DUNE Experiment & NOvA Update

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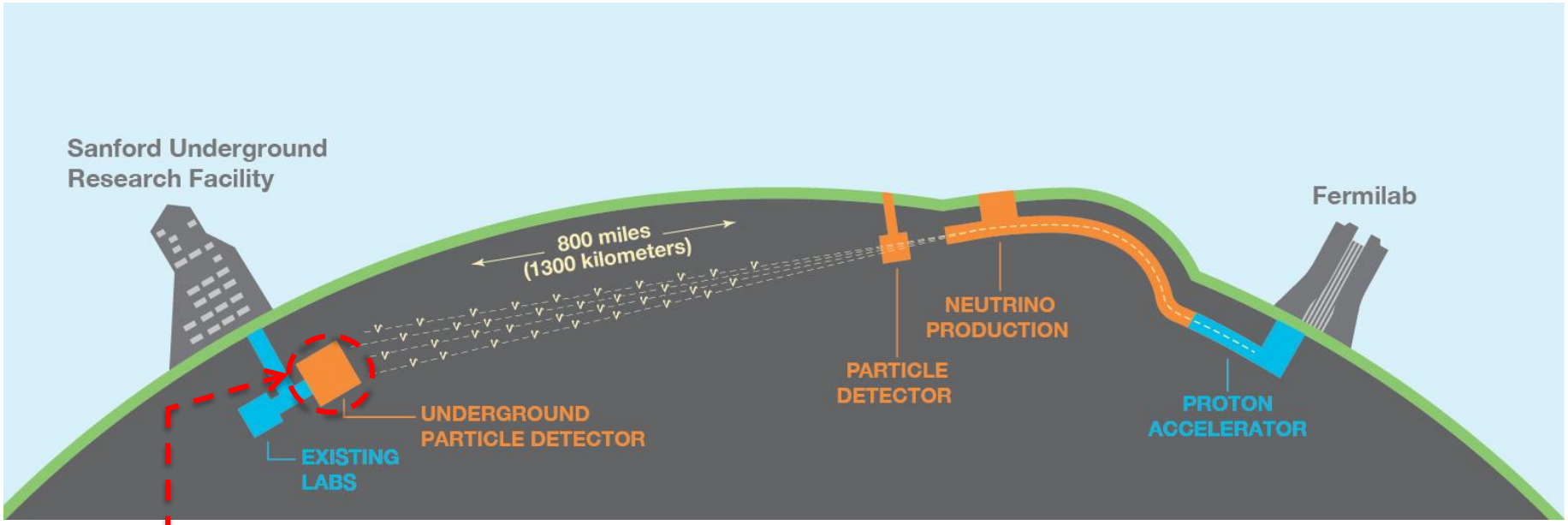
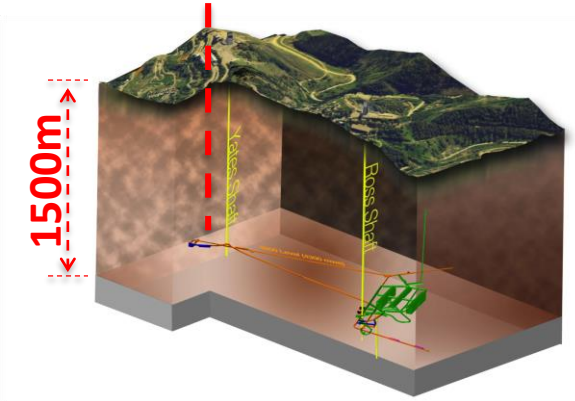
RAL LHCOPN/LHCONE Meeting

March 5, 2018


DUNE
DEEP UNDERGROUND
NEUTRINO EXPERIMENT





- Near (FNAL) & far end (SURF) detectors:
  - 1300km apart
- Far end detector ~1500m below surface

DUNE Science Objectives

Origin of matter
Discover what happened after the big bang: Are neutrinos the reason the universe is made of matter?

Unification of forces
Move closer to realizing Einstein's dream of a unified theory of matter and energy

Black hole formation
Use neutrinos to look into the cosmos and watch the formation of neutron stars and black holes in real time

DUNE Timeline & Collaboration Scale

An international effort

The Deep Underground Neutrino Experiment brings together over 1,000 scientists from more than 30 countries around the world.

