

Neutrinos and **DUNE**

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QuarkNet Teachers Workshop 2024

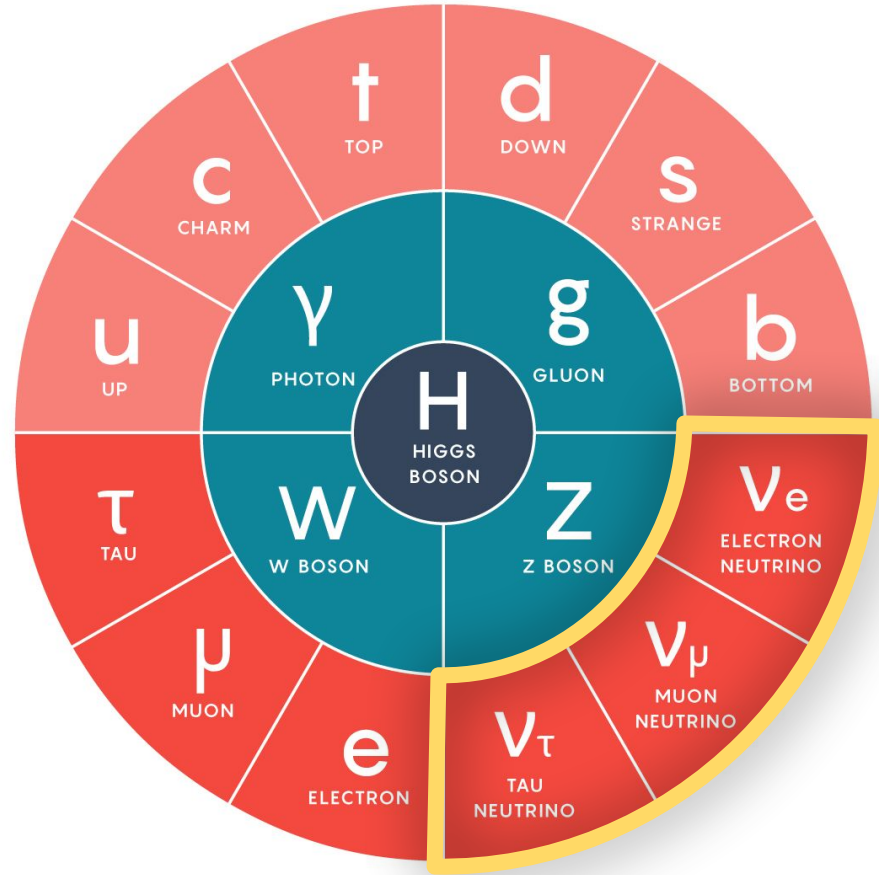
31 July 2024



What is a neutrino?

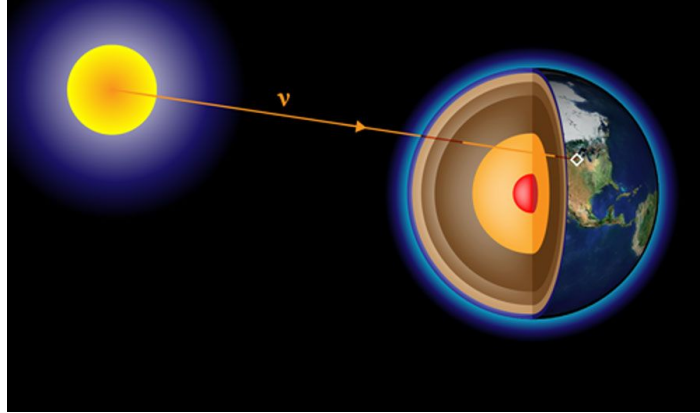
- A fundamental particle

The Standard Model

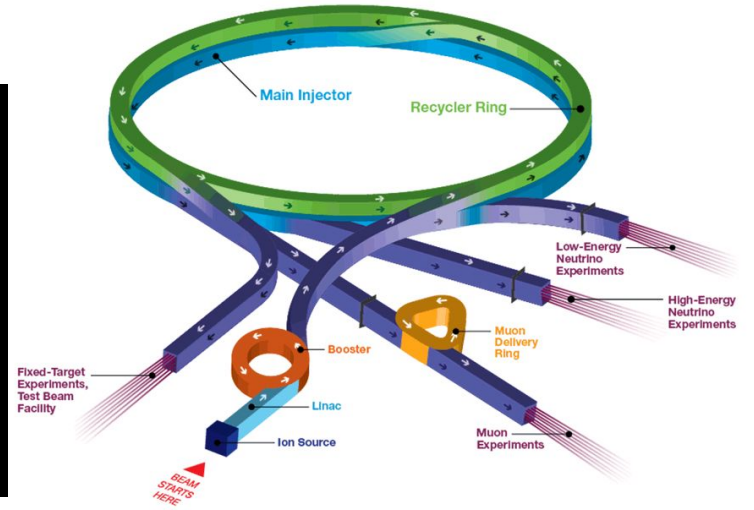


What is a neutrino?

