Study of Reactor Antineutrino Interaction via Neutron Capture on Hydrogen Using RENO Data

The RENO collaboration has measured the amplitude and frequency of reactor antineutrino oscillations. Recently, we published an updated result on the reactor antineutrino oscillation parameters using neutron capture on Gadolinium (n-Gd) using a full 3800-day dataset. The antineutrinos can also be detected via the inverse beta-decay process and subsequent neutron capture on Hydrogen (n-H). The measurement of the parameters using the n-H channel can be conducted independently of the n-Gd channel, allowing a cross-check of consistency with the n-Gd channel result. In this poster, we present the current status of the n-H data analysis.

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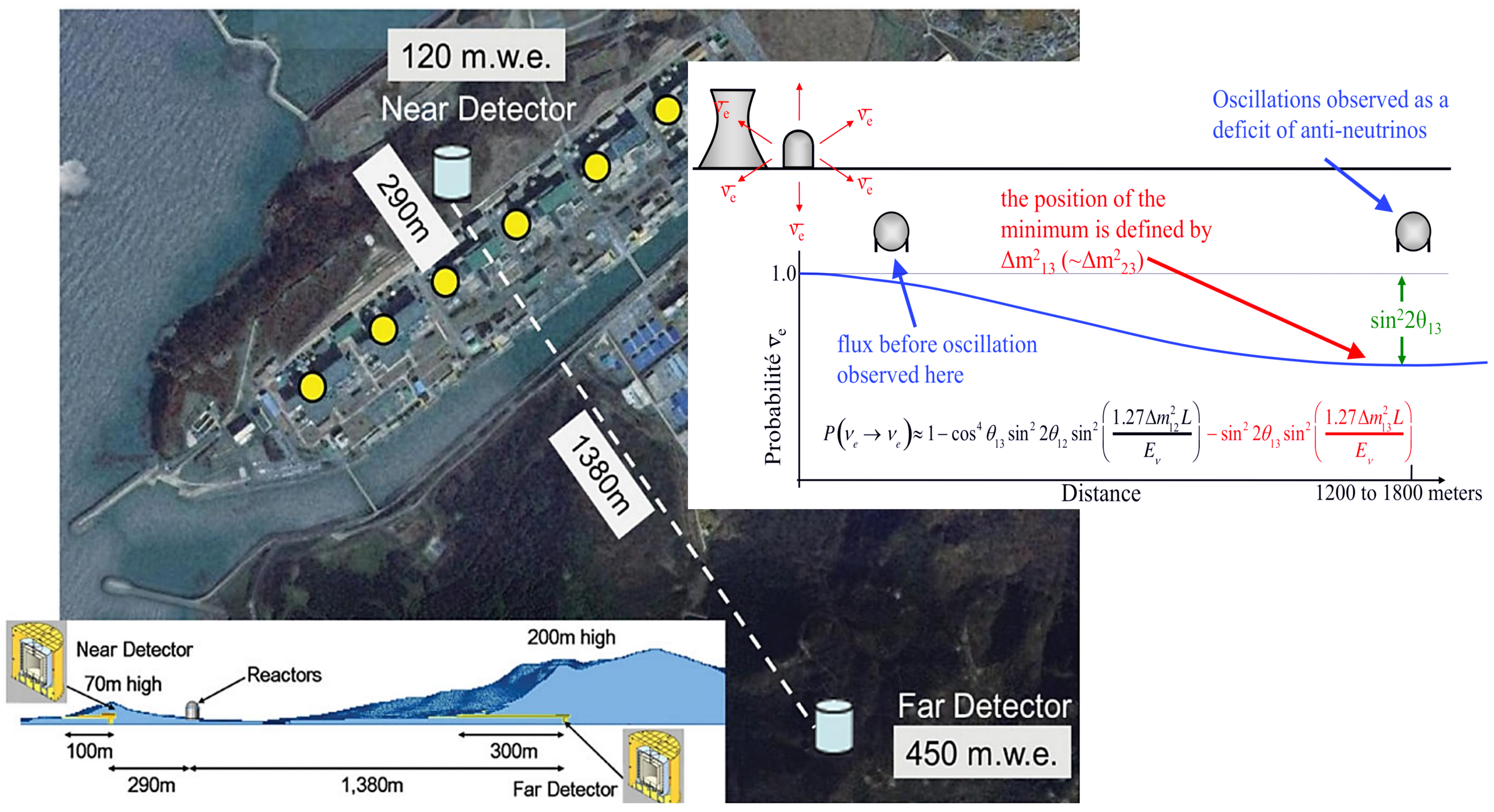
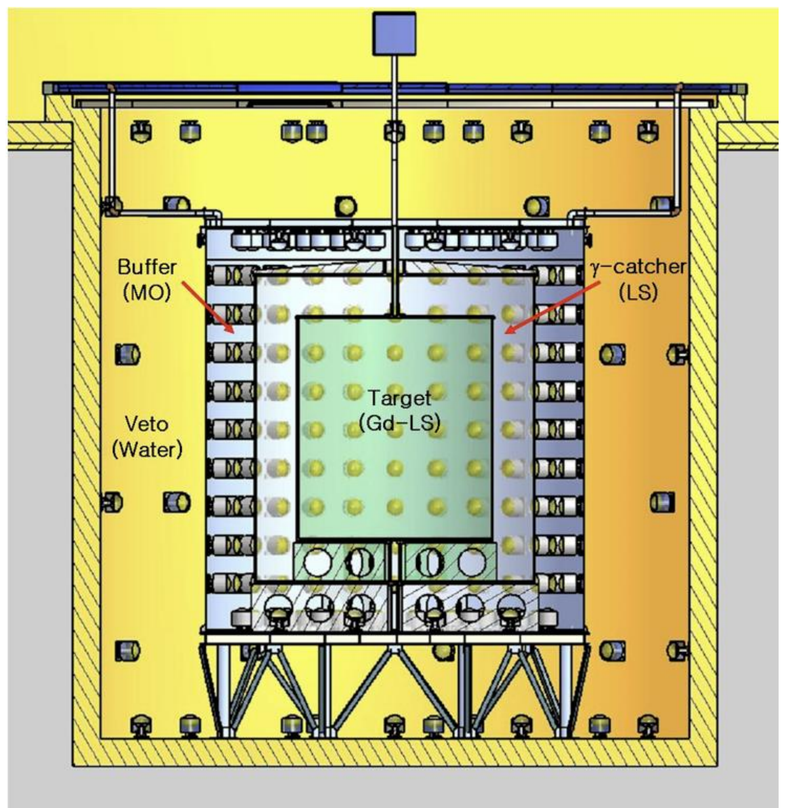
on behalf of RENO Collaboration

