First in a series of discussions…

Intensity Frontier discussion forum in advance of and in parallel with Snowmass.

Starting local…

- First with Fermilab Intensity Frontier researchers,
- then the broader Fermilab research community,
- then the broader community.

Goals:

Establish a common basis for discussion
Develop communication strategies

April 23rd 2013: Steve Brice & Bob Tschirhart, led discussion in advance of the Snowmass IF All-hands meeting at ANL April 25th-27th.

Ten-Year Goals for Fermilab

1. Fermilab is the world's preeminent leader on the Intensity Frontier

2. Fermilab is a world leader on the Energy Frontier, the Cosmic Frontier, and Theory

3. Fermilab plays a leadership role in developing the technology for next generation accelerator facilities and in advancing basic understanding

4. Fermilab plays a leadership role in developing the technology for next generation detectors and computing facilities

5. Fermilab plays a leading role in applying technologies to society's problems

YKK, April 19th 2013

Status of Projects (managed by Fermilab)

We are here

Project	FY2006	FY2007	FT2008	FY2009	FY2010	FY2011	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017
							Project: from CD-0 to CD-4					
Intensity Frontier												
MINERvA	CD-0	CD-1/2/3a	CD-3b		CD-4							
NOvA	CD-0	CD-1	CD-2	CD-3a						CD-4		
MicroBooNE					CD-0/1	CD-2/3a	CD-3b		CD-4			
Muon g-2							CD-0	CD-1/3a	CD-2/3b		CD-4	
Muon (AIPs, GPPs)												
Mu2e					CD-0		CD-1	CD-3a	CD-2/3b	CD-3		
LBNE					CD-0			CD-1		CD-3a	CD-2	CD-3b
Project X									CD-0	CD-1		
Energy Frontier												
LHC CMS			CD-4				CD-0	CD-1	CD-2/3			
LHC Machine			CD-4						CD-0/1	CD-2/3		
Cosmic Frontier												
DE Cam	CD-0		CD-1/2/3a	CD-3b			CD-4					
Gen2 Dark Matter							CD-0		CD-1	CD-2		
Infrastructure												
SLI				CD-0		CD-1			CD-2 CD-3		CD-4	

SLI: Science Laboratories Infrastructure

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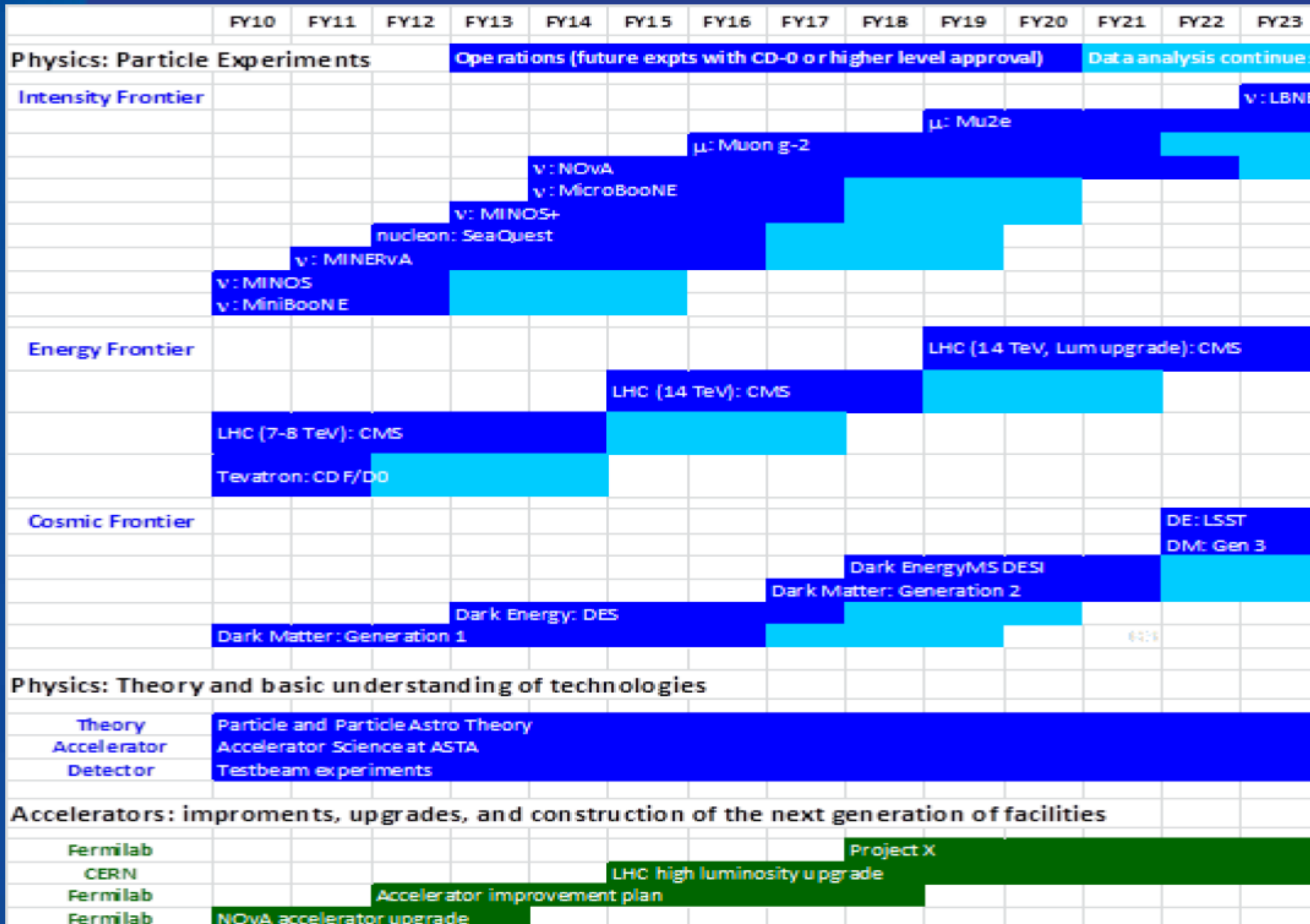
We continuously produce physics results.



