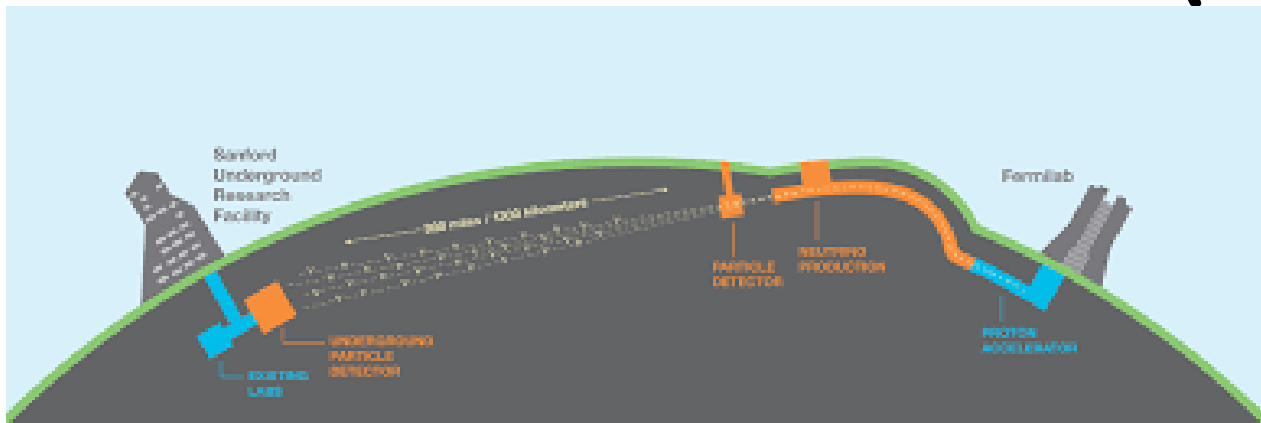




Long-Baseline Neutrino Facility/ Deep Underground Neutrino Experiment Project (LBNF/DUNE Project)



Adam Bihary
Federal Project Director
Office of Science/Fermi Site Office



Outline

- Mission Need
- Project Overview
- Four Amazing Things about LBNF/DUNE
- Tailoring Change and Progress Since
- What We've Learned

Core LBNF/DUNE-US Federal Team



Russ Alber
Deputy FPD



Shannon Foreman
CO



Simona Rolli
Program Manager



Inti Alam
Deputy FPD



Josh Lewis
Fac. Rep.



Joseph Diehl
Deputy PM



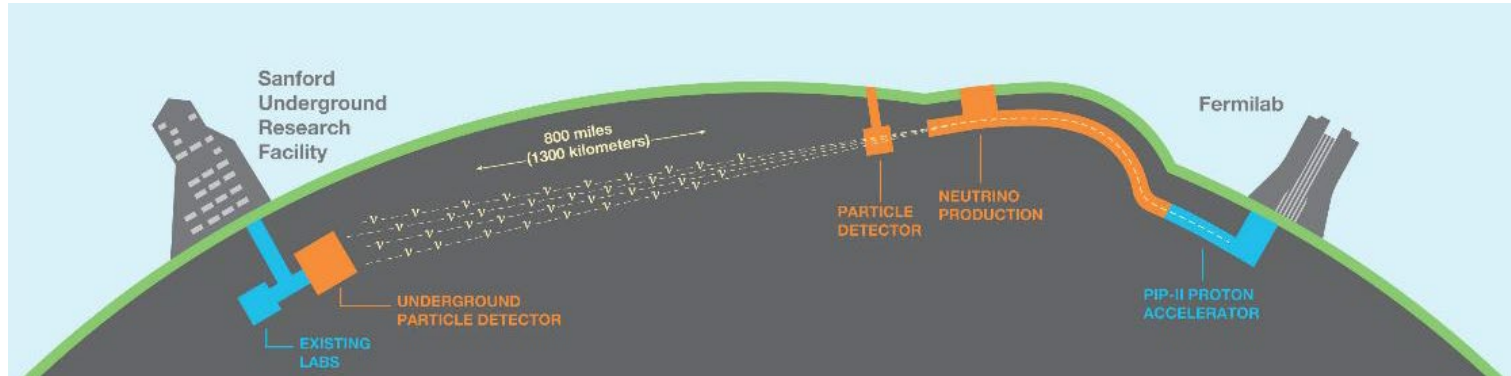
Why Do We Care About Neutrinos?

- Neutrinos are all around us
- They are mysterious and surprising
- We know they are important
 - May play a pivotal role in the evolution of the universe
- They are challenging to study
 - Need very intense beams (many, many neutrinos)
 - Need very large detectors sited deep underground

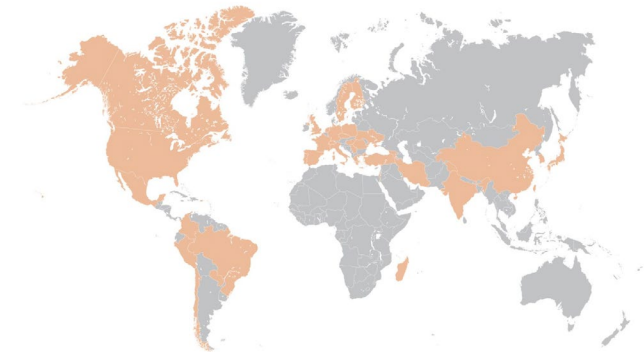
The LBNF/DUNE project is the result of recommendations from the particle physics communities in the US and Europe



Fulfilling a Worldwide Scientific Capability Gap



International DUNE



Origin of matter. Investigate leptonic CP violation. Are neutrinos the reason the universe is made of matter?



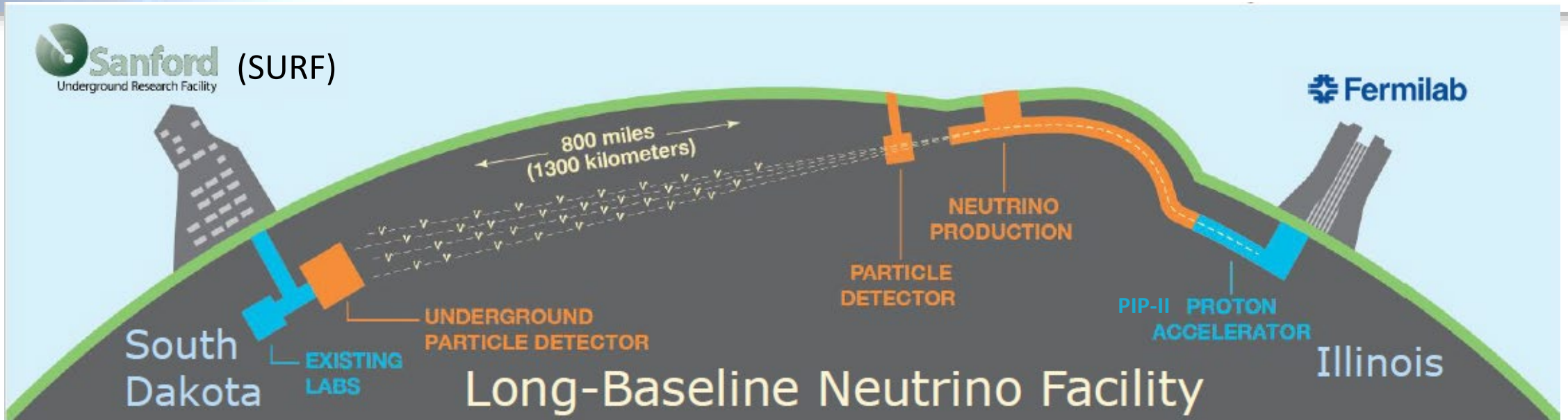
Neutron star and black hole formation. Ability to observe neutrinos from supernovae events and perhaps watch formation of black holes in real time.



Unification of forces. Investigate nucleon decay, advance unified theory of energy and matter.



