Henderson DUSEL

Robert J. Wilson
Colorado State University

April 6th 2005
UNO Collaboration Meeting
Aussois, France
DUSEL

• Deep Underground Science and Engineering Laboratory
  – Multi-purpose laboratory for physics, geoscience, microbiology and geoengineering
  – National Science Foundation (NSF) lead agency; agreement and support from other US agencies (Dept. of Energy, NASA…) and Office of Science and Technology Policy (advises the President)

• Solicitation 1: Science & eng infrastructure needs
  – In progress; more from Bernard Sadoulet in NNN05 session

• Solicitation 2: Site specific conceptual design development
  – 7 proposals submitted Feb. ’05
  – 3-5 awards of ~300-500k$, ~June ’05

• Solicitation 3: Detailed design development
  – Sometime ’06?; 1-2 awards
Potential US DUSEL Sites
**Great circle distances (km)**

<table>
<thead>
<tr>
<th>Location</th>
<th>FNAL</th>
<th>BNL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Icicle Creek</td>
<td>2700</td>
<td>3800</td>
</tr>
<tr>
<td>Homestake</td>
<td>1300</td>
<td>2500</td>
</tr>
<tr>
<td>Henderson</td>
<td>1500</td>
<td>2700</td>
</tr>
<tr>
<td>San Jacinto</td>
<td>2700</td>
<td>3900</td>
</tr>
<tr>
<td>Soudan</td>
<td>750</td>
<td>1700</td>
</tr>
<tr>
<td>Kimballton</td>
<td>800</td>
<td>800</td>
</tr>
<tr>
<td>Carlsbad</td>
<td>1800</td>
<td>2900</td>
</tr>
</tbody>
</table>

**VLBNO: 1500-2500 km**
To the Western States

Eisenhower Tunnel

Continental Divide

Henderson Mine

Interstate-70

US-40

Denver
Henderson Mine

- Owned by Climax Molybdenum Co.
  - Subsidiary of Phelps Dodge
  - Operating since 1970’s
- High grade molybdenum (”moly”)
- One of 10 biggest hard rock mines

- Major modernization 1999 ($150M)
- 15-20 year remaining ore
- Long term planning a high priority
  - would like to be a “poster child” for sustainable re-use
- Enthusiastic and cooperative partners
  - pro bono contributions
  - geology consultants for core logging etc.
  - lots of tours!
Hoist – 50 ton capability

Cage can accommodate 20ft shipping container of 30 tons

28-ft diameter shaft
Transport 200 people
2800’ in < 5 minutes
Moly Ore

Unusual new moly seam found 2005
80 ton trucks dump rock at crusher. Gyratory crusher reduces to – 4 in. 1 mile PC1 and 10.5 mile long PC2 underground conveyors. 4 mile long PC3 surface conveyor to mill site. ~40k - 50kton/day capacity
High speed conveyor for crushed rock transfer to mill site
Henderson Solicitation-2 Proposal

• Henderson Underground Science and Engineering Project (HUSEP) Collaboration
  – Evolved from Colorado Alliance for Underground Science and Engineering (CAUSE)
• PI and spokesman – Chang Kee Jung, Stony Brook Univ.
• 7 co-PIs cover all primary solicitation “modules”
  – Physics: Bob Wilson (Deputy spokesman, Colorado State Univ.), Eric Zimmerman (Univ. of Colorado)
  – Geotech. & Mining Eng.: Mark Kuchta and Scott Kieffer (Colorado School of Mines)
  – Geoscience: Judy Hannah (Colorado State Univ.)
  – Microbiology: Jeff Mitton (Univ. of Colorado)
  – Education & Outreach: Dan Claes (Univ. of Nebraska)
  – 36 senior investigators; 7 academic institutions; 4 industrial partners; 5 states
• 2 senior Henderson Mine personnel: Chip DeWolfe, Dick Propernick
• Incorporated non-profit local community group: Arapaho Project
  – Exec director: Steve Schultz
• 46 “tasks” including 5 workshops in a six month period: $500,000
International Advisory Board
A. Betin, B. Huot, L. Moska, K. Nakamura, P. Paul, D. Sinclair, B. Wojcik

Executive Committee
C.K. Jung, Spokesperson/Chair
R. Wilson, Deputy Spokesperson
C. deWolfe, M. Kuchta, D. Propernick, S. Schultz, E. Zimmerman

Henderson Mine/Phelps Dodge
F. Menzer
C. deWolfe, D. Propernick

Collaboration Council
HUSEP Executive Committee
Standing Committee Chairs and Co-Chairs

Physical Sciences Committee
R. Wilson, Chair
E. Zimmerman, Co-Chair

Geoscience Committee
J. Hannah, Chair

Bioscience Committee
J. Milton, Chair

Mining & Engineering Committee
M. Kuchta, Chair
S. Kiefer, Co-Chair

ES&H
D. Propernick, Chair

Industry Relations Committee
C. deWolfe, Chair
C. K. Jung, Co-Chair

Government & Community Committee
S. Schultz, Chair
R. Wilson, Co-Chair

Broader Impacts Committee
D. Class, Chair
S. Piffner, Co-Chair, B. Jones, Co-Chair

