# Debriefing Discussion of the Snowmass Intensity Frontier All Hands Meeting April 25th-27th @ ANL

Link to All-Hands meeting:
(https://indico.fnal.gov/conferenceDisplay.py?ovw=True&confId=6248)

May 14th 2013
(Steve B & Bob T)

U.S. DEPARTMENT OF ENERGY

Fermilab

# Action items from our previous meeting

- "CD-free" graphic of Fermilab program (Chris Polly).
- Fielding provocative questions, e.g. "What do we learn from neutrino properties in terms of fundamental physics….?

  (Stephen Parke)

# Intensity Frontier Plan for "Snowmass"

SLAC

- Follow same working group structure
- Incorporate recent results/plans in neutrino sector
- Continue to develop science case for next 2 decades
- Educate community on Intensity Frontier discovery potential so that community can communicate science to others
- Engage the full HEP community
- Further explore connections with other frontiers

**Develop crisp message that captures the essence of Intensity Frontier science**

JoAnne Hewett, March 2013

# CSS13 Working Groups

SLAC

| | |
|---|---|
| **Quark Flavor Physics:**<br>Joel Butler, Zoltan Ligeti, Jack Ritchie | K, D & B Meson decays/properties |
| **Charged Lepton Processes**<br>Brendan Casey, Yuval Grossman, David Hitlin | Precision measurements with muons, taus |
| **Neutrinos**<br>Andre deGouvea, Kevin Pitts, Kate Scholberg, Sam Zeller | All experiments for properties of neutrinos. Accelerator & non-accel. |
| **Baryon Number Violation**<br>Kaladi Babu, Ed Kearns | Proton decay, Neutron Oscillation |
| **New Light, Weakly Coupled Particles**<br>Rouven Essig, John Jaros, William Wester | "Dark" photons, paraphotons, axions, WISPs |
| **Nucleons, Nuclei & Atoms**<br>Krishna Kumar, Z.-T. Lu, Michael Ramsey-Musolf | Properties of nucleons, nuclei or atoms (EDM), as related to HEP |

JoAnne Hewett, March 2013

# A Success?

- Generally agreement of “Yes” among attendees.
- Notables:
- Clearer vision regarding LBNE.
- Clearer vision of Project X as program enabler.
- Clearer vision of the role of ORKA in the US quark flavor program
- ….

# LBNE

- Consensus has emerged that the “Baseline” concept in any staged scenario starts with a detector underground. This is “The Plan”, not to be confused with the DOE Project. The Plan requires greater international collaboration. Stage-1 is 10-kT underground. The collaboration position on near detector staging is less clear.

- Underground construction adds a premium to the cost/detector-mass…what is this? From discussion…start-up costs dominate in either case, whether you are on the surface or underground. Differences in marginal costs/kTon are relatively small.

# Project X presenters at All-Hands Meeting

- **Muons probes:**
  C. Cheng, B.  Echenard, D. Glenzinski, R. Ray,
- **Kaon probes:**
  D. Jaffe
- **EDM probes:**
  Z. T. Lu
- **n-nbar probes:**
  T. Gabriel, Y. Kamyshkov, A. Young.
- **Hidden Sector probes:**
  A. Hatzikoutells, R. Van de Water