LBNF/DUNE-US Project



PIP-II – new superconducting proton accelerator with partner in-kind contributions



International DUNE - international project and experiment for the DUNE detectors

DUNE-US – U.S. contributions to the international DUNE experiment

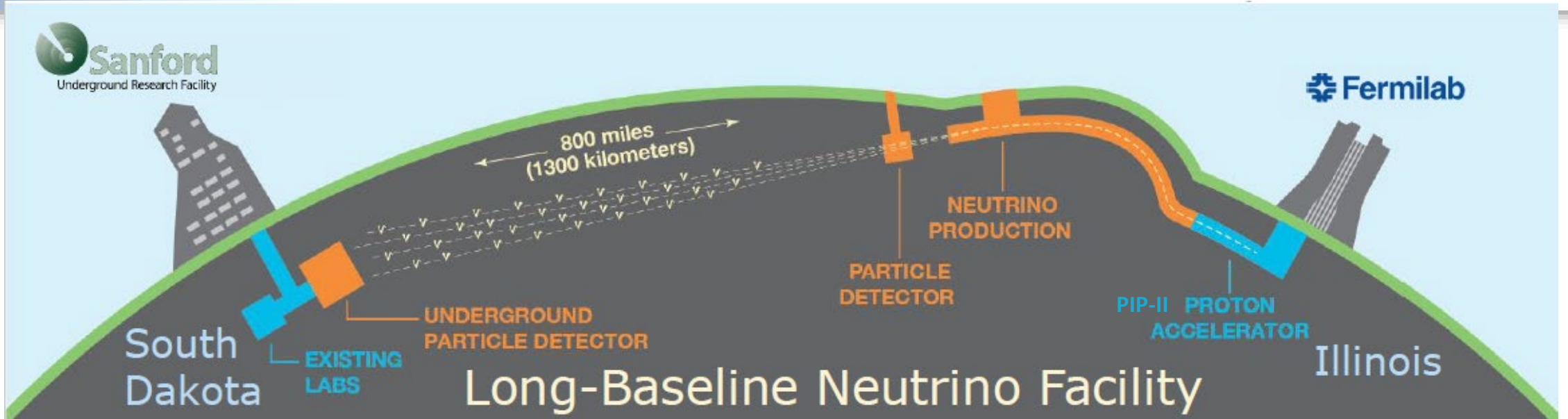


Long Baseline Neutrino Facility – facilities to support DUNE with partner in-kind contributions





LBNF/DUNE-US Project



PIP-II – new superconducting proton accelerator with partner in-kind contributions



International DUNE - international project and experiment for the DUNE detectors



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Long Baseline Neutrino Facility – facilities to support DUNE with partner in-kind contributions

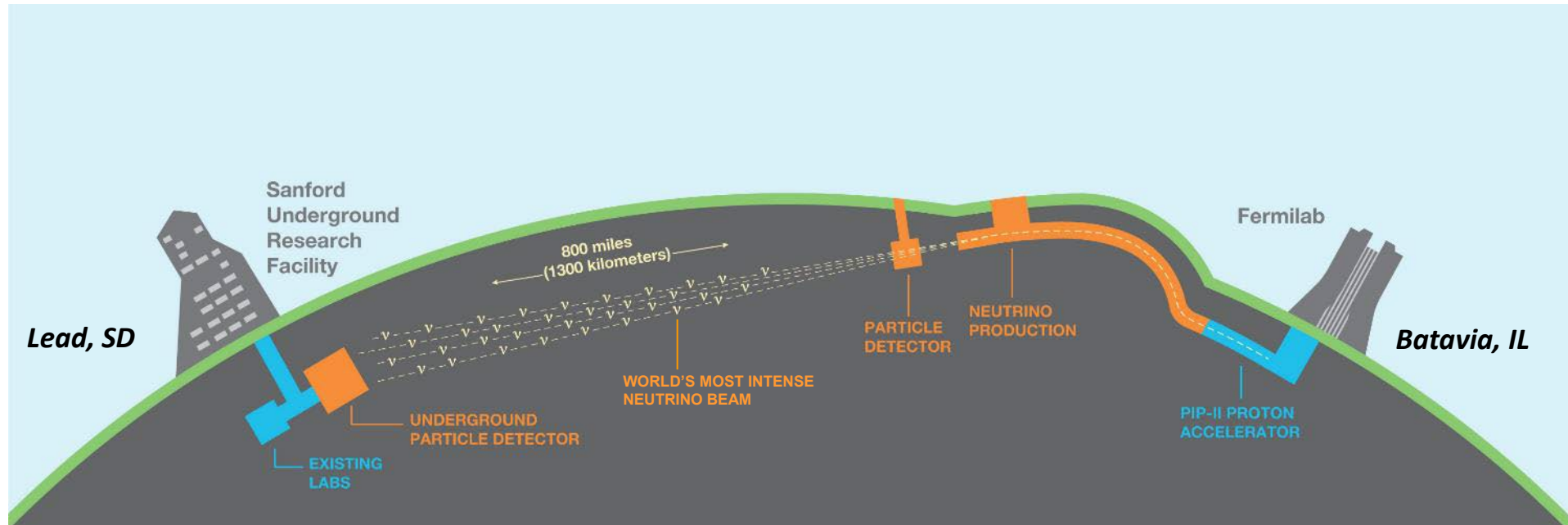


LBNF/DUNE-US



Delivering Unprecedented Capabilities

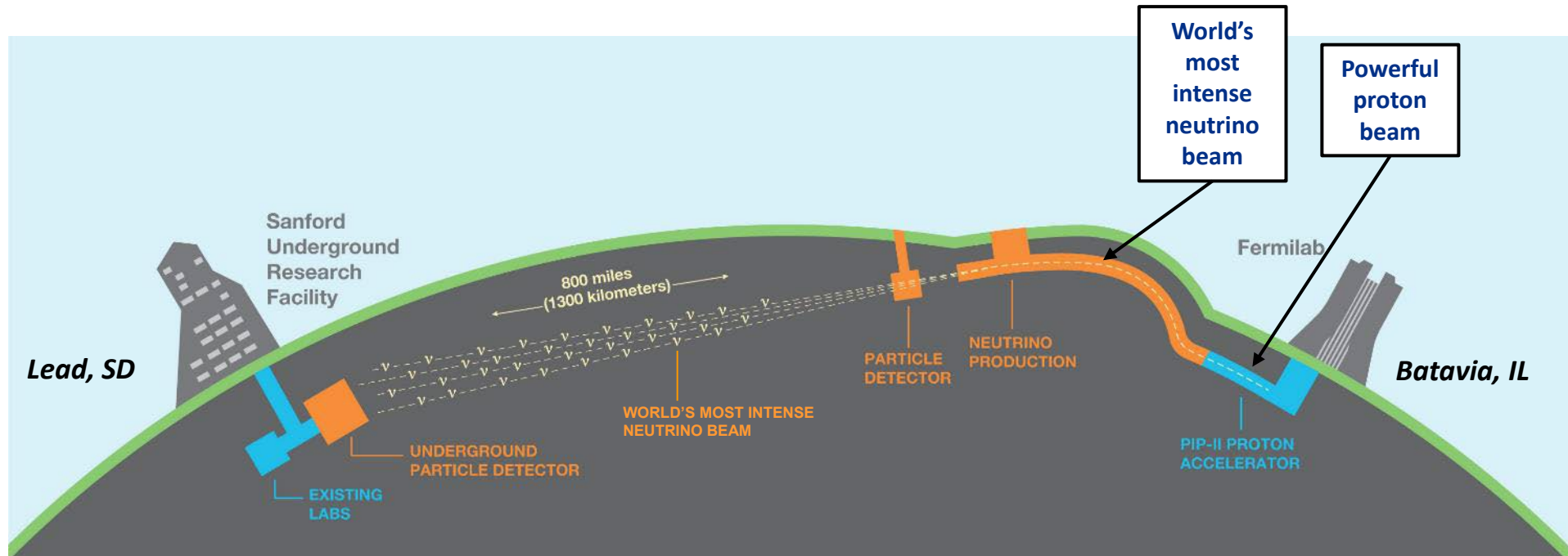
- Dual-site facilities (LBNF)
 - Deep underground caverns to support up to 4 x 17 kton detector modules
 - High power neutrino beam with wideband capability enabled by PIP-II
- Deep Underground Neutrino Experiment (DUNE)
 - Next-generation neutrino detectors: initial experiment includes capable near detector and 2 far detector modules