Not included are the ORKA experiment (Fermilab Stage 1 approval), and experiments such as nuSTORM, pEDM and nn-bar oscillation experiments which are currently developing proposals with the encouragement of PAC.

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LBNE (LAr TPC)

- Physics:
  - neutrino oscillation, proton decay, supernova neutrinos, …
- Collaboration (keep growing):
  - 384 members from 67 institutions, 6 countries
- Stage 1:
  - Goal with non-DOE partners: 15%~20% in-kind contributions
    - beamline + near detector + 10 kt underground far detector
    - US funds: beamline + undergrnd infrastructure(far+near) + far det.
    - In-kind contributions: additional far detector + near detector
    - (DOE 2nd stage approval in December 2012)
- Stage 2 and beyond:
  - More neutrino flux from Project X (up to 2.3 MW)
  - Additional far underground detector (35 kt in total)

YKK, April 19th 2013

Statement by the LBNE Collaboration

The LBNE Institutional Board requests that FRA consider the following points:

- The recent rapid progress in neutrino physics has confirmed the scientific importance as well as the outstanding design of the Long-Baseline Neutrino Experiment. We need the full support of FNAL and DOE to enhance the scientific scope of LBNE phase 1 and rapidly proceed with the project.
- Both the full scope of LBNE with the underground 35 kt LArTPC detector and Project X are essential and interdependent ingredients for the Intensity Frontier program at Fermilab. We support the development of a strategy to accomplish both projects in a timely way.

HEPAP Facilities Panel Report (March 2013)

- Dec. 20, 2012, DOE Office of Science has charged its Federal Advisory Committees to help with their task of prioritizing facilities (> $100M) that contribute to world-leading science in the next decade,
- The Intensity Frontier
  - LBNE Stage 1 (scope without non-DOE contributions) begins a world leading program in neutrinos. Science reach of Stage 1 is important and it lays the groundwork for an absolutely central facility. It is ready for construction.
  - Mu2e will search for muon to electron conversion in the field of a nucleus with unparalleled sensitivity. It is absolutely central and ready for construction.
  - Project X is a unique world leading facility at Fermilab for intensity frontier physics. It is absolutely central and although it is pre CD0 it is ready for construction.
  - nuSTORM is a muon storage ring that would provide neutrino beams with well-defined flavor composition and spectrum. While the committee is not aware of major technical challenges in realizing nuSTORM, its performance requirements are not yet fully defined. While nuSTORM has great potential the committee doesn't know enough yet to assess nuSTORM's role in U.S. world-leading science.

Experiment demographies, publications, theses

Experiment	# authors	# institutions	# publications	# theses	# future analysis topics
KTeV	78 - 86	12 - 13	50	32	0
CDF run II	348(end)	57(end)	293 (2004 -)	241(2004 -)	several
D0 run II	360 - 580	68 - 84	301	275 (2004 -)	several
SciBooNE	65	18	7	7	0
ArgoNeut	34	9	3	1	
MiniBooNE	84	18	23	16	9 (+6 MB+)
MINOS(+)	124	32	54	65	
MINERvA	100	22	3	2	29
NOvA	180	34	0	0	26
MicroBooNE	112	19	0	0	33
Muon g-2	112	26	0	0	6
Mu2e	137	25	0	0	14
LBNE	384	67	0	0	112(ND)

