

# **Overview and Presentation of Charge**

Steve Holmes  
AAC Meeting  
July 28-30, 2010

# Update Since November Meeting

## Operations: Collider Run II



- FY2010 numbers (to date)
  - 2.2 fb<sup>-1</sup> delivered to CDF and D0
  - 9.1 fb<sup>-1</sup> total for Run II
  - 5 week shutdown currently underway
- LHC startup at 7 TeV (center of mass) in spring 2010
- The current plan is to continue operations through 9/30/11
  - Most likely integrated luminosity through FY2011: 11.5 – 12.0 fb<sup>-1</sup>
- **Proposal to continue collider operations through 2014 currently under evaluation by the Physics Advisory Committee**
  - Delivered luminosity up to ~19 fb<sup>-1</sup>
  - Any decision will be taken in early fall in consultation with the DOE

# Update Since November Meeting

## Operations: Neutrinos



- FY2010 numbers (to date)
  - $3.0 \times 10^{20}$  protons to NuMI
    - $11 \times 10^{20}$  protons total
    - Typical operations at 300 kW simultaneous with antiproton production
      - Design goal is 320 kW
      - Limited by losses during injection
        - » “Gap-clearing kickers” being installed for mitigation
  - $1.3 \times 10^{20}$  protons to Booster Neutrino Beam (8 GeV)
    - $15 \times 10^{20}$  protons total
    - Interesting results from both experiments on neutrino-anti-neutrino asymmetries(?)
- The current plan is to continue operations until NO $\nu$ A starts up in FY2013
  - 700 kW design goal

# Update Since November Meeting Committee Membership



- Half of the committee membership has turned over since the last meeting:

## Continuing Members

Ilan Ben-Zvi/BNL  
Kathy Harkay/ANL, Chair  
(Stuart Henderson/ORNL)  
Jamie Rosensweig/UCLA  
Katsunobu Oide/KEK  
Roland Garoby/CERN

## New Members

Eric Colby/SLAC  
Steve Gourlay/LBNL  
Andrew Hutton/JLab  
Lia Merminga/TRIUMF  
Peter Ostroumov/ANL  
Andrei Seryi/JAI

## Guest Members (July 2010 meeting)

Mike Blaskiewicz/BNL  
Ferdinand Willeke/BNL

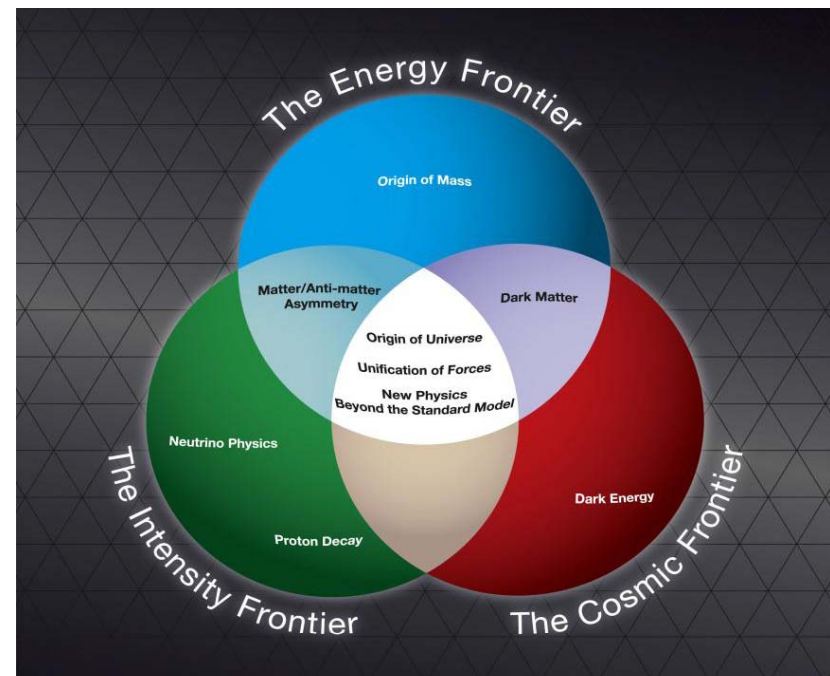
# Strategic Planning

## The Fermilab Long Range Plan



Fermilab is the sole remaining U.S. laboratory providing facilities in support of accelerator-based Elementary Particle Physics

