



U.S. DEPARTMENT OF  
**ENERGY**

OFFICE OF  
**SCIENCE**

# **Intensity Frontier Implementation**

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# Outline

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**Defining the Intensity Frontier**

**The Ongoing Program**

**The Experiments Nearing  
Completion**

**The Approved Initiatives**

**The Intensity Frontier Review**

**Leadership at the Intensity Frontier**

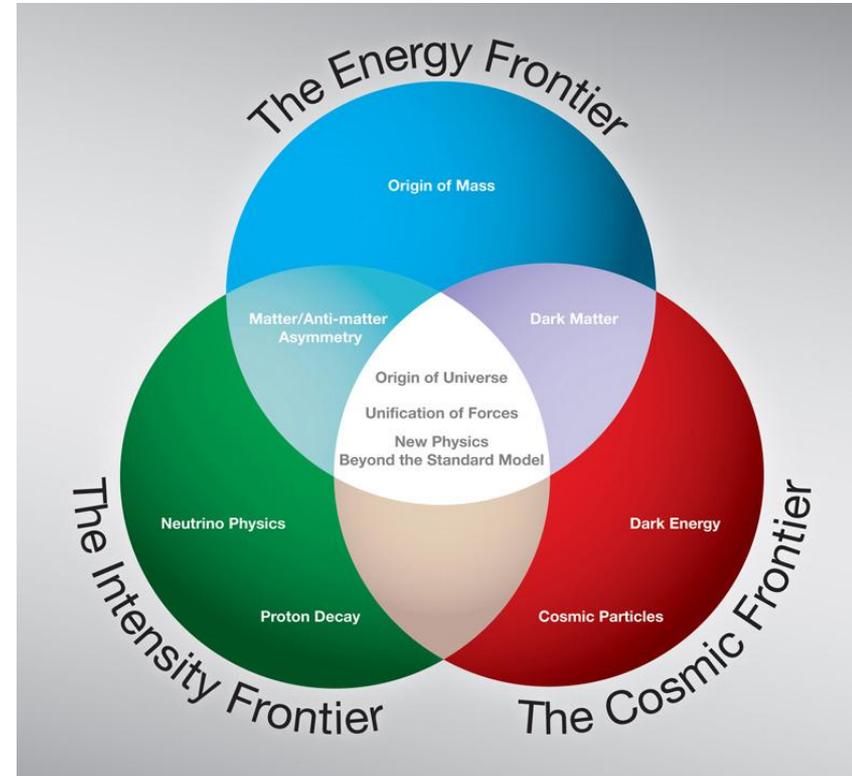
# Description of the Intensity Frontier

## The Physics

- neutrino mass
- neutrino oscillations
- neutrinoless double beta decay
- CP violation
- proton decay
- rare decays of muons, kaons, and B mesons
- precision measurements like  $g-2$

## The Tools

- a deep underground laboratory
- a multi-megawatt proton source
- B-factories/Super B-factories
- Nuclear reactors
- Innovative detectors that can reject backgrounds.
- Large yet affordable detectors for neutrinos

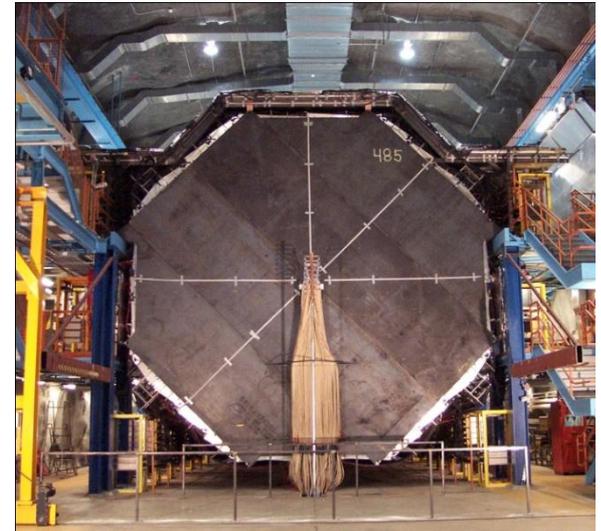


The Intensity Frontier, using intense particle beams to uncover properties of neutrinos and observe rare processes that will tell us about new physics beyond the Standard Model.

