

# Project X Preparations for Snowmass

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<http://www.snowmass2013.org/>  
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U.S. DEPARTMENT OF  
**ENERGY**



# The 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.  $n, \bar{n}$  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](#)

# Example Research Program, definitive space of accelerator parameters on [PXPS Indico site](#)

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.

## What is Snowmass About?

- Sponsored by the APS Division of Particles and Fields ...**not** the DOE.
- Community strategic planning for the 2020-2030 era.
- Message from the funding agencies: **Not** a process to re-consider Projects that are currently within the Critical Decision process.
- Snowmass output will be input to the Particle Physics Projects Prioritization Panel (P5) which will recommend programs in the context of budget scenarios.



# SNOWMASS WORKING GROUPS

- Energy Frontier
- Intensity Frontier
- Cosmic Frontier
- Frontier Capabilities
- Instrumentation Frontier
- Computing Frontier
- Education and Outreach



## Intensity Frontier group charge:

Conveners: JoAnne Hewett (SLAC),  
Harry Weerts (Argonne)

The Intensity Frontier working group is charged with summarizing the current state of knowledge and identifying the most promising future opportunities at the intensity frontier. Topics are described under the working groups.



# Frontier Capabilities Group

Conveners: William Barletta (MIT), Murdock Gilchriese (LBNL)

Frontier Facilities will assess the existing and proposed capabilities of two distinct classes of experimental capabilities for high energy physics broadly understood, namely, those provided by accelerator-based facilities and those provided by detector facilities distinct from accelerators. We expect the evaluations to be performed with two principal groups that will operate independently: Accelerator Facilities and Non-accelerator Facilities.

# Accelerator Sub-Groups in the Frontier Capabilities Group

- Energy Frontier Hadron Colliders
- Energy Frontier Lepton and Gamma Colliders
- High Intensity Secondary Beams Driven by Protons
- High Intensity Electron and Photon Beams
- Electron-ion Colliders
- Accelerator Technology Test-beds and Test Beams

## Input mechanism to the sub-group: “High Intensity Secondary Beams Driven by Protons”

- Conveners of this sub-group:
- John Galambos (ORNL), Sergei Nagaitsev Mei Bai (BNL)
- These conveners need input from the research program:

Particle	Energy	Rate	Timing	Purity	Spatial...
Kaons					
Muons					
Neutrinos					
Neutrons					
....					

# CSS 2013 Engagement Plan: Accelerator Reference Design Report\*

- Accelerator Reference Design Report (RDR) will be prepared for distribution to the community in at the Fermilab Users Meeting June 12<sup>th</sup> 2013. The RDR will include:
  - Staging plan, capability of each stage.
  - Some information on cost drivers and scaling.

\*Editor: S. Holmes

# CSS 2013 Engagement Plan: Research Program Report\*

- Research program opportunities report will be prepared for distribution be prepared for distribution to the community at the Fermilab Users Meeting June 12th 2013. This report will include:
  - Experimental concepts and physics reach opportunities of each stage.
  - Evolution of existing white papers, work at the Project X Physics Study, a URA funded theory study group (C. Quigg P.I.) and PX/CSS Intensity Frontier meetings April 24<sup>th</sup>-27<sup>th</sup> 2013.

\*Editors: A. Kronfeld, R.T.

# PX Physics Study Conveners for Experimental Concepts and Sensitivities

## Neutrinos:

Andre de Gouvea (Northwestern University), Patrick Huber (Virginia Tech) , Geoff Mills (LANL)  
Ko Nishikawa (University of Chicago/FNAL), Steve Geer (FNAL)

## Muon Experiments:

Bob Bernstein (Fermilab), Graham Kribs, (University of Oregon)

## Kaon Experiments:

Kevin Pitts (University of Illinois UC), Vincenzo Cirigliano (LANL)

## EDMs:

Tim Chupp (University of Michigan) , Susan Gardner (University of Kentucky), Zheng-Tian Lu (ANL)

## n-nbar oscillations:

Chris Quigg (FNAL), Albert Young (North Carolina State University)

## Hadron physics:

Stephen Godfrey (Carleton University), Paul Reimer (ANL)

## CSS 2013 Engagement Plan: Necessary Detector R&D Report\*

- A report on Detector R&D required to develop the research program opportunities will be prepared for distribution to the community at the Fermilab Users Meeting June 12th 2013. This report will include:
  - R&D necessary for each stage.
  - Coordination with the DPF Coordination Panel for Advanced Detectors (CPAD) and connections to other scientific and technical disciplines. Meetings at ANL in January, Boulder Co. in the spring.

\*Editors: E. Ramberg, R.T.

# PX Physics Study Conveners for Enabling Technologies and Techniques

## **High rate Precision Photon Calorimetry:**

David Hitlin (Caltech), Milind Diwan (BNL)

## **Very Low-Mass High-Rate Charged Particle Tracking:**

Ron Lipton (FNAL), Jack Ritchie (University of Texas, Austin)

## **Time-of-Flight System Performance below 10 psec:**

Mike Albrow (FNAL), Bob Wagner (ANL)

## **High Precision Measurement of Neutrino Interactions:**

Kevin McFarland (Rochester University), Jonghee Yoo (FNAL), Rex Tayloe (University of Indiana)

## **Large Area Cost Effective (LACE) Detector Technologies:**

Mayly Sanchez (Iowa State University), Yury Kamyshev (University of Tennessee)

## **Lattice QCD:**

Ruth Van de Water (BNL), Tom Blum (University of Connecticut)

## CSS 2013 Engagement Plan: Broader Impacts Report\*

- A report on the broader impacts of Project-X will be prepared for distribution to the community at the Fermilab Users Meeting June 12th 2013. This report will include:
  - Energy and material irradiation applications working closely with our DOE NE colleagues at ANL, LANL and PNNL and our Indian collaborators.
  - muon Spin Rotation applications.

\*Editors: TBD

# Schedule in advance of CSS 2013

- December 2012: Provide table of particle beam requirements to Bill Barletta (CSS2013 capabilities group).
- Broader applications forums and workshops Oct 2012 (muSR), January 2013 (Energy & Materials).
- EDM theory study session at Fermilab associated with colloquium from Klaus Kirch (PSI), February 13<sup>th</sup>-15<sup>th</sup> 2013.
- April 24<sup>th</sup>, 27<sup>th</sup>-pm: Meeting at Fermilab/ANL to review Project X draft materials for Snowmass. This meeting will be coordinated with an Intensity Frontier CSS 2013 preparatory meeting at ANL April 25<sup>th</sup>, 26<sup>th</sup>.
- April 2013: Project-X Boot-Camp for Project-X ambassadors.
- June 2013: Post and distribute Project X Snowmass materials at Fermilab Users Meeting June 11<sup>th</sup>-12<sup>th</sup>.

# Opportunities for Contribution and Leadership

- Continued development of PX/LBNE case.
- Continued development of Stage-1 experimental concepts, particularly the  $n$ - $\bar{n}$  and proton-EDM initiatives.
- Active participation on writing teams, engagement with Frontier Capabilities group.
- Developing Detector R&D required for all stages.
- Project-X ambassador team, participate in the outreach Boot-Camp.