- A fundamental particle
- Produced in radioactive decay, in the sun, at accelerators

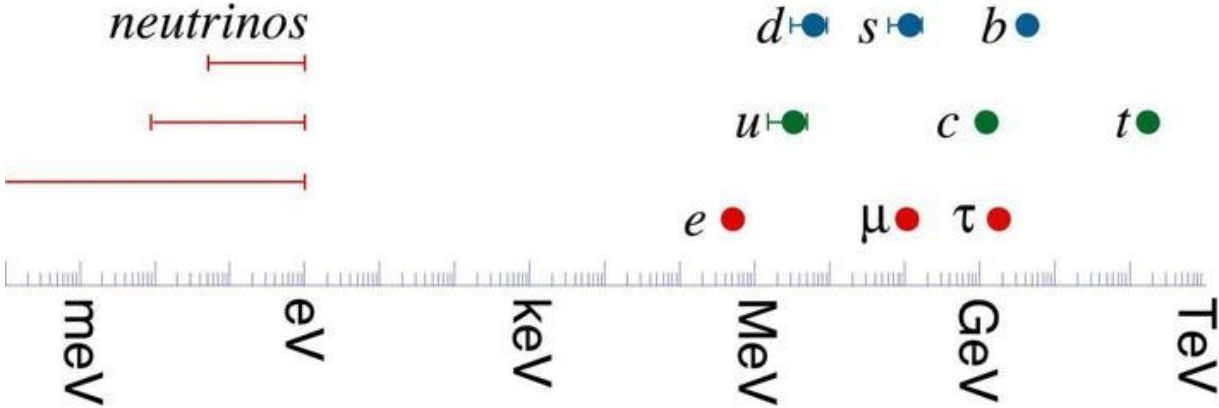


Fermilab Accelerator Complex



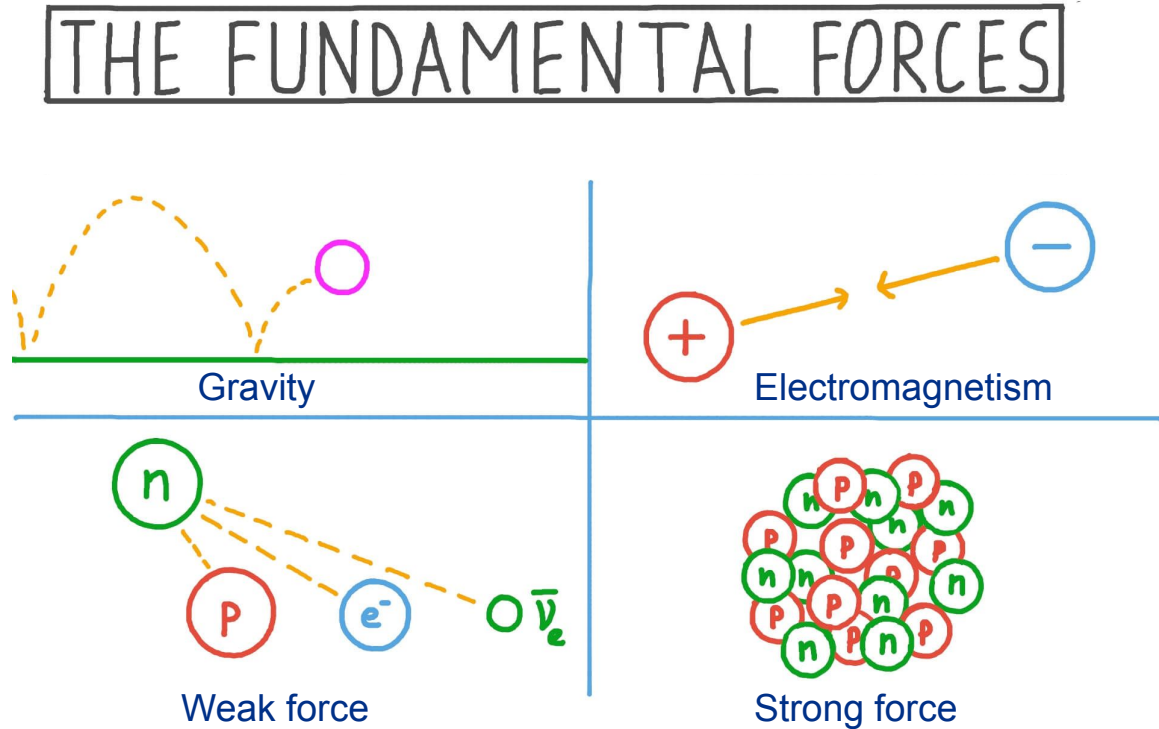
What is a neutrino?