31 Countries

Armenia	Finland	Mexico	Spain
Brazil	France	Netherlands	Sweden
Bulgaria	Greece	Paraguay	Switzerland
Canada	India	Peru	Turkey
Chile	Iran	Poland	Ukraine
China	Italy	Romania	United Kingdom
Colombia	Japan	Russia	United States
Czech Republic	Madagascar	South Korea	

Project timeline

July 2017
Groundbreaking for LBNF/DUNE

Autumn 2018
ProtoDUNE detectors online at CERN

2019
Begin main cavern excavation in South Dakota

2022
Begin installing the first DUNE detector

2026
Fermilab's high-energy neutrino beam to South Dakota operational with two DUNE detectors online

DUNE Collaboration Sites

>160 Labs & Universities; >1000 Scientists

List of countries and participating institutions

Armenia Yerevan Inst. for Theoretical Physics and Modeling
Brazil Univ. Federal do ABC; Univ. Federal de Alfenas em Poços de Caldas; Univ. de Campinas; Centro Brasileiro de Pesquisas Físicas; Univ. Estadual de Feira de Santana; Univ. Federal de Goias
Bulgaria Univ. of Sofia
Canada York University
Chile Univ. Tecnica Federico Santa Maria
China Tsinghua University
Colombia Univ. del Atlantico
Czech Republic Charles University, Prague; Czech Technical University, Prague; Institute of Physics ASCR, Prague
Finland Univ. of Jyvaskyla
France Lab. d'Annecy-le-Vieux de Phys. des Particules; Inst. de Physique Nucleaire de Lyon; APC-Paris; CEA/Saclay
Greece Univ. of Athens
India Aligarh Muslim University; Banaras Hindu University; Bhabha Atomic Research Center; Indian Inst. of Tech. Bombay; Univ. of Delhi; Indian Inst. of Technology, Guwahati; Harish-Chandra Research Institute; Indian Inst. of Technology, Hyderabad; Univ. of Hyderabad; Univ. of Jammu; Jawaharlal Nehru University; Koneru Lakshmaiah University; Univ. of Lucknow; Panjab University; Physical Research Laboratory; Punjab Agri. University; Variable Energy Cyclotron Centre
Iran Inst. for Research in Fundamental Sciences
Italy Lab. Nazionali del Gran Sasso, Assergi; Univ. di Catania; Gran Sasso Science Institute; Univ. di Milano; INFN Sezione di Milano Bicocca; INFN Sezione di Napoli; Univ. of Padova; Univ. of Pavia, INFN Sezione di Pavia; CNI Pisa; Univ. di Pisa
Japan Iwate University; KEK; Kavli IPMU, Univ. of Tokyo; National Inst. of Tech. Kure College
Madagascar Univ. of Antananarivo
Mexico Univ. de Colima; CINVESTAV; Univ. de Guanajuato
Netherlands NIKHEF
Peru Univ. Nacional de Ingineria; PUCP
Poland Inst. of Nuclear Physics, Krakow; National Centre for Nuclear Research, Warsaw; Warsaw Univ. of Technology; Univ. of Warsaw; Wroclaw University
Romania Horia Hulubei National Institute
Russia Inst. for Nuclear Research, Moscow
South Korea Chung-Ang University
Spain Inst. de Fisica d'Altas Energias, Barcelona; CIEMAT; Inst. de Fisica Corpuscular, Madrid; Madrid Autonoma Univ.
Sweden KTH Royal Institute of Technology
Switzerland Univ. of Basel; Univ. of Bern; CERN; ETH Zurich
Turkey TUBITAK Space Technologies Research Institute
Ukraine Kyiv National University
United Kingdom Univ. of Birmingham; Univ. of Bristol; Univ. of Cambridge; Daresbury Laboratory; Univ. of Durham; Imperial College of Science, Tech. & Medicine; Lancaster University; Univ. of Liverpool; University College London; Univ. of Manchester; Univ. of Oxford; Rutherford Appleton Laboratory; Univ. of Sheffield; Univ. of Sussex; Univ. of Warwick
USA Univ. of Alabama; Argonne National Lab; Boston University; Brookhaven National Lab; Univ. of California, Berkeley; Univ. of California, Davis; Univ. of California, Irvine; Univ. of California, Los Angeles; California Inst. of Technology; Univ. of Chicago; Univ. of Cincinnati; Univ. of Colorado; Colorado State University; Columbia University; Cornell University; Dakota State University; Drexel University; Duke University; Fermi National Accelerator Lab; Univ. of Hawaii; Univ. of Houston; Idaho State University; Illinois Institute of Technology; Indiana University; Iowa State University; Univ. of Iowa; Kansas State University; Lawrence Berkeley National Lab; Los Alamos National Lab; Louisiana State University; Univ. of Maryland; Massachusetts Institute of Technology; Michigan State University; Univ. of Michigan; Univ. of Minnesota (Duluth); Univ. of Minnesota (Twin Cities); Univ. of New Mexico; Northern Illinois University; Northwestern University; Univ. of Notre Dame; Ohio State University; Oregon State University; Pacific Northwest National Lab; Univ. of Pennsylvania; Pennsylvania State University; Univ. of Pittsburgh; Princeton University; Univ. of Puerto Rico; Univ. of Rochester; SLAC National Accelerator Lab; Univ. of South Carolina; Univ. of South Dakota; South Dakota School of Mines and Technology; South Dakota Science And Technology Authority; South Dakota State University; Southern Methodist University; Stanford University; Stony Brook University; Syracuse University; Univ. of Tennessee; Texas A&M University, Corpus Christi; Univ. of Texas at Arlington; Univ. of Texas at Austin; Tufts University; Valley City State University; Virginia Tech; Wichita State University; College of William and Mary; Univ. of Wisconsin; Yale University

