Overview of RENO/RENE

Byeongsu Yang (CNU)
On behalf of RENO/RENE collaborations

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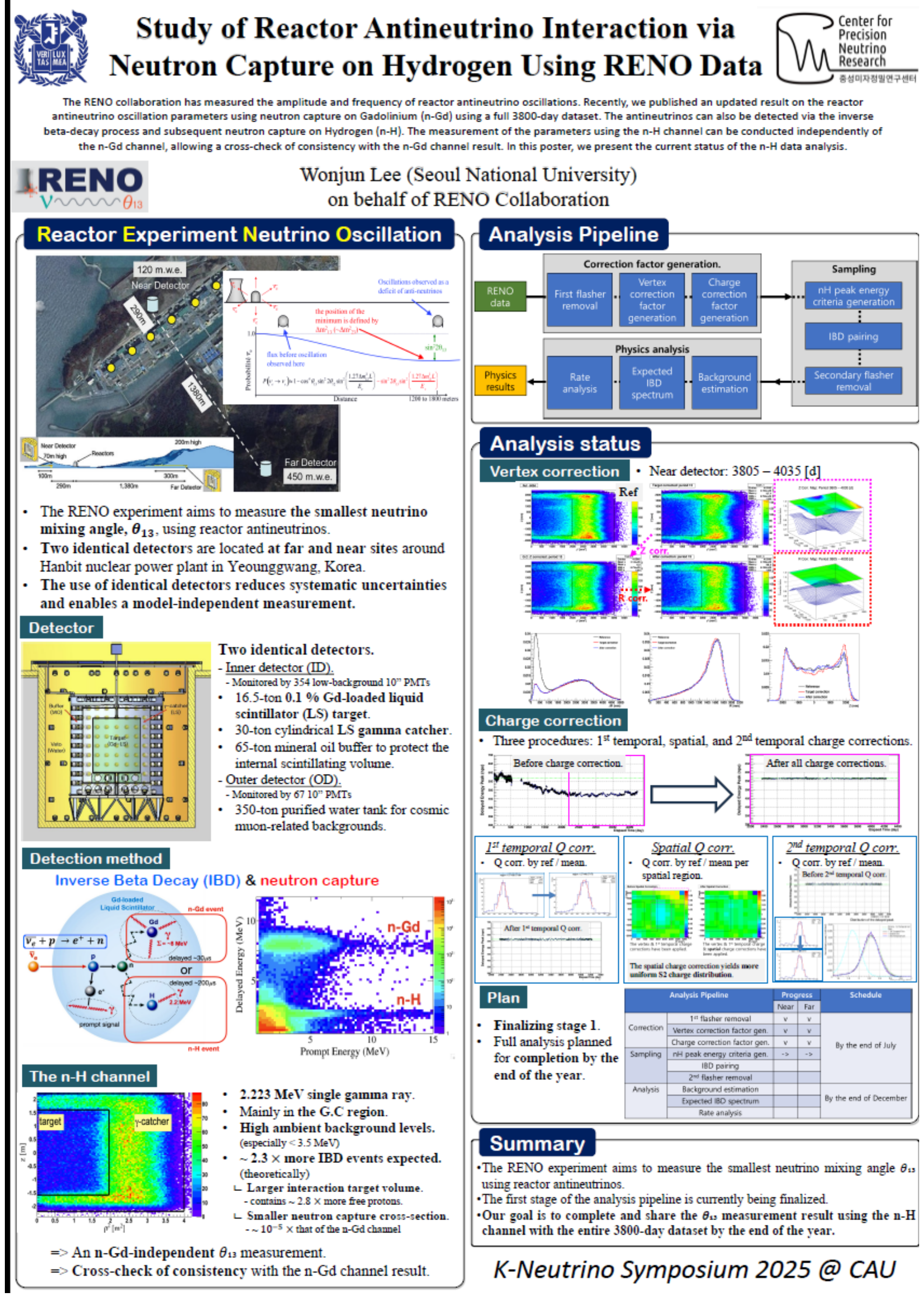
K-Neutrino Symposium 2025

Chung-Ang University, Seoul, Korea


Overview of the RENO and RENE Experiments
YANG Byeongsu
On behalf of RENO and RENE Collaboration
Introduction
RENO Experimental Setup
RENE Experimental Setup
Physics goal
RENO
Reactor Experiment for Neutrino Oscillation
RENE
Reactor Experiment for Neutrino and Exotics
To confirm the allowed regions, need to improve energy resolution and systematics.
Collaboration
8 Institutes and 30 Physicists
Chonnam National University
Dongshin University
Gwangju Institute of Science and Technology
Gyeongsang National University
Kyungpook National University
Seoul National University
Seoyeong University
Sungkyunkwan university
11 institutions & about 30 members
Time Line
Start of project: 2006
RENO DAQ running Aug. 2011~ Mar. 2023 3800 days livetime
Recently, started re-operating DAQ of the near detector. →RENE experiment
Physics results of RENO
Precise measurement of $|\Delta m^2_{ee}|$ and θ_{13}
Phys. Rev. Lett. 108, 191802 (2012) - 229[d]
Phys. Rev. Lett. 116, 211801 (2016) - 500[d]
Phys. Rev. D 98, 012002(2018) - 500[d]
Phys. Rev. Lett. 121, 201801 (2018) - 2200[d]
Phys. Rev. D 11, 112006 (2025) - 3800[d]
Measurement of θ_{13} with nH capture
JHEP 04 029 (2020) - 1500[d]
2800[d] days of data
Reactor neutrino yield & spectrum
Phys. Rev. Lett. 122, 232501 (2019) - 1800[d]
Phys. Rev. D 104, L111301 (2021) - 2900[d]
Results from sterile neutrino search
Phys. Rev. Lett. 125, 191801 (2020) - 2200[d]
Phys. Rev. D 105, L111101 (2022) - 2500[d] x NEOS 180[d]


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.
Wonjun Lee (Seoul National University)
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.
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.
=> An n-Gd-independent θ_{13} measurement.
=> Cross-check of consistency with the n-Gd channel result.
Analysis Pipeline
Analysis status
Vertex correction
Charge correction
Plan
Finalizing stage 1.
Full analysis planned for completion by the end of the year.
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.
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청주
대전
경상북도
Yeonggwang
전주
대구
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한빛원자력본부
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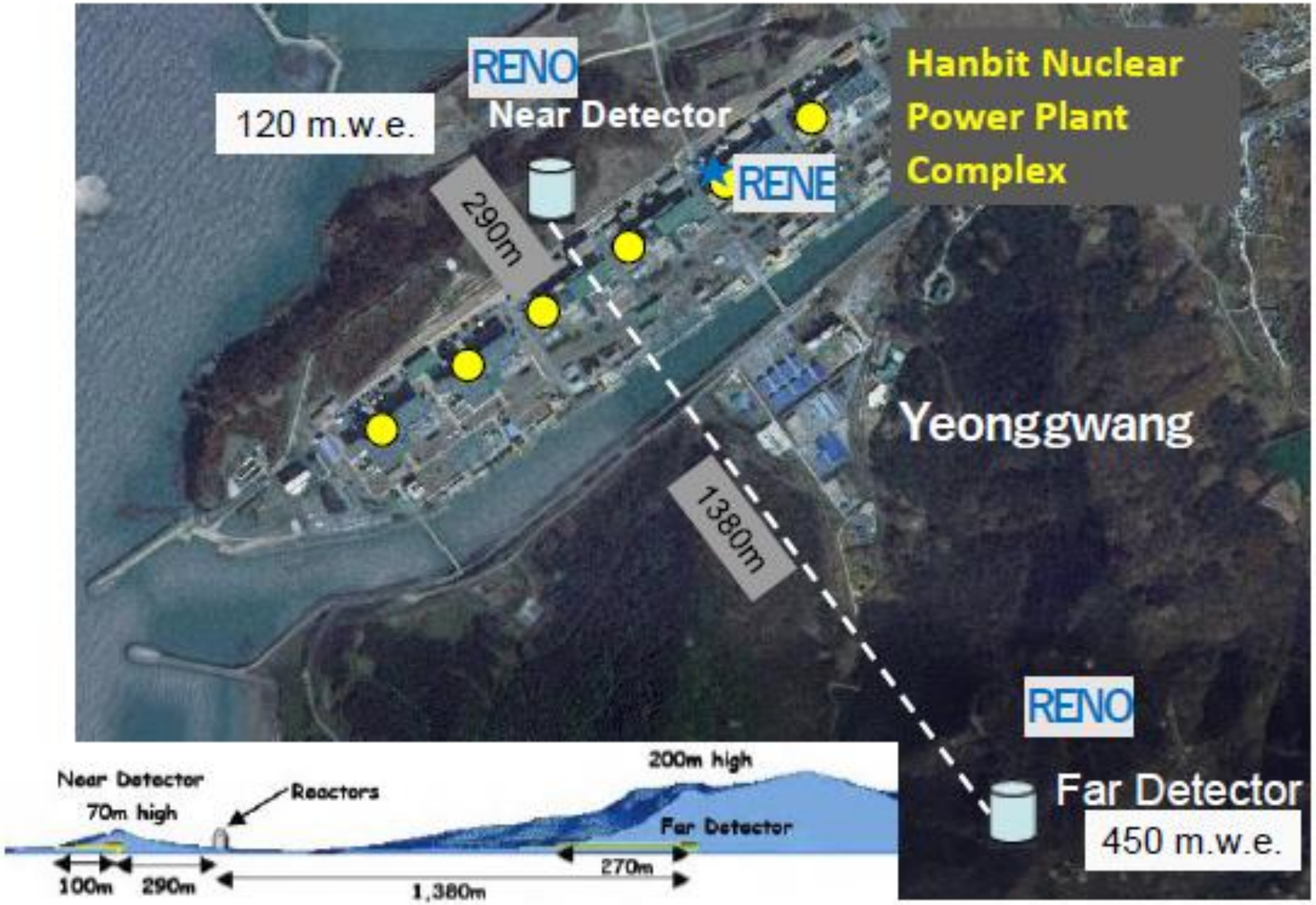
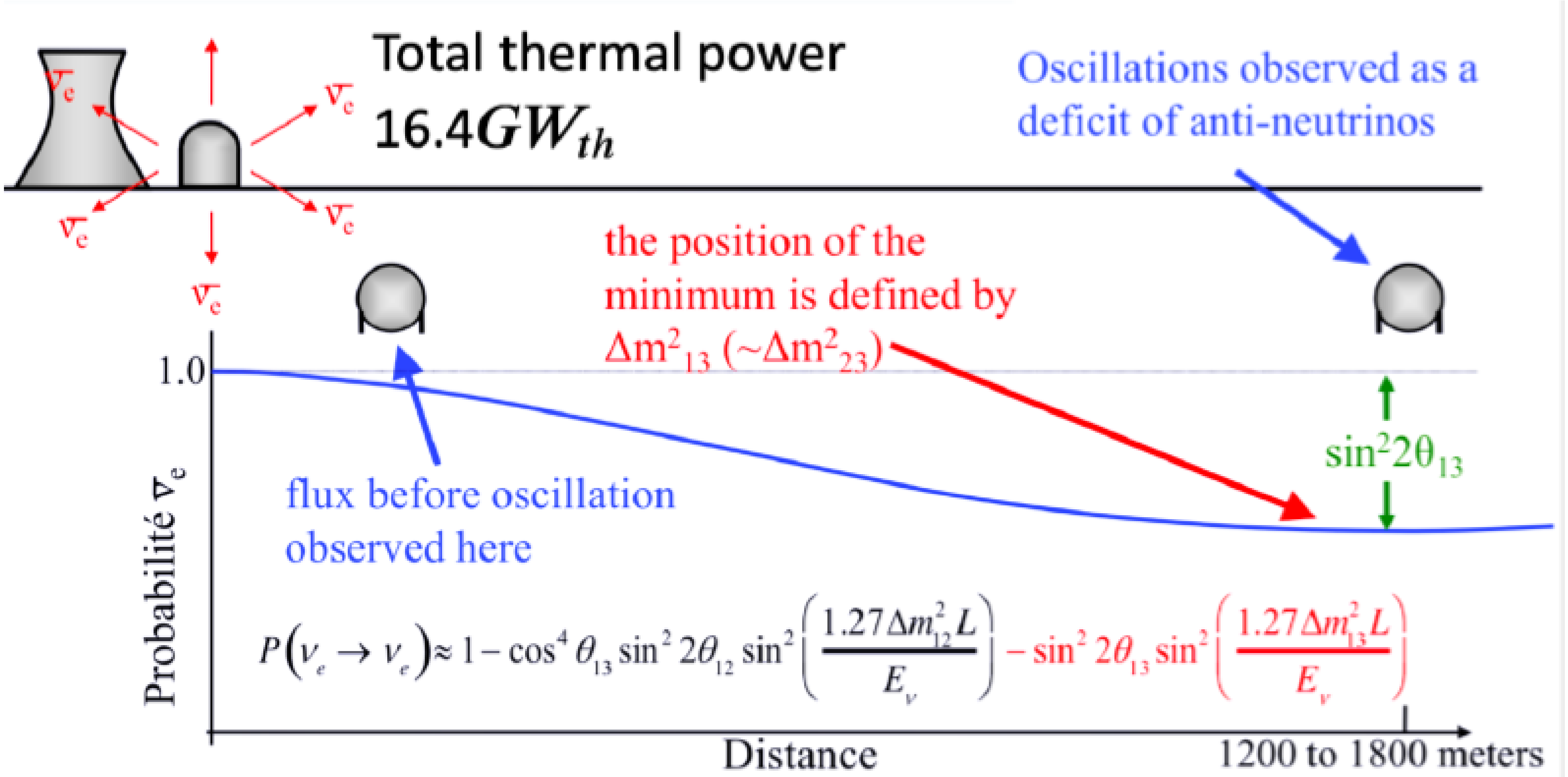

RENO
Near Detector
120 m.w.e.
290m
RENE
Hanbit Nuclear
Power Plant
Complex
Yeonggwang
1380m
RENO
Far Detector
450 m.w.e.
Near Detector
70m high
Reactors
200m high
Far Detector
100m
290m
1,380m
270m

