The status of Reactor Experiment for Neutrino and Exotics (RENE)

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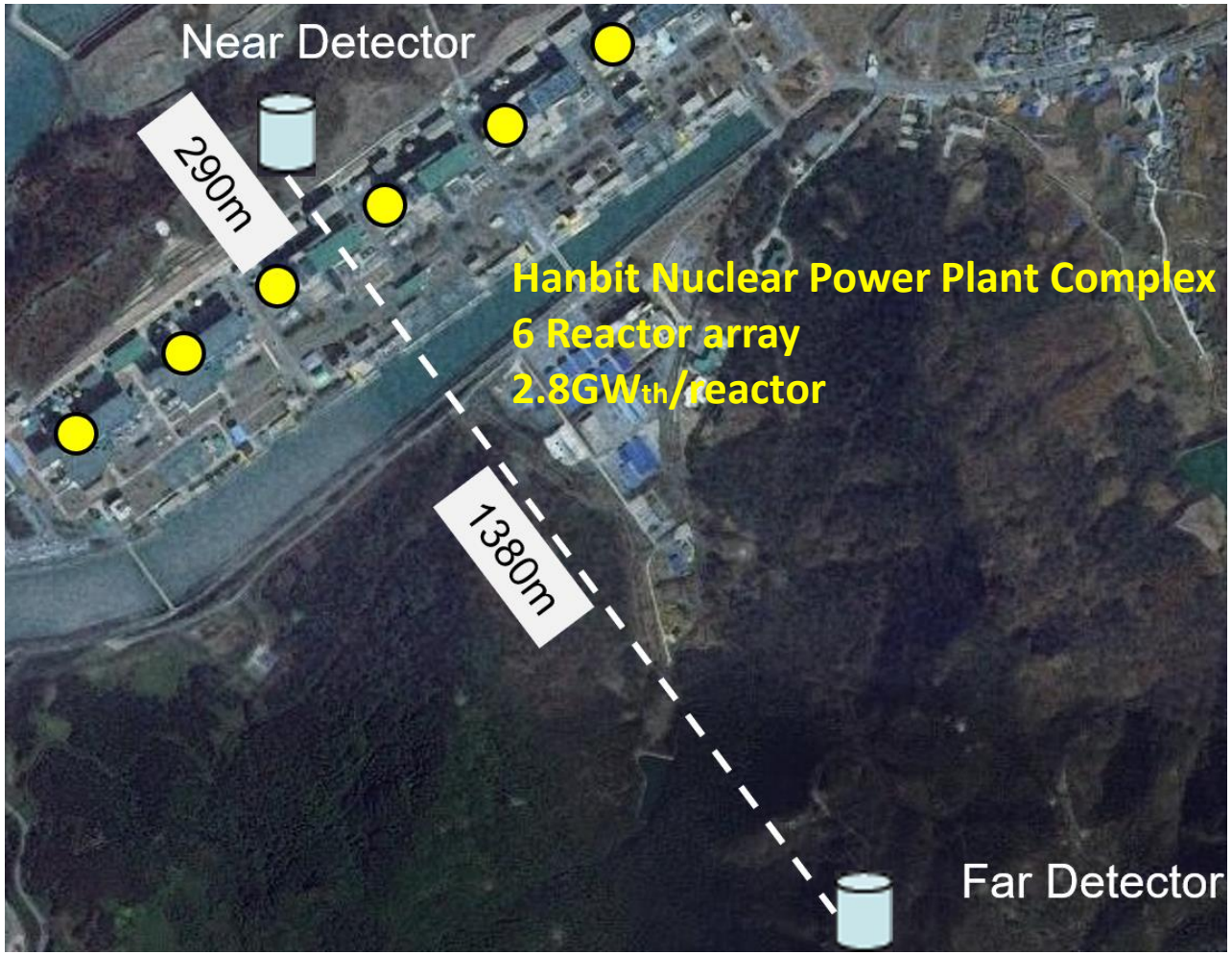
RENE project