National Security Committee
T. Borek, Chair

Ad hoc Committee
Proposal Required Elements

• For this solicitation the phrase “plans for developing a…” precedes most of the following:
• Initial suite of experiments and long-term vision for the DUSEL
• Conceptual lab design
  – Preliminary concepts
  – Site characterization
  – Health & safety
  – Environment and permitting
  – Shared infrastructure
• Engaging broad science and engineering community
• Assessing public support
• National and International cooperation
• DUSEL management
• Broader impact (other sciences, education, community)
• Project management – team qualifications
• Project deliverables, cost, schedule.
Developing the Science Program

• Continued participation in DUSEL related workshops and other venues
• Essential to get input from broader range of expertise
  – Workshops specific to Henderson
  – Physics (CSU), geoscience (CSU), microbiology (CU), geoengineering (CSM), capstone (SB) in last month
  – Each workshop will feature an integrated broader impacts component
• Direct communication between the HUSEP team and the leadership of candidate experiments.
• Presentations at the major professional gatherings, such as the American Physical Society, the American Geophysical Union, American Society for Microbiology, and the Society of Mining Engineers.
• Consolidation of the recommendations of S1 reports from the workshops and meetings to generate a comprehensive plan for experiments at Henderson DUSEL.
Geological, Geotechnical and Geobiological Characterization

- Extensive geologic database (over 30 years) for Henderson Mine will be compiled and summarized
  - 90 miles of existing core drilling
- Further analysis of the 2500 ft core and borehole from the 7500-level toward proposed Central Campus (summer 2004)
  - No moly, no gold!
  - Very competent granite, low fracture (RQ 80-100)
  - ~$180,000 project funded by HUSEP members and the State
- Geological, geochemical, and hydrogeologic analysis
  - constrain the age, source, and composition of existing water in fractures
  - provide approximation of rock chemistry and the extent of water-rock interactions
  - very little water from recent core drilling
- Examine the scientific characteristics of the underground environment to include local radioactivity, and microbial abundance, diversity and activity
  - Review of mine radon monitoring indicated levels similar to Gran Sasso
- Develop a detailed design-level exploration drilling program with cost estimates
Red Mountain Geology

Surprise from core drilling – Urad porphyry extends further than expected, all the way to proposed central campus … will need to modify this published drawing!
Infrastructure Plans

- 12 near-term tasks for developing plans for three phases of lab development in conjunction with science and engineering plans
  - CSM faculty + students
  - CNA, Dunhan Assoc., Miller-Dunwiddie Architects
- Develop work breakdown structures for capital and operating costs
- Evaluate underground access alternatives
- Develop and evaluate underground lab layout alternatives - massing and relationship diagrams of physics and geoscience labs and estimates of required utility and support spaces
- Preliminary Geomechanical Modeling. Two-dimensional and select three-dimensional numerical simulations of the most critical excavations to evaluate underground excavation and support requirements.
- Develop conceptual design of underground access, lab layouts, and ventilation raises and other project components.
- Conceptual design of primary mechanical and electrical systems for lab occupants, experiments and fire and life safety.
- Project development cost estimates, including construction costs; construction schedule and phasing; overall construction management plan and project delivery strategy.
Preliminary Conceptual Design Layout for Henderson DUSEL
DUSEL Layout – Central Campus

Shaft Collar
Elev 10,400 ft

Shaft Bottom
Elev 7,500 ft

PC2 Conveyor to Mill Site

Harrison Mt.
Elev. 12,300 ft

LA Ramp

PC1 Conveyor

Fresh air

Exhaust air

Primary Access Ramp
3600 ft

Secondary Access Ramp
3200 ft

Central Campus
Elev. 6,750 ft
(4200 mwe)

Large Multipurpose Detector

Red Mt.

7065 Level

Crusher
DUSEL Layout – Lower Campus

SurPac Vision….

Central Campus
Elev. 6750 ft
(4200 mwe)

Midway Campus
Elev. 5825 ft
(5100 mwe)

Lower Campus
Elev. 4900 ft
(6000 mwe)

Earthlab &
geoscience
areas
Environment, Permitting, ES&H

• Henderson has excellent record of environmental and community sensitivity
• Has an excellent safety record
  – Works to develop a “safety culture”
  – Each meeting begins with a “safety share”
• No new permits required for DUSEL excavation; ~ few % of current permitted
• No rock needs to leave company property

• Huge benefits compared to green field sites
Shared Infrastructure

• Simultaneous operation of the Henderson mining activities with DUSEL will have distinct advantages compared to other potential sites
  – Cost effective construction and operations management
  – Cost-sharing of facilities (CMC goal – revenue neutral)
  – Safety conscious industrial partner

• But… there will also be coordination challenges
• Henderson has
  – hired consultants to investigate business model, including interoperation of mine+lab
  – Visited Kamioka and Gran Sasso
  – Planned visit to Creighton Mine (SNOLab)
  – Morton Salt Mine/IMB another existence proof
Assessing Public Support

• Already have great support at all levels of government down to county commissioners, town mayors, mine employees and local high school.

