Budget Impact on Fermilab

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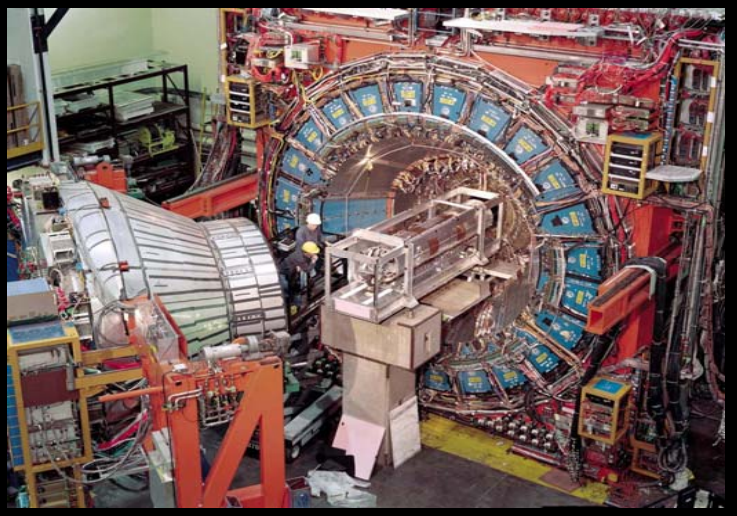
Outline

- The good
- The bad
- The ugly
- Path to recovery

Ongoing program: Tevatron

- Greatest discovery opportunities before LHC
- Strong collaborations; 80 PhDs last year
- Great operations at high luminosity
- Dominates world physics results



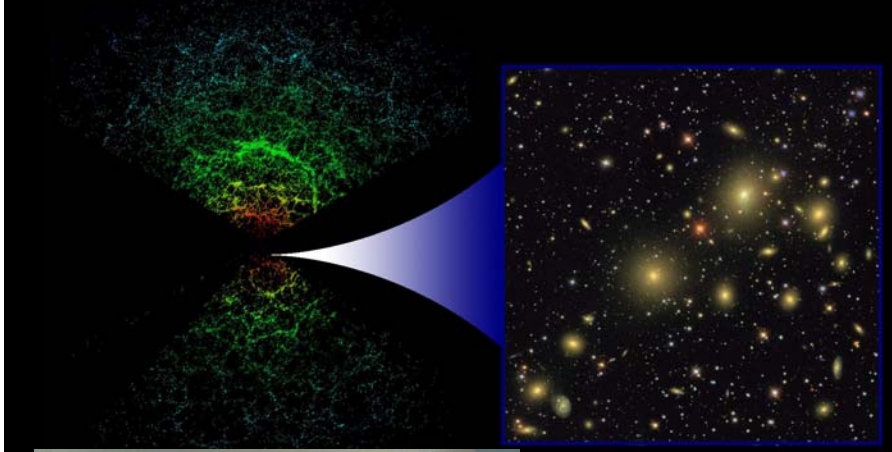
Ongoing program: neutrinos

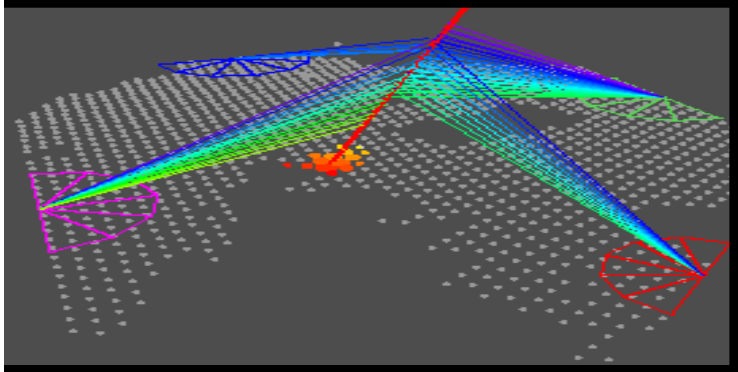
Minos Far detector

MiniBooNE detector

- **MINOS: neutrino oscillations in the atmospheric region; coming electron appearance at CHOOZ limit or below**
- **MiniBooNE: neutrino oscillations in the LSND region; exploration of low energy anomaly in neutrino interactions**
- **SciBooNE: neutrino cross sections**

