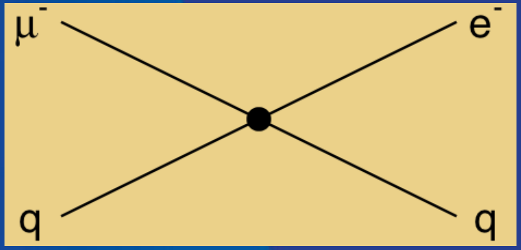


Heavy Neutrinos

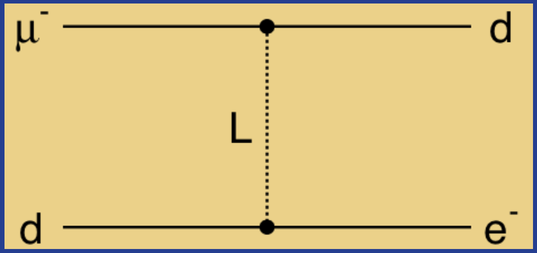


Two Higgs Doublets

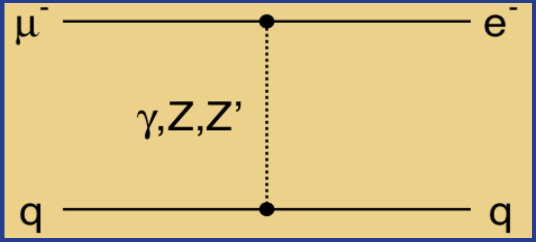
Contact Terms



Compositeness

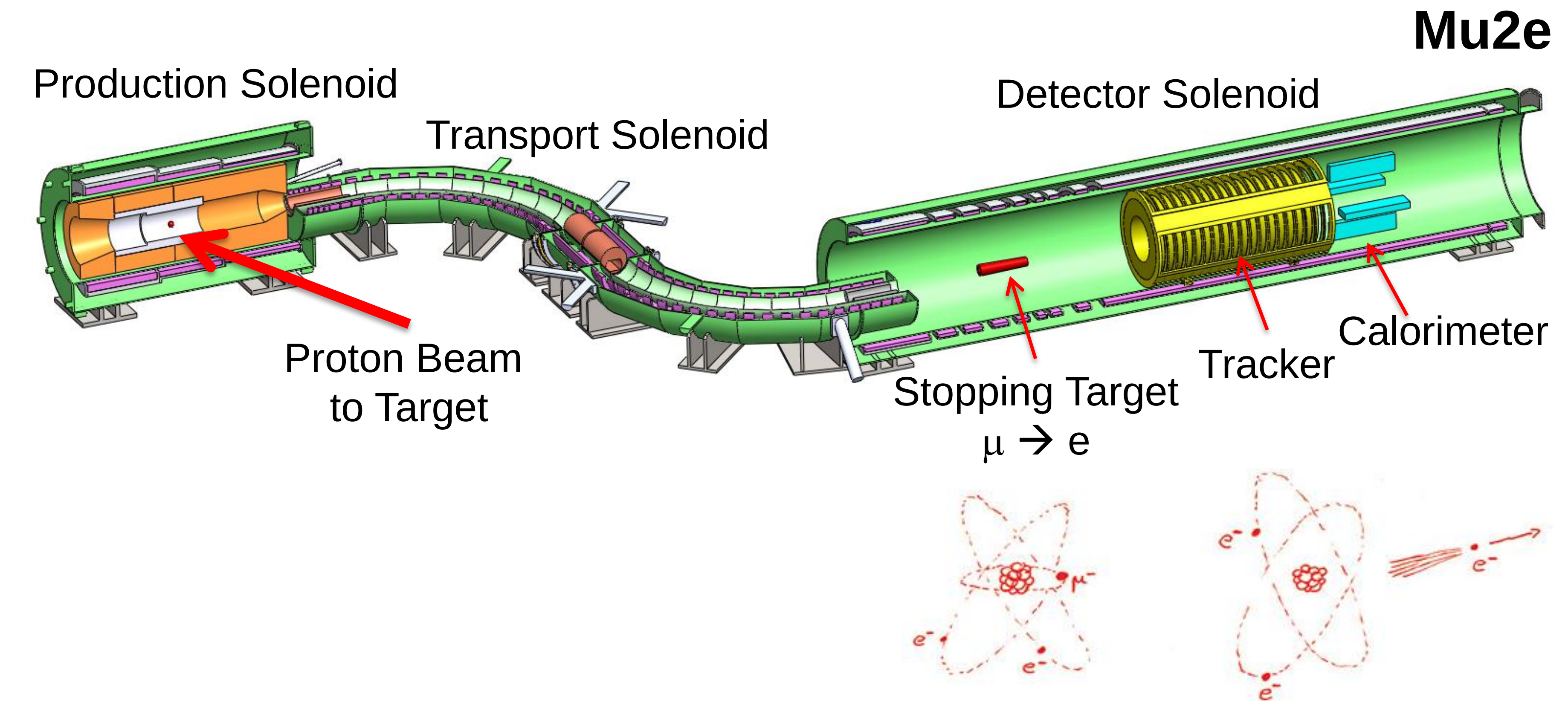


Leptoquarks



New Heavy Bosons / Anomalous Couplings

Intensity Frontier at Fermilab: $\mu \rightarrow$ e conversion



Conversion of a muon into an electron in the field of a nucleus:

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

Mu2e has discovery sensitivity to many new physics models

Seaquest

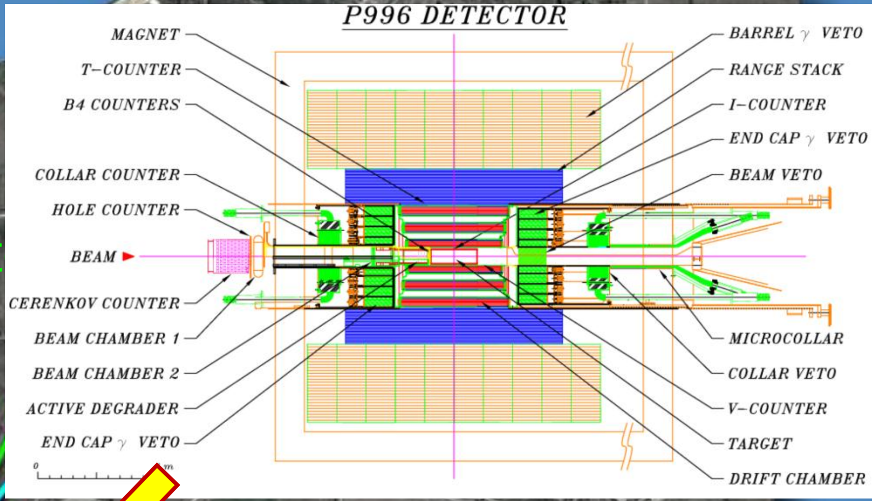
- Drell-Yan experiment and possible polarized extensions

