DEEP UNDERGROUND NEUTRINO EXPERIMENT

First ASFAP Particle Physics Day

DEEP UNDERGROUND NEUTRINO EXPERIMENT
and
UNIVERSITY OF ANTANANARIVO MADAGASCAR

Nov.18th 2021

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GenesisCare USA/ Duke University Medical Center

Outline

Introduction: The University of Antananarivo at DUNE

Overview of the DUNE Collaboration

Our contribution

Current analysis

Outcome of being part of DUNE

The University of Antananarivo at DUNE

- Motivation in being a member of DUNE
  - DUNE is an international flagship experiment to unlock the mysteries of neutrinos
  - Opportunity for graduate students to do experimental physics research
  - Strong theoretical background from HEP at the University of Antananarivo
  - Expand horizon, bring knowledge back, share with others
  - Increase the number of research from Madagascar in neutrino experimental physics
    - In 2012: 2 graduate students in experimental physics (1 at CERN, 1 at Fermilab)
    - By 2022: 12 experimental physicists

The University of Antananarivo at DUNE:

- The leadership:
  - Pr. Roland Raboanary- based in Madagascar
  - Dr. Feno Andrianala- based at CERN-Madagascar
  - Dr. David Martinez-based in the US, affiliated with South Dakota
  - Dr. Laza Rakotondravohitra- based in the US, affiliated with Duke University/GenesisCare USA- ASP2010
- Current researcher
  - Rado Razakamiandra- (ASP 2020) Alumnus
  - Michael Andrianjafy
  - Anjary H. Rasamimanana
  - Antalia Rabarisoa