Ongoing program: astrophysics





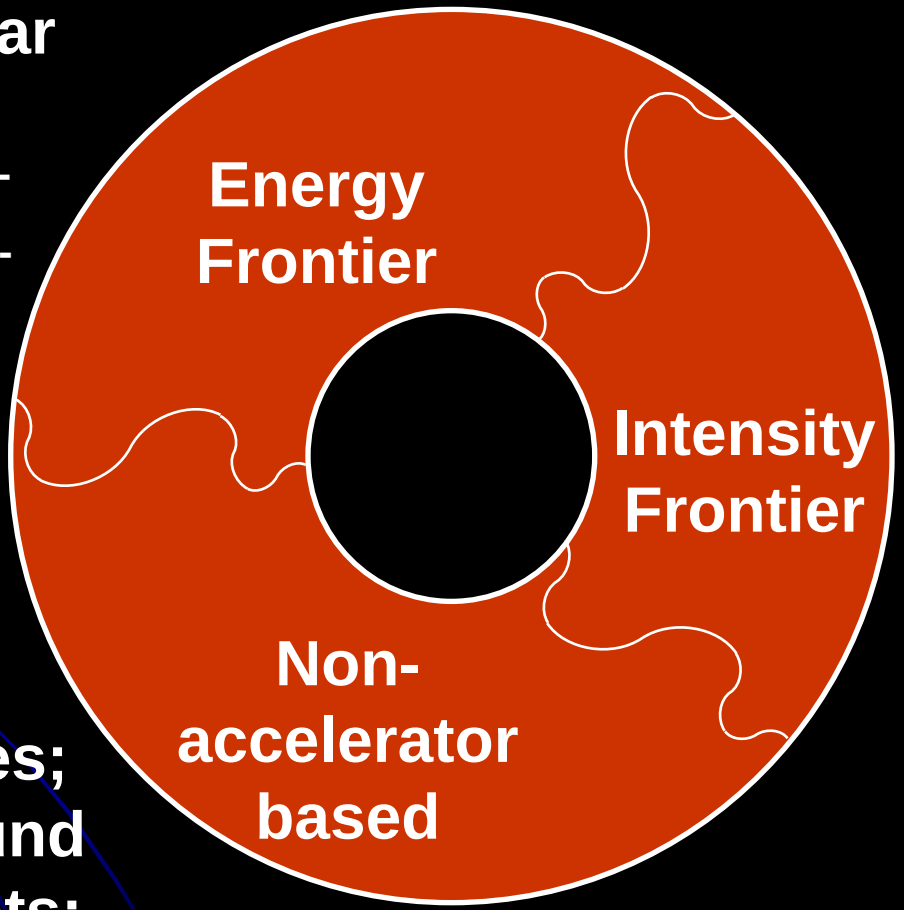
- **CDMS II – days from best dark matter limits**
- **SDSS – huge impact survey, baryon acoustic oscillation**
- **Pierre Auger – GZK, association with active galactic nuclei**
- **COUPP – competitive results for spin-dependent WIMPS, scalable**

On going program: capabilities

- Powerful theory group, including leading role in phenomenology, lattice gauge
- Computational science, large data sets
- Detector instrumentation, silicon detectors
- Accelerator design, control and operations
- Mechanical (including cryogenic), electronic engineering, magnet design
- World-wide collaborations

Fermilab and the future

pp-bar
pp
e^+e^-
$\mu^+\mu^-$



Intense ν, μ, K, . beams; and B, C factories;

Telescopes; Underground experiments;

Fermilab and astrophysics

- Dark Energy Survey: CD-2 review went well
- CDMS – 25kg is being supported by the agencies
- COUPP scaling from 2 → 60 kg
- Collaborators in SNAP

