Project X: News, Strategy, Meeting Goals

Steve Holmes
Project X Collaboration Meeting
April 10, 2012

Outline

- Project Goals
- Update on Activities of the Six Months
  - DOE Intensity Frontier Workshop
  - Briefing to OHEP: Staging
  - R&D Program/PXIE
- Project X Status and Strategy
- Collaboration Activities
- Meeting Goals, Agenda, and Organization

Our websites:

http://projectx.fnal.gov

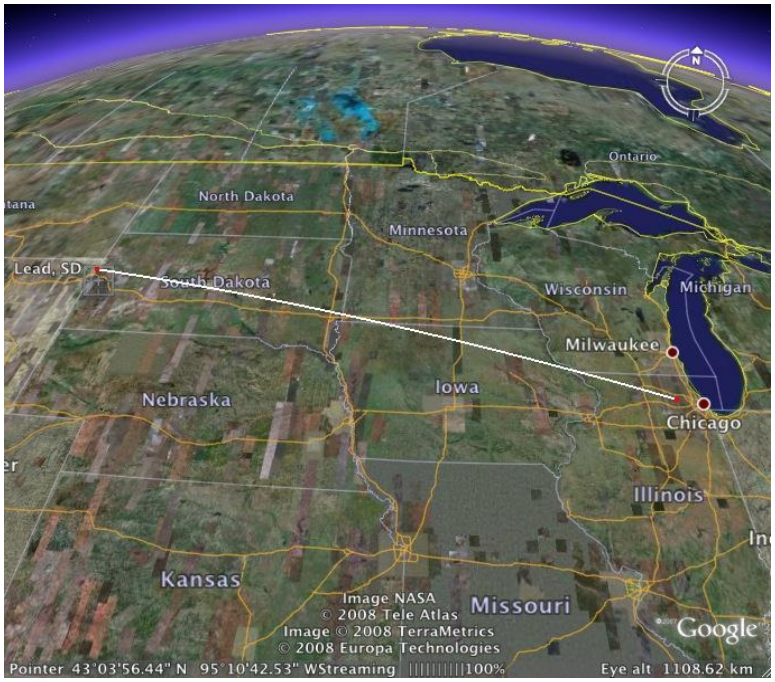
http://projectx-docdb.fnal.gov

Meeting website:

