

Overview of Fermilab's Intensity Frontier Research Program

Steve Brice, Head of Intensity Frontier Department, Fermilab
DOE Laboratory Intensity Frontier Research Review
May 21, 2013

Outline

- The Experimental Program
- The Scientific Personnel
- Supporting the Community
- Structural Changes at Fermilab

(Pre-Review Questions along with Budgets and a breakdown of General and G&V Spending will be covered in the closed session)

Ten-Year Goals for Fermilab



1. Fermilab is the world leader on the Intensity Frontier



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



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

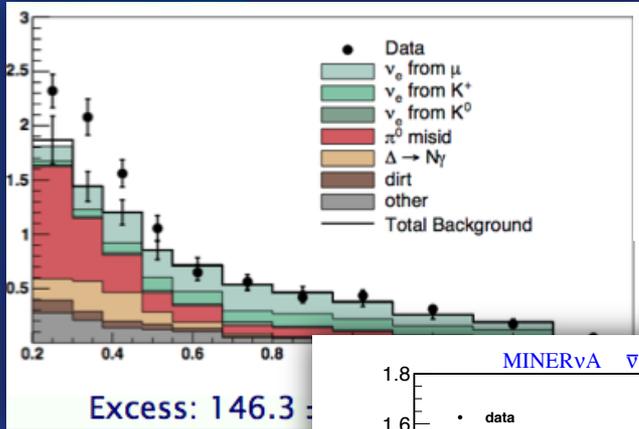
Goals 2-4 also contribute to Goal 1

The Experimental Program

- Fermilab's Intensity Frontier Program probes the new physics landscape beyond the Standard Model
- The Program uses intense particle beams of neutrinos, muons, kaons, to make discoveries.
- The Program follows the P5 roadmap
- The Program delivers outstanding physics while designing and building the next generation Intensity Frontier facilities.

Short Baseline Thrust (Sam Zeller Talk)

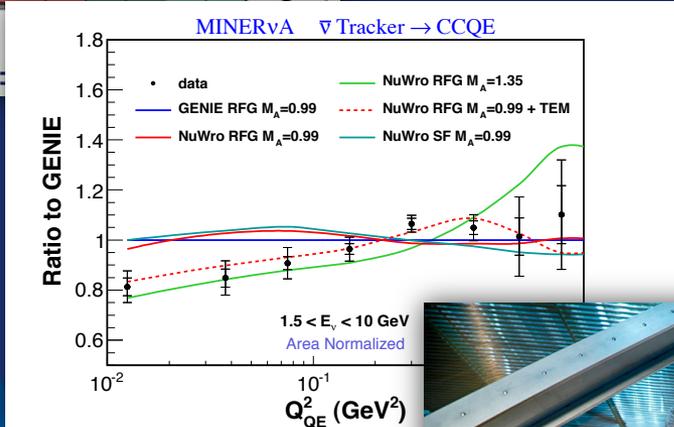
Cross Section Measurement & Short Baseline Oscillation



MiniBooNE

Searching for $\nu_\mu \rightarrow \nu_e$

Ground breaking cross-sections



MINERvA

Precision cross-sections



MicroBooNE

MB low energy excess
Argon cross-sections
LAr TPC R&D

Long Baseline Thrust (Brian Rebel Talk)

Exploring the PMNS Matrix

MINOS(+)

Precision Δm_{32}^2



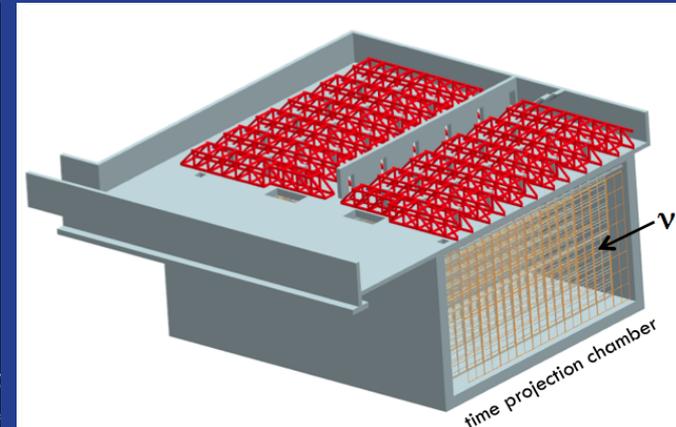
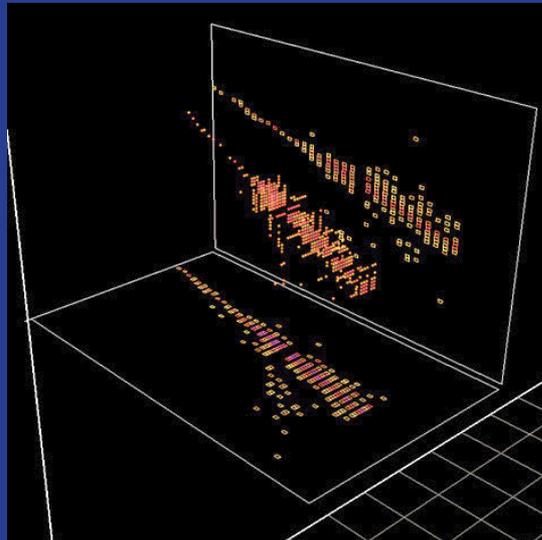
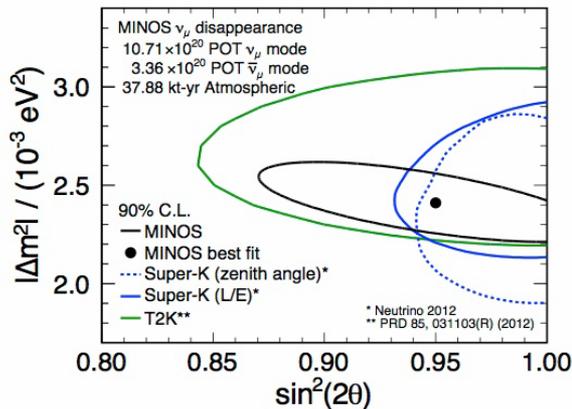
NOvA

