D2O Detector Data Analysis

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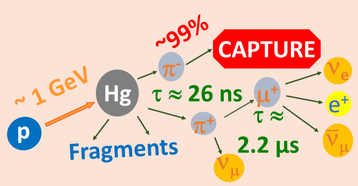
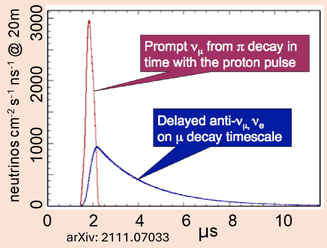
Our Detector

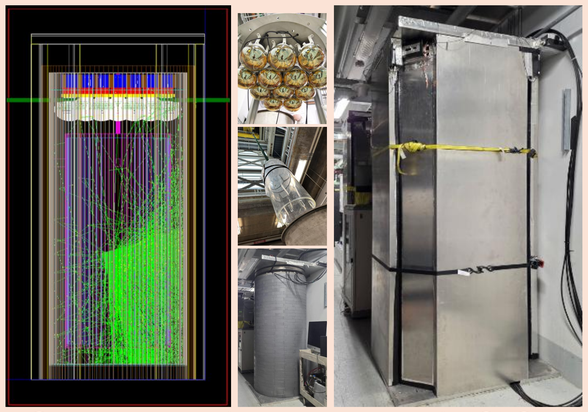
For deployment and performance details, check out Seung Mok's poster #84!

The SNS is the most intense pulsed source of pion-decay-at-rest neutrinos in the world!

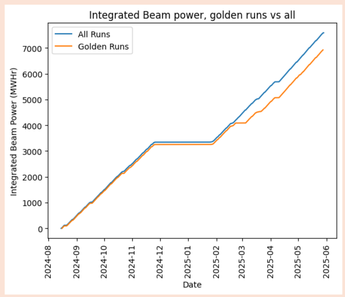




Our heavy water Cherenkov detector is built to measure this neutrino flux to better than 5% uncertainty in two SNS-years of data taking.



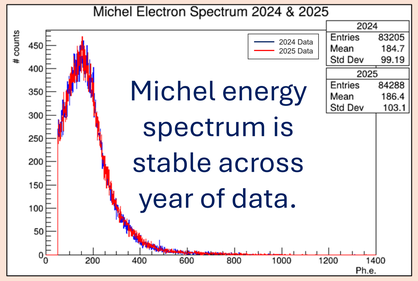
Current theoretical models predict SNS ν flux with 10% uncertainty.

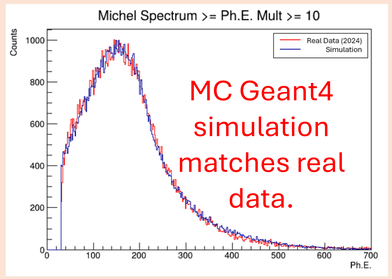


We have analyzed one SNS-year of data so far, for the period from August 2024 to May 2025.

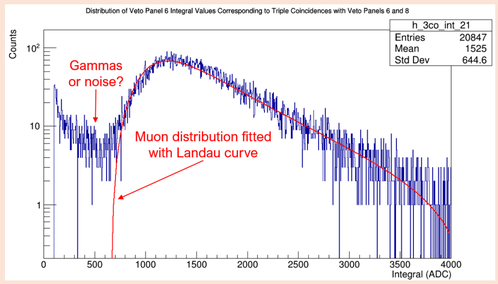
Detected Signals

Michel electrons, muons, steady-state background, and beam-related neutrons.

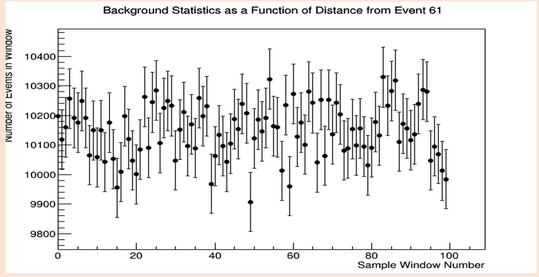




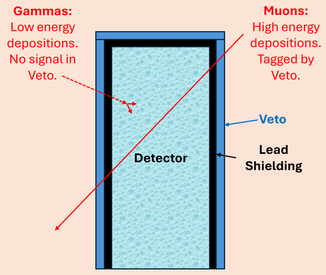
Michel electrons have a similar energy spectrum to pion-decay-at-rest neutrinos, so we use them as a signal proxy.