- A fundamental particle
- Produced in radioactive decay, in the sun, at accelerators
- Has a very small mass



What is a neutrino?

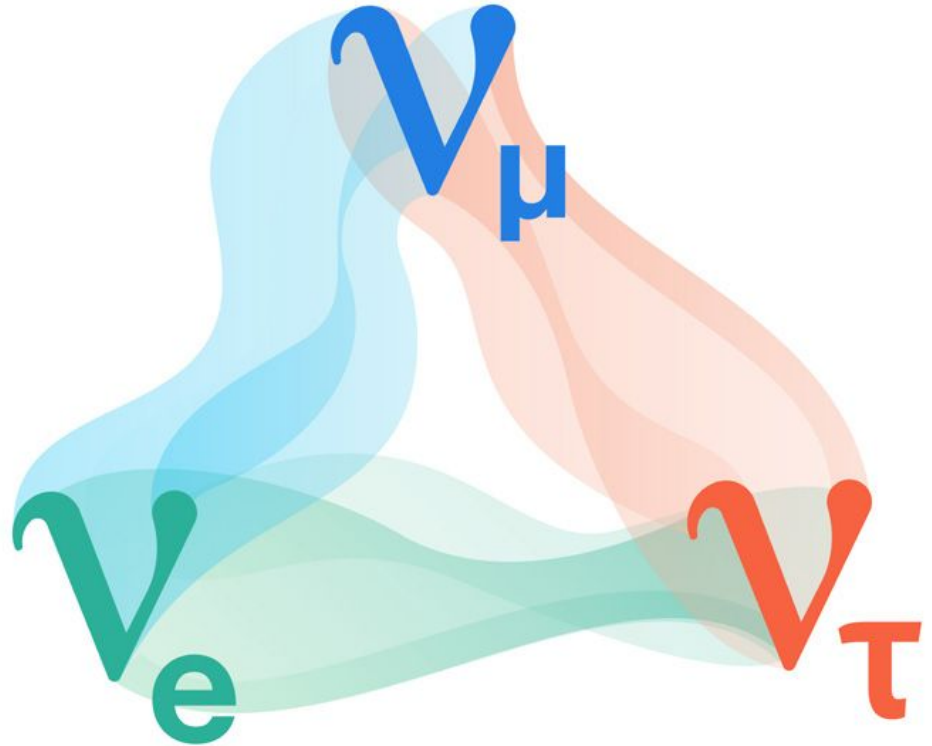
- A fundamental particle
- Produced in radioactive decay, in the sun, at accelerators
- Has a very small mass
- Only* interact via the weak force



