# Development Status of the RENE Experiment

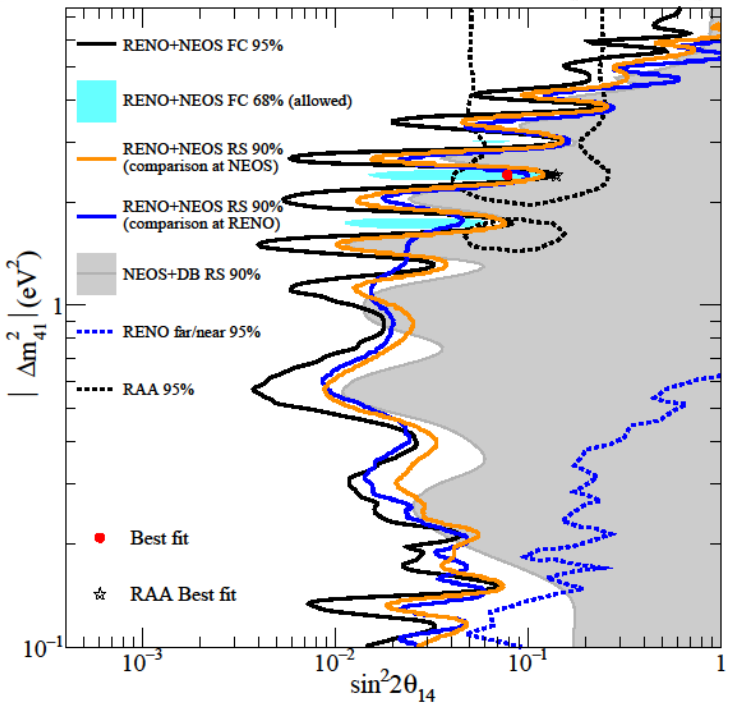
Sunkyu Lee

On behalf of the RENE collaboration
Chonnam National University

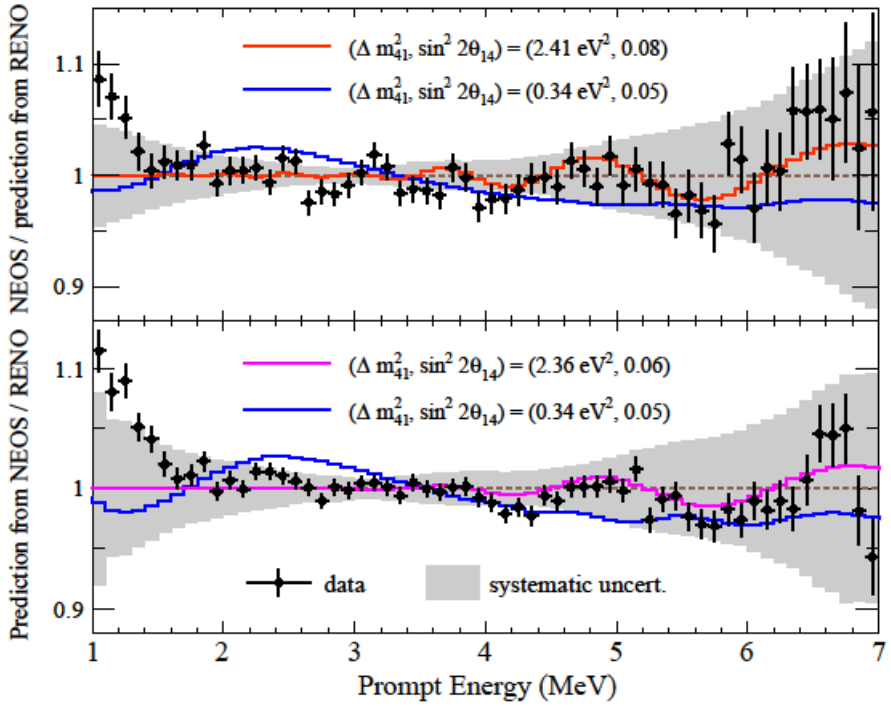
K-Neutrino 2026, Chung-Ang University, 27th Oct. 2026

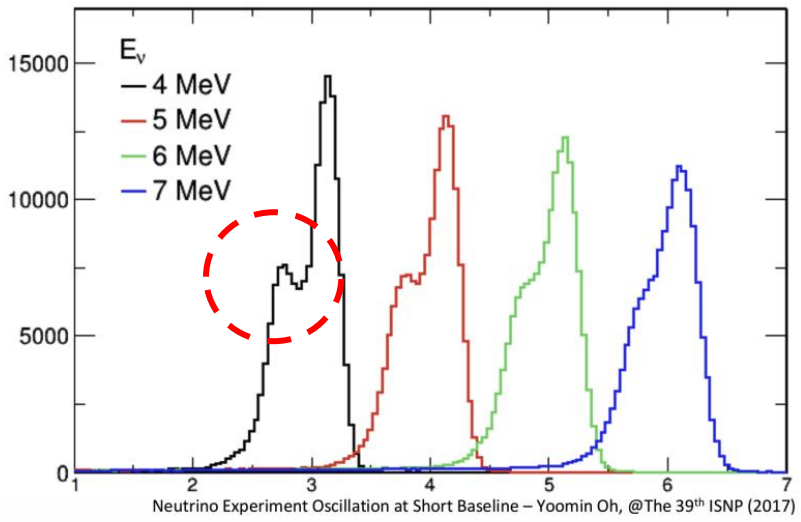
# Motivation

(PRD 105, 111101)




(PRD 105, 111101)





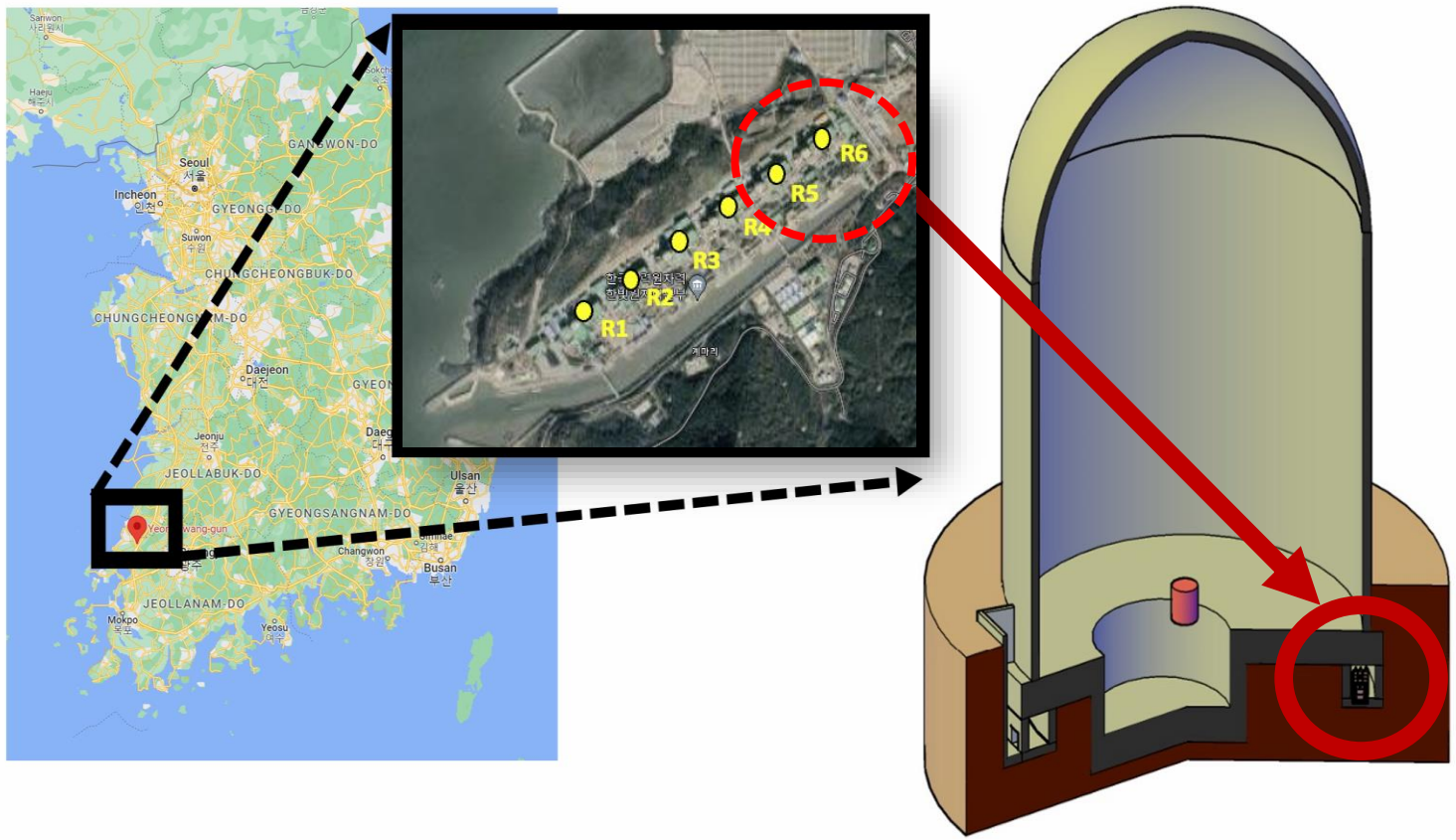


- ***RENO-NEOS joint analysis*** **hint** for the sterile neutrino at $\Delta m^2_{41} \sim 2\ eV^2$.
- To **cross-check** RENO-NEOS result, need to improve systematics.
- NEOS detector has **2nd peaks, which come from the escaping gammas,** in the main peak.