http://projectx.fnal.gov/meetings/2012/april_12_collaboration_meeting.html

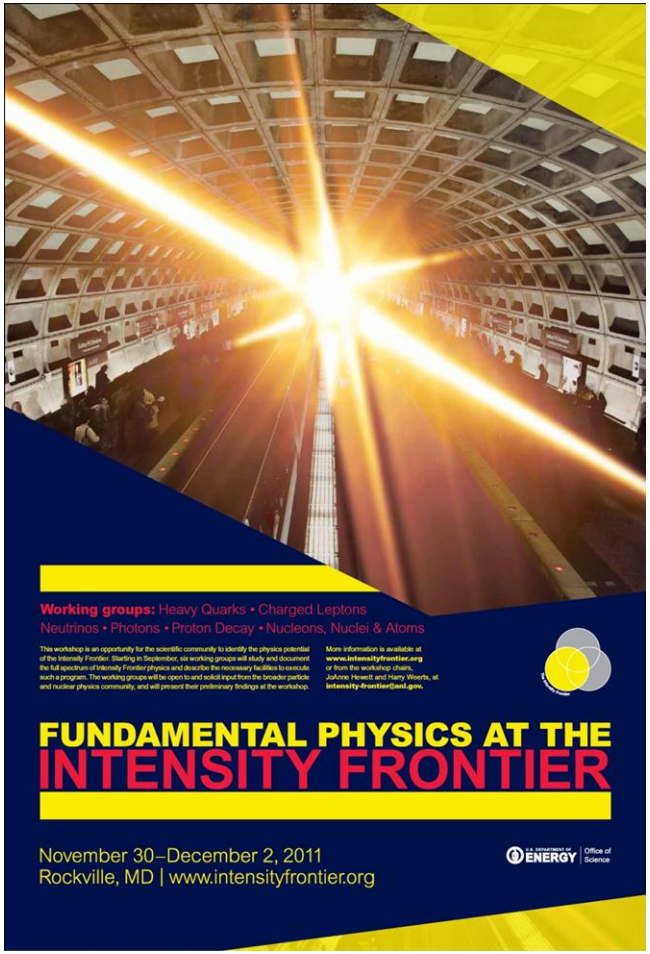
Project Goals
Mission Elements

- A neutrino beam for long baseline neutrino oscillation experiments
  - 2 MW proton source at 60-120 GeV
- High intensity, low energy protons for kaon and muon based precision experiments
  - Operations simultaneous with the neutrino program
- A path toward a muon source for possible future Neutrino Factory and/or a Muon Collider
  - Requires ~4 MW at ~5-15 GeV



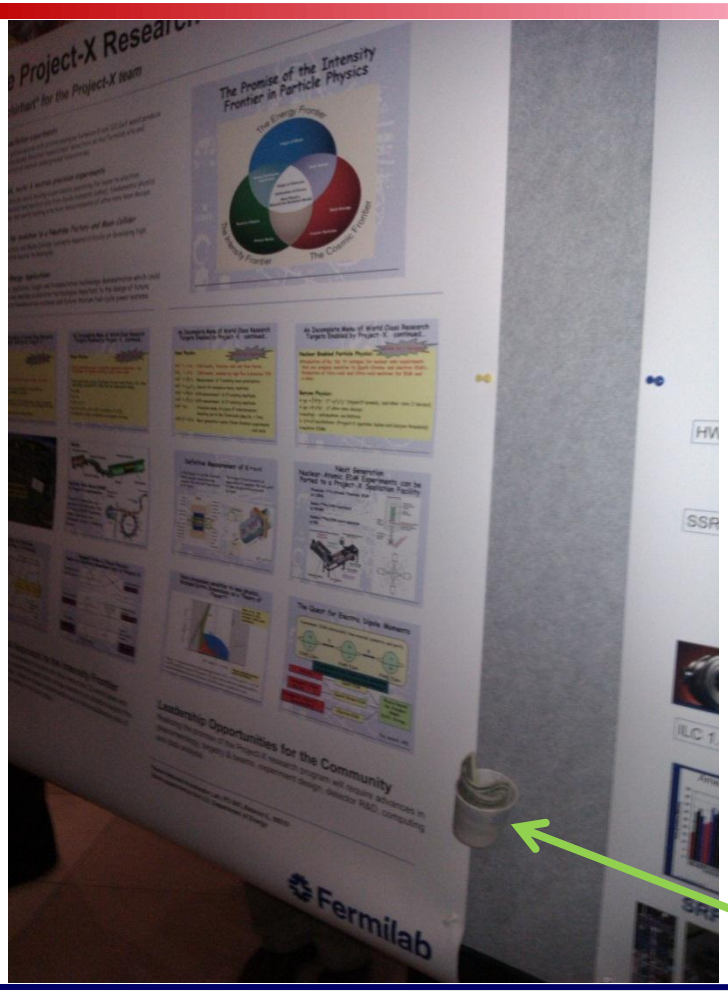
- Possible missions beyond P5
  - Standard Model Tests with nuclei and energy applications

DOE Intensity Frontier Workshop



- 500+ Attendees
- Five very active working groups:
  - Charged leptons
  - Heavy Quarks
  - Hidden Sector
  - Neutrinos
  - Nucleons/Nuclei/Atoms
  - Proton Decay
- Draft report prepared and submitted to OHEP
- Intensity Frontier strategy due to Congress in early summer

