

What is a Neutrino?

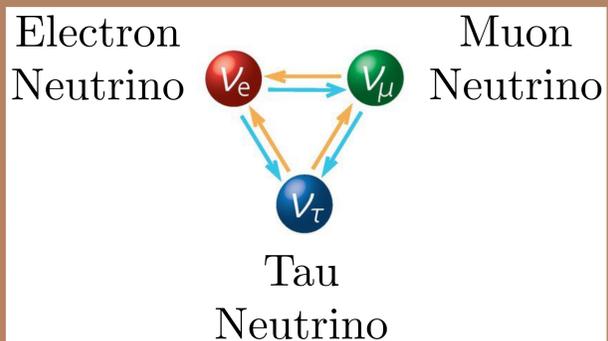
- Means *little neutral one*
- Popularly called a

'Ghost Particle'

- Can pass through through over one light-year of lead
- 7.7×10^7 neutrinos from the Sun travel through your thumbnail every second!

Why Are Neutrinos Important?

Neutrinos undergo a quantum mechanical process called flavor oscillations where a neutrino of definite flavor (type) is produced and later measured as a different flavor. There are three flavors



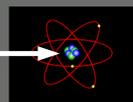
Flavor oscillations might explain the observed matter and anti-matter asymmetry in the Universe i.e. humans.

The Tokai-to-Kamioka (T2K) experiment



EXPERIMENTAL GOALS

- Measure parameters that describe flavor oscillations
- Study nuclear structure

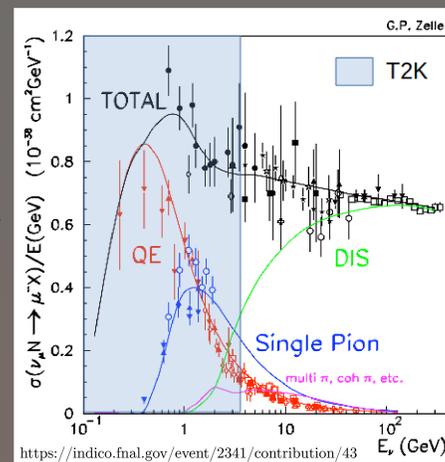


EXPERIMENTAL METHOD

- Produce INTENSE beam of muon neutrinos
- Count how many neutrinos oscillated after traveling 295 km through the Earth's crust

Neutrino-Induced Single Pion Production Cross Section

- **Goal:** measure single pion production (SPP) cross section (interaction strength) at ND280
- **Why:** need better understanding of SPP cross section
- **Application:** a background in T2K electron neutrino appearance measurement

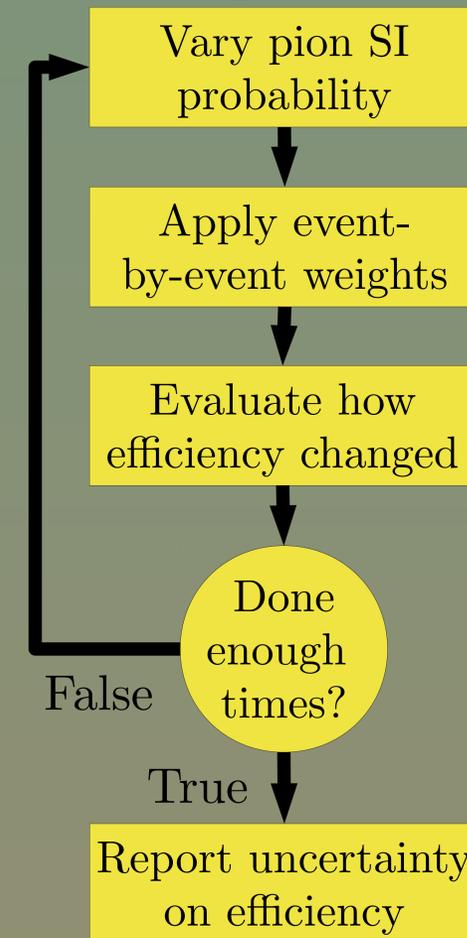


$$\text{Cross Section} = \frac{\text{(number of measured SPP interactions)}}{\left(\frac{\text{measurement efficiency}}{\text{neutrinos per unit area}} \right) \times \left(\frac{\text{number of neutrino targets}}{\text{neutrino targets}} \right)}$$

- **Complication:** important uncertainty on **measurement efficiency** is simulating pion secondary interactions (SI) in ND280

Estimation the Pion SI Systematic

- Event simulation: neutrino interactions to estimate SPP selection efficiency
- For all simulated events with at least one pion:



- **Impact:** Yet to be evaluated
- **Closing:** Complementary analysis in T2K showed that pion SI had an impact as high as 8% on their **measurement efficiency** uncertainty.