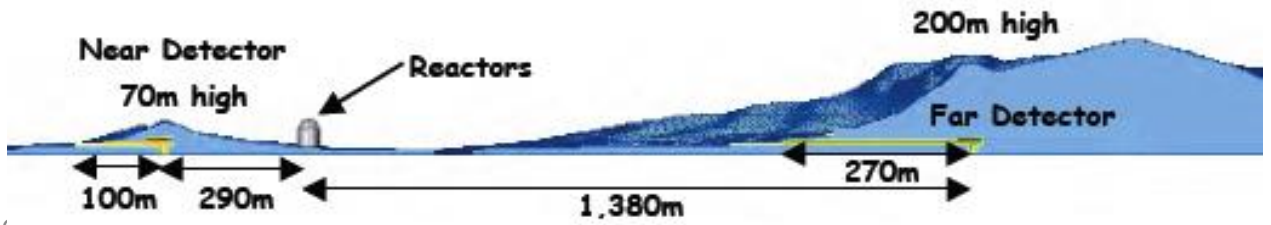
- RENE (Reactor Experiment for Neutrino and Exotics) Collaboration is formed (Nov. 2022)
- Goal
  - Primarily, search for the sterile neutrino oscillation at $\Delta m^2_{41} \sim 2$ eV^2, hinted by RENO-NEOS joint analysis (PRD 105 (2022) 111101)
  - Precise measurements of the flux and spectrum of reactor electron antineutrinos
  - Separation of the reactor neutrino spectrum into those from ^{235}U and ^{239}Pu.

RENO

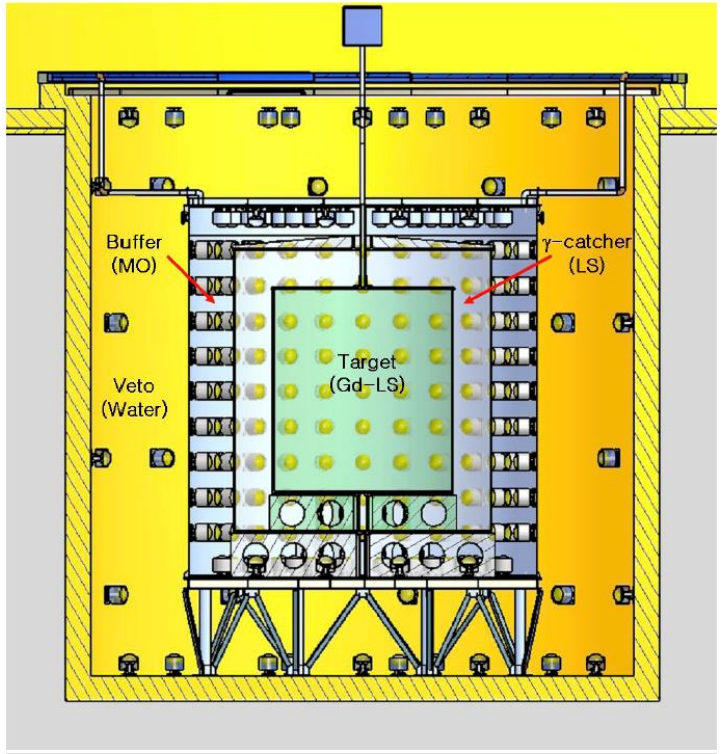
(Reactor Experiment for Neutrino Oscillation)

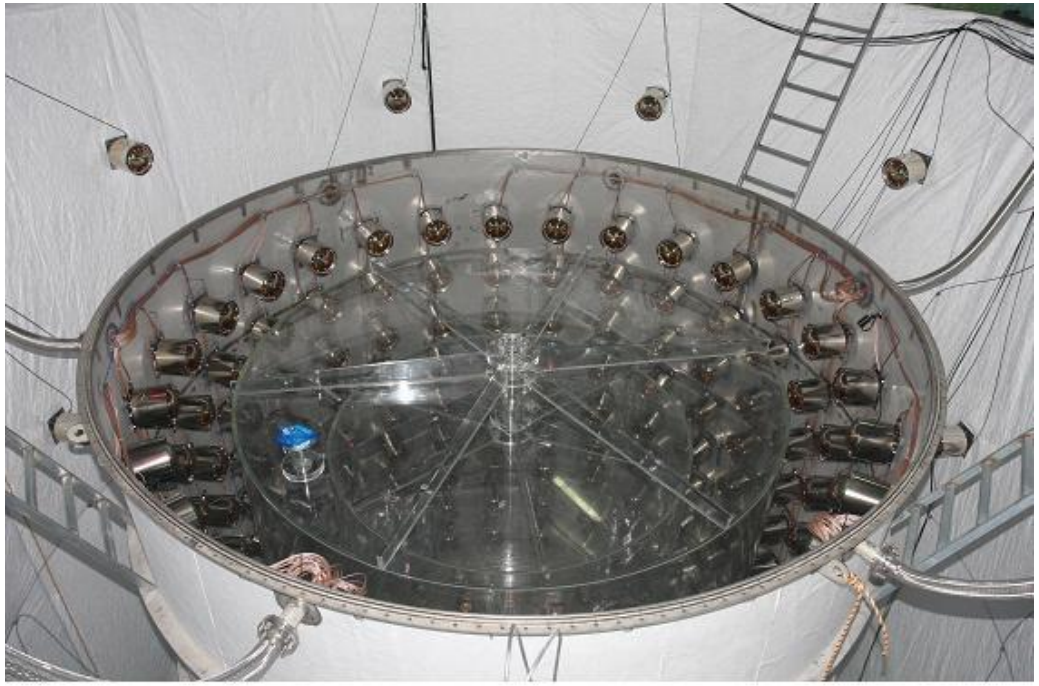
- Primary goal: Measurement of θ_{13}
- Start taking data in August 2011





