The DUSEL Experiment Development Coordinators (DEDC)

Derek Elsworth, Penn State University (Chair)
Steve Elliott, Los Alamos National Laboratory
Hank Sobel, University of California, Irvine
Tullis C. Onstott, Princeton University
Larry Murdoch, Clemson University

March 17, 2008

The DUSEL Experiment Development Coordinators (DEDC) was formed to address the development of the Initial Suite of Experiments (ISE) to be included in the NSF's MREFC proposal for a Deep Underground Science and Engineering Laboratory (DUSEL). DUSEL is a facility that will house a large and varied portfolio of experiments for scientists in physics, biology, geosciences and the engineering communities. The DEDC is charged with coordinating the development of the superset of ISE candidate experiments in their respective disciplines, and helping to bring them to the most advanced state of maturity possible in the available time in order to optimize their strategy for development, so they may be best positioned for consideration in the ISE.

The DEDC comprises two representatives of the particle physics and astrophysics community (Steve Elliott and Hank Sobel) and one each from the biology (Tullis C. Onstott), geoscience (Larry Murdoch) and engineering (Derek Elsworth) communities.

The DEDC will:

- Develop the framework for the initial suite of experiments (ISEs) consistent with the community-driven efforts reported in the S-1 and other plans, and consistent with the capabilities of the proposed facility.
- Coordinate the activities of the community in defining the portfolio of ISEs and in completing the necessary design and evaluation of experiments to ensure safe and successful operation within a DUSEL.
- Liaise between the scientific community and both NSF and the Homestake design team to ensure on-schedule development for the ISEs' plans and for the timely completion of an MREFC application.

These objectives will be met through a series of workshops and meetings. The ultimate objective is the timely completion of an MREFC application and the resulting successful funding and development of a long-term multi-user facility developed at optimal cost and schedule that will serve the physics, biology, geosciences and engineering communities.

The DEDC has organized the community in working groups around ISEs or logical groupings of experiments towards developing a compelling science plan for DUSEL. The working groups led by scientists in the respective fields will develop detailed science and engineering plans for experiments to reach readiness for an MREFC application in December 2009, and subsequent implementation in 2012.

A proposed project timetable from present until the establishment of the initial suite of experiments is below followed by a list of working group themes and leads.

DEDC Project Activities Timetable			
2008			
	Pre-workshop:	Invite proponents, solicit initial input, plan workshop agenda	March 10th
		Complete initial agenda and one-page white paper	April 1st
	Lead ISE Workshop:	Craft working group and ISE modules: objectives, approach, expected results	April 20
		Present strawman outline at close of workshop - plan S-4 proposals	April 26
	NSF S-4 Proposal:	Submit S-4 proposals for initial critical design elements of ISEs	June 30th
	ISE e-Workshop	Potential teleconference to assess progress in ISE proposals and integrate ISEs	October
		S-4 funding available from NSF	expected October
	Grantees Meeting and Workshop	Summary of design progress and recruitment of further community involvement into development of ISEs, including those that were submitted for S-4 but didn't receive funding	December
2009			
	ISE e-Workshop	Potential teleconference to assess progress in ISE proposals and integrate ISEs	March
		Preliminary Design proposals for ISEs due	May
	Grantees Meeting:	Final report on ISE design for incorporation into CDR/MREFC	May
		Initial Suite of Experiments selected and announced	July
	ISE Workshop	Writing workshop as input for MREFC submission	October
	MREFC:	Assembly of MREFC and submission for review by NSF's NSB	December
2010		MREFC submitted to Congress	March
2011-2016		ISEs begin	

Physics Working Groups

1. **Dark Matter, Dan Akerib, Case Western University & Rick Gaitskell, Brown University:** The direct detection of Dark Matter is addressed by various techniques. What is this dark matter that binds the galaxies? Although physicists have studied ordinary matter–atoms–in detail, nothing they have seen so far has the right qualities for dark matter. Discovering what dark matter really is stands as one of the major challenges in science today. (Experiments: CDMS, XENON, LUX, LAr, HPSG, COOUP, CLEAN)

2. **Long Baseline/Nucleon Decay, Bob Svoboda, University of California at Davis:** Building on the discoveries of neutrino oscillation studies using solar, atmospheric and reactor

neutrinos, a large detector in DUSEL would measure much more precisely neutrino mixing angles and mass parameters. In addition, the neutrino mass hierarchy (ordering of masses) and value of the CP violating phase could be unambiguously determined using an intense wideband neutrino beam with appropriate detector. This detector is a natural match for a next generation proton decay experiment and a wide range of other physics. (Experiments: MMM, LAr)

3. **Neutrinoless Double Beta Decay, Giorgio Gratta, Stanford University:** The detection of neutrinoless double beta decay is also addressed by various techniques. Neutrinoless double beta decay experiment is unique in discerning whether the neutrino is its own antiparticle (also known as being a Majorana neutrino). (Experiments: EXO, 1-Tonne Ge, COBRA, MOON, Low Pressure Xe)