⇒ *The Fermilab strategy is to mount a world-leading program at the intensity frontier, while using this program as a bridge to an energy frontier facility beyond LHC in the longer term.*



# Strategic Planning

## Evolution of the Fermilab Complex



- A multi-MW Proton Source, Project X, is the linchpin of Fermilab's strategy for future development of the accelerator complex.
- Project X provides long term flexibility for achieving leadership on the intensity and energy frontiers
  - Intensity Frontier:  
NuMI → NOvA → LBNE/mu2e → Project X → Rare Processes → NuFact
    - Continuously evolving world leading program in neutrino and rare processes physics; opportunities for applications outside EPP
  - Energy Frontier:  
Tevatron → ILC or Muon Collider
    - Technology alignment
    - Fermilab as host site for ILC or MC

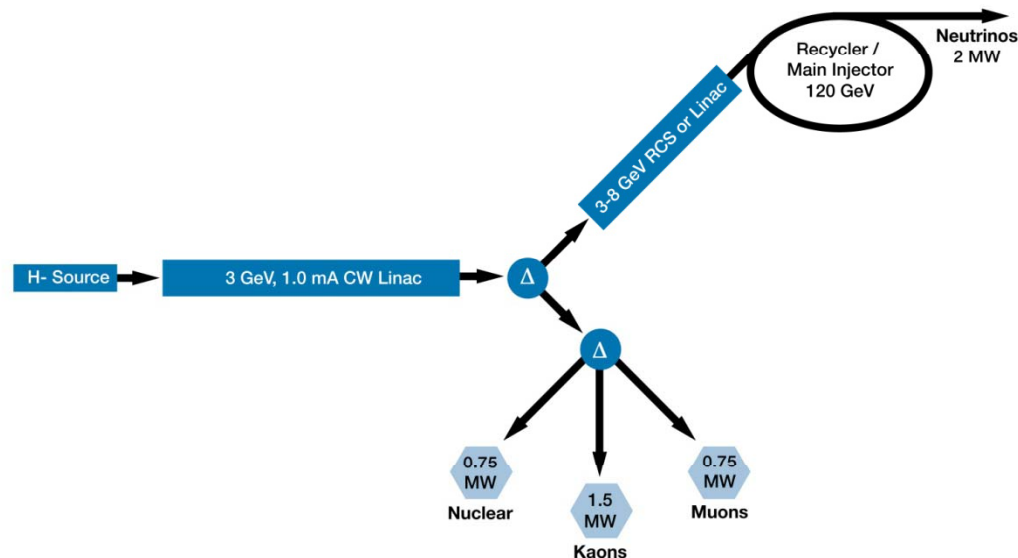
# Strategic Planning Project X



- Goals:
  - Complete RD&D and establish project baseline (CD-3) by 2014
    - Execute RD&D phase via multi-laboratory collaboration
    - Coordinate development with ILC/GDE and the Muon Collaborations
  - Construct over time period ~2015~2019
- Design Criteria based on mission need established by P5
  - Long Baseline Neutrinos: >2 MW at 60-120 GeV
  - Rare Processes:  $\geq$  few  $\times$  100 kW at 3 – 8 GeV
  - Muon Platform: upgradable to 4 MW at 5 – 15 GeV

