ν_e Charged Current Event Identification Based on Shower Energy Profile in LArTPCs

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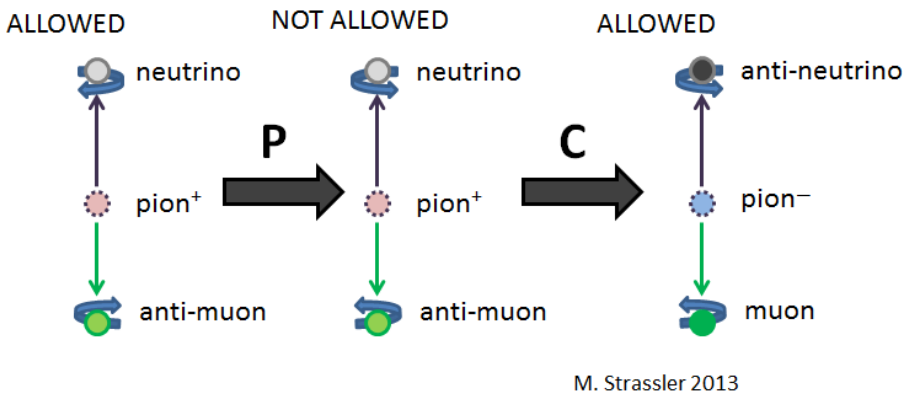
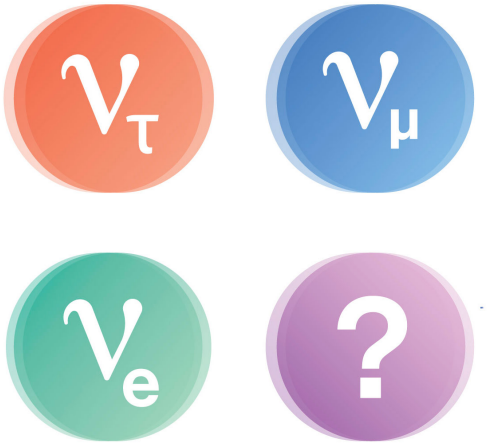
Why do we care about neutrinos?

- Standard Model: Neutrinos have no mass
- Super-Kamiokande/SNO: Neutrino oscillations → Neutrinos have mass
- Neutrinos could give us insight into physics beyond the SM:
  - The matter/antimatter asymmetry in the universe (CP violation)
  - The nature of dark matter (sterile neutrinos)