4. **Nuclear Astrophysics, Michael Wiescher, University of Notre Dame:** The principal goal of an underground High Current Ion Accelerator (HCIA) is to empirically quantify the cross sections for nuclear fusion reactions that are important for energy production in stars, with particular emphasis on those reactions that are responsible for the flux of neutrinos with energies above those from the pp fusion in the Sun. (Experiments: UG accelerator)

5. **1-km Vertical Space, Yuri Kamyshkov, University of Tennessee, Knoxville:** There are a number of proposals that would make use of a large vertical space. These include neutron-antineutron oscillation, which is a key test of an unexplained but fundamental symmetry, baryon number conservation; the precise study of the diurnal rotation of the Earth; the study of small cloud formation. (Experiments: N-Nbar, Cloud Physics, atom interferometry, diurnal rotation rate of Earth)

6. **Gravity Waves, Vuk Mandic, University of Minnesota:** The search for gravity waves requires an environment that is isolated from the seismic noise associated with activity on the surface of the Earth. An underground experimental site has significant advantages.

7. **Low Background Counting, Prisca Cushman, University of Minnesota:** A low background counting facility would have broad application for a number of experiments, in particular for material screening.

8. **Solar Neutrinos, Bruce Vogelaar, Virginia Tech:** The study of solar neutrinos began as an effort to directly verify calculations indicating that nuclear reactions powered the sun. It evolved into historic discoveries about the basic properties of neutrinos. The current program is the development of real-time, precision experiments that measure the spectrum of solar neutrinos down to the earliest and lowest energy part of the chain, from proton-proton (pp) fusion.

9. **Studies of Effects of Energetic Particles, Rob McTaggart, South Dakota State University:** Studies of effects of energetic particles on electronic devices, biological systems, materials and development of structure imaging from cosmic rays

Geoscience, Geomicrobiology and Engineering Working Groups

1. **Baseline characterization and monitoring, Stephen Martel, University of Hawaii:** Characterization of the current state of subsurface conditions, monitoring of processes prior to ISEs. *Conditions and processes related to deformation, fluid flow, mass transport, chemical reactions, microbial distribution and reactions*

2. **Ambient rock deformation processes, Herb Wang, University of Wisconsin:** Deformation processes occurring naturally or as a result of ambient conditions resulting from ongoing operations at the facility including excavation and dewatering. *e.g. Poroelastic processes, stress dependent permeability, natural seismicity, scaling of stress and deformation, biogeochemical reactions, microbial interactions, and related.*

3. **Induced rock deformation processes, Leonid Germanovich, Georgia Tech:** Deformation processes induced by manipulating *in situ* conditions. *e.g. Fluid-driven and mixed mode propagation, fracture interaction, faulting, fracture energy scaling, thermal effects, healing, sealing and triggering, biogeochemical reactions, and microbial interactions, and related.*

4. **Ambient flow, transport, diversity and activity, David Boutt, University of Massachusetts:** Flow, transport and reaction processes occurring naturally or as a result of ambient conditions at the facility. *e.g. Natural flow systems, permeability scaling, fracture connectivity and architecture, aqueous geochemistry, natural tracers, flow paths and rates, water ages, microbial activity and diversity, microbial interactions with subsurface facility, and related.*

5. **Induced flow, transport and activity, Eric Sonnenthal, LBNL:** Flow and transport processes induced by manipulating in situ conditions. *e.g. Heat, mass and microbial transport, hydrothermal reactions, thermal stresses and permeability changes, multiphase, pressure solution, microbially mediated reactions, and related.*

6. **Underground construction, mining and environment, Charles Fairhurst, University of Minnesota:** Processes related to creating, designing, characterizing or monitoring and maintaining underground construction and mining activities. *e.g. Large cavities, tunnels, wellbores, rupture, uncertainty, preconditioning, ventilation, corrosion, and related.*

7. **CO_2 Sequestration, Joe Wang, LBNL:** Processes associated with designing and predicting the performance of long-term disposal or sequestration of wastes in rock. *e.g. CO_2 transport, multi-phase transport, reactions and mineralization, microbial induced precipitation and immobilization of metals, and related.*

8. **Resource extraction, Jean-Claude Roegiers, University of Oklahoma:** Processes related to designing and improving the recovery and management of valuable earth resources; petroleum, gas, geothermal energy, ore minerals, water, biofuels, etc. *e.g. Fracturing, drilling, secondary and tertiary recovery, well completion, formation characterization, microbially enhanced recovery, and related.*

9. **Subsurface imaging and sensing, Steven Glaser, UC Berkeley:** Techniques for improving the spatial and temporal resolution of important subsurface properties or states. *e.g. Seismic, electrical, radar tomography, and emerging geophysical techniques; raman, UV fluorescent and emerging sensors, mobile laboratories, or related techniques.*

10. **Ultra-deep drilling and exploration, Tom Kieft, New Mexico Tech:** Biological and geological processes occurring at depths from 2.5 to 5 km. *Microbial population, fluid composition, flow rates, fluid age, stress state, permeability and related.*