Project X

-Accelerator Aspects

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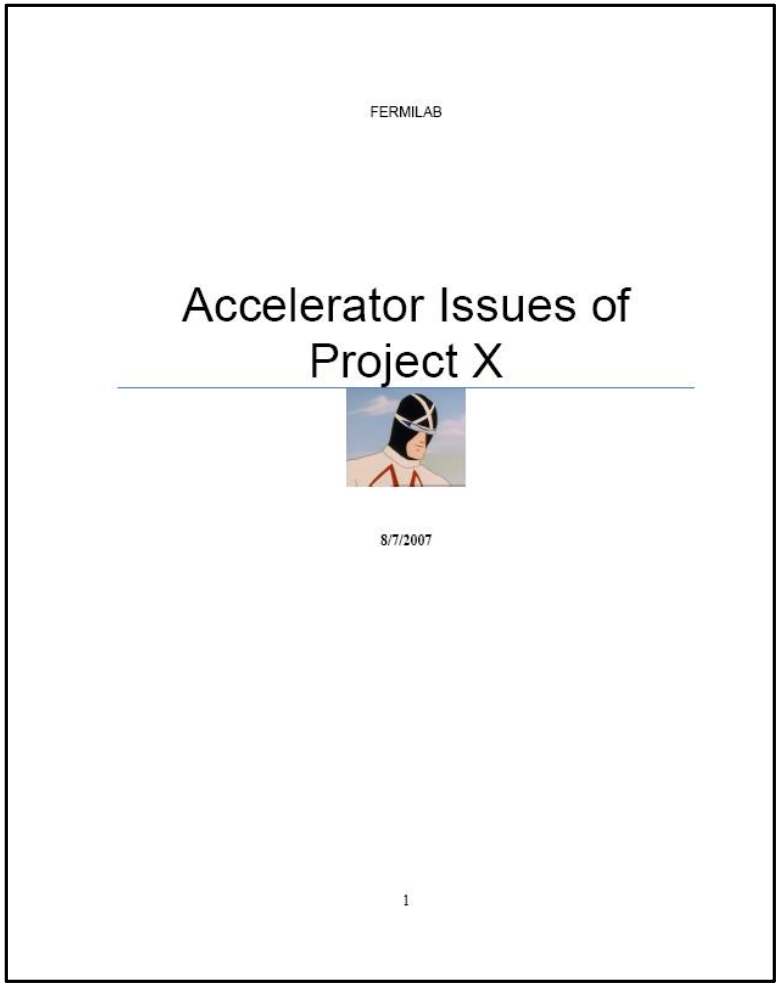
(NB. Most slides either plainly stolen or adapted from Dave McGinnis, Steve Holmes or Young-Kee Kim.)

The Origins of Project X

August, 2007



What is Project X?

- The basic scheme is an 8 GeV H^- linac operating with ILC-like parameters (9mA x 1mS x 5Hz)
  - 0.6 GeV Front End linac
  - 0.6 – 8 GeV ILC style linac
- Stripping and accumulation in the Recycler
- Beam distributed
  - to the Main Injector for acceleration to (up to) 120 GeV
  - to an 8 GeV program.
- Components
  - 0.6 GeV Front End linac + 0.6 – 8 GeV ILC style linac
  - 8 GeV transfer line and H- Injection
  - Recycler as a proton accumulator and stripping ring
  - Extraction system for the Recycler
  - Main Injector
  - 120 GeV Targeting system

Motivation

- Currently, the relatively modern Main Injector is fed protons by an aged proton source.
  - The current Fermilab proton source provides on the order of 30kW for the current neutrino program and has the capability of providing up to 70kW.
  - Space charge tune shift at injection into the Booster limits the beam power in the current Fermilab proton source
- Space charge is almost completely mitigated if the proton source is replaced by an 8 GeV Linac.
  - The major issue of an 8 GeV injector linac is cost.
  - Superconducting RF technology raises economic cross-over point between a linac and a synchrotron to the few GeV range.
  - Fermilab Proton Driver design.