→ "**Gamma catcher**" is needed.

# RENE Experiment

## **R**eactor **E**xperiment for **N**eutrinos and **E**xotics




- Will install its detector in **tendon gallery at Hanbit nuclear power plant**.
- ~ 24 m baseline; distance from a reactor to the detector.
- Utilize **Gd-loaded liquid scintillator (Gd-LS) target with LS gamma catcher.**
- **RENE Technical Design Report was published (2025.09.23)**
  **(Prog. Theor. Exp. Phys. 2025 093C03)**

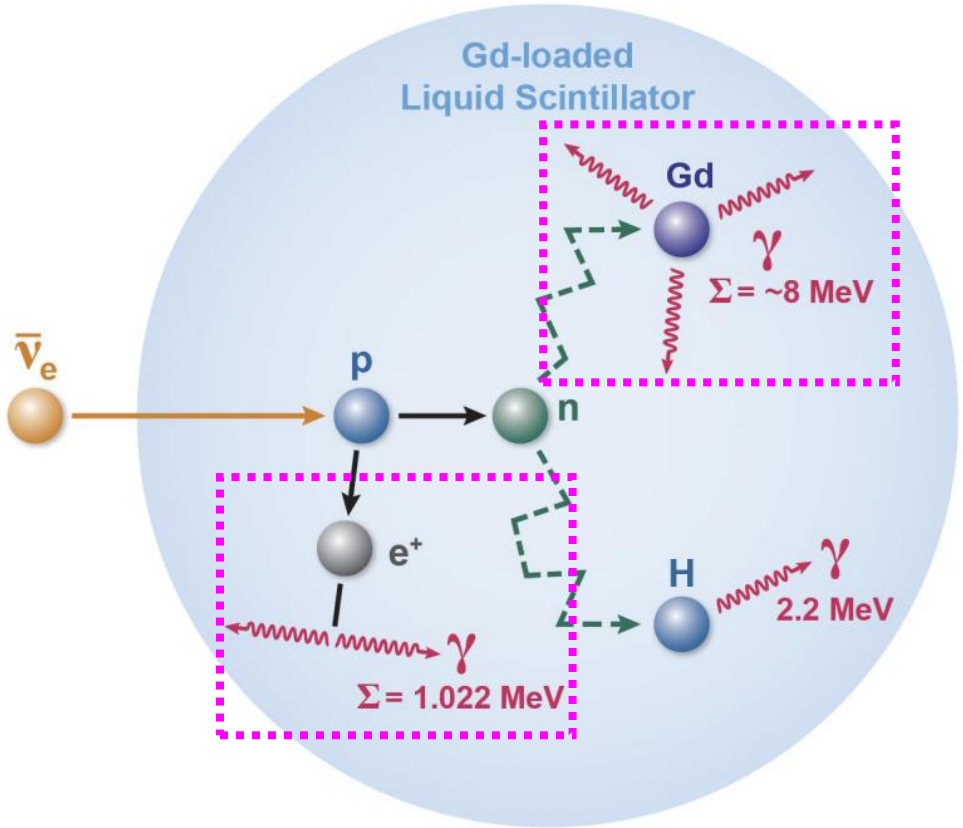
# RENE Collaboration



**8th RENE collaboration meeting (2026.01.12)**

11 institutions & about 30 members

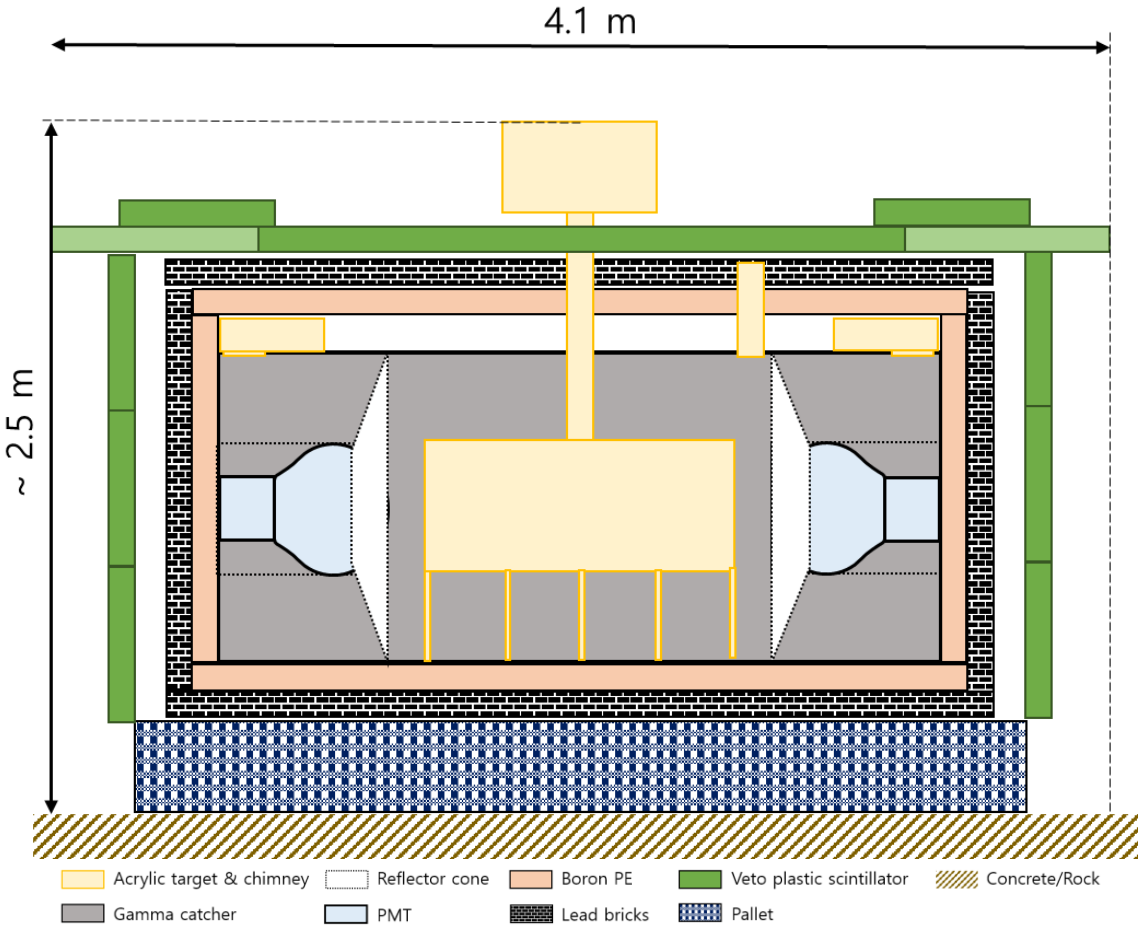
# Detection Method: Inverse Beta Decay (IBD)