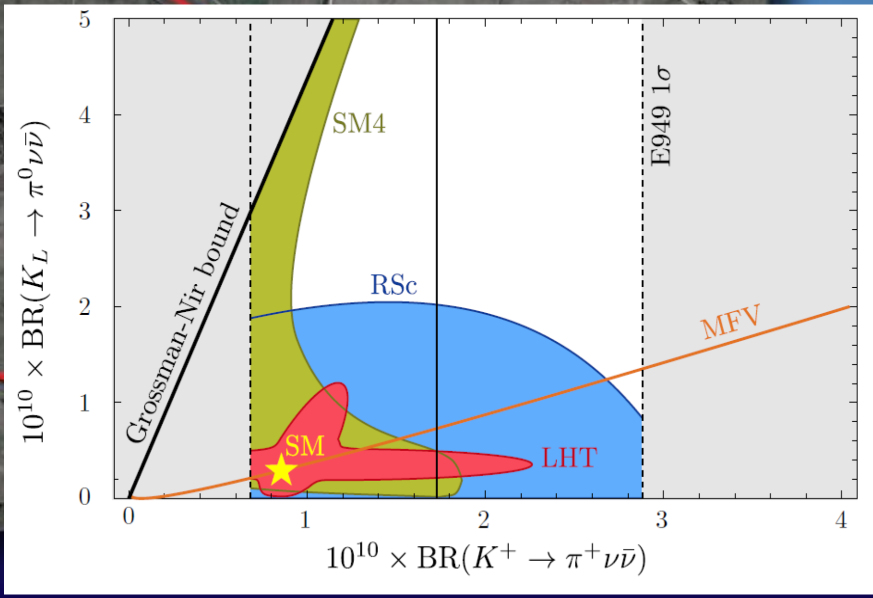
Fermilab

Intensity Frontier at Fermilab

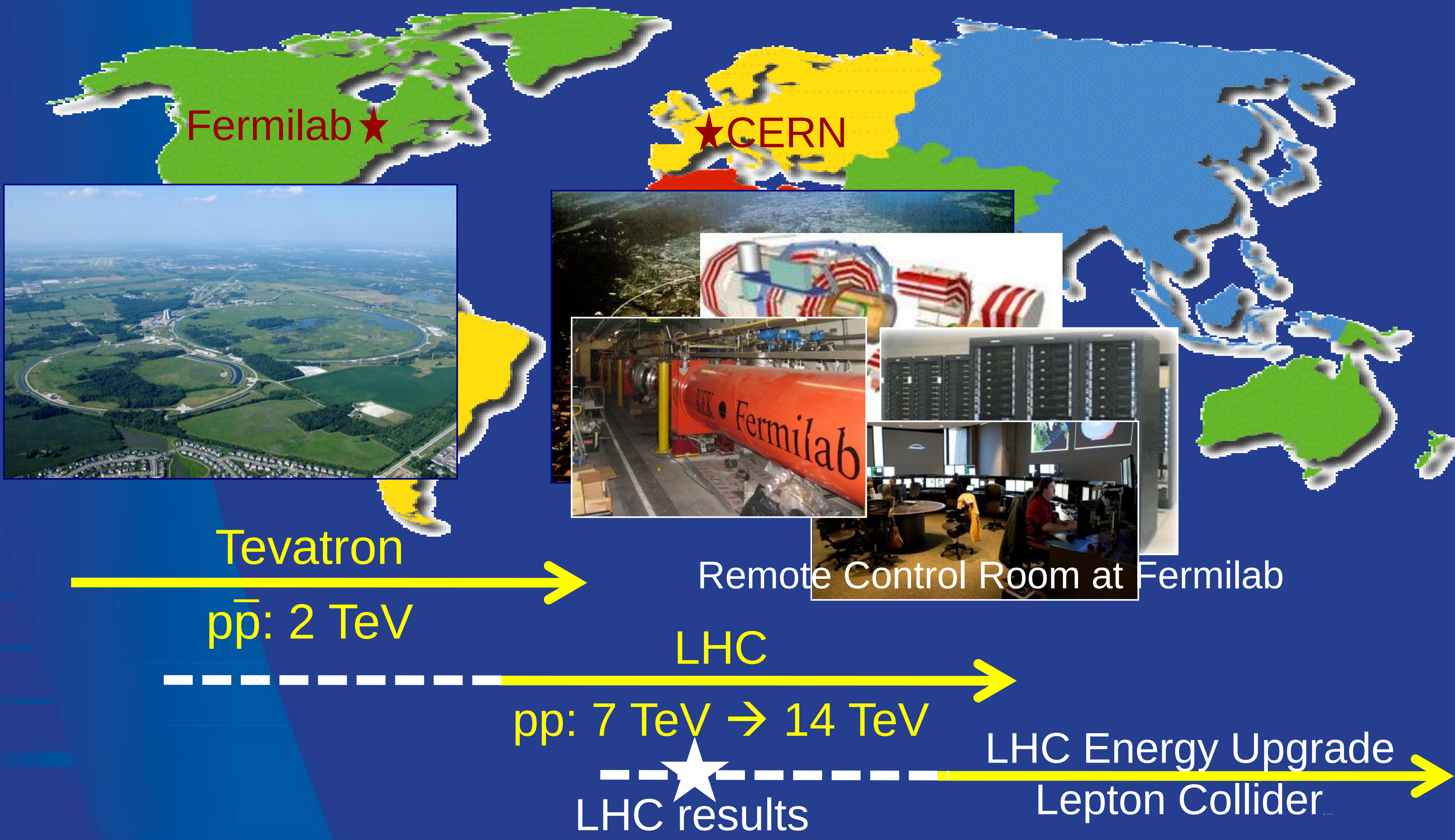
Kaon beam (if an opportunity arises)

$K^+ \rightarrow \pi^+ \nu\nu$ rate in SM ~ 10^{-10}

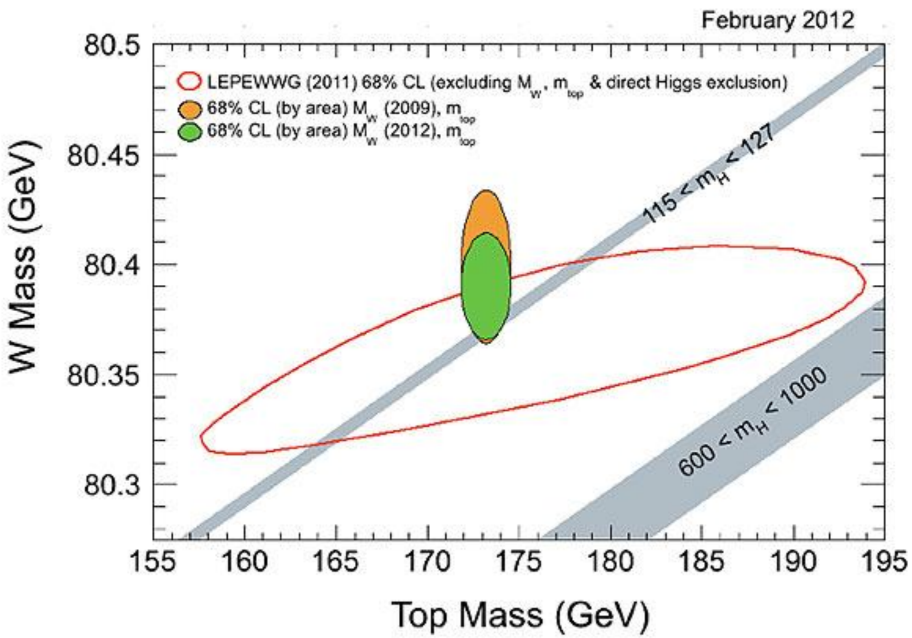




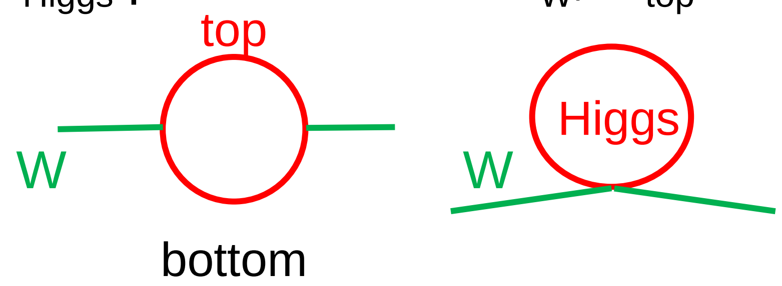
Energy Frontier at Fermilab



At the Energy Frontier: the Higgs boson?