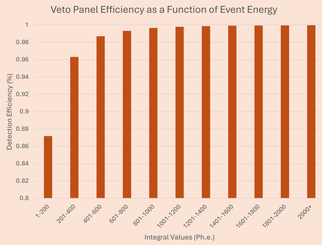
We see cosmic muons traveling through detector.



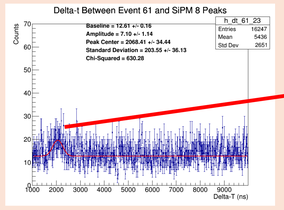
We sample the steady-state background (SSB) between beam spills.

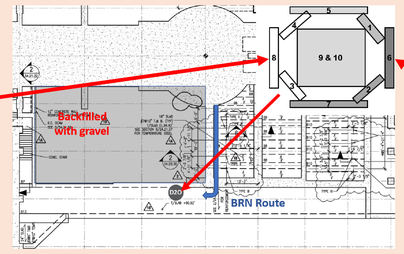


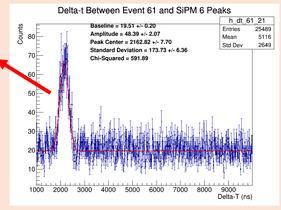
We count how many events are detected in the veto panels vs in the PMTs, and we find veto system has an efficiency of 99.95%!



We detect directional flux of beam-related neutrons (BRNs) in veto system.

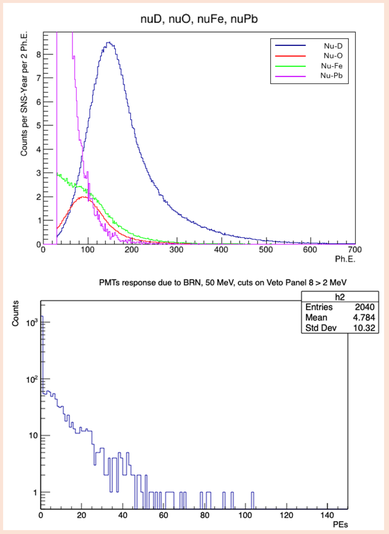






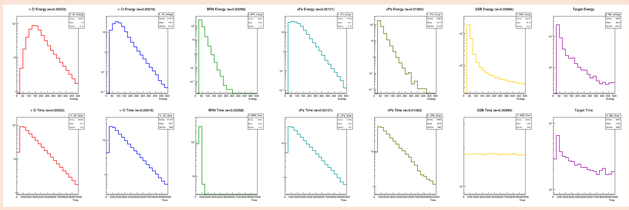
Predicted ν Spectrums

We are nearly ready to unblind!

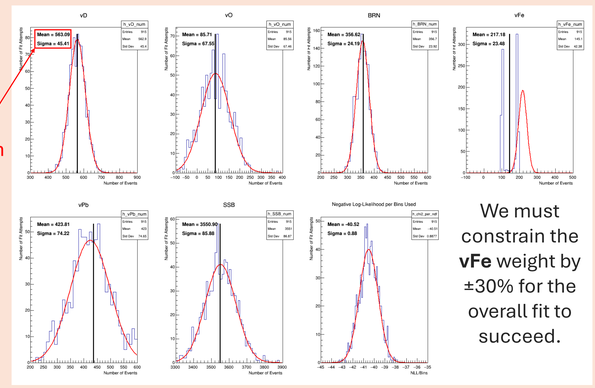


We expect to see **vFe** and **vPb** events in our detector, in addition to **vD** and **vO** events.

The **vD** spectrum is well known, but the **vO** and **vPb** cross sections have never been measured in this energy range before!



We simulate neutrino and BRN data, and sample the real SSB data, then fill a target with the expected number of each event.



We must constrain the **vFe** weight by ±30% for the overall fit to succeed.

We fit the neutrino, BRN, and SSB data to the target via Negative Log-Likelihood minimization.

R. M. et al., "Neutrino spectroscopy with karmen," Progress in Particle and Nuclear Physics, vol. 40, pp. 183–192, 1998, Neutrinos in Astro, Particle and Nuclear Physics, issn: 0146-6410.