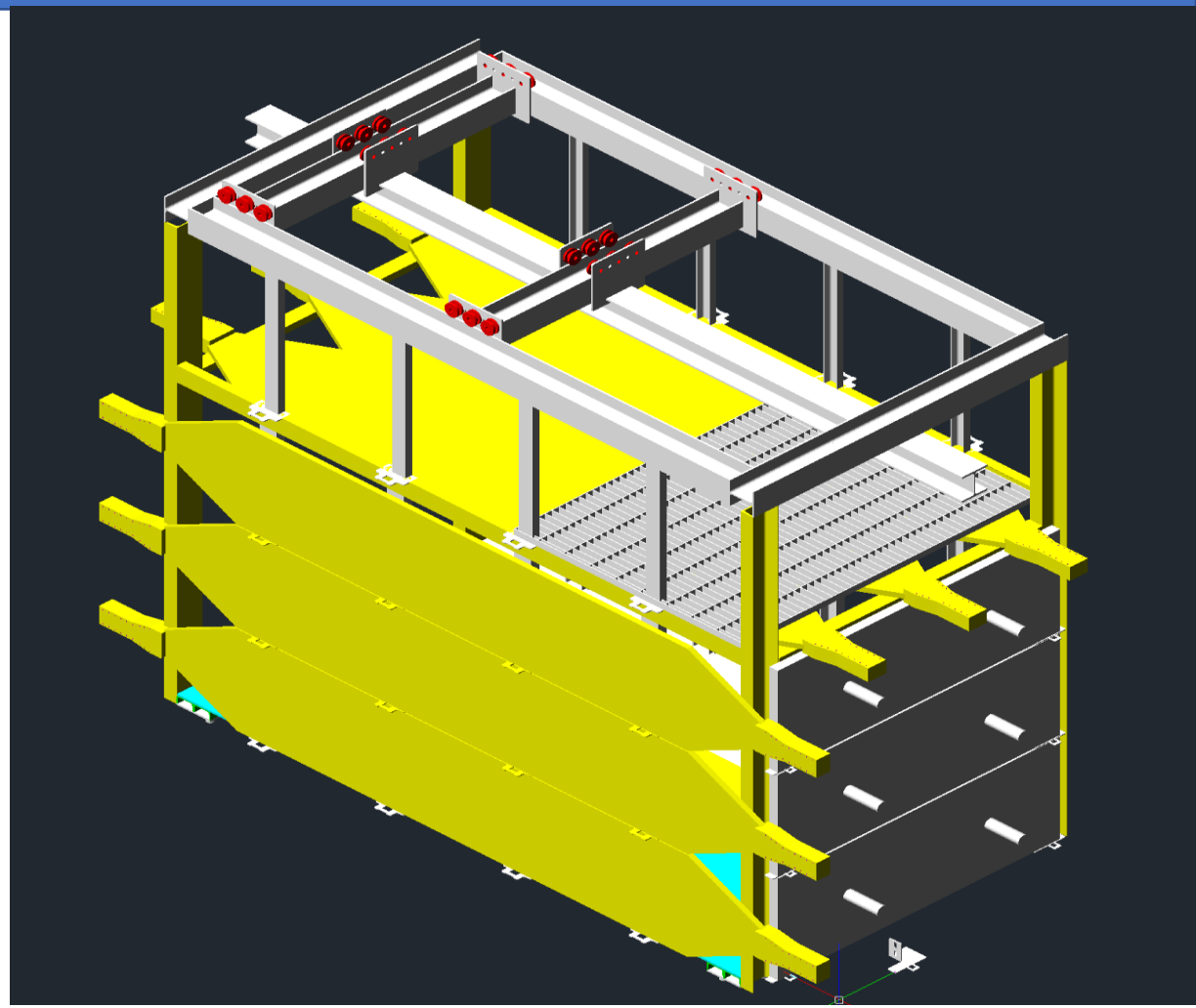



Physics with Reactor Neutrinos, X. Qian (2018).

- $\bar{\nu}_e$ interacts with a proton (IBD), then the process makes a positron and a neutron.
- A neutron has O(keV) kinetic energy.
- The neutron needs to be thermalized, while the positron leaves its energy.
- After the signal by the positron (prompt signal), we can detect the delayed signal by the neutron capture process.
- With the signal pair, the neutrino interaction event can be distinguished.

# Detector Structure



## Detector

(Prog. Theor. Exp. Phys. 2025 093C03)

- 2 20-inch PMTs for the target.
- 0.5 % Gd-loaded LS target.
- Box-shaped LS gamma catcher.
- Plastic scintillators with 2-inch PMTs for VETO detectors.

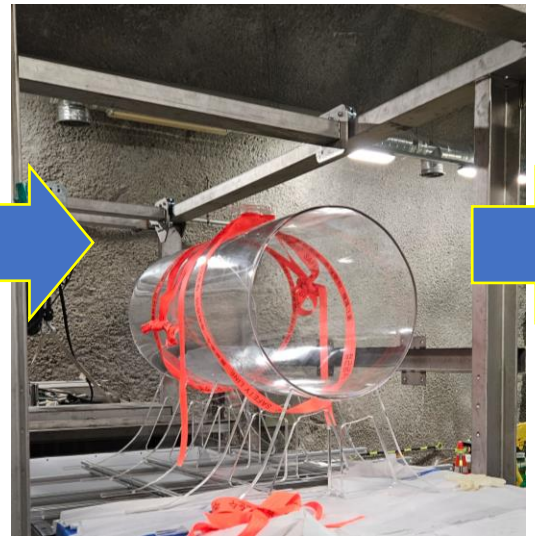
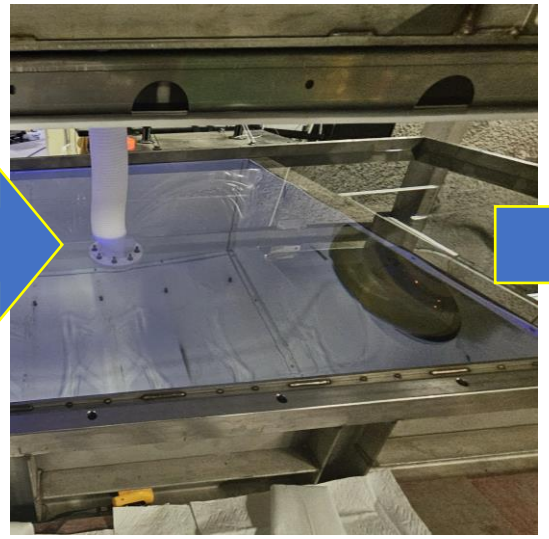
*"VETO detectors from IBS."*

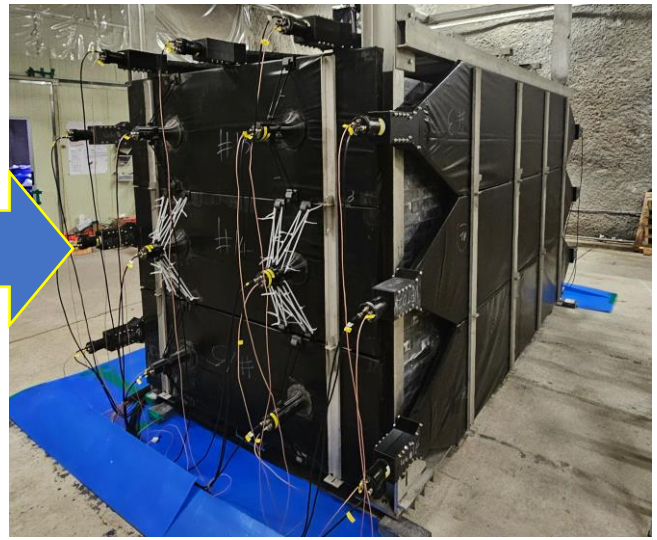
## Background shielding

- 100 mm borated PE & High-density PE.
- 100 mm lead bricks.

# Detector Construction





# DAQ Equipment

## NOTICE NKFADC500

For the target and gamma catcher, **NOTICE NKFADC500** will be used.




- 4 + 4 channels
- Resolution = 12 bit
- 2.5 Vpp dynamic range
- Sampling rate = 500MS/ch/s
- 4 + 4 GB DRAM

## NOTICE TCB

**NOTICE TCB (Trigger Control Board)** will be employed to control and synchronize the detector and veto system.




- Make trigger and clock signals
- RJ-45 port

## NOTICE M64ADC

For the veto DAQ system, **NOTICE M64ADC** will be utilized.




- 32 channels
- Resolution = 12 bit
- 2 Vpp dynamic range
- Sampling rate = 62.5MS/ch/s
- 4 GB DRAM