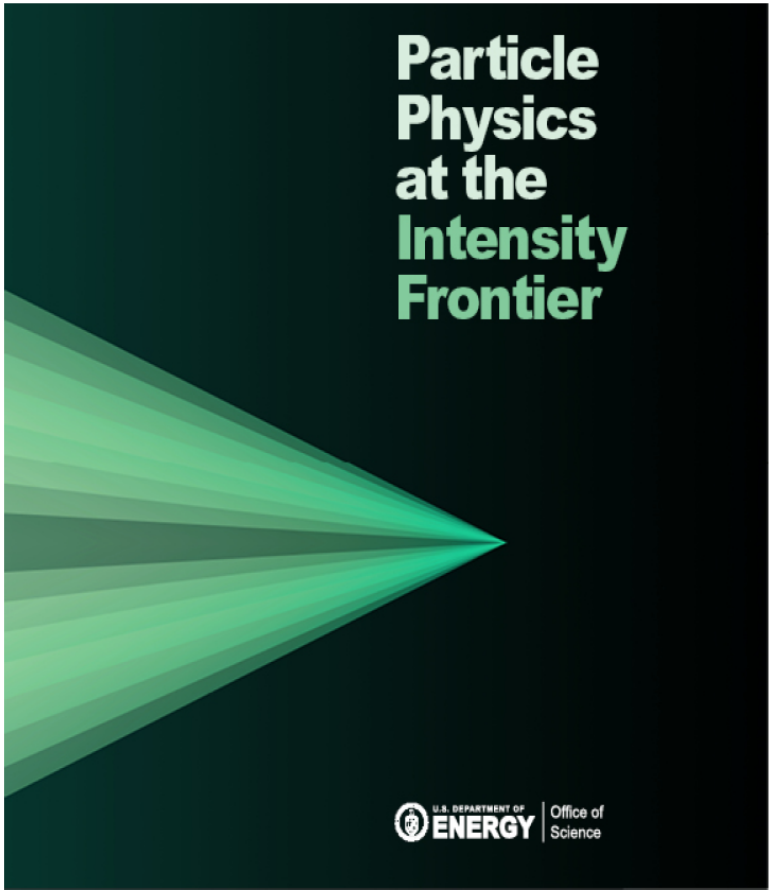
DOE Intensity Frontier Workshop



- Provided WGs with overview of Fermilab proton capabilities over next two decades
- Presentations/discussions on Project X in all sessions
  - Two page summaries provided post-Workshop to each WG
- Widespread interest in:
  - Neutrino physics
  - Rare K decays
  - Charged lepton flavor violation
  - edms
  - n-nbar oscillations
- Significant interest in multi-MW 8 GeV option within the Neutrino WG
- Multiple challenges with MW-class targets

Project X initial funding

Vision for Program Development



Dr. Jim Siegrist, Associate Director
Office of High Energy Physics
Office of Science, U.S. Department of Energy

- Our domestic program is the world leader in 'Intensity Frontier' area, and we need to increase investments there, while keeping a balance with the other frontiers
- Community is engaged on further developing the science case on all 3 frontiers – we need a healthy portfolio of construction ideas supported by compelling science drivers at achievable budget levels
  - Will need more help from the community here; see also talks tomorrow
- Our program will deliver science now, in the near term, and in the long term on all 3 frontiers

Briefing to OHEP on January 27, 2012

- Intensity Frontier Workshop
- Staging Options
  - Physics Opportunities – Bob T
- Planning
- R&D Program
  - PXIE Program - Sergei
- 2012 Summer Study
- Thoughts on 2013 Snowmass?
- Collaboration
- The Name

Staging Options
Accelerator Configuration

- Staging opportunities are under discussion with DOE. Goals:
  - Significantly <$1B/stage
  - Significant physics program at each stage
  - Full Reference Design ultimately realized
- Stage 1
  - 1 GeV × 1 mA CW linac injecting into existing (upgraded) Booster
- Stage 2
  - Add 1-3 GeV × 1 mA CW linac
- Stage 3 (Reference Design)
  - Add 3-8 GeV × 1 mA @4.3% duty factor pulsed linac injecting into (upgraded) Recycler/MI
- Stage 4 (Beyond the Reference Design)
  - Upgrade power to 4 MW at 8 GeV