Delivering Unprecedented Capabilities

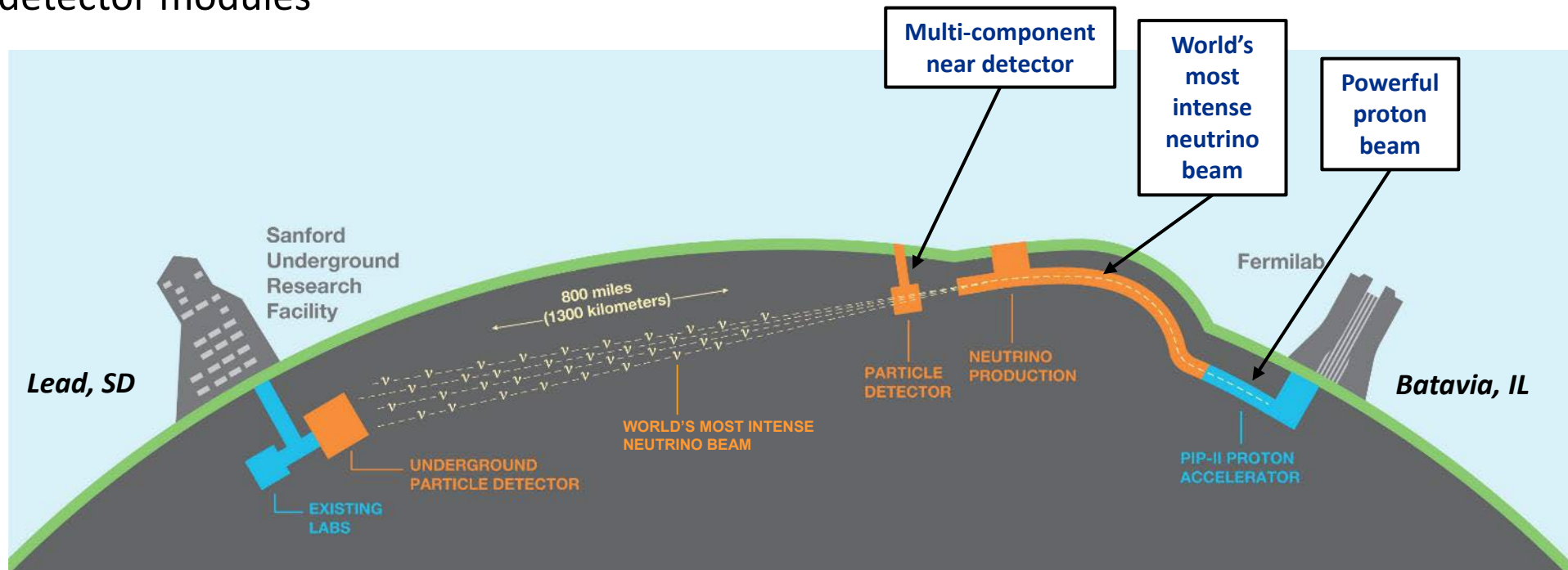
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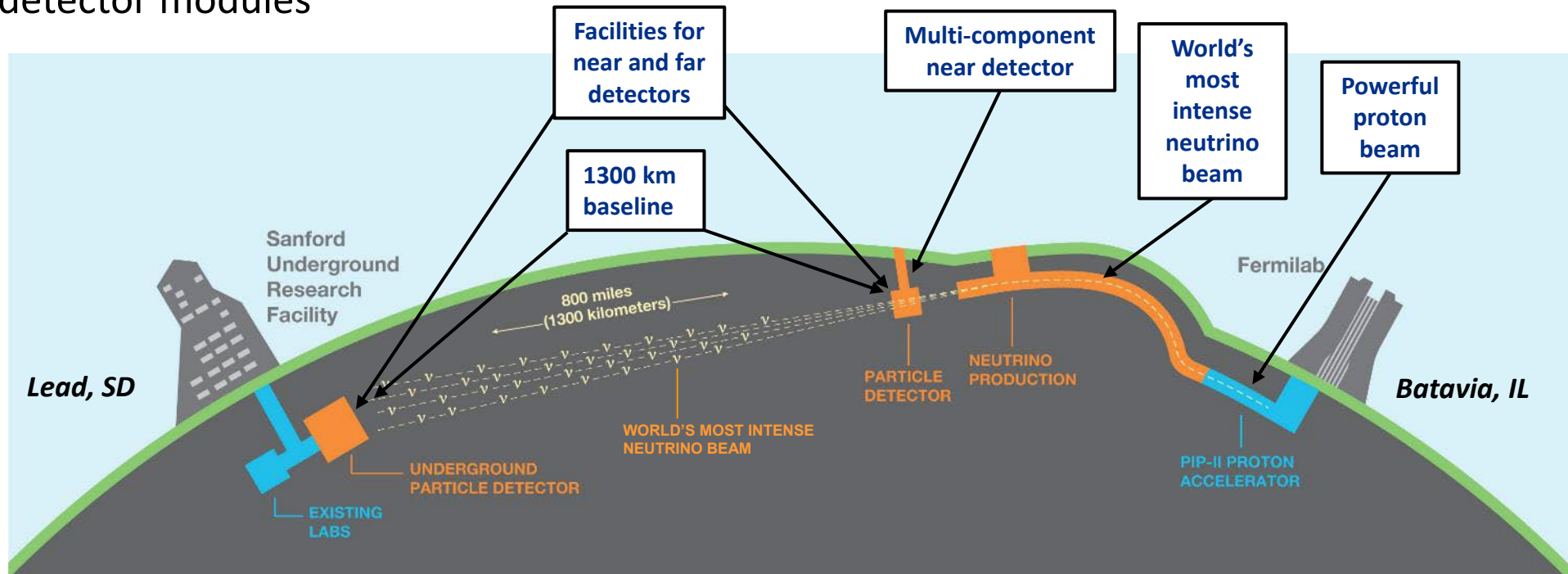
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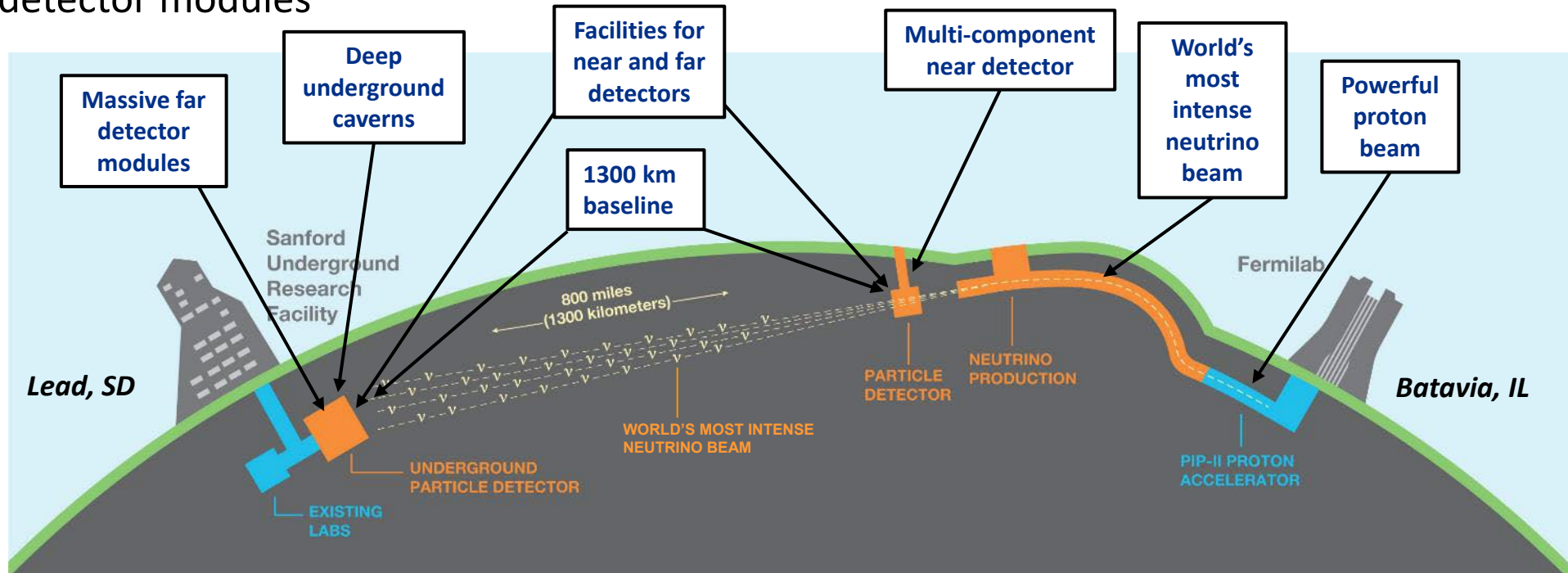
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Delivering Unprecedented Capabilities