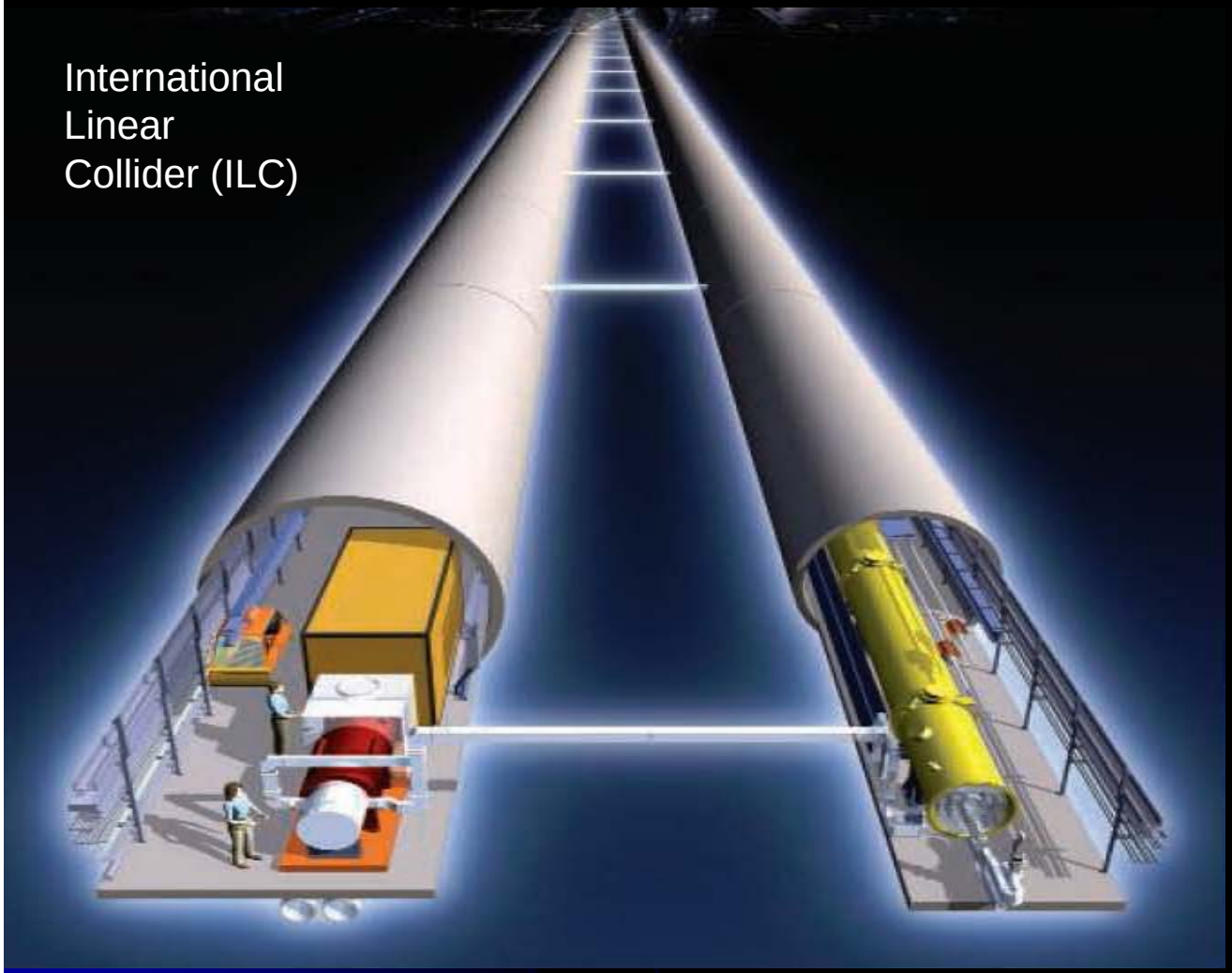
HEP world: LHC and Fermilab

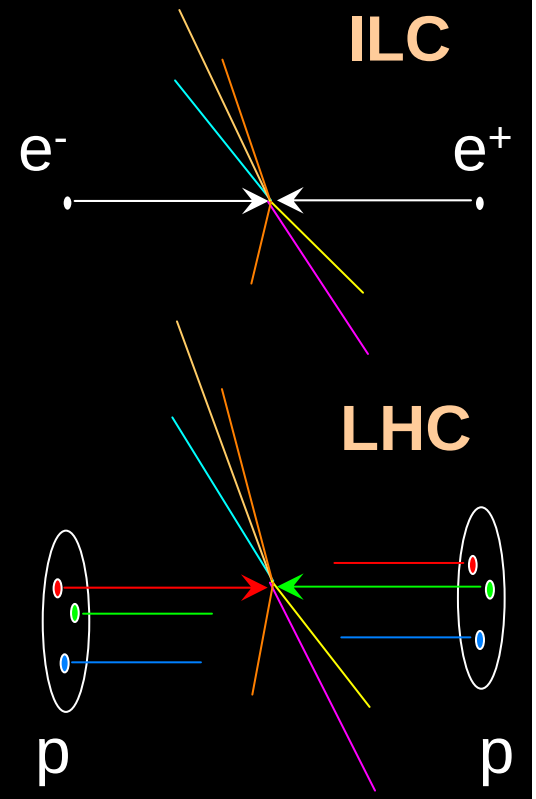
Compact Muon Spectrometer CMS

Remote Operations Center at Fermilab

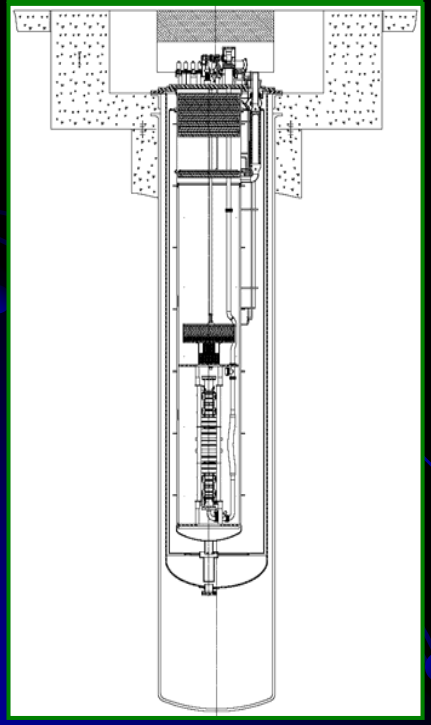
HEP world: need TeV lepton collider

International Linear Collider (ILC)