1000+

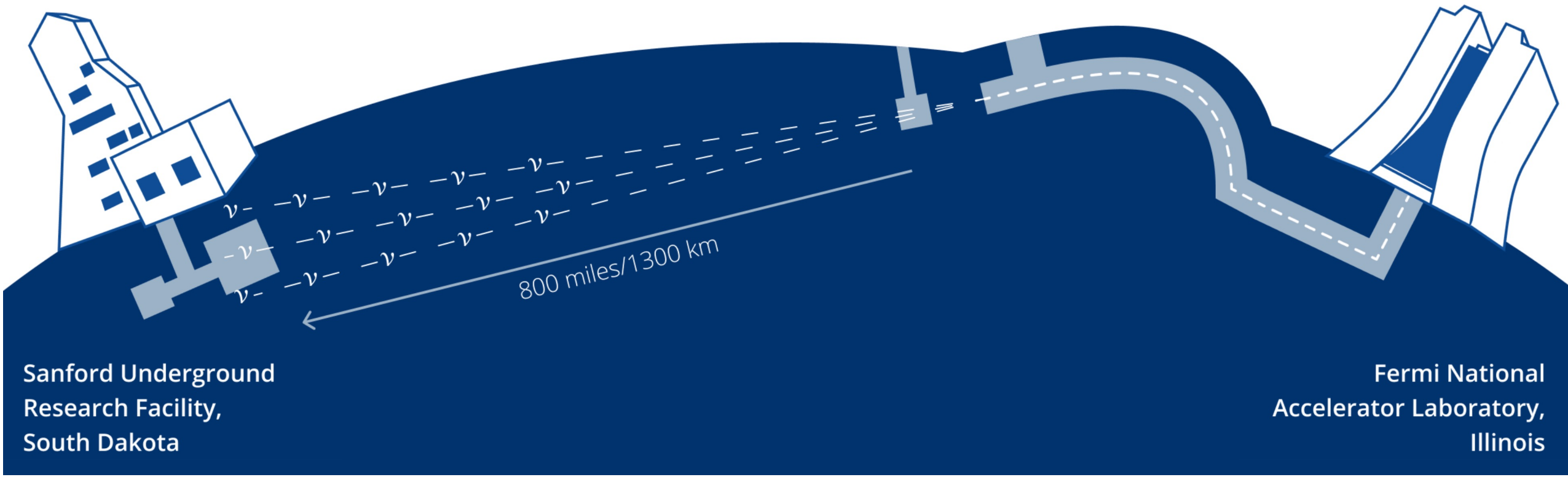
Scientists

200+

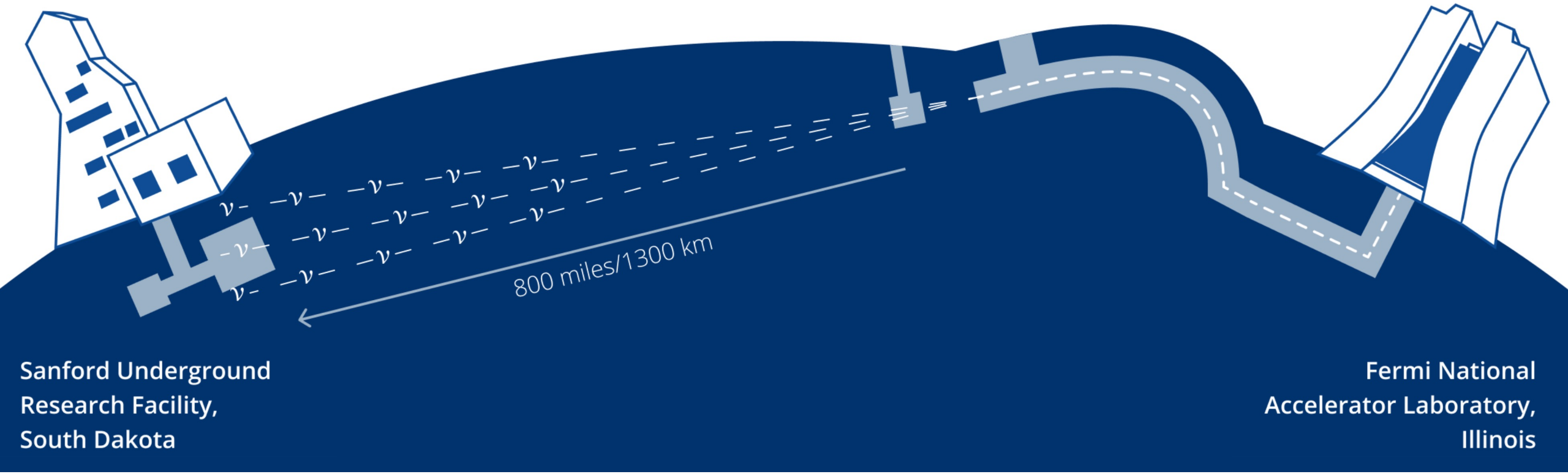
Laboratories and universities

30+

Countries



https://lbnf-dune.fnal.gov/people/dune-collaboration/



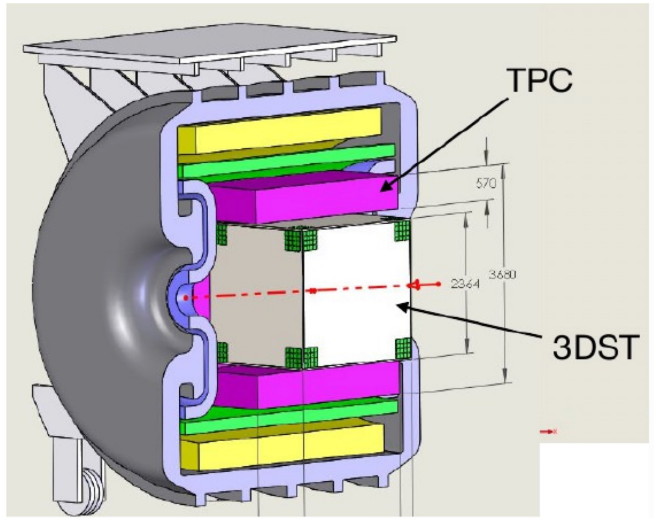
- World's most intense neutrino beam
- Neutrino beam with broad energy spectrum
- Greatest distance between source and detector for lab-made neutrinos
- Gigantic far detector, Deep underground
- Superb images of particle interactions with liquid-argon technology

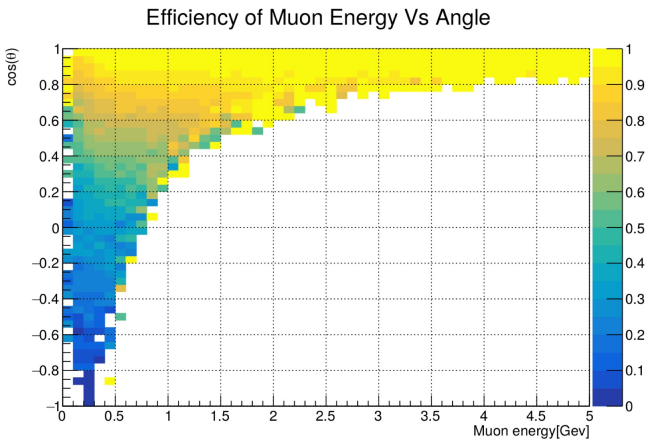
https://lbnf-dune.fnal.gov/people/dune-collaboration/