Reactor Experiment Neutrino Oscillation



- The RENO experiment aims to measure **the smallest neutrino mixing angle, θ_{13}**, using reactor antineutrinos.
- **Two identical detectors** are located **at far and near sites** around Hanbit nuclear power plant in Yeounggwang, Korea.
- **The use of identical detectors reduces systematic uncertainties and enables a model-independent measurement.**

Detector

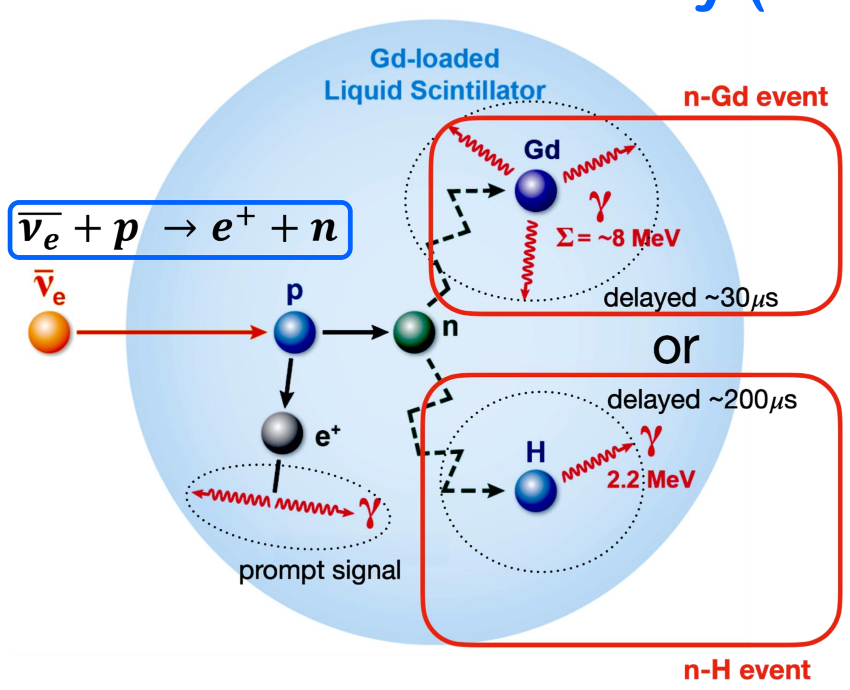


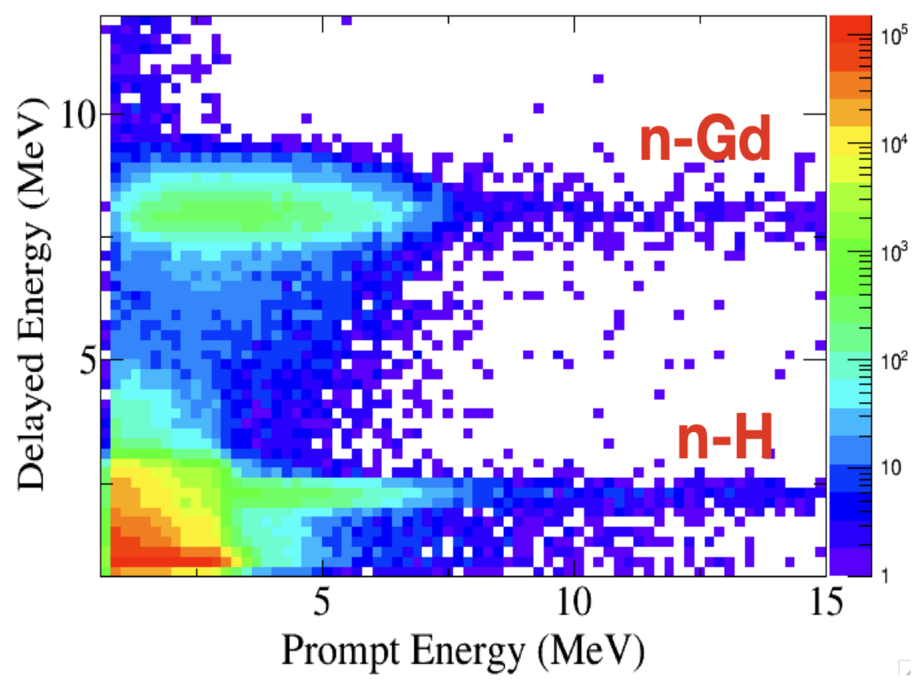
Two identical detectors.

- Inner detector (ID).
  - Monitored by 354 low-background 10" PMTs
  - 16.5-ton **0.1 % Gd-loaded liquid scintillator (LS) target**.
  - 30-ton cylindrical **LS gamma catcher**.
  - 65-ton mineral oil buffer to protect the internal scintillating volume.
- Outer detector (OD).
  - Monitored by 67 10" PMTs
  - 350-ton purified water tank for cosmic muon-related backgrounds.