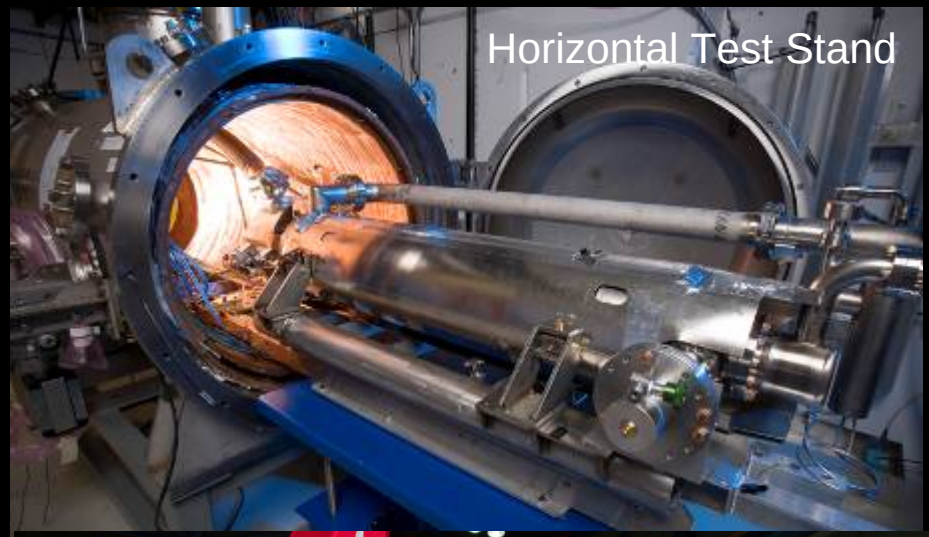




HEP World: ILC technology



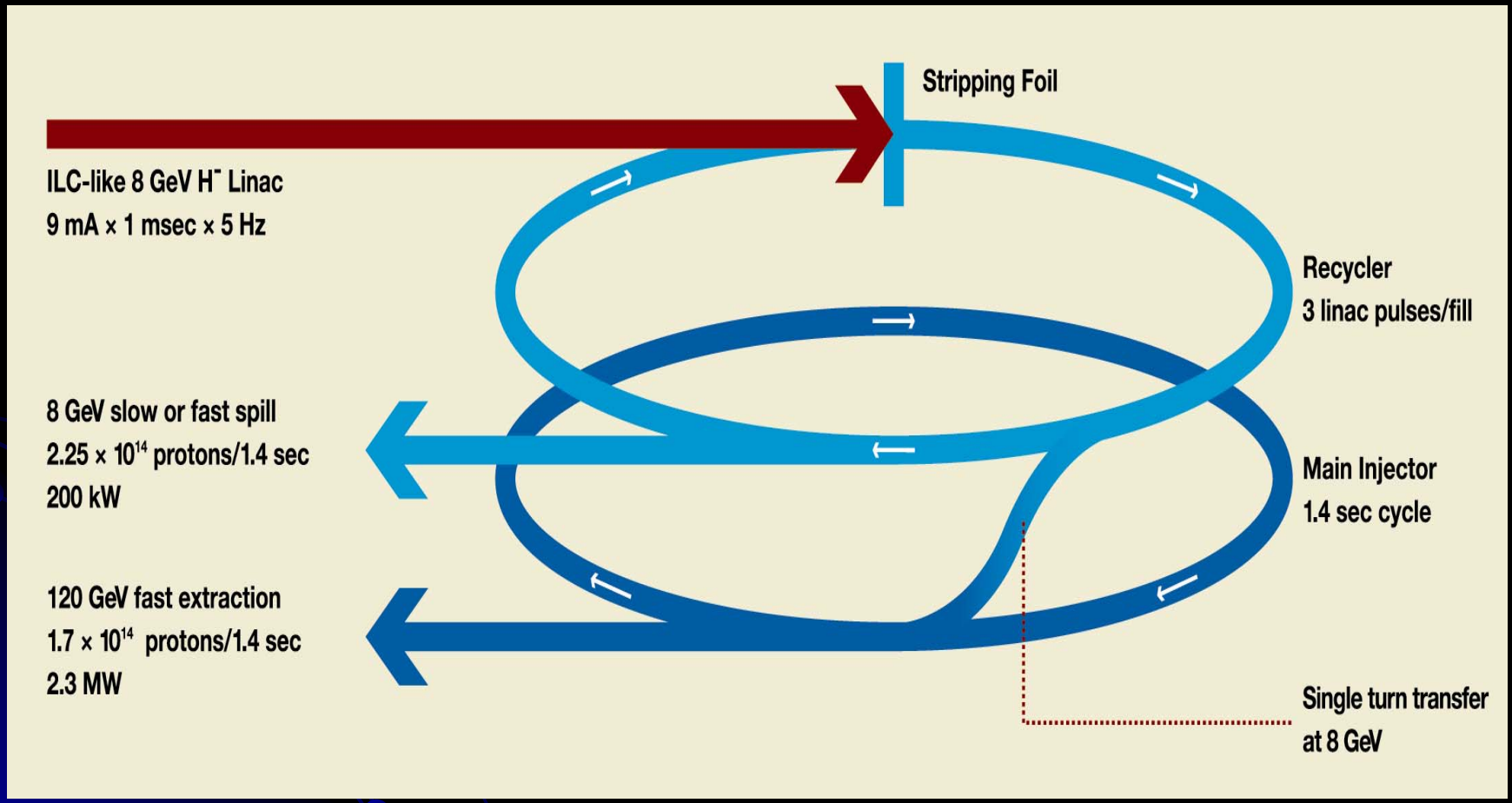
Vertical Test Stand



Fermilab and the intensity frontier

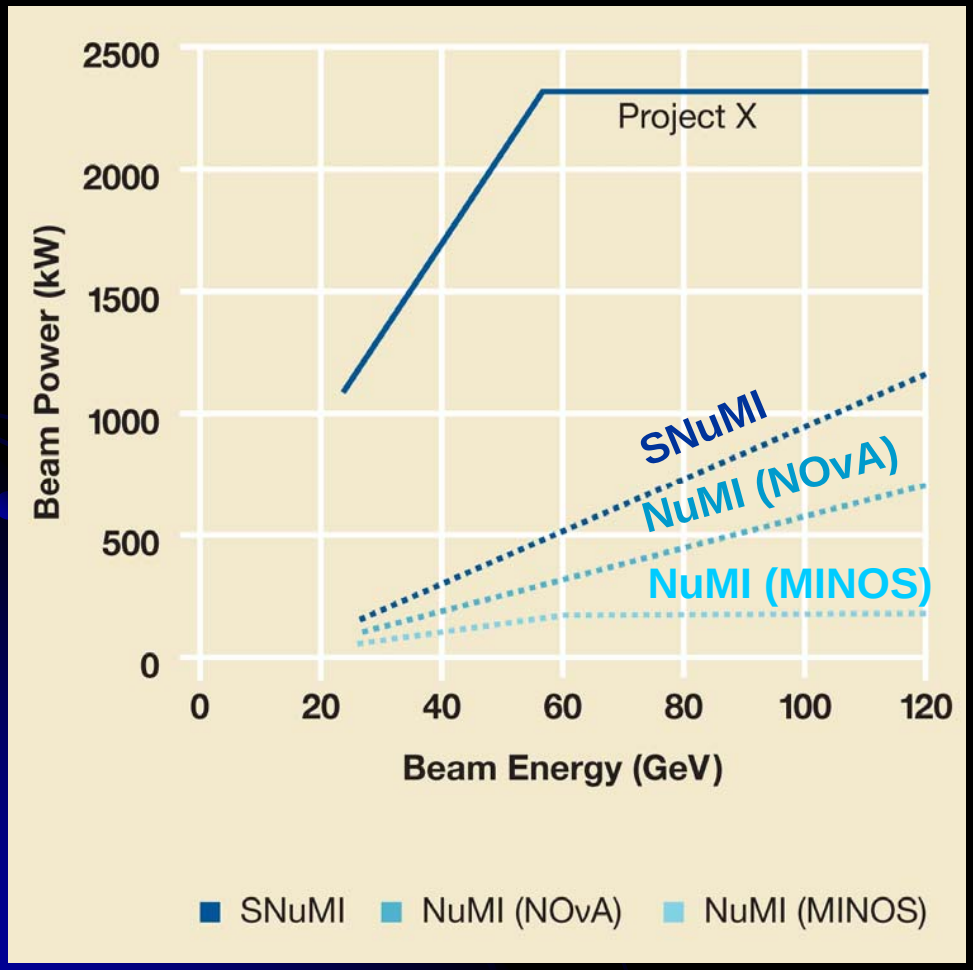
- Successful CD-2 for NOvA, a major neutrino detector and upgrades to present complex
- Steering Group strategic planning: facility for neutrinos and rare processes at the intensity frontier