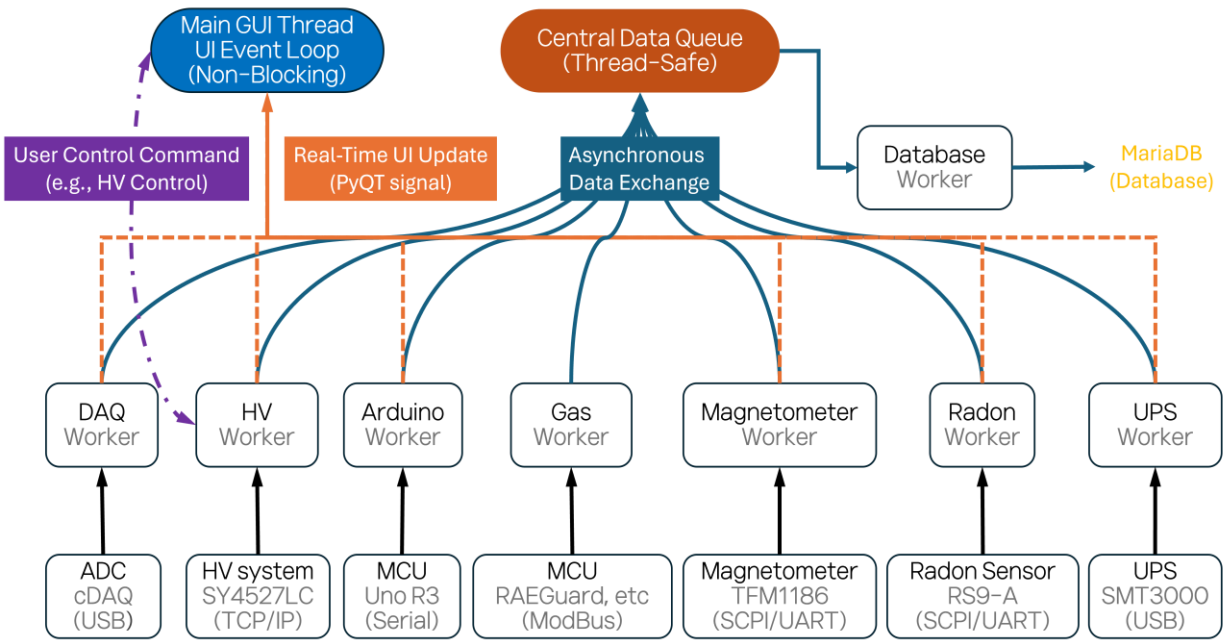
## Dell Precision 5860 Tower

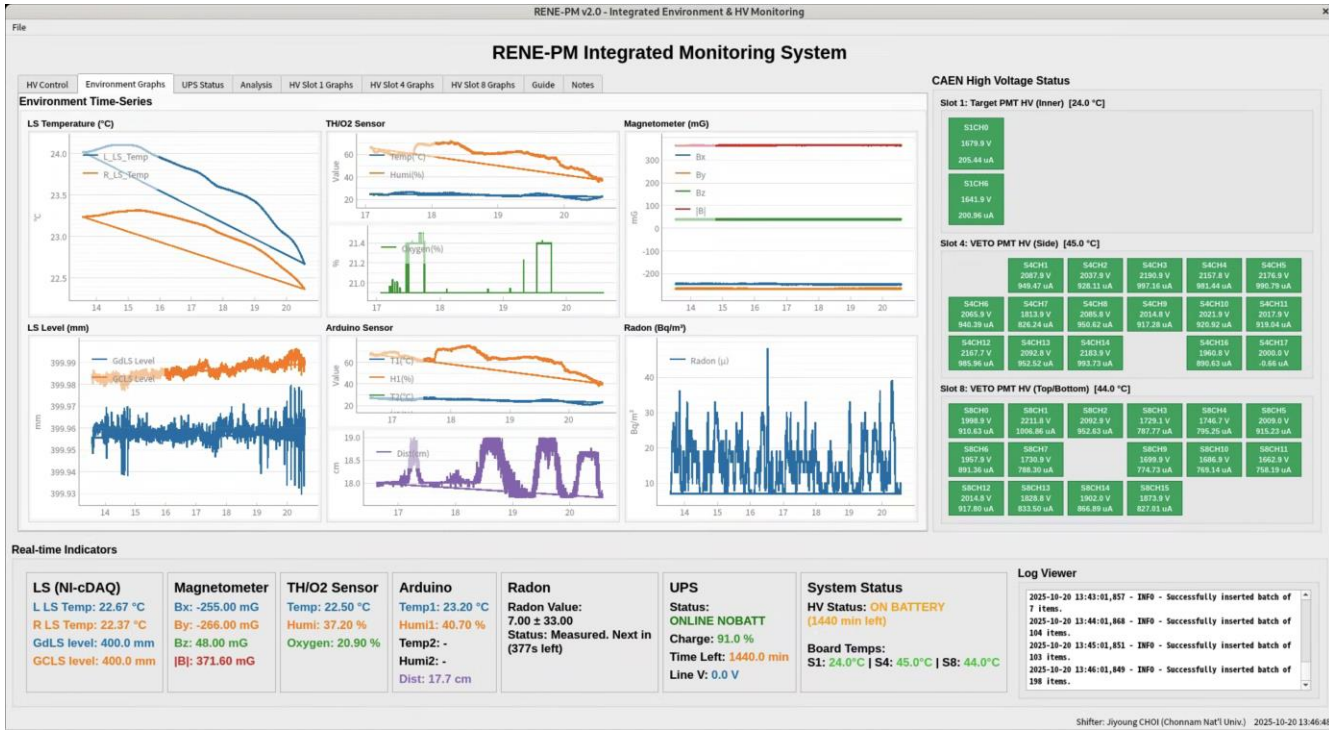



- 32 GB RAM
- 32 TB HDD
- Rocky linux 8

- CPU : 인텔® 제온® W3-2423 (15 MB 캐시, 6 코어, 12 threads, 2.1 GHz to 4.2 GHz Turbo, 120 W)
- OS : ROCKY 8, Linux
- Power : Precision 5860 타워 750W 섀시 (2SATA Flexbay L6)
- RAM : 32GB, 2x16GB, DDR5, 4800MHz, RDIMM ECC 메모리
- GPU : NVIDIA® T400, 4 GB GDDR6, 3 mDP to DP 어댑터
- SSD : 512 GB, M.2, PCIe NVMe, SSD, Class 40
- HDD : 4 x 12 TB, 7200 RPM, 3.5-인치, SATA, HDD
- Additional storage : 144TB, NFS mount

# SCM (Slow Control Monitoring)



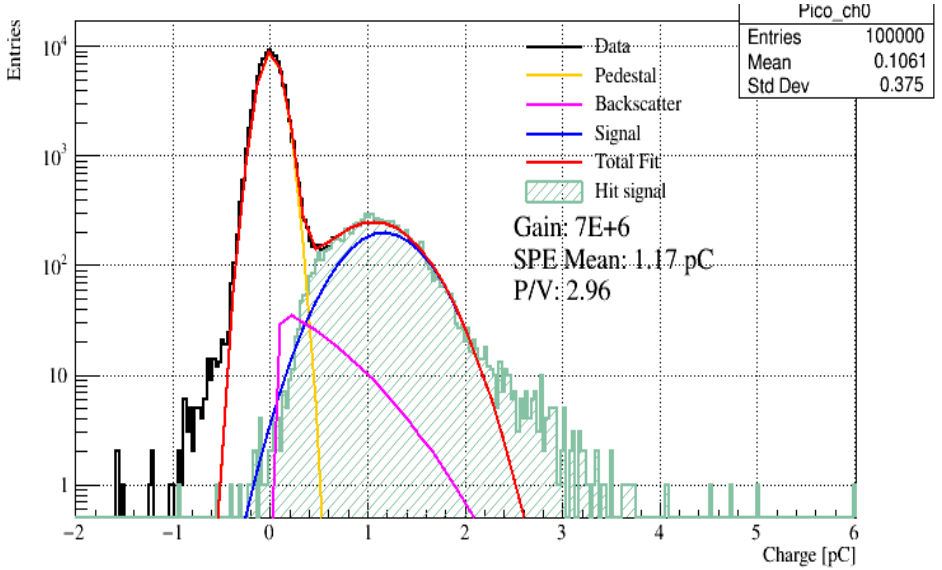




**All monitoring system development was published. (@Prog. Theor. Exp. Phys. 2026 033C01)**

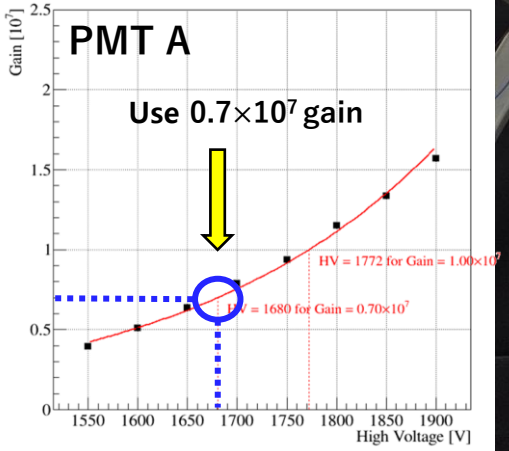
- HV, environmental temperature, humidity, and radon monitoring is done.
- LS temperature, LS level, DAQ rack temperature monitoring is done