RENO
Reactor Experiment for Neutrino Oscillation

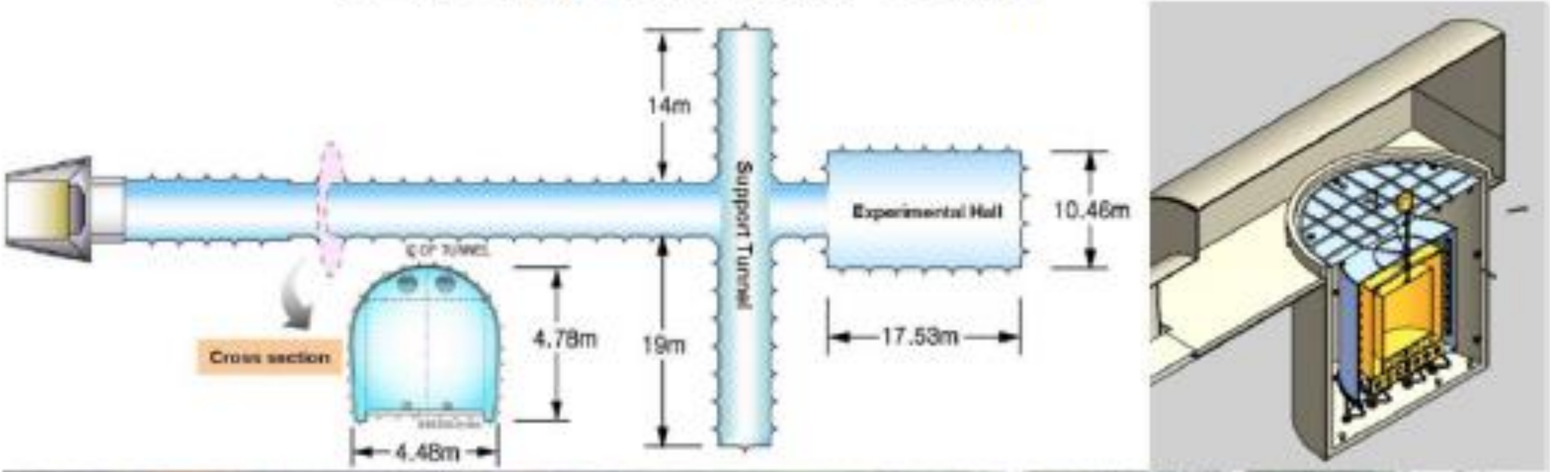


The current RENO collaboration

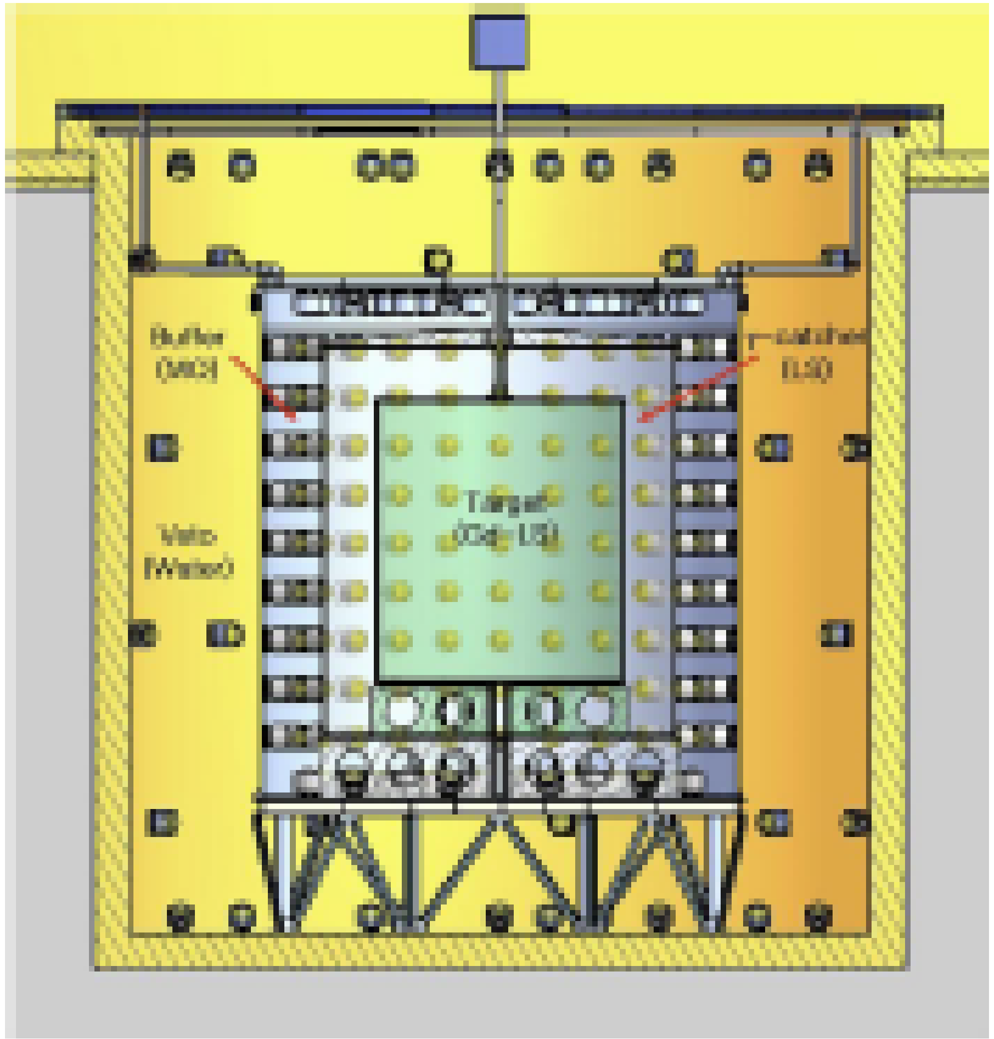
8 Institutes and 30 Physicists

Chonnam National University
Dongshin University
Gwangju Institute of Science and Technology
Gyeongsang National University
Kyungpook National University
Seoul National University
Seoyeong University
Sungkyunkwan university

RENO Experimental Setup



Detector



Two identical detectors.

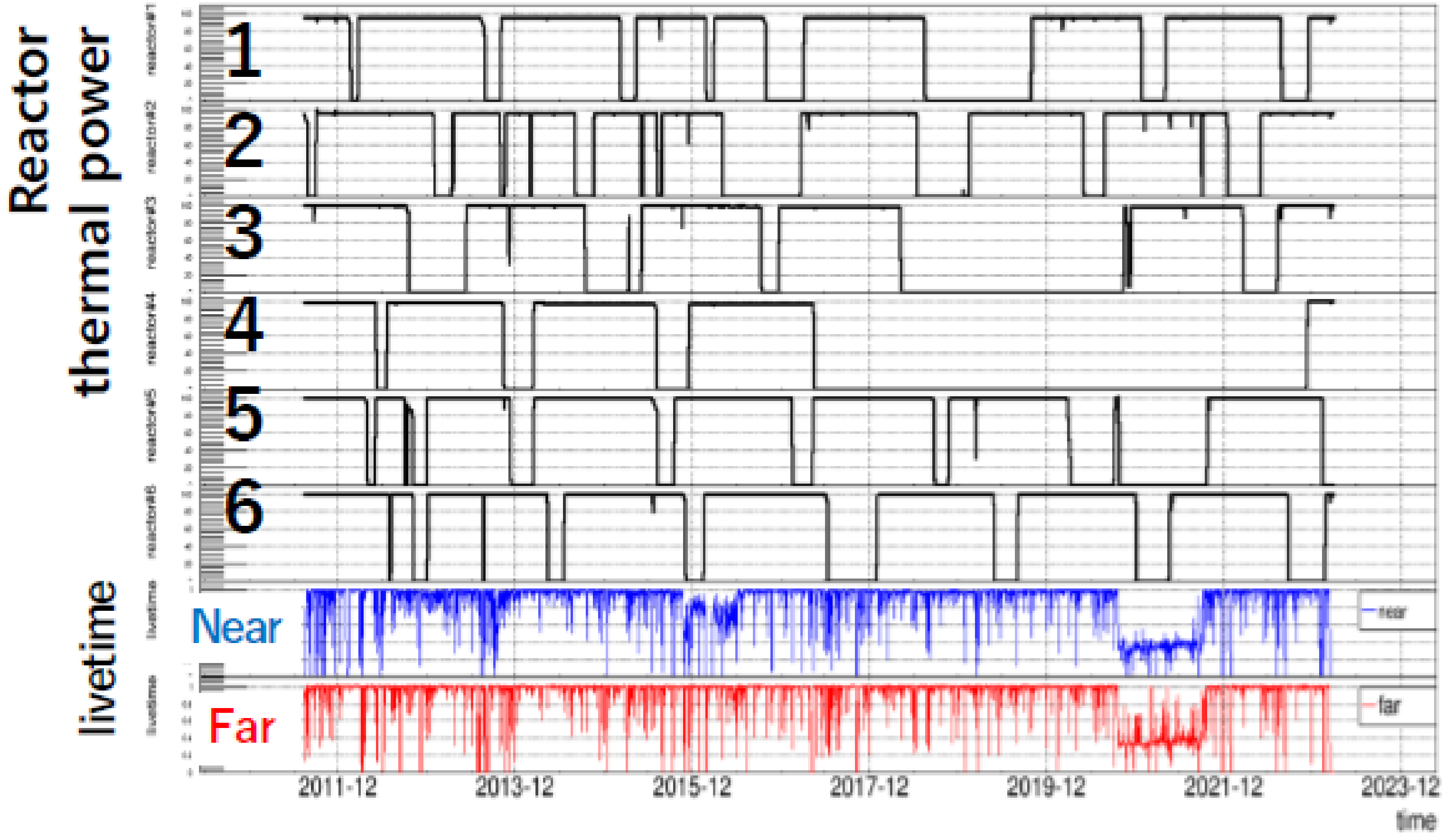
- <u>Inner detector (ID).</u>
  - Monitored by 354 low-background 10" PMTs
- 16.5-ton 0.1 % Gd-loaded liquid scintillator (LS) target.
- 30-ton cylindrical LS gamma catcher.
- 65-ton mineral oil buffer to protect the internal scintillating volume.

- <u>Outer detector (OD).</u>
  - Monitored by 67 10" PMTs
- 350-ton purified water tank for cosmic muon-related backgrounds.

RENO Time Line

- Start of project: 2006
- RENO DAQ running
  Aug. 2011~ Mar. 2023
  3800 days livetime