Fermilab and the intensity frontier



Project X: Beam power / flexibility

Main Injector Protons



8 GeV protons with 120 GeV MI protons

200 kW (Project X)

0* (SNuMI)

16 kW (NuMI-NOvA)

17 kW (NuMI-MINOS)

35-year-old injection (technical risk)

* Protons could be made available at the expense of 120 GeV power.

In the last three years…..

- Steady progress towards a great program:
  - High energy frontier: Tevatron, LHC, ILC R&D
  - Neutrino program: MINOS, MiniBooNE, SciBooNE, NOvA and Minerva + Project X
  - Particle Astrophysics: Pierre Auger, CDMS II, SDSS, CDMS-25 kg, COUPP, DES, SNAP

In the last three years…..

- Tight budgets but great productivity
  - FY 2006 $324M
  - FY 2007 $342M
  - FY 2008 $372M (President's Request)
- Increases reflected the ramp up of ILC R&D and also the start of new projects, principally NOvA

The FY2008 budget process

- House bill supported the President's request for FY 2008
- No Senate bill, but Energy and Water Committee mark added $7M for JDEM
- Full impasse. Spending in Congressional bills $22B above President's request. Leads to Continuing Resolution.

The FY2008 budget process

- After several months, Omnibus bill fits President's envelope: required cut $22B
- Priorities are not aligned: Congress emphasizes different areas than the President leading to major cuts.

Particle physics cuts

- HEP budget is cut
  - President's Request FY08 $782M
  - Operational plan FY2007 $752M
  - Omnibus bill for HEP $688M
- About $90M taken out of the expected program for FY08

Effect on Fermilab

- From the expected budget of $372M receive only $320M for FY08.
- Therefore we need to reduce expenditures by $52M from PBR in the remaining of FY08 and adjust to a smaller base for FY09.

Effect on Fermilab

- Immediate stop of ILC, SCRF, and NOvA. Staff will move to other projects.
- For the future, re-size the laboratory to absorb the reduction in the program. The size of the RIF is about 200 FTEs.
- Implement a “rolling furlough” approx. 2 days/month.

Effect on Fermilab

- Rolling furloughs are the only fast acting remedy to get within budget in FY08. They take 10% of the labor out of the lab
- Layoffs are necessary to adapt to a smaller base. Scary prospect in the last five months of this year: between furloughs and layoffs 20% of the labor will be out.

Effect on Fermilab

- A critical goal to maintain the planned 2008 run for the Tevatron and the neutrino programs
- We will fully support our commitment and participation in the LHC
- We also will try to maintain the smaller projects that add vitality to our program.

Impact on the community

- ILC is a broad national and international collaboration; our US HEP partners will suffer as much (60% of ILC R&D done at SLAC, ANL, BNL, LBNL and JLAB)

- Coupled with cut of ITER construction funds, there could be long lasting impact on US credibility as international partner

Impact on the community

- Damage the immediate future for accelerator based physics with lack of NOvA funding and the long term future with the lack of funding for ILC and SCRF
- Collateral damage with the early termination of the B-factory.
- At the omnibus level: no capital funds to invest in developing a future unless we reduce the field

Recovery Plan

- We will work with DOE to explore any available avenue to mitigate the problem.
- Projects are not cancelled: money was not allocated in FY2008; President's budget request restores the program substantially.
- We will work with Illinois representatives and representatives of the many states that use Fermilab to explore any available avenues to help in FY08 and in sustaining FY09.

Recovery Plan

- Work with the community, P5 and HEPAP to make a compelling roadmap that the DOE, the public and the legislators will support in future years.
- Maintain throughout this our ability to operate, design and construct detectors and accelerators.
- Well on our way to do this with the Steering Group report and the development of a broader R&D program into the future based on a path with Project X at the intensity frontier.