Staging Options
Physics Program

- Stage 1
  - Neutrinos: long and short baseline
  - Rare kaon decays from the MI
  - Muon to electron conversion
  - Ultra-cold neutrons and edms
  - Material and energy applications test facility
- Stage 2 – all of the above, plus
  - MW-class kaon physics program
  - MW-class muon physics program
- Stage 3 (Reference Design) – all of the above, plus
  - Multi-MW long baseline neutrinos
- Stage 4 (Beyond the Reference Design)
  - Multi-MW short baseline neutrinos
  - Muon source for Neutrino Factory or Muon Collider

Power Profile for the Research Program

Program:	Stage-0: Proton Improvement Plan	Stage-1: 1 GeV CW Linac driving Booster & Muon Campus	Stage-2: Upgrade to 3 GeV CW Linac (MI>70 GeV)	Stage-3: Project X RDR (MI>60GeV)	Stage-4: Beyond RDR: 8 GeV power upgrade to 4MW
MI neutrinos	470-700 kW**	515-1200 kW**	1200 kW	2300 kW	2300-4000 kW
8 GeV Neutrinos	15 kW + 0-50 kW**	0-40 kW* + 0-90 kW**	0-40 kW*	85 kW	3000 kW
8 GeV Muon program e.g, (g-2), Mu2e-1	20 kW	0-20 kW*	0-20 kW*	85 kW	1000 kW
1-3 GeV Muon program	-----	80 kW	1000 kW	1000 kW	1000 kW
Kaon Program	0-30 kW** (<30% df from MI)	0-75 kW** (<45% df from MI)	1100 kW	1100 kW	1100 kW
Nuclear edm ISOL program	none	300 kW	300 kW	300 kW	300 kW
Ultra-cold neutron program	none	300 kW	300 kW	300 kW	300 kW
Nuclear technology applications	none	300 kW	300 kW	300 kW	300 kW
# Programs:	4	8	8	8	8
Total* power (mean):	660 kW	2020 kW	4210 kW	5490 kW	11300kW

* Operating point in range depends on MI energy for neutrinos.

** Operating point in range is depends on MI injector slow-spill duty factor (df) for kaon program.

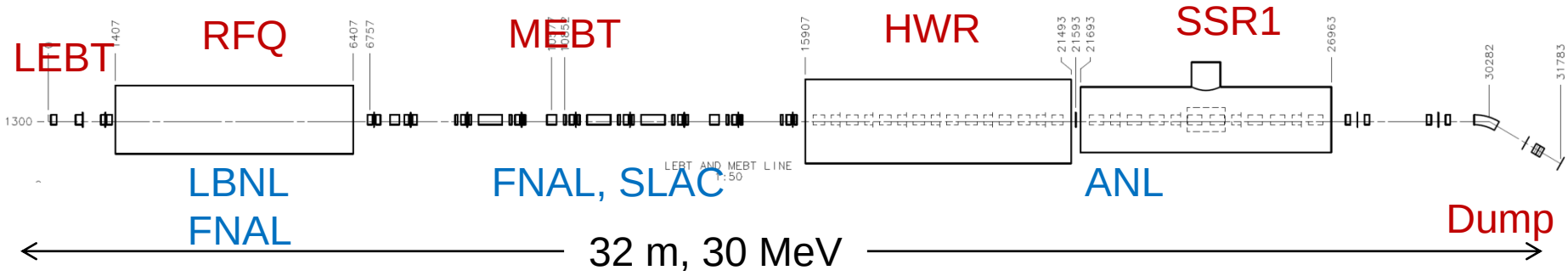
R&D Program

- Goal is to mitigate risk: technical, cost, and schedule
  - Primary elements of the R&D program:
    - The primary technical risk element is the front end
      - CW ion source/RFQ
      - Wideband chopping with high (1×10^{-4}) extinction rate
      - (Low-β) acceleration through superconducting resonators with minimal halo formation
      - MEBT beam absorber (>8 kW)
    - Development of an H- injection system
    - Superconducting rf development
      - Cavities, cryomodules, rf sources – CW to long-pulse
      - Development of partners and vendors
    - High Power targetry
    - Integrated facility design
      - Physics performance requirements
      - reliability analysis
    - Upgrade paths: MC and Muons@PX Task Forces
    - First and third elements addressed in an integrated system test: PXIE
- Goal is to complete R&D phase by 2016