*and technically gravity since they have a tiny mass

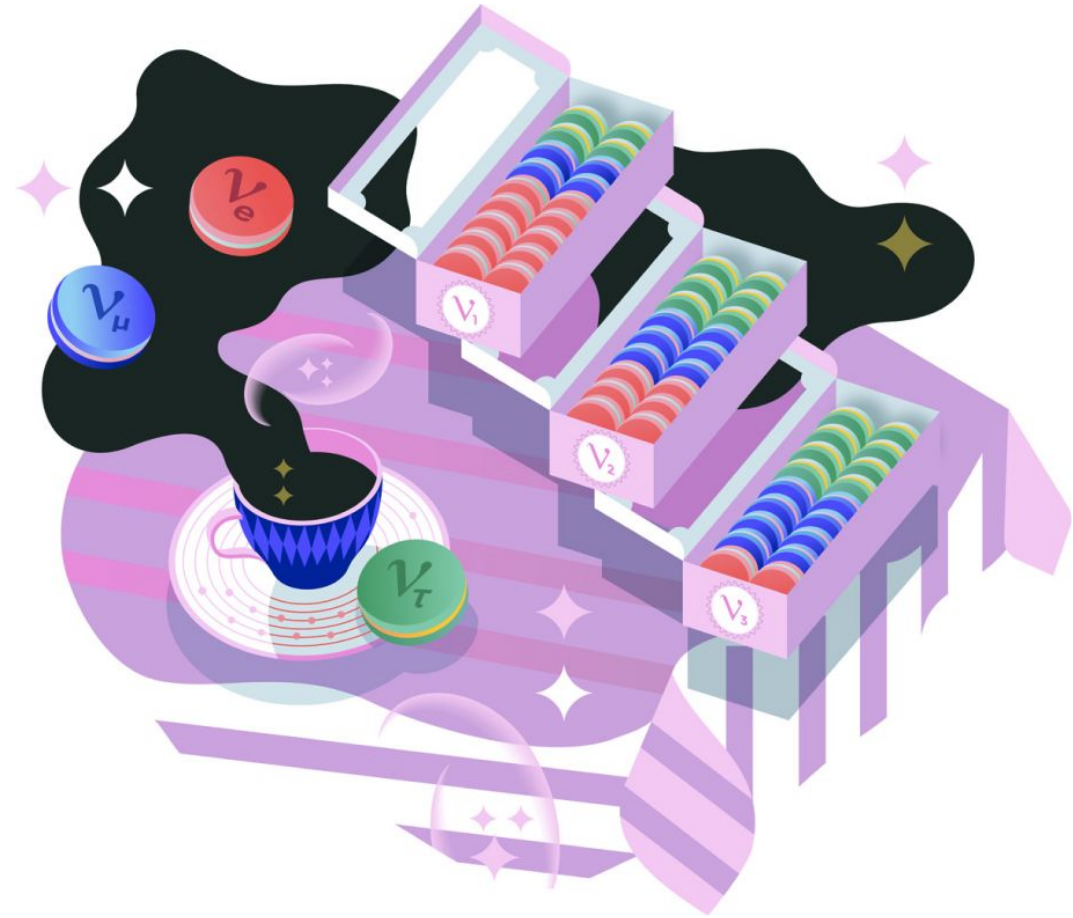
What is a neutrino?

- A fundamental particle
- Produced in radioactive decay, in the sun, at accelerators
- Has a very small mass
- Only* interact via the weak force
- They change flavors as they travel (neutrino oscillation)