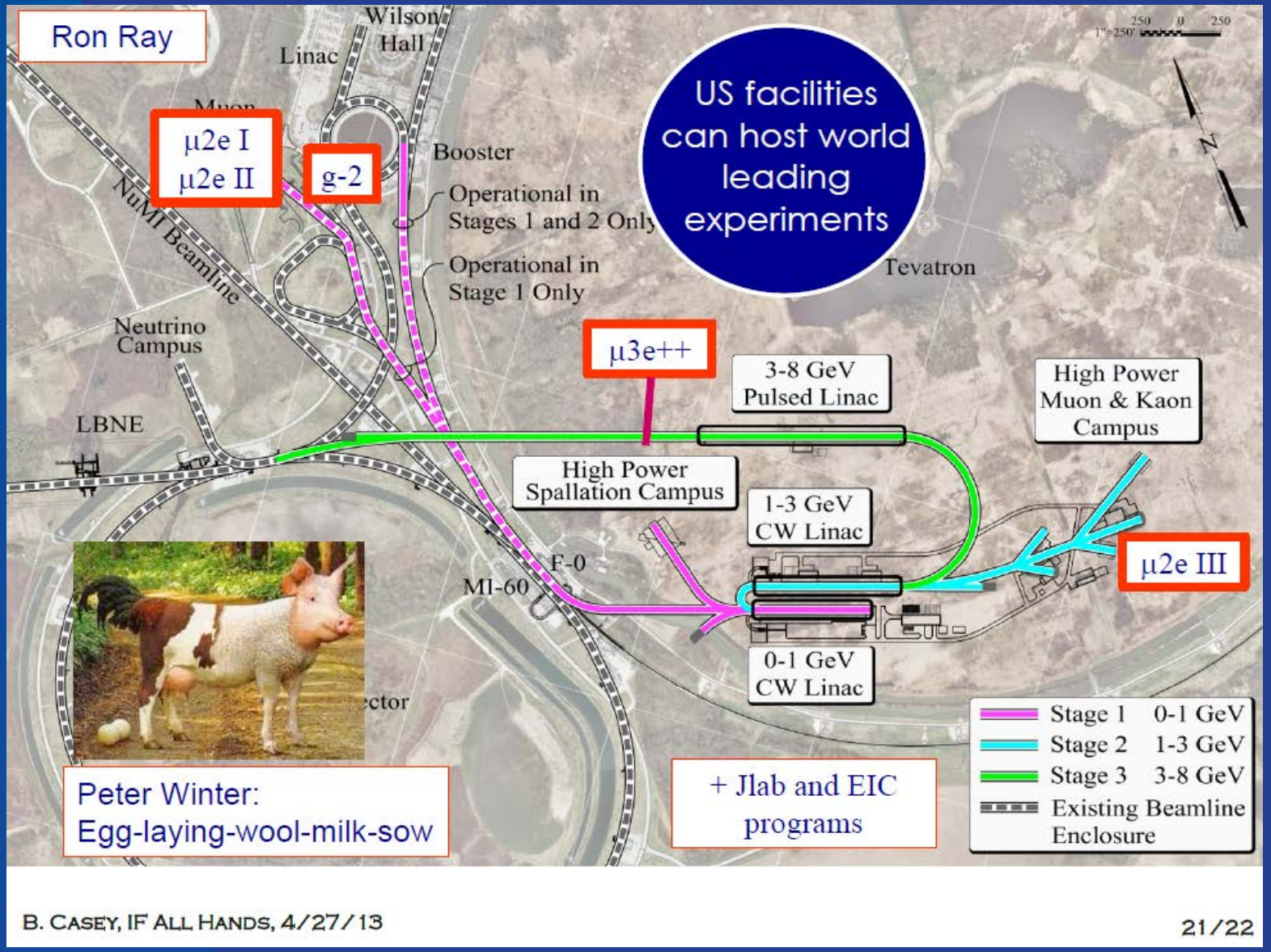
# Summary


- Project X is an ideal platform for the next generation of kaon and muon experiments
  - Beam power and flexible beam parameters enable a broad program that addresses the unique requirements of each measurement.
  - Deliver substantial beam power simultaneously to multiple programs
  - Each stage of Project X is affordable and produces world class science
  - Staging of Project X matches well with the steps that can be made on the experimental side.
- When we build it, the world will come
  - At least the part of the world that is interested in neutrino, kaon and muon physics.

# Summary

- A Mu2e-II at ~x10 better sensitivity relative to currently planned experiment
  - Interesting regardless of Mu2e outcome
  - Looks feasible at Project X
- Feasible because Project X offers important advantages:
  - High duty factor : re-use much of currently planned Mu2e
  - High power at low $E_{beam}$ : get needed #muons without pbars
  - Narrow pulses, high intrinsic extinction: mitigate RPC bgd
- Plenty of work to do - if you're interested, please let us know.
  - Simulation tools exist… you can get started quickly!
  - douglasg@fnal.gov

# Brendan Casey (Convener) Summary



# Quark Flavor Summary

## Message for Snowmass

- Flavor physics probes far above the TeV scale.
  - A necessary complement to LHC if new physics is found there.
  - Probes above the reach of LHC and other foreseeable machines.
- Existing facilities at Fermilab can support unparalleled rare K decay experiments (ORKA, and potentially others).
  - A cost effective way to mount quark-flavor experiments in **this** decade with significant potential to uncover new physics.
  - This opportunity is not open-ended (the world won't wait).
- Project X can open a new regime of sensitivity for rare K decay experiments in the next decade.
  - An order of magnitude beyond other kaon sources in the world.
- B-physics and charm physics will be led by non-U.S. programs for the foreseeable future.
  - These programs will do great physics! The U.S. should be actively involved in these experiments (Belle II and LHCb).