m_{Higgs} prediction from m_W, m_{top} meas.s



$m_{Higgs} < 145$ GeV/c^2 at 95%CL

Results still coming out from Tevatron

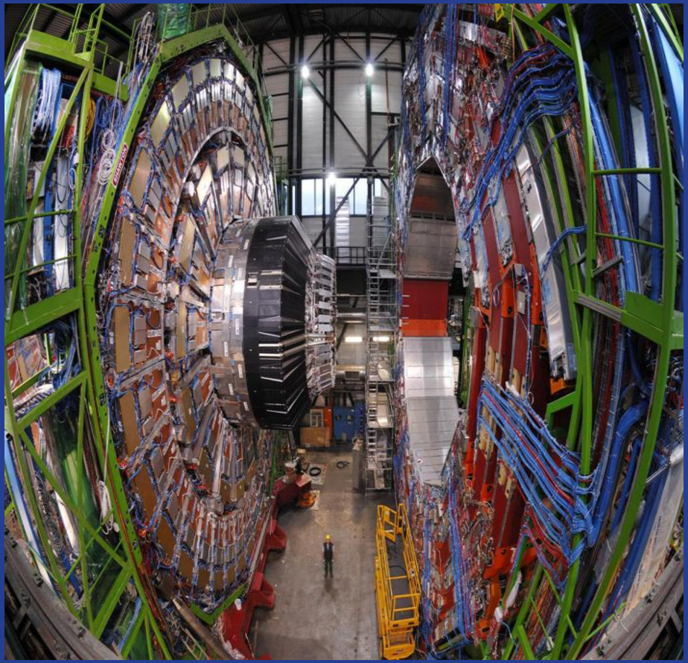
Excluded by direct searches at 95%CL

Higgs Mass [GeV/c^2]

Consistent with expectation from precision measurements

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
New Director Mark Palmer

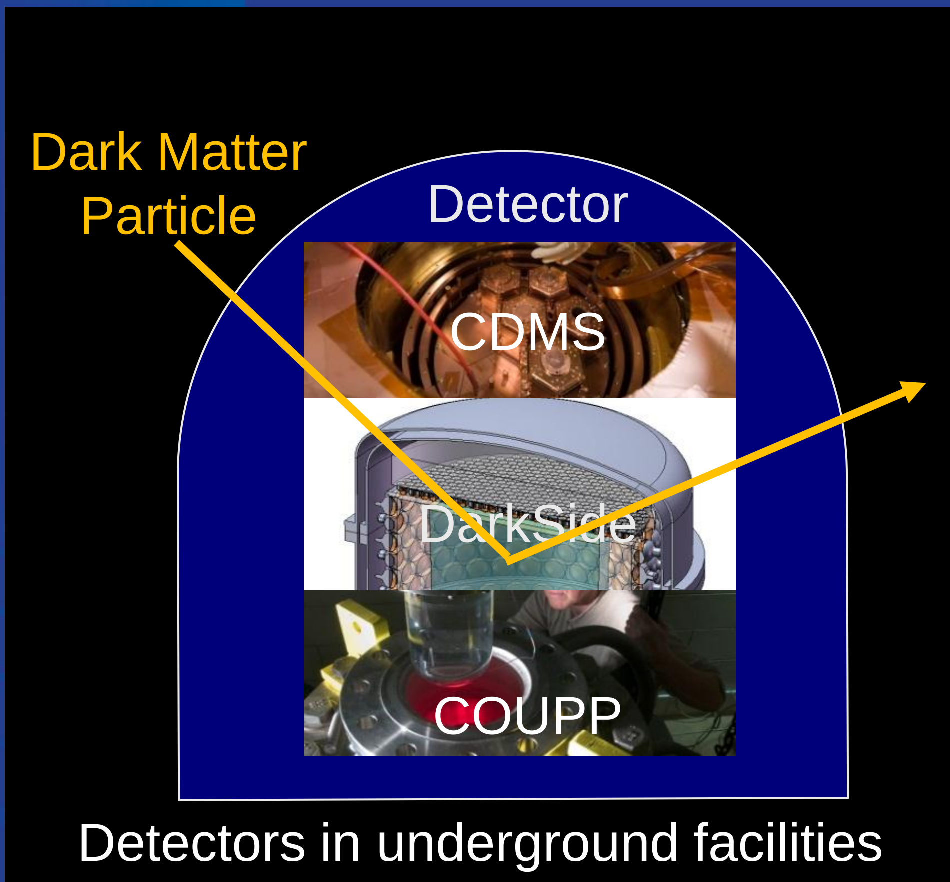
Fermilab

Cosmic Frontier at Fermilab

- Pioneering role in establishing the connection between cosmology and particle physics: David Schramm, Rocky Kolb, Michael Turner…
- Leader of the Sloan Digital Sky Survey: established large surveys as cosmological tools (progenitor of DES, LSST, BigBOSS….)
- Pioneering work in dark-matter searches and the study of ultra-high-energy cosmic rays

Cosmic Frontier at Fermilab

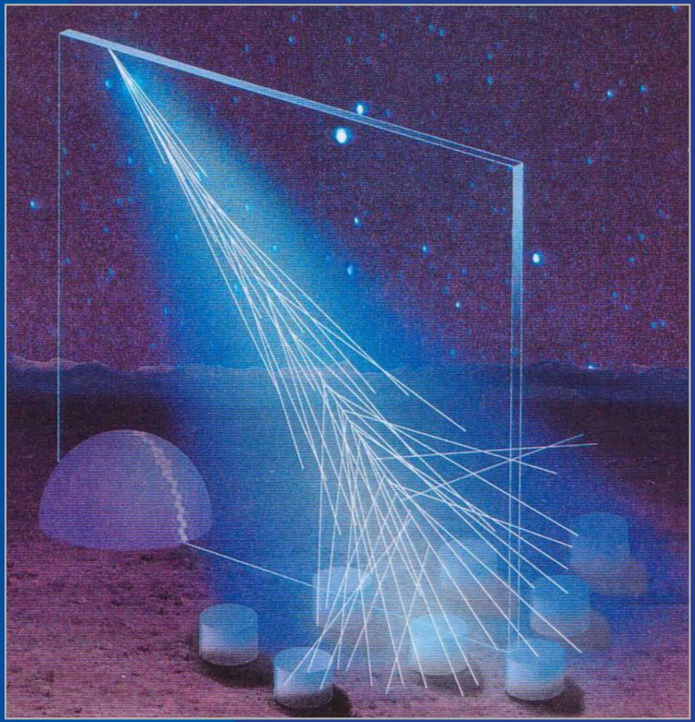
Dark Matter Detector



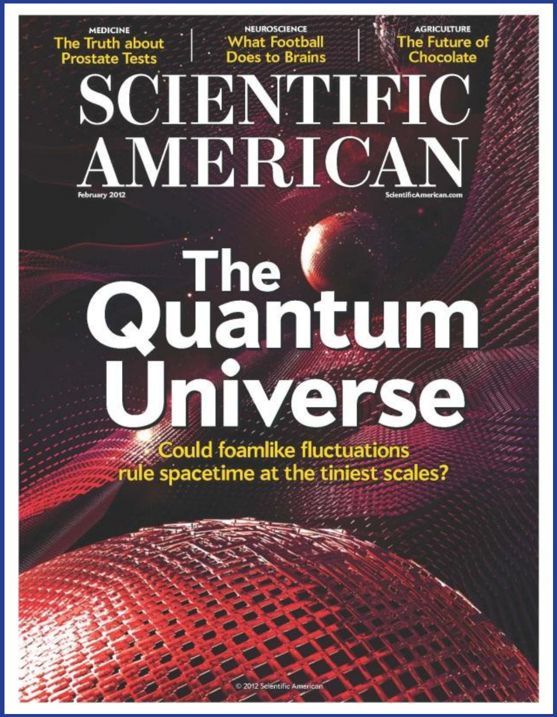
Dark Energy Camera

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

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R&D this decade: SCRF and Project X

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Accelerator HEP experiments (non-CMS)