- Recently, started re-operating DAQ of the near detector.
  →RENE experiment



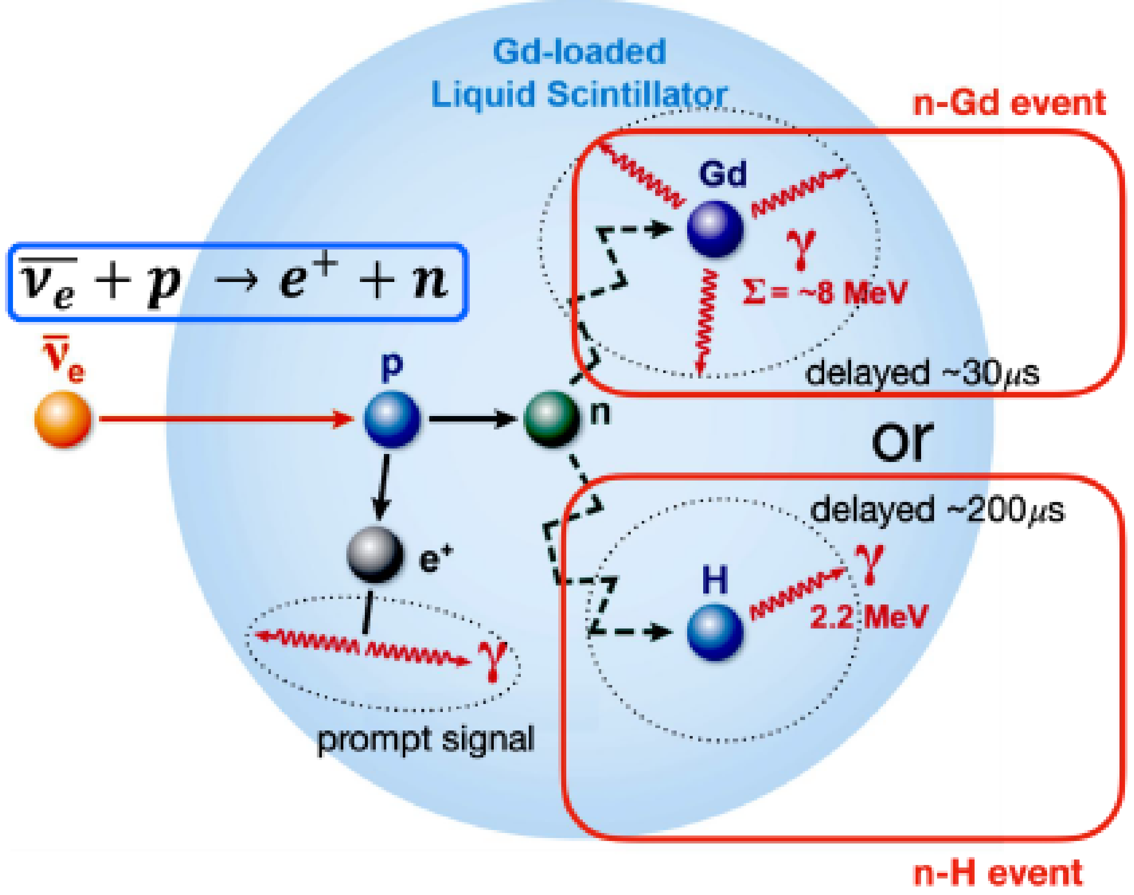
RENO Major Results

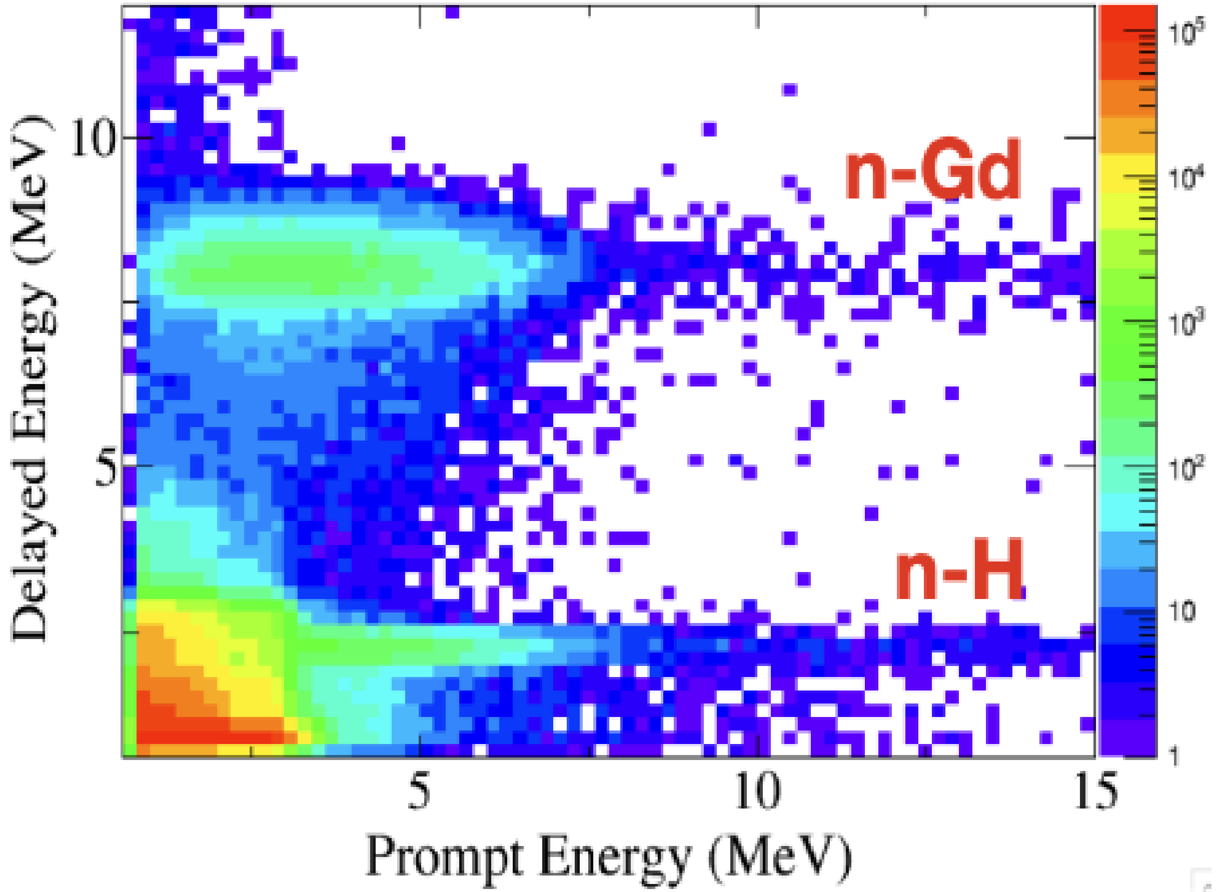
- Precise measurement of $|\Delta m^2_{ee}|$ and θ_{13}
  - Phys. Rev. Lett. 108, 191802 (2012) - 229[d]
  - Phys. Rev. Lett. 116, 211801 (2016) - 500[d]
  - Phys. Rev. D 98, 012002(2018) - 500[d]
  - Phys. Rev. Lett. 121, 201801 (2018) - 2200[d]
  - Phys. Rev. D 11, 112006 (2025) - 3800[d]
- Measurement of θ_{13} with nH capture
  - JHEP 04 029 (2020) - 1500[d]
  - 2800[d] days of data

- Reactor neutrino yield & spectrum
  - Phys. Rev. Lett. 122, 232501 (2019) - 1800[d]
  - Phys. Rev. D 104, L111301 (2021) - 2900[d]
- Results from sterile neutrino search
  - Phys. Rev. Lett. 125, 191801 (2020) - 2200[d]
  - Phys. Rev. D 105, L111101 (2022) - 2500[d] x NEOS 180[d]

Detection method

Inverse Beta Decay (IBD) & neutron capture



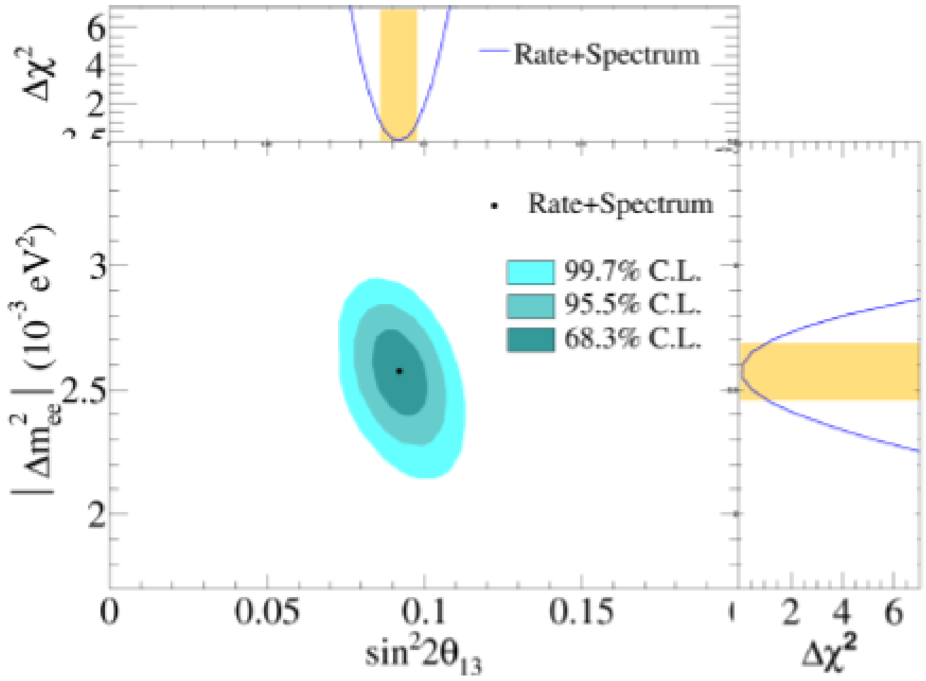


RENO Recent Result by nGd

Phys. Rev. D 11, 112006 (2025) - 3800[d]

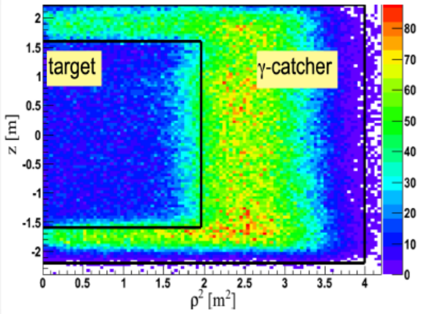
$\sin^2 2\theta_{13} = 0.0920^{+0.0044}_{-0.0042}\,(stat.)^{+0.0041}_{-0.0041}(syst.)$ (6.4% precision)

$|\Delta m^2_{ee}| = 2.57^{+0.10}_{-0.11}(stat.)^{+0.05}_{-0.05}(syst.)\ (\times 10^{-3}\ \mathrm{eV}^2)$(4.5% precision)



RENO on-going analysis: nH

The n-H channel

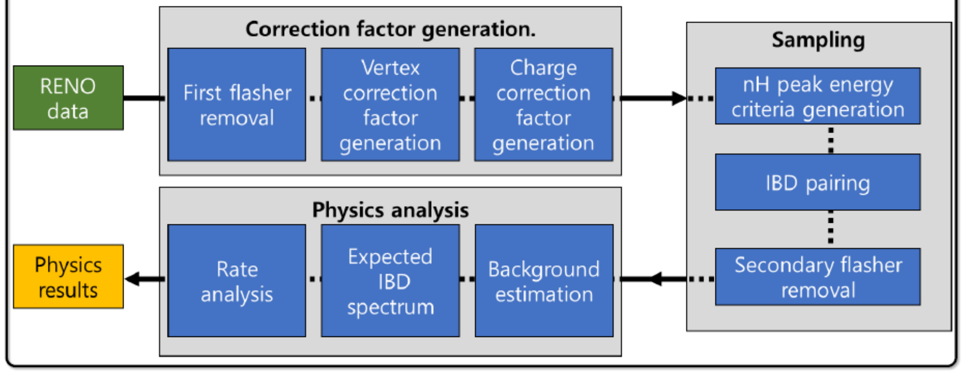


- **2.223 MeV single gamma ray**.
- Mainly in **the G.C region**.
- **High ambient background levels.** (especially < 3.5 MeV)
- ~ **2.3 × more IBD events expected.** (theoretically)
  - ∟ **Larger interaction target volume**.
    - contains ~ 2.8 × more free protons.
  - ∟ **Smaller neutron capture 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.

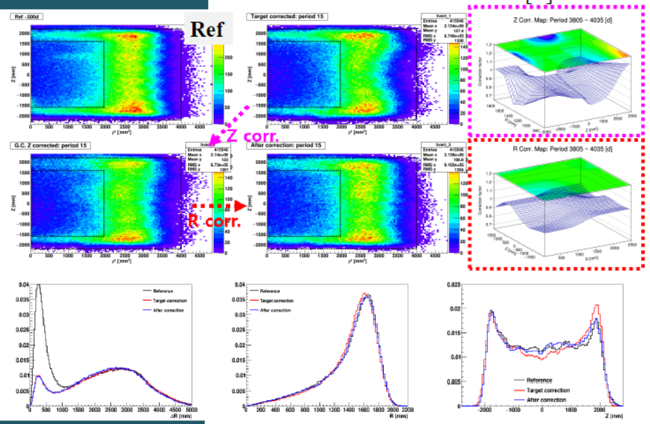
Analysis Pipeline



Analysis status

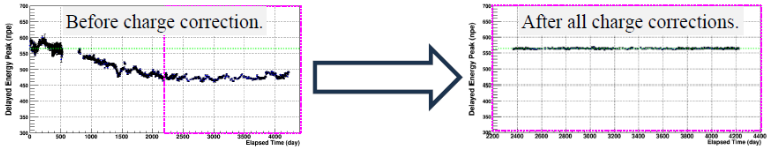
Vertex correction

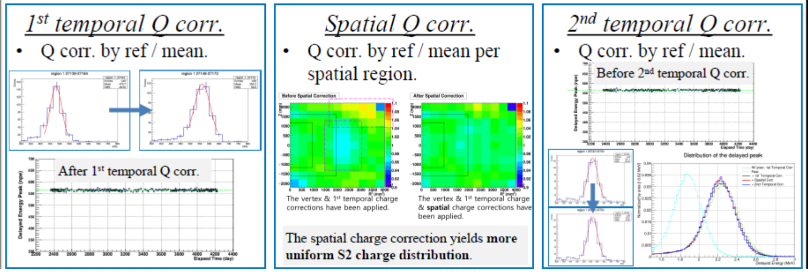
- Near detector: 3805 – 4035 [d]