Determine hierarchy



LBNE

CP violation search

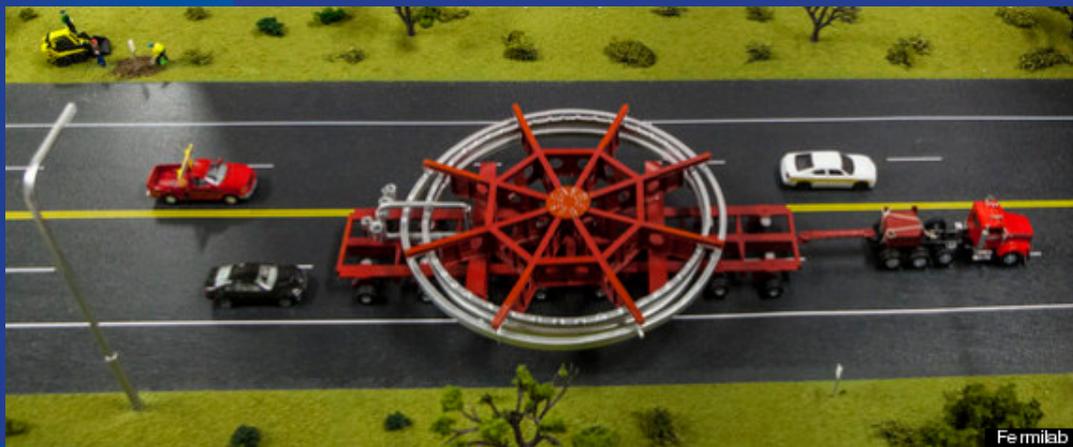


Precision Accelerator Thrust (Chris Polly Talk)

Rare Processes and Precision Measurements as Windows into New Physics

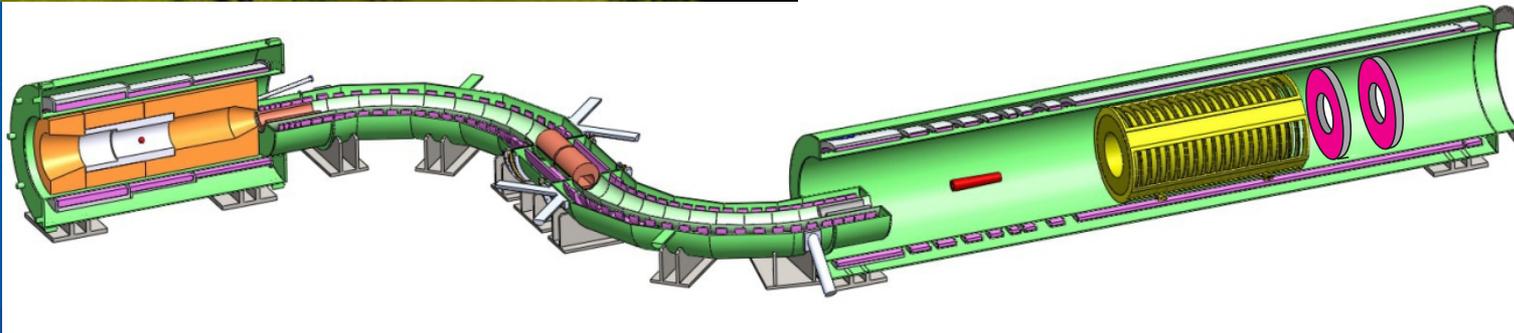
Muon (g-2)

Muon anomalous mag. mom.