# Project X

## Initial Configuration-2

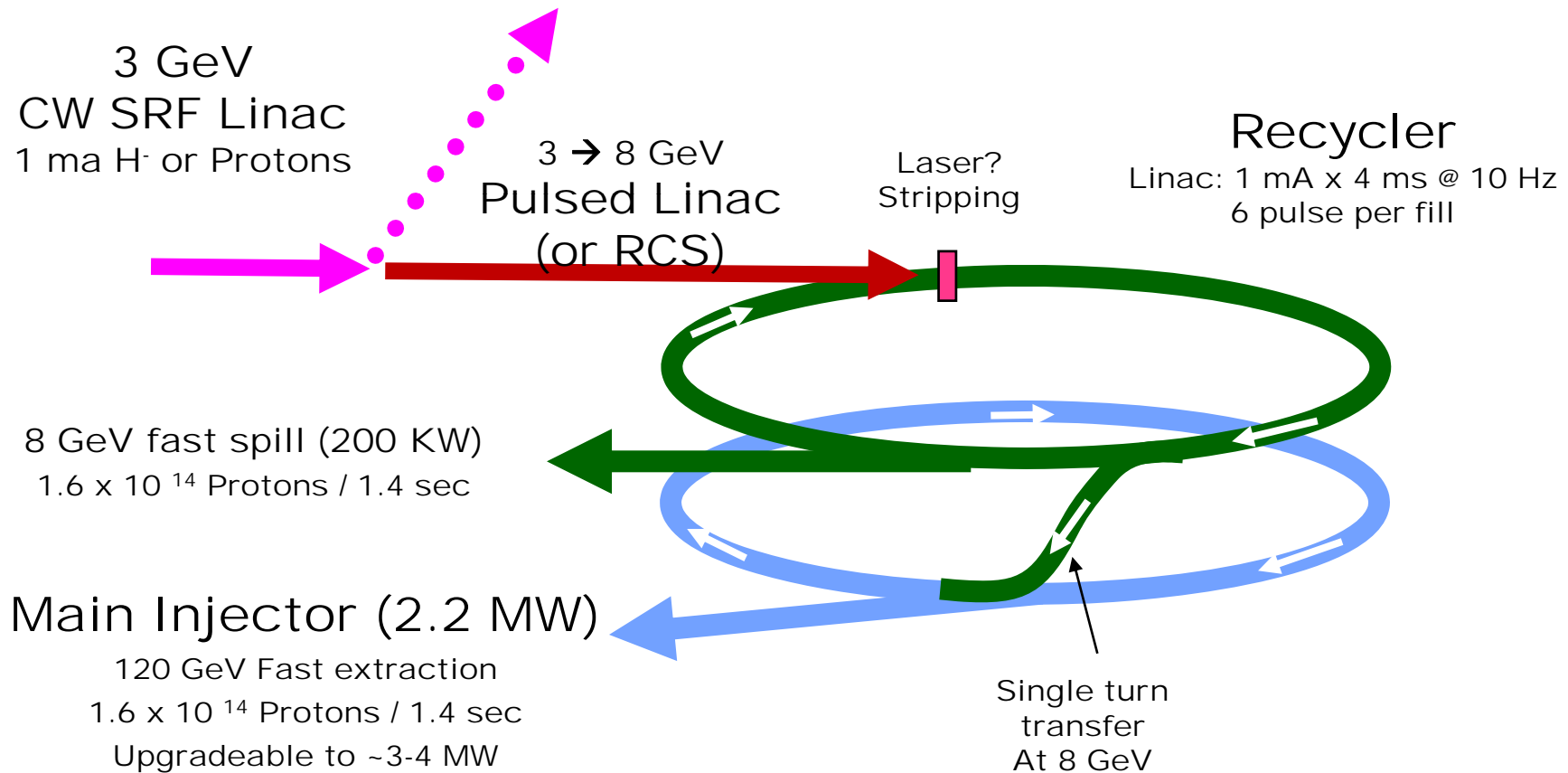


- 3 GeV CW linac provides greatly enhanced rare process program
  - 3 MW; flexible provision for beam requirements of multiple users
- Options for 3-8 GeV acceleration: RCS or pulsed linac
  - Linac would be 1300 MHz with 4-25 msec pulse length
- Initial Configuration Document-2 in preparation for summer release



# Project X

## IC-2 Operating Scenario



# Project X

## IC-2 Performance Goals



### Linac

Particle Type  
Beam Kinetic Energy  
Average Beam Current  
Linac pulse rate  
Beam Power  
Beam Power to 3 GeV program

H<sup>-</sup>  
3.0 GeV  
1 mA  
CW  
3000 kW  
2870 kW

### RCS/Pulsed Linac

Particle Type  
Beam Kinetic Energy  
Pulse rate  
Pulse Width  
Cycles to MI  
Particles per cycle to Recycler  
Beam Power to 8 GeV program

protons/H<sup>-</sup>  
8.0 GeV  
10 Hz  
0.002/4.3 msec  
6  
 $2.6 \times 10^{13}$   
200 kW