Project X Injector Experiment PXIE

- The primary technical risk element of Project X is the front end
  - CW ion source/RFQ
  - Wideband chopping with high (1×10^{-4}) extinction
  - (Low-β) acceleration through superconducting resonators with minimal halo formation
  - MEBT beam absorber (>8 kW)
- PXIE is the centerpiece of the Project X R&D program
  - Integrated systems test for Project X front end components
    - Validate the concept for the Project X front end, thereby minimizing the primary technical risk element within the Reference Design.
    - Operate at full Project X design parameters
- Integrated systems test goals
  - 1 mA average current with 80% chopping of beam delivered from RFQ
  - Efficient acceleration with minimal emittance dilution through ~30 MeV
  - Achieve in 2016
- Collaboration between Fermilab, ANL, LBNL, SLAC, India

PXIE Program



PXIE will address the address/measure the following:

- Ion source lifetime
- LEBT pre-chopping
- Vacuum management in the LEBT/RFQ region
- Validation of chopper performance
- Kicker extinction
- Effectiveness of MEBT beam absorber
- MEBT vacuum management
- Operation of HWR in close proximity to 10 kW absorber
- Operation of SSR with beam
- Emittance preservation and beam halo formation through the front end

PXIE Status

- We have written a whitepaper that has been shared with DOE
  - Rationale
  - Goals
  - Plan

  http://projectx-docdb.fnal.gov/cgi-bin/ShowDocument?docid=966
- Technical Review March 6-7

  https://indico.fnal.gov/conferenceDisplay.py?confId=5278
- We have developed a cost estimate and funding plan that will allow completion of the full scope of PXIE in 2016
  - Requires maintenance of Project X and SRF budgets at FY12 levels
- The DOE has requested that we organize and execute PXIE as a “project”, not a “Project”
  - Organization Chart
  - Program Design Handbook
  - Resource Loaded Schedule
  - DOE oversight
    - Periodic reporting
    - Periodic review

Project X Status and Strategy

- Project X strategy is strongly tied to the overall DOE Intensity Frontier Strategy
  - LBNE: What will or will not be done is in a state of flux at the moment
    - Two Task Forces established at Fermilab
- Project X strategy is strongly tied to the overall fiscal condition of the U.S.
  - Strong message from the DOE on staging
- We remain well supported financially for the R&D phase
  - $13M in FY12 and FY13 + significant investment in srf
- A significant effort is going into defining the physics research opportunities at all stages
  - Recent workshops on opportunities with spallation sources and on short baseline neutrinos
  - Project X Physics Study schedule June 14-23, 2012
  - Snowmass 2013 in planning stages (DPF)
- A significant contribution from India remains a strong possibility

Project X Status and Strategy

- Strategy
  - Develop the physics case and mobilize support within the community
    - Includes outreach to non-HEP communities
  - Maintain the RDR as the description of the ultimate goal
  - Maintain the cost estimate for the RDR, with the Stage 1 piece easily segregated
  - Develop a Reference Design description for Stage 1
  - Pursue the PXIE program as a priority within the Project X R&D program
  - Maintain an R&D plan based on a flat-budget
  - Be immediately responsive to DOE when they ask for information

Collaboration Activities

- Two MOUs covering the RD&D Phase

National		IIFC
ANL	ORNL/SNS	BARC/Mumbai
BNL	PNNL	IUAC/Delhi
Cornell	TJNAF	RRCAT/Indore
Fermilab	SLAC	VECC/Kolkata
LBNL	ILC/ART	
MSU		

