HEPAP Facilities Subpanel Overview

HEPAP-   March 11, 2013

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Subpanel Chair

University of California, Irvine

Context of Subpanel

- **The DOE Office of Science has charged all of its Federal Advisory Committees to help with "an important task" – prioritization of facilities.**

Goal Statement: Prioritization of scientific facilities to ensure optimal benefit from Federal investments.

By September 30, 2013, formulate a 10-year prioritization of scientific facilities across the Office of Science based on (1) the ability of the facility to contribute to world-leading science, (2) the readiness of the facility for construction, and (3) an estimated construction and operations cost of the facility.

- **3-step process:**
  1. *The DOE/SC Associate Directors (Siegrist) create a list of facilities or upgrades.*
     complete
  2. *DOE/SC Federal Advisory Committees (HEPAP) provide advice and input.*
     this exercise
  3. *DOE/SC Director (Brinkman) prioritizes proposed facilities and upgrades across scientific disciplines according to his/her assessment.*
     comes next

Role of Subpanel

- The DOE Office of Science has charged all of its Federal Advisory Committees to help with "an important task" – prioritization of facilities.

- At SC's suggestion, empanelled a subcommittee.
- The specific advice sought is an assessment of:
  - ability of facility to contribute to "world-leading science" in next decade
  - readiness of the facility for construction
- The assessment is to be summarized in broad categories:
  - Science
    - a) absolutely central
    - b) important
    - c) lower priority
    - d) don't know enough yet
  - Construction readiness
    - a) ready to initiate construction
    - b) significant scientific/engineering challenges to resolve before initiating construction
    - c) mission and technical requirements not yet fully defined
- SC: "do not rank order the facilities"

- In the preceding presentation, Jim Siegrist has covered the relationship of this subpanel to the Community Planning & P5 process.

Relationship to Community Planning & P5 Process

- See recent letter from Fleming Crim (NSF) & Jim Siegrist (DOE).
  (posted on agenda page)

Covered by Jim Siegrist in presentation on charge.

- A multistep process
  - Each step will inform and prepare for the next.

- Facilities subpanel is 1st step.
  - Note well-defined scope: >100M$ & 10 years
  - No rank ordering by HEP
  - NOT intended to preclude add'l. ideas that emerge in subsequent steps

- DPF-led community planning ("*Snowmass*") process is 2nd step.
  - Capable of more detailed studies
  - Culminates in July 20 – August 10 workshop
  - Wider portfolio of activities
  - ~20 year time horizon

- Project prioritization subpanel is 3rd step.
  - Expected after Snowmass process complete
  - Work with input from Snowmass + budgetary input from DOE/NSF
  - Form strategic plan in various scenarios
  - HEPAP/P5 is one of few official paths for agencies to gather community input.

Science Classification

- **ability of facility to contribute to “world-leading science” in next decade**

- **Classes:**
  - **a) absolutely central**
  - **b) important**
  - **c) lower priority**
  - **d) don’t know enough yet**

- **consider, for example:**
  - **Scientific impact:** extent to which the proposed or existing facility or upgrade would answer the most important scientific questions;
  - **Uniqueness:** whether there are other ways or other facilities that would be able to answer these questions;
  - **Breadth:** whether facility would contribute to many or few areas of research
  - **Breadth of users:** especially whether facility will address needs of the broad community of users including those supported by other Federal agencies;
  - **User demand:** what level of demand exists within the (sometimes many) scientific communities that use the facility.
  - **Synergies:** whether construction of the facility will create new synergies within a field or among fields of research;

Subpanel Timeline

12/20/2012	Brinkman letter w/charge
	Constitute committee
1/31/2013	1st subpanel telecon
2/ 7 /2013	2nd subpanel telecon
2/13/2013	Open Meeting
2/14/2013	Subpanel face-to-face meeting
	5 subpanel telecons
3/11/2013	Preliminary conclusions presented at HEPAP meeting discussion and feedback from HEPAP
	subpanel and drafting meetings
3/22/2013	Final (HEPAP approved) report due to SC