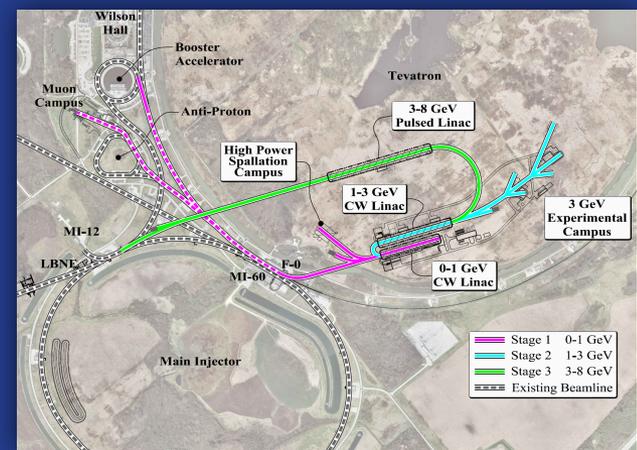
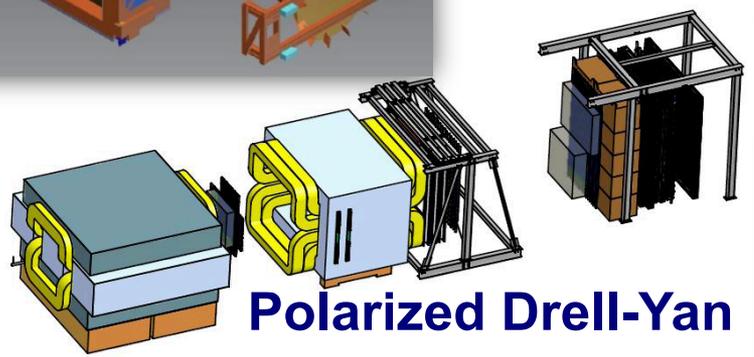
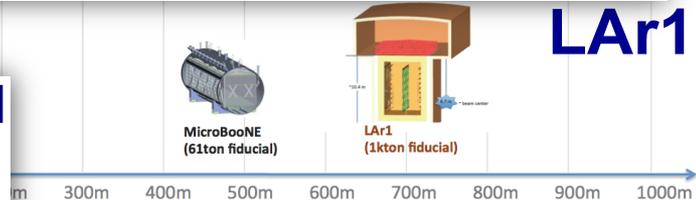
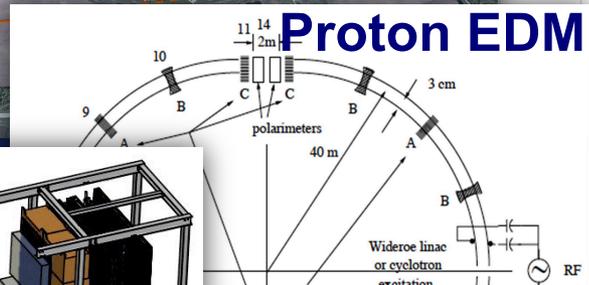
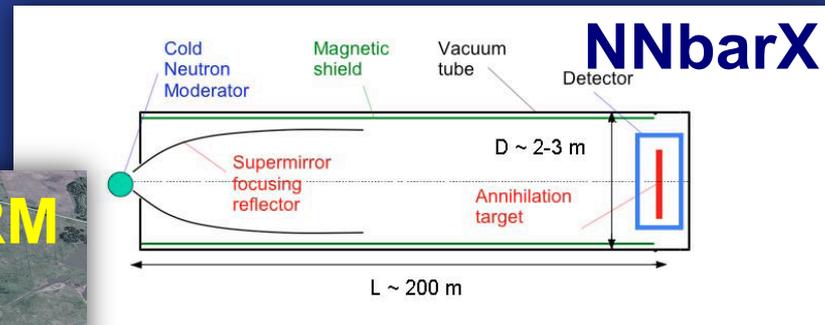
Mu2e

Searching for $\mu + N \rightarrow e + N$



The Further Future

Future Intensity Frontier Experiments not yet part of the established program....



.... leading to Project X

Fermilab Intensity Frontier Experiment Operations

Accelerator Shutdown

		2011	2013	2015	2017	2019	2021	2023
Neutrinos	Long baseline	MINOS	MINOS+	NOvA		LBNE		
	Short baseline	MINERvA	MiniBooNE	MicroBooNE				
Muons					g-2	Mu2e		
Protons		SeaQuest						
Testbeam								