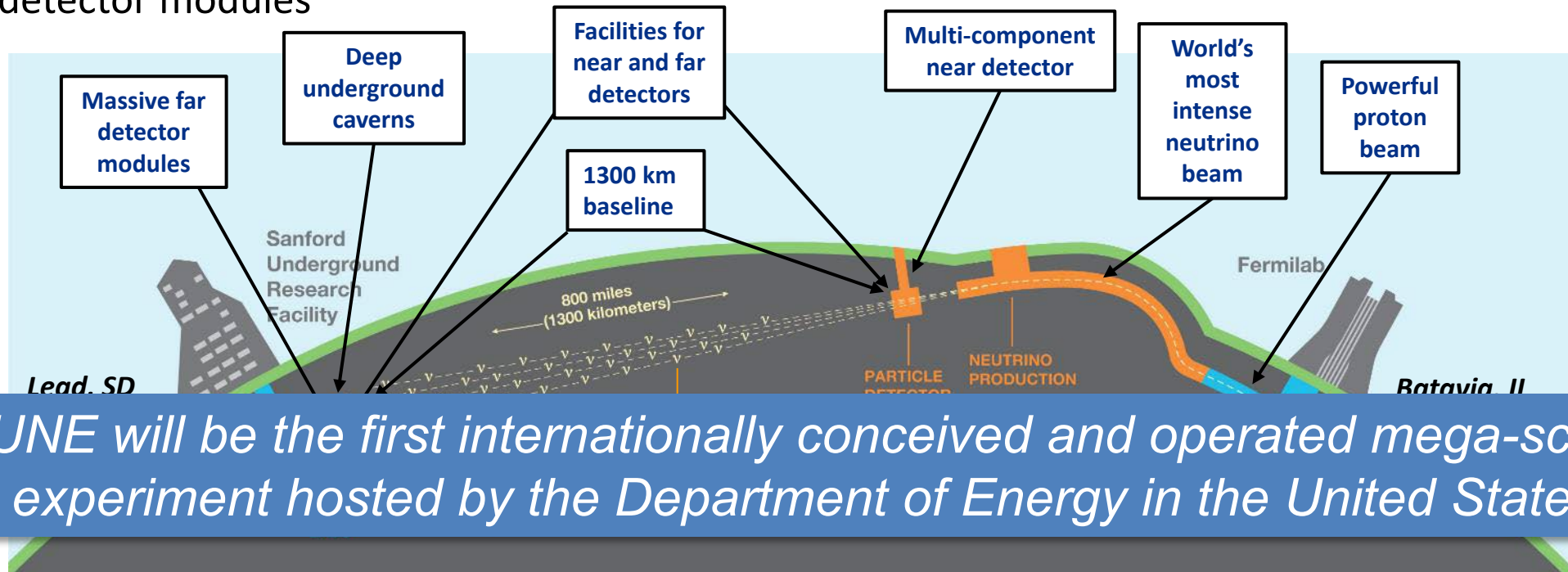
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Delivering Unprecedented Capabilities

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“DUNE will be the first internationally conceived and operated mega-science experiment hosted by the Department of Energy in the United States”

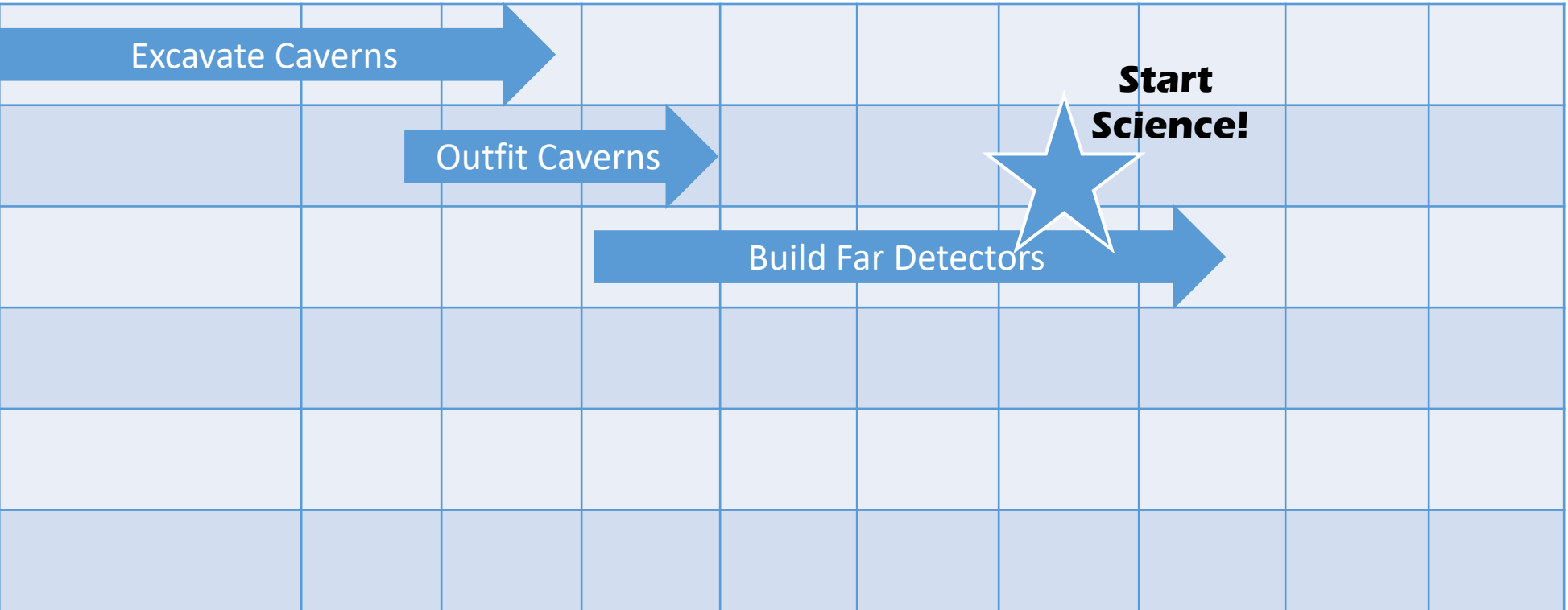


Cost & Schedule Summary

LBNF/DUNE-US Cost Range
 \$3,160M → \$3,677M

LBNF/DUNE-US Project Funding Profile (\$M) / Schedule

Thru 2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Total
\$955	\$180	\$255	\$280	\$305	\$305	\$305	\$305	\$262	\$0	\$3,277



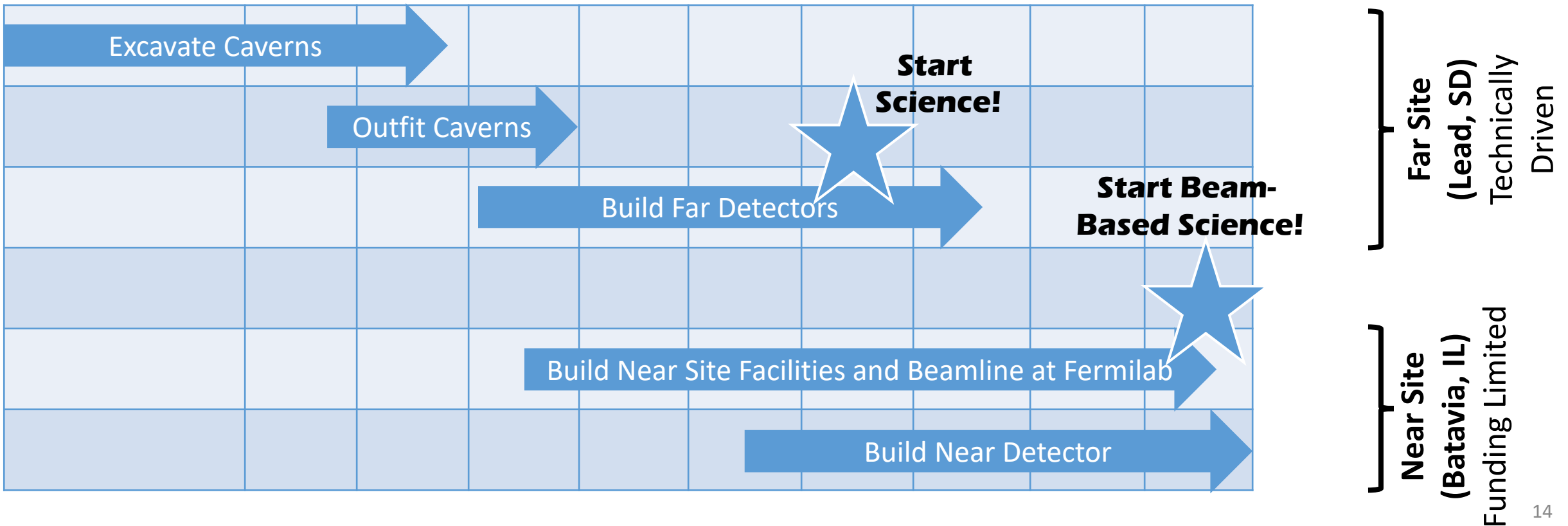
Far Site
 (Lead, SD)
 Technically
 Driven