Subpanel Members

Andy Lankford,	*UC Irvine (chair)*
Sally Dawson,	*BNL*
Peter Fisher,	*MIT*
Joshua Frieman,	*Chicago/Fermilab*
Stuart Henderson,	*Fermilab*
Norbert Holtkamp,	*SLAC*
Mark Messier,	*Indiana U.*
Ritchie Patterson,	*Cornell*
Regina Rameika,	*Fermilab*
Marjorie Shapiro,	*UC Berkeley/LBNL*
Robert Tschirhart,	*Fermilab*
Andrew White,	*U. Texas, Arlington*
Mark Wise,	*Caltech*

Facilities List - initial version

- **Initial list provided by OHEP.**

Energy Frontier
- Hi Lum LHC Accelerator
- Hi Lum LHC detectors - ATLAS
- Hi Lum LHC detectors - CMS
- ILC (hosted in Japan) Accelerator
- ILC (hosted in Japan) ILC Detectors
- Higgs Factory

Intensity Frontier
- Mu2e
- LBNE
- Project X Accelerator
- Project X Detectors
- nuSTORM

Cosmic Frontier
- LSST
- G3 Dark Matter
- Next Generation Dark Energy

- **Subpanel may add or subtract from list.**
  - **additions must: US cost > 100M$ + be ready for CD-1 by 2024**

Facilities List - final version

Energy Frontier

- Hi Lum LHC Accelerator
- Hi Lum LHC detectors - ATLAS
- Hi Lum LHC detectors - CMS
- ILC (hosted in Japan) Accelerator
- ILC (hosted in Japan) ILC Detectors
- ~~Higgs Factory~~

facility plan not sufficiently well defined to assess at this time
→ expect discussion at Snowmass

Intensity Frontier

- Mu2e
- LBNE
- Project X Accelerator
- Project X Detectors
- nuSTORM

Cosmic Frontier

- LSST
- G3 Dark Matter
- Next Generation Dark Energy

Notes on Facilities

- **Scope**
  - **(US) cost > 100M$**
  - **Timescale – 2024**
    - **Taken to mean ready for DOE CD-1 by 2024**

- **Next generation neutrino-less double beta decay experiment**
  - **On NSAC facilities list**
    - **Office of Nuclear Physics is currently steward.**
    - **Subpanel will monitor, to ensure our community's interests represented**

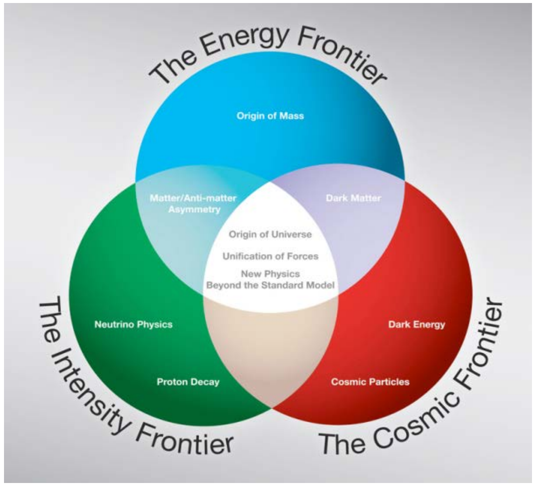
- **Other projects called to Subpanel's attention:**
  - Cherenkov Telescope Array (CTA)
  - e-NuMI
  - Dedaelus
  - Next generation axion searches (DM on list is G3 WIMP searches)
  - Next generation cosmic microwave background program
  - 80-100 km tunnel capable of pp and/or e+e- collider
  - **Much input material is posted on subpanel Open Meeting agenda page.**
- **These projects were estimated to be below or approx at the facility cost threshold and/or DOE/SC is not lead agency.**

Open Meeting – Feb. 13

- **Facilities on initial list invited to provide input to Subpanel:**
  - **1-2 page summary, addressing scientific impact & construction readiness**
  - **Optional <10 pp supporting note (with references)**
  - **(see agenda page:** https://indico.fnal.gov/conferenceDisplay.py?ovw=True&confId=6381 **)**
- **Primary purpose of open meeting was to allow Subpanel to have its questions addressed by the proposed facilities.**
- **Format was:**
  - **Brief introduction of project**
  - **Longer Q & A**
    - **Subpanel followed by audience in Q&A**
- **Time reserved at end of meeting for broader discussion**
  - **This was an opportunity to suggest, or inquire about, other facilities.**
  - **This time went unused** (at the end of a long day)
- **Thank you to facilities' contacts & colleagues, who prepared:**
  - o **Written input**
  - o **Short presentations**

on very short notice, and for answering Subpanel's questions.