Since last meeting

- Informal collaboration/contacts with CERN/SPL, ESS China/ADS, UK, Korea/KoRIA
- Collaboration Council
  - Institutional representation from all collaborators
  - Semi-annual meeting
- Weekly Friday meeting: https://indico.fnal.gov/categoryDisplay.py?categId=168
  - Collaborator participation via webex
  - Meeting notes posted
- Semi-annual Collaboration meetings

Collaboration Meeting: Goals

- Detailed discussion of the front end development program, with an emphasis on PXIE goals, concepts, and planning.
- Exploration of research opportunities for particle physics research with nuclei
  - edms
  - Energy applications
- Statusing and plans for SRF development for PX and other applications
  - Cavity development
  - Cryomodule design efforts
  - Rf sources
- Collaboration Council Meeting
  - Review of Project X status and strategy
  - Review current institutional assignments
  - Budget outlook
  - Establish next Collaboration Meeting dates

Collaboration Meeting
Working Groups

- As in the recent past we will run only two working groups in parallel at any given time. This will allow people to have access to multiple working groups.
- WG 1: PXIE
  - Plans, design concept, institutional assignments
- WG 2: Experimental Opportunities
  - Emphasis on nuclei and nuclear energy applications
- WG 3: SRF Development
  - Cavities, couplers, cryomodules, test stands
  - For both PX and NGLS

Collaboration Meeting
Agenda

- Tuesday, April 10
  - Plenary Session 09:00-12:00
    - Welcome, Overview of LBNL Accelerator Programs — S. Gourlay
    - Project X News, Strategy, Meeting Goals — S. Holmes
    - PXIE Overview: Goals, Concepts, and Planning — S. Nagaitsev
  - Break 10:00-10:30
    - Physics Research Opportunities at Project X — R. Tschirhart
    - Overview of SLAC Accelerator Programs — N. Holtkamp
  - Lunch 12:00-13:00
  - Working Groups 1 & 2 13:00-15:00
  - Coffee Break 14:30-15:00
  - Working Groups 1 & 2 15:00-17:30
  - Adjourn 17:30
  - Collaboration Council 18:00-19:00

https://indico.fnal.gov/conferenceOtherViews.py?view=standard&confId=5300

Collaboration Meeting
Agenda

- Wednesday, April 11
  - Working Groups 1 & 2 08:30-10:00
  - Coffee Break 10:00-10:30
  - Working Groups 1 & 2 10:30-12:00
  - Lunch 12:00-13:00
  - Working Groups 3 & 2 13:00-15:00
  - Coffee Break 15:00-15:30
  - Working Groups 3 & 2 15:30-17:30
  - Adjourn 17:30

Collaboration Meeting
Agenda

- Thursday, April 12
  - Working Group 3 08:30-9:00
  - Working Group Action Items/Deliverables 9:15-10:00
  - Coffee Break 10:00-10:30
  - Working Group Action Items/Deliverables 10:30-11:00
  - Adjourn 11:00