Cost & Schedule Summary

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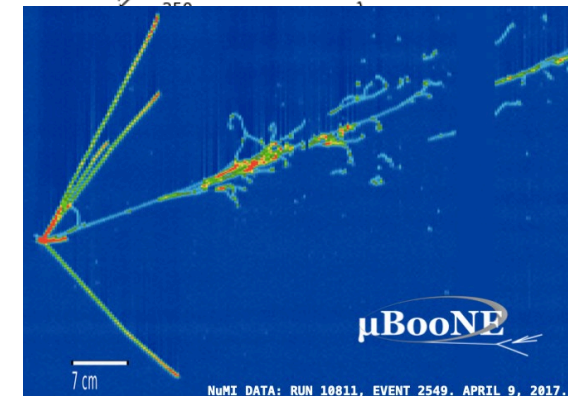
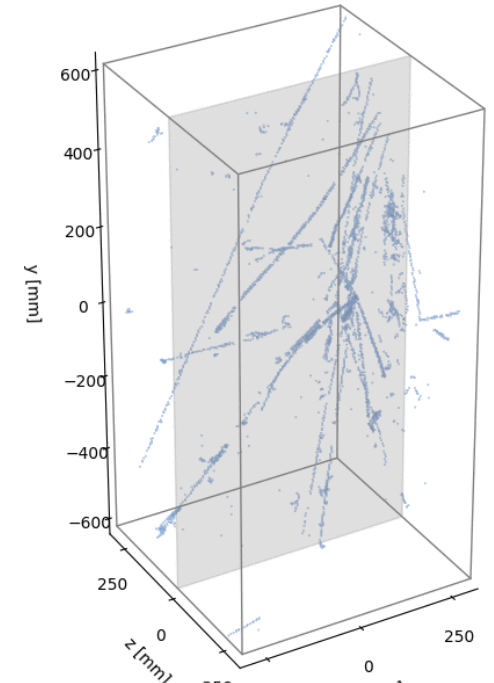
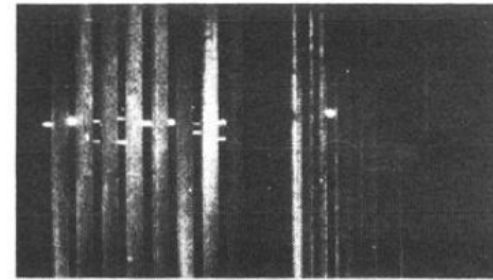


Four Amazing Things About LBNF/DUNE



#1 Unmatched Capabilities for Ground-Breaking Science

- World's most intense neutrino beam
- Gigantic far detectors sited deep underground at optimal distance from neutrino source
- Superb precision images of particle interactions



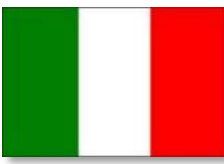


#2 Partnerships are Key to Success

- Private and State investments at SURF
- International contributions to LBNF, DUNE and PIP-II
- LBNF/DUNE and PIP-II would not be feasible without the facilities and expertise of our partners



Brookhaven National Laboratory



LBNF/DUNE is enabled by >\$1B of investment by International, National, State and Private partners



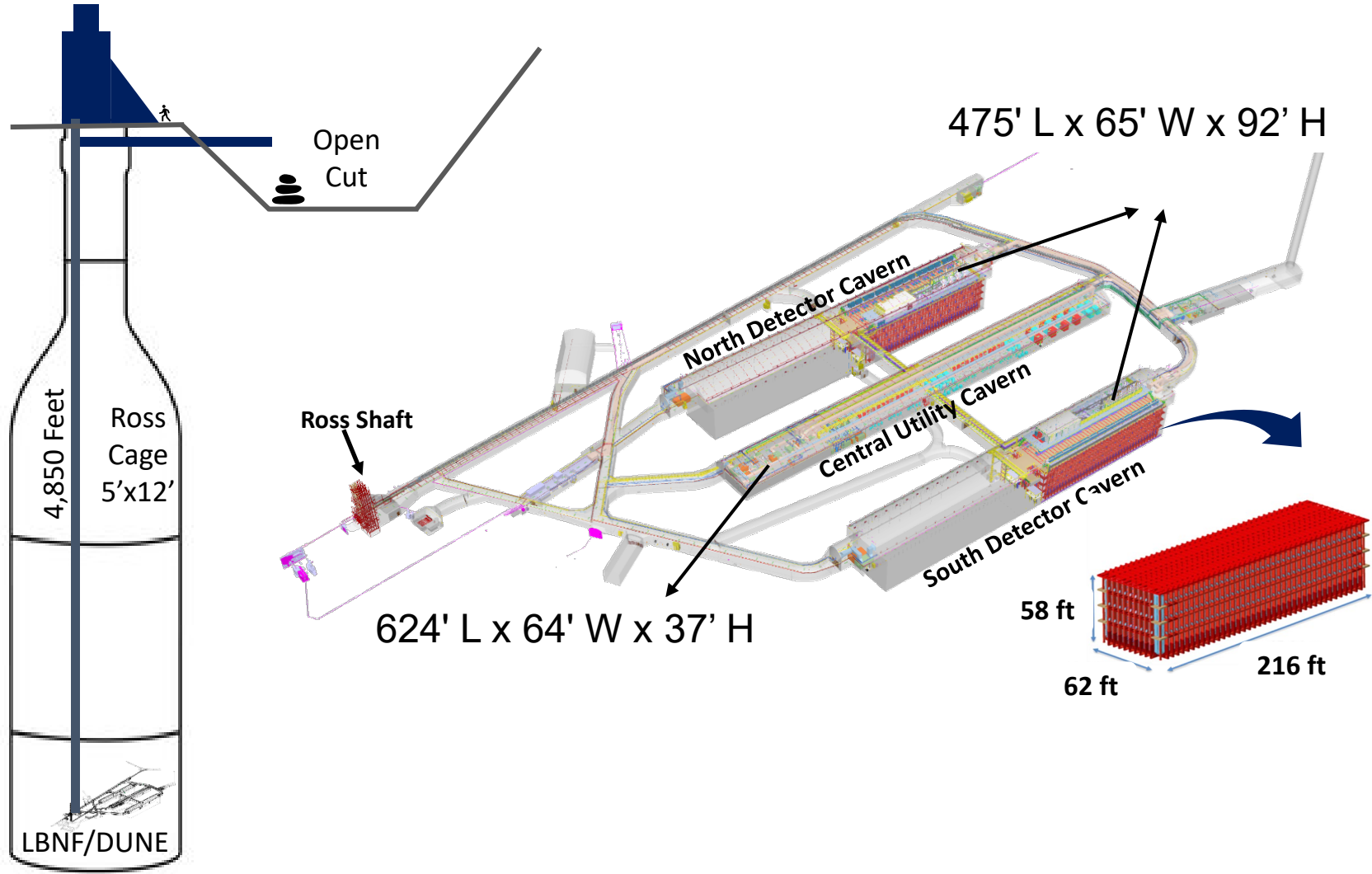
#3 Building a Ship in a Bottle





#3 Building a Ship in a Bottle

- Remote site and “bottlenecked” access to underground caverns





#4 Societal Benefits



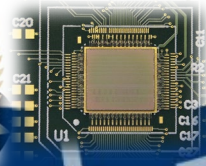
Significant Economic Benefits
> 3,000 jobs
+ \$4.2 Billion



S.T.E.M. Opportunities
Reaching tens of thousands of K-12 students in IL and SD



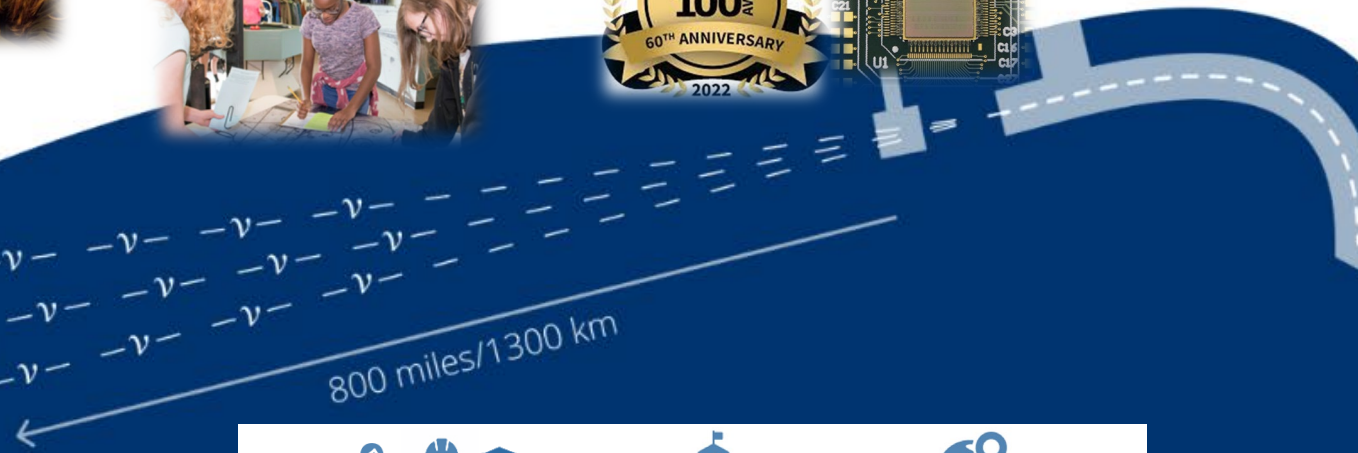
Development of Cutting-Edge Technology
Electronics, ultra-sensitive particle and light imaging, machine learning/AI, etc.



