Identifying Standard Candles in Liquid Argon TPC at MeV Energies

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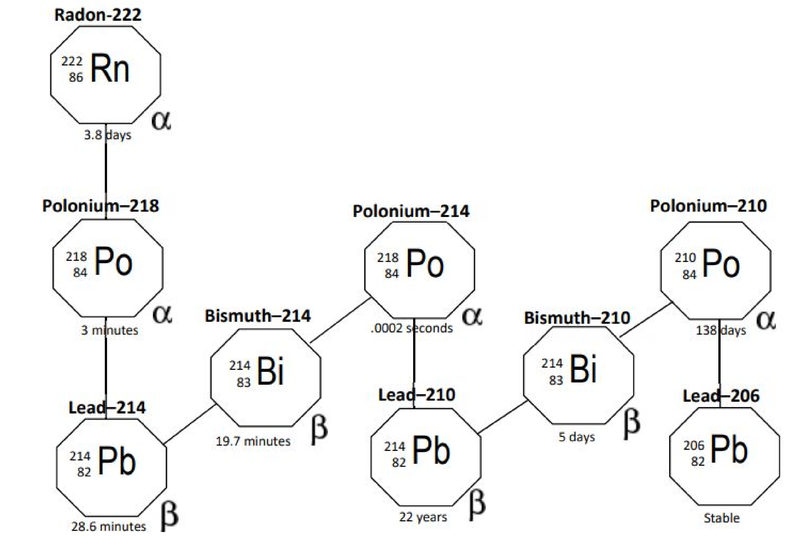
Background

Liquid argon TPCs are neutrino detectors which collect calorimetric and spatial data from ionization electrons created in neutrino collisions with argon nuclei. The purpose of our research is to understand the energy reconstruction of LArTPCs at low energies.

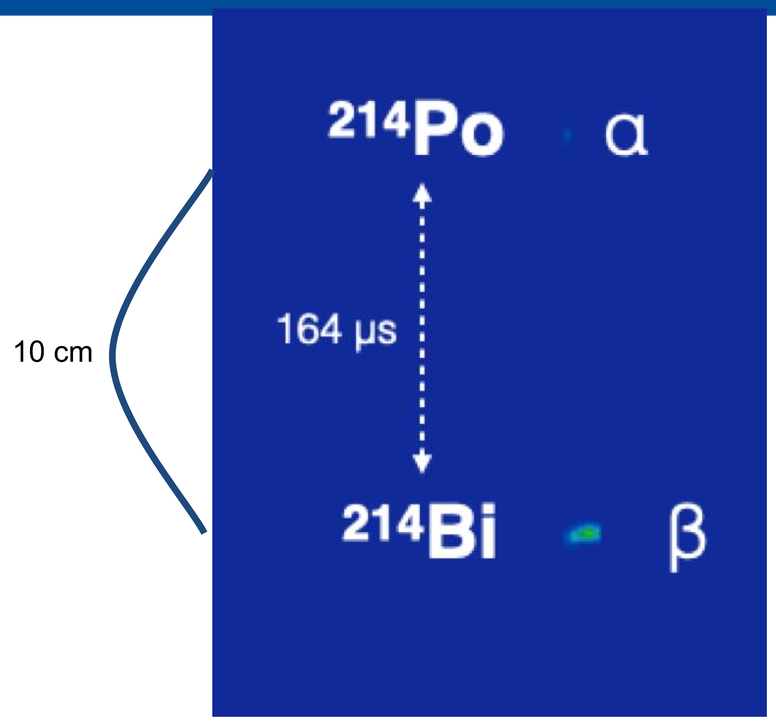
Radon-222 Decay Chain



Radon-222 Decay Chain -Image from EPA
https://www.epa.gov/sites/default/files/2018-12/documents/radon-22-decay-chain.pdf

Methods

The experiment was conducted by injecting the radioactive source Rn-222 into MicroBooNE LArTPC detector and analyzing its unique decay features. Our analysis focused on identifying alphas coming from Po-214 to minimize bias from selecting data



Bi-214 & Po-214 LArTPC Event Display - Image provided by Dr. Joseph Zennamo

Advantages using Rn-222 as a radioactive source:

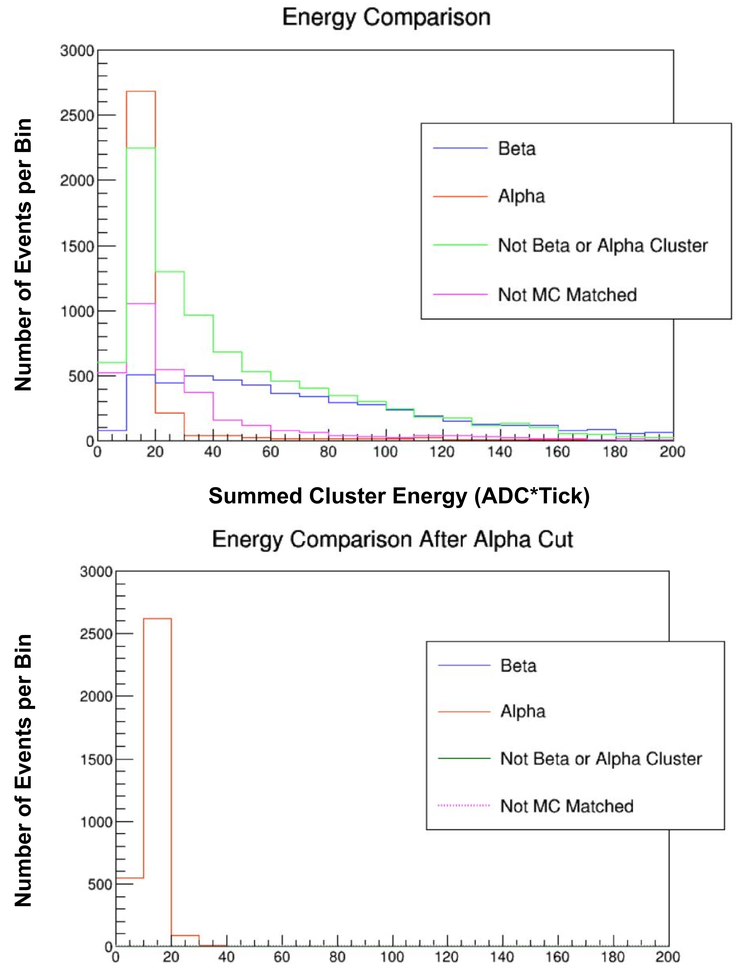
- Many day half life to enable mixing with liquid argon
- Taggable topology driven by short Po-214 half life decay
- Monoenergetic alpha on same channel as beta allows tagging

Results

The cuts were applied to select for unique alpha features such as:

- Narrow Width
- Approximately Gaussian Distribution
- Faint Signal

Applying optimal cuts enables selection to be 99% pure to true alpha particles



(Top) Cluster energy comparison before Alpha selection is applied.
(Bottom) Cluster energy comparison after Alpha selection is applied

Next Steps

The next step is to combine our analysis results together with the spatial resolution of TPCs to select betas without bias by matching them to our selected alphas.This will then allows us to use the betas to measure the TPC energy resolution at the MeV scale.

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