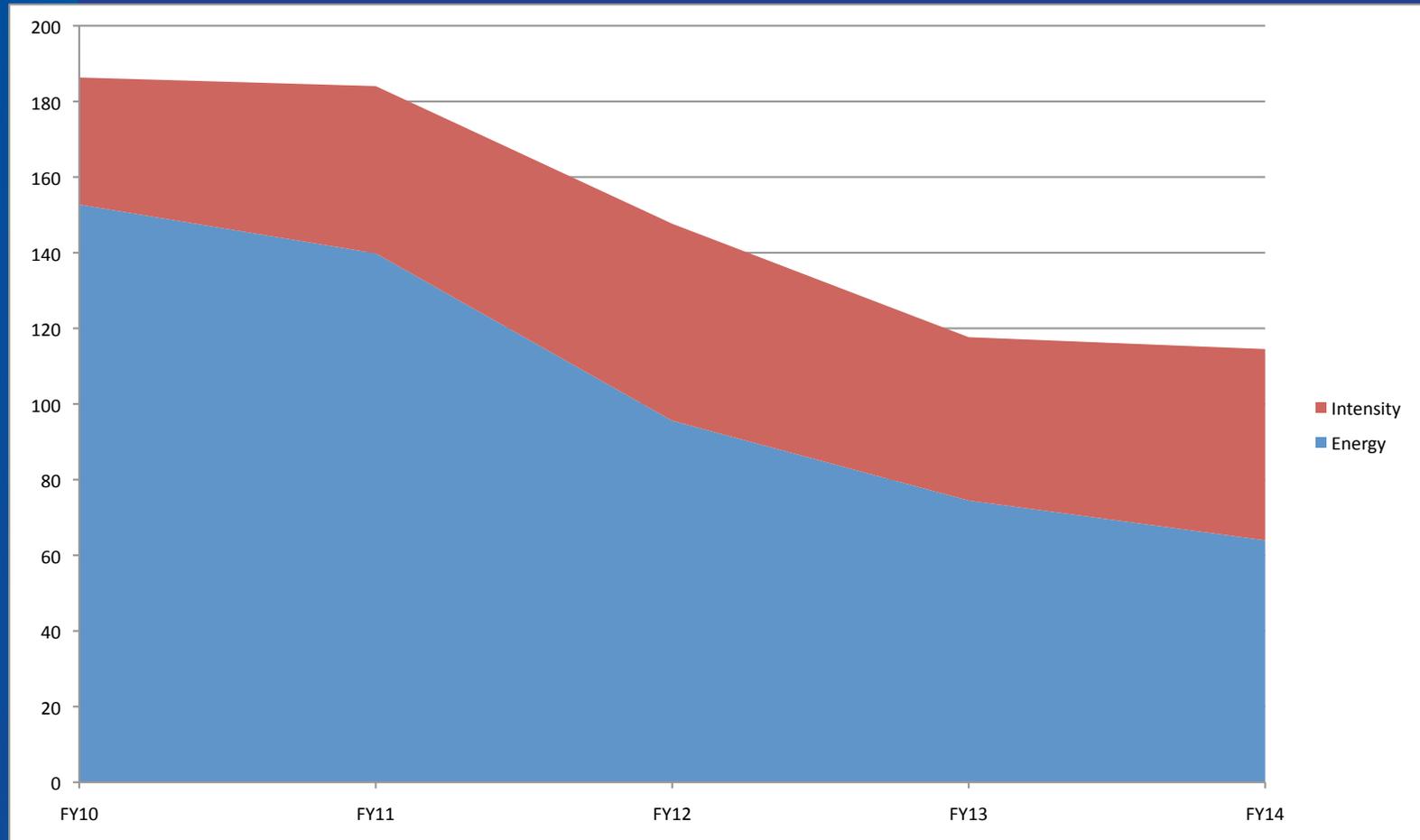
Fermilab Scientific Staff

- Fermilab scientists
 - conduct world class research
 - provide leadership across the Intensity Frontier
 - design, build, manage projects and experiments
 - bring continuity and experience to experiments
- 11 Fermilab IF Scientists are APS Fellows
 - Bernstein, Bross, Glenzinski, Lukens, Lundberg, Neuffer, Plunkett, Pordes, Rameika, Strait, Tschirhart
- Fermilab scientific careers often cycle between planning, project, analysis roles (e.g. PM → Spokesperson) each role brings value to the other roles

Fermilab Scientific Leadership (last 3 years)

	Short Baseline Neutrino			Long Baseline Neutrino			Precision Accelerator	
	MiniBooNE	MINERvA	MicroBooNE	MINOS	NOvA	LBNE	Muon (g-2)	Mu2e
Co-Spokes person	Brice	Harris, Morfin	Zeller	Plunkett				Bernstein
Analysis Coordinator	Zeller, Polly	Schmitz						
Project Manager/ Director		Harris	Rameika		Cooper	Strait, McCluskey, Rameika	Polly	Ray
Deputy/ Associate Project Manager		Grossman, DeMaat	James		Tesarek, Derwent		Merritt	Glenzinski
Level 2 Manager		Pla-Dalmau	Baller, Bogert, Rebel, Raaf		Lukens, Miao	Baller, Papadimitriou	Casey, Convery, Nguyen	Ginther, Lamm, Mukherjee

Scientific Effort (FTEs) Transitioning from Energy to Intensity Frontier



Scientific Hiring

- Since 2009 Fermilab has hired 16 scientists of whom
 - 11 are Intensity Frontier experimentalists
 - 2 are theorists focusing on IF physics
- Overall laboratory staff reduced by 10% during that same time period
- There would be considerable benefit from continued Fermilab Intensity Frontier hiring, but future budgets will not accommodate it.

Fermilab Intensity Frontier Postdocs

- Fermilab currently has 14 IF postdocs and last week we finished interviewing for 4 more
 - Compare to 15 CMS, 14 Theory (incl Astro), 10 Particle Astro Expt.
- Current positions of last 10 IF postdocs (theory in orange)
 - Dave Schmitz (Asst Prof, Chicago)
 - Joachim Kopp (Prof, MPI Heidelberg)
 - Alysia Marino (Asst Prof, Colorado)
 - Brian Rebel (Scientist I, Fermilab)
 - Olga Mena (Asst Prof, Valencia)
 - Niki Saoulidou (Prof, Athens)
 - Holger Meyer (Prof, Wichita State)
 - Bonnie Fleming (Prof, Yale)
 - Nicole Bell (Prof, Melbourne)
 - Andre De Gouvea (Prof, Northwestern)