### Main Injector/Recycler

Beam Kinetic Energy (maximum)  
Cycle time  
Particles per cycle  
Beam Power at 120 GeV

120 GeV  
1.4 sec  
 $1.6 \times 10^{14}$   
2200 kW

simultaneous

# Project X

## IC-2 Operating Scenario



1  $\mu$ sec period at 3 GeV

mu2e pulse (9e7) 162.5 MHz, 100 nsec

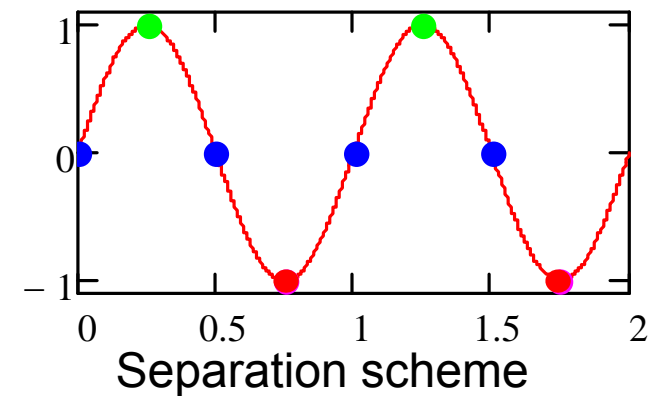
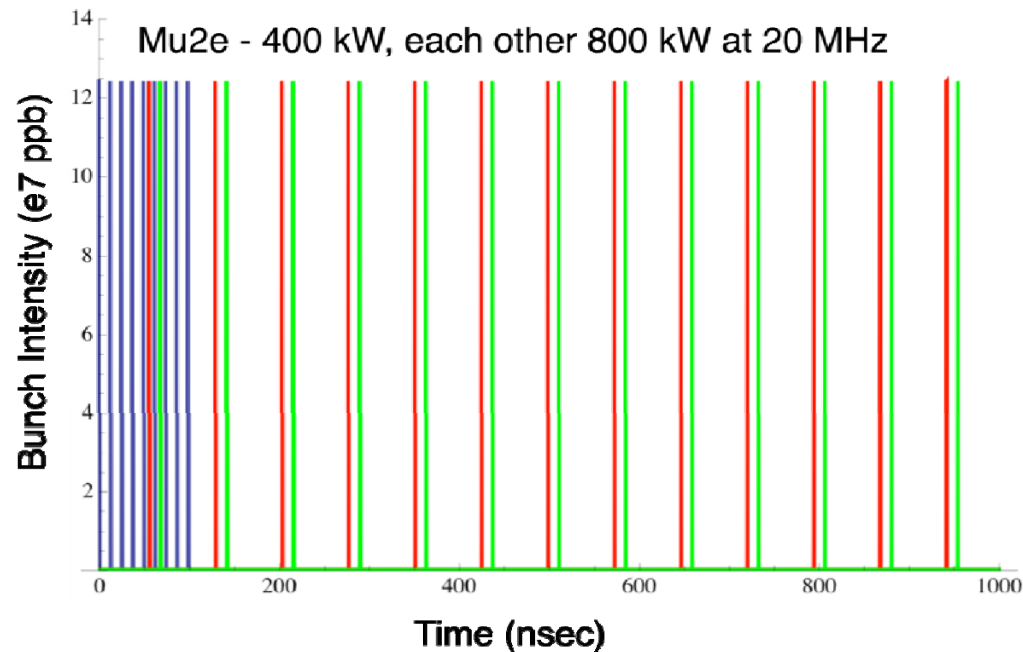
400 kW