DUNE Computing Model & Data Movement

- DUNE computing model currently under development:
  - Technical proposal being finalized
  - Conceptual design report due in 2019
  - Final Technical Design Report (TDR) not due until 2024
- Multiple DAQ designs under consideration
- Current raw data estimate is ~30PB/yr
  - Similar to LHC Run-2
- Primary storage & 1st level data processing at FNAL (HEPcloud)
  - Data replication at CERN
  - Secondary data centers in Europe, East Asia, India
- Full-scale networking for experiment needed by 2024
  - Production data taking in 2026

DUNE & LHCONE

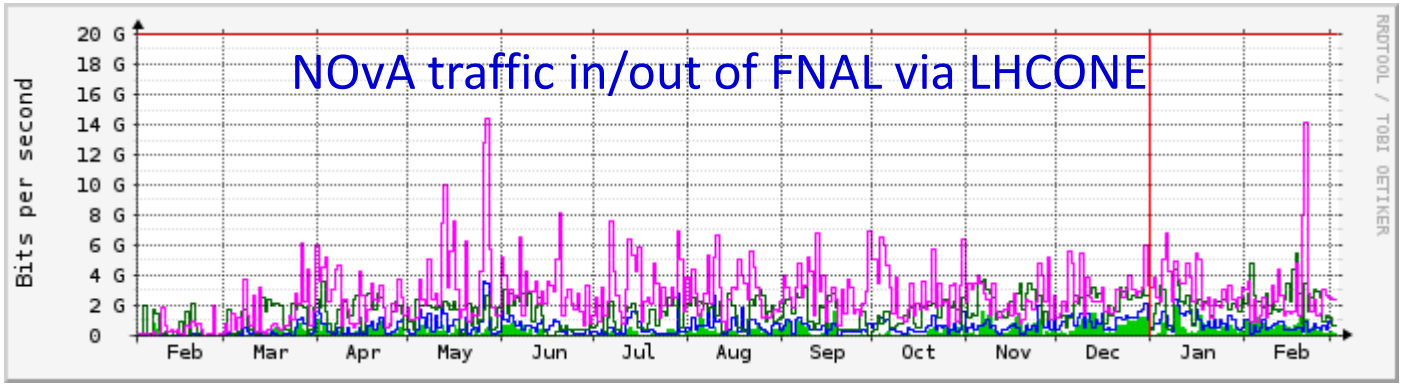
- High level of overlap between DUNE sites & LHC sites
- LHCONE seen as highly desirable network service for DUNE
- Not clear how soon DUNE will be in a position to make use of LHCONE
  - But a request for approval to use LHCONE will come at some point…


NOvA

Update on NOvA Use of LHCONE

- NOvA received authorization to use LHCONE in July 2016:
  - Only FZU (Prague) <-> FNAL traffic expected to use LHCONE
  - Traffic levels were projected to be 3-5Gb/s (peak periods…)

- FZU <-> FNAL traffic levels (NOvA) remain within projected range:



- JINR (Russia) now using LHCONE for its FNAL NOvA traffic:
  - Has not added appreciable NOvA traffic to LHCONE
  - No expectations for additional NOvA sites using LHCONE

Update on NOvA Use of LHCONE (II)

- Some lingering performance issues in movement of NOvA data between FZU & FNAL:
  - Not believed to be a network problem
    - Issues with storage system performance…
  - Latency is not a concern