RENO



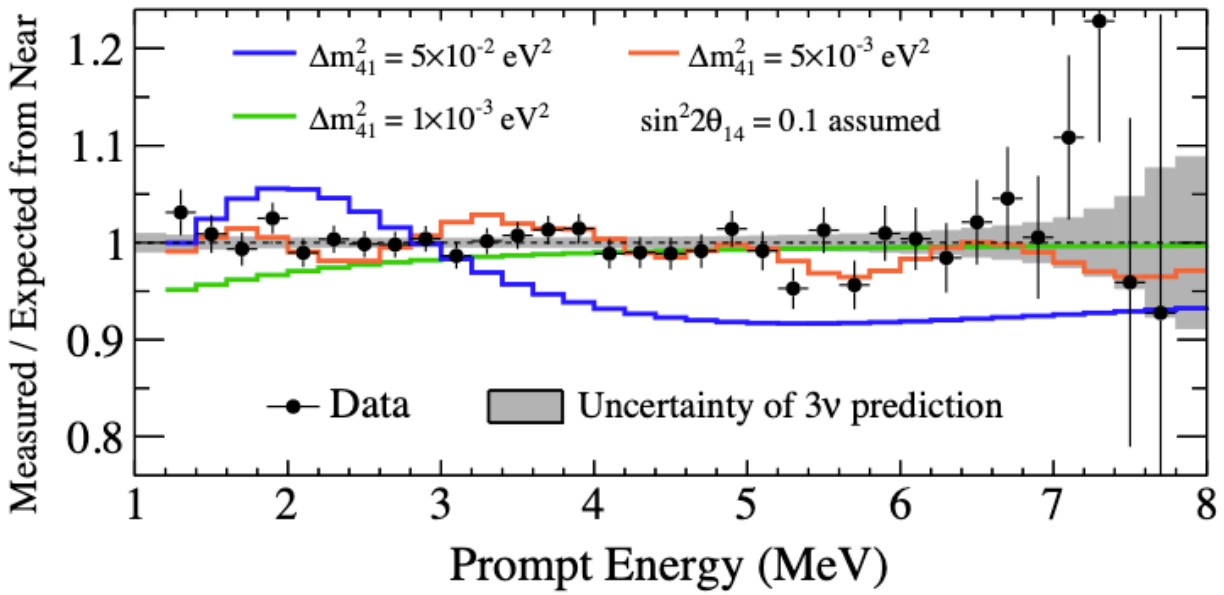


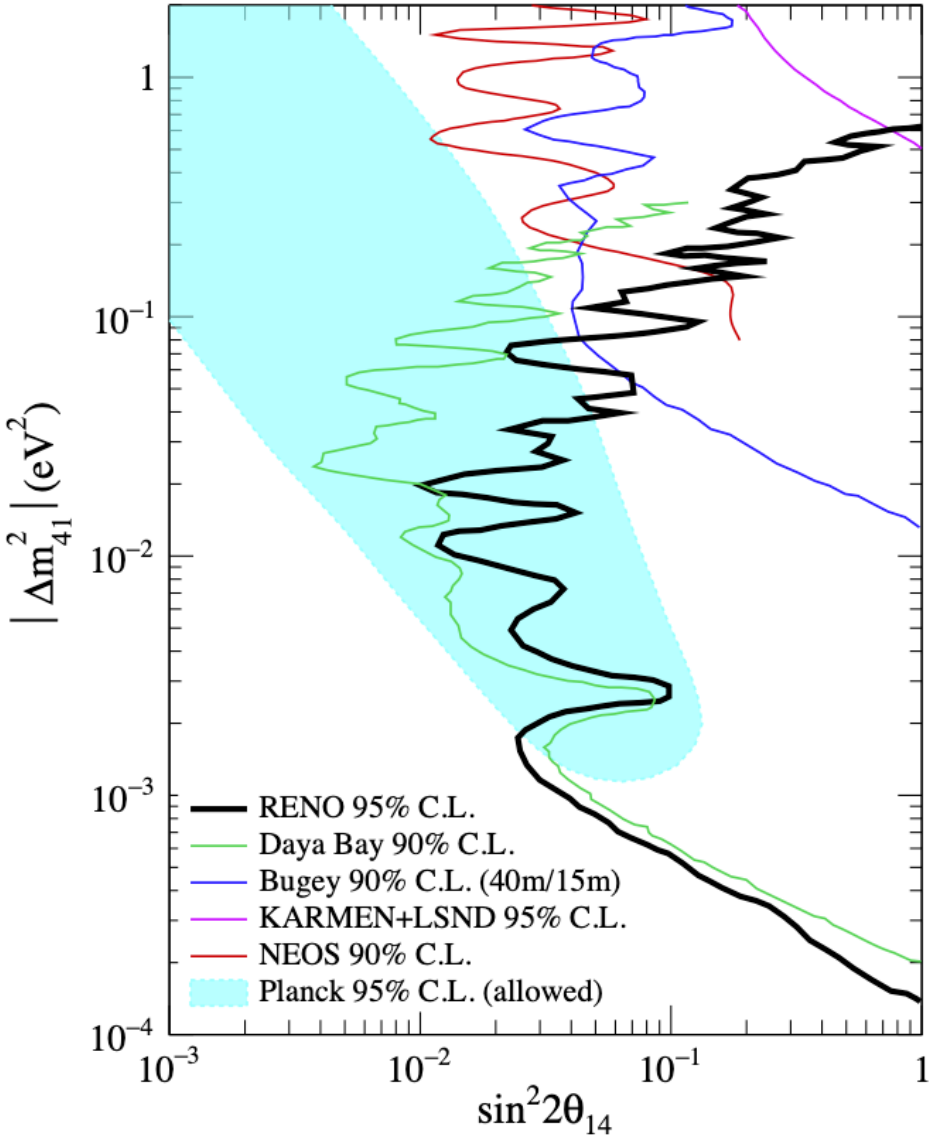
- 354 ID +67 OD 10” PMTs
- Target : 16.5 ton Gd-LS, R = 1.4 m, H = 3.2 m
- Gamma Catcher : 30 ton LS, R = 2.0 m, H = 4.4 m
- Buffer : 65 ton mineral oil, R = 2.7 m, H = 5.8 m
- Veto : 350 ton water, R = 4.2 m, H = 8.8m

RENO results for sterile neutrino

- Search for Sub-eV sterile neutrino in the 4 ν framework.