Physics

	SeaQuest	MINERvA	MINOS+	NOvA	Micro-BooNE	g-2	mu2e
2013							
2014	Initial proton dbar/ubar ratio.	LE beam CCQE ν X-sections + vtx activity	Search for non-PMNS. Osc. params. BSM searches: (sterile ν, extra dims ...)	NDOS CCQE & inclusive X-sections			
2015	Initial EMC sea-quark ratios.			Initial numu disap. & nue appearance Initial NC disap.			
2016		neutral pion X-sections + spectra		Initial mass hierarchy & θ23 octant	Initial ν cross-sections for LAr		
2017	Final dbar/ubar & sea-quark ratios.		Final results on non-stand. phenomena. Combined param. fits.	Initial anti-numu disap.	Initial ν osc. results		
2018		Nuclear dependence of str. fus in DIS				Initial g-2 & EDM search results	
2019				Updated mass hierarchy & θ23 octant		Updated g-2	
2020				Exotic Searches		Final g-2 & CPTV + EDM	Initial eng. run result

Snowmass meeting

- Timeline
  - Snowmass meeting: focus on science (Summer 2013)
  - P5:budget scenarios/prioritization(Spring 2014) →implementation
- Travel expenses: plan
  - $160k from DOE OHEP
  - Support each participant up to $1,300 (full duration)
  - $160k supports ~120 participants
  - Estimated # of participants

Including some large project managers (→ Dir.)

AD	APC	Comp.	FCPA	PPD	TD	WDRS	Dir.	Total
7	14 + 5	14	5	~150	9	2	~10	~170

  - We are looking into other mechanisms (e.g. FRA funds) to support some of participants. Please plan ahead and provide accurate information to your organization.

The Fermilab Project-X Research Program

- ***Neutrino experiments***

A high-power proton source with proton energies between 1 and 120 GeV would produce intense neutrino sources and beams illuminating near detectors on the Fermilab site and massive detectors at distant underground laboratories.

- ***Kaon, muon, nuclei & nucleon precision experiments***

These could include world leading experiments searching for lepton flavor violation in muons, atomic, muon, nuclear and nucleon electron dipole moments (edms), precision measurement of neutron properties (e.g. n,nbar oscillations) and world-leading precision measurements of ultra-rare kaon decays.

- ***Platform for evolution to a Neutrino Factory and Muon Collider***

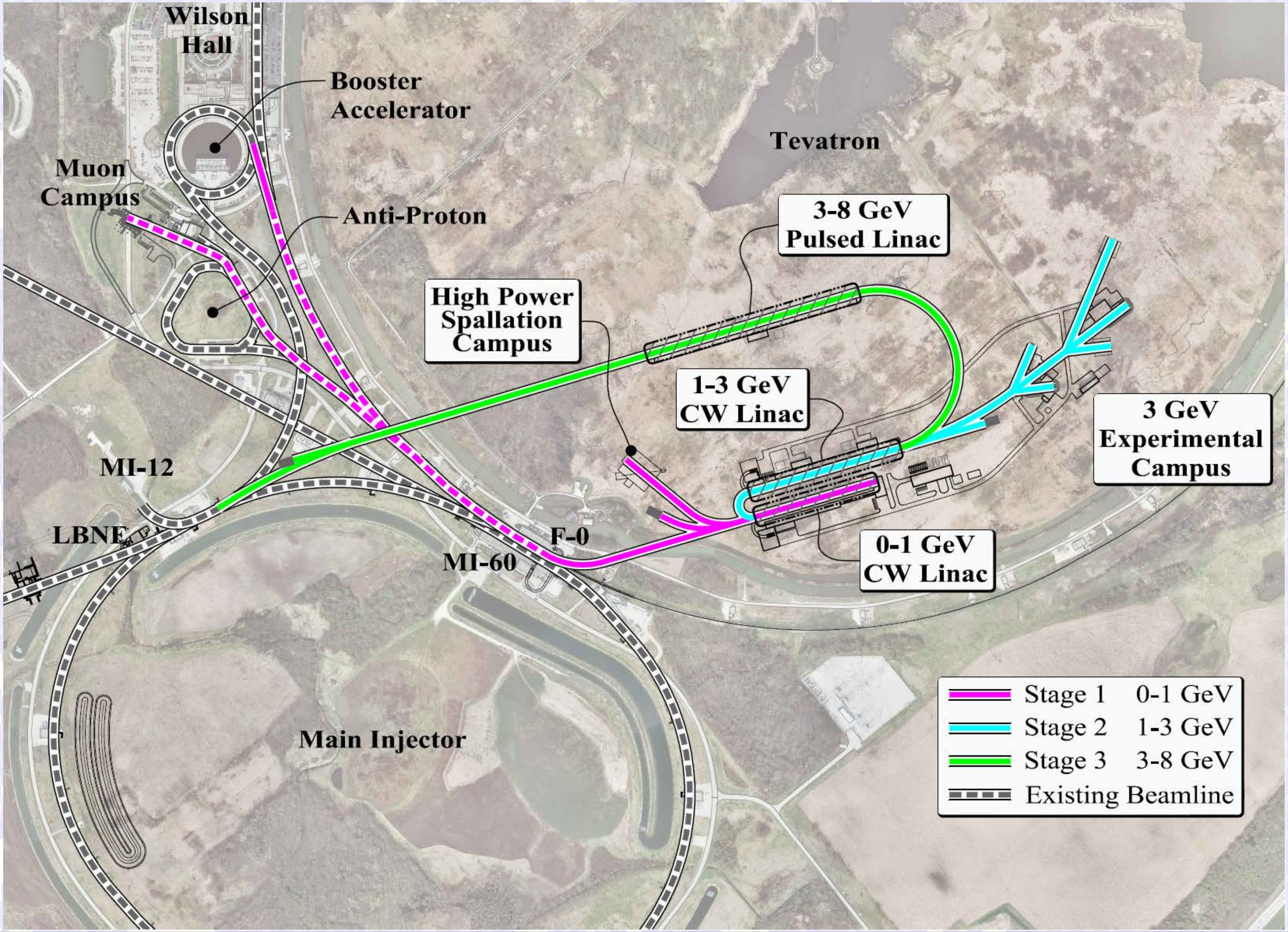
Neutrino Factory and Muon-Collider concepts depend critically on developing high intensity proton source technologies.