Kaon pulse (9e7) 27 MHz

800 kW

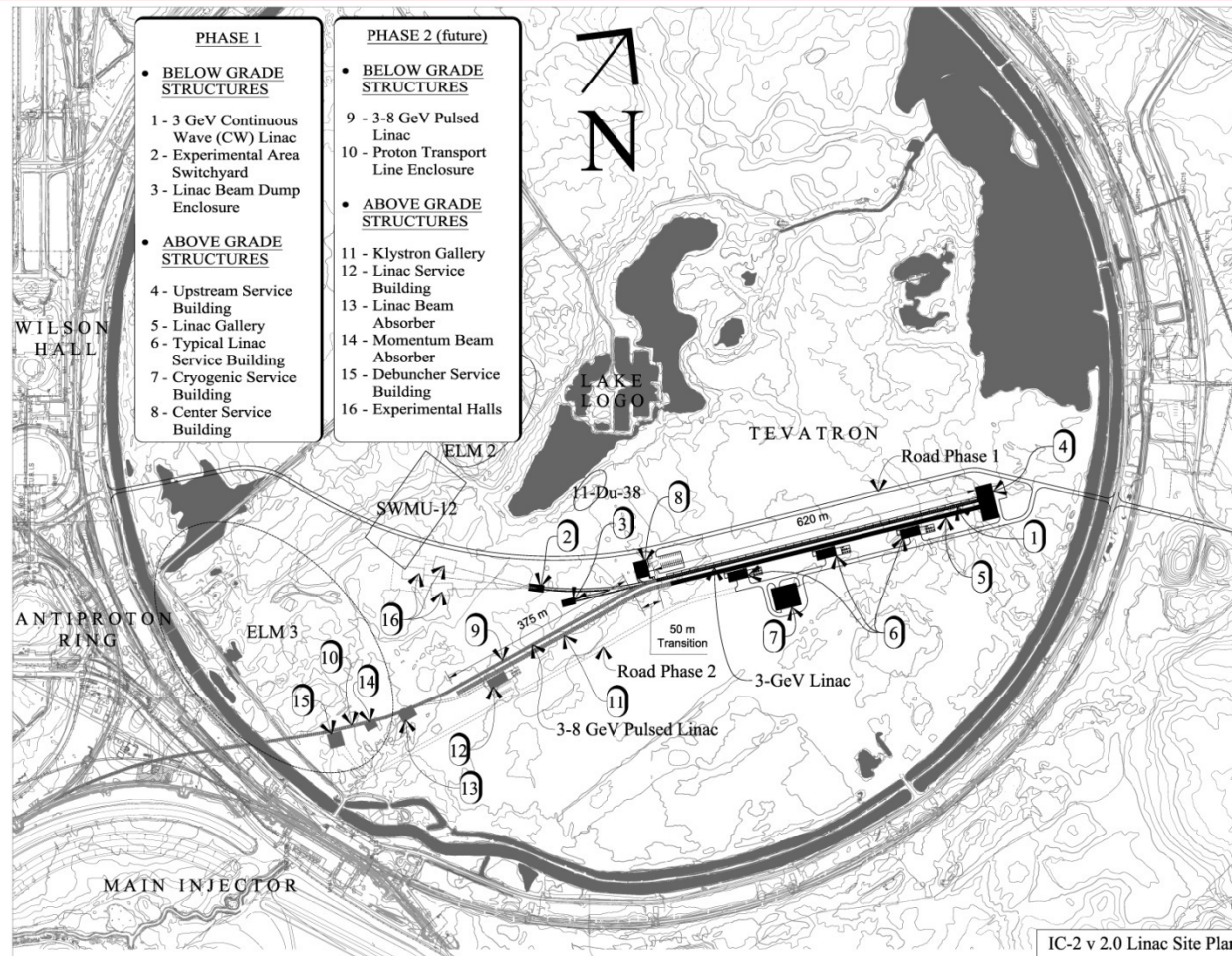
Other pulse (9e7) 27 MHz

800 kW



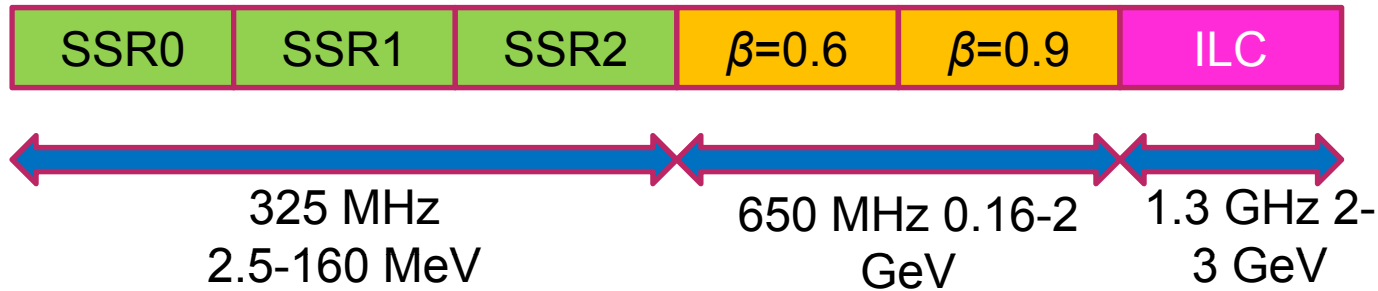
# Project X

## IC-2 Provisional Siting



# Project X

## IC-2 Technology Map



Section	Freq	Energy (MeV)	Cav/mag/CM	Type
SSR0 ( $\beta_G=0.11$ )	325	2.5-10	26 /26/1	SSR, solenoid
SSR1 ( $\beta_G=0.22$ )	325	10-32	18 /18/ 2	SSR, solenoid
SSR2 ( $\beta_G=0.4$ )	325	32-160	44 /24/ 4	SSR, solenoid
LB 650 ( $\beta_G=0.61$ )	650	160-520	42 /21/ 7	5-cell elliptical, doublet
HB 650 ( $\beta_G=0.9$ )	650	520-2000	96 /12/12	5-cell elliptical, doublet
ILC 1.3 ( $\beta_G=1.0$ )	1300	2000-3000	64 / 8/ 8	9-cell elliptical, quad

# Project X

## IC-2 Primary Technical Issues



- Linac
  - SRF development at all relevant frequencies
    - Cavities, cryomodules, power sources
  - Baseline concept for the (wideband) chopper
  - Low loss cw linac design
  - Concepts for marrying a 3-8 GeV pulsed linac to CW front end
- Rings
  - Injection into RCS or Recycler
  - (Elimination of the Recycler as a proton accumulator?)
  - High power operations of the Main Injector (4x current protons per pulse; 2.5 A circulating current)
  - (High power targetry)

# Project X/ILC SRF Development



- Fermilab Facilities
  - HINS
    - Front end development (first 10-20 MeV)
  - VTS – one operational, two more under construction at Fermilab
  - HTS – one operational, one in design
  - BCP and ep processing facility in operation (at ANL)
  - Cryomodule assembly facility operational
  - NML\_ILCTA under construction
  - ARRA funded facilities (under construction)
    - NML extension
    - NML refrigerator
    - CMTF
    - Vendor development
  - Illinois funded facility
    - IARC