Approach

- The general rule:
  - If the LHC discovers new particles – precision experiments tell about the physics behind through rates/couplings to standard particles
  - If the LHC does not see new particles – precision experiments with negligible rates in the SM are the only avenue to probe higher energies
- Additionally, neutrino oscillations coupled with charged lepton number violating processes constrain GUT model building

Approach: an expandable Project X

- Initial configuration exploits alignment with ILC
- But it is expandable (we will make sure the hooks are there)
  - Three times the rep rate
  - Three times the pulse length
  - Three times the number of klystrons
- Would position the program for a multi-megawatt source for intense muon beams at low <8 GeV energies – very difficult with a synchrotron.

Project X: it is the best source

- Neutrino program at 120 GeV (2.3 MW); 55% recycler available at 8 GeV (200kW)
- We can develop existing 8 GeV rings to deliver and tailor beams, allowing full duty cycle for experiments with the correct time structure: *K* decays, μ → e conversion, *g-2.*
- High rate experiments do not decrease protons-on target for the neutrino program at 120 GeV.

Example: neutrino strategy

- Build NOvA. Only experiment sensitive to mass hierarchy; together with T2K and reactor: best shot at neutrino oscillation parameters
- Replace MINOS by 5 kton LAr detector on axis. Together with NOvA, by far best reach into angle CP and mass hierarchy for full decade
- Develop caverns/detectors for DUSEL – with new beam-line from Project X it is the ultimate super-beam experiment (water or LAr)
- If neutrino factory is needed – Project X is the ideal source

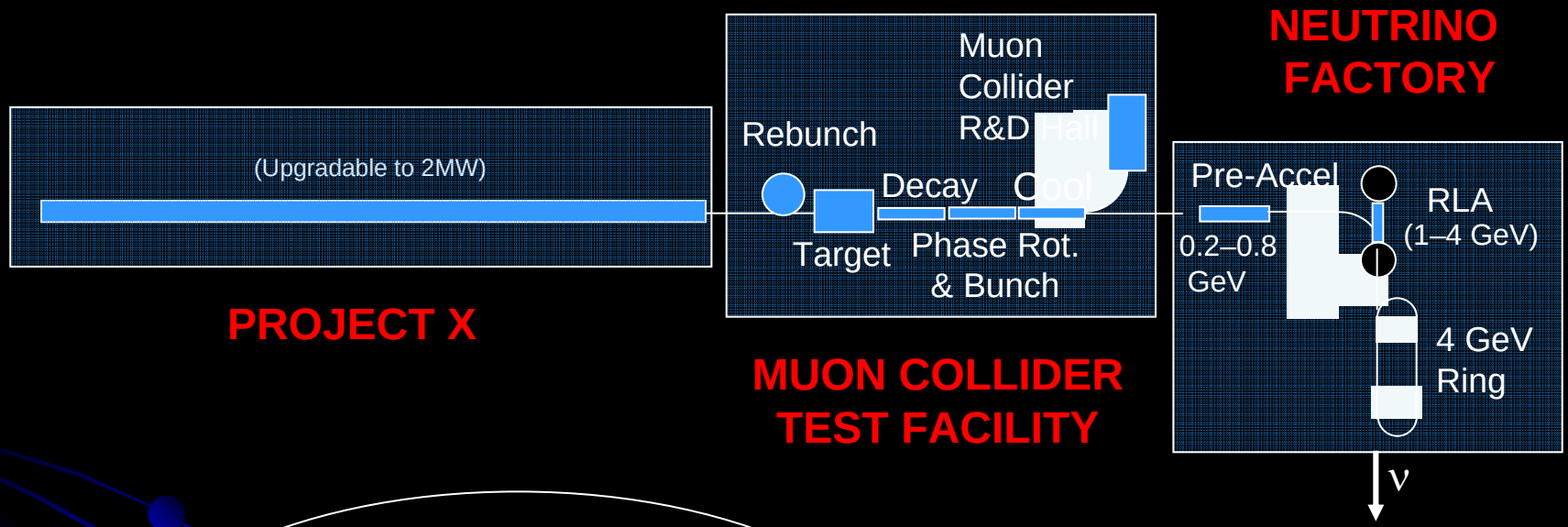
Example: μ to e conversion

- Could start with Booster beam: already better than MECO experiment
- If signal found at 10^{-16} level: study A dependence, with higher beam levels
- If signal not found, extend search with higher beam levels – full Project X 200 kW
- Further power levels with Project X if 8 GeV power is increased.