• Community outreach with public interest articles, web sites, and contact with the local FM radio station for live interviews with HUSEP members, town hall meetings, letters to the editor of four local papers, press releases and continued presentations to local groups by local community leaders and HUSEP scientists etc.

• On-going discussions with the local and the state government concerning their possible financial or other tangible forms of support for Henderson DUSEL, such tax relief/credit for Henderson or property developers etc.; regulatory relief etc.
February 23, 2005

Board of Directors of the National Science Foundation:

It is without reservation that I provide my wholehearted support for the selection of the Henderson Mine as the site for the National Deep Underground Science and Engineering Laboratory.

Respectfully,

Bill Owens

---

Dear Steve,

I strongly support the Arapaho Project's efforts to organize a bid for the National Science Foundation's (NSF) new National Underground Science Laboratory. Based on the preliminary research you shared with us, it seems that the Henderson Mine in Clear Creek County would be the superior location in the United States.

Sincerely,

Janet E. Norton

---

Executive Chambers

134 State Capitol
Denver, Colorado 80203-1792
Phone: (303) 866-2471

SENATE JOINT RESOLUTION 05-014


---

Richard N. Boyd, Program Director
Division of Physics
Directorate for Mathematics and Physical Science
National Science Foundation
Washington, DC

Dear Mr. Boyd:

I want to take this opportunity to express the Department of Local Affairs' support of the Henderson Underground Science and Engineering Proposal (HUSEP) to locate the Deep Underground National Science and Engineering Laboratory (DUSEL) in the Henderson Mine in Clear Creek and Grand Counties.

Sincerely,

Michael I. Brasey
Executive Director

---

Russell George
Executive Director
Colorado Department of Natural Resources

The Colorado Department of Natural Resources (DNR) wishes to convey our support for the Henderson Underground Science and Engineering Proposal (HUSEP) efforts to host the NSF's proposed Deep Underground Science and Engineering Laboratory (DUSEL) at the Henderson Mine near Empire, Colorado.
National and International Cooperation

- UNO a natural for this
  - Work with BNL to develop an integrated schedule for development of the VLBNO beam and experiment. Communicate with Fermilab and keep them informed of the Henderson DUSEL development
  - Several international advisors already

- SNOLab in Canada: Current expansion will provide a deep site “soon”
  - Will work with SNOLab management to develop scenarios for inter-laboratory cooperation in scheduling experiments at the two sites

- Concept of a multi-site North American lab
  - Multiple sites may be needed to address conflicting physics/geoscience/microbiology interest
Management Plan

• Identified three models:
  – Single Professional Organization Management Model. Examples: Fermilab by Universities Research Association (URA), a consortium of major research universities, and Pacific Northwest Lab by Battelle Memorial Institute (Battelle).
  – Single Academic Institution Management examples: Los Alamos National Lab, Lawrence Livermore Lab and Lawrence Berkeley Lab by Univ. of California, Berkeley; Stanford Linear Accelerator Center by Stanford Univ.; and LIGO Lab by California Inst. of Technology (in partnership with MIT)
  – Co-management through Partnership Examples: BNL by Brookhaven Science Associates, LLC (consisting of Stony Brook University and Battelle, 50-50 partnership); Oak Ridge Lab by UT-Battelle, LLC (consisting of the University of Tennessee and Battelle); and National Renewable Energy Lab by Battelle, Bechtel and Midwest Research Institute.

• Will continue to investigate – LIGO model has appeal (have spoken with director Barry Barish and queried former NSF official about this)
Education and Outreach

- SALTA/CROP (Claes, UNL)
  - first experiment at Henderson - cosmic ray measurements underground by high school students
- Little Shop of Physics (Jones, CSU)
  - reaches 15,000 students and 200 teachers each year
- NSF’s REU-funded Biogeochemical Education Experience in South Africa (Sue Pfiffner, UTenn)
- Combination of physics, geoscience, microbiology maps well onto K-12 curriculum requirements
  - Plans for teacher workshops to get their input
- Visitor Center planning
SALTA Cosmic Ray Counters at Henderson Mine

An experiment by Colorado High School students to measure the cosmic ray rate at different depths in the Henderson Mine near Empire, Colorado. The project is lead by Prof. Dan Claes, Univ. of Nebraska.

Colorado State University physicists, led by Prof. R. Wilson, are investigating Henderson as a potential site of a future national underground science laboratory.

Rates at Henderson surface (10,337 ft) = 2.5 x rates at Lincoln, NE (1189 ft)

4 locations: depths of 2800-3900 ft: raw rates in muon telescopes drop from 10 Hz (surface rate) → 1 Hz → 0.5 Hz → 0.3 Hz
Summary

- Henderson Mine was originally motivated as an “ideal” site for UNO
- Now being developed also as a broader science laboratory under NSF program – initial phase ~$300 million
- Expect DoE primary sponsor of UNO + super-beam (>> NSF investment)
- Proposal submitted; hope to know more ~July ‘05