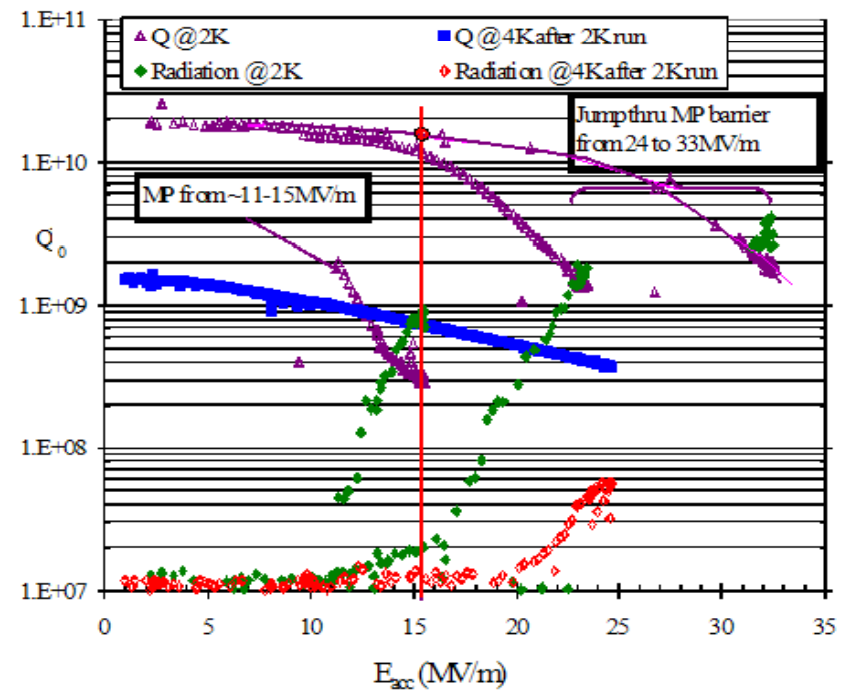
# Project X/ILC SRF Development



NML test facility



# Project X/ILC SRF Development



SSR1 Cavity

# Project X/ILC SRF Development



NML Extension w/ refrigerator and CMTF buildings

# Project X Collaboration Status



- 
- Multi-institutional collaboration established to execute the Project X RD&D Program.
    - Fermilab as lead laboratory
    - International participation via in-kind contributions, established through bi-lateral MOUs.
  - MOU outlines basic goals, and the means of organizing and executing the work. Signatories:

ANL	ORNL/SNS	BARC/Mumbai
BNL	MSU	IUAC/Delhi
Cornell	TJNAF	RRCAT/Indore
Fermilab	SLAC	VECC/Kolkata
LBNL	ILC/ART	
  - Collaborator R&D responsibilities largely defined
  - Other interested parties: CERN, IHEP, Korea, ESS
  - Collaboration meeting 9/8-9

# Project X

## Strategy/Timeline



- 
- Department of Energy Science and Technology Review July 13-15
    - ⇒ Accelerator concept sufficiently developed for CD-0
    - ⇒ Physics case not sufficiently developed for CD-0
  - August: Complete preliminary design, configuration, and cost range information for IC-2
    - ICD-2v2.0
    - Cost estimate
    - Updated RD&D Plan with resource loaded schedule
  - Continue conceptual development on outstanding technical questions
    - Baseline concept for the chopper
    - Concepts for marrying a 3-8 GeV pulsed linac to CW front end
    - Injection into RCS or Recycler
  - Pursue R&D aimed at the CW linac
    - Emphasis of srf development at all relevant frequencies
    - Engage external collaborators and identify roles
  - Further development of the physics program
    - Five working groups established to complete draft white papers by 8/31; fall physics workshops
  - Prepare to complete all RD&D supporting a FY2015 construction start
    - Prepare to construct Project X over a five year time period
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# Strategic Planning Muon Facilities