	Experiment	Collaborating Countries
Energy Frontier	CDF	Canada, Finland, France, Germany, Greece, Italy, Japan, Korea, Russia, Slovakia, Spain, Switzerland, Taiwan, UK, US
	DZero	Argentina, Brazil, Canada, China Columbia, Czech Republic, Ecuador, France, Germany, India, Ireland, Korea, Mexico, Netherlands, Russia, Sweden, UK, Ukraine, US
Intensity Frontier	MiniBooNE	Mexico, US
	MicroBooNE	Italy, Switzerland, US
	MINOS	Brazil, Greece, UK, US
	MINERvA	Brazil, Chile, Greece, Mexico, Peru, Russia, US
	NOvA	Greece, India, Russia, US
	LBNE	India, Italy, Japan, UK, US
	Muon g-2	India, Italy, Japan, Netherlands, Russia, US
	Mu2e	Italy, Russia, US
	SeaQuest	China, Japan, Taiwan, US
Others	Test beam	Belgium, Canada, China, Cyprus, Czech Republic, England, France, Germany, Italy, Japan, Norway, Russia, South Africa, Spain, US

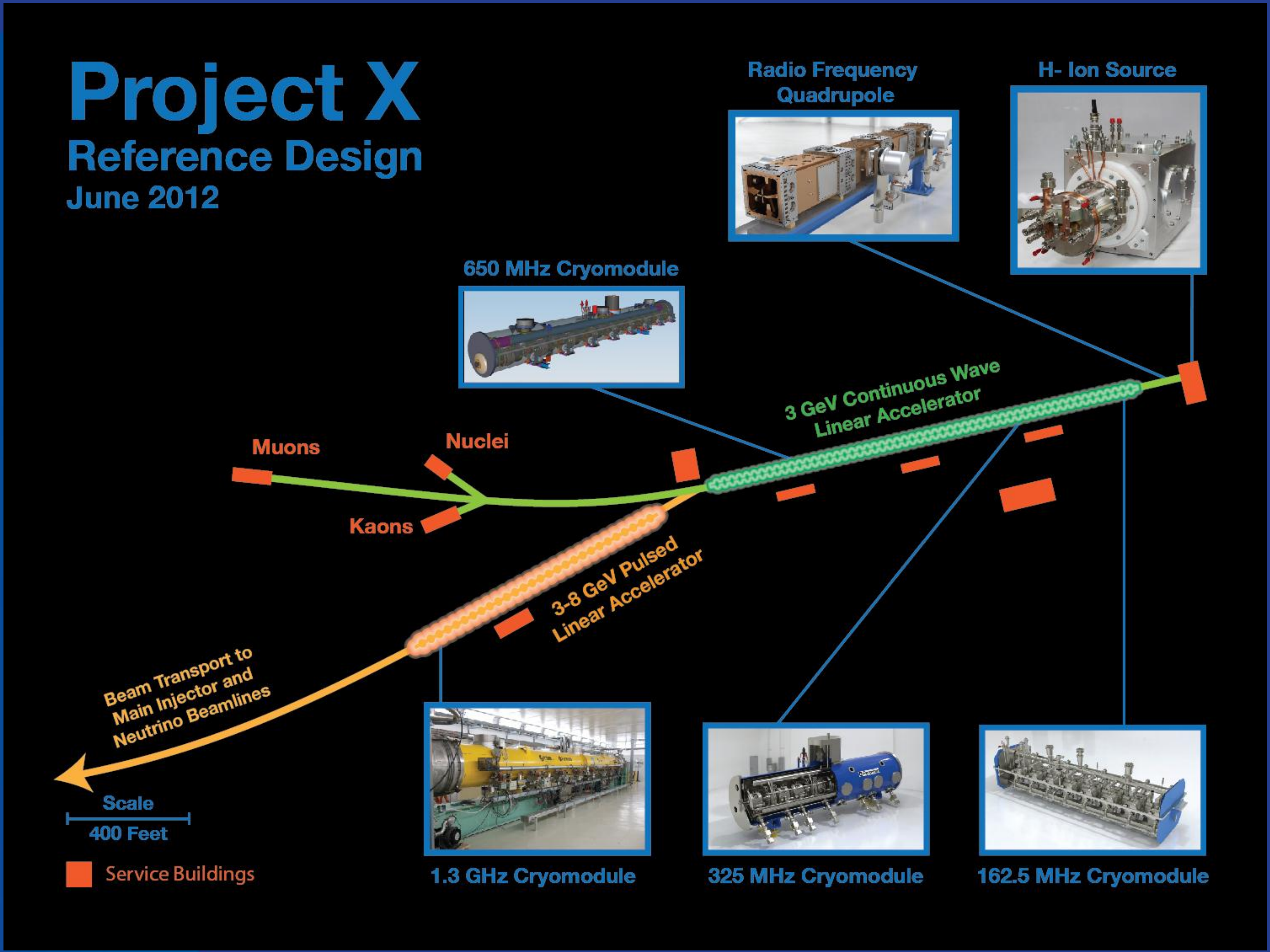
Summary overall program this decade

- A very strong start to establish the Intensity Frontier with premier neutrino and muon experiments. It is a great short term program without LBNE
- We hope by mid decade to start the construction of LBNE having developed a strong international collaboration
- Carry out a vigorous R&D program on SCRF and Project X to start construction by the end of the decade
- Exploit the physics opportunities at the LHC and at the Cosmic Frontier

