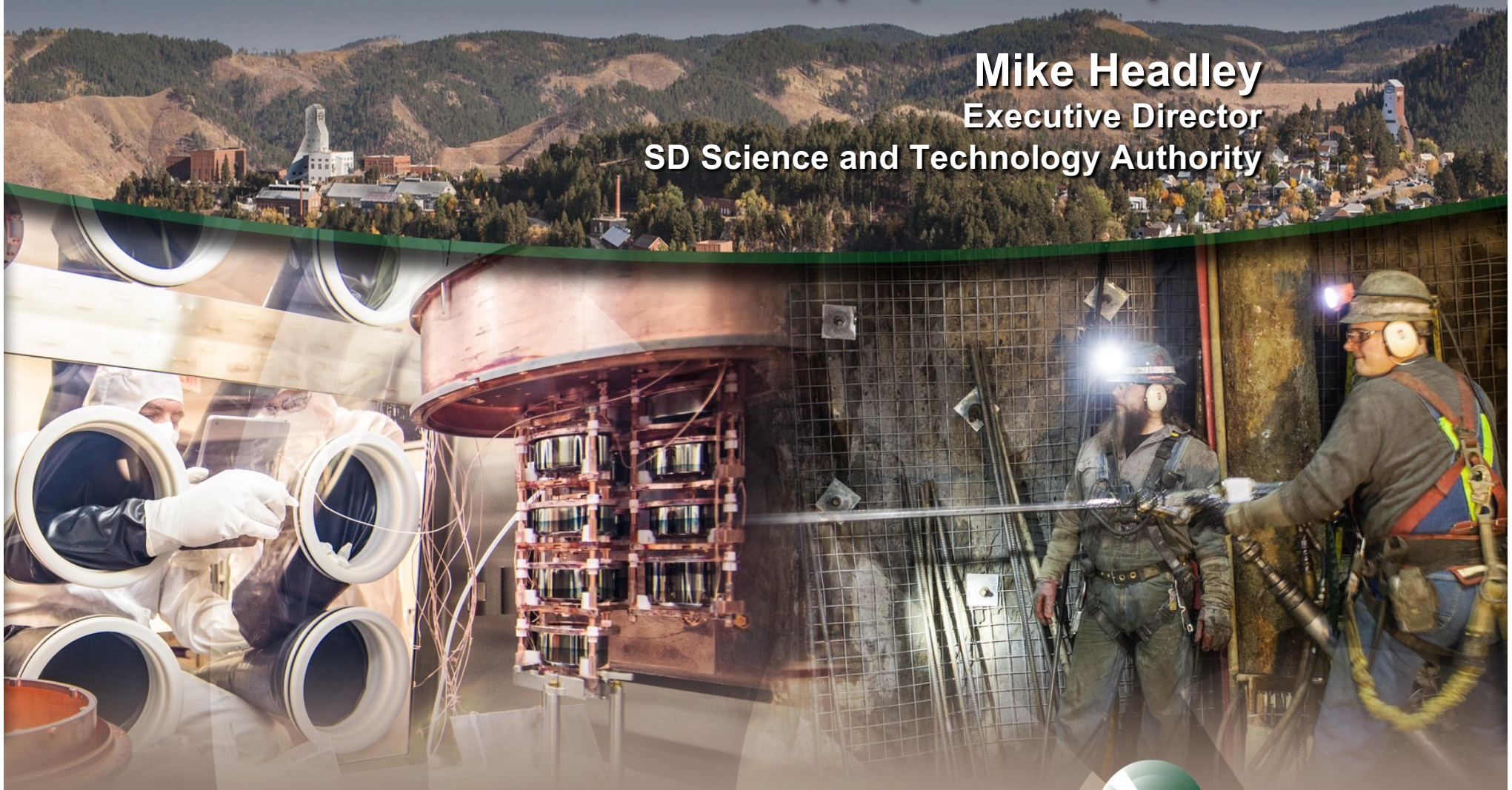
Sanford Underground Research Facility

Joint Committee on Appropriations Update

Mike Headley
Executive Director
SD Science and Technology Authority



January 17, 2019

Sanford
Underground Research Facility
South Dakota Science and Technology Authority

JCA Budget Questions

- Overview of programs and services provided by your agency.
  - Outlined in remainder of presentation.