Charge correction

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





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			

Overview of the RENO and RENE Experiments
YANG Byeongsu
On behalf of RENO and RENE Collaboration
Center for Precision Neutrino Research
Introduction
RENO Experimental Setup
RENE Experimental Setup
Reactor
Tendon gallery
Physics goal
RENO
Reactor Experiment for Neutrino Oscillation
Total thermal power 16.4GW_th
Oscillations observed as a deficit of anti-neutrinos
flux before oscillation observed here
Distance
1200 to 1800 meters
RENE
Reactor Experiment for Neutrino and Exotics
RENO and NEOS joint analysis
Hint for the sterile neutrino at Δm²41 ~ 2 eV²
Allowed regions
To confirm the allowed regions, need to improve energy resolution and systematics.
Collaboration
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3800 days livetime
Recently, started re-operating DAQ of the near detector.
→RENE experiment
Year 2022 2023 2024 2025
Collaboration Start
Design
Simulation
Gd-LS and LS
DAQ
PMT
Construction
Commissioning (RENO far site/CNU)
RENE Data taking (Tendon gallery)
Physics results of RENO
Precise measurement of |Δm²ee| and θ13
Phys. Rev. Lett. 108, 191802 (2012) - 229[d]
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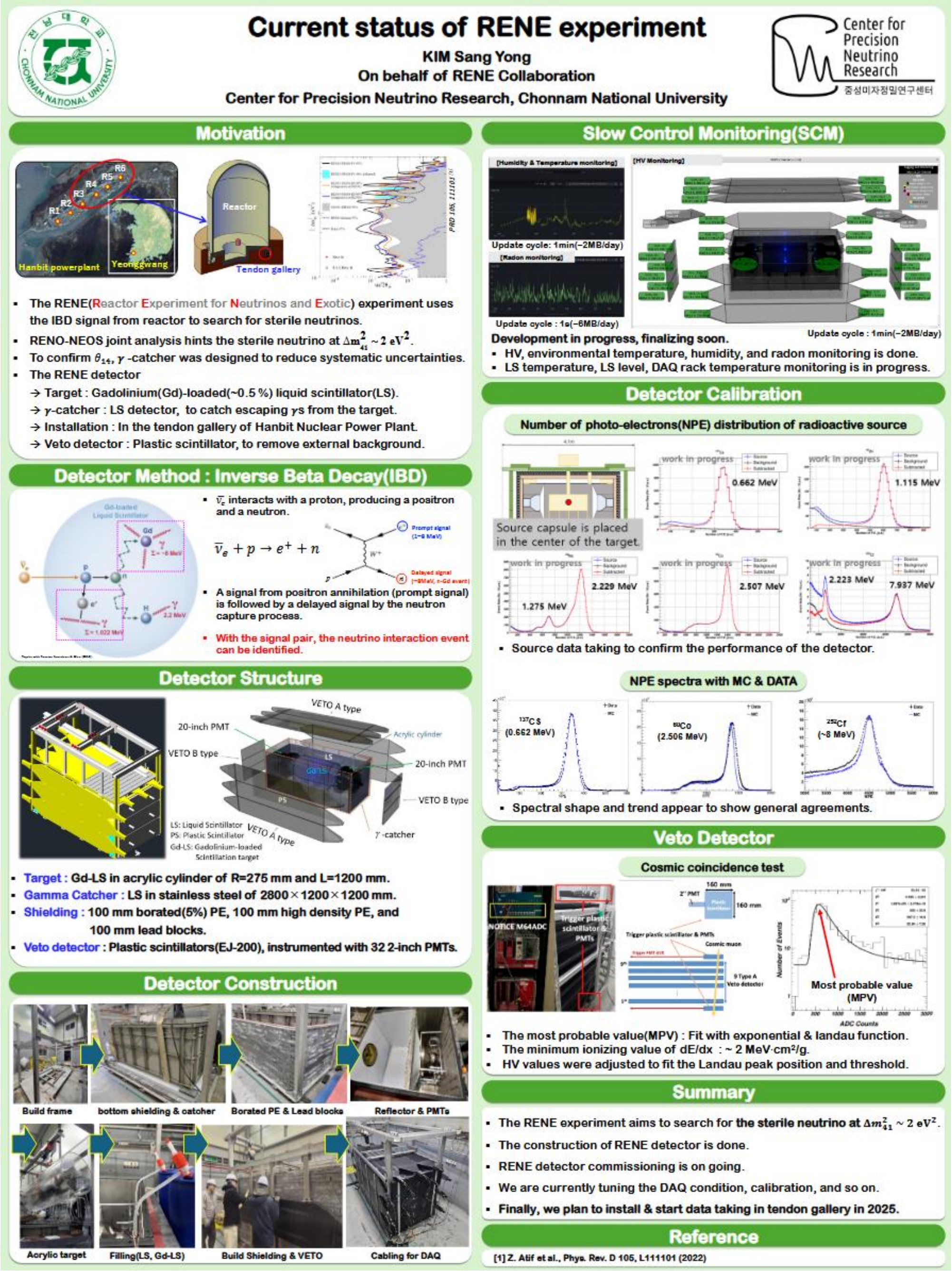
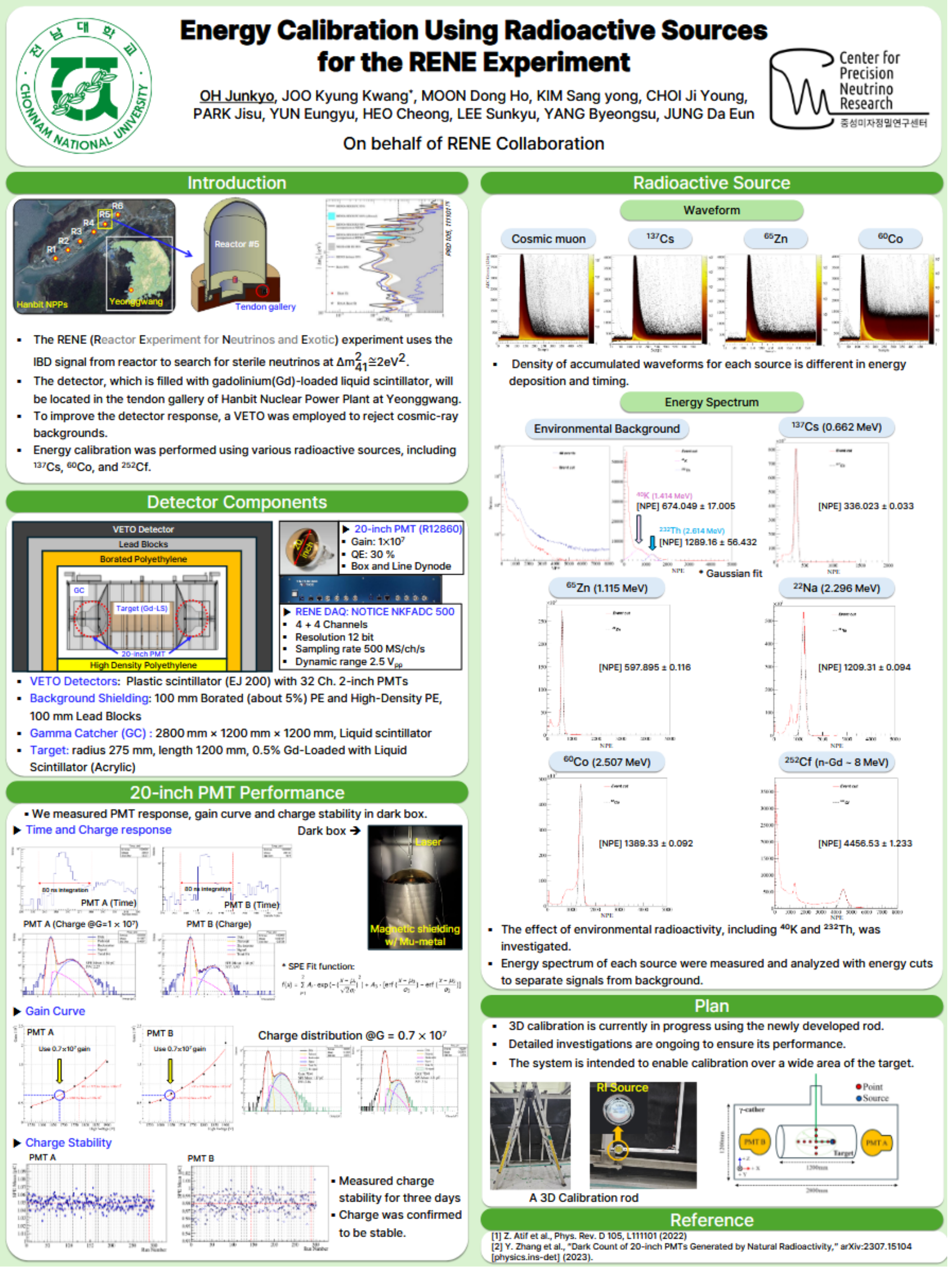
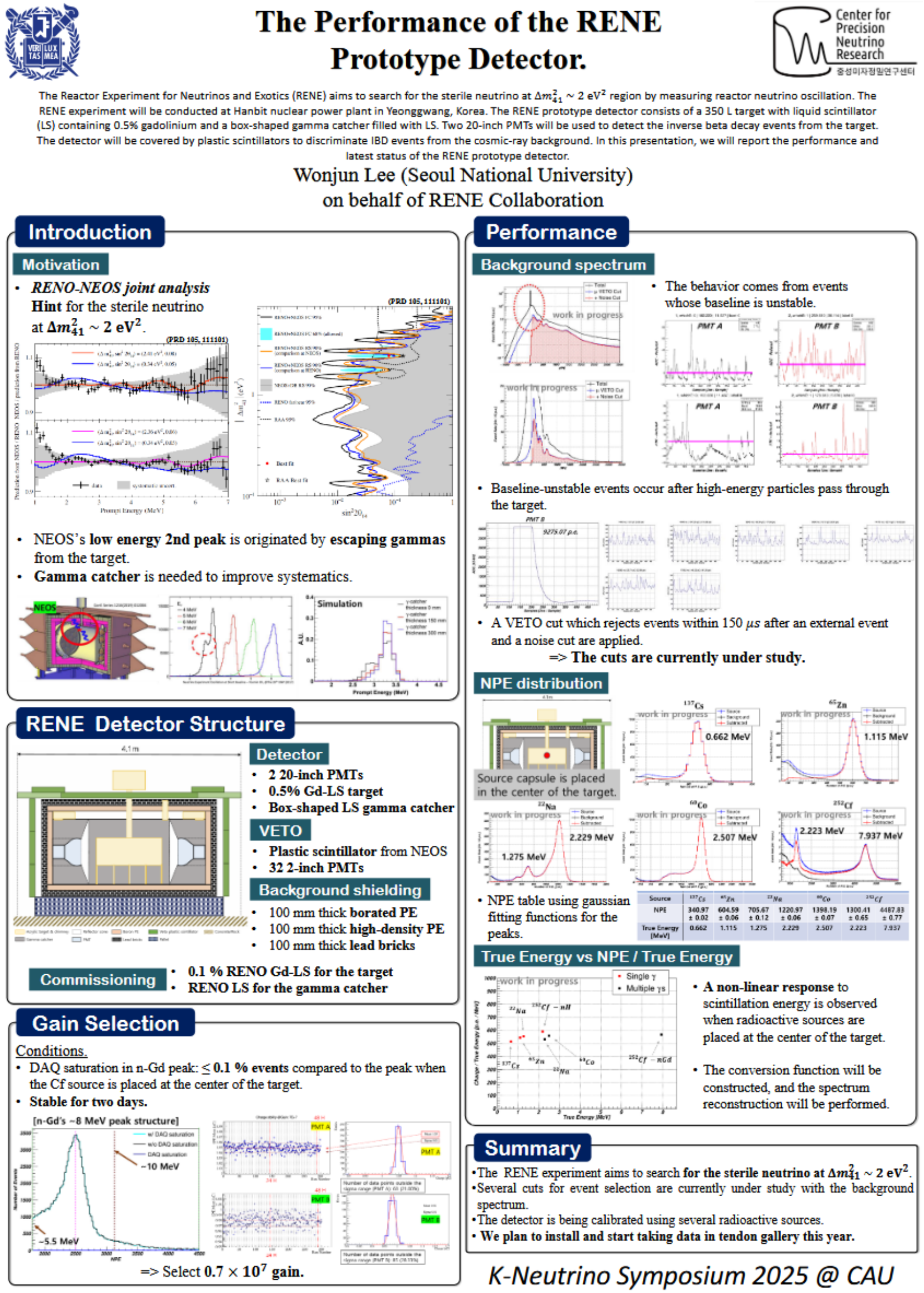
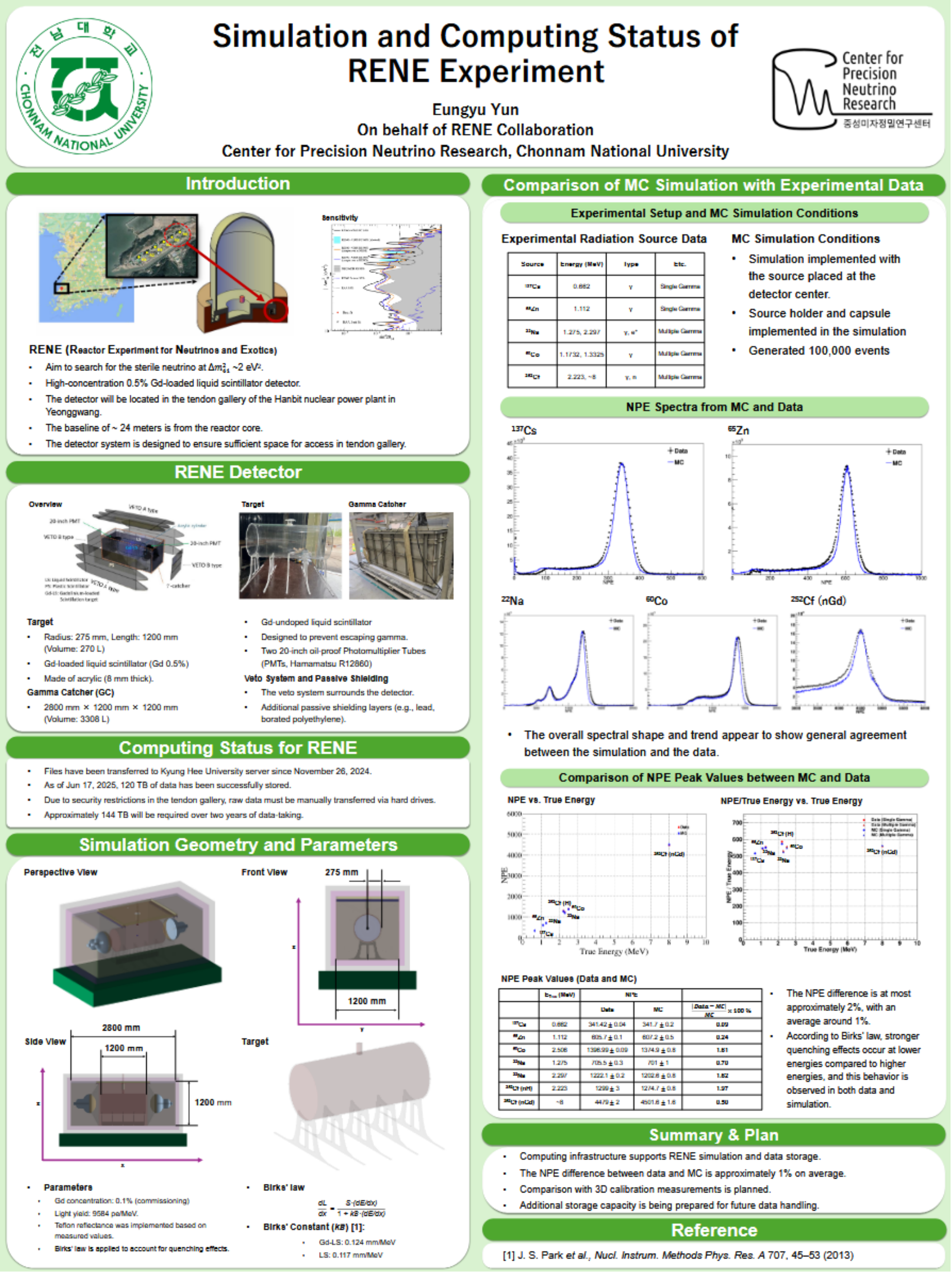


Current status of RENE experiment
KIM Sang Yong
On behalf of RENE Collaboration
Center for Precision Neutrino Research, Chonnam National University
Motivation
The RENE(Reactor Experiment for Neutrinos and Exotic) experiment uses the IBD signal from reactor to search for sterile neutrinos.
RENO-NEOS joint analysis hints the sterile neutrino at Δm²41 ~2 eV².
To confirm θ14, γ-catcher was designed to reduce systematic uncertainties.
The RENE detector
→ Target : Gadolinium(Gd)-loaded(~0.5 %) liquid scintillator(LS).
→ γ-catcher : LS detector, to catch escaping γs from the target.
→ Installation : In the tendon gallery of Hanbit Nuclear Power Plant.
→ Veto detector : Plastic scintillator, to remove external background.
Detector Method : Inverse Beta Decay(IBD)
ν̄e interacts with a proton, producing a positron and a neutron.
ν̄e + p → e⁺ + n
A signal from positron annihilation (prompt signal) is followed by a delayed signal by the neutron capture process.
With the signal pair, the neutrino interaction event can be identified.
Detector Structure
Target : Gd-LS in acrylic cylinder of R=275 mm and L=1200 mm.
Gamma Catcher : LS in stainless steel of 2800×1200×1200 mm.
Shielding : 100 mm borated(5%) PE, 100 mm high density PE, and 100 mm lead blocks.
Veto detector : Plastic scintillators(EJ-200), instrumented with 32 2-inch PMTs.
Detector Construction
Build frame
bottom shielding & catcher
Borated PE & Lead blocks
Reflector & PMTs
Acrylic target
Filling(LS, Gd-LS)
Build Shielding & VETO
Cabling for DAQ
Slow Control Monitoring(SCM)
Development in progress, finalizing soon.
HV, environmental temperature, humidity, and radon monitoring is done.
LS temperature, LS level, DAQ rack temperature monitoring is in progress.
Detector Calibration
Number of photo-electrons(NPE) distribution of radioactive source
Source capsule is placed in the center of the target.
Source data taking to confirm the performance of the detector.
NPE spectra with MC & DATA
Spectral shape and trend appear to show general agreements.
Veto Detector
Cosmic coincidence test
Most probable value (MPV)
The most probable value(MPV) : Fit with exponential & landau function.
The minimum ionizing value of dE/dx : ~ 2 MeV·cm²/g.
HV values were adjusted to fit the Landau peak position and threshold.
Summary
The RENE experiment aims to search for the sterile neutrino at Δm²41 ~ 2 eV².
The construction of RENE detector is done.
RENE detector commissioning is on going.
We are currently tuning the DAQ condition, calibration, and so on.
Finally, we plan to install & start data taking in tendon gallery in 2025.
Reference
[1] Z. Atif et al., Phys. Rev. D 105, L111101 (2022)