Example: evolutionary path to ILC

- Project X linac develops US capabilities towards an ILC
- Positions Fermilab as potential host
- Positions US to contribute on major part of the ILC
- Allows concrete collaboration with potential partners

Example: evolutionary path muons

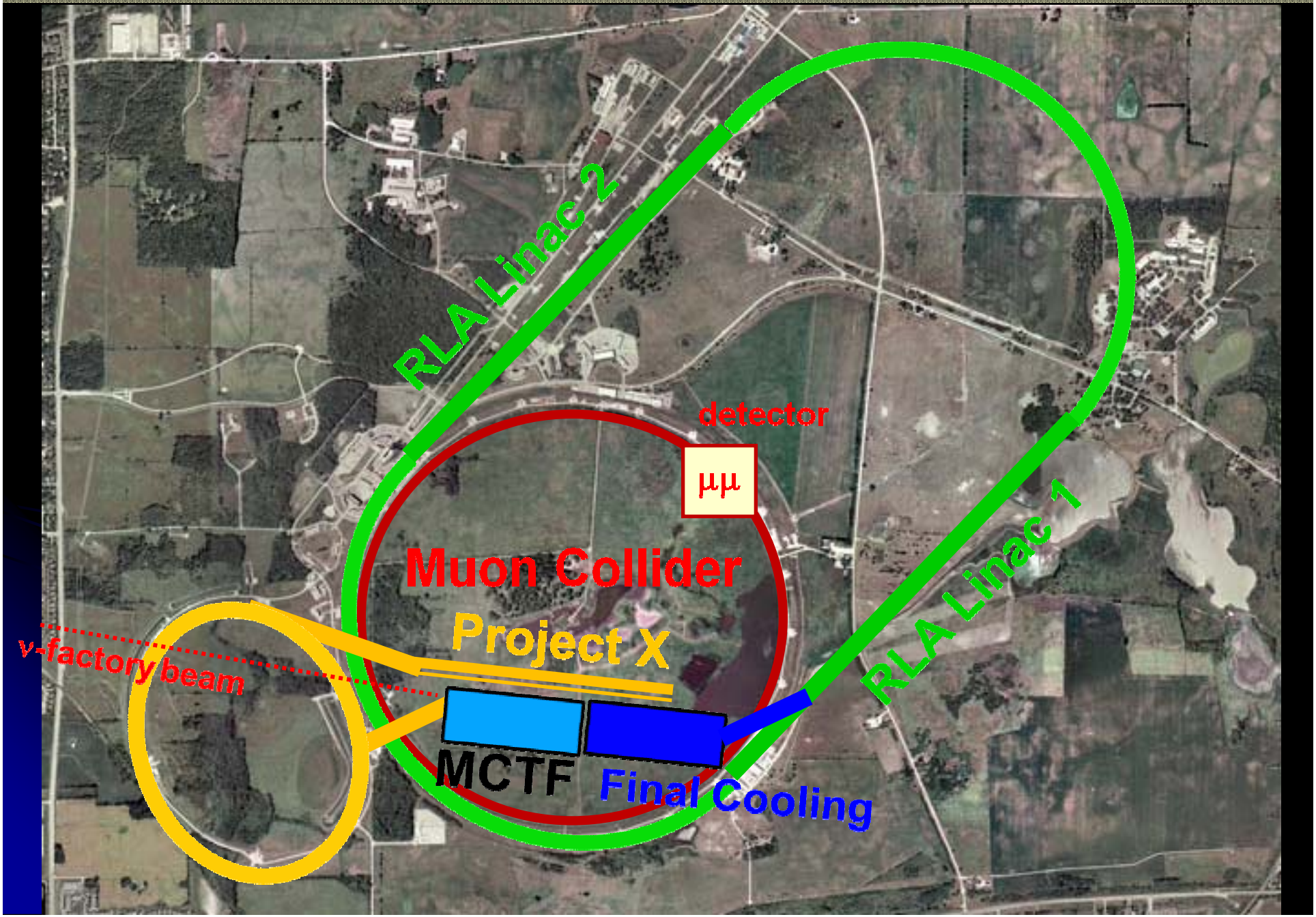


Illustrative Vision

Three projects of comparable scope:

- Project X (upgraded to 2MW)
- Muon Collider Test Facility
- 4 GeV Neutrino Factory

1.5-4 TeV Muon Collider at Fermilab



Concluding remarks

- We need a base program that
  - provides exciting physics
  - maintains many options for the future
  - is not dependent on huge jumps in funding
  - it can be carried out incrementally in bite size pieces
  - supports a path to gain a large machine at the energy frontier