Early Career Awards

Brendan Casey
Muon g-2 Research



Sam Zeller
Liquid Argon TPC Research

Fermilab Intensity Frontier Scientist Community Leadership and Service

- HEPAP
 - Glenzinski, Tschirhart, Rameika
- Scientific Advisory Committees
 - Ice Cube – Merritt
 - JPARC – Tschirhart
 - JPARC Accelerator Technology - Zwaska
 - ICFA Neutrino – Zeller
 - ICFA Instrumentation - Para
 - AIDA – Bross
 - PDG – Harris
- DPF and DPB Roles
 - Bernstein, Johnstone, Strait
- Summer School Organizing Committee Chairs
 - Neutrino – Brice, Harris
 - Hadron Collider – Glenzinski
 - CTEQ – Morfin
- Snowmass Roles
 - Casey, Zeller, Rebel, Kutschke, Wolbers
- Reviewers of SBIR, NSF, DOE, refereed journals, international conference organizers - too numerous to detail

University and Lab Researchers

- University and Lab researchers make excellent teams with complementary strengths
 - Experiments work best when these two groups are knit together
 - Fermilab scientists enable the community by mentoring of postdocs and (informally) of students
- Fermilab Scientists facilitate and amplify the work of university and other lab scientists

Fermilab Scientists Facilitate and Amplify the Work of University and other Lab Scientists

- **Interface with technical and engineering support staff**
 - critical to safe, efficient, and successful detector design, assembly, commissioning and operations
- **Interface with the computing support staff**
 - critical to data acquisition, data handling and processing, and analysis development and operations
- **Provide continuity and local expertise readily accessible for visiting students, post-docs, and faculty**

Fermilab Scientists Facilitate and Amplify the Work of University and other Lab Scientists

- Facilitate access to Fermilab resources for their colleagues from other laboratories and universities
 - technical and engineering resources
 - broad range of expertise from the Theory Department
- Organize the startup and legacy phases of efforts
 - project management expertise
 - existing relationships with the Laboratory support personnel

Guest & Visitor Programs Supporting HEP Community

- Strong support of Guests and Visitors (G&V) to the lab from all over the world
 - Breakdown of IF G&V spending in closed session
- **International Fellows**
 - All 6 current fellows working on Intensity Frontier
- **Joint Appointments**
 - Craig Group (Fermilab/Virginia) working on NOvA and Mu2e
 - Mitch Soderberg (Fermilab/Syracuse) working on LAr
- **URA Visiting Scholarships**
 - Financial support from the institutions that operate Fermilab
- **New Intensity Frontier Research Fellowship Program**
 - Coarsely modeled after the successful LPC Fellowships at Fermilab

Student Programs

- **International Fellows**
 - 4 students working on Intensity Frontier
- **South American Student Program**
 - 23 Masters students, 11 doctoral students and 3 postdocs in or graduated from the program organized by Jorge Morfin
 - Looking to expand beyond neutrino physics into wider IF
- **Indian Student PhD Program**
 - 10 Intensity Frontier students in or graduated from the program
 - Ramping up to 20 Intensity Frontier students present at Fermilab
 - Coupled to much larger plans for India-Fermilab
- **Summer students**
 - About 100 each summer labwide

Interface to Theory – Fermilab and Beyond

- **Neutrinos Thrusts**
 - Parke, Quigg - long baseline neutrino strategy
 - Kayser – sterile neutrino fits and LBL work
 - Hill – axial anomaly interpretation of MiniBooNE excess
 - LANL Nuclear Theorists (Garvey, Carlson) – collaboration to better model GeV neutrino interactions
- **Precision Accelerator Thrust**
 - Van de Water, Kronfeld – Muon (g-2)
 - Kronfeld, MacKenzie – ORKA measurement strategy
 - Hill, Lykken, Carena - EDMs

Scientific Organizational Changes

- Fermilab's Divisions have been changed to focus on the Intensity Frontier
 - In the Accelerator Division
 - Anti-Proton Department dissolved
 - Muon Department created to design and operate the beam lines for the Muon (g-2) and Mu2e experiments.
 - In the Computing Division
 - Established computing liaisons between IF experiments and Division
 - Establishing a common suite of IF tools - ART, LArSoft, ART-DAQ, SAM-IF, Grid Submissions etc
 - In the Particle Physics Division
 - Intensity Frontier Department created
 - Operations Support group created
 - DAQ/Online Software Support group created

Intensity Frontier Department

INTENSITY FRONTIER DEPARTMENT

S. Brice, Head

B. Casey, Deputy Head

FIXED TARGET

D. Christian, Ldr

(A. Bross)

A. Mazzacane, G

R. Raja

S. Wang, IF

MUON (g-2)

C. Polly, WF Ldr.

(B. Casey)

T. Gadfort

B. Kiburg, LF

(A. Lyon, CD)

H. Nguyen

M. Rominsky, RA

(M. A. Soha)

LBNE/

LIQUID ARGON R&D

B. Rebel, WF, Ldr.

R. Acciarri, RA

C. Escobar, IF

A. Hahn

(H. Jostlein, SE OC)