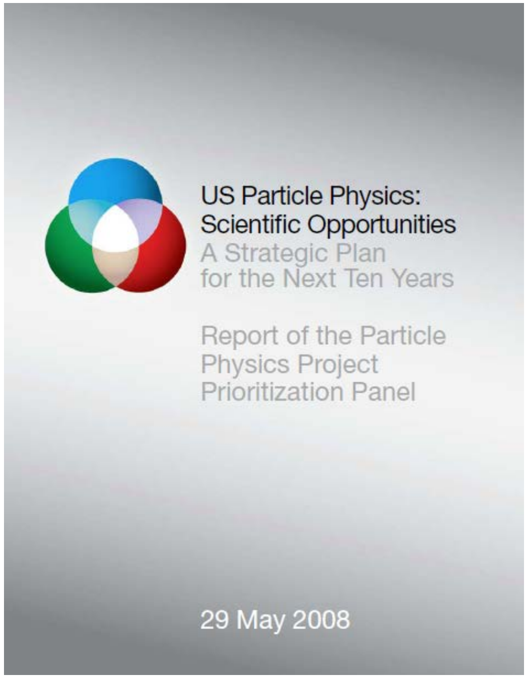
Reference frame



- **The subpanel is not without guidance.**
- **From charge letter:**

  "In its deliberations, the subcommittees should reference relevant planning documents and decadal studies."

- **HEP has a roadmap: 2008 P5 report**
  - **A balanced program on 3 frontiers**
  - **Nearly all facilities on the initial list are on P5 roadmap.**