- Address the impact of any proposed budget reductions or increases.
  - Federal FY18 budget was $22.9M. Increased in FY19 to $24.3 due to increased emergency response support requirements and increased maintenance support equipment funds.

- Discuss the federal and other fund sources used within your agency.
  - Total FY2019 Federal budget is $24.3M
    - SURF Operations $18.0M
    - LBNF Construction Support $4.6M
    - LZ Experiment Support $1.5M
    - Support to other experiments $0.2M
  - $4M in Future Fund grant for new Maintenance Support Facility

JCA Budget Questions

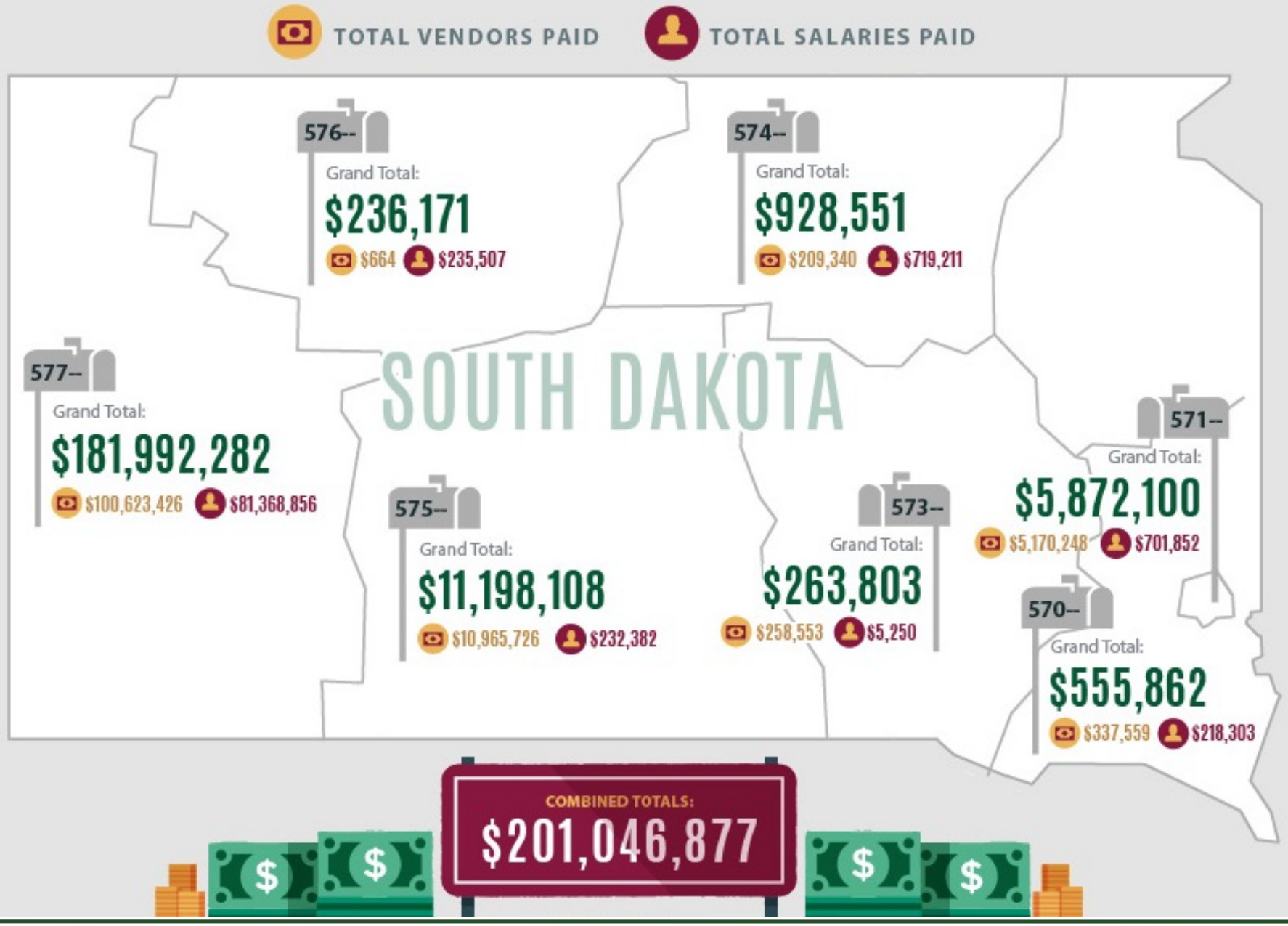
- Add, eliminate, or restructure any programs
  - No major changes to programs expected. Operations support subcontract with Fermilab likely to be replaced with a "Cooperative Agreement" – a direct SDSTA to Dept of Energy relationship.
- Changes to your original FY2019 appropriation – None.
- Any special appropriation requests – None.
- SDSTA workforce overview:
  - Currently 130 full-time employees, 13 part time.
  - Full-time workforce to increase to 150 FTE in federal FY2019.
- Unutilized FTE for the two previous fiscal years – None.
- Instituting any other methods to raise revenue – None.