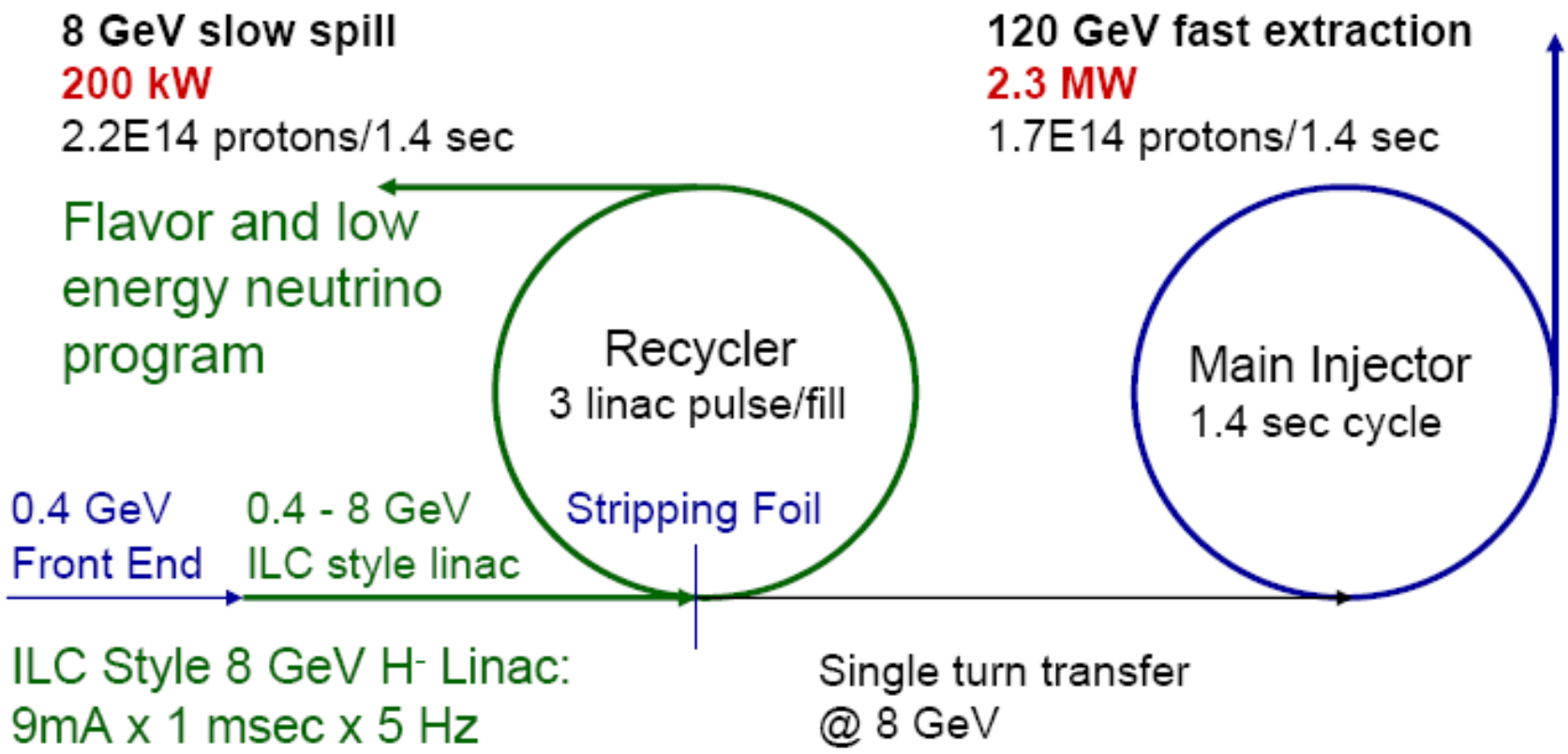
Recycler as a Proton Accumulator

- A holding or accumulation ring inserted between the 8 GeV Linac and the Main Injector can reduce the charge/pulse of the 8 GeV Linac to the same charge/pulse as the ILC linac.
- Feed consecutive pulses of beam from the 8 Gev Linac into the Recycler every 0.2 seconds (5Hz)
  - The H- linac beam is stripped in the Recycler
  - Each Linac pulse is over-laid on top of the previous Linac pulse by re-energizing the stripping system.
- Three Linac pulses is 150×10^{12} protons
- Extract beam from the Recycler and load the Main Injector in a single turn