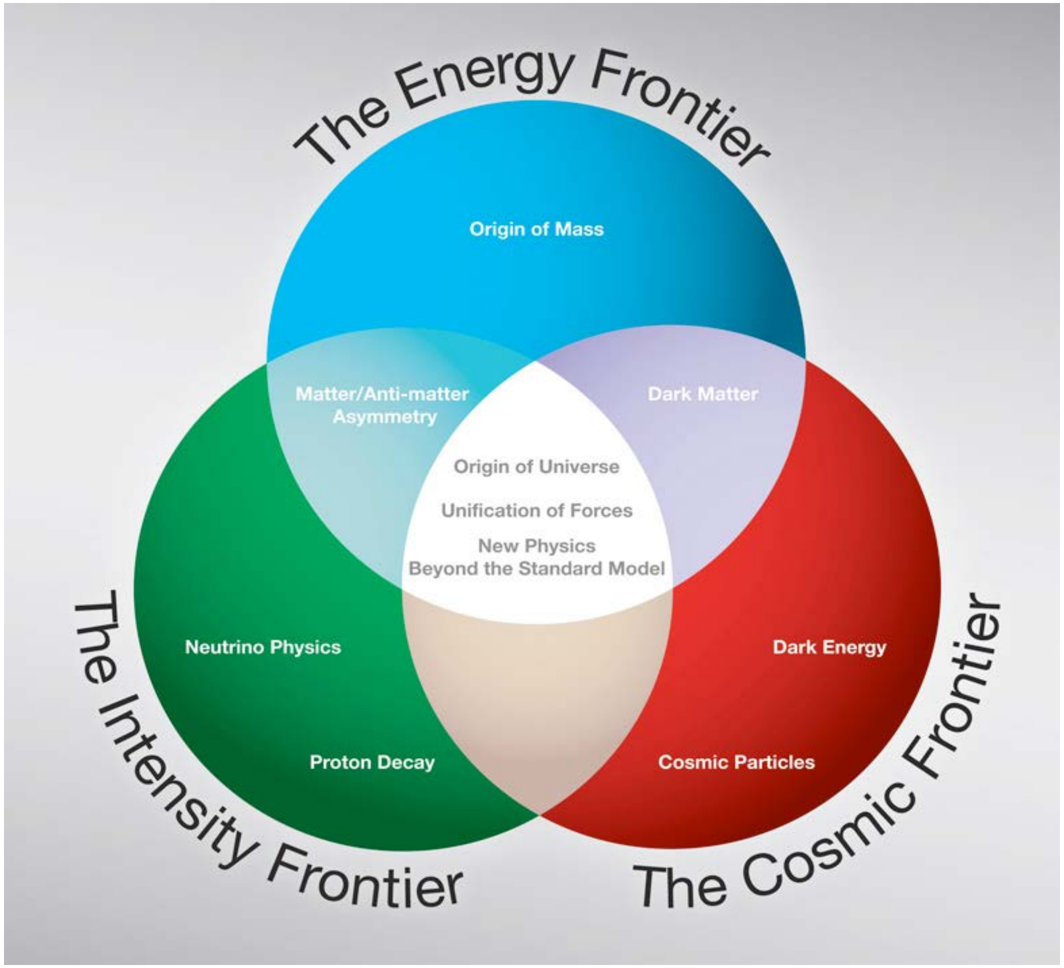


- **Other reports and studies, including:**
  - **2003 HEP facilities report**
  - **PASAG**
  - **NRC DUSEL report**
  - **NRC decadal survey for astronomy & astrophysics**
  - **LBNE reconfiguration report**
  - **Proposed Update of the European Strategy**

The facilities on list have generally been in planning, discussion, and on HEP roadmap for considerable time.
They are the facilities needed to address the most important science questions, on the 3 frontiers, in the near or longer term.

P5 Vision: A balanced program on 3 frontiers

to address the most important science questions.



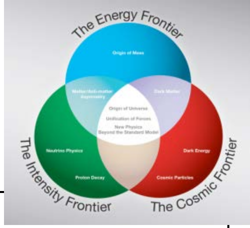
The panel recommends that the US maintain a leadership role in world-wide particle physics.

The panel recommends a strong, integrated research program at the three frontiers of the field: the Energy Frontier, the Intensity Frontier and the Cosmic Frontier.

A program that:

- **continuously produces important results on each frontier**
- **harmonizes with the worldwide program**

P5 – Energy Frontier - 1



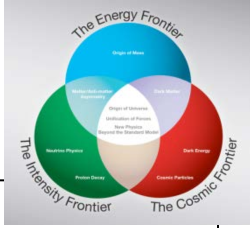
Tevatron

The panel recommends continuing support for the Tevatron Collider program for the next one to two years, to exploit its potential for discoveries.

LHC

Significant US participation in the full exploitation of the LHC has the highest priority in the US high-energy physics program.

The panel recommends support for the US LHC program, including US involvement in the planned detector and accelerator upgrades.



P5 – Energy Frontier - 2

ILC

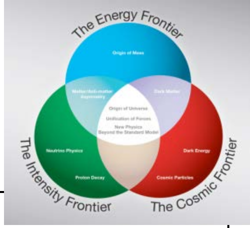
The international particle physics community has reached consensus that a full understanding of the physics of the Terascale will require a lepton collider as well as the LHC. The panel reiterates the importance of such a collider.

In the next few years, results from the LHC will establish its [ILC's] required energy. If the optimum initial energy proves to be at or below approximately 500 GeV, then the International Linear Collider is the most mature and ready-to-build option with a construction start possible in the next decade.

The panel recommends for the near future a broad accelerator and detector R&D program for lepton colliders that includes continued R&D on ILC at roughly the proposed FY2009 level in support of the international effort. This will allow a significant role for the US in the ILC wherever it is built. The panel also recommends R&D for alternative accelerator technologies, to permit an informed choice when the lepton collider energy is established.

Note: Should LHC results show ILC is lepton collider of choice, possible construction start abroad in good budget scenarios.

P5 – Intensity Frontier - 1



Neutrino program w/ Project X

The panel recommends a world-class neutrino program as a core component of the US program, with the long-term vision of a large detector in the proposed DUSEL and a high-intensity neutrino source at Fermilab.