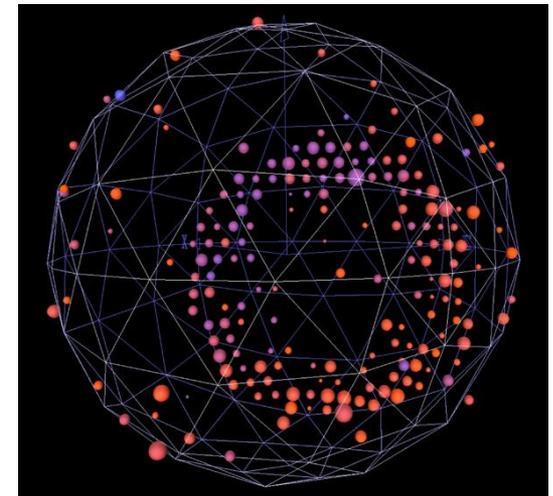
-P5 2008

# The Ongoing Program

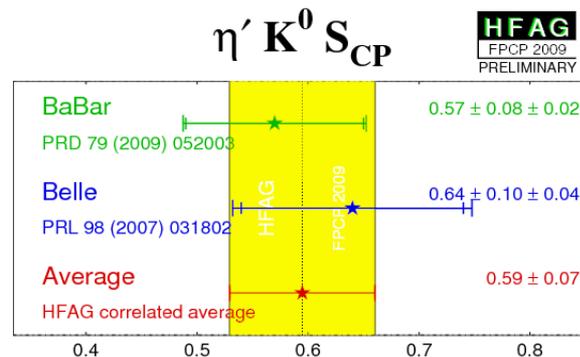
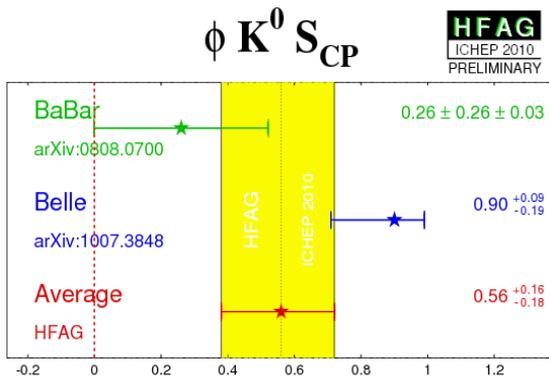
- **MINOS, MiniBooNE, and MINERvA are all taking data today at Fermilab.**
  - Utilizing two different neutrino beams at Fermilab.
  - MINOS and MiniBooNE are pursuing discrepancies that they have seen in their antineutrino data.
  - MINERvA is carrying out a program of precision cross-section measurements that can now be done due to the high power of the NuMI beam.
  