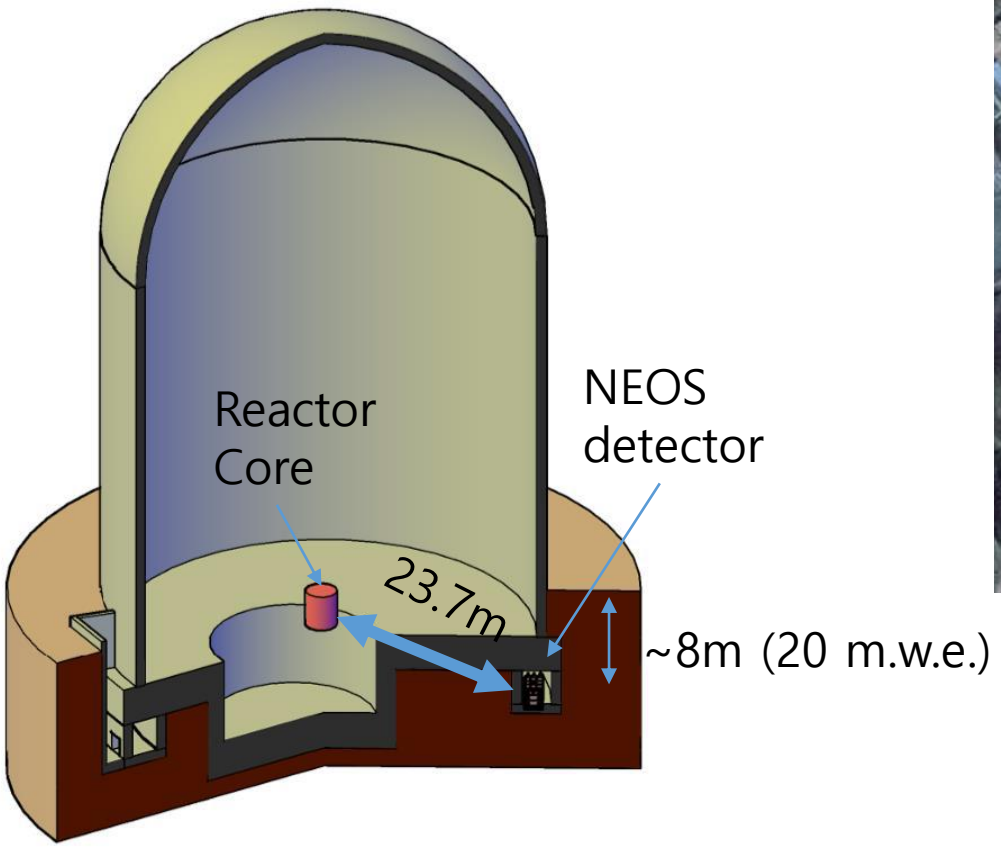
PRL 125 (2020) 191801