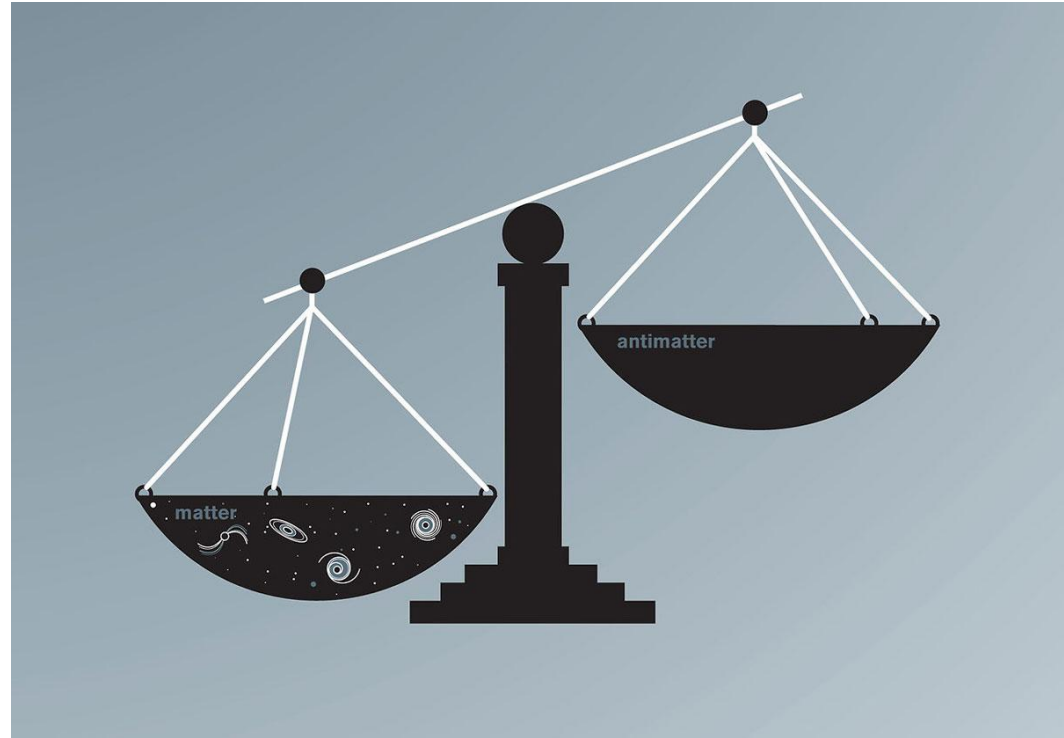
Questions about the neutrino

- How massive are they?
- Are they their own antiparticle?
- Are there more than three flavors? (sterile neutrinos)



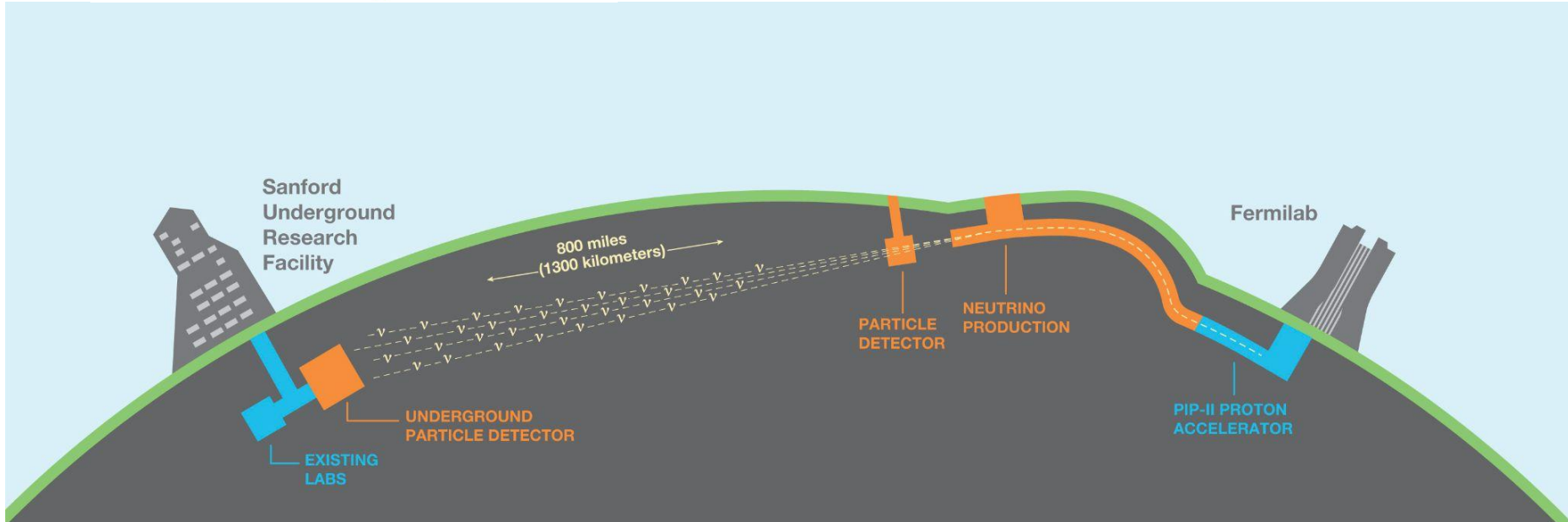
Questions about the neutrino

- How massive are they?
- Are they their own antiparticle?
- Are there more than three flavors? (sterile neutrinos)
- Can they tell us about the matter/antimatter asymmetry in the Universe?