The panel recommends an R&D program in the immediate future to design a multi-megawatt proton source at Fermilab and a neutrino beamline to DUSEL and recommends carrying out R&D on the technologies for a large multi-purpose neutrino and proton decay detector.

DUSEL

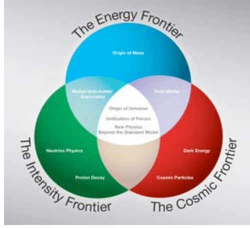
The panel endorses the importance of a deep underground laboratory to particle physics and urges NSF to make this facility a reality as rapidly as possible. Furthermore the panel recommends that DOE and NSF work together to realize the experimental particle physics program at DUSEL.

Other neutrino recommendations:

- **700 kW proton beam**
- **NOvA in all but bad budget scenario**
- **Daya Bay & DoubleCHOOZ**
- **Neutrinoless double beta decay**

Note:
Possible LBNE + Project X start within 10 yrs

P5 – Intensity Frontier - 2



Precision measurements

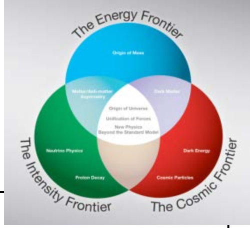
The panel recommends funding for measurements of rare processes to an extent depending on the funding levels available, …

The panel recommends pursuing the muon-to-electron conversion experiment, subject to approval by the Fermilab PAC, under all budget scenarios considered by the panel.

The intermediate budget scenario, scenario B, would allow pursuing significant participation in one overseas next-generation *B factory*.

The more favorable* funding scenario, scenario C, would allow for pursuing a program in rare *K decay experiments.

P5 – Cosmic Frontier



Thrust of Cosmic Frontier

The panel recommends support for the study of dark matter and dark energy as an integral part of the US particle physics program.

Dark Energy

The panel recommends that DOE support the space-based Joint Dark Energy Mission, in collaboration with NASA, at an appropriate level negotiated with NASA.

The panel recommends DOE support for the ground-based Large Synoptic Survey Telescope program in coordination with NSF at a level that depends on the overall program budget.

Dark Matter

The panel further recommends joint NSF and DOE support for direct dark matter search experiments.

Particle astrophysics

The panel recommends limited R&D funding for other particle astrophysics projects and recommends establishing a Particle Astrophysics Science Advisory Group.

Notes:
LSST delayed in bad budgets
Particle astrophysics in good budgets

Cosmic Frontier - Vision & Status

Vision:

- **Discover (or constrain?) the particles that make up Dark Matter.**
- **Advance the understanding of Dark Energy.**
- Conduct broad program of **particle astrophysics**.

Status – current scope:

ADMX, AMS, ANITA, Auger, BOSS, CDMS/SuperCDMS, DES, Fermi/GLAST, LSST, LUX, SuperNova, Supernova, Factory, Cosmology Project, VERITAS

Note significant interagency partnerships at this frontier.

- **For example, LSST**
  - **Highest priority for ground-based in ASTRO2010 decadal survey**
  - **NSF – telescope and data management**
  - **DOE – (advanced CCD) camera**

Note: APS Division of Particles and Fields (DPF) cosmic frontier group to investigate all dark matter search methods: direct, indirect, and accelerator production

Cosmic Frontier - Facilities

Dark Matter:

- Generation 2 DM being initiated presently
- Generation 3 DM to follow, late in 10-yr period covered by facilities report

Dark Energy:

- LSST progressing (CD-1, NSB approved)
- Possible next generation DE facilities under discussion (see Snowmass)

Energy Frontier – Vision & Status

Vision: Explore the Terascale.