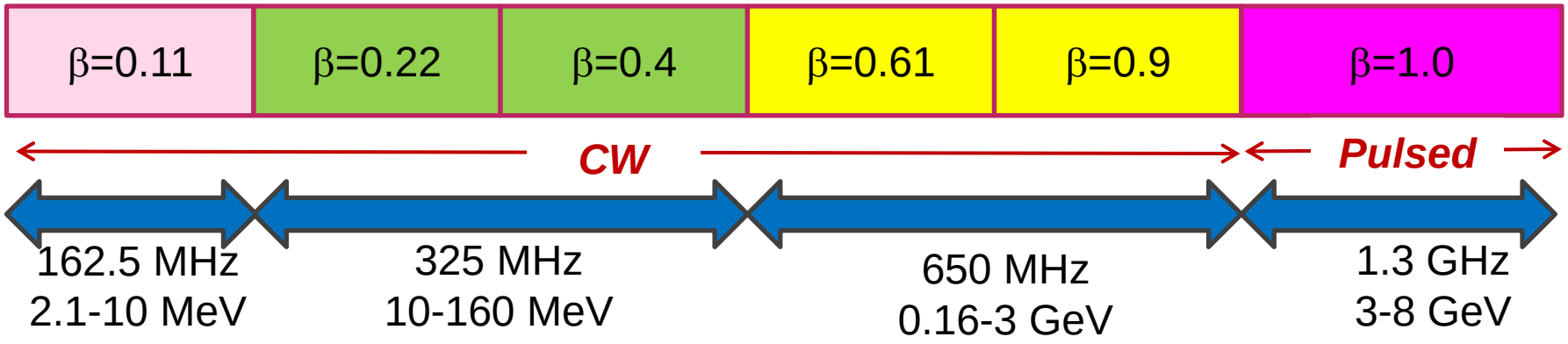
  - RFQ Design Review 13:00-15:00

Summary

- Project X Reference Design concept has remained stable for two years, subject to technical adjustments
  - Adopted 162.5 MHz front end through 10 MeV prior to last meeting
- Funding constraints within the DOE have led us to identify staging scenarios
  - A 1 GeV CW linac feeding the existing Booster appears the most likely first step
- R&D program underway with very significant investment in srf
  - Emphasis on the CW linac, including front end development program (PXIE)
  - See Sergei's talk
- Significant activities are underway to define physics programs associated with all stages
- Date of CD-0 is unknown: DOE Intensity Frontier Strategy under development
  - "Move forward and be ready"
- Collaboration Meeting Goals:
  - Understand, and modify as necessary, the PXIE plan
  - Identify research opportunities with nuclei and nuclear energy applications at 1 GeV
  - Understand, and modify as necessary, the srf development plan