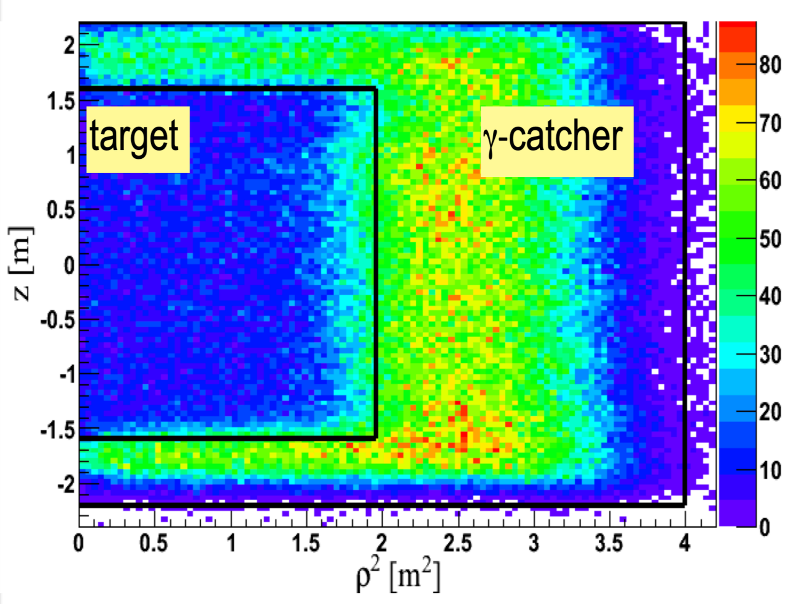
Detection method

Inverse Beta Decay (IBD) & neutron capture





The n-H channel

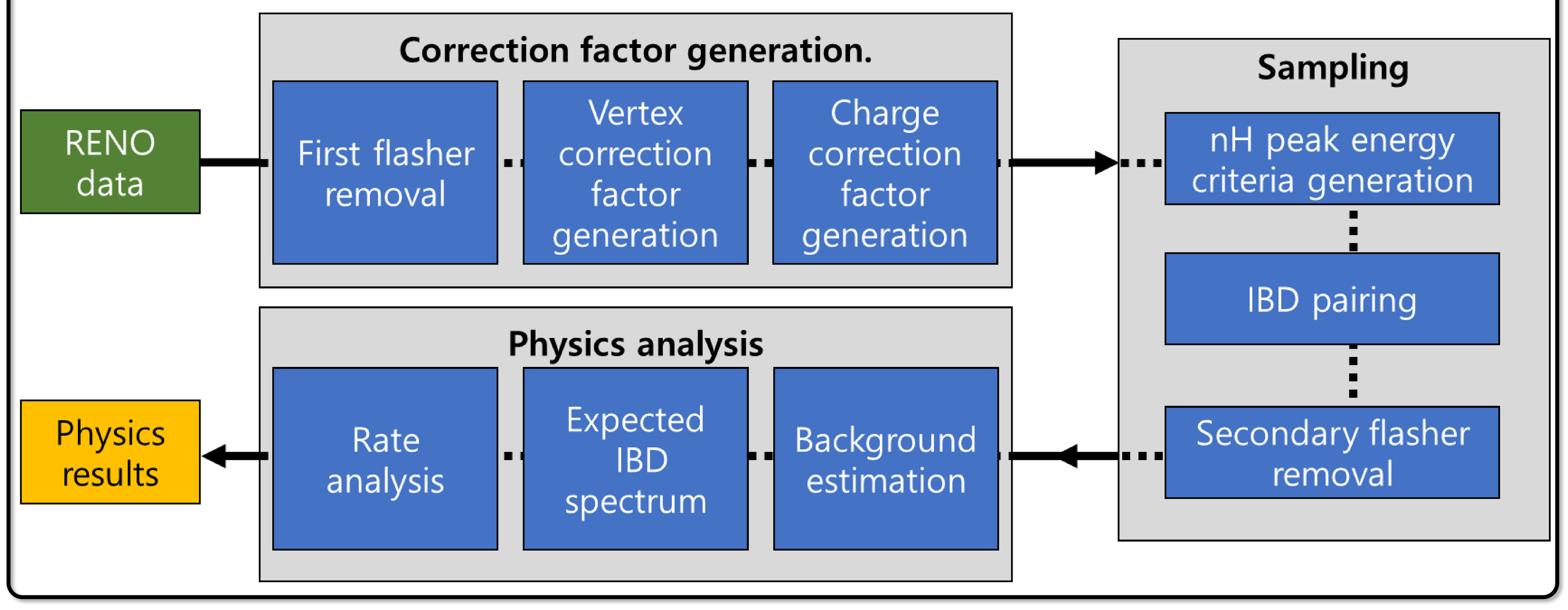


- **2.223 MeV single gamma ray**.
- Mainly in **the G.C region**.
- **High ambient background levels.** (especially < 3.5 MeV)
- **~ 2.3 × more IBD events expected.** (theoretically)
  - ∟ **Larger interaction target volume.**
    - contains ~ 2.8 × more free protons.
  - ∟ **Smaller neutron capture cross-section.**
    - ~ 10^{-5} × that of the n-Gd channel

=> An **n-Gd-independent** θ_{13} measurement.

=> **Cross-check of consistency** with the n-Gd channel result.