Energy Calibration Using Radioactive Sources for the RENE Experiment
OH Junkyo, JOO Kyung Kwang*, MOON Dong Ho, KIM Sang yong, CHOI Ji Young, PARK Jisu, YUN Eungyu, HEO Cheong, LEE Sunkyu, YANG Byeongsu, JUNG Da Eun
On behalf of RENE Collaboration
Center for Precision Neutrino Research
Introduction
The RENE (Reactor Experiment for Neutrinos and Exotic) experiment uses the IBD signal from reactor to search for sterile neutrinos at Δm²41≃2eV².
The detector, which is filled with gadolinium(Gd)-loaded liquid scintillator, will be located in the tendon gallery of Hanbit Nuclear Power Plant at Yeonggwang.
To improve the detector response, a VETO was employed to reject cosmic-ray backgrounds.
Energy calibration was performed using various radioactive sources, including 137Cs, 60Co, and 252Cf.
Detector Components
20-inch PMT (R12860)
Gain: 1x10^7
QE: 30 %
Box and Line Dynode
RENE DAQ: NOTICE NKFADC 500
4 + 4 Channels
Resolution 12 bit
Sampling rate 500 MS/ch/s
Dynamic range 2.5 Vpp
VETO Detectors: Plastic scintillator (EJ 200) with 32 Ch. 2-inch PMTs
Background Shielding: 100 mm Borated (about 5%) PE and High-Density PE, 100 mm Lead Blocks
Gamma Catcher (GC) : 2800 mm × 1200 mm × 1200 mm, Liquid scintillator
Target: radius 275 mm, length 1200 mm, 0.5% Gd-Loaded with Liquid Scintillator (Acrylic)
20-inch PMT Performance
We measured PMT response, gain curve and charge stability in dark box.
Time and Charge response
Dark box
Gain Curve
Charge distribution @G = 0.7 × 10^7
Charge Stability
Measured charge stability for three days
Charge was confirmed to be stable.
Radioactive Source
Waveform
Cosmic muon
137Cs
65Zn
60Co
Density of accumulated waveforms for each source is different in energy deposition and timing.
Energy Spectrum
Environmental Background
137Cs (0.662 MeV)
65Zn (1.115 MeV)
22Na (2.296 MeV)
60Co (2.507 MeV)
252Cf (n-Gd ~ 8 MeV)
The effect of environmental radioactivity, including 40K and 232Th, was investigated.
Energy spectrum of each source were measured and analyzed with energy cuts to separate signals from background.
Plan
3D calibration is currently in progress using the newly developed rod.
Detailed investigations are ongoing to ensure its performance.
The system is intended to enable calibration over a wide area of the target.
A 3D Calibration rod
Reference
[1] Z. Atif et al., Phys. Rev. D 105, L111101 (2022)
[2] Y. Zhang et al., "Dark Count of 20-inch PMTs Generated by Natural Radioactivity," arXiv:2307.15104 [physics.ins-det] (2023).


The Performance of the RENE Prototype Detector.
The Reactor Experiment for Neutrinos and Exotics (RENE) aims to search for the sterile neutrino at Δm²41 ~ 2 eV² region by measuring reactor neutrino oscillation. The RENE experiment will be conducted at Hanbit nuclear power plant in Yeonggwang, Korea. The RENE prototype detector consists of a 350 L target with liquid scintillator (LS) containing 0.5% gadolinium and a box-shaped gamma catcher filled with LS. Two 20-inch PMTs will be used to detect the inverse beta decay events from the target. The detector will be covered by plastic scintillators to discriminate IBD events from the cosmic-ray background. In this presentation, we will report the performance and latest status of the RENE prototype detector.
Wonjun Lee (Seoul National University)
on behalf of RENE Collaboration
Introduction
Motivation
RENO-NEOS joint analysis
Hint for the sterile neutrino at Δm²41 ~ 2 eV².
NEOS's low energy 2nd peak is originated by escaping gammas from the target.
Gamma catcher is needed to improve systematics.
RENE Detector Structure
Detector
2 20-inch PMTs
0.5% Gd-LS target
Box-shaped LS gamma catcher
VETO
Plastic scintillator from NEOS
32 2-inch PMTs
Background shielding
100 mm thick borated PE
100 mm thick high-density PE
100 mm thick lead bricks
Commissioning
0.1 % RENO Gd-LS for the target
RENO LS for the gamma catcher
Gain Selection
Conditions.
DAQ saturation in n-Gd peak: ≤ 0.1 % events compared to the peak when the Cf source is placed at the center of the target.
Stable for two days.
=> Select 0.7 × 10^7 gain.
Performance
Background spectrum
The behavior comes from events whose baseline is unstable.
Baseline-unstable events occur after high-energy particles pass through the target.
A VETO cut which rejects events within 150 μs after an external event and a noise cut are applied.
=> The cuts are currently under study.
NPE distribution
Source capsule is placed in the center of the target.
NPE table using gaussian fitting functions for the peaks.
True Energy vs NPE / True Energy
A non-linear response to scintillation energy is observed when radioactive sources are placed at the center of the target.
The conversion function will be constructed, and the spectrum reconstruction will be performed.
Summary
The RENE experiment aims to search for the sterile neutrino at Δm²41 ~ 2 eV².
Several cuts for event selection are currently under study with the background spectrum.
The detector is being calibrated using several radioactive sources.
We plan to install and start taking data in tendon gallery this year.
K-Neutrino Symposium 2025 @ CAU



Simulation and Computing Status of RENE Experiment

Eungyu Yun
On behalf of RENE Collaboration
Center for Precision Neutrino Research, Chonnam National University

Introduction

RENE (Reactor Experiment for Neutrinos and Exotics)

- Aim to search for the sterile neutrino at Δm^2_{41} ~2 eV^2.
- High-concentration 0.5% Gd-loaded liquid scintillator detector.
- The detector will be located in the tendon gallery of the Hanbit nuclear power plant in Yeonggwang.
- The baseline of ~ 24 meters is from the reactor core.
- The detector system is designed to ensure sufficient space for access in tendon gallery.

RENE Detector

Overview / Target / Gamma Catcher

Target
- Radius: 275 mm, Length: 1200 mm (Volume: 270 L)
- Gd-loaded liquid scintillator (Gd 0.5%)
- Made of acrylic (8 mm thick).

Gamma Catcher (GC)
- 2800 mm × 1200 mm × 1200 mm (Volume: 3308 L)
- Gd-undoped liquid scintillator
- Designed to prevent escaping gamma.
- Two 20-inch oil-proof Photomultiplier Tubes (PMTs, Hamamatsu R12860)

Veto System and Passive Shielding
- The veto system surrounds the detector.
- Additional passive shielding layers (e.g., lead, borated polyethylene).

Computing Status for RENE

- Files have been transferred to Kyung Hee University server since November 26, 2024.
- As of Jun 17, 2025, 120 TB of data has been successfully stored.
- Due to security restrictions in the tendon gallery, raw data must be manually transferred via hard drives.
- Approximately 144 TB will be required over two years of data-taking.

Simulation Geometry and Parameters

Perspective View / Front View / Side View / Target

- **Parameters**
  - Gd concentration: 0.1% (commissioning)
  - Light yield: 9584 pe/MeV.
  - Teflon reflectance was implemented based on measured values.
  - Birks' law is applied to account for quenching effects.
- **Birks' law**

$$\frac{dL}{dx} = \frac{S \cdot (dE/dx)}{1 + kB \cdot (dE/dx)}$$

- **Birks' Constant (kB) [1]:**
  - Gd-LS: 0.124 mm/MeV
  - LS: 0.117 mm/MeV

Comparison of MC Simulation with Experimental Data

Experimental Setup and MC Simulation Conditions

Experimental Radiation Source Data

Source	Energy (MeV)	Type	Etc.
^{137}Cs	0.662	γ	Single Gamma
^{65}Zn	1.112	γ	Single Gamma
^{22}Na	1.275, 2.297	γ, e^+	Multiple Gamma
^{60}Co	1.1732, 1.3325	γ	Multiple Gamma
^{252}Cf	2.223, ~8	γ, n	Multiple Gamma

MC Simulation Conditions
- Simulation implemented with the source placed at the detector center.
- Source holder and capsule implemented in the simulation
- Generated 100,000 events

NPE Spectra from MC and Data

^{137}Cs, ^{65}Zn, ^{22}Na, ^{60}Co, ^{252}Cf (nGd)

- The overall spectral shape and trend appear to show general agreement between the simulation and the data.

Comparison of NPE Peak Values between MC and Data

NPE vs. True Energy / NPE/True Energy vs. True Energy

NPE Peak Values (Data and MC)

	E_{True} (MeV)	NPE		
		Data	MC	$\frac{\lvert Data - MC \rvert}{MC} \times 100\ \%$
^{137}Cs	0.662	341.42 ± 0.04	341.7 ± 0.2	0.09
^{65}Zn	1.112	605.7 ± 0.1	607.2 ± 0.5	0.24
^{60}Co	2.506	1398.99 ± 0.09	1374.9 ± 0.8	1.81
^{22}Na	1.275	705.5 ± 0.3	701 ± 1	0.70
^{22}Na	2.297	1222.1 ± 0.2	1202.6 ± 0.8	1.62
^{252}Cf (nH)	2.223	1299 ± 3	1274.7 ± 0.8	1.97
^{252}Cf (nGd)	~8	4479 ± 2	4501.6 ± 1.6	0.50

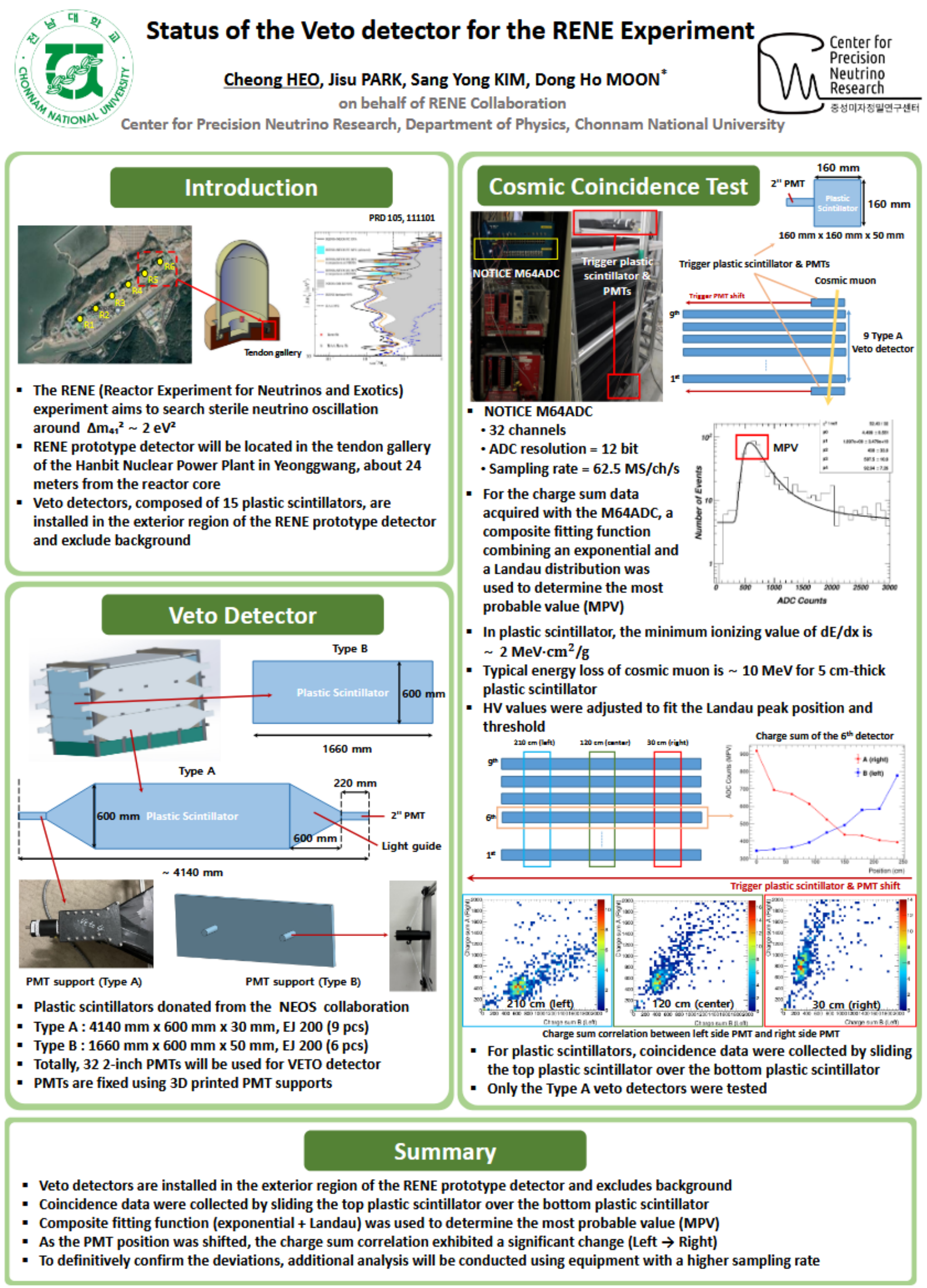
- The NPE difference is at most approximately 2%, with an average around 1%.
- According to Birks' law, stronger quenching effects occur at lower energies compared to higher energies, and this behavior is observed in both data and simulation.

Summary & Plan

- Computing infrastructure supports RENE simulation and data storage.
- The NPE difference between data and MC is approximately 1% on average.
- Comparison with 3D calibration measurements is planned.
- Additional storage capacity is being prepared for future data handling.