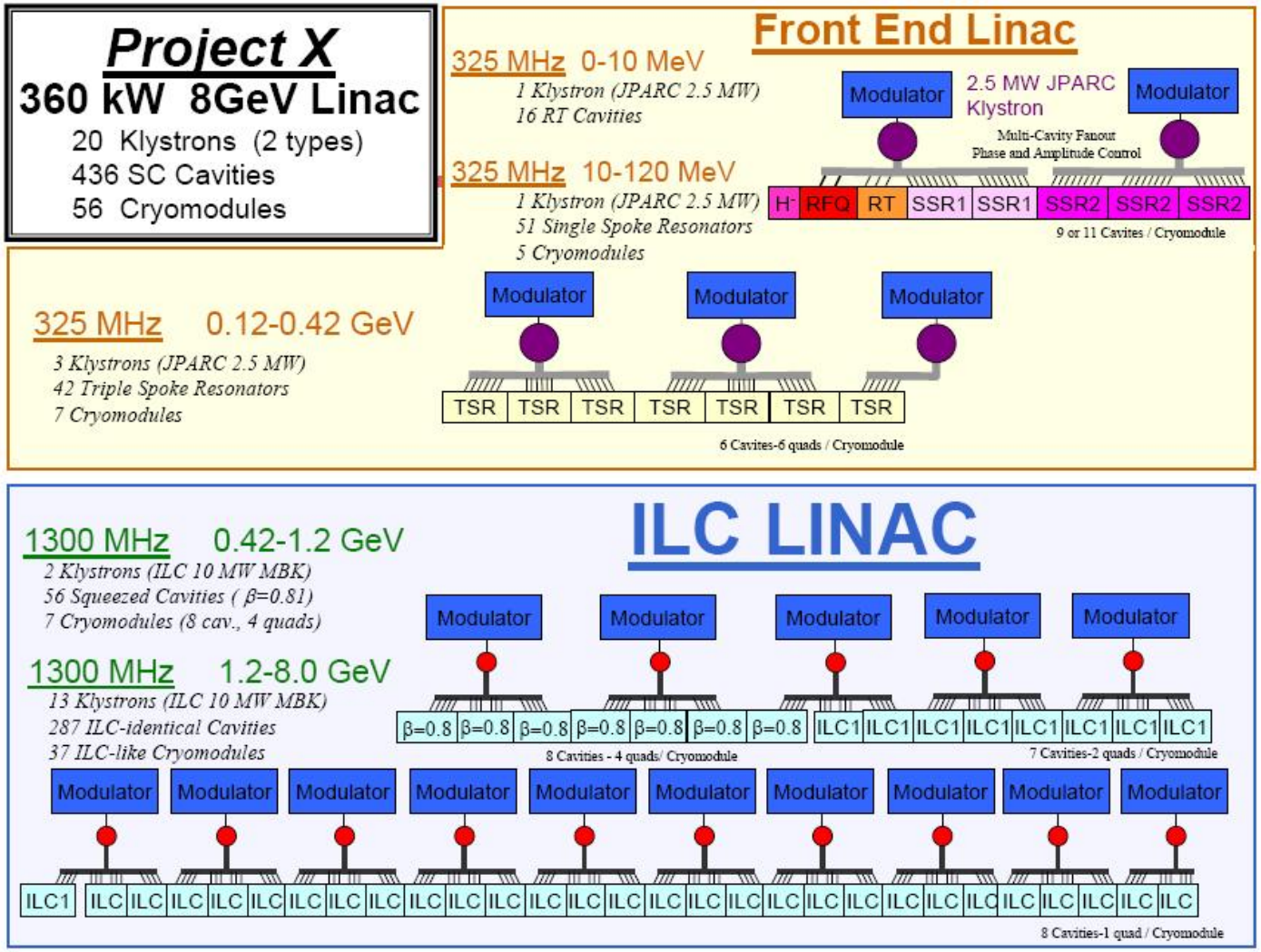
8 GeV Physics Program

- The other advantage to stripping in the Recycler (instead of in the MI) is that the stripping system is available to the Linac while the Main Injector is ramping.
  - There is 0.8 seconds left before the Recycler needs to be reloaded for the Main injector
  - Load and spill 4 pulses for an 8 GeV physics program
- Upgrade Paths
  - 9 mA x 1 ms x 5 Hz = 360 kW at 8 GeV
  - 9 mA x 3 ms x 10 Hz = 2100 kW at 8 GeV
  - 27 mA x 1 ms x 10 Hz = 2100 kW at 8 GeV