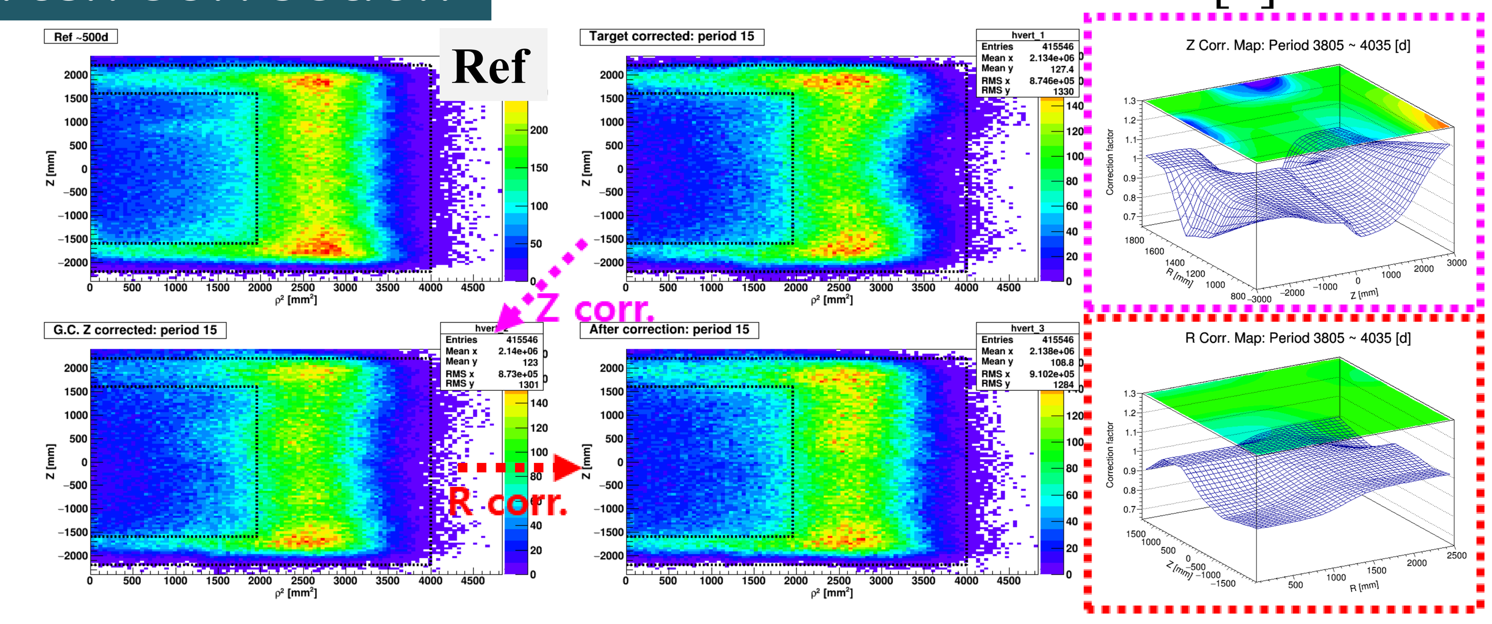
Analysis Pipeline

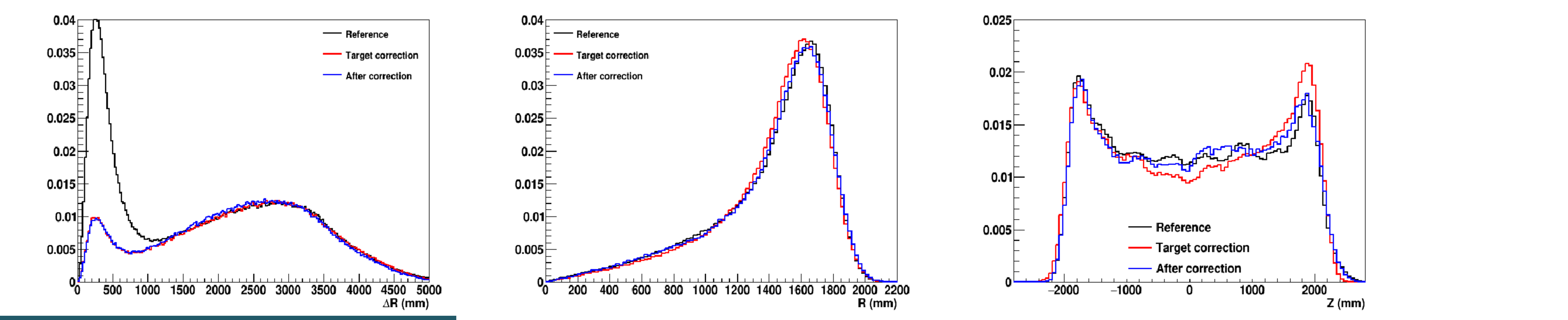