The program after 2020

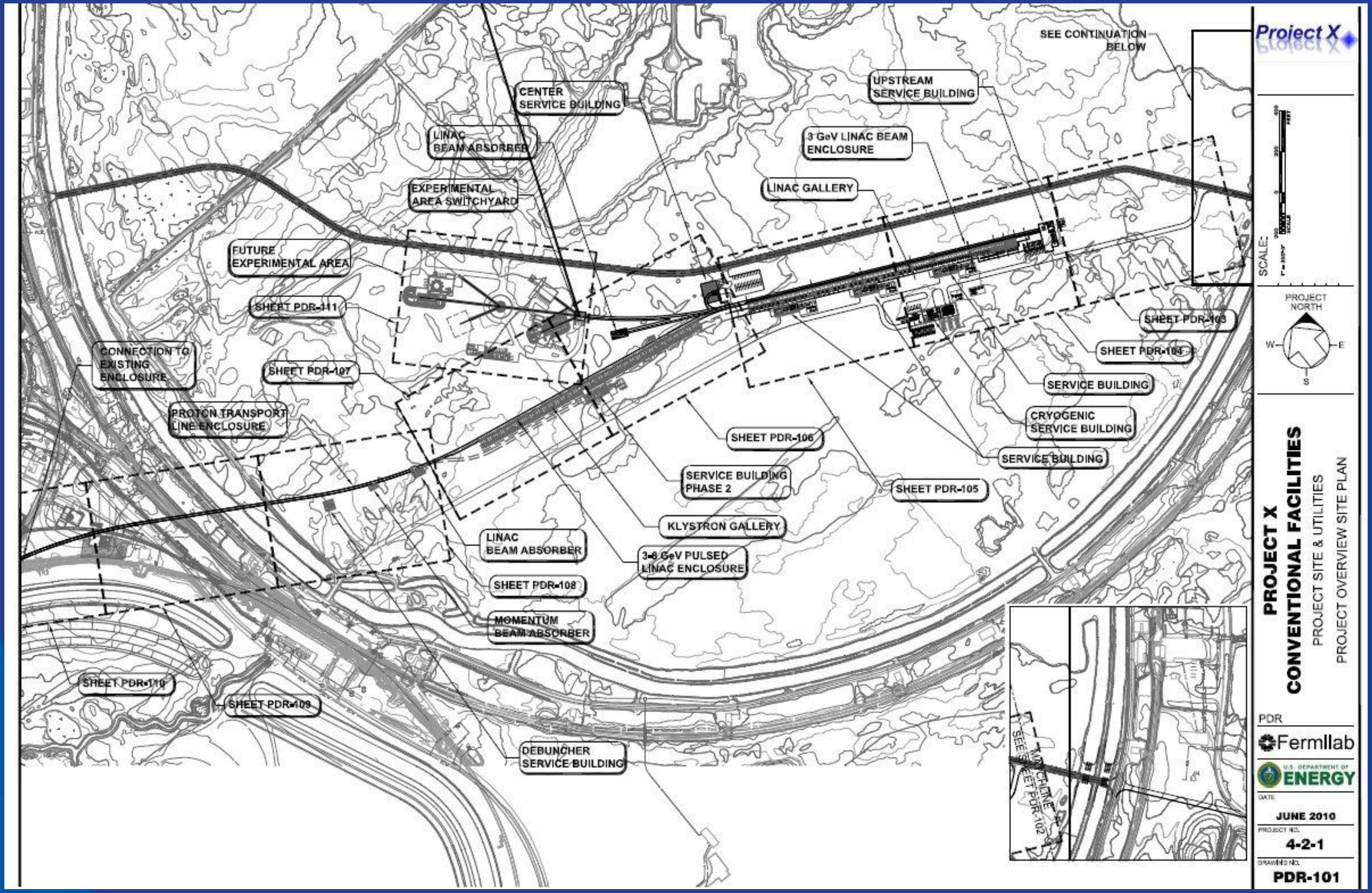
Program next decade

- LBNE: will have completed Phase 1 of the project and we would be running a 700kW beam to Homestake (or alternative). Assuming a detector on the surface, the second phase of LBNE would be to add mass underground to enlarge the program to proton decay and SN collapse in addition to better neutrino measurements
- Project X: a broad program with megawatts of continuous beam, ideal to lead at the Intensity Frontier
  - Neutrino, long/short base-lines, more than 2 MW to LBNE
  - Kaons where the Standard Model backgrounds are minimal and we are sensitive to many models
  - Rare muon decay with sensitivity to masses 10000 TeV
  - Symmetry violations through electric dipole moments in nuclei
  - Applications to transmutation, spallation targets, ADS



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
Bhaba Atomic Research Center • Raja Ramanna Center of Advanced Technology • Variable Energy Cyclotron Center • Inter University Accelerator Center

Project X Siting



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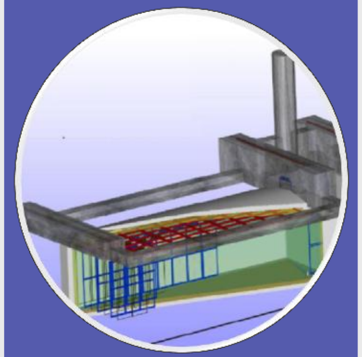
Project X

- Unique facility with a 3 MW at 3 GeV continuous-wave (CW) linac. Multiplies low-energy flux of protons at Fermilab by 100 with flexible timing patterns, ideal for rare decays
- Solves "proton economics". Experiments run simultaneously at 3 GeV, 8 Gev and 60-120 GeV at high power
- Delivers 2+ MW to LBNE
- To be developed consistently to serve as front end of neutrino factory or muon collider

Phased approach to Project X

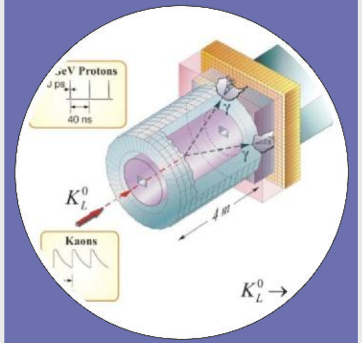
- Project X can be broken into three phases, each for about a third of the cost
  - Phase 1: Up to 1 GeV. Retires old linac, increases flux of neutrinos x1.7, enhances existing Mu2e by x10, starts EDM, nuclear-physics and nuclear-material studies
  - Phase 2: Up to 3 GeV. Starts powerful Intensity Frontier experiments with kaons and short baseline neutrino programs
  - Phase 3: Up to 8 GeV; Multiplies power to LBNE by factor of 3; power at 8 GeV by several fold for short-baseline neutrino experiments
- Decision on when these phases should start can wait to much later in the decade

Project X: new experiments



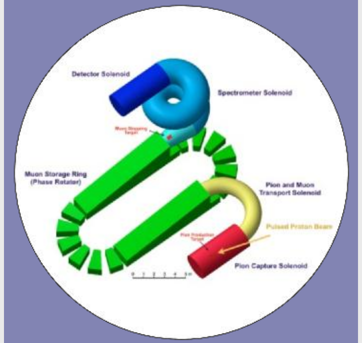
Neutrinos

- Matter-antimatter asymmetry
- Neutrino mass spectrum
- Neutrino-antineutrino differences
- Anomalous interactions
- Proton decay
- SuperNova bursts



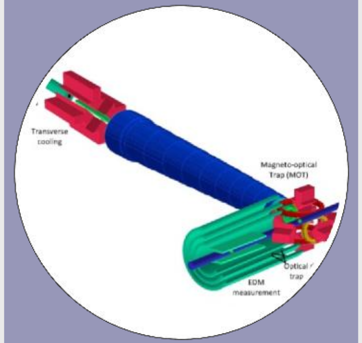
Kaons

- Physics beyond the Standard Model
- Elucidation of LHC discoveries
- Two to three orders of magnitude increase in sensitivity



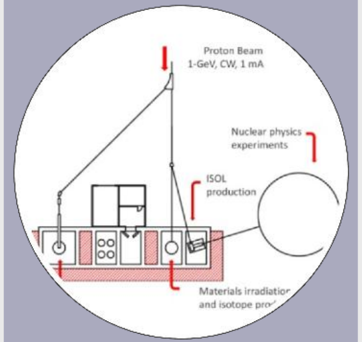
Muons

- Oscillation in charged leptons
- Physics beyond the Standard Model
- Elucidation of LHC physics
- Sensitive to energy/mass scales three orders of magnitude beyond LHC



Nuclei

- New generation of symmetry-test experiments
- Electric Dipole Moments
- Three or more orders of magnitude increase in Francium, Radium, Actinium isotopes



Energy Applications

- Transmutation experiments with nuclear waste
- Spallation target configurations
- Materials test under high irradiation
- Neutron fluxes under various configurations relevant to ADS

Fermilab

Project X and 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?

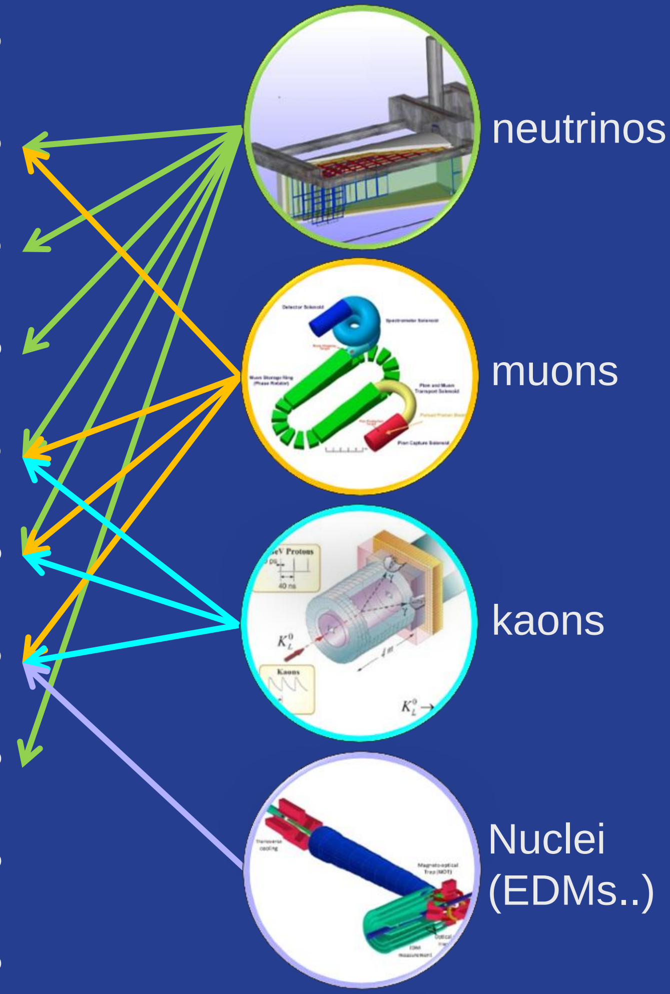
Do the forces unify?