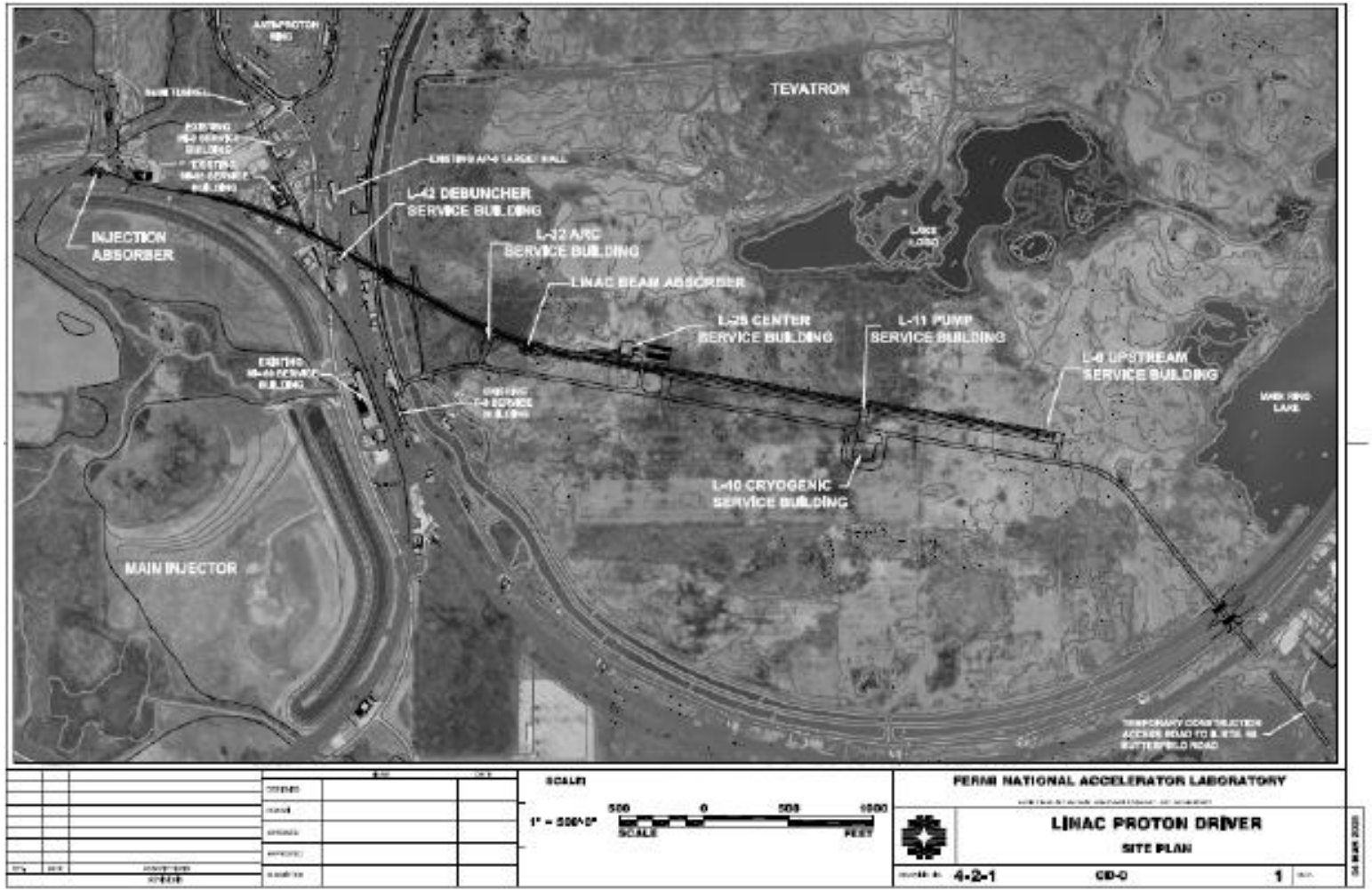
Project X Overview



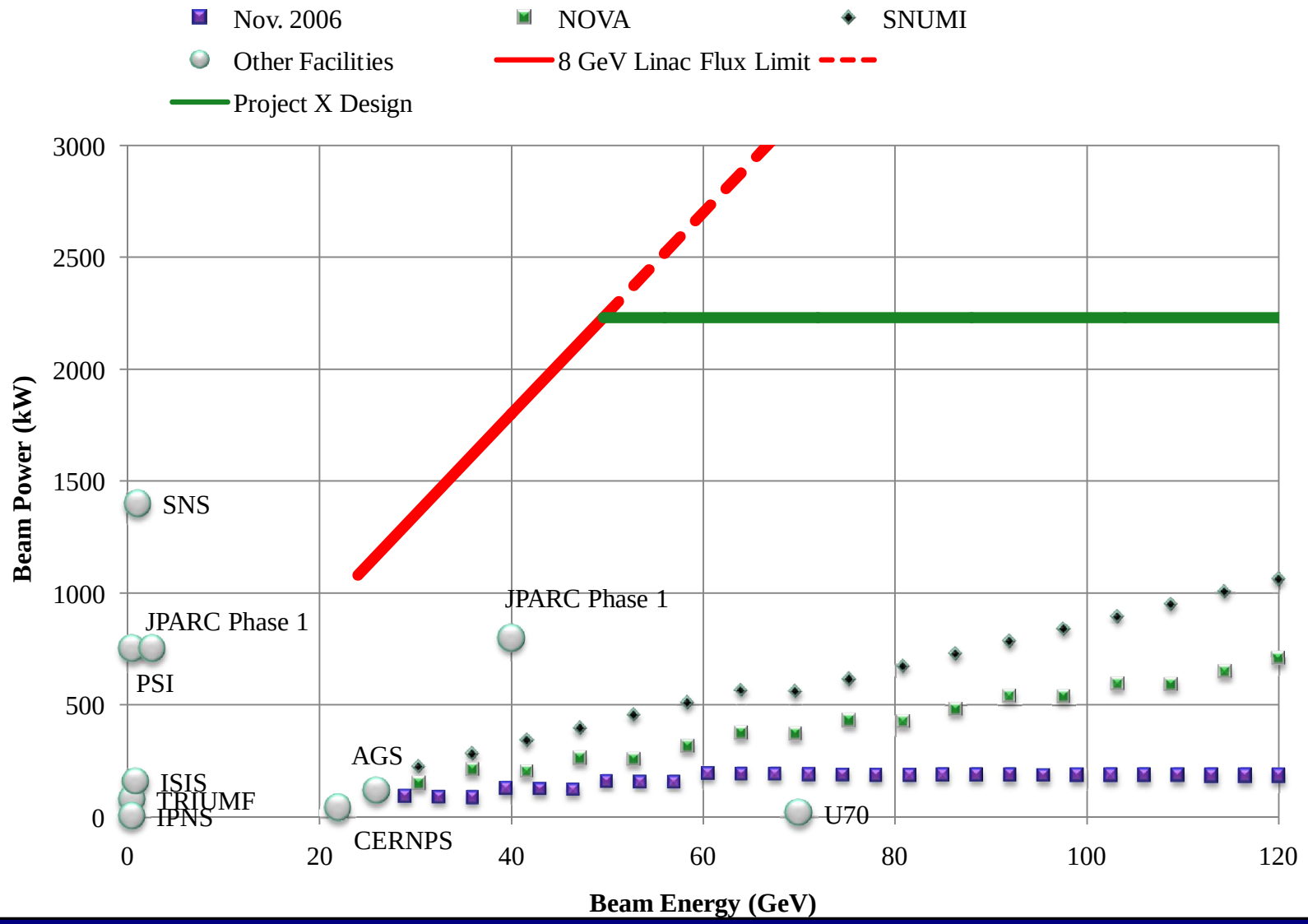
Project X Linac



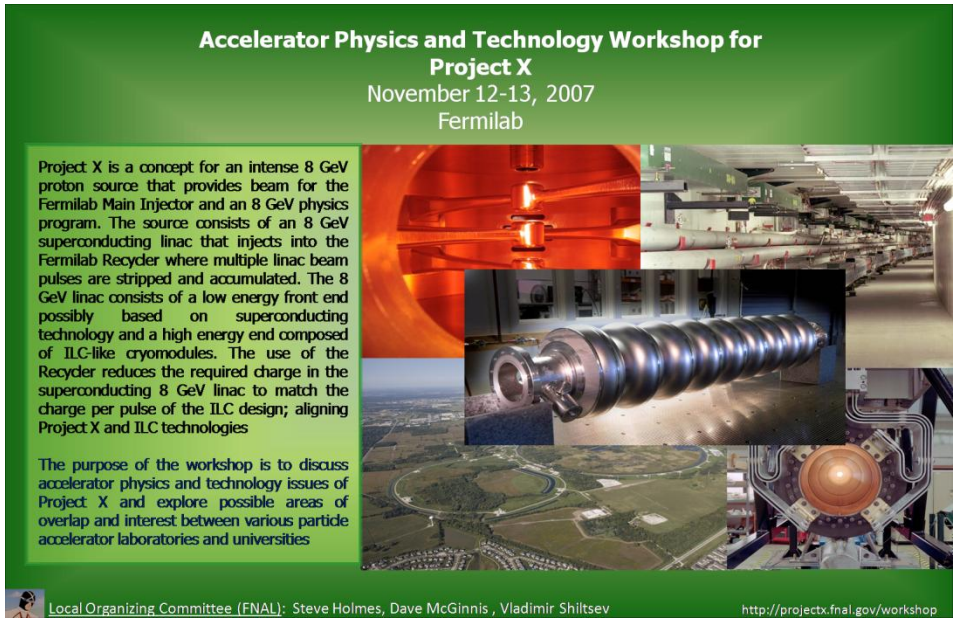