Reference

[1] J. S. Park *et al.*, *Nucl. Instrum. Methods Phys. Res. A* 707, 45–53 (2013)



Status of the Veto detector for the RENE Experiment

Cheong HEO, Jisu PARK, Sang Yong KIM, Dong Ho MOON*
on behalf of RENE Collaboration
Center for Precision Neutrino Research, Department of Physics, Chonnam National University

Introduction

- The RENE (Reactor Experiment for Neutrinos and Exotics) experiment aims to search sterile neutrino oscillation around Δm^2_{41} ~ 2 eV^2
- RENE prototype detector will be located in the tendon gallery of the Hanbit Nuclear Power Plant in Yeonggwang, about 24 meters from the reactor core
- Veto detectors, composed of 15 plastic scintillators, are installed in the exterior region of the RENE prototype detector and exclude background

Veto Detector

Type A: 4140 mm, 600 mm, 220 mm, 2" PMT, Light guide; Type B: 1660 mm, 600 mm

PMT support (Type A) / PMT support (Type B)

- Plastic scintillators donated from the NEOS collaboration
- Type A : 4140 mm x 600 mm x 30 mm, EJ 200 (9 pcs)
- Type B : 1660 mm x 600 mm x 50 mm, EJ 200 (6 pcs)
- Totally, 32 2-inch PMTs will be used for VETO detector
- PMTs are fixed using 3D printed PMT supports

Cosmic Coincidence Test

Trigger plastic scintillator & PMTs: 160 mm x 160 mm x 50 mm; 9 Type A Veto detector

- NOTICE M64ADC
  - 32 channels
  - ADC resolution = 12 bit
  - Sampling rate = 62.5 MS/ch/s
- For the charge sum data acquired with the M64ADC, a composite fitting function combining an exponential and a Landau distribution was used to determine the most probable value (MPV)
- In plastic scintillator, the minimum ionizing value of dE/dx is ~ 2 $MeV \cdot cm^2/g$
- Typical energy loss of cosmic muon is ~ 10 MeV for 5 cm-thick plastic scintillator
- HV values were adjusted to fit the Landau peak position and threshold

Charge sum of the 6th detector

Trigger plastic scintillator & PMT shift: 210 cm (left), 120 cm (center), 30 cm (right)

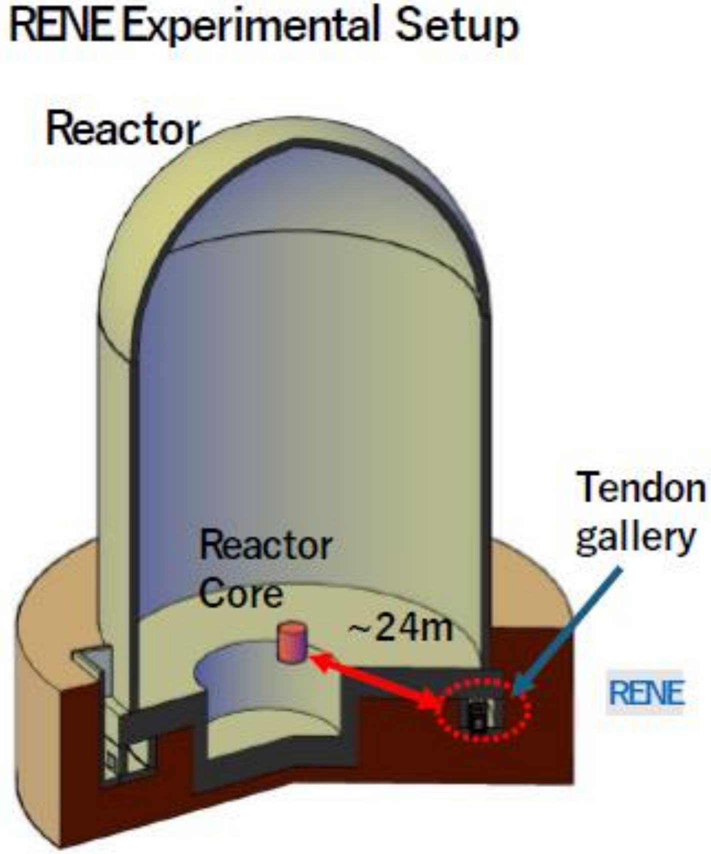
Charge sum correlation between left side PMT and right side PMT

- For plastic scintillators, coincidence data were collected by sliding the top plastic scintillator over the bottom plastic scintillator
- Only the Type A veto detectors were tested

Summary

- Veto detectors are installed in the exterior region of the RENE prototype detector and excludes background
- Coincidence data were collected by sliding the top plastic scintillator over the bottom plastic scintillator
- Composite fitting function (exponential + Landau) was used to determine the most probable value (MPV)
- As the PMT position was shifted, the charge sum correlation exhibited a significant change (Left → Right)
- To definitively confirm the deviations, additional analysis will be conducted using equipment with a higher sampling rate

RENE Experimental Setup

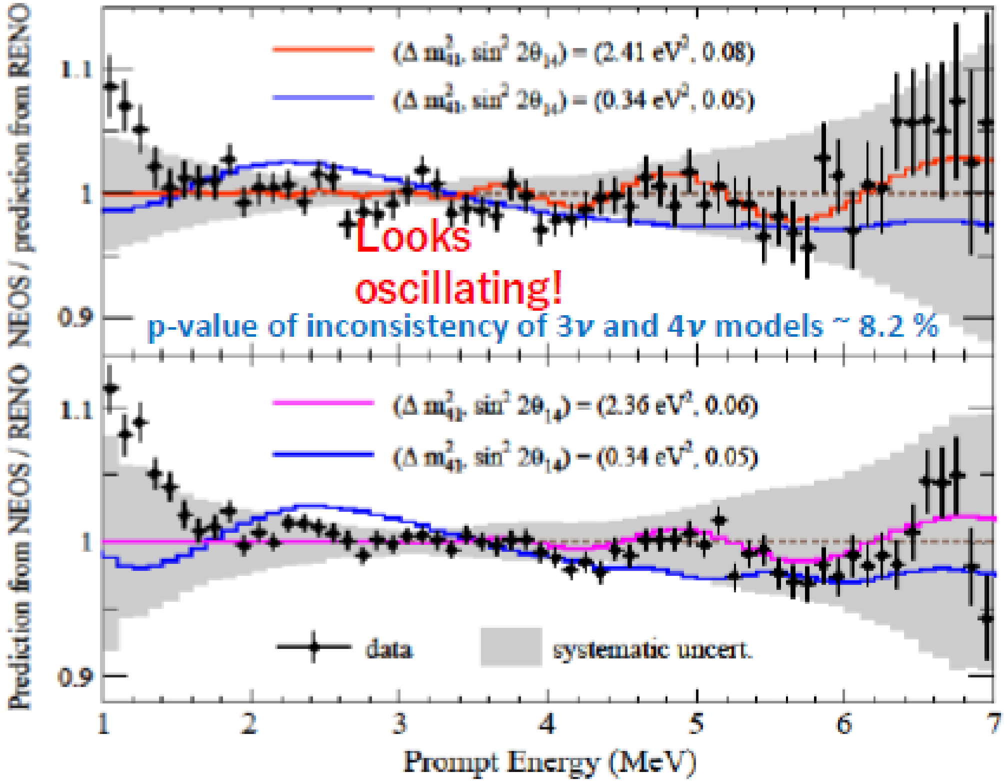


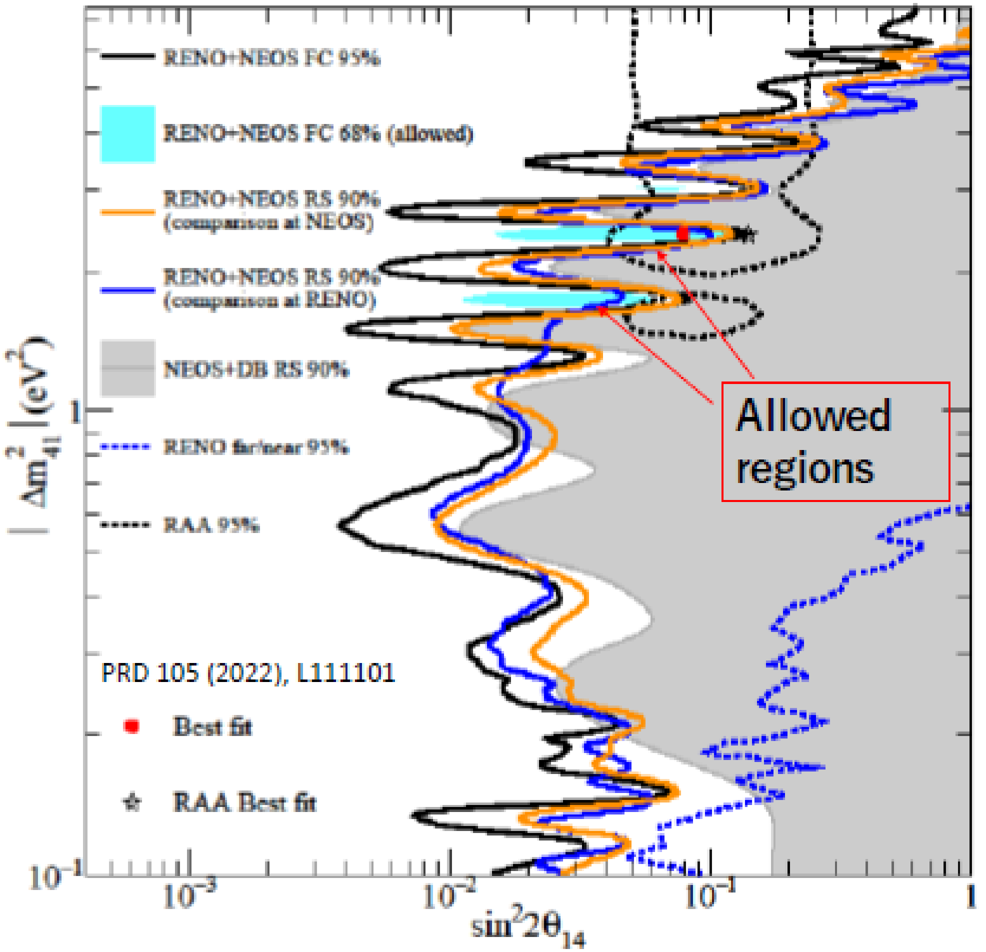
RENE

Reactor Experiment for Neutrino and Exotics

RENO and NEOS joint analysis

Hint for the sterile neutrino at $\Delta m_{41}^2 \sim 2\ eV^2$.





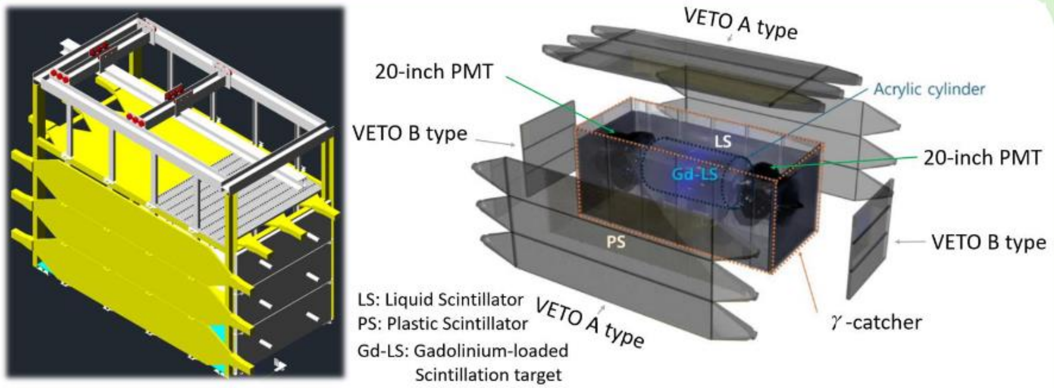
- To confirm the allowed regions, need to **improve energy resolution and systematics.**

RENE Collaboration

11 institutions & about 30 members

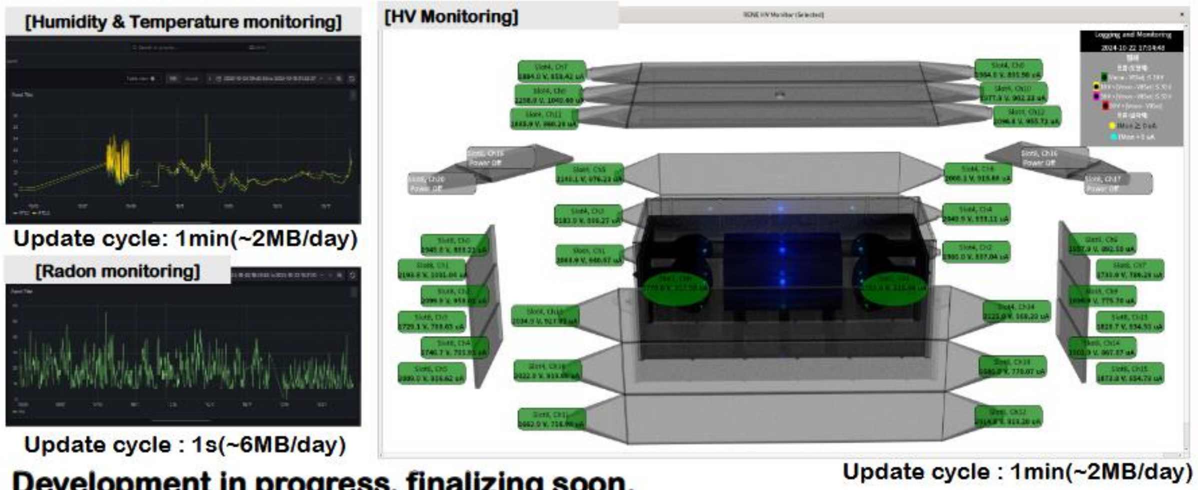
RENE Detector and SCM

Detector Structure



- **Target :** Gd-LS in acrylic cylinder of R=275 mm and L=1200 mm.
- **Gamma Catcher :** LS in stainless steel of 2800 × 1200 × 1200 mm.
- **Shielding :** 100 mm borated(5%) PE, 100 mm high density PE, and 100 mm lead blocks.
- **Veto detector :** Plastic scintillators(EJ-200), instrumented with 32 2-inch PMTs.