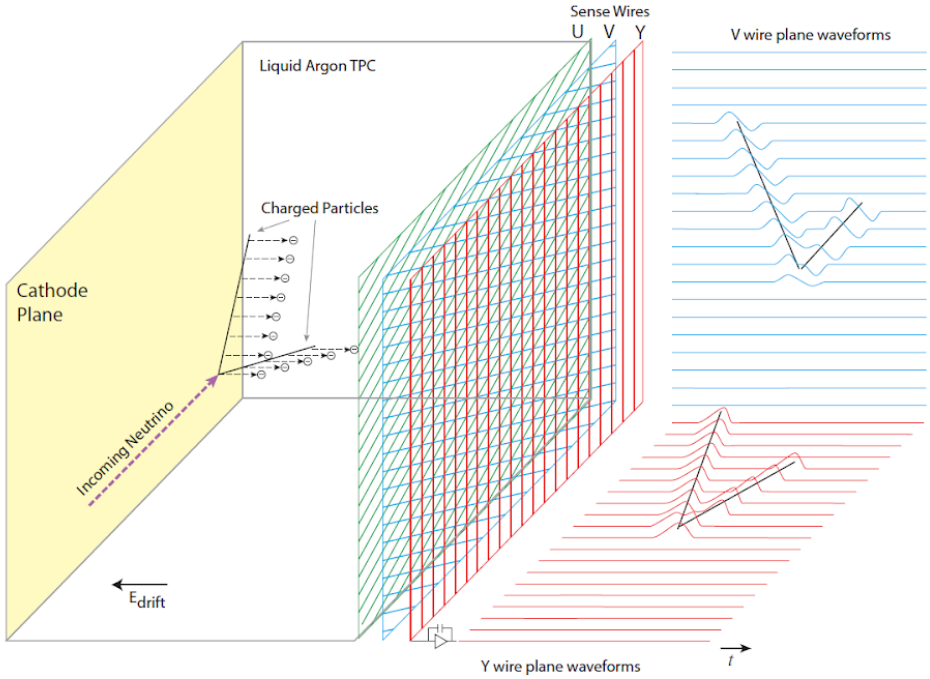


M. Strassler 2013



Liquid Argon Time Projection Chamber (LArTPC)

- Why LArTPC?
  - Sensible to lower energies
  - Provide high-resolution particle track and energy reconstruction
- How does LArTPC work?
  - $\nu_{e,\mu}$ + Ar → particles such as e^-, μ^-, γ, p
  - Charged particles → wires
  - Wires store charge (hits)
  - Photomultiplier tubes store light signals
  - 3D reconstruction for events



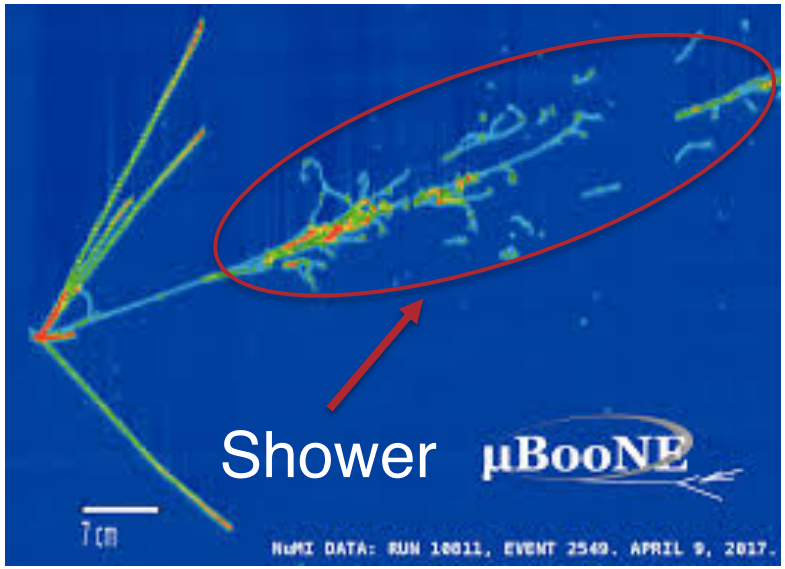
- LArTPC Experiments: MicroBooNE, DUNE, etc.

What is a Charged Current Neutrino Interaction?

- ν_e , ν_μ $(\bar{\nu}_e, \bar{\nu}_\mu)$ Interactions:
  - Neutral current (Z^0): $\nu_e + n \rightarrow \nu_e + n \mid \nu_\mu + n \rightarrow \nu_\mu + n$
  - Charged current $(W^{+,-})$: $\nu_e + n \rightarrow e^- + p \mid \nu_\mu + n \rightarrow \mu^- + p$
- Neutrino oscillations:
  - Change flavor $\nu_\mu \rightarrow \nu_e \mid \bar{\nu}_\mu \rightarrow \bar{\nu}_e$
  - If CC final state identified, then mother neutrino identified
- ν_e CC event important to study oscillations
  - MicroBooNE and DUNE beams contain many $\bar{\nu}_\mu, \nu_\mu$

Shower Profile for ν_e CC Identification

- Showers: group of hits, has branch-like form
- Different particles → different showers
- Use shower profiles ($\frac{dE}{dx}$ or $\frac{dQ}{dx}$) to find mother particle
- Focus on e^- showers. Decide if e^- shower directly from ν_e CC interaction.
- Study $\nu_\mu \rightarrow \nu_e$ oscillation.



Develop this technique based on the shower profile using DUNE FD simulations. We will apply that to other LArTPCs like MicroBooNE