Provisional Siting



Proton Beam Power



Evolution of Project X

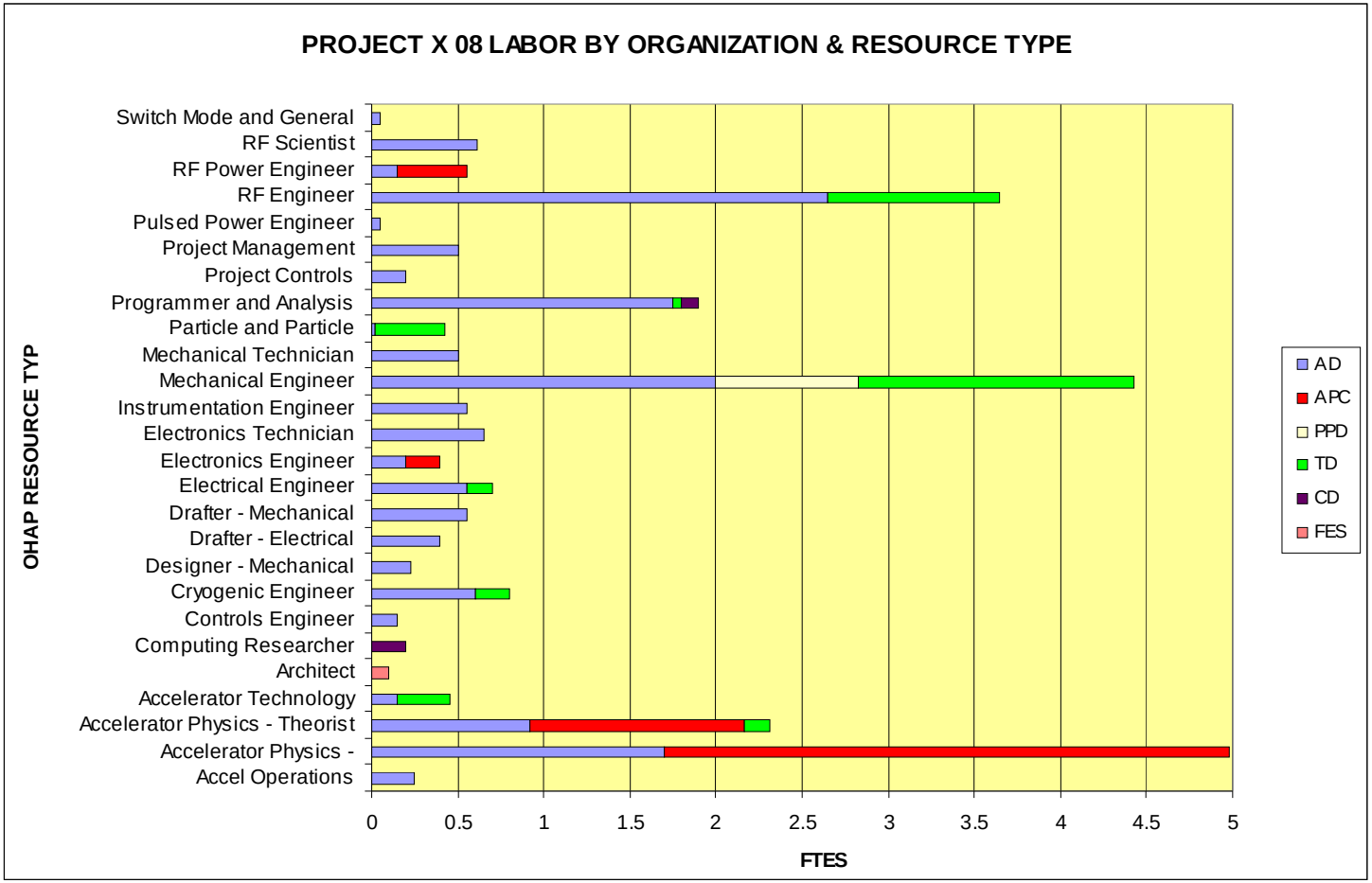


- The Accelerator aspects of Project X were discussed at a workshop in December, 2007.
  - No showstoppers identified
- Since then, a detailed R&D plan has been developed
  - Document available at http://projectx.fnal.gov/RnDplan/