Economic Impacts in South Dakota

Spending in South Dakota (as of Sep 30, 2018)	**$201 million**
FY19 total budget (all sources & activities)	$28.1 million
FY19 SURF Operations budget (DOE funds)	$18.0 million
Annual payroll budget in SD (FY19)	$14.6 million
Annual non-payroll budget in SD (FY19)	$13.5 million
Jobs in South Dakota	180
Active research groups	27
Research groups with SD members	21

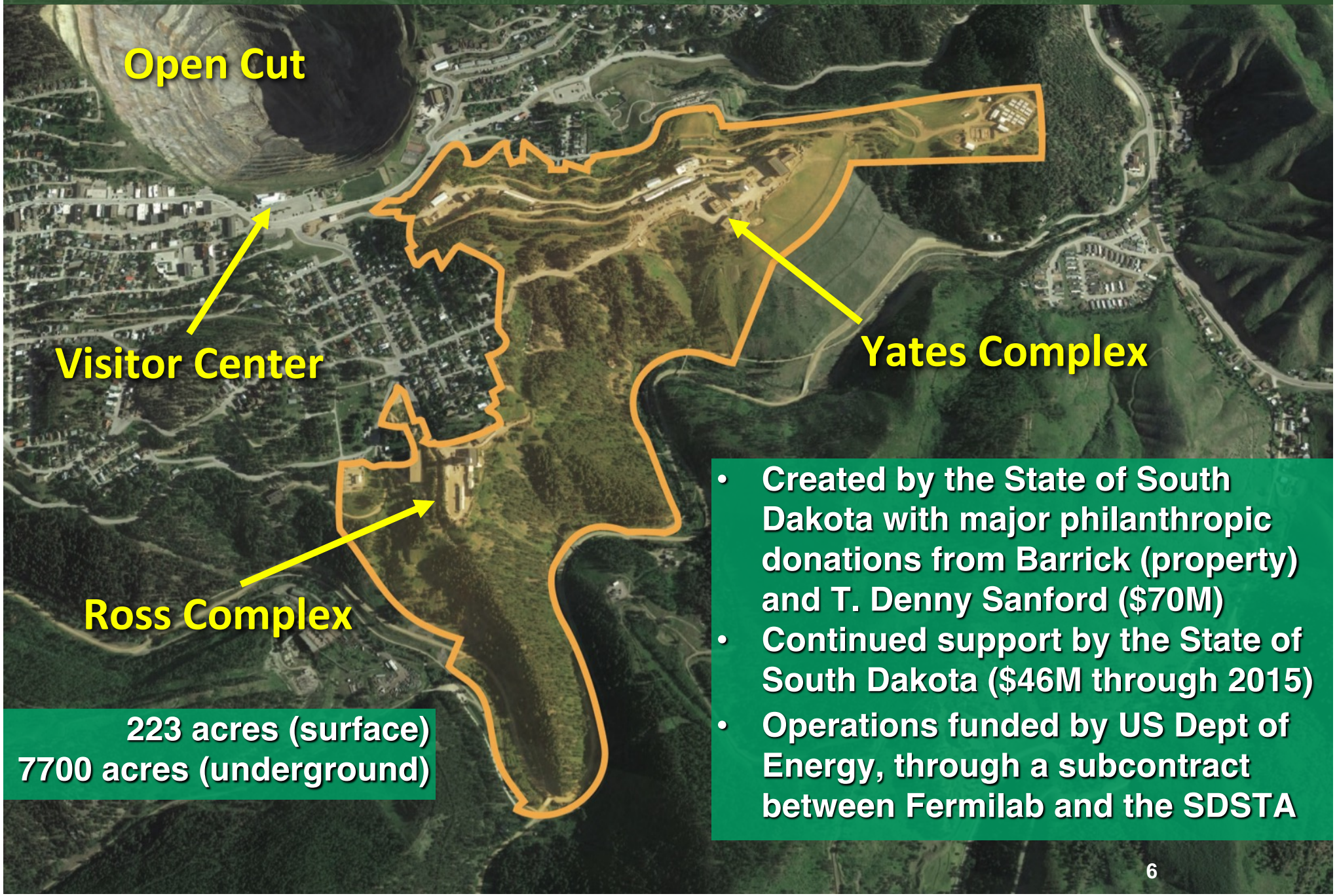
Total Spending in South Dakota through Sept 30, 2018

