Underground Physics at the National Science Foundation

Jon Kotcher

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Outline

- **Recent history, current status**
- **Moving forward**
- **Dear Colleague Letter: underground physics**
- **Mid-scale program**
- **NSF support of G2 dark matter**
- **Closing remarks**
- **NSF/DOE collaboration on G2 dark matter (Kotcher, Salamon)**

NSF Physics Division Personnel

- **Underground physics is overseen by the Particle Astrophysics (PA) Program Directors:**
  - **Jean Cottam*, Jon Kotcher, Jim Whitmore**
- **Much interaction between the NSF PDs:**
  - **Marv Goldberg, Saul Gonzalez*, Randy Ruchti* (EPP)**
  - **Kyungseon Joo, Brad Keister (NP)**
- **Significant turnover in NSF Physics Division (NSF PHY) at the end of CY 2011.**
  - *** = new hires**
- **Many thanks to Moishe Pripstein & Jim Reidy (retired).**

Recent History, Background

- **In December 2010, the Committee on Programs and Plans (CPP) of the National Science Board (NSB) voted to discontinue further DUSEL design funding.**
- **NSF DUSEL facility design activities were zeroed out in the FY12 budget.**
- **Consideration of underground infrastructure and related activities at the Sanford Laboratory (SL) has shifted to the Department of Energy, with continuing support from the State of South Dakota.**

Follow-Up Agency Actions

- **After the NSB decision, NSF agreed to provide $4M to continue dewatering and maintenance of security at SL to cover the remainder of FY11 (June – Sep, 2011).**
- **Funds have been provided in the FY12 DOE HEP and NP budgets to maintain conditions in SL.**
- **Early science program (LUX, MJD) is moving forward.**
  - **Co-funded by the NSF and DOE programs.**
- **NSF assisted in the transition of the facility to DOE in FY12, which was completed this past February.**
- **NSF is supporting UC Berkeley project team in their transition in any and all ways possible, short of providing additional funds.**
- **NSF/DOE JOG (DOE HEP & NP, NSF PHY) continues to meet regularly.**

DUSEL Solicitation 4 (S4) Program

- **Solicitation 4 (S4): called for proposals to develop designs and pursue targeted R&D for potential DUSEL experiments. Jan 2009.**
- **25 proposals received; 300 senior researchers; 91 institutions.**

- **Nine proposals funded in physics:**
  - **Dark matter (4)**
  - **Neutrino-less double-beta decay (2)**
  - **Large water Cerenkov detector (multi-purpose)**
  - **Underground accelerator**
  - **Assaying sub-facility**
- **Total physics awards: $21M over 3 years.**

- **Seven proposals funded in BIO, GEO & ENG sciences:**
  - **Fracture processes**
  - **Coupled processes**
  - **Subsurface imaging and sensing**
  - **Fiber optic strain monitoring**
  - **CO_2 sequestration**
  - **Eco-hydrology & deep drilling**
  - **Underground monitoring**
- **Total BGE awards: $3M.**

NSF DUSEL-Related Funding

DUSEL Awards	NSF Funding ($M)
Facility Design (to UCB)	
S3	15
S3 Supplement	3
PDR	29
PDR Supplement	6
Subtotal Facility Design	***53***
Physics Experimental Design	
S4 *(nine awardees, complete)*	***21 (over 3 yrs)***
DUSEL R&D	
Individual awards (~ *complete*)	***12 (over 3 yrs)***
Dewatering in FY11	***4***
TOTAL	***90***

Excludes ~ $3M in BIO, GEO and ENG (BGE) awards from S4 and individual programs, and funding for early science experiments (LUX/MJD).

Facility Design

Experiment Design ★

Dewatering

Excludes funding for DUSEL-related development from the State of South Dakota ($124M) and DOE (~ $50+M).

Moving Forward (1)

- **As stated by the NRC and other advisory panels, underground physics offers the opportunity for discoveries of seminal importance in the coming years.**
- **In light of this, and also in response to the recent shift in agency responsibilities, NSF PHY is redirecting its future-generation, facility-driven investments in underground research to the site-independent, nearer-term development of individual underground experiments and experimental techniques.**

Moving Forward (2)

- **Such an approach is responsive to the stated NSF and NSB goals and directives, as well as the strong NRC and community endorsement of underground physics.**
- **It also optimally leverages investments in the NSF PHY, and is consistent with its long-standing goal to support the best possible research.**
- **Dear Colleague Letter (DCL) announcing this funding redirection published in January 2012.**
  - **http://www.nsf.gov/pubs/2012/nsf12043/nsf12043.pdf**
- **The DCL review and funding decisions are being coordinated with the PA program.**

DCL (1)

NSF 12-043

Dear Colleague Letter: Announcement of a Redirection in the Funding of Detector Development and Related Activities in Underground Physics by the Division of Physics