# Detector Calibration















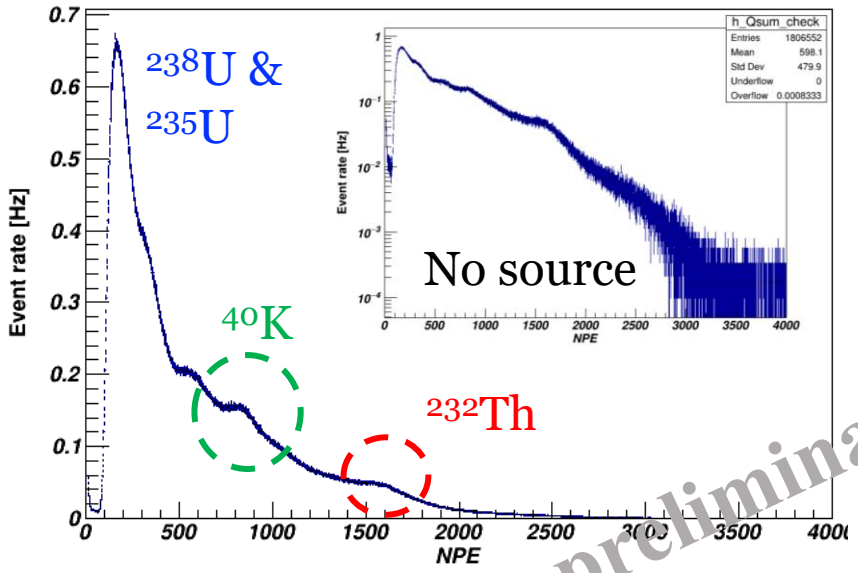

*** SPE Fitting Function**

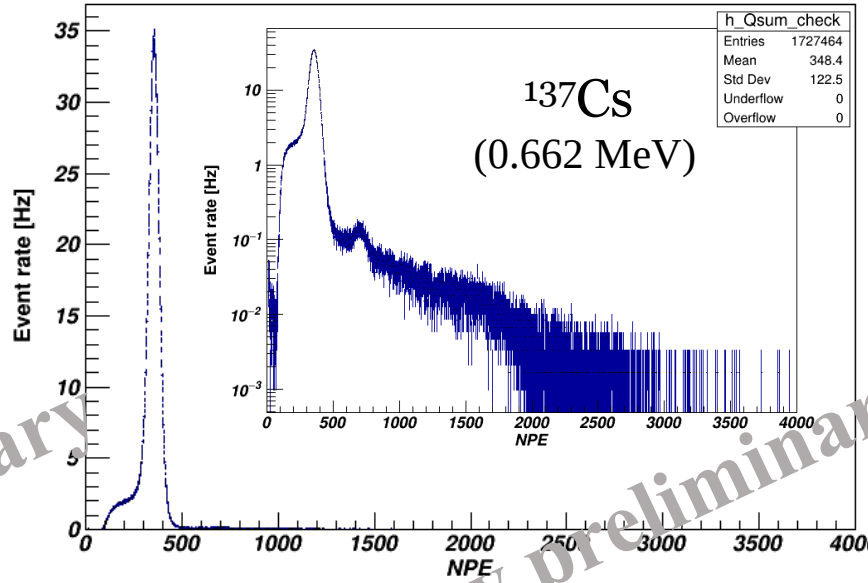
$$f(x) = \sum_{i=1}^{2} A_i \cdot \exp\left\{-\left(\frac{x-\mu_i}{\sqrt{2}\sigma_i}\right)^2\right\} + A_3 \cdot \left\{erf\left(\frac{x-\mu_3}{\sigma_3}\right) - erf\left(\frac{x-\mu_2}{\sigma_2}\right)\right\}$$

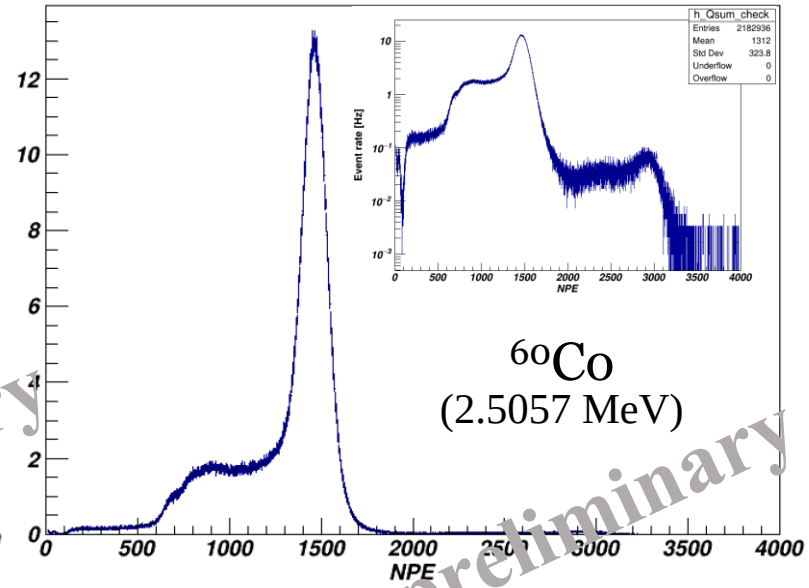
(Prog. Theor. Exp. Phys. 2026 053H02)

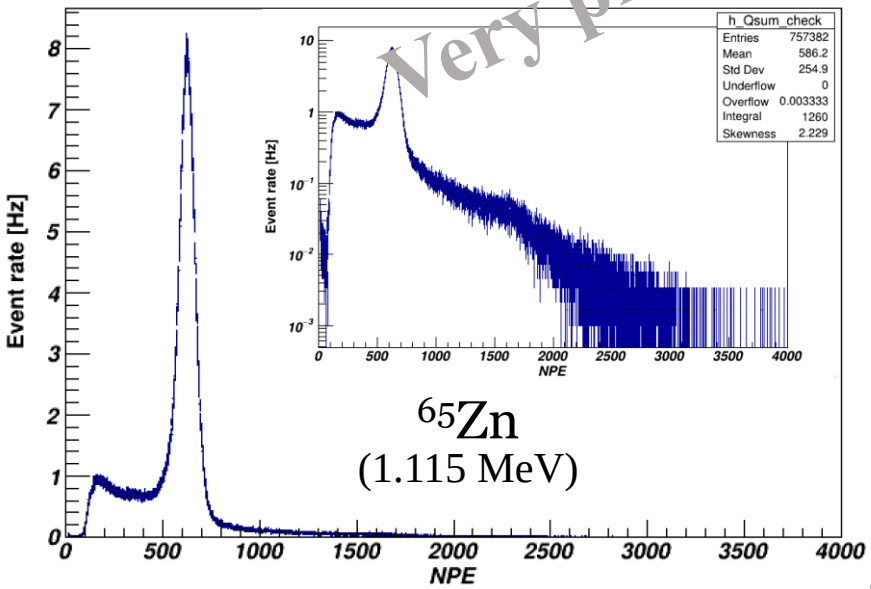
# Radioactive source data taking

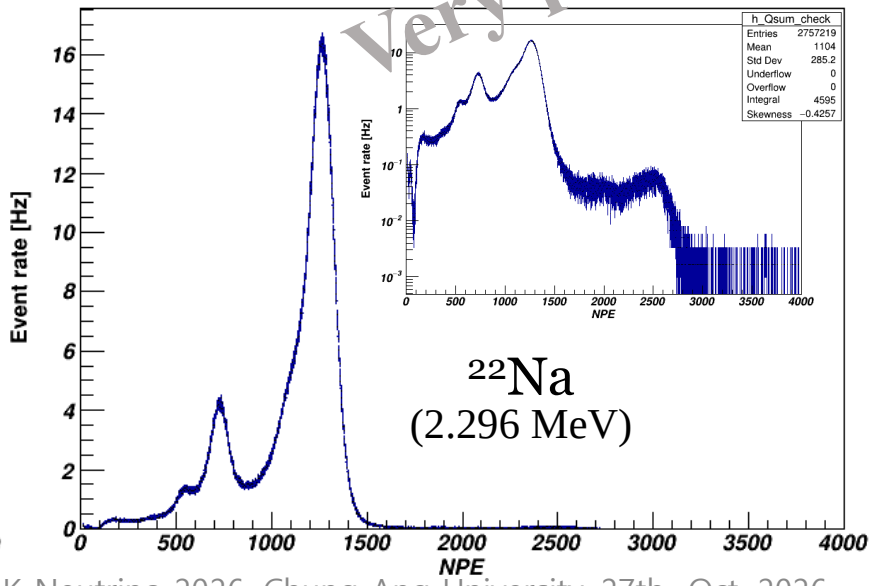
- PMT gains : ~0.7 x $10^7$ , Threshold : ~36 mV (~0.1 MeV), Source position : target center.