Does nature use supersymmetry or other new symmetries?

Are there extra dimensions of space?

What is dark matter?

What is dark energy?



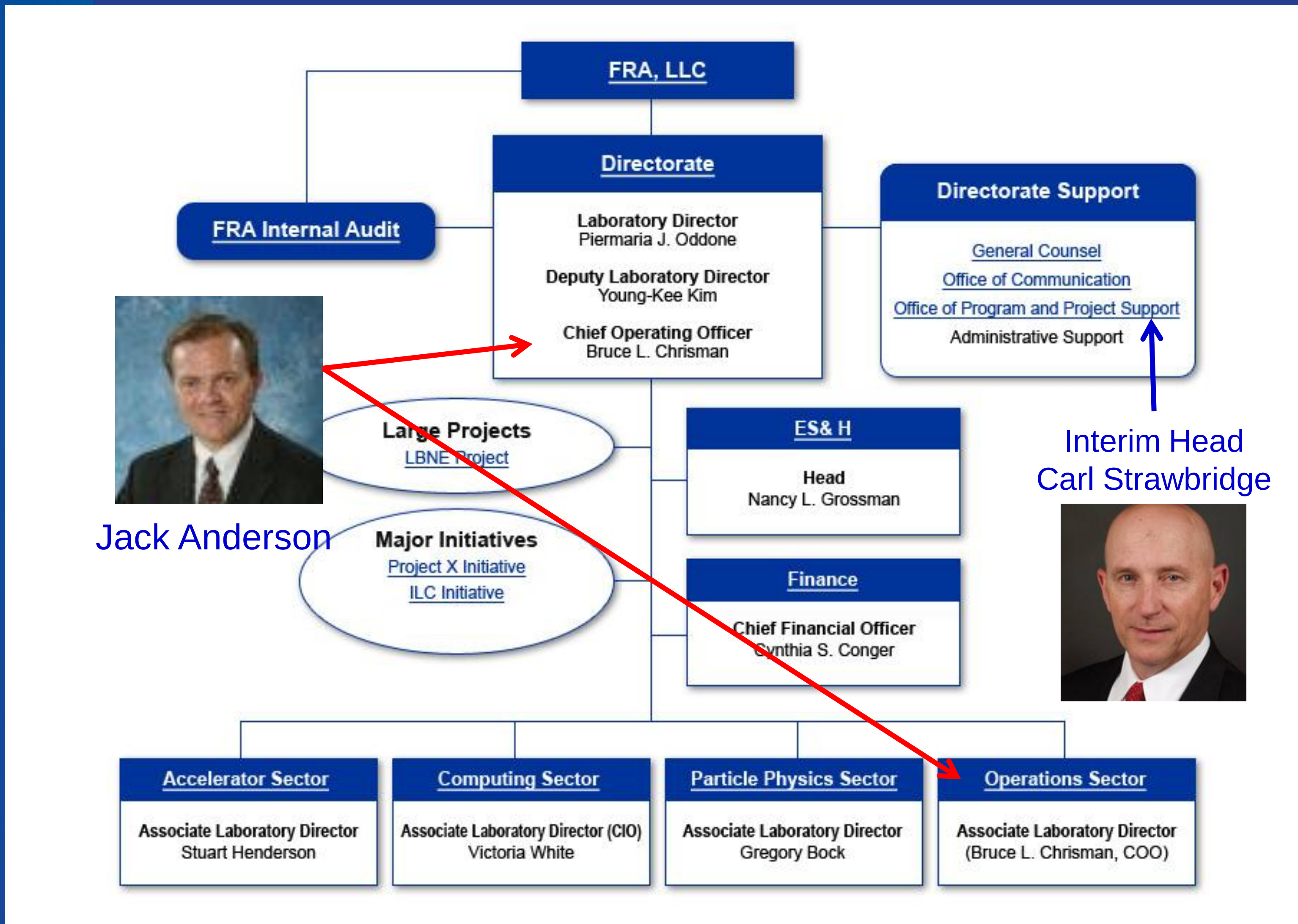
Did we meet strategic criteria?

- Drives world-leading physics ✓
- Is supported by the HEP community ✓
- Continually produces scientific results ✓
- Attracts international participation ✓
- Is resilient relative to instability in the US system ✓
- Is resilient relative to new discoveries ✓
- Has the full support of the Office of Science if plan accepted
- Is affordable (the definition of affordability varies with time, up and down) now consistent with stable, flat budgets

Management and operations that sustain the future of Fermilab

Some highlights. For fuller descriptions refer to the Annual Laboratory Planning Document for Fermilab

Fermilab Organization



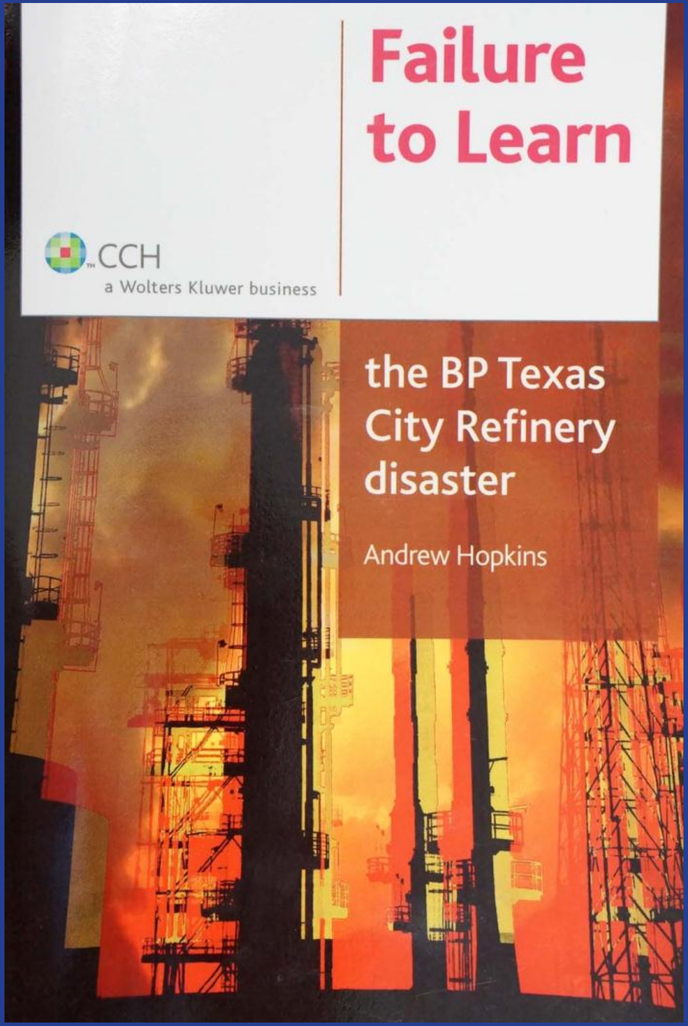
Fermilab

Numerous improvement initiatives

- Safety: persistent awareness
- Recruitment and retention
- Site planning and utilization
- Sustainability
- Transparency: FermiDash and Contract Assurance
- Office of Program and Project Support
- Employee Advisory Group
- Community Advisory Group
- Project management

Safety: persistent awareness

- This year's performance is poorer than previous year. Hard to measure real performance because of low statistics – but we take the increase in injuries seriously
- Weekly report by division/section managers on all events starting from first aid up
- Monthly safety walk by senior leaders
- Increasing number of employees trained on Human Performance Improvement (HPI)
- Signage at the front gates constantly updated; Director's Corners calling attention to safety; we use other tools like the "porcelain press"
- Special campaigns: e.g. distributed "Failure to Learn" to division, section and safety managers and discussed it. It has every conceivable organizational failure mode.