Analysis status

Vertex correction

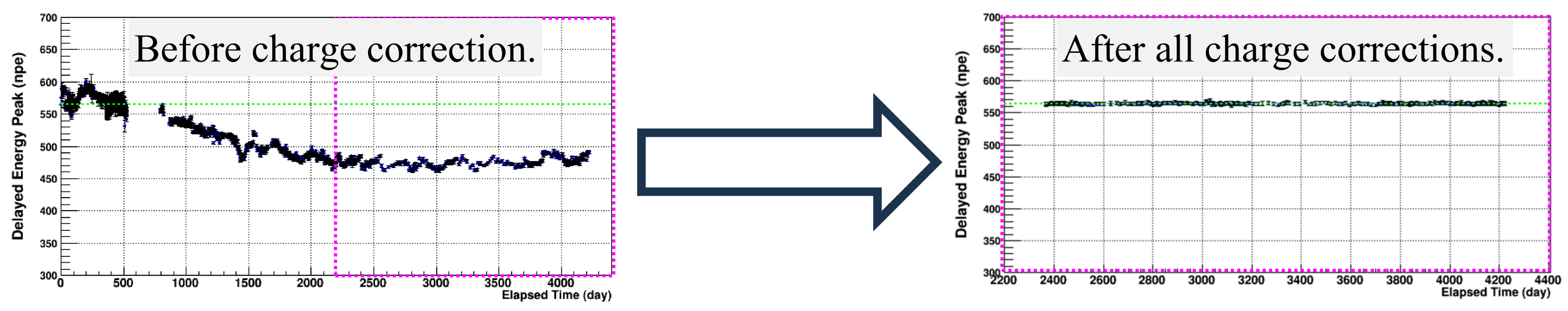
- Near detector: 3805 – 4035 [d]