T. Junk

B. Lundberg

S. Pordes

M. Stancari

(J. Strait, LBNE, PO)

T. Yang, RA

J. Yoo, WF

ADMIN. SUPPORT

(C. Kennedy)

(E. Johnson)

(S. Schuler)

MICROBOONE

R. Rameika, Ldr

B. Baller

B. Carls, RA

(M. Cooke, RA)

(H. Greenlee)

C. James

R. Krull

S. Lockwitz, RA

J. Raaf

M. Soderberg

G. Zeller

MINERvA

D. Harris, Ldr.

D. Boehnlein, IPA

(D. Hahn)

J. Morfin

D. Martinez Caicedo, IF

J. Osta, RA

L. Rakotondravohitra, IF

(R. Snider, CD)

(D. Torretta)

MINOS+

R. Plunkett, Ldr

(S. Hahn)

(R. Hatcher, CD)

M. Kiveni, RA

(A. Kreymer, CD)

M. Medeiros, IF

R. Pahlka, RA

Mu2e

R. Ray, Ldr.

R. Bernstein

(H. Brown)

A. Gaponenko, WF

M. Gardner

D. Glenzinski

C. Group

(K. Knoepfel, RA)

(R. Kutschke, CD)

S. Moed Sher

A. Mukherjee

G. Piacentino, IF

V. Rusu

G. Tassielli, IF

R. Wagner

NOVA

J. Cooper, Ldr.

H. Brown

X. Bu, RA

H. Ferguson

W. Freeman

D. Jensen

(P. Lukens)

T. Miao

M. Muether, RA

(A. Norman, CD)

D. Perevalov, RA

T. Sarlina

P. Shanahan

R. Tesarek

J. Zalesak, IF

Created to support the scientific effort
on IF projects and experiments

New Enabling Facilities

- The construction of a Muon Complex for the Muon (g-2) and Mu2e experiment halls has begun



Beneficial occupancy just obtained
to the Liquid Argon Test Facility

More New Enabling Facilities

NuMI underground area expanded to incorporate the NOvA near detector



Intensity Frontier Operations Center (XOC)

Control room for IF experiments
On the main floor of Wilson Hall
Serious investment already made
- bid package created

New Testbeam planned

Largely for LAr TPC work



Summary

- Fermilab has made the transition to leading an Intensity Frontier program
- Fermilab scientists play strong and interlocking leadership and scientific roles in this program
- Fermilab scientists facilitate and enhance the work of university and other lab scientists

Agenda

- 10:30 Overview – Steve Brice (25')
- 11:10 Short Baseline Thrust – Sam Zeller (25')
- 11:50 lunch
- 13:20 Long Baseline Thrust – Brian Rebel (25')
- 13:55 Precision Accelerator Thrust – Chris Polly (25')
- 14:30 Summary – Greg Bock (10')

EXTRA SLIDES

Support and infrastructure - Computing

- Fermilab scientists and staff play a leading role in planning and deploying the computing infrastructure that is operated by Laboratory staff in support of the full scientific program and the associated user community.
 - Tools and services used by almost all users and experiments
 - Infrastructure solutions for large scale data handling
 - The staff also provides database, email, and desktop computing support.

Infrastructure and Administrative Support

- **Administrative support**
 - Travel, housing, telephones, videoconferencing
 - Office support and supplies (desks, chairs, supplies, etc.)
 - Building and office maintenance
 - Procurement and stockroom support on-site
- **Conference office – 2 FTE's running ~20 conferences/workshops each year**
 - Logistical and Financial support
 - Many Fermilab scientists serve on Organizing committees
 - Summer schools – Neutrino, Hadron Collider Physics

Current International Fellows

Name	Institution	Position	Project	Period
Michelle de Madeiros	Univ. Federal de Goias, Brazil	Student	MINOS	Jan 2012 – Jan 2014
Carlos Escobar	Campinas, Brazil	Scientist	LBNE	Apr 2011 – Apr 2014
David Martinez	CBPF, Brazil	Student	MINERvA	Nov 2012 – Nov 2013
Laza Rakotondravohitra	Univ. Antananarivo	Student	MINERvA	Aug 2012 – Aug 2014
Su-Yin Wang	Nat. Kaohsiung Normal U, Taiwan	Student	SeaQuest	Oct 2011 – July 2014
Jaroslav Zalesak	Inst. Phys. Acad. Sci. Czech Republic	Scientist	NOvA	Oct 2012 – Oct 2013