Grouped by 3-digit zip code region



Sanford Underground Research Facility

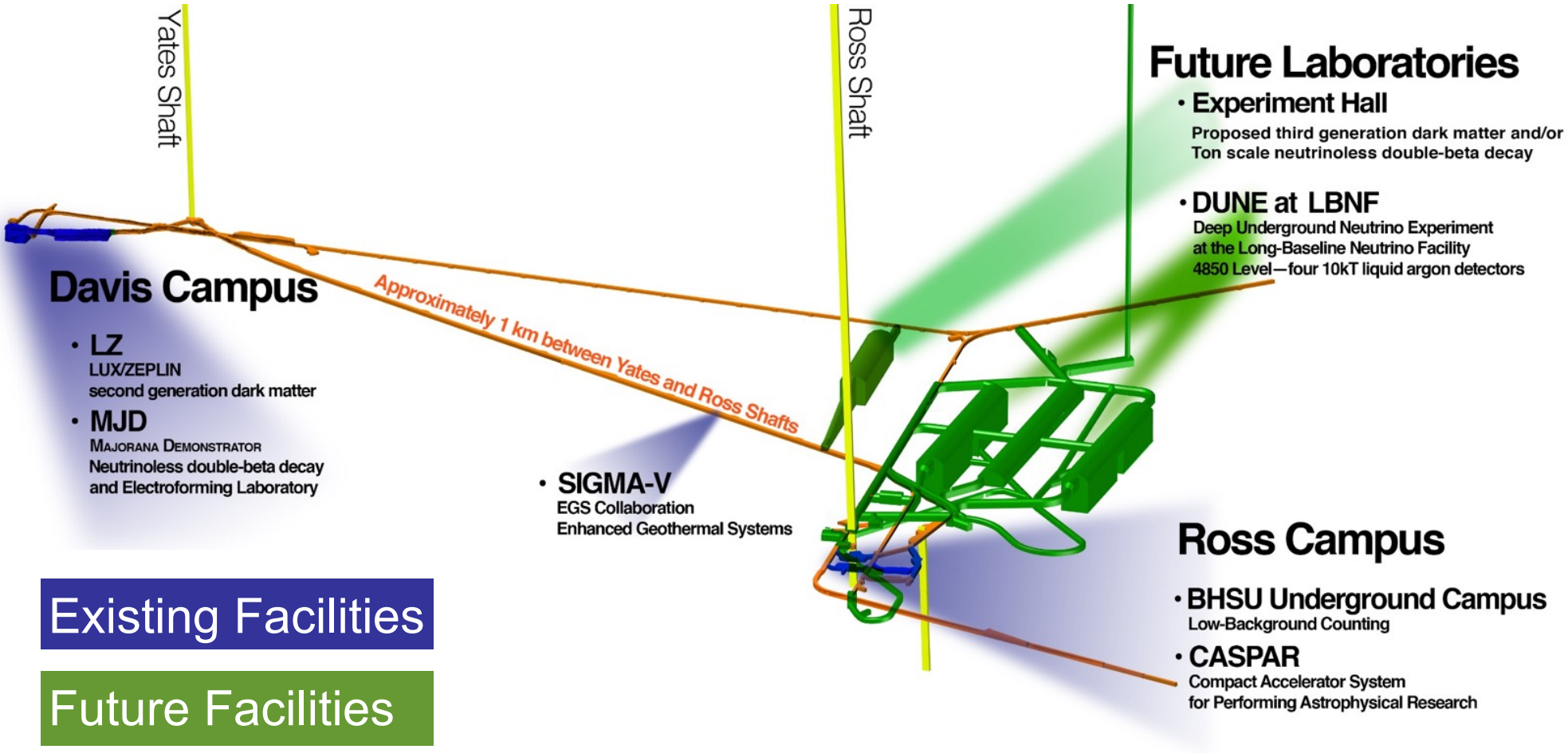
Dedicated facility for underground scientific research