- **Babar and Belle collaborations continue to publish results on B physics.**



**MINOS FAR DETECTOR**

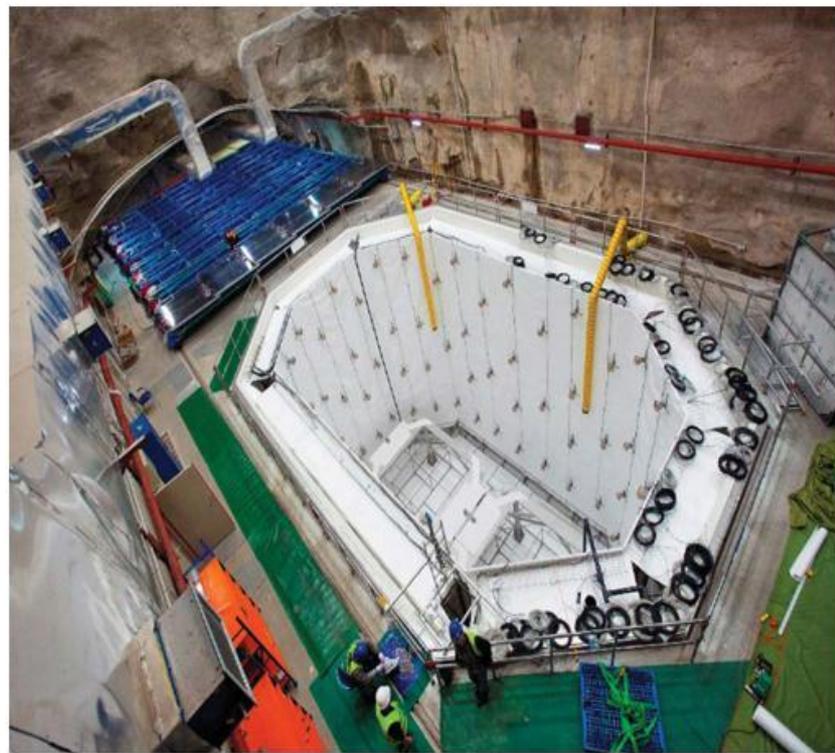


**MINIBOONE EVENT**



# The Nearing Completion

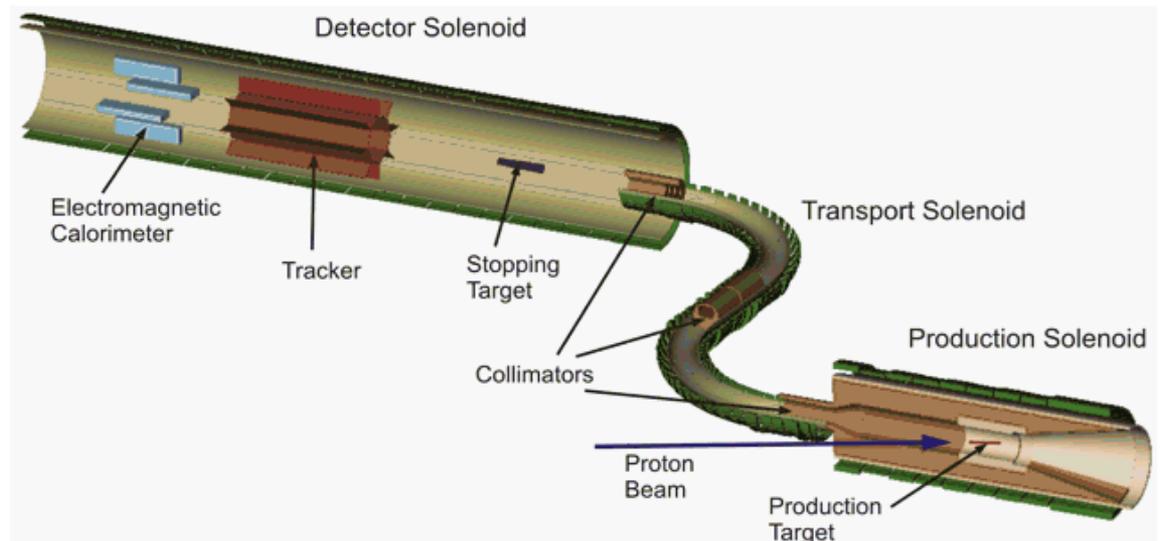
- **The Daya Bay Reactor Neutrino Experiment is nearing completion.**
  - The first hall will go into operation this summer/fall.
  - Completion is expected in 2012.