Spring 2012 URA Visiting Scholars

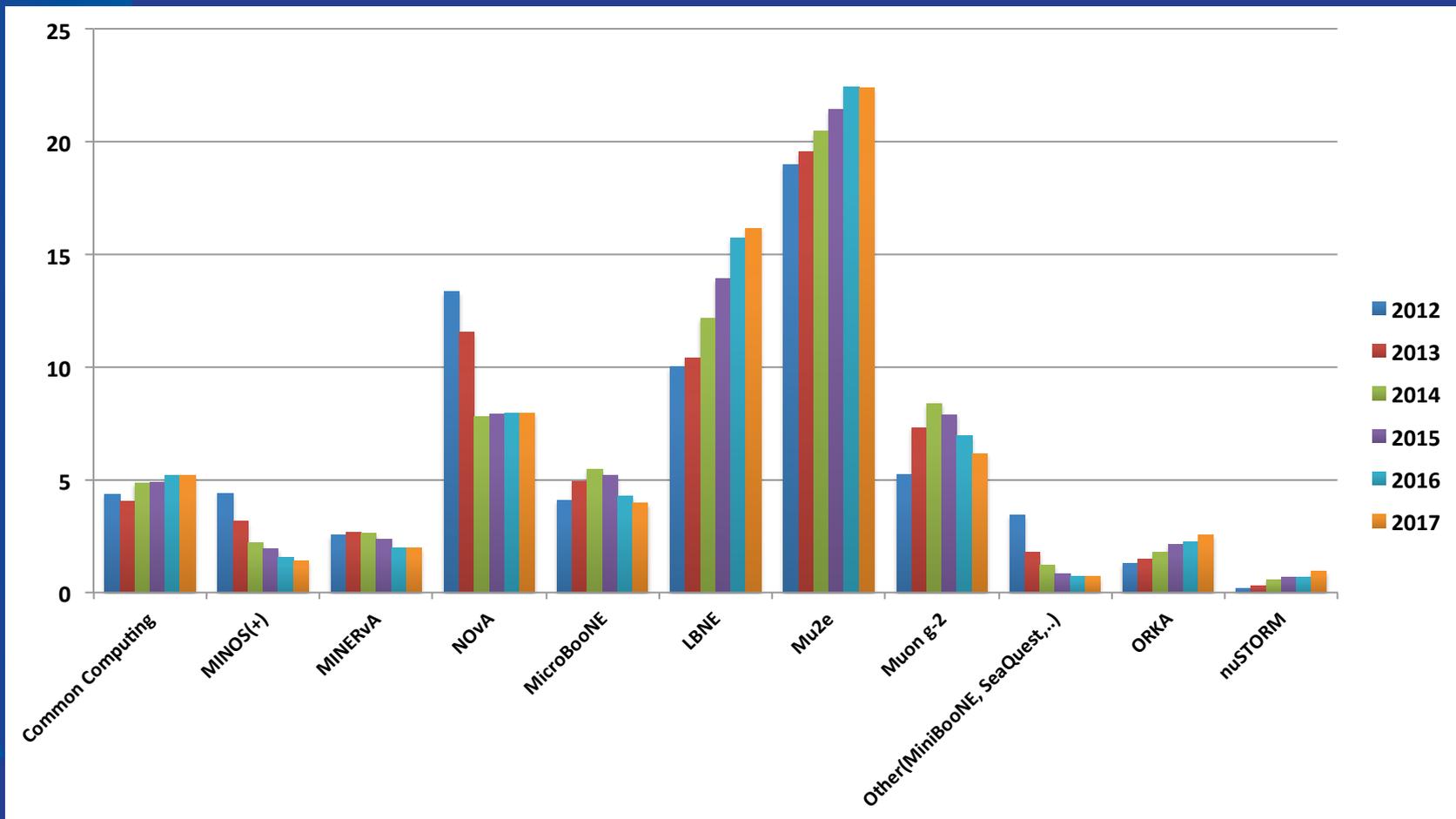
Intensity Frontier Scientists in yellow

- Cavanna & Palamara Yale University
- Church, Eric, Yale University
- Dharmapalan, Ranjan, University of Alabama
- Fox, Patrick, Fermilab (group award organized for selected participants from URA member universities)
- Geer, Steve, Fermilab (group award organized for selected participants from URA member universities)
- Gran, Richard, University of Minnesota
- Khanna, Rahul, University of IL-Chicago
- Kribs, Graham , University of Oregon
- Liu, Yuzhi, University of Iowa
- Mishra, Sanjib, University of South Carolina
- Moore, Ron, Harvard University
- Orr, Robert, University of Toronto
- Ozturk, Sertac, University of Iowa
- Palni, Prabhakar, University of New Mexico
- Prebys, Eric, Fermilab (group award organized for selected participants from URA member universities)
- Roberts, Lee, Boston University
- Slattery, Paul, University of Rochester
- Swanson, Molly, Harvard University
- Tao, Runzhe, University of IL-Chicago
- Tschirhart, Robert, Fermilab (group award organized for selected participants from URA member universities)
- Wester, William, Fermilab (group award organized for selected participants from URA member universities)
- Wilson, Jonathon, University of Michigan
- Xue, Wie, McGill University