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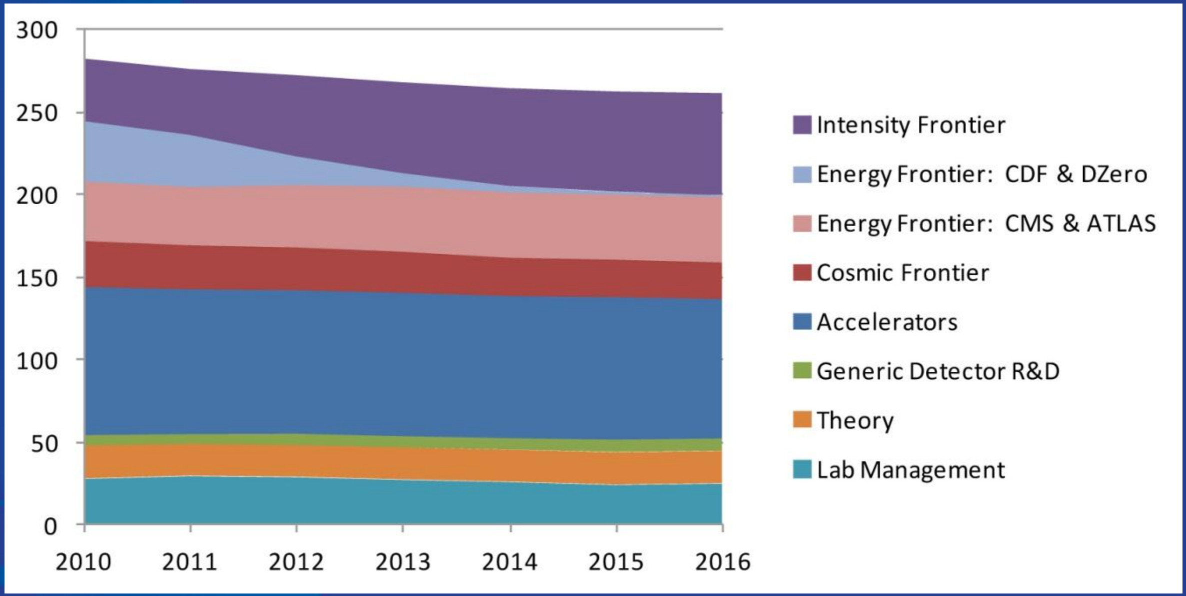
Human resources planning (OHAP)

- We track individuals in 125 skill categories
  - Define the program
  - Gap analysis
  - Steer staff to the predicted needs over time



Example: scientist by program, excluding postdocs

- Main issue: instability of planning assumptions

Fermilab

Recruiting and retention

- Extraordinary record in recruiting top-level junior investigators. For example: Wilson fellows recruitment top candidate acceptance greater than 90%
- Excellent record in recruiting leadership positions. For example, Stuart Henderson (ALD accelerators), Mark Palmer (Head of Muon Collider Program); Jack Anderson (COO)
- We have lost some top-flight scientists and engineers, more than usual: primarily the necessary delay in starting Project X
- Some drastic cuts contemplated for SCRF will damage competency established over the last several years: we are in negotiation with OHEP

Some awards and recognition….

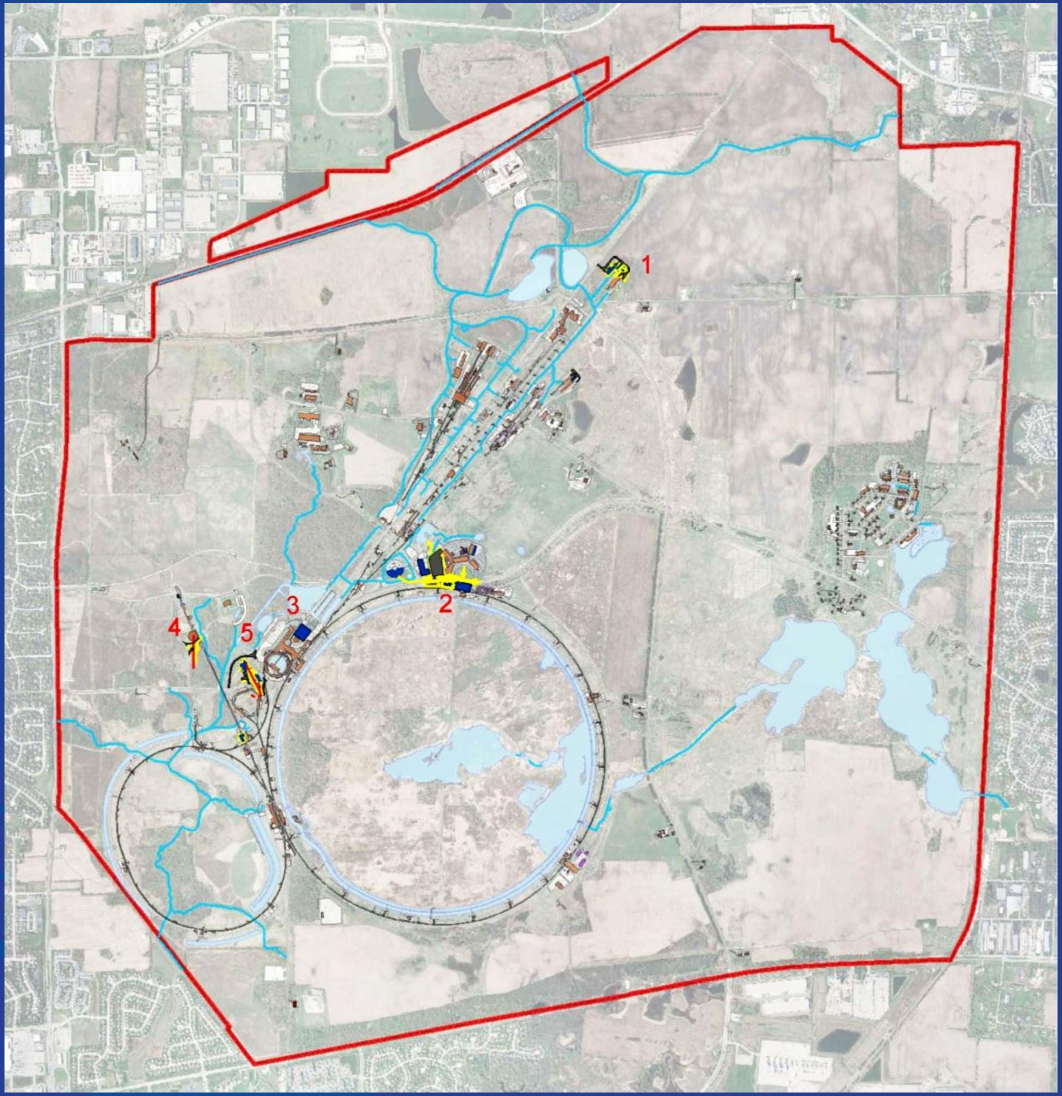


- DOE Early Career Awards (2 in 2011, four in 2012)
- 2012 IOP Career Prize (Schwanenberger)
- 2012 Vannevar Bush Award (Lederman)
- 2010 Wilson Prize (Peoples)
- 2011 Sakurai Prize (Quigg, Eichten)
- AAAS Fellows (Kim, Mackenzie)
- NAS (Oddone)
- 2011 IEEE Council on Superconductivity Award (Tollestrup)
- 2011 Alexander von Humboldt Research Award (Carena)



Fermilab

Site planning and utilization



- Powerful Geographic Information System (GIS) documents the site in great detail and gives us an excellent planning tool. In the next five years:
  - 1. CMT (ARRA)
  - 2. IARC (IL)
  - 3. WH Intensity Ops Center
  - 4. Liquid Argon Test facility
  - 5. Muon campus (GPP)
  - Distributed: SLI #1
- Working on master plan to sustain the program, including moving out of obsolete shops and trailers