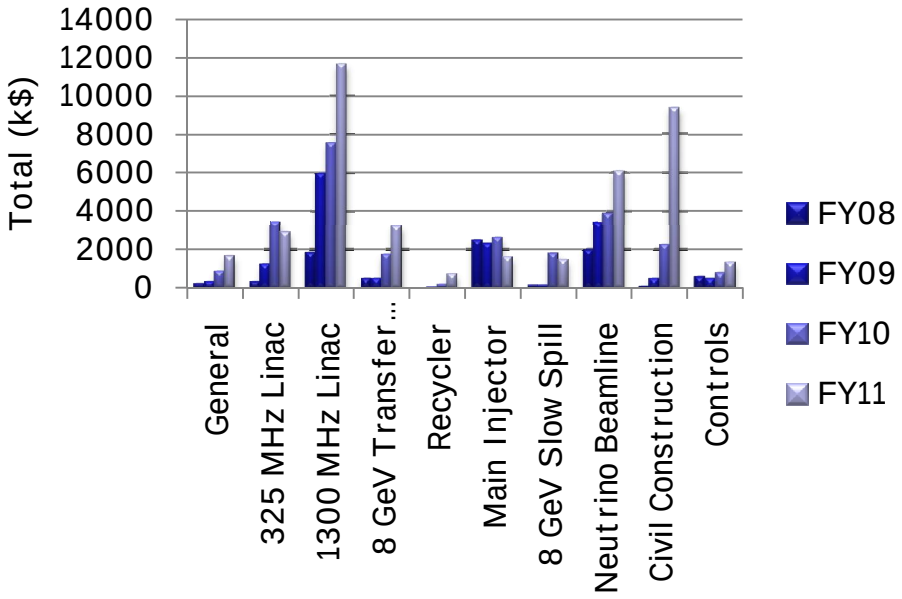
Project X RD&D Program Goals

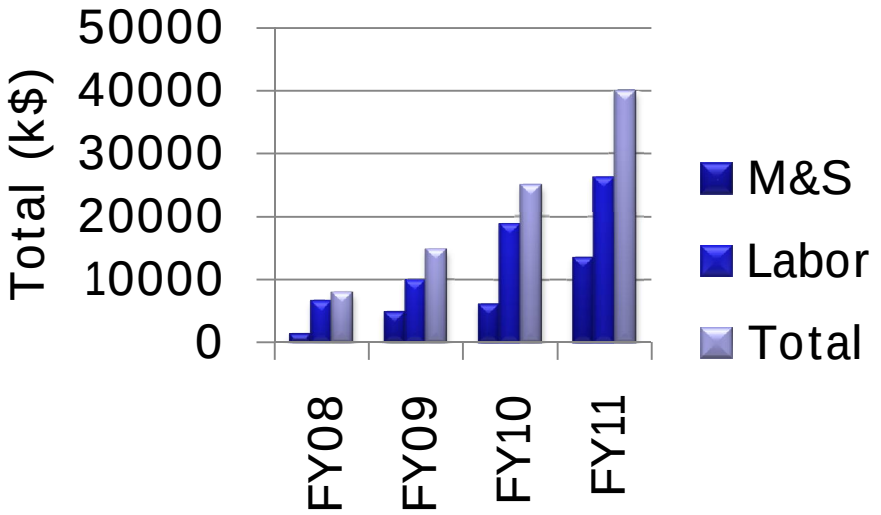
- The goal of the Project X RD&D program is to provide support for a Critical Decision 1 (CD-1) in 2010, leading to a CD-2/3a in 2011.
  - Design and technical component development;
  - Development of all project documentation mandated by DOE 413.3;
  - Formation of a multi-institutional collaboration capable of executing both the R&D plan and the provisional construction project.
- The primary technical goal is completion of a Conceptual Design Report, followed by a fully developed baseline cost estimate and schedule, and supported by a technology development program.
  - Capability of delivering at least 2 MW of beam power over the range 60 – 120 GeV, simultaneous with at least 200 kW of beam power at 8 GeV.

Project X FY08 Labor Needs



RD&D Plan Resource Requirements





A Slight Change of Direction

- Last year, the Fermilab Accelerator Advisory Committee said:
  - We congratulate the Project X team on an innovative design"
  - "Project-X is especially suitable for Fermilab in the current scenario of a not well-defined schedule of ILC construction, because of synergies with ILC. "
  - "The committee therefore very strongly supports the work that is planned for Project-X."

In the meantime, we had the dismal FY08 omnibus budget, the ILC schedule was readjusted and a new P5 committee was formed

- This year, they said:
  - "Synergy with ILC needs to be re-evaluated. There are limitations due to ILC adoption – may be detrimental if needed for a neutrino/muon facility later on --- that must be articulated: peak current, repetition rate, pulse length,….."
  - "It is desirable that the future 8 GeV SC linac be upgradeable to satisfy needs of future users of high beam power at 8 GeV , in order to surpass capability of other options (Rapid Cycling Synchrotrons). Capability for the upgrade to multi-MW version should be reviewed in detail. "

Adjustment

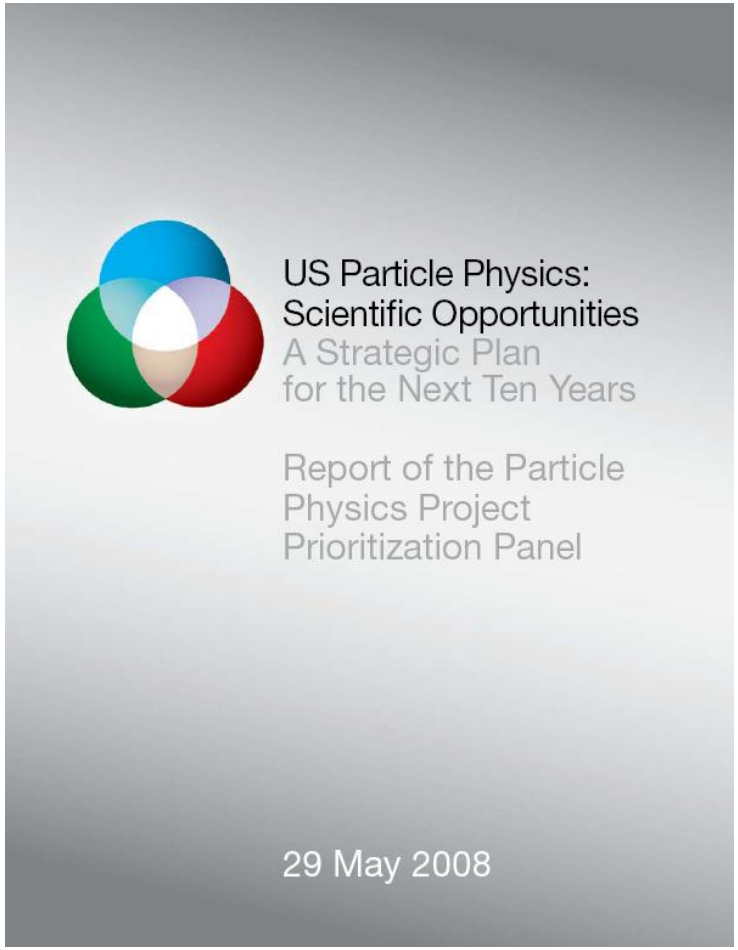
- The Project X team is responsible for a baseline design of a complete facility based on a 1.3 GHz sc linac with a beam power of 360 kW at 8 GeV.
- The Project X linac subgroup will develop a conceptual design for a 1.3 GHz linac capable of at least 2 MW at 8 GeV.
  - The Muon specification will be used to establish details as to packaging of the beam.
  - In the event that no such design can be developed we will reexamine the frequency choice for the upgrade (whether this choice would propagate into the baseline design is TBD.)
  - The Project X Physics Workshops will start exploring needs for multi-MW at 8 GeV.
- The Project X Recycler subgroup will address stripping and storage issues at 2 MW.