Future Applications for Neutrinos?
nonproliferation, communications, subsurface imaging, etc.



Sanford Underground Research Facility, South Dakota



 Thousands Scientists, engineers, technicians, and students	 200+ Laboratories and universities	 30+ Countries
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Fermi National Accelerator Laboratory, Illinois



Decision to Change the Tailoring and Progress Since



LBNF/DUNE Tailoring

- In 2021 it became evident that the broad scope of LBNF/DUNE-US could not be matured and authorized on the same timescale due to:
 - Funding limitations
 - R&D needed to validate detector technology and production scaling
 - External dependencies like partner schedules
- Urgency to act so that excavation work at the Far Site could proceed
- Gathered lessons learned and best practices from around the DOE complex to inform a new subproject tailoring strategy

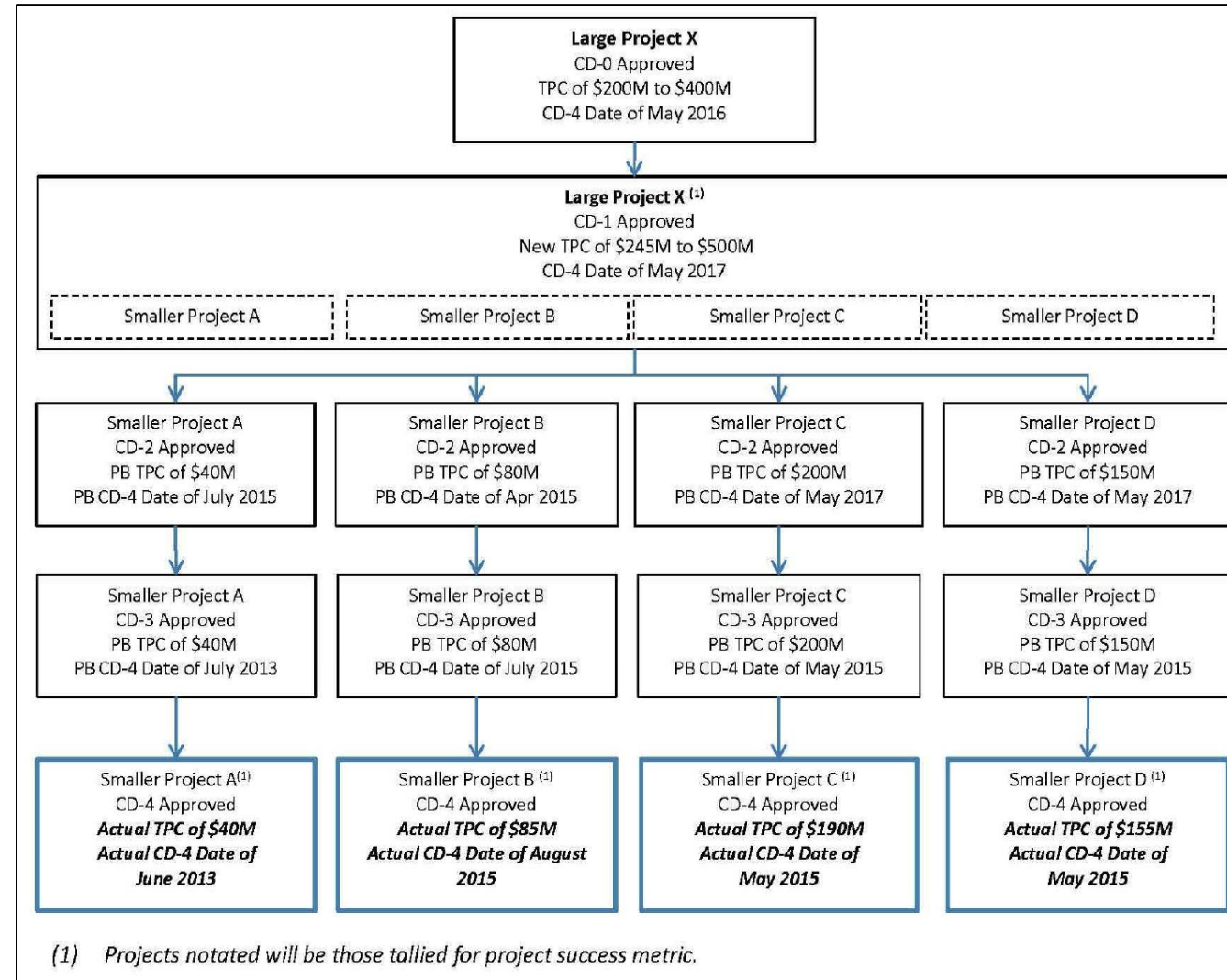
*Thank you to several colleagues in NNSA and FE
for sharing their experiences*



See 413.3b for Subproject Guidance

- DOE O 413,3b provides direction on phasing large projects or “subprojects”*
 - “*Distinct performance baselines*” for each “*complete and useable*” subproject
 - Recommended to request funds as a single line-item

*see Appendix C; 28. Tailoring; b. Phasing





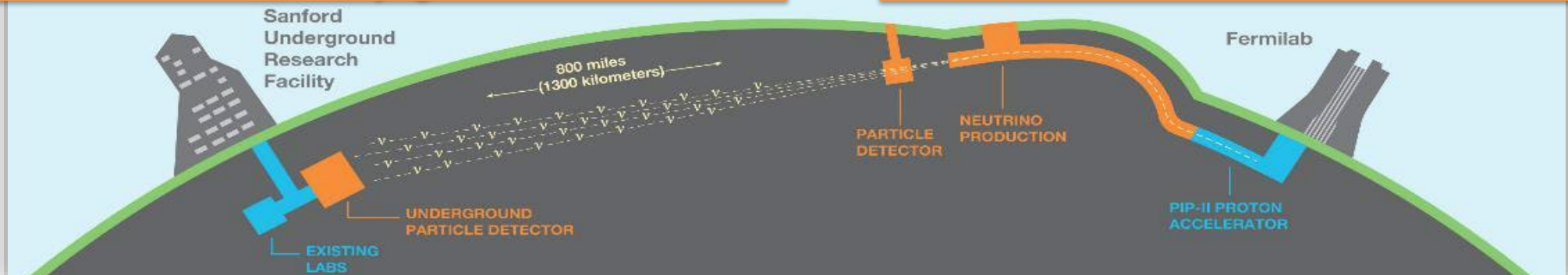
LBNF/DUNE Subprojects

Far Site – SURF in Lead, SD

- **FSCF-EXC** – Far Site Excavation
- **FSCF-BSI** – Far Site Building & Site Infrastructure
- **FDC** – Far Detectors and Cryogenic Infrastructure

Near Site – FNAL in Batavia, IL

- **NSCF+B** – Near Site Conventional Facilities + Beamline
- **ND** – Near Detector



Subproject	Scope	Critical Decision Status
FSCF-EXC	Excavation to support far detector modules	CD-2/3 approved in 2022
FSCF-BSI	Outfitting to support far detector modules	CD-2/3 approved in 2023
FDC	Fabricate and install 2 far detector modules and cryogenic systems*	Preparing for CD-2/3
NSCF+B	1.2 MW upgradeable beam, facilities for beam and near detector *	Preparing for CD-2/3 in FY25
ND	Fabricate and install near detector and cryogenic systems *	Expect CD-2/3 in ~FY26