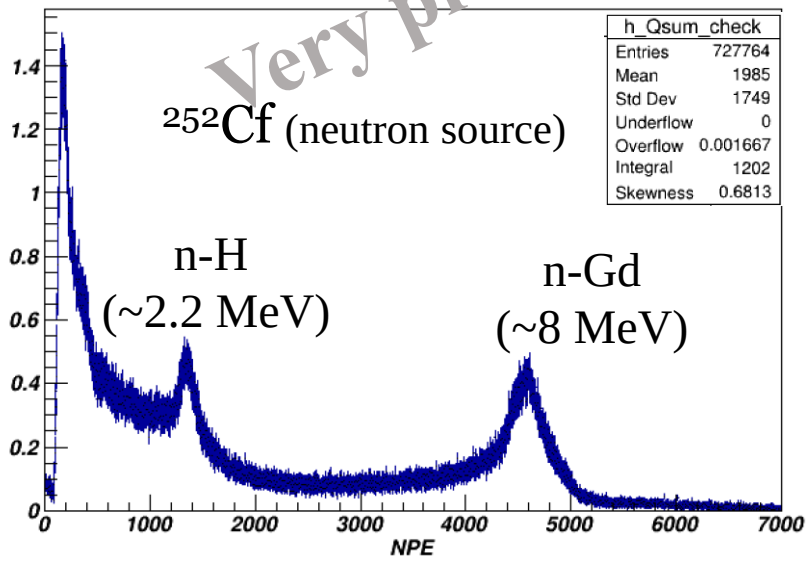


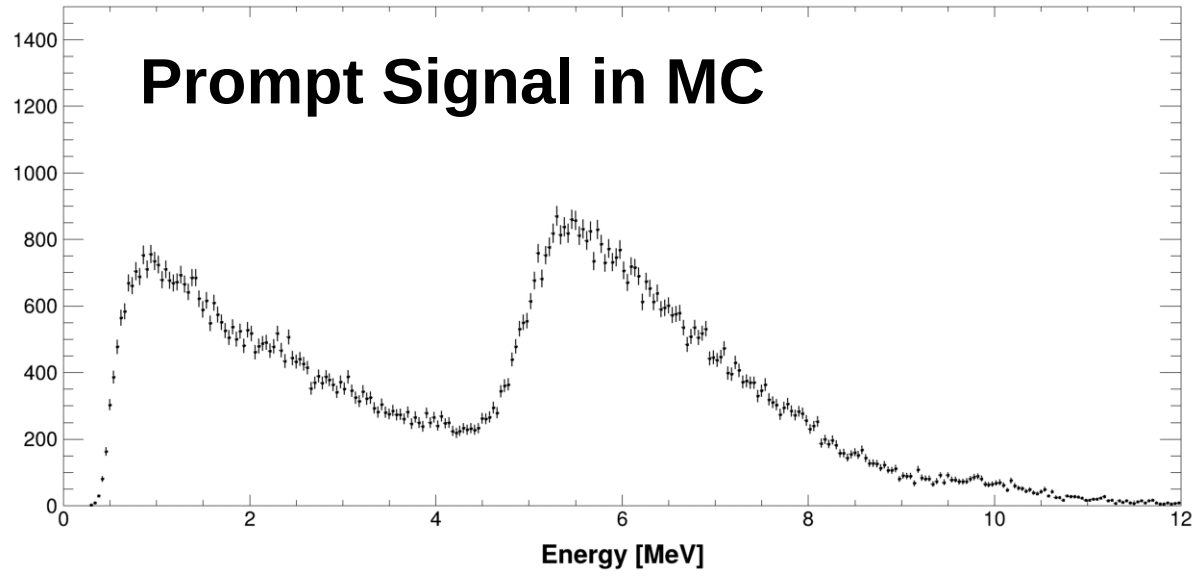



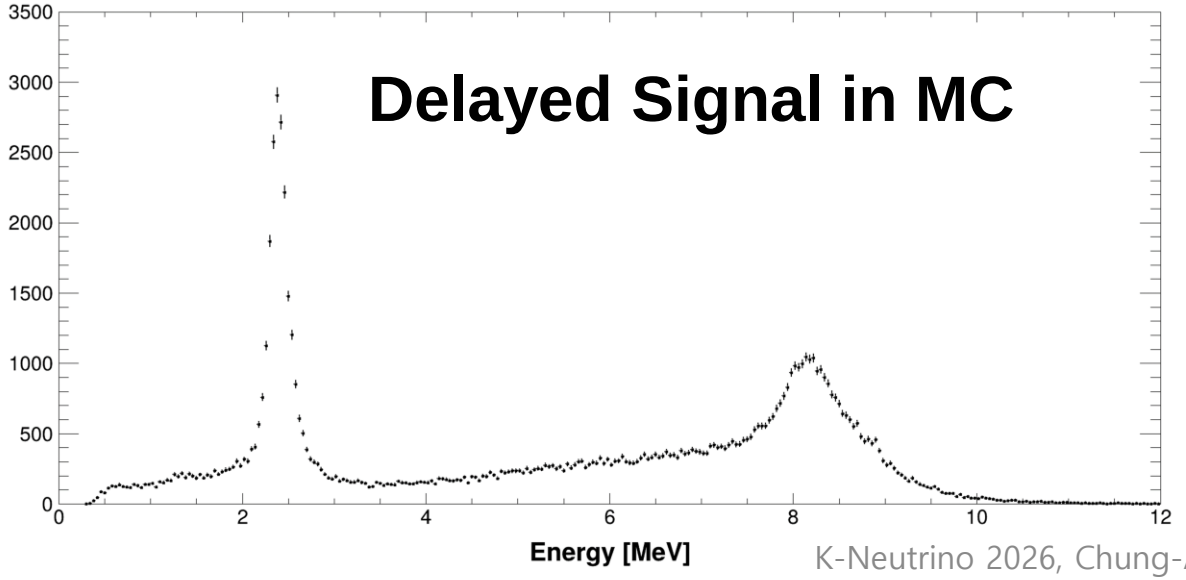



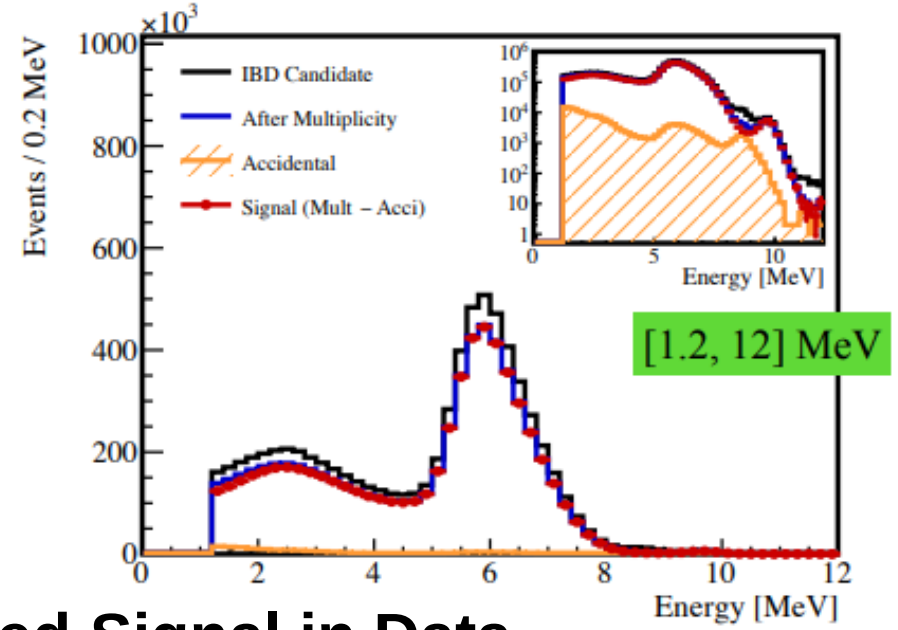

Very preliminary
Very preliminary
Very preliminary

# Energy Spectrum of the Am-Be Source:

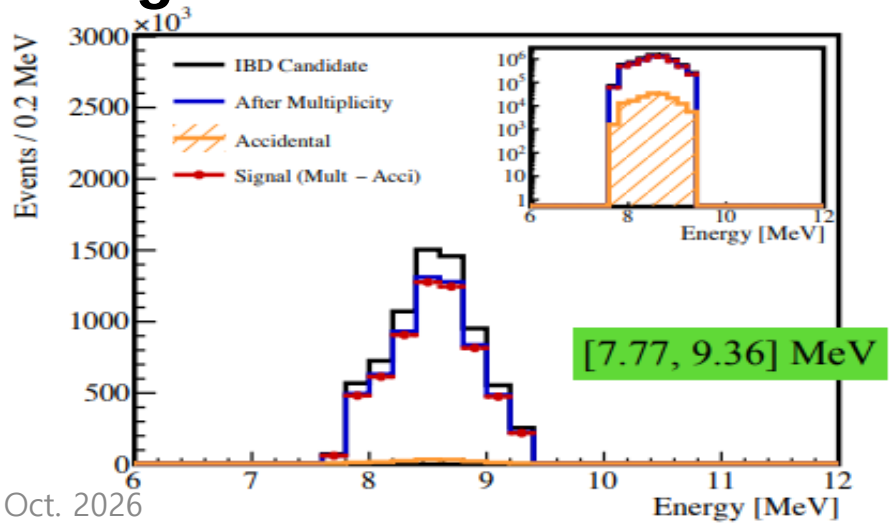


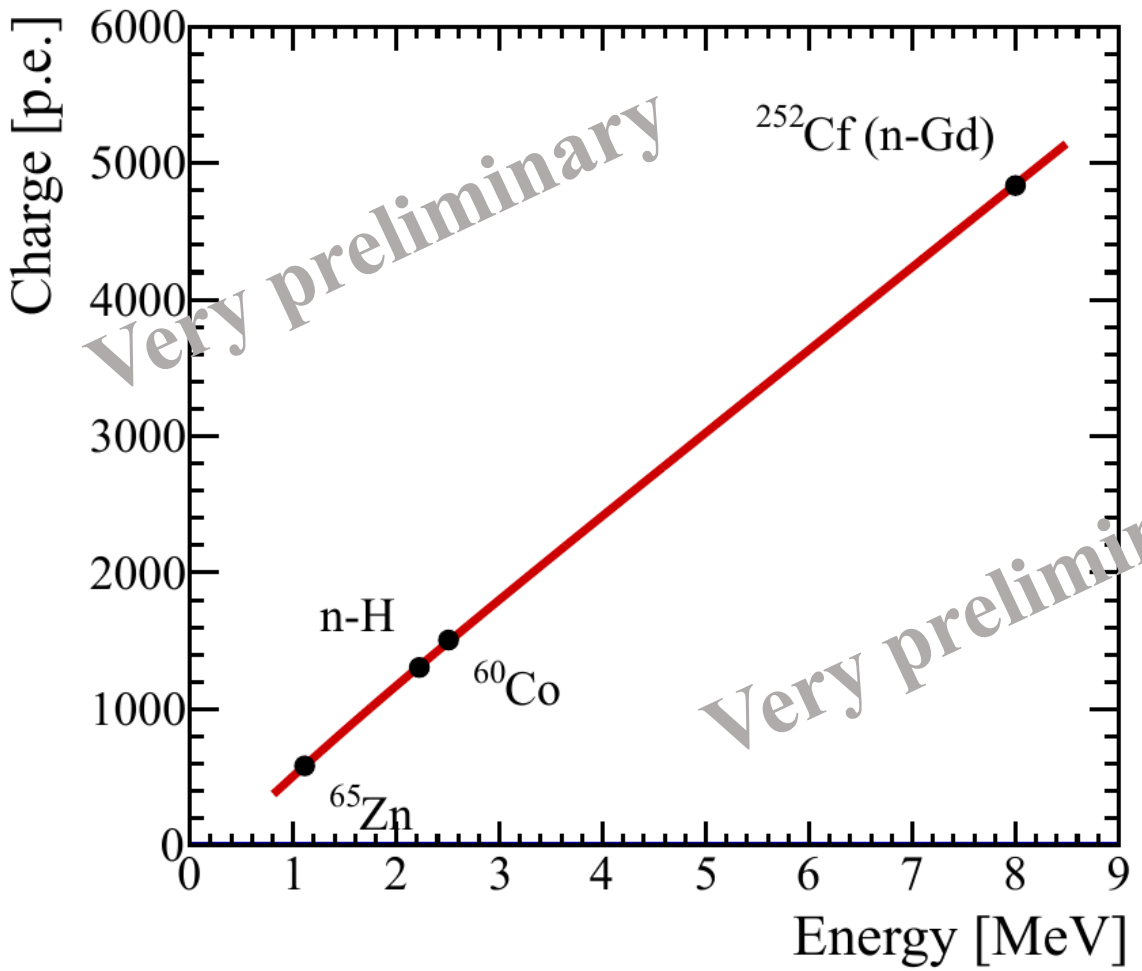

## Prompt Signal in Data

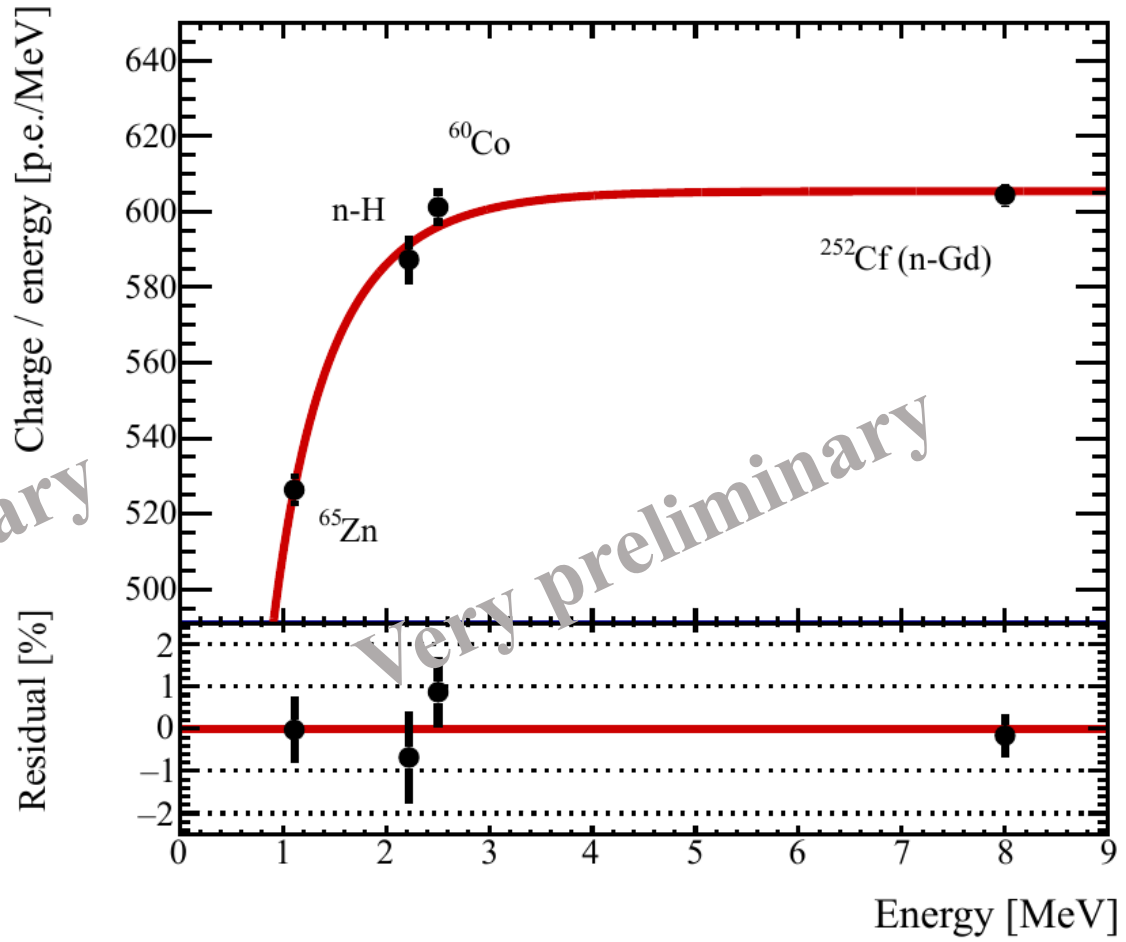



## Delayed Signal in Data



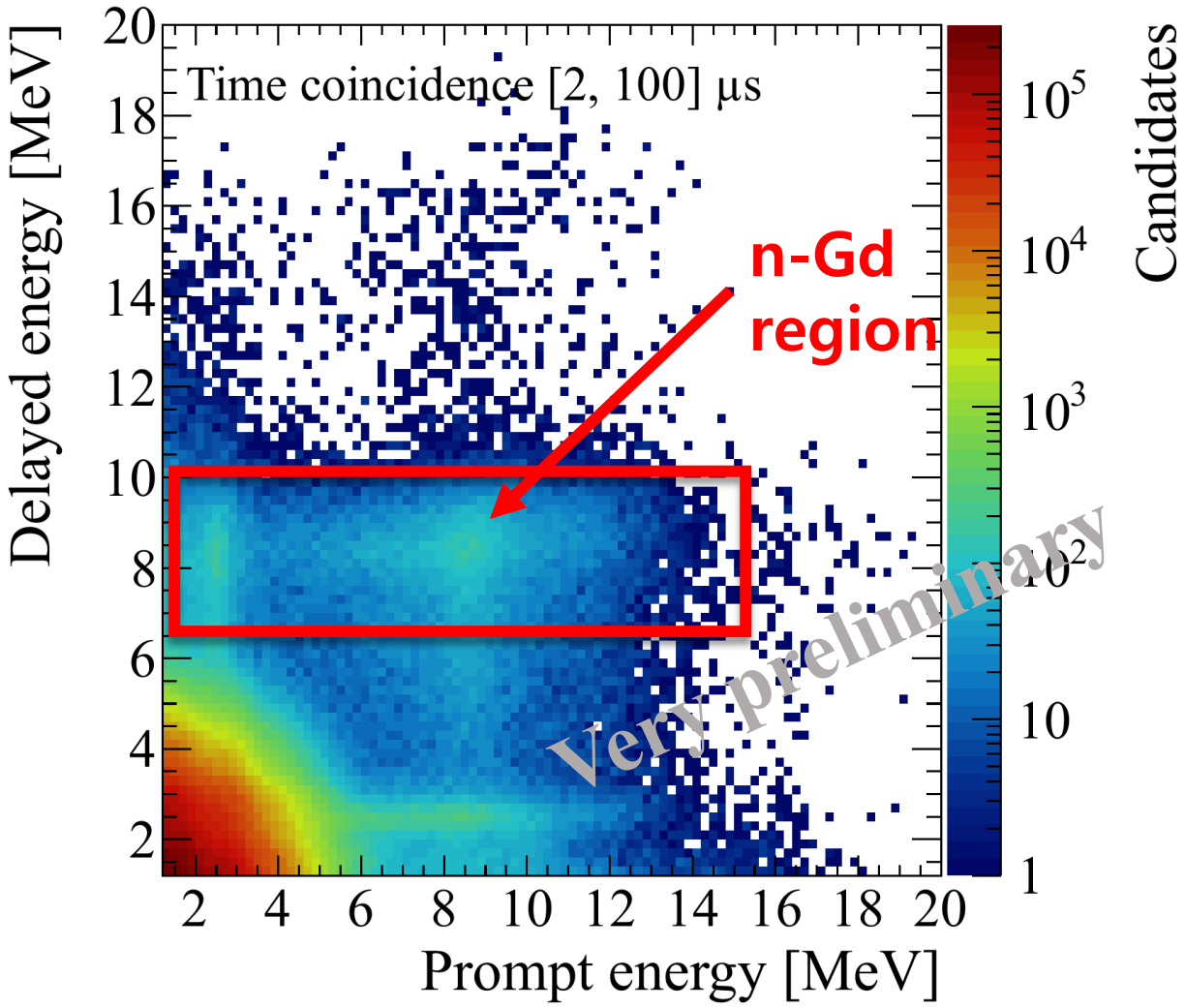
# Energy conversion function




- **Energy resolution:** $\sigma/E = 4.4\ \% / \sqrt{E} + 2.4\ \%$ (6.8 % at 1 MeV)

# IBD Candidates




| Selection criteria | n-Gd capture |
|---|---|
| Muon veto | 150 μs after a muon |
| Prompt | 1.2 < Ep < 10 MeV |
| Delayed | 6 < Ed < 10 MeV |
| Coincidence | 2 < ΔT < 100 μs |
| Isolation | (−200, S1], [S2, +400) μs |
