LBNF/DUNE Update Public Meeting
Sanford Lab Update

Mike Headley
SDSTA Executive Director and Sanford Lab Director
13 March 2017
Sanford Underground Research Facility
Dedicated facility for underground scientific research

- Created by the State of South Dakota with major philanthropic donations from Barrick (property) and T. Denny Sanford ($70M).
- Continued support by the State of South Dakota ($46M through 2016).
- Operations funded by US Dept of Energy, through a subcontract between Fermilab and the SDSTA.
4850L Science Facilities

**Existing Facilities**
- **Davis Campus**
  - LZ
    - LUXZEPLIN
      - Proposed second generation dark matter
    - R&D opportunities
  - LUX
    - Large Underground Xenon Laboratory
    - First generation dark matter
  - MJD
    - MAJORANA DEMONSTRATOR
      - Neutrinoless double-beta decay

**Future Facilities**
- **Ross Campus**
  - BHSU Underground Campus
    - Low Background Counting
  - CASPAR
    - Compact Accelerator System for Performing Astrophysical Research
  - MJD
    - MAJORANA DEMONSTRATOR
      - Electroforming laboratory

**Future Laboratories**
- **Experiment Hall**
  - Proposed third generation dark matter and/or 1 T neutrinoless double-beta decay
- **DUNE at LBNF**
  - Proposed Deep Underground Neutrino Experiment at the Long-Baseline Neutrino Facility
  - 4650 Level—four 10kT liquid argon detectors
Current Underground Science Program
Physics (4850L Davis Campus)

MAJORANA DEMONSTRATOR:
• Studying the neutrino’s mass and the matter/antimatter imbalance in the universe. Proving techniques for a larger experiment.

Large Underground Xenon (LUX):
• Direct detection of dark matter.
• Status: Data taking completed in May 2016. Remains most sensitive DM experiment in world. Decommissioning underway in prep for the LUX-ZEPLIN (LZ) next generation experiment.
Current Underground Science Program
Physics (4850L Ross Campus)

Compact Accelerator System for Performing Astrophysical Research (CASPAR):

• Studying nuclear reactions in stars resulting in the generation of elements heavier than Iron.
• **Status:** SDSM&T faculty and students leading onsite activities. Beamline components assembled, commissioning underway. Operations planned mid-2017.

Black Hills State University (BHSU) Underground Campus:

• Low background counting to characterize radiopurity of detector components.
• **Status:** Installed 4 low background counters. Completed counting activities for the first 45 LZ photo multiplier tubes. Providing opportunities for undergraduate students.
LUX-ZEPLIN (LZ) Dark Matter Experiment
LZ will be located in the Davis Cavern on the 4850 foot level

- LZ collaboration includes ~220 members at 36 institutions.
- 10,000 kg Xe (3,500 gallons). 30x larger, 100x more sensitive than LUX.
- Using existing Surface Laboratory and 4850L Davis Campus facilities.
- Experiment and facility design work underway. Project has been “baselined” for construction.
- Facility modifications are underway on the surface and are planned for 2018 underground in Davis Campus.
- Experiment installation underground planned for 2018-19.
- Operate for 5 years starting ~2020.

LZ Detector and Shielding
LZ Surface Construction
Surface facility construction to complete in May 2017
Ross Shaft Refurbishment Update
4,679 feet down from surface (90% complete overall)

- Ross Shaft constructed in 1930s. Rehabilitation initiated in August 2012 to modernize the shaft for LBNF construction.
- Project total cost $32.2M: $5.95 in SD appropriated funds, $11.6M in U.S. DOE federal funds, and $14.6M in Sanford private funds.
Sanford Lab Educational Opportunities for K-12 Students

School Presentations

Elementary
- A Day in the Life…
- Particle Accelerators

Middle School
- Career Opportunities
- Dark Matter

High School
- Neutrinos

Curriculum Units

Elementary
- Exploring Unseen
- Force Be With You

Middle School
- Seismic Science
- Search Dark Matter

High School
- Perplexing Puddles
- Star-Stuff

In Development
- There & Back Again
- Waterworks

Field Trips

Opportunities to visit the lab are limited. School visits available:
- Fall
- Spring
Sanford Lab Education and Outreach Impacts
K-12 students served from September 2015 to February 2017

<table>
<thead>
<tr>
<th></th>
<th>School Presentations</th>
<th>Curriculum Units</th>
<th>Field Trips</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Students</td>
<td>14,064</td>
<td>2,231</td>
<td>944</td>
</tr>
<tr>
<td>Number of Classrooms</td>
<td>1004</td>
<td>159</td>
<td>67</td>
</tr>
</tbody>
</table>

• Before 2015, Sanford Lab’s E&O Program focused primarily on field trips.

• The total number of K-12 students participating in programming from 2008 to the end of February 2017 is 23,352.
## Economic Impacts in South Dakota
Through Year End CY2016

<table>
<thead>
<tr>
<th>Category</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spending in South Dakota to date</td>
<td>$171M</td>
</tr>
<tr>
<td>Annual total budget (all sources &amp; activities)</td>
<td>$23.4M</td>
</tr>
<tr>
<td>Annual SURF operations budget (DOE funds)</td>
<td>$14.75M</td>
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<tr>
<td>Annual payroll in SD</td>
<td>$13.6M</td>
</tr>
<tr>
<td>Annual non-payroll expenses in SD</td>
<td>$5.9M</td>
</tr>
<tr>
<td>Jobs in South Dakota</td>
<td>163</td>
</tr>
<tr>
<td>Active research groups</td>
<td>24</td>
</tr>
<tr>
<td>Research groups with SD members</td>
<td>18</td>
</tr>
</tbody>
</table>
Total Spending in South Dakota through year end 2016
Grouped by 3-digit zip code region.

**TOTAL VENDORS PAID**

- **576--**
  - Grand Total: $236,171
  - Total Vendors Paid: $664
  - Total Dollars Paid: $235,507

- **577--**
  - Grand Total: $156,141,468
  - Total Vendors Paid: $90,713,063
  - Total Dollars Paid: $85,428,405

- **575--**
  - Grand Total: $8,875,720
  - Total Vendors Paid: $8,524,818
  - Total Dollars Paid: $232,822

- **573--**
  - Grand Total: $260,252
  - Total Vendors Paid: $256,277
  - Total Dollars Paid: $3,975

- **571--**
  - Grand Total: $4,382,791
  - Total Vendors Paid: $3,749,279
  - Total Dollars Paid: $633,512

- **570--**
  - Grand Total: $513,821
  - Total Vendors Paid: $297,700
  - Total Dollars Paid: $218,303

**TOTAL SALARIES PAID**

- **576--**
  - Grand Total: $714,911
  - Total Salaries Paid: $161,791
  - Total Dollars Paid: $553,120

**COMBINED TOTALS:**

- $171,008,796
Economic Impact of the Long-Baseline Neutrino Facility

Economic impact, 2016-2026*

- **South Dakota**
  - $952 million
  - Total economic output

- **Illinois**
  - $1,204 million
  - Total economic output

- **Illinois**
  - $340 million
  - Income for South Dakota households

  - $593 million
  - Income for Illinois households

90% of economic output is in the 13-county western South Dakota region.

94% of economic output is in the 9-county Chicago metro region.

Jobs created, 2016–2026*

- **South Dakota**
  - 1,859 jobs

- **Illinois**
  - 2,048 jobs