**Includes international contributions*



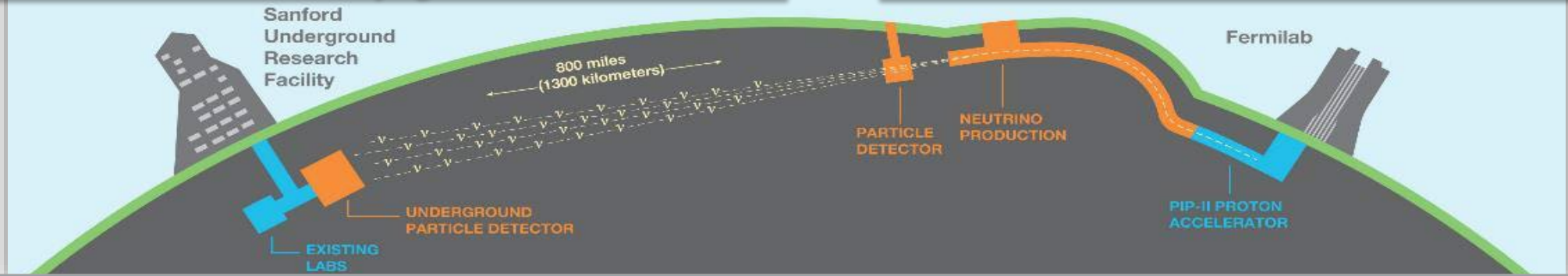
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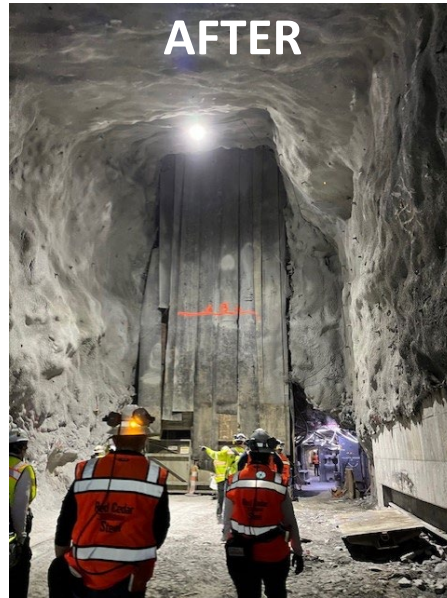
Subproject	Scope	Critical Decision Status
FSCF-EXC	Excavation to support up to 4 far detector modules	CD 2/2 approved in 2022
FSCF-BSI		
FDC		
NSCF+B		
ND		

Six Critical Decisions since pivoting to the subproject approach enabling construction and long-lead procurements across the LBNF/DUNE-US project

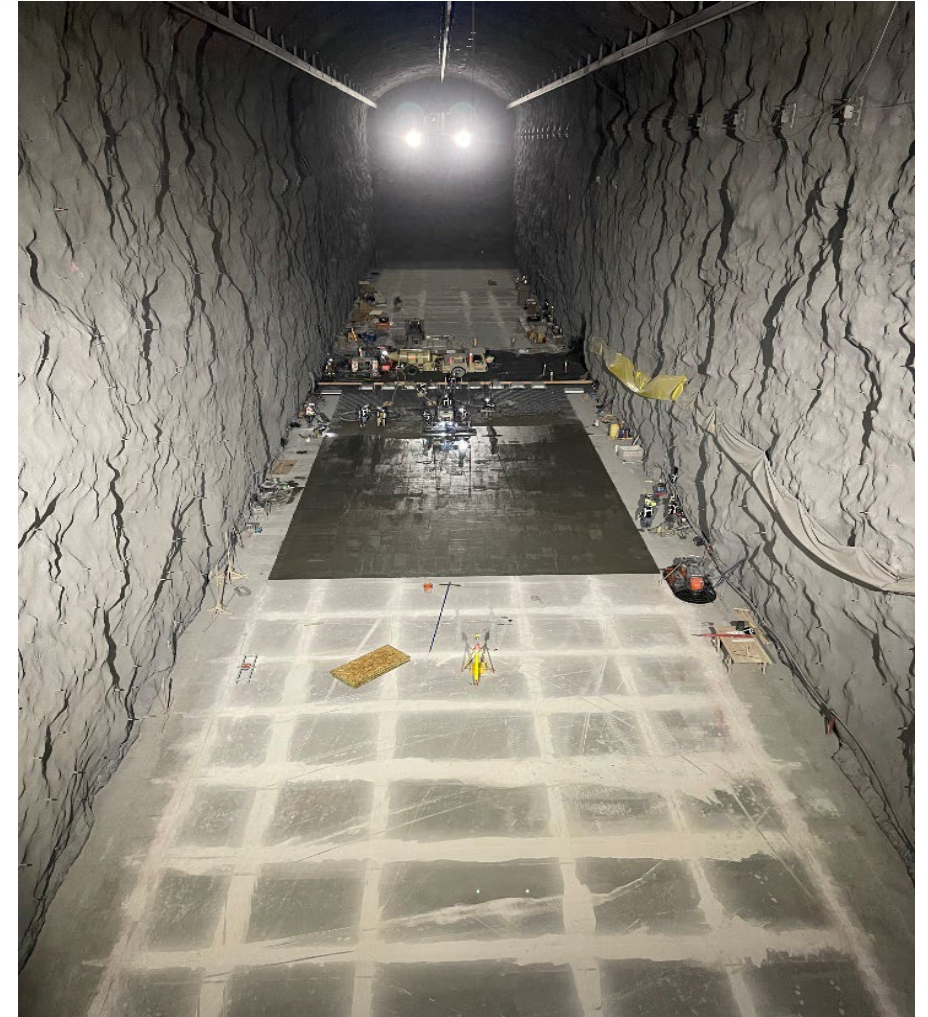


Progress Since Shifting to Subprojects- Far Site

- Far Site construction progress
 - Far Site Excavation subproject nearly complete!
 - Preparing to outfit the caverns



Adjusted “brow” to allow long materials to be maneuvered out of the shaft



Massive underground caverns have been completely excavated



Progress Since Shifting to Subprojects- Far Site Contd.

- Long-lead procurements for Far Detector technical systems
 - Far Detector components
 - Manufacturing long-lead cryogenic equipment
 - Preparing for detector installation phase at the Far Site



Ready for production on many technical systems thanks to a highly successful R&D program hosted by CERN

Black Hills Pioneer
Friday, January 19, 2024 Vol. 148 No. 161 Since 1876 \$1.50

Leads-Deadwood high school Showcase Pg 2
Sturgis Meets receives loan Pg 3

First components for DUNE experiment in Lead

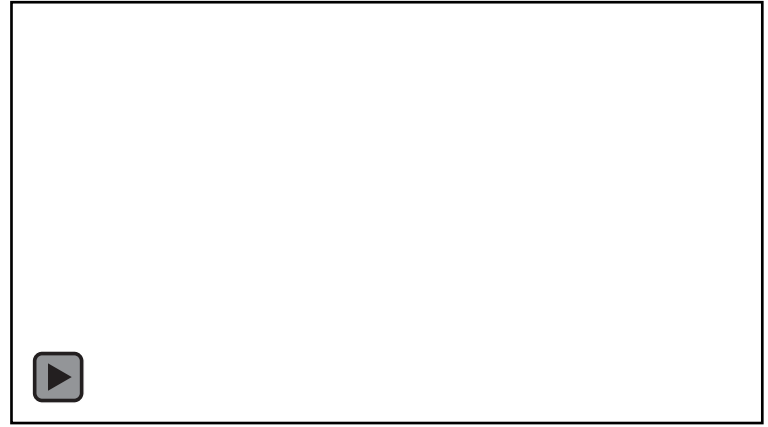


The first of what will eventually be 2,000 pieces of the cryostats for the deep underground neutrino experiment arrived in Lead last week. This spring members of the LBNF/DUNE team will work with Sanford Lab employees to begin tests to ensure the massive pieces can be safely and efficiently lowered down the Ross Shaft.
Photo by Stephen Kenny

By WENDY PITLUCK
Black Hills Pioneer

first piece is more than 8 tons and 40 feet by 3 feet by 1.5 feet. The second piece is nearly 6 tons and 18 feet by 11 feet. Work starts from first a corner of the massive... wanted to work out before it is time to actually assemble the cryostats underground. Besides the massive size of the structure, the construction referred to...