- **The NOvA far detector building is just about complete.**
  - **Assembly of the detector to start at end of 2011.**

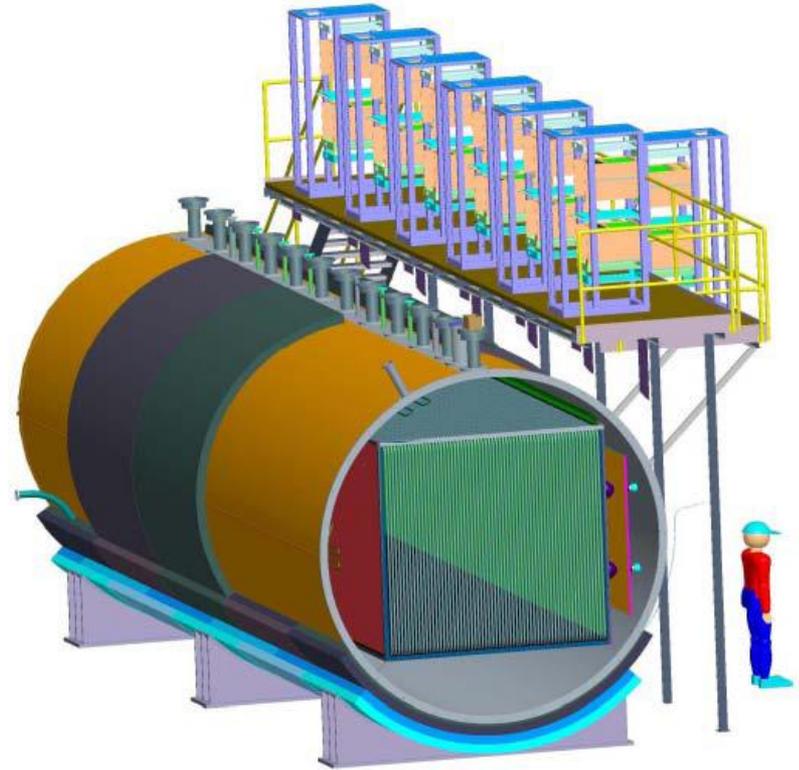
# The Approved Initiatives

- **The Muon to Electron Conversion Experiment received CD-0 in November 2009.**
  - This was a highly rated initiative by P5.
- **Program Engineering and Design (PED) Funds were requested in the FY 2011 budget.**
  - Considered a new start so the PED funds are not available under the CR.
  - Work has been slowed somewhat to preserve cash.
  - Goal is to have a CD-1 review this summer.



# The Approved Initiatives

- The MicroBooNE experiment has received CD-1.
  - Utilizes the Booster neutrino beam
  - Study neutrino oscillations and cross sections.
    - MiniBooNE low energy excess
  - A technology demonstration for liquid argon TPCs.
- Planning CD-2 review for this spring/summer.
- MicroBooNE appears in the FY 2011 request for the first time as an MIE.
  - Makes it a new start.
  - Cannot start fabrication until we have a budget.



# Long Baseline Neutrino Experiment

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- The CD-0 was approved in January 2010 and PED funds were requested in the FY 2011 budget.
  - Like Mu2e PED funds were held up by the CR.
  - Unlike Mu2e only PED funds were requested. Project survived on carryover.
- Siting the experiment at DUSEL was the primary alternative being considered.
- The decision of the National Science Board to stop support of DUSEL has forced us to reconsider our options.
- The LBNE team has been preparing for the Review of Underground Science at Homestake.
  - Costing for both liquid argon at 800 ft. and water Cerenkov at 4850 ft. will be done.
- Decisions about how to continue with LBNE will be made after the review.
  - The Mission Need still exists.
  - Alternative sites can be considered.
  - The cost to DOE will probably be higher than planned due to reduced NSF participation.
- FY 2012 budget requests both OPC and PED funds to avoid CR disruptions.

# Intensity Frontier Review

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- The 2008 P5 Report called for new investments at the Intensity Frontier to establish a world-leading US program
- In one of the mid-range funding scenarios (Scenario B), P5 called for modest U.S. participation in an overseas “Super-B factory,” that will significantly extend the search for new physics and complement the domestic Intensity Frontier program centered at Fermilab
  - Two US proposals (Japan, Italy) were submitted to respond to this recommendation
  - Note that we are currently somewhat below this funding scenario
- Subsequent to the P5 Report, DOE also received a revised proposal to re-mount the g-2 experiment at Fermilab which would require about the same level of investment as US participation in the Super-B projects
- All three proposals were sent out for mail review, but the results were inconclusive, as all three proposals rated highly and reviewers recommended proceeding with them
- To help decide between these competing proposals HEP convened a comparative review panel (Aug 10-12 2010) to prioritize the three proposals.