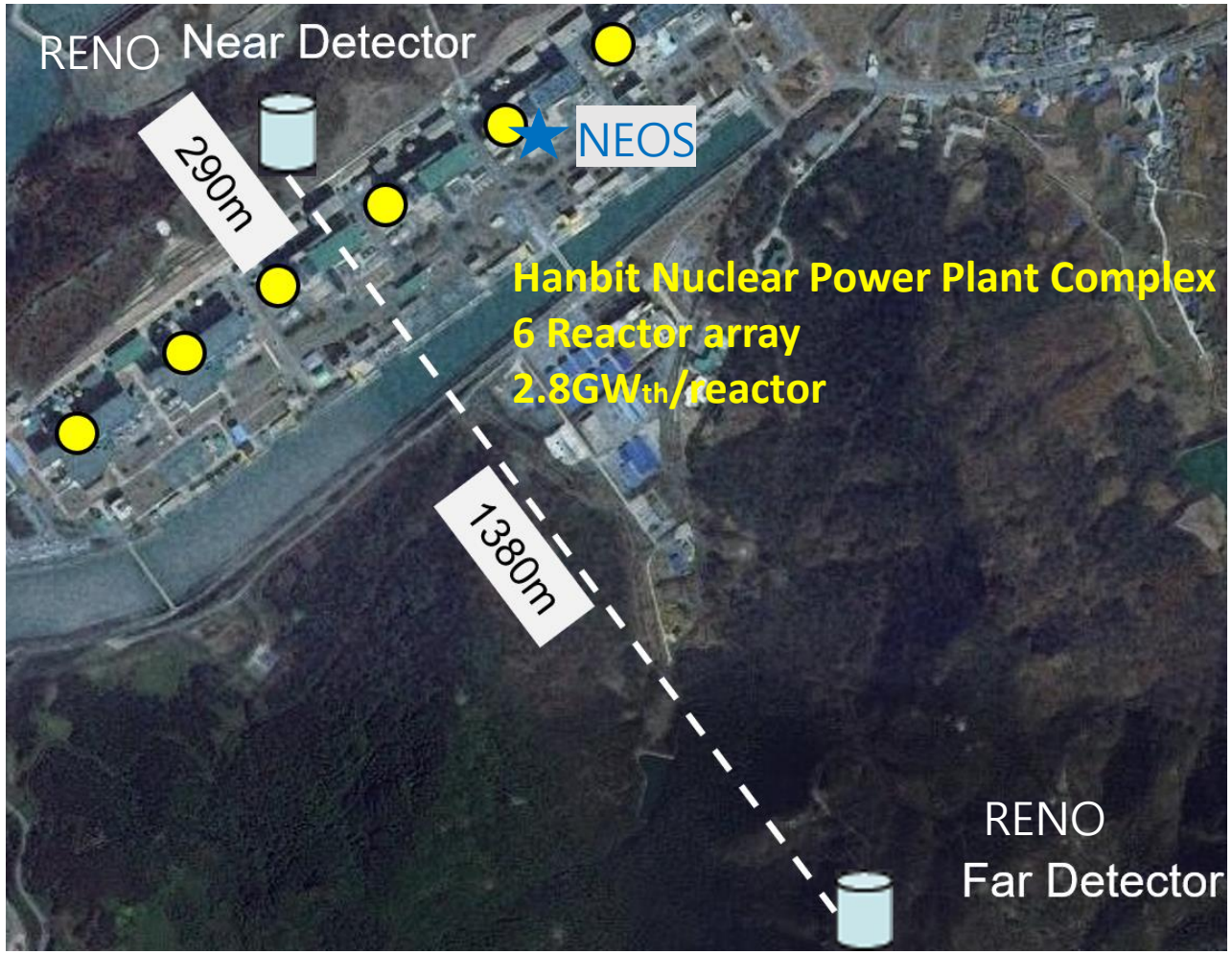




NEOS