Steel structures from CERN delivered for time and motion studies

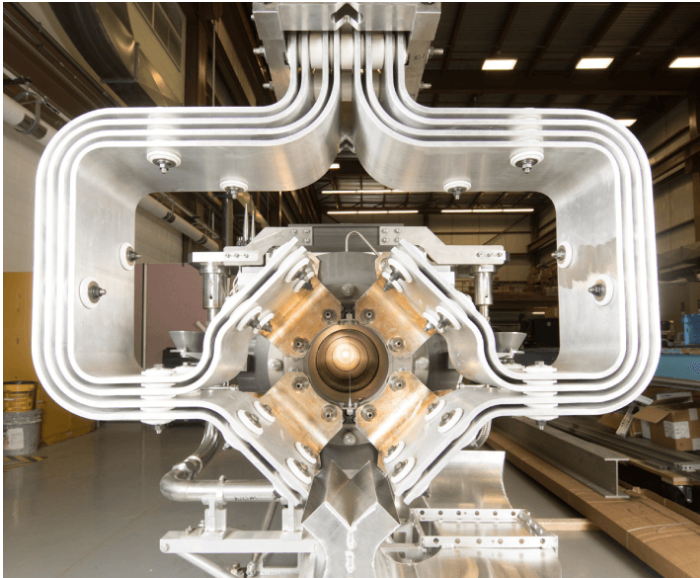


APA Winder (Video)



Progress Since Shifting to Subprojects- Near Site

- Site clearing and wetland mitigations at the Near Site
- Initiated long-lead procurements for Beamline



Long-lead procurements for Beamline technical components allows for completion of R&D and design including focusing horns and magnets



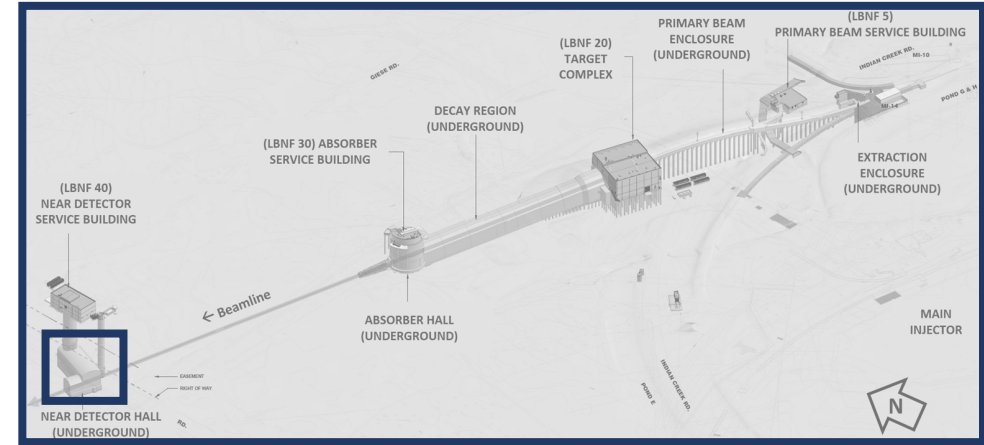
Site Preparation work enabled us to meet commitments to mitigate environmental impacts



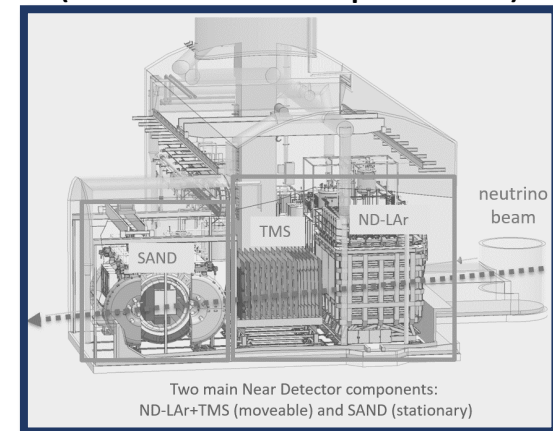
What We've Learned about Subprojects

- Subproject approach is more ideally suited when:
 - Broad scope that cannot mature on the same timeline
 - Program's funding commitments must be time-phased
 - Other aspects exist that would benefit from compartmentalization (differing jurisdictions/governance, multiple locations of work, etc.)

Near Site Conventional Facilities (Large Civil Construction)



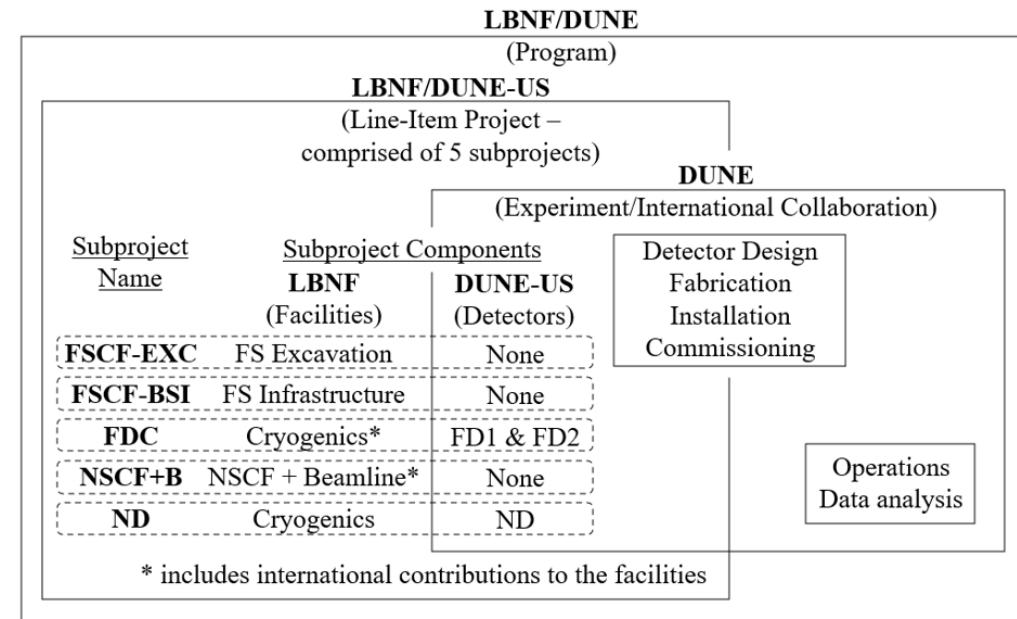
Near Detector (Technical Components)





What We've Learned about Subprojects Contd.

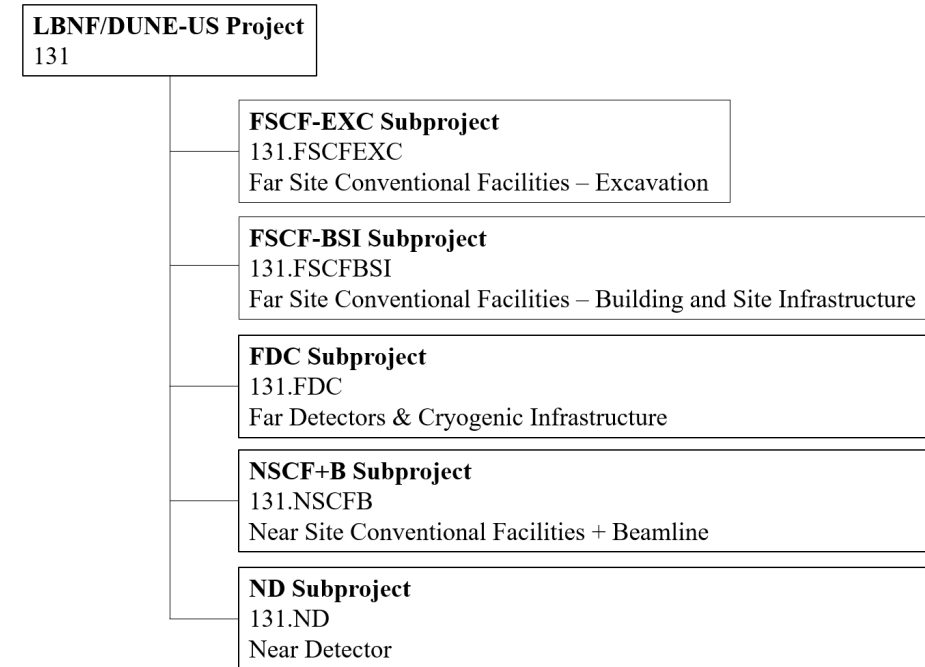
- Benefits are not just about a compliant way to incrementally authorize work
- Inherently leads to more focused and effective management and oversight
- Subproject Critical Decisions presented to the PME tend to be less complicated and more compelling





What We've Learned about Subprojects Contd.

- Examples of things to watch out for:
 - Scope subprojects to minimize dependencies
 - Align your WBS, schedules, and organization to the subproject construct
 - Deliverable-oriented construct is always best
 - FPD needs to approach it like a Program Manager
 - Maintain DOE's authority to optimize funding across subprojects!



Paying it forward... our team would be happy to share more details about our experiences



LBNF/DUNE

An unprecedented international flagship endeavor hosted by the US
to unlock mysteries in our universe



Thank You