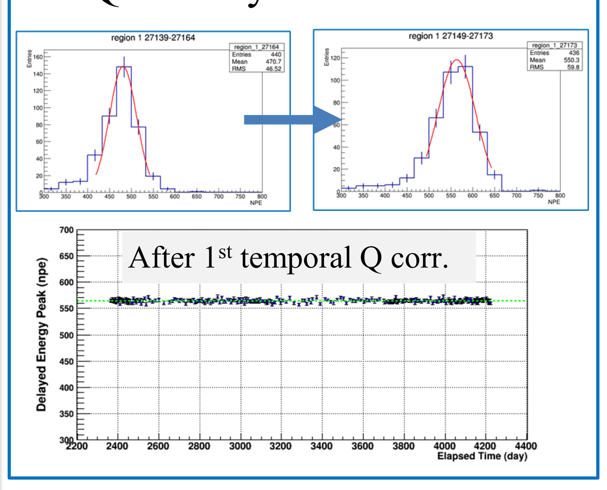


Charge correction

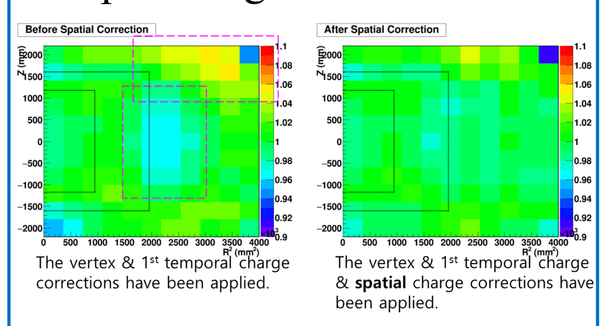
- Three procedures: 1st temporal, spatial, and 2nd temporal charge corrections.



1st temporal Q corr.
- Q corr. by ref / mean.

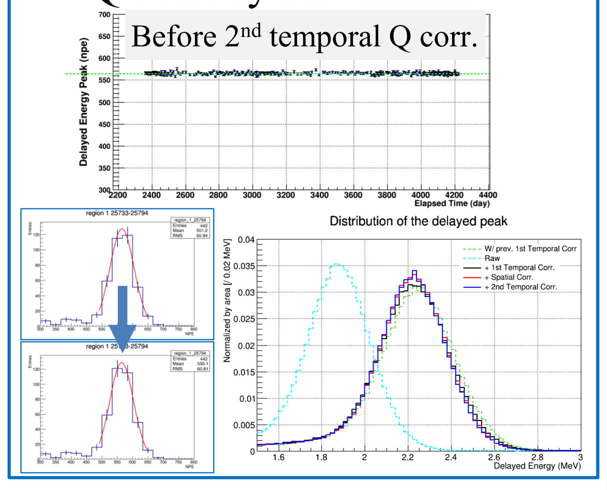


Spatial Q corr.
- Q corr. by ref / mean per spatial region.



The spatial charge correction yields **more uniform S2 charge distribution**.

2nd temporal Q corr.
- Q corr. by ref / mean.



Plan

- **Finalizing stage 1.**
- Full analysis planned **for completion by the end of the year**.

Analysis Pipeline		Progress		Schedule
		Near	Far	
Correction	1st flasher removal	v	v	By the end of July
	Vertex correction factor gen.	v	v	
	Charge correction factor gen.	v	v	
Sampling	nH peak energy criteria gen.	->	->	
	IBD pairing			
	2nd flasher removal			
Analysis	Background estimation			By the end of December
	Expected IBD spectrum			
	Rate analysis			

Summary

- The RENO experiment aims to measure the smallest neutrino mixing angle θ_{13} using reactor antineutrinos.
- The first stage of the analysis pipeline is currently being finalized.
- **Our goal is to complete and share the θ_{13} measurement result using the n-H channel with the entire 3800-day dataset by the end of the year.**

K-Neutrino Symposium 2025 @ CAU