Our contribution: Near Detector

- Near Detector Conceptual Design Report-
- SAND-System for on-Axis Neutrino Detection
  - Figure 5.15 from the CDR Report made by our students
  - The efficiency to reconstruct muons generated by neutrino

  interactions in the 3DST that escape and enter into the TPCs





Our contribution: Near Detector

- One goal of the DUNE ND is to improve measurements of neutrino interactions by observing particles and kinematic regions not studied at all (or very well) before. The additional information may provide improved energy reconstruction, improved measurements of transverse kinematic variables, and a path to cross section model improvements

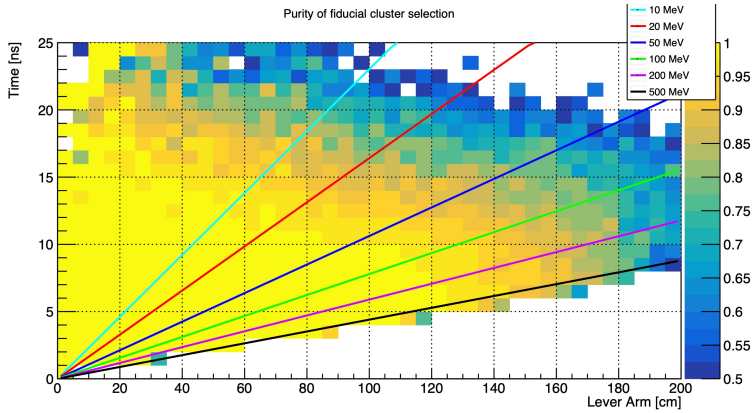


Figure 5.23: The purity for selecting in-fiducial neutron candidate clusters (mostly due to neutrons and photons) as a function of the time and distance from the vertex. The time and vertex can be used in the analysis to tune the purity. The efficiency for detecting the clusters is 60%, largely independent of time and space. The impurity in this plot is due to the out-of-fiducial neutron and gamma background. This plot was made with a $\bar{\nu}_\mu$-CC inclusive sample of events.

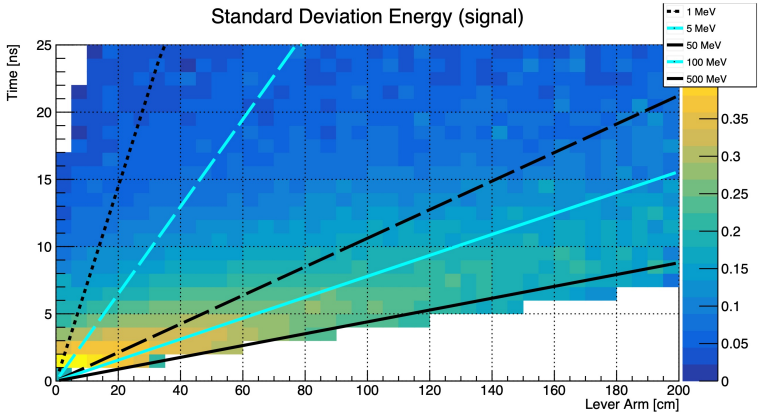


Figure 5.24: The fractional resolution of the reconstructed neutron kinetic energy for leading (first in time) neutrons created from neutrino events inside the fiducial volume of the 3DST. The axes are the time and distance of the neutron cluster from the neutrino vertex. The lines indicate specific neutron kinetic energies. This plot was made with a $\bar{\nu}_\mu$-CC inclusive sample of events.

Outcome of our contribution

- Joining DUNE is a tremendous opportunity
- Learning collaborative works
- 4 defended Masters thesis since 2016
- 1 PHD candidate at the University of Antananarivo
- 3 graduate students research in training focusing on the near detector
- All 4 graduates has obtained PHD position due to outstanding performance during their masters
    - Manoa Andriamirado- PhD candidate at IIT
    - Sitraka Andriaseta-PhD candidate in South Dakota
    - Miriama Rajaoalisoa- (ASP 2016) PhD candidate at the University of Cincinnati
    - Herilala Razafinime- PhD candidate at the University of Cincinnati