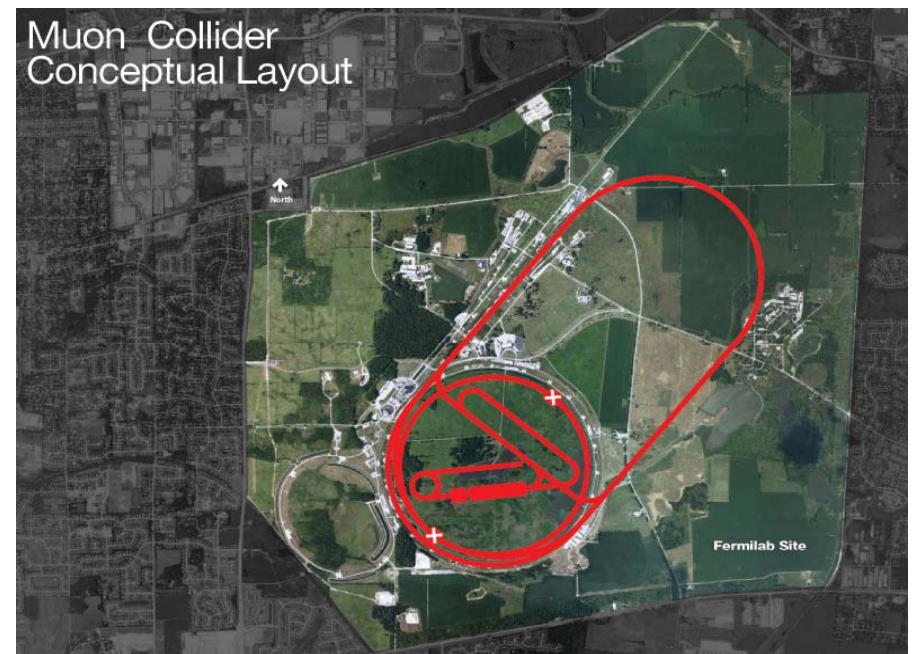


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- **Muon Accelerator Program**
    - In the fall of 2009 the DOE requested the Fermilab Director to organize a national muon activities within a single program with Fermilab as the lead laboratory
    - The DOE invited the submission of a ~5-year proposal covering these activities.
    - The proposal was submitted in the spring of 2010 and will be reviewed by the DOE on August 24-26
  - **MAP Deliverables**
    - Reference Design Report for a muon-storage-ring-based Neutrino Factory: ~2014
      - Completed with international partners (IDS\_NF)
    - Design Feasibility Study for a Muon Collider with a center of mass energy in excess of 1 TeV: ~2016
    - Technology development + technology roadmap for a MC Conceptual Design Report: ~2016
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# Muon Facilities



- Project X shares many features with the proton driver required for a Neutrino Factory or Muon Collider
  - NF and MC require  $\sim 4$  MW @  $10 \pm 5$  GeV
  - Primary issues are related to beam “format”
    - NF wants proton beam on target consolidated in a few bunches; Muon Collider requires single bunch
  - Project X linac is not capable of delivering this format



⇒ It is inevitable that a new ring(s) will be required to produce the correct beam format for targeting.

# Charge to the Committee



- 
- Review and comment on in three areas:
    - Proposal for an extended period of accelerator studies following the end of collider operations
    - AARD activities at A0, followed by a program at NML utilizing the beam provided for/by the ILC rf unit test
    - Project X as a Muon Facility front end

# Charge to the Committee (cont.)



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- Proposed Accelerator Studies Following the End of Collider Operations

The Committee is asked to review and offer comments/recommendations relative to the end-of-run Tevatron studies proposal. In particular we request specific comments and recommendations in the following areas:

- Are goals of the study period well defined?
- What aspects of the proposal are most compelling in terms of advancing the world's knowledge of the accelerator physics phenomena in high energy proton colliders?
- What aspects of the proposal are most compelling in terms of providing information required to maximize performance of the LHC over the upcoming decade?
- Is the accompanying studies plan/schedule well structured to achieve the goals outlined?

More generally, we would be happy to receive comments and suggestions from the AAC on how the studies plan could be strengthened.



# Charge to the Committee (cont.)



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- Advanced Accelerator R&D Program at A0 and the New Muon Lab (NML)  
The A0 photoinjector is scheduled to be relocated to NML in order to provide direct support of the ILC rf unit test. This move affords the opportunity for development of a world-class program of Advanced Accelerator R&D based on the photoinjector and the ILC cryomodules. Fermilab would like the AAC's advice in identifying potential activities that could form the basis of a competitive proposal for AARD to be submitted to DOE:
    - Identify those elements of the potential program that hold the highest scientific interest within both a national and international context.
    - Identify those characteristics of the NML facility that are unique, and suggest how those characteristics might best be capitalized on.
    - Any further suggestions on the development of a competitive proposal are appreciated.

Fermilab has received a proposal for a Source Development Laboratory at A0 following the departure of the photoinjector. The Committee is asked to review this proposal and offer advice in the following areas:

- How compelling and timely are the scientific objectives?
- How credible is the plan for achieving the objectives?
- What are the opportunities for development of the facility beyond initial objectives?

# Charge to the Committee (cont.)



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- Concepts for Evolving Project X into a Muon Collider Front End

An important mission of Project X is to provide a basis for the eventual development of a muon based facility (Neutrino Factory or Muon Collider) on the Fermilab site. The effort in defining requirements and upgrade paths has just begun, and we would like the committee to look at and comment on the approach. Specifically, we would like feedback from the Committee on the following points:

- Have the fundamental physics/technical issues that need to overcome to utilize Project X as a muon front end been identified?
- What is the level of understanding relative to translating these issues into performance requirements for Project X, either in its initial or upgraded configuration?
- Do the general concepts outlined lead one to conclude that an upgrade path should, in principle, exist?
- Does the program of study proposed provide confidence that such an upgrade path, and corresponding requirements on Project X, could be established over the next two years?

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## Fine Print

As usual the committee is invited to issue comments or suggestions on any aspect of the programs discussed beyond those specifically included in this charge. It is requested that a concise report responsive to this charge be forwarded to the Fermilab Director by September 1, 2010. Thank you.

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