- ***Material Science and Nuclear Energy Applications***

Accelerator, spallation, target and transmutation technology demonstrations which could investigate and develop accelerator technologies important to the design of future nuclear waste transmutation systems and future thorium fuel-cycle power systems. Possible applications of muon Spin Resonance techniques (muSR). as a sensitive probes of the magnetic structure of materials .

Detailed discussion on Project X website

Project X Campus



Project X: Evolution of the Fermilab Accelerator Complex

Program:	Onset of NOvA operations in 2013	Stage-1: 1 GeV CW Linac driving Booster & Muon, n/edm programs	Stage-2: Upgrade to 3 GeV CW Linac	Stage-3: Project X RDR	Stage-4: Beyond RDR: 8 GeV power upgrade to 4MW
MI neutrinos	470-700 kW**	515-1200 kW**	1200 kW	2450 kW	2450-4000 kW
8 GeV Neutrinos	15 kW +0-50kW**	0-42 kW* + 0-90 kW**	0-84 kW*	0-172 kW*	3000 kW
8 GeV Muon program e.g, (g-2), Mu2e-1	20 kW	0-20 kW*	0-20 kW*	0-172 kW*	1000 kW
1-3 GeV Muon program, e.g. Mu2e-2	-----	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	1870 kW	1870 kW
Nuclear edm ISOL program	none	0-900 kW	0-900 kW	0-1000 kW	0-1000 kW
Ultra-cold neutron program	none	0-900 kW	0-900 kW	0-1000 kW	0-1000 kW
Nuclear technology applications	none	0-900 kW	0-900 kW	0-1000 kW	0-1000 kW
# Programs:	4	8	8	8	8
Total max power:	735 kW	2222 kW	4284 kW	6492 kW	11870kW

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

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

Stimulating questions from the field…

- IFQ1:

What do we learn from neutrino properties in terms of fundamental physics? To what extent is it worthwhile to spend a large fraction of the US HEP budget in this direction, given the fact that knowing the corresponding quark parameters (which are sometimes over constrained and testable for consistency) has not revolutionized our understanding of flavor structure and the matter-antimatter asymmetry, and -- compared with colliders --relatively few results can be expected?

Stimulating questions from the field…

IFQ2:

If additional resources can be found to restore some of the scope to LBNE, what is the highest scientific priority: moving underground or improving the beam and/or surface detectors?

IFQ3:

In the currently approved configuration for LBNE (assuming no new international support), is LBNE worth doing? For example, requiring 5 sigma evidence, in which scenarios will it make discoveries (as opposed to confirmations of results from other experiments)?

Stimulating questions from the field…

IFQ4:

Original motivations to look for light ultra-weakly interacting particles (from dark matter, for example) seem to have largely evaporated. In light of that fact, is there a motivated parameter space to aim for? Does it make sense to look at a next generation of experiments?

IFQ5:

What are some qualitatively interesting thresholds for EDM constraints? (For example, one might be the predictions of SUSY models with very heavy scalars, but sub-TeV gauginos and Higgsinos.) What experimental program is required to reach these thresholds I the coming 5, 10, 20 years?