223 acres (surface)
7700 acres (underground)

- 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 2015)
- Operations funded by US Dept of Energy, through a subcontract between Fermilab and the SDSTA

4850L Science Facilities

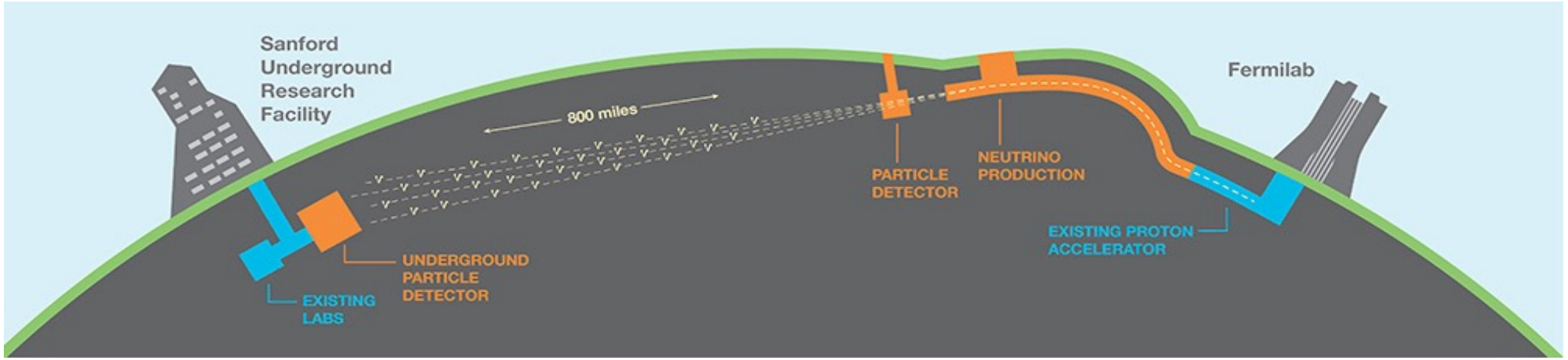


Existing Facilities

Future Facilities

Long-Baseline Neutrino Facility (LBNF)

LBNF will host the Deep Underground Neutrino Experiment (DUNE)



- **The first internationally conceived, constructed, and operated mega-science project hosted by the Department of Energy in the United States.**
- Project led by Fermilab with significant international contributions (including CERN).
- DUNE collaboration includes 1180+ scientists from 178 institutions / 32 nations (59% non-US)
- Four DUNE detectors planned at SURF with 70kT liquid argon total (13 million gallons).
- *DOE approved construction of SD facilities in Sept 2016. Federal appropriations of FY17 $50M, FY18 $95M, FY19 $130M has sent a strong signal to international collaborators.*
- *Construction in South Dakota started Jan 2019. Excavation expected in Jan 2021.*
- Fermilab has a Construction Manager under contract - Kiewit Alberici Joint Venture.
- LBNF/DUNE construction expected to last 10 years. Experiment will operate for 20+ years.

http://news.fnal.gov/

January 7, 2019

News

Newsroom

- News and features
- Press releases
- Fermilab in the news
- Fact sheets and brochures
- LBNF/DUNE newsroom
- Photo gallery
- Search photos and videos
- Social media
- Press release sign-up
- Subscribe to Fermilab Frontiers
- Internship in science writing
- Contact the Office of Communication