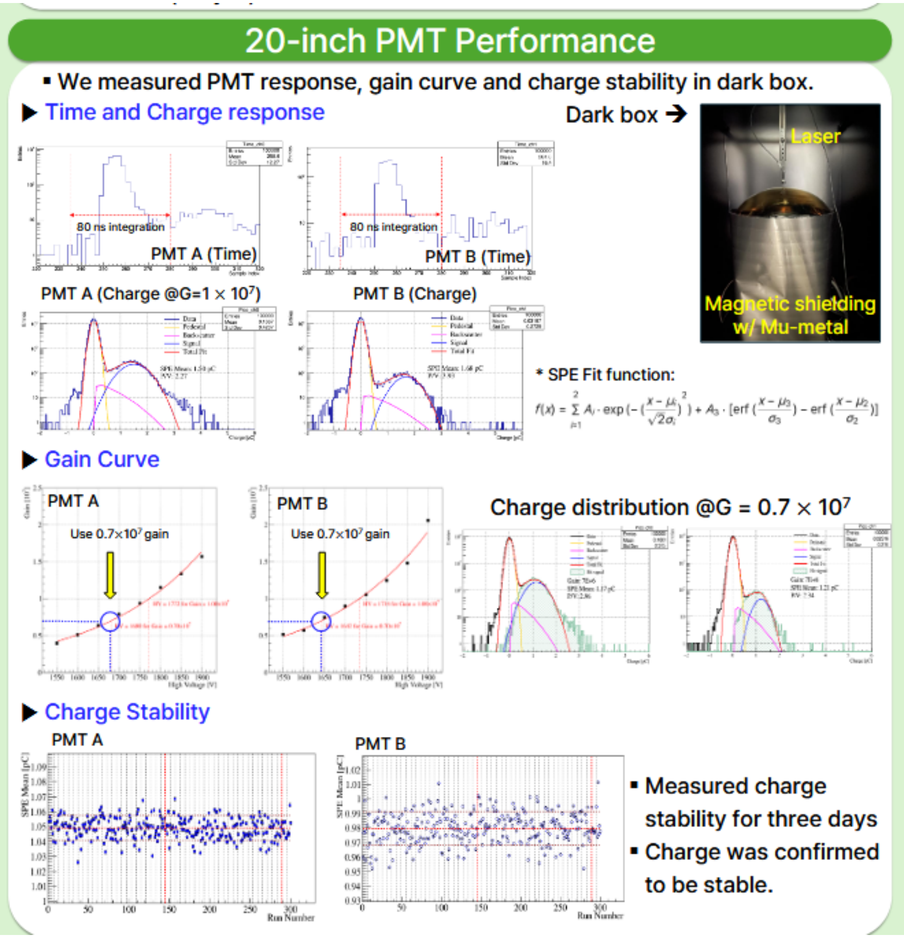
Slow Control Monitoring(SCM)

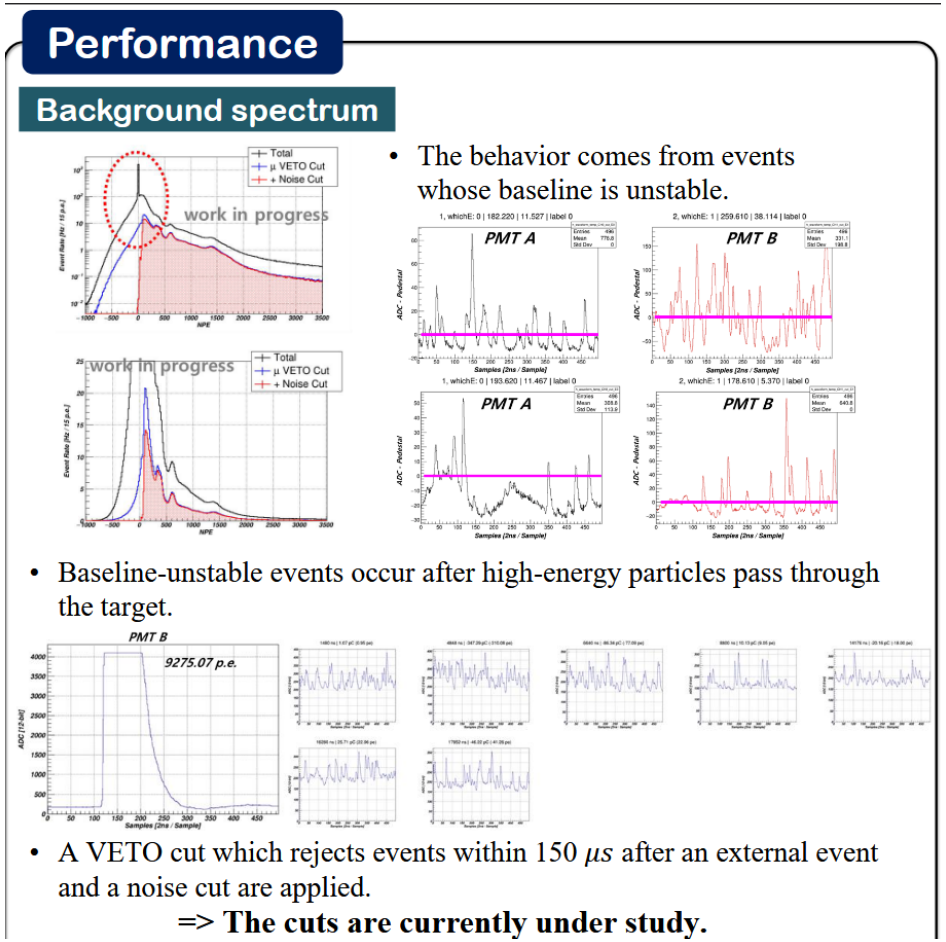


Development in progress, finalizing soon.

- HV, environmental temperature, humidity, and radon monitoring is done.
- LS temperature, LS level, DAQ rack temperature monitoring is in progress.

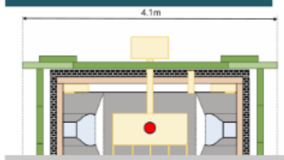
RENE Data Analysis and Calibration



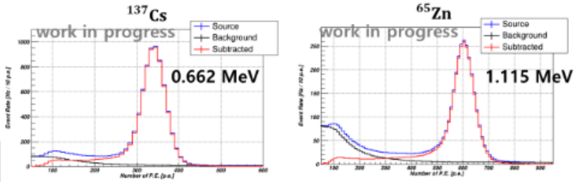


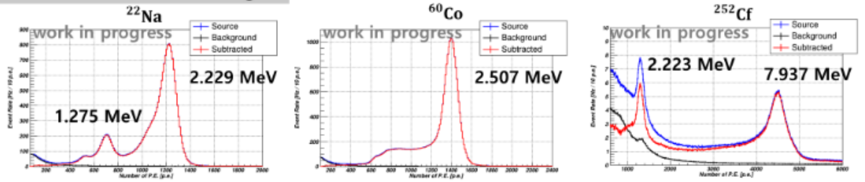
RENE Data Analysis and Calibration

NPE distribution



Source capsule is placed in the center of the target.

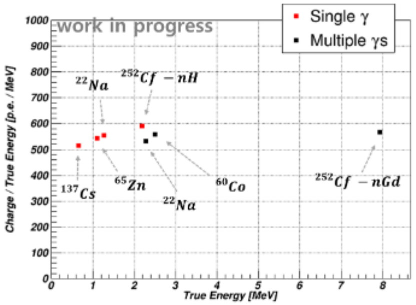




- NPE table using gaussian fitting functions for the peaks.

Source	^{137}Cs	^{65}Zn	^{22}Na		^{60}Co	^{252}Cf	
NPE	340.97 ± 0.02	604.59 ± 0.06	705.67 ± 0.12	1220.97 ± 0.06	1398.19 ± 0.07	1300.41 ± 0.65	4487.83 ± 0.77
True Energy [MeV]	0.662	1.115	1.275	2.229	2.507	2.223	7.937

True Energy vs NPE / True Energy

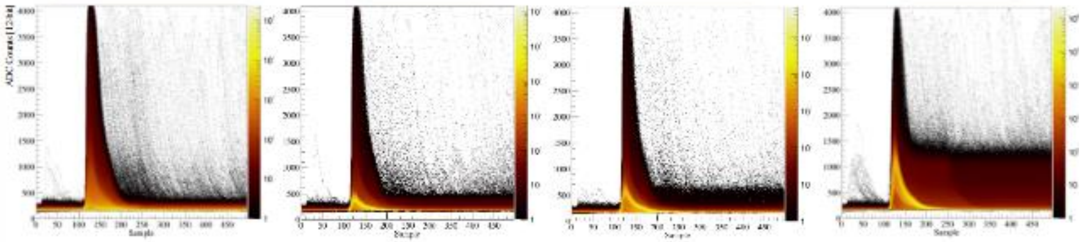


- **A non-linear response** to scintillation energy is observed when radioactive sources are placed at the center of the target.
- The conversion function will be constructed, and the spectrum reconstruction will be performed.

Radioactive Source

Waveform

Cosmic muon | ^{137}Cs | ^{65}Zn | ^{60}Co

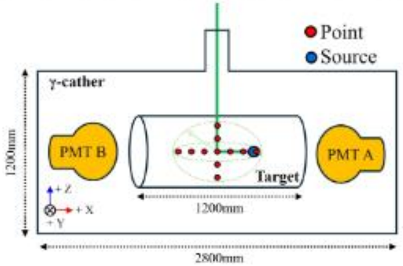


- Density of accumulated waveforms for each source is different in energy deposition and timing.

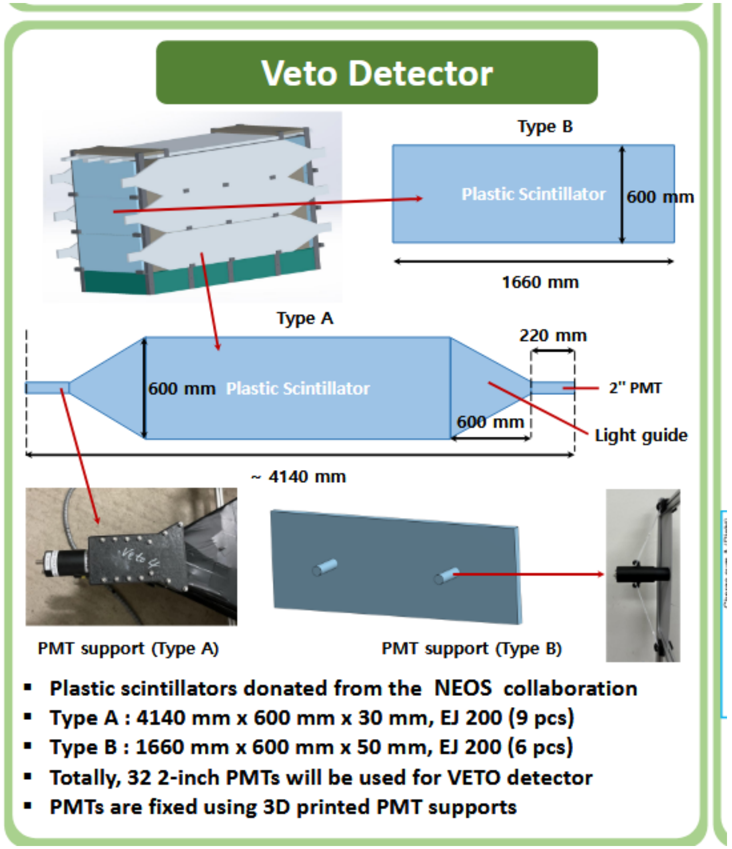
Plan

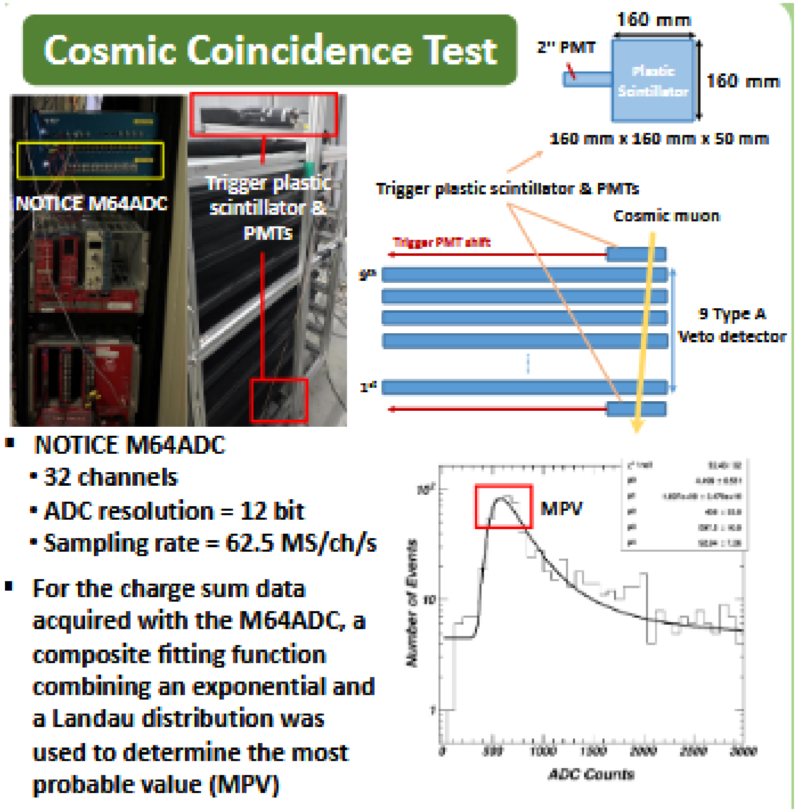
- 3D calibration is currently in progress using the newly developed rod.
- Detailed investigations are ongoing to ensure its performance.
- The system is intended to enable calibration over a wide area of the target.

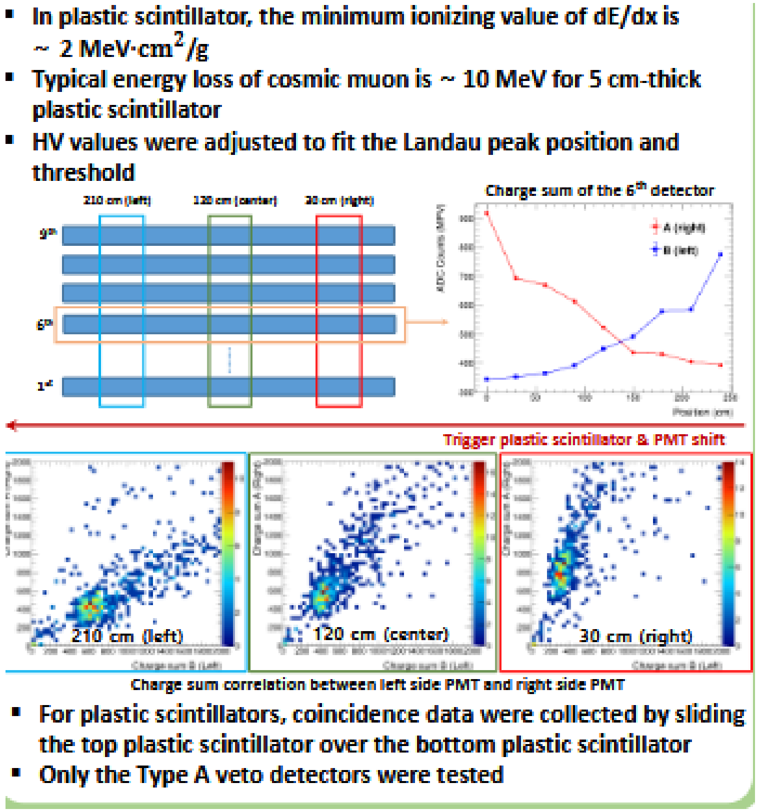
A 3D Calibration rod



RENE Veto Detector Calibration





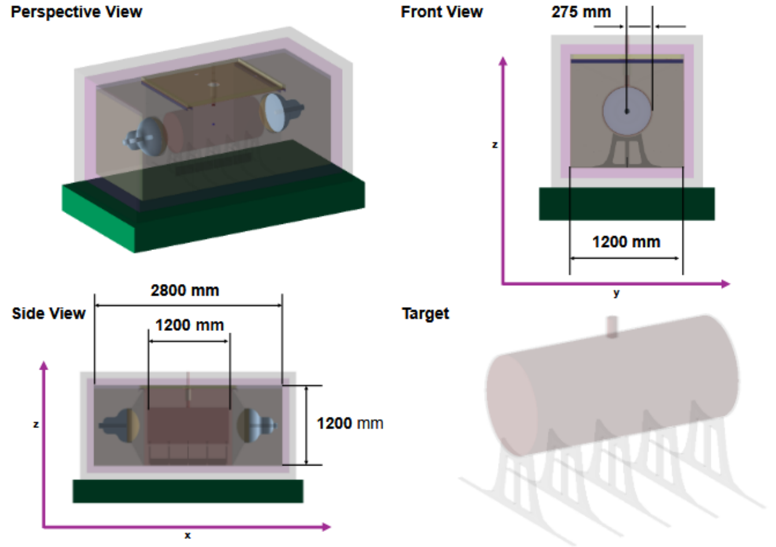


RENE MC simulation

Computing Status for RENE

- Files have been transferred to Kyung Hee University server since November 26, 2024.
- As of Jun 17, 2025, 120 TB of data has been successfully stored.
- Due to security restrictions in the tendon gallery, raw data must be manually transferred via hard drives.
- Approximately 144 TB will be required over two years of data-taking.