April 27, 2013 Argonne IF Workshop 30

J. Ritchie

# Baryon Number Violation Summary (Kearns)

- We need new ideas on how to take nucleon decay search to the next scale (beyond 1e35). Deep ice?
- A free neutron antineutron is an appealing method to pursue BNV, perhaps in the absence of proton decay.
- Observation of neutron antineutron oscillation would signal new physics at the 100 TeV scale and may fit in with new physics at higher scales.
- There is a specific proposal being evaluated for operation with Project X (NNBARX). The reach in free lifetime can be as high as 50x better than the current result.

# Issues and next steps for the Project X research program:

- Research Program document: Final draft posted in advance of the Fermilab Users Meeting.
- Staging dialog: Staging is an *opportunity*, not a requirement. Project X advances every research program element at every stage.
- Must up our game on targetry and beam delivery systems in FY14.

# Status of “Provocative Questions (PQs)”

- We have discussed the PQs from our Cosmic colleagues
- PQs from our Energy colleagues exist
- The PQs should be in our heads, but there is a risk of getting our hackles up too much and Snowmass becoming a blood sport….we need to resist this. How? (1) Deal with premises that are ill-informed (gently). (2) Abstract questions one level up constructively answer per frontier….Brendan Casey is taking a crack at this, examples on following slides.
- Questions will be clarified by conveners, and will serve as input to Plenary Panel discussions at Snowmass. These plenary sessions will have generous Q&A periods.

# B.C.: Can we rule out electroweak baryo-genesis as the source of the matter asymmetry in the universe?

- **Energy frontier:** search for new scalars needed to create a first order phase transition
- **Intensity frontier:** new sources of CPV in flavor violating and flavor conserving processes
- **Cosmic frontier:** measurements of the matter asymmetry

# B.C.: Can we solve the hierarchy problem?

- **Energy frontier:** direct probes
- **Intensity frontier:** indirect probes
- **Cosmic frontier:**

(not sure here. Any relation to the cosmological constant problem and dark energy?)

# B.C.: What is dark matter?

- **Energy frontier:** production at high energy
- **Intensity frontier:** production at low energy and direct searches at ultra low mass
- **Cosmic frontier:** direct detection plus indirect astronomical detection

# B.C.: Can we explain neutrino mass?

- **Energy frontier:** direct searches for the TeV scale Dirac neutrino that is the pivot in the see-saw. Searches for doubly-charged Higgs.
- **Intensity frontier:** direct measurements of neutrino mass differences, direct probe of Majorana or Dirac nature of light neutrinos, indirect probes of Higgs-doublet models.
- **Cosmic frontier:** information on neutrino mass from CMB, …

# Further Discussion of PQs.

- Need to get IF-to-Other PQs  in asap.
- Need to transformed into constructive provocative probing questions.  Don't know when.  Timescale for distributing PQs to community not clear today, should be asap.
- Baseline model is that these questions are drivers for the panel discussion.

# How to promote and capture the most constructive dialog?

- Send candidate questions to JoAnne & Harry. Snowmass Proceedings?
- Call for Independent whitepapers, what does this mean?
  (https://www-public.slac.stanford.edu/snowmass2013/submissionform.aspx)
- Existing neutrino WPs can be expanded and submitted explicitly to the Archive. Archive is the default. Not clear how these WPs relate to the proceedings.

# Action items

- Bob B will investigate the relationship between the Snowmass proceedings and submitted white papers.
- Submit questions from the IF -> CF,EF to JoAnne and Harry.
- Send comments and suggestion to Brendan Casey on integrated frontier answers to questions.
- Expect a dear colleague letter from the agencies in the near future regarding the charge and structure of P5, be thinking about nominations for P5 membership.
- Send comments and suggestions to Bob B regarding the Snowmass panel discussion.