Fermilab news Search

Useful links

- Symmetry magazine
- Interactions

Interact

Pre-excavation work on LBNF/DUNE begins in South Dakota

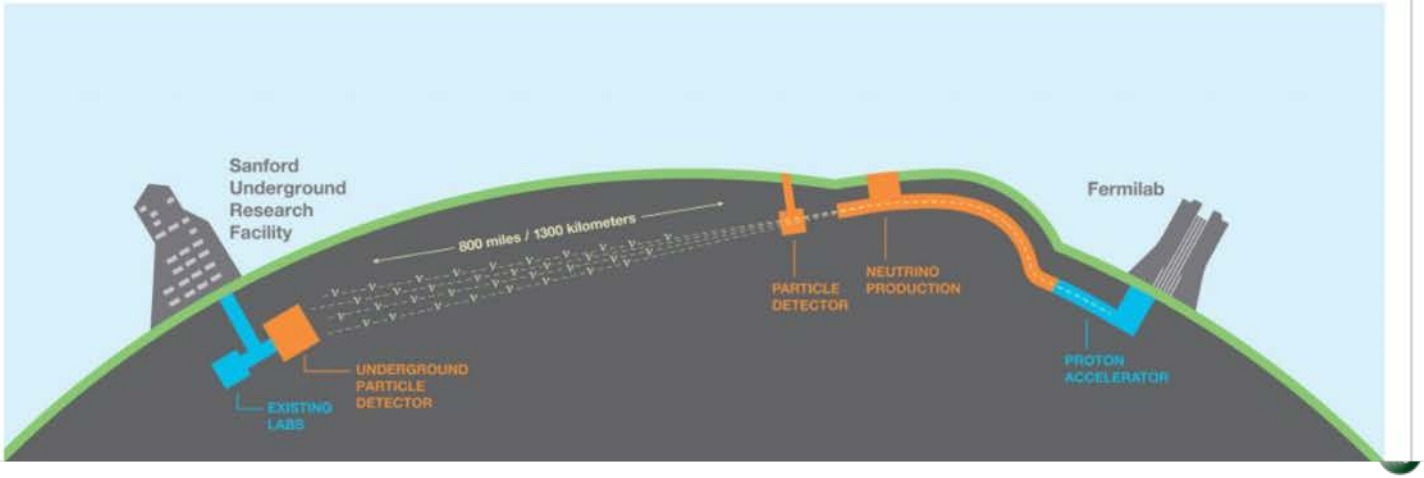
January 7, 2019 | Andre Salles

An international project to build the largest physics experiment ever constructed in the United States took a major step forward as a new phase of work has begun at the project's South Dakota site.

The U.S. Department of Energy's Fermi National Accelerator Laboratory has finalized an agreement with construction firm Kiewit-Alberici Joint Venture (KAJV) to start pre-excavation work for the Long-Baseline Neutrino Facility (LBNF), which will house the enormous particle detectors for the Deep Underground Neutrino Experiment (DUNE). The South Dakota portion of the facility will be built a mile beneath the surface at the Sanford Underground Research Facility in Lead, South Dakota.

The contract with KAJV covers the next two years and includes everything that will be needed to support the next phase of work — the fast, safe and continuous removal of approximately 875,000 tons of rock to create the large caverns that will house the massive DUNE detector modules.

"After years of design and planning, it's gratifying to put boots on the ground and begin this pre-excavation work," said Chris Mossey, Fermilab's deputy director for the Long-Baseline Neutrino Facility. "Getting to this point has been the result of a lot of work from the entire LBNF/DUNE team and our partners at KAJV, Arup, Sanford Lab and DOE, and we're all ready for this next phase of the project to begin."