Status:

- **Tevatron** stopped operations 30 Sep 2011
- Now exploiting the **LHC**.
- No new facilities under construction at this time.
- Preparing for **upgrades to LHC accelerator & experiments**
- Preparing for participation in **ILC accelerator & experiments**
- R&D for **future options** – lepton colliders, HE-LHC

Energy Frontier - Facilities

Hadron colliders:

- Tevatron – closed 2011
- LHC operational since ~2010; Phase I LHC + expt. upgrades being initiated
- **High Luminosity LHC (HL-LHC) - in research and development - ~2022 install**
- More distant options for higher energy being explored (e.g. HE-LHC, VLHC)

Lepton colliders:

- **International Linear Collider (ILC hosted in Japan) – TDR complete; initiative from Japan to host; allows staged approach to E_{cm}**
- More distant options for higher energy being explored (e.g. CLIC, μ collider)

Intensity Frontier – Vision, Status, Strategy

Vision: Implement comprehensive program to understand **neutrino mixing.**

Deliver much improved limits (measurements?) of **charged lepton mixing** and **hidden sector phenomena**

Explore **neutrino properties**: mass and nature

Status:

- **Diverse program** of existing experiments **beyond Fermilab**
  Daya Bay, Double-Chooz, K2K/SuperK, EXO-200, MJD, K0TO, Belle/Belle-II, BES III
- **Ongoing world-class neutrino program** at Fermilab
  Sterile neutrino sector: MicroBooNE (appearance), MINOS+ (disappearance)
  Establishing framework: MINERvA (neutrino cross-sections),
  NOvA (confirm θ_{13} thru appearance; determine mass hierarchy)
  Includes accelerator upgrade for NOvA & Proton Improvement Plan
- **Emerging program –** g-2, Mu2e, LBNE entering construction

Strategy:

- **Devote FNAL accelerator complex to IF to advantage of worldwide community**
- **Develop LBNE to its full potential**
- **Construct Project X to feed rich, world-leading IF program** w/ ν's, μ's, K's

Intensity Frontier - Facilities

Neutrino physics:

- Long baseline:
  - NOvA – coming on line this year; MINOS+ this year
  - LBNE – CD-1 approval for Stage 1, with possible further enhancements from international collaboration; further stage(s) in future
- Short baseline:
  - MINERvA, MicroBooNE
  - nuSTORM – conceptual stage

Flavor physics in the quark sector:

- PEP-II/BABAR & CESR/CLEO - closed 2008
- LHCb – small but important US participation
- Super-KEKB/BELLE-II

Muon physics:

- g-2 – in preparation
- Mu2e – CD-1 approved;

Project X:

- Project X accelerator: technically ready for construction
- Project X experimental program:
  - Significantly enhances LBNE & Mu2e (the CD-1 approved experiments)
  - Rich scientific program – in conceptual development

Summary & Next Presentations

HEP: a balanced program on 3 frontiers

- To address critical science questions
- On each frontier, a program reaching further, probing deeper with time
  basing subsequent steps on progress of predecessors
- Facilities are required to address the questions in the near term & longer term.
  leading to a suite of required facilities to enable a set of critical experiments.

HEP planning occurs in a global context.

- This exercise includes both facilities in US & US participation in facilities overseas.
- Progress in HEP requires:
  - US access and intellectual contributions to central science facilities overseas.
  - Offering facilities in the U.S. that fit the global program and that serve worldwide scientific community, while providing intellectual opportunity within the U.S.
- This model has worked in the past, but is more challenging now w/ big facilities.
  - US has demonstrated very effective international collaboration, e.g. LHC.

Presentations by frontier:

- Energy Frontier – Sally Dawson (BNL)
- Intensity Frontier – Norbert Holtkamp (SLAC), Mark Wise (Caltech)
- Cosmic Frontier – Josh Frieman (Chicago/Fermilab)

based on input material provided for and/or presented at Open Meeting

Conclusion

Recent results ⇨ An exciting time, of momentous opportunity

Significant, fundamental scientific questions to be addressed

Concepts and technologies exist to address these questions

- **in accelerators**
- **in experiments and detectors**

The challenge (the biggest challenge) is budgetary.

- **How to mount a program of significant experiments and significant opportunity while in a world confronted by environmental and social problems, and economic downturn?**
- **Our exercise was not charged to confront budgetary issues, nor did it try to. It puts forward the scientific opportunities.**

A well-formulated global program is a way to address this challenge; future facilities are being planned with that in mind.

- **Our exercise discusses US facilities and participation in the context of worldwide program.**