The U.S. National Science Foundation’s Deep Underground Laboratory at Homestake- DUSEL

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The US National Science Foundation has launched a program to establish a world-class, multi-disciplinary deep underground science and engineering laboratory - DUSEL. The NSF has selected as the prime site to be developed for an international world-class research facility. Recently there has been increasing interest in underground physics, astrophysics and other fields of science that require deep underground laboratory and research facilities. I will review the scientific case for DUSEL and the near-term experiments anticipated in Homestake, as well as presenting the efforts to create the Sanford Laboratory at Homestake in advance of DUSEL.

One of the most compelling questions in 21st century science is the mass and make-up of our universe. We now know that its large fraction is made of unknown material. Leading theoretical conjecture points to a weakly interacting massive particle or WIMPs. Recent advances in detector technology highlight the need for appropriately outfitted space in a deep laboratory to pursue the next generation of detectors whose mass will likely surpass 1 ton and which will require exquisite shielding from cosmic rays at depths of over 7000 feet below ground. We need to prepare sites which has to be sheltered by the earth's crust from the background cosmic rays and human activity for exquisitely sensitive particle physics and astrophysics experiments searching for the subtle but unmistakable signatures of a revolutionary new physics of the universe.

The study of neutrinoless double beta decay has made significant advances in technology. Coupling these advances with the increase in knowledge of the neutrino mass states and mixing angles highlights the need for next-generation experiments with detector masses, again, approaching 1 ton. These large-scale experiments will require excellent support and appropriately outfitted laboratory space below 7000 feet below ground.

Both neutrinoless double beta decay and dark matter experiments are being approached in a phased manner, with intermediate mass prototype detectors. Homestake’s 4850 Level (feet below ground) and the laboratory at the 7400 Level are well suited to this phased approach and in providing the essential experimental requirements for these efforts.

Long baseline neutrinos experiments will require massive detectors, with masses over 100 ktons. These large cavities will present engineering challenges. Producing these at depth enables parallel scientific programs, in the same detector, of nucleon decay searches, supernovae detections, and even atmospheric and solar neutrino detection.
Nuclear astrophysics efforts, centered around a modern high-current accelerator will be a showcase experiment for the nuclear astrophysics community.

Biologists probe the secrets of microbial life at extreme depths, in hot, harsh environments sequestered for millennia from the earth's surface. Geoscientists and engineers research the behavior of subsurface rock, minerals, water and energy sources.

A new Deep Science Initiative, structured around DUSEL would extend the frontiers of particle physics and astrophysics, biology, geoscience and engineering—and foster the synergies among them. This Deep Science Initiative and DUSEL will yield discoveries about the fundamental nature of our own planet, about the life that it harbors and about the universe that is its home. It would contribute strongly to the basic science. It would provide unique opportunities for innovation in underground technology, with immediate and long-term applications. A Deep Science Initiative would address the need to sustain research in fundamental and applied science and to educate, train and inspire the next generation of scientists and engineers. Fig.1 shows conceptual design of DUSEL at Homestake. The need of DUSEL is well documented with many reports and studies. The NSF has adopted a careful thorough review of sites and recently selected Homestake as the site to focus their efforts in creating the facility. The Homestake Collaboration is currently working to developing plans for DUSEL at Homestake in South Dakota.

I shall discuss the multidisciplinary research efforts identified in the nearer term for Homestake Interim Laboratory and the Initial Suite of Experiments being discussed by the NSF and its committees [1].

Figure 1. The Deep Underground Science and Engineering Laboratory at Homestake, SD. This figure presents the conceptual design DUSEL in the former Homestake goldmine in South Dakota.

References
[1] http://www.dusel.org/