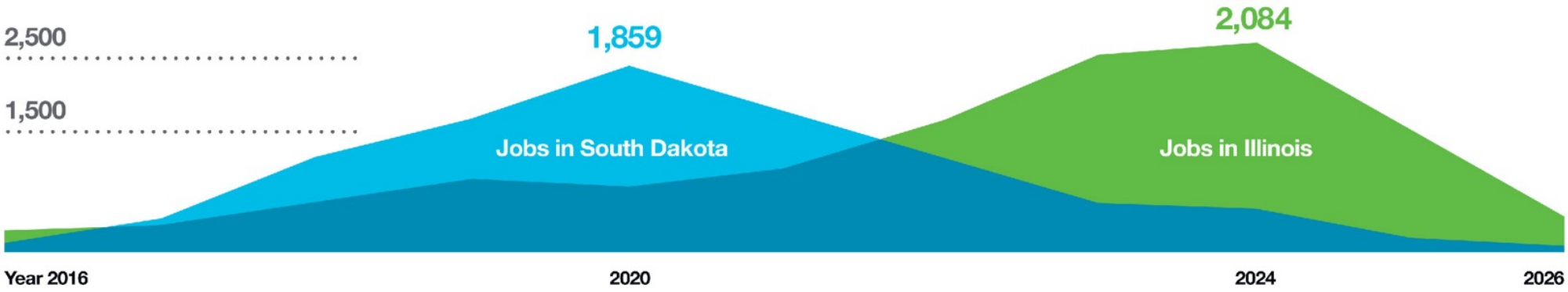
LBNF/DUNE Economic Impact

South Dakota		Illinois	
$952 million	**$340 million**	**$1,204 million**	**$593 million**
Total economic output	Income for South Dakota households	Total economic output	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*



Full report available at: http://lbnf.fnal.gov/economic-impact.html

LUX-ZEPLIN (LZ) Dark Matter Experiment

LZ will be located in the Davis Cavern on the 4850 foot level

LZ Cryostat undergoing leak checks in SURF Surface Laboratory

- LZ collaboration includes over 250 members at 37 institutions.
- 10,000 kg Xe (3,500 gallons). 30x larger, 100x more sensitive than LUX experiment.
- Using existing Surface Laboratory and 4850L Davis Campus facilities.
- *Project is in construction.*
- *Surface and underground facility upgrades completed in 2018*
- *LZ cryostat arrived at SURF May 2018.*
- *Experiment installation in 2018-19.*
- LZ to operate for 5 years starting 2020.

K-12 STEM Education Opportunities

School Presentations

Elementary
- A Day in the Life…
- Particle Accelerators
- Magnificent Thing

Middle School
- Career Opportunities
- Dark Matter
- Hot Rocks

High School
- Neutrinos
- Water – Where does it go?

Curriculum Units

Early Elementary
- Creature Features
- Between a Rock and a Dark Place

Elementary
- Exploring Unseen
- Force Be With You
- There & Back Again

Middle School
- Seismic Science
- Search Dark Matter
- Waterworks

High School
- Perplexing Puddles
- Star-Stuff

Field Trips

Opportunities to visit the lab are limited. School visits available:
- Fall
- Spring

E&O Curriculum Units

K-12 Student Impact - Numbers in Review

(Students Participating in SURF E&O Programs from 2015 to date)

Activity	Students
School Assemblies	25,778
Science Curriculum Units	8,265
Field Trips to SURF	2,305
Total	36,348

- 20.2% of students participating from schools with >10% American Indian population.
- 6.4% of students participating from schools with >50% American Indian population.

New Maintenance Support Facility Planned

Maintenance Facility Conceptual Design

Current Underground Physics Program

MAJORANA DEMONSTRATOR (MJD):

- Studying the neutrino's mass and the matter/antimatter imbalance in the universe. Proving the techniques needed for a tonne-scale experiment.
- 2 cryostats with 44 detectors (40kg Ge) assembled. Data collection underway.
- *March 2018 - Paper published in Physical Review Letters. Results are competitive with world-leading experiments. Exceptional energy resolution and low backgrounds achieved. SURF 4850L is deep enough for a next generation experiment.*
- Planning is underway for LEGEND experiment – a midscale experiment with a 200kg target at Gran Sasso in Italy.

Current Underground Physics Program

Compact Accelerator System for Performing Astrophysical Research (CASPAR):

- Studying nuclear reactions in stars resulting in the generation of elements heavier than Fe.
- SDSM&T faculty and students leading assembly and commissioning process.
- *"First beam" achieved in July 2017. First physics data collected in 2018.*

Black Hills State University (BHSU) Underground Campus (BHUC):

- Low background counting to characterize radiopurity of detector components.
- *Installed 6 low background counters.*
- *Near term activities focused on the LZ dark matter experiment equipment.*
- Providing opportunities for undergraduates in physics and other science disciplines.

Sanford Underground Research Facility

Thank You!