Project X Requirements

Req. No.	Description		Req.	Unit
1.0	General			
1.1		120 GeV Beam Power	2.3	MW
1.2		8 GeV Beam Power	360	kW
1.3		8 GeV Slow Spill Beam Power	200	kW
1.4		8 GeV Slow Spill Duty Factor	55	%
1.5		120 GeV Availability	75	%
1.6		8 GeV Availability	80	%
1.7		Upgradeable 8 GeV Beam Power for Civil, RF, & Cryo Systems	2	MW

- Notes:
  - Availability is defined as the percentage time that the complex is delivering beam
  - 8 GeV duty factor is the result of slow spill being done in the Recycler

P5 Recommendations



- "The panel recommends a world-class neutrino program as a core component of the US program, with the long-term vision of a large detector in the proposed DUSEL and a high-intensity neutrino source at Fermilab."
- "The panel recommends an R&D program in the immediate future to design a multi-megawatt proton source at Fermilab and a neutrino beamline to DUSEL"
- "A neutrino program with a multi-megawatt proton source would be a stepping stone toward a future neutrino source, such as a neutrino factory based on a muon storage ring… This in turn could position the US program to develop a muon collider as a long-term means to return to the energy frontier in the US."

Summary

- Project X is an intense 8 GeV proton source that provides beam for the Fermilab Main Injector and an 8 GeV physics program.
- The source consists of an 8 GeV superconducting linac that injects into the Recycler where multiple linac beam pulses are stripped and accumulated.
- The use of the Recycler reduces the required charge in the superconducting 8 GeV linac to match the charge per pulse of the ILC design so that much of the ILC technology can be used in the design.
- Although there are many challenging technical issues to building an intense protons source , at least for the baseline (2.3MW @ 120GeV + 200kW @ 8GeV) these issues seem to be surmountable.
- A detailed R&D plan has been developed, with the aim of CD-3a (construction approval) in 2011. P5 has recommended such a program.
- Recently, the focus has shifted from alignment with ILC to ensuring future upgrade capabilities.
- Upgradability to >2MW will be studied. May require significant changes (e.g. abandoning ILC cryomodule or changing the RF frequency).

Fermilab Today

Friday, June 27, 2008

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Layoff Information

New information on Fermilab layoffs, including an up-to-date Q&A section, appears on the layoff Web pages.

Furlough Information

Information on the furloughs at Fermilab, which stopped May 31, 2008, is available on the furlough Web pages.

Calendar

Friday, June 27
11 a.m.
Theoretical Physics Seminar - WH-3NW(NOTE DATE, TIME, LOCATION)
Speaker: S. Pascoli, Durham University
Title: Detecting Dark Matter with Neutrino Detectors
3:30 p.m.
DIRECTOR'S COFFEE BREAK - 2nd Flr X-Over

In the News

U.S. Senate approves funding bill for Fermilab

From *Kane County Chronicle*, June 27, 2008

The U.S. Senate on Thursday approved an emergency spending bill that will allow Fermilab to continue its research.

By a vote of 92-6, the U.S. Senate passed the emergency supplemental spending bill that includes $400 million in funding for critical science programs.

The U.S. House approved the measure last week.

The legislation provides $62.5 million for the Office of Science to ensure that Fermilab, Argonne and other scientific facilities are able to continue their research and retain staff.

Another $62.5 million is appropriated for the National Science Foundation to continue critical research, a portion of which will benefit both Illinois laboratories.

Special Director's Corner

Great News!!

Pier Oddone

It is a pleasure to tell you that yesterday evening the US Senate, by a vote of 92 to 6, passed a supplemental funding bill for FY2008. The House of Representatives had previously passed the bill, and the President has indicated that he will sign it. Among the bill's provisions is an appropriation of $62.5 million for DOE's Office of Science. This is very good news for science and for Fermilab. I will hold an All Hands meeting next Wednesday. Thanks to savings from the voluntary separations and the additional funding in the supplemental bill, I expect to announce the end of involuntary layoffs at the laboratory. All of us at Fermilab express profound thanks to all those who have worked so very hard to achieve this critical support for science at Fermilab and across the nation.