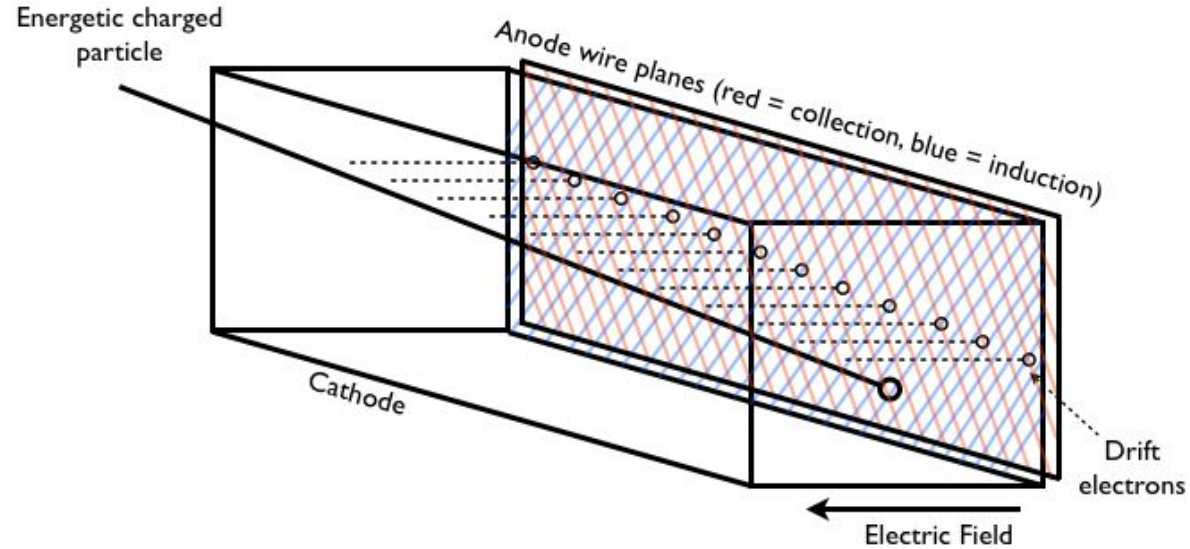
DEEP UNDERGROUND NEUTRINO EXPERIMENT



DUNE will measure neutrinos and antineutrinos. Comparing these interactions can tell us about the matter/antimatter asymmetry in the Universe

How do we detect neutrinos?

- Liquid Argon Time Projection Chambers (LAr TPC)
 - Measures the energy and provides a 3-D picture of particle interactions



How do we detect neutrinos?

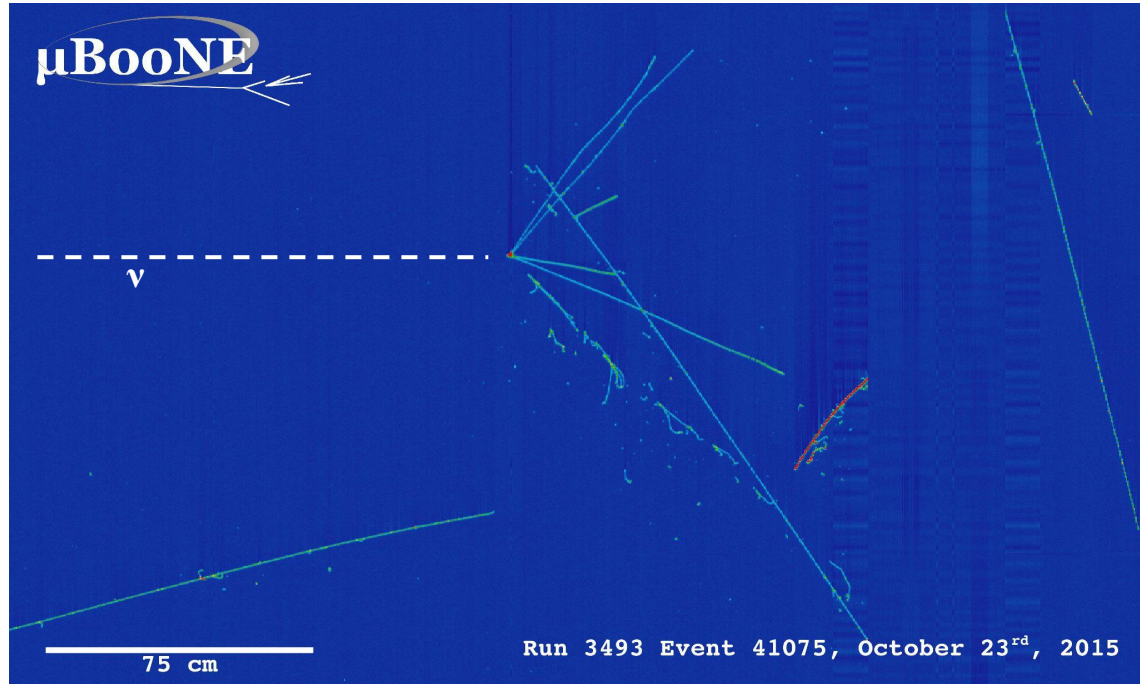
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Wire planes to collect signal in a DUNE TPC