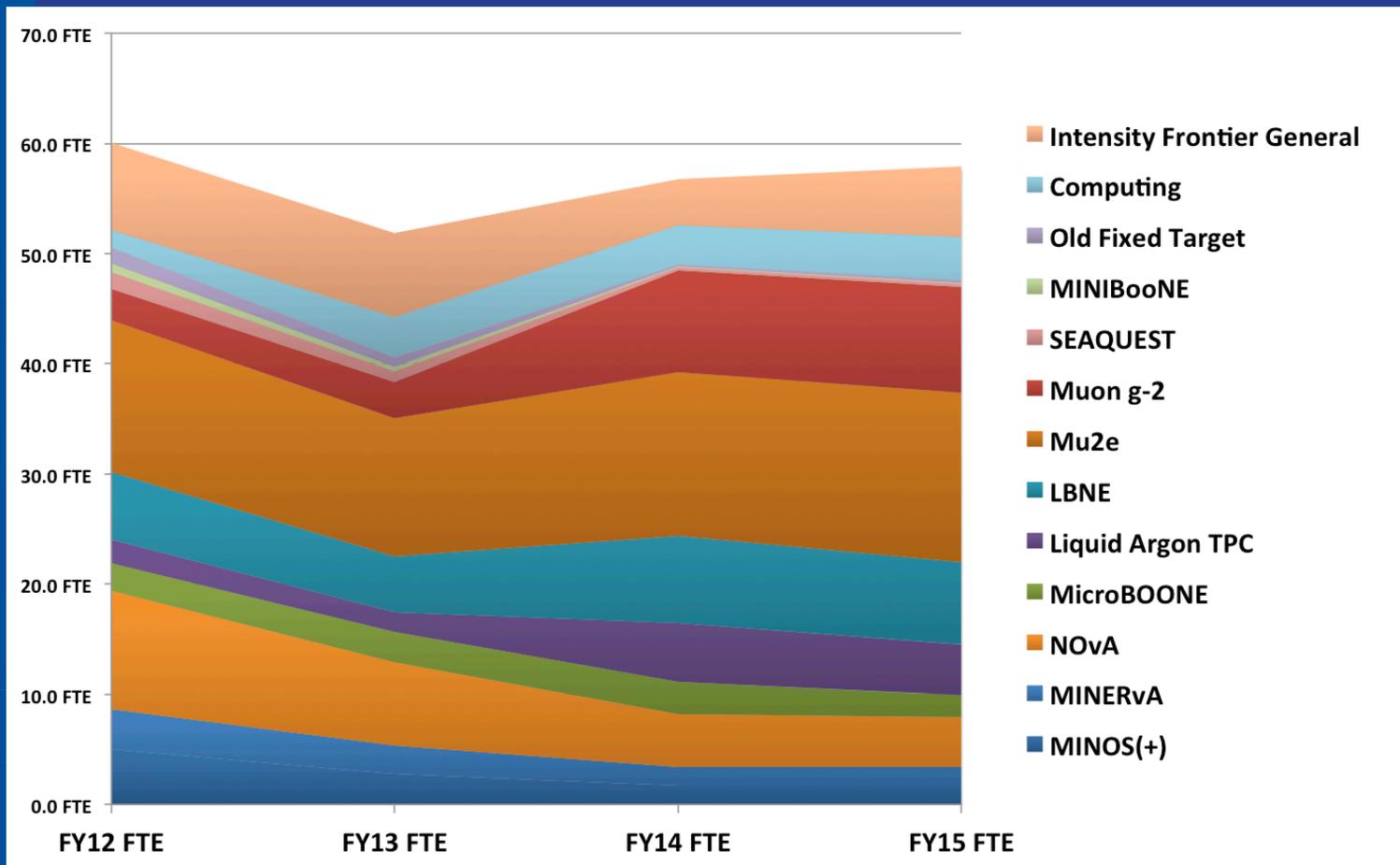
Intensity Frontier Fellowship Program

- A **community driven** mechanism to support an **Intensity Frontier intellectual hub** at Fermilab
- Support extended visits to Fermilab from university and other lab scientists
 - Work on Intensity Frontier Projects
 - Home institution can be anywhere in the world except Fermilab
 - Emphasis on current and potential future IF research rather than operations
 - Theorists or experimentalists
- Applications will be judged by peer review
 - Committee with majority of members from outside Fermilab
 - First committee currently being invited
 - Advertising out very soon
- **Hope to have first batch of Fellows starting fall 2013**

Intensity Frontier Scientist FTE Projections



FTE By Experiment Over Time



2009 Proton Review Recommendations Neutrino Thrust

The reviewers recommended that new physicist hires at Fermilab should be directed to the intensity frontier programs. It was also recommended that, if necessary, efforts should be made to attract expert senior scientists and visitors to the intensity frontier, while keeping a constant level of effort at Fermilab.

- Of 16 Scientific hires in the last 3 years, 13 have been in the Intensity Frontier
- Intensity Frontier Research Fellowship Program Initiated

2009 Proton Review Recommendations

Neutrino Thrust

The reviewers also recommended that the overall Fermilab proton program should continue to be supported at approximately the current level, moving resources from the Tevatron to other programs at the laboratory over the next several years to maintain a strong national program in HEP on the intensity frontier. In particular, many of the reviewers recommended that the effort level in LBNE should be increased, although, given the potential risks, any increase should be managed carefully.

- Funding for the overall Fermilab proton program has decreased
- Nonetheless, Fermilab has continued to increase support to the Intensity Frontier
- Resources have been moved from the Tevatron to the Intensity Frontier
- Effort on LAr TPC R&D leading to LBNE has increased

2009 Proton Review Recommendations Fixed Target Thrust

The panel recommends that a decision be made in the next three years regarding the Mu2e experiment.

- Mu2e has CD1 and has strong involvement from Fermilab scientists

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