Date: 01/10/2012

In the last few years, the Division of Physics (PHY) has supported R&D directed at future generation underground physics experiments in a potential deep underground laboratory in the U.S. In FY 2012 consideration of underground infrastructure for a Long Baseline Neutrino Experiment and other related activities has been shifted to the Office of Science at the Department of Energy. This Dear Colleague Letter (DCL) is meant to inform the community that, in response to this shift of responsibility, *PHY is redirecting its related investments from a primary focus on future generation experiments to one that emphasizes the greatest potential for scientific discovery that will evolve over the next decade. The scope of this ongoing program considers, in a site-independent and generation-independent way, the near- and mid-term development of detectors and related activities in underground physics.*

DCL (2)

The importance of the physics that is enabled by deep underground locations has been stressed by multiple scientific assessment panels over the last decade [see, for example, the most recent study performed by the National Academy of Sciences, "An Assessment of the Deep Underground Science and Engineering Laboratory", http://www.nap.edu/catalog.php?record_id=13204.]
The investment announced in this DCL is consistent with the ongoing practice in PHY to support world-class, transformational research at all three frontiers of particle physics, including those questions at the cosmic and intensity frontiers that can only be addressed by means of state-of-the-art detectors placed underground. It also continues the long-standing interagency partnership between PHY and DOE's Office of Science in this area of physics, as the agencies and the community adapt to the recent shift in responsibilities.

DCL (3)

Subject matter for activities in this area may be interpreted broadly, but includes such topics as searches for dark matter, neutrino-less double beta decay, underground nuclear astrophysics, neutrino oscillations, proton decay, and other physics topics that require an underground environment. Proposals may request funds to support activities related to the development of underground physics experiments, including research and development, engineering and design, detector construction and deployment, operations and maintenance, and/or other activities on the critical path to significant scientific advances. **Related information may be found on the Particle and Nuclear Astrophysics (PNA) home page [url provided].**

Proposals are required to be prepared and submitted in accordance with general guidelines contained in the Grant Proposal Guide or the NSF Grants.gov Application Guide. These documents are available electronically at the NSF website [urls provided]. ***Proposals should be submitted to the Particle and Nuclear Astrophysics program and reference this DCL. The target date for submission is May 1, 2012. Applicants are requested to contact the cognizant Program Director in PHY prior to submission.***

Joseph L. Dehmer, Director
Division of Physics

Mid-Scale Program Concept

- **Projects > $140M (10% of the $1.4B MPS budget) are funded through the Major Research Equipment and Facilities Construction (MREFC) budget line.**
- **Major Research Instrumentation (MRI) program supports acquisition or development of instrumentation at universities. Range = $0.1M - $4M.**
- **Mid-scale instrumentation program is currently under development in NSF PHY that would fill the gap between few M$ (programs, MRI) and $140M (MREFC).**
- **Would support one-time capitalization (i.e., construction, not research groups).**
- **Competed Division-wide (AMO, Biophysics, EPP,…). Is independent of aforementioned redirection of underground science funding.**

NSF Support of Next-Generation (G2) DM

- **The DM community is, generally speaking, not ready to proceed with G2 construction.**
- **NSF support of G2 R&D, engineering and design is being supported via the final spend-out of S4 funding this year, as well as the ongoing PA program.**
- **Opportunities for future support for such development work exist via proposal submissions to:**
  - **DCL announcement (May 1, 2012)**
  - **PA program (October 31, 2012)**
- **Proposals to NSF for G2 construction should be submitted to the PA program in October 2013.**
  - **See following discussion on coordination with DOE.**

Closing Remarks

- **Particle, nuclear and astrophysics are poised to probe a series of rich, fundamental questions, a number of which can be accessed only underground.**
- **NSF PHY is adapting to a leaner, more focused future during this period of transition in U.S. underground research, and while the more global scientific and budgetary priorities are being assessed.**
- **Resources in the next few years will be stretched – a strongly collaborative, consensus-driven community approach will be a major determinative factor in the quality of the scientific future that can be established.**
- **NSF PHY looks forward to working with the community in defining this new path forward during this interesting, but challenging, time.**

NSF /DOE Coordination on G2 Dark Matter

Working Model for DOE/NSF Coordination on G2 DM

- **Proposals for R&D, engineering and design, etc. (pre-construction) submitted to NSF and/or DOE will be reviewed independently by the sponsoring agency.**
  - **NSF DCL announcement, PA program, DOE RFP R&D phase.**
- **PDs from the sister agency will attend these reviews as observers.**
- **G2 construction proposals will be submitted in ~ late CY13, and the selection will be co-reviewed together by both agencies.**
  - **October 2013 PA, ~ end 2013 DOE RFP construction phase.**
- **NSF & DOE will discuss and, as warranted, coordinate the funding decisions for all phases above, but the decisions will ultimately be made independently by each agency.**
- **The working model above has been agreed upon by the NSF PHY and DOE HEP PDs, and each step has a precedent: it's been done before.**

Backup

Moving Forward (3)

- **This redirection encompasses experimental physics topics that require an underground environment, such as:**
  - **Underground nuclear astrophysics, direct detection of dark matter, neutrinoless double-beta decay, neutrino oscillations, proton decay, supernovae neutrinos...**
- **The funds will support site-independent development of experiments and/or techniques, including:**
  - **R&D, engineering and design, detector construction and deployment, operations and maintenance, or other activities on the critical path to significant scientific advancement.**