# Intensity Frontier Review

## Outcomes (Part I)

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- The clear recommendation from the panel was to fund both g-2 and U.S. participation in the Japanese Super-B proposal if possible. The Italian Super-B proposal was not recommended for funding.
- The FY2012 HEP Budget Request does not have a construction start for either g-2 or U.S. contributions to BELLE-II
  - However DOE/HEP is interested in supporting g-2/BELLE-II, including contributions of equipment , if a feasible cost and schedule can be arranged.
  - Addition of new research groups to bolster the U.S. effort can also be considered.
  - Proponents were encouraged to work with their international colleagues, lab management and other funding agencies as appropriate to identify revised project schedules and budget plans that meet the needs of all parties.
  - Proponents met with DOE Mar 15 (BELLE-II) and Mar 16 (g-2, with NP + NSF) and we had very useful discussions
- We will try our best to accommodate these projects in our out-year planning, subject to budget uncertainties.
- Will prepare Mission Need statements (or equivalent) as soon as possible.

# Intensity Frontier Review

## Outcomes (Part II)

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- The review panel endorsed the scientific merit and competency of the U.S. groups in the Italian Super-B proposal as excellent. However, the panel felt the proposal was too ambitious and potentially exposed the U.S. HEP program to significant cost risks if the project encountered difficulty.
- Since the review was held, the Italian government has formally announced its support for the Super-B proposal, to be managed by INFN
- We would be pleased to supply reusable PEP-II and Babar detector components to the Italian Super-B project provided the Italian government can assist with disassembly efforts and shipping costs.
  - SLAC and INFN are starting to have discussions
- Due to the outcome of the review and overall fiscal constraints, we will not be able to provide any other significant equipment contributions to the Italian Super-B project.
- Individual university PIs or lab staff who wish to participate in the Italian Super-B research program (as distinct from the construction project) should submit proposals and they will be evaluated through the standard merit review process.
- The priority of DOE/HEP in this research area will be BELLE-II.

# Stages of the Intensity Frontier

Ongoing Program	Nearing Completion	Approved	Next Up
MINOS	Daya Bay	MicroBooNE	g-2
MiniBooNE	NOvA	Mu2e	BELLE upgrade
MINERvA		LBNE	
Babar/Belle			

**The ongoing program is dominated by neutrinos as well the experiments that are nearing completion.**

**Muons appear in the program with Mu2e broadening the program.**

**G-2 and BELLE upgrade will continue to broaden the program.**

**No kaon experiments approved yet. P5 considered a proposal for a  $K \rightarrow \pi \nu \nu$  experiment and stated that such an experiment that observed 1000 events would be very important.**

# Leadership of the Intensity Frontier

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- The Intensity Frontier is a centerpiece of the U.S. HEP program (and particularly the domestic program) for the coming decade and can maintain U.S. leadership in the worldwide HEP arena.
  
- More than a collection of good experiments
  - Need a community with expertise
  - Need high quality tools for that community to use
    - Both facilities and technologies
  - Need a program with breadth
    - Do science while training students and advancing technology.
  
- Attracts the best physicists from around the world.

# Building the Future

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- A multi-megawatt proton source was envisioned by P5 as a important future Intensity Frontier Facility.
- Fermilab has been developing this concept over the last several years.
  - It has evolved from a ILC like accelerator well suited to neutrinos to a more flexible accelerator capable of supporting a broad program in a very capable manner.
  - The program can include muons, kaons, short and long baseline neutrinos.
- We are working with the lab to determine the next steps in developing this program.
- We expect to come back to the community for further input.