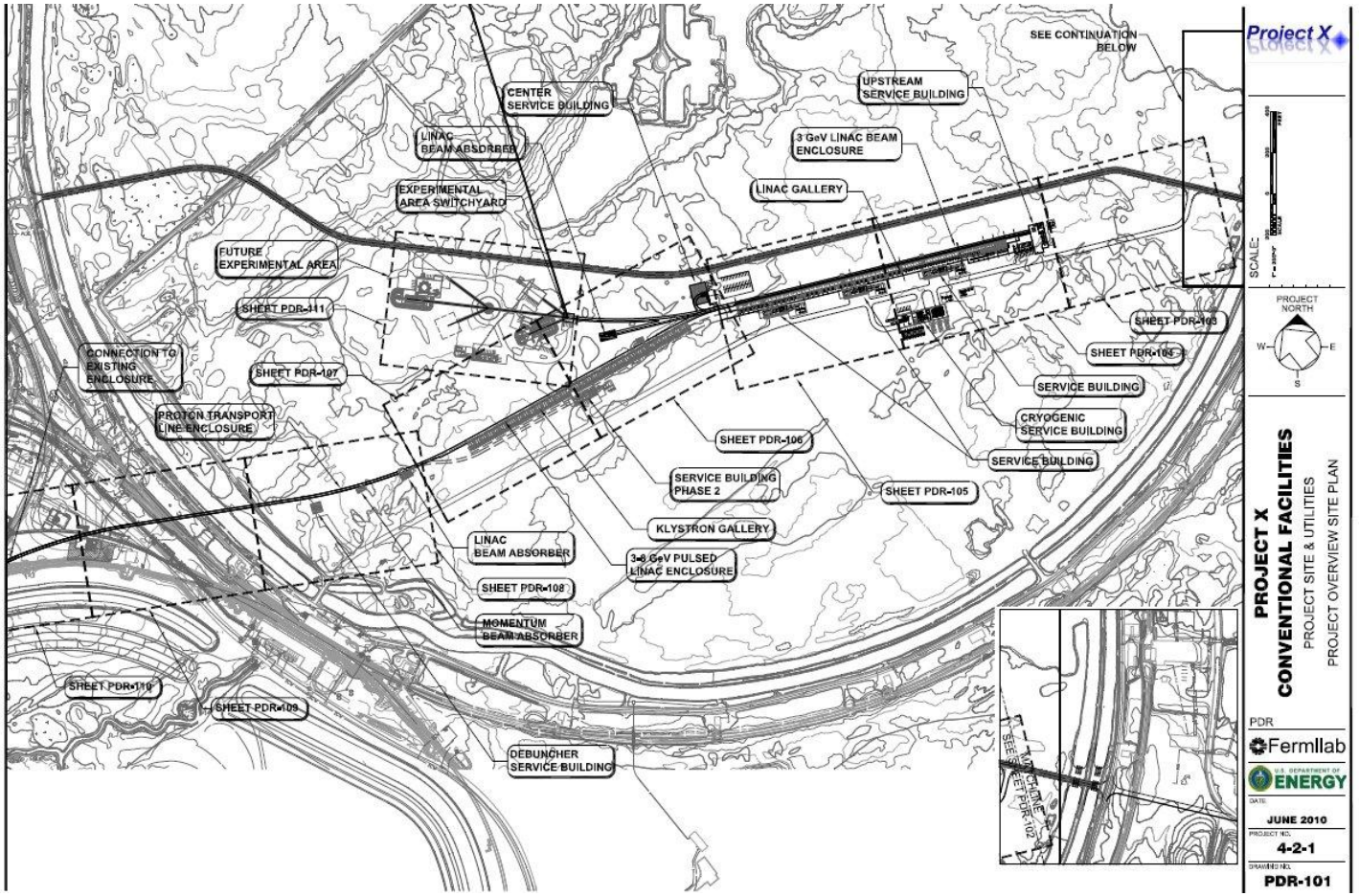
Backup Slides

SRF Linac Technology Map



Section	Freq	Energy (MeV)	Cav/mag/CM	Type
HWR (β_G=0.1)	162.5	2.1-10	9/6/1	HWR, solenoid
SSR1 (β_G=0.22)	325	10-42	16/18/ 2	SSR, solenoid
SSR2 (β_G=0.47)	325	42-160	36/20/4	SSR, solenoid
LB 650 (β_G=0.61)	650	160-460	42 /14/7	5-cell elliptical, doublet
HB 650 (β_G=0.9)	650	460-3000	152/19/19	5-cell elliptical, doublet
ILC 1.3 (β_G=1.0)	1300	3000-8000	224 /28 /28	9-cell elliptical, quad

Siting


SEE CONTINUATION BELOW
CENTER SERVICE BUILDING
UPSTREAM SERVICE BUILDING
LINAC BEAM ABSORBER
3 GeV LINAC BEAM ENCLOSURE
EXPERIMENTAL AREA SWITCHYARD
LINAC GALLERY
FUTURE EXPERIMENTAL AREA
SHEET PDR-111
SHEET PDR-103
SHEET PDR-104
CONNECTION TO EXISTING ENCLOSURE
SHEET PDR-107
SERVICE BUILDING
PROTON TRANSPORT LINE ENCLOSURE
CRYOGENIC SERVICE BUILDING
SHEET PDR-106
SERVICE BUILDING
SERVICE BUILDING PHASE 2
SHEET PDR-105
KLYSTRON GALLERY
LINAC BEAM ABSORBER
3-8 GeV PULSED LINAC ENCLOSURE
SHEET PDR-108
MOMENTUM BEAM ABSORBER
SHEET PDR-110
SHEET PDR-109
DEBUNCHER SERVICE BUILDING
SEE CONTINUATION SHEET PDR-102
Project X
SCALE:
PROJECT NORTH
PROJECT X
CONVENTIONAL FACILITIES
PROJECT SITE & UTILITIES
PROJECT OVERVIEW SITE PLAN
PDR
Fermilab
ENERGY
DATE:
JUNE 2010
PROJECT NO.
4-2-1
DRAWING NO.
PDR-101