| Accidental | > 1 ms |

# RENE Schedule

| Year | 2022 | 2023 | | | | 2024 | | | | 2025 | | | | 2026 | | | | 2027 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Month | 10-12 | 1-3 | 4-6 | 7-9 | 10-12 | 1-3 | 4-6 | 7-9 | 10-12 | 1-3 | 4-6 | 7-9 | 10-12 | 1-3 | 4-6 | 7-9 | 10-12 | ••• |
| Collaboration Start | ☼ | | | | | | | | | | | | | | | | | |
| Design | | → | → | → | → | → | → | → | → | | | | | | | | | |
| Simulation | | → | → | → | → | → | → | → | → | → | → | → | → | | | | | |
| Gd-LS and LS | | | | | | → | → | → | → | | | | | | | | | |
| DAQ | | | → | → | → | → | → | → | → | | | | | | | | | |
| PMT | | | → | → | → | → | → | → | → | | | | | | | | | |
| Construction | | | | | | | | | → | → | → | → | → | | | | | |
| DAQ Commissioning (CNU & Yeonggwang site) | | | | | | | | | | | | | | → | → | → | → | |
| RENE Data-taking | | | | | | | | | | | | | | | | | → | ⇢ |

☼ : RENE started

# Progress of individual tasks

- Technical Design Report was published (2025.09.23)

  → **Prog. Theor. Exp. Phys. 2025 093C03**

- Monitoring system paper was published (2026.02.12)

  → **Prog. Theor. Exp. Phys. 2026 033C01**

- PMT study paper was published (2026.04.24)

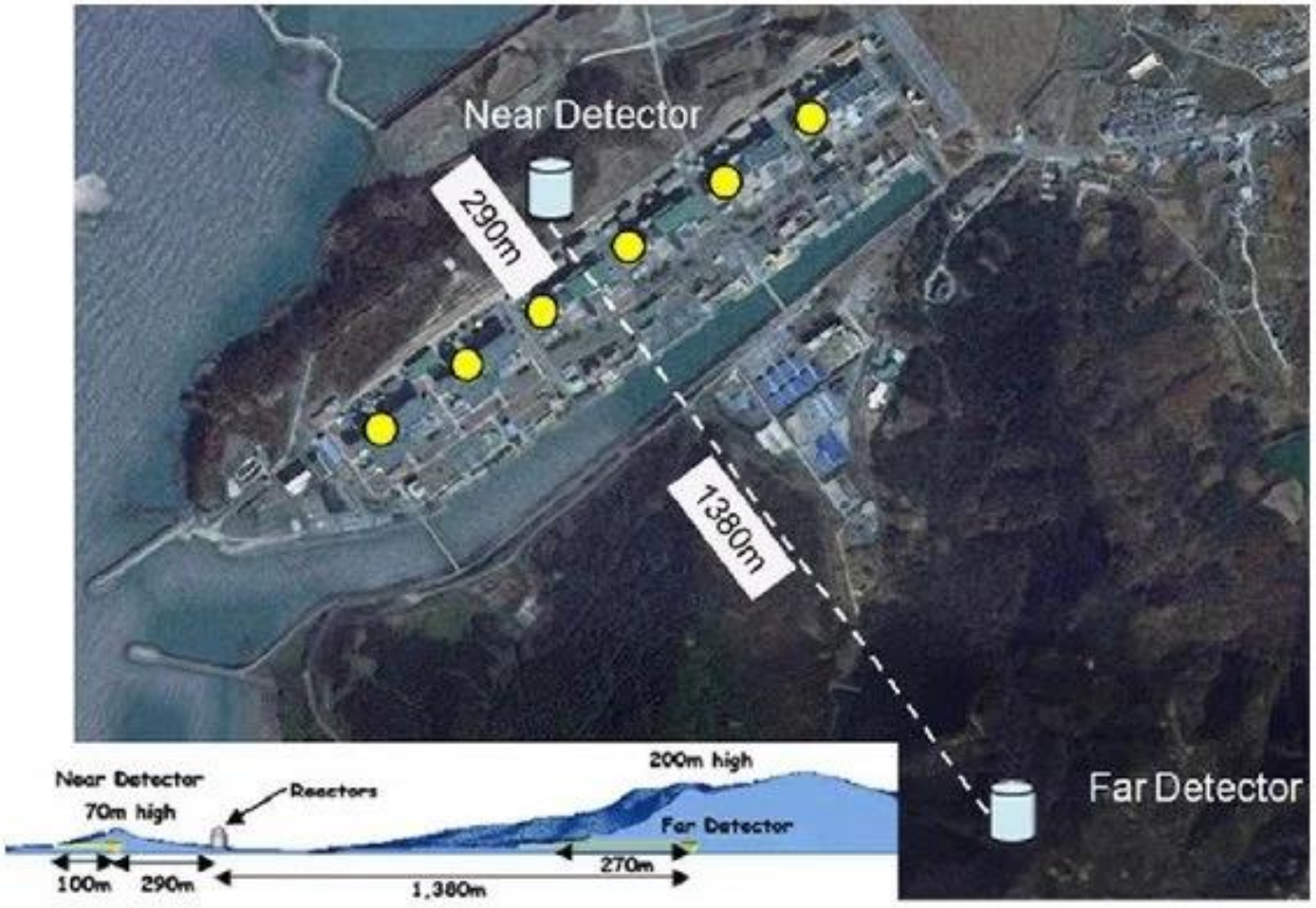
  → **Prog. Theor. Exp. Phys. 2026 053H02**

- VETO detector study is undergoing.

# Summary

- The RENE experiment aims to search for **the sterile neutrino at $\Delta m_{41}^2 \sim 2\ eV^2$**.
- The construction of RENE detector is done.
- RENE detector  is on going.
- We are currently tunning the DAQ condition, calibration, and so on.

# Back up


Near Detector
290m
1380m
Far Detector
Near Detector
70m high
Reactors
200m high
Far Detector
100m
290m
1,380m
270m