Simulation Geometry and Parameters

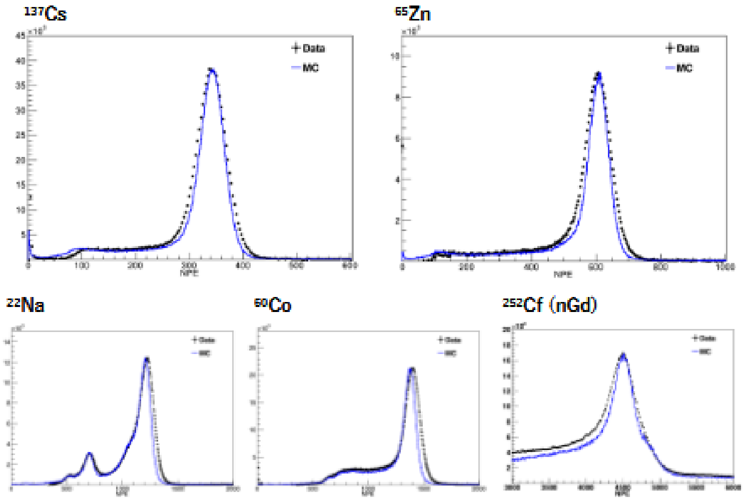


- **Parameters**
  - Gd concentration: 0.1% (commissioning)
  - Light yield: 9584 pe/MeV.
  - Teflon reflectance was implemented based on measured values.
  - Birks' law is applied to account for quenching effects.
- **Birks' law**

$$\frac{dL}{dx} = \frac{S \cdot (dE/dx)}{1 + kB \cdot (dE/dx)}$$

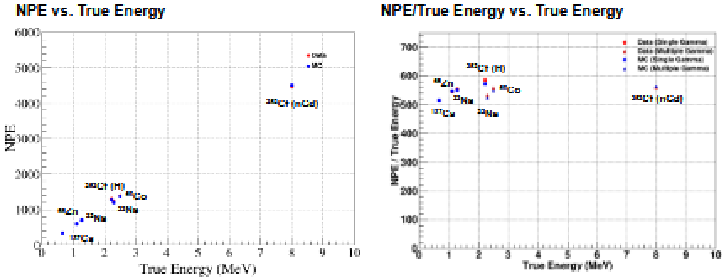
- **Birks' Constant (*kB*) [1]:**
  - Gd-LS: 0.124 mm/MeV
  - LS: 0.117 mm/MeV

NPE Spectra from MC and Data

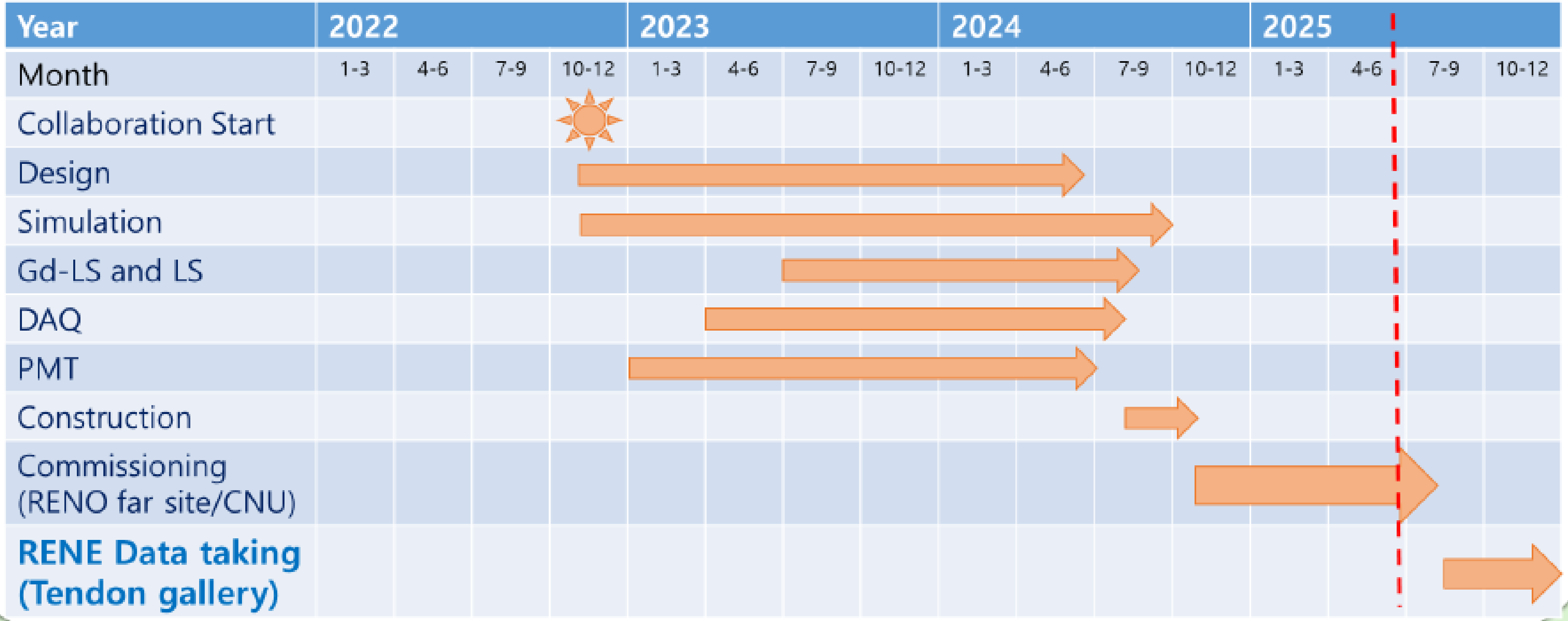


- The overall spectral shape and trend appear to show general agreement between the simulation and the data.

Comparison of NPE Peak Values between MC and Data

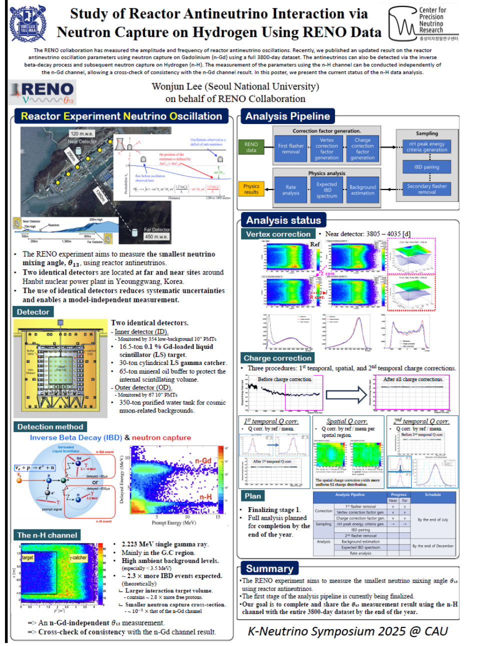


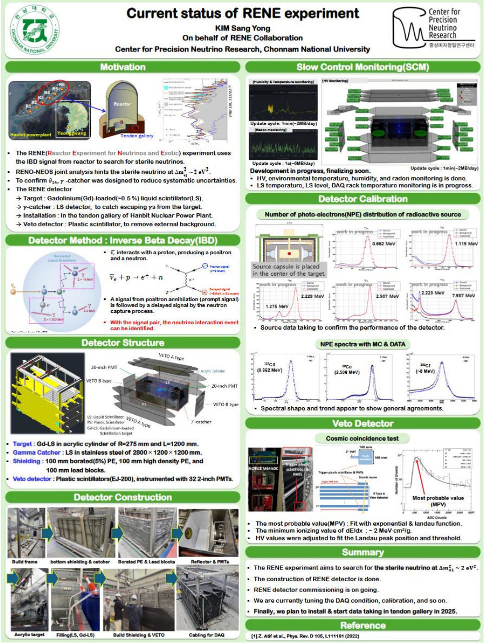
RENE Time Line

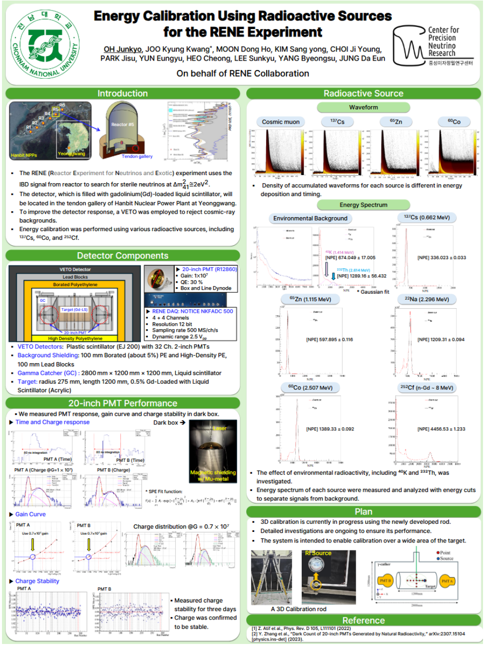


RENO
RENE


Overview of the RENO and RENE Experiments
YANG Byeongsu
On behalf of RENO and RENE Collaboration
Introduction
Physics goal
Collaboration
Time Line
Physics results of RENO


Study of Reactor Antineutrino Interaction via Neutron Capture on Hydrogen Using RENO Data
Wonjun Lee (Seoul National University)
on behalf of RENO Collaboration
Reactor Experiment Neutrino Oscillation
Analysis Pipeline
Analysis status
Detector
Detection method
The n-H channel
Summary
K-Neutrino Symposium 2025 @ CAU


Current status of RENE experiment
KIM Sang Yong
On behalf of RENE Collaboration
Center for Precision Neutrino Research, Chonnam National University
Motivation
Slow Control Monitoring(SCM)
Detector Method : Inverse Beta Decay(IBD)
Detector Calibration
Detector Structure
Veto Detector
Detector Construction
Summary
Reference


Energy Calibration Using Radioactive Sources for the RENE Experiment
On behalf of RENE Collaboration
Introduction
Radioactive Source
Detector Components
20-inch PMT Performance
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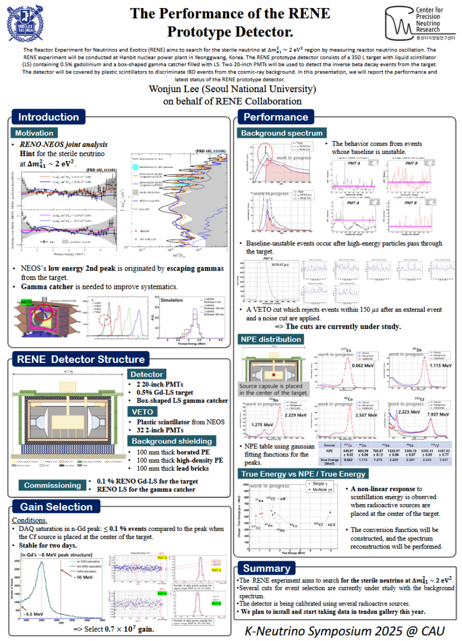
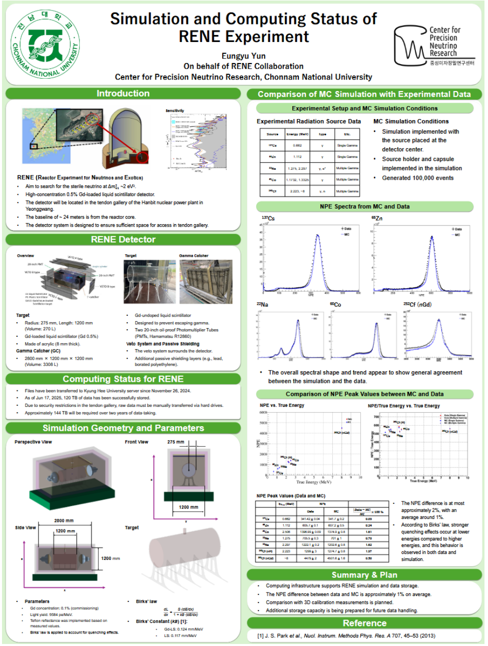
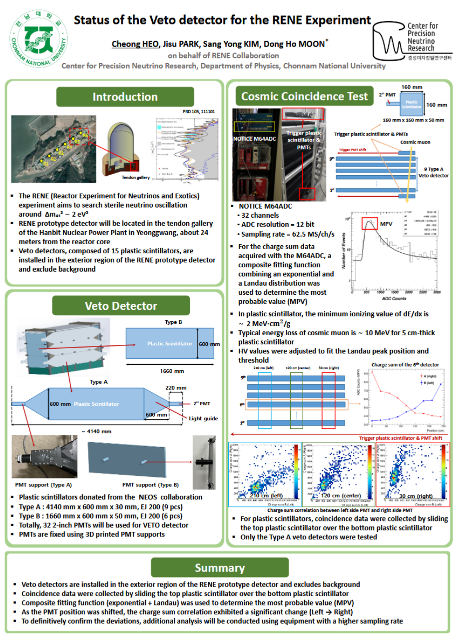
Reference


The Performance of the RENE Prototype Detector.
Wonjun Lee (Seoul National University)
on behalf of RENE Collaboration
Introduction
Performance
RENE Detector Structure
Gain Selection
Summary
K-Neutrino Symposium 2025 @ CAU


Simulation and Computing Status of RENE Experiment
Eungyu Yun
On behalf of RENE Collaboration
Center for Precision Neutrino Research, Chonnam National University
Introduction
Comparison of MC Simulation with Experimental Data
RENE Detector
Computing Status for RENE
Simulation Geometry and Parameters
Summary & Plan
Reference


Status of the Veto detector for the RENE Experiment
on behalf of RENE Collaboration
Center for Precision Neutrino Research, Department of Physics, Chonnam National University
Introduction
Cosmic Coincidence Test
Veto Detector
Summary