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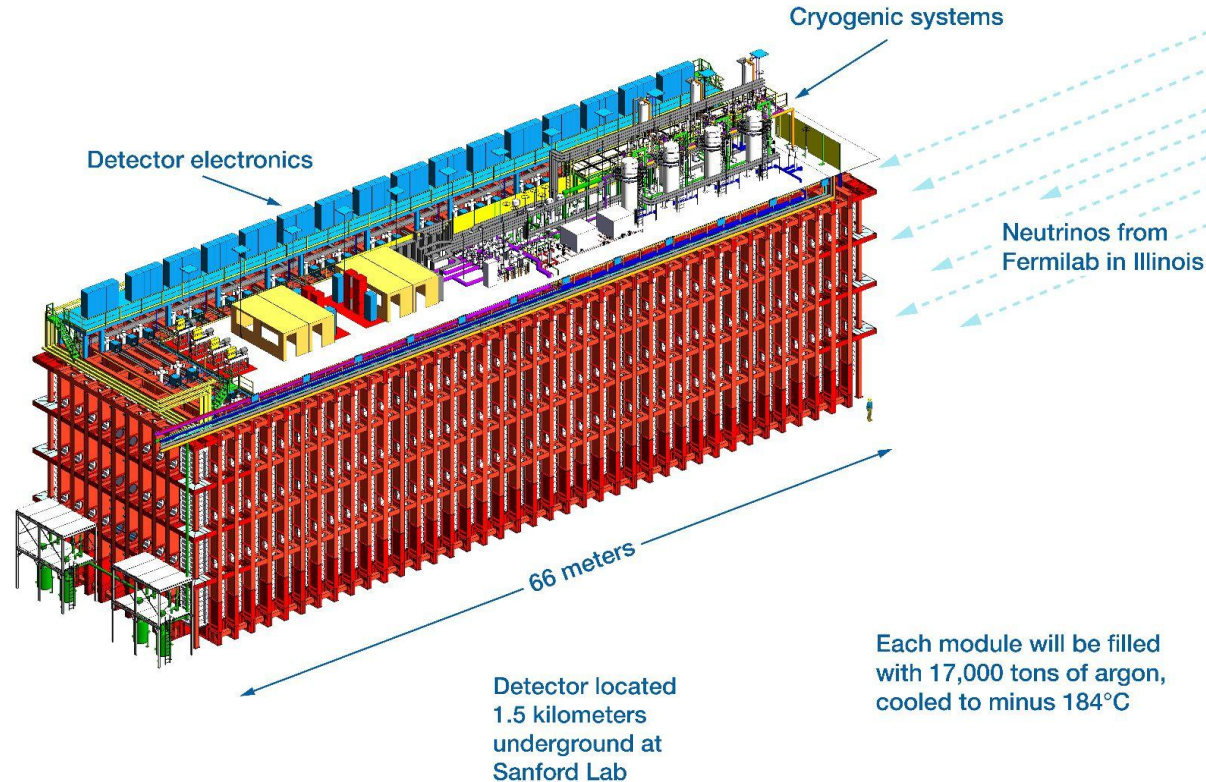
- Liquid Argon Time Projection Chambers (LAr TPC)
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How do we detect neutrinos?

- Liquid Argon Time Projection Chambers (LAr TPC)
 - Measures the energy and provides a 3-D picture of particle interactions
 - Extremely sensitive to neutrino interactions
 - DUNE will have very large TPCs to collect many neutrino interactions

Deep Underground Neutrino Experiment One of four detector modules in South Dakota



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A prototype of DUNE at CERN

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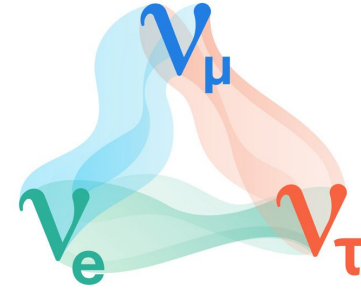
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The cavern in South Dakota that will host the DUNE detectors

Stay tuned for neutrinos at DUNE!

- Neutrinos
 - Fundamental particles that oscillate
 - Can tell us about the matter/antimatter asymmetry in the Universe



- Deep Underground Neutrino Experiment
- Will measure neutrinos and antineutrinos using advanced neutrino detectors (LAr TPCs)