Site planning and utilization

- The program is well defined for the rest of the decade and site planning is ongoing. Principal uncertainties: when LBNE? When Project X? We do have developed plans for them as part of the R&D studies, but for plans to be taken seriously we need a more solid foundation
- SLI projects essential: electrical and water upgrades start in FY13 budget. Thank you!
- Next SLI project is the consolidation of antiquated shops into new building in the industrial area: really important

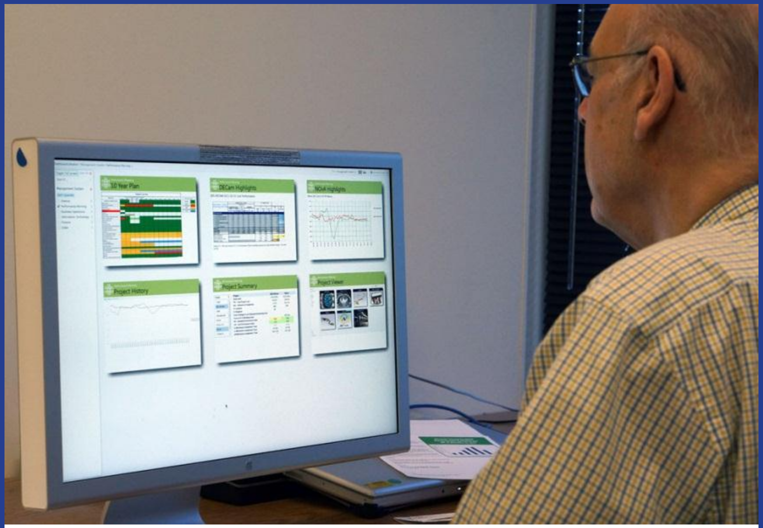
Fermilab

Sustainability (SSP Dec 2011)

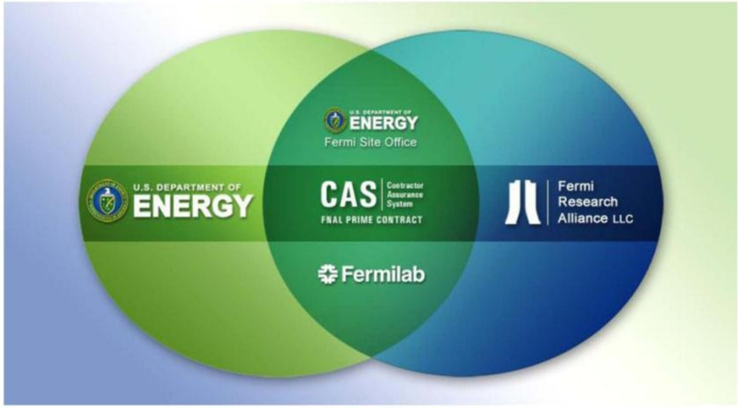
- Scope 1 GHG: fugitive emissions have been greatly reduced (>76% from refrigerants and other gases)
- Scope 2 GHG: 90% dominated by accelerators. Increase efficiency of non-accelerator loads, but RECs will be required for the rest
- We have ESPC initiative in FY12
- Assessing 15% of buildings to be improved in compliance with guiding principles. Requires $3M in FY14 and $5M in FY14 to meet compliance
- Water goals achieved
- For detailed status see Laboratory Planning Document

Transparency: FermiDash

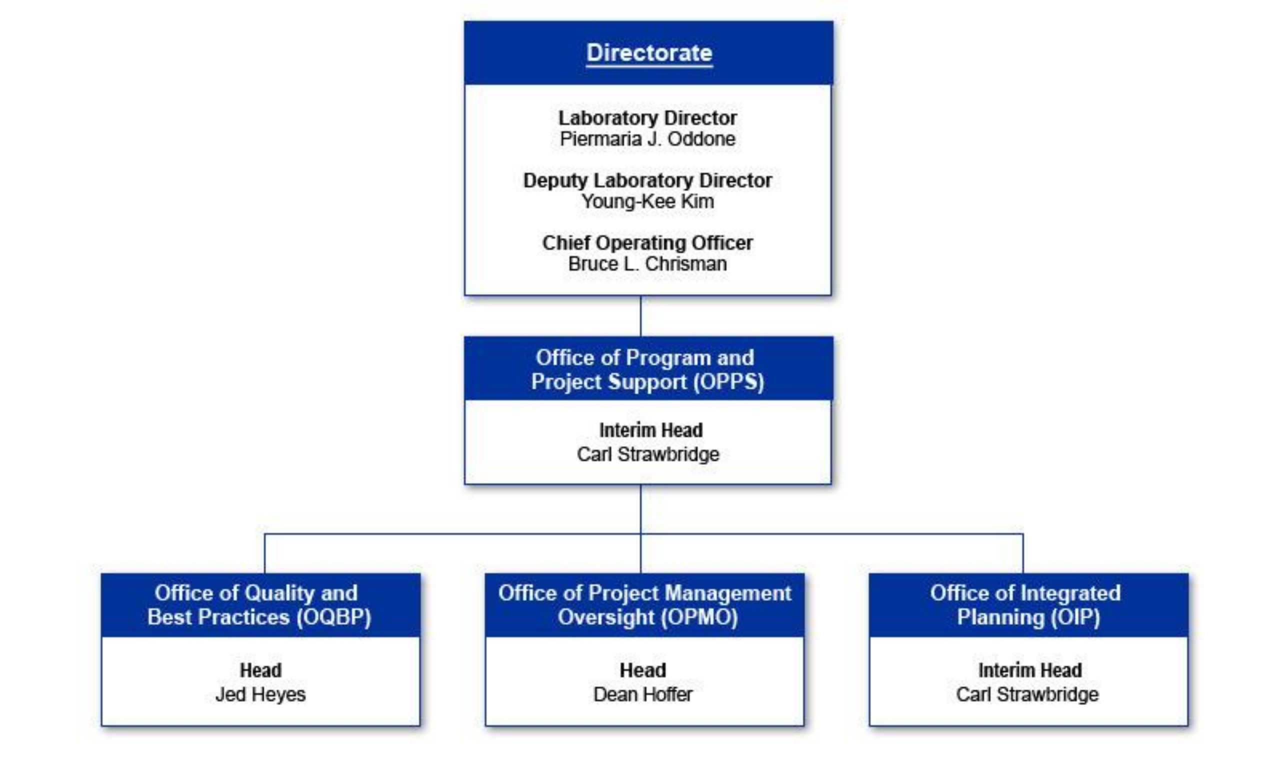
- Strive for maximum transparency to our sponsors and stakeholders
- 11 CAS management systems, mapped to the FRA Board of Director's Oversight with specific owners
- New Tool: FermiDash keyed to the 11 CAS management systems; available to staff and DOE



Contractor Assurance System Description



Office of Program and Project Support



We have created OPPS to enhance coordination between CFO and Programs and Projects, oversight for Office of Quality and Best Practices, Office of Project Management Oversight and new Office of Integrated Planning

Employee Advisory Group

- Employee Advisory Group meets monthly with senior managers.
- Brings together diverse group of employees from all job classifications.
- The aim is to improve policies and working environment

Fermilab

Community Advisory Group

Close advisors on laboratory development

Project management

- Essential to the future of the laboratory as Fermilab's life for the next decade is dominated by projects as the program is re-stocked
- We have taken steps to bring more oversight experience to the laboratory: Office of Program and Project Support
- Performance on MINERvA and DES completed on budget and on schedule
- On-going projects NOvA and MicroBOONE on track, but ample room for improvement. Primarily: better early warning system as technical or other difficulties develop

Critical and immediate needs

- On LBNE, DOE needs to decide if we have answered the charge satisfactorily. We need the following actions:
  - Define the path forward
  - Accept that the path is consistent with CD-0
  - Integrate into project management key decision process with CD-1 by early next year
- We need your support to complete the muon program Mu2e and Muon g-2. CD-1 for Mu2e is ongoing today; Muon g-2 needs funding profile and we need GPP support for the “Muon Campus”
- For both LBNE and Project X - we need your help in establishing a stable path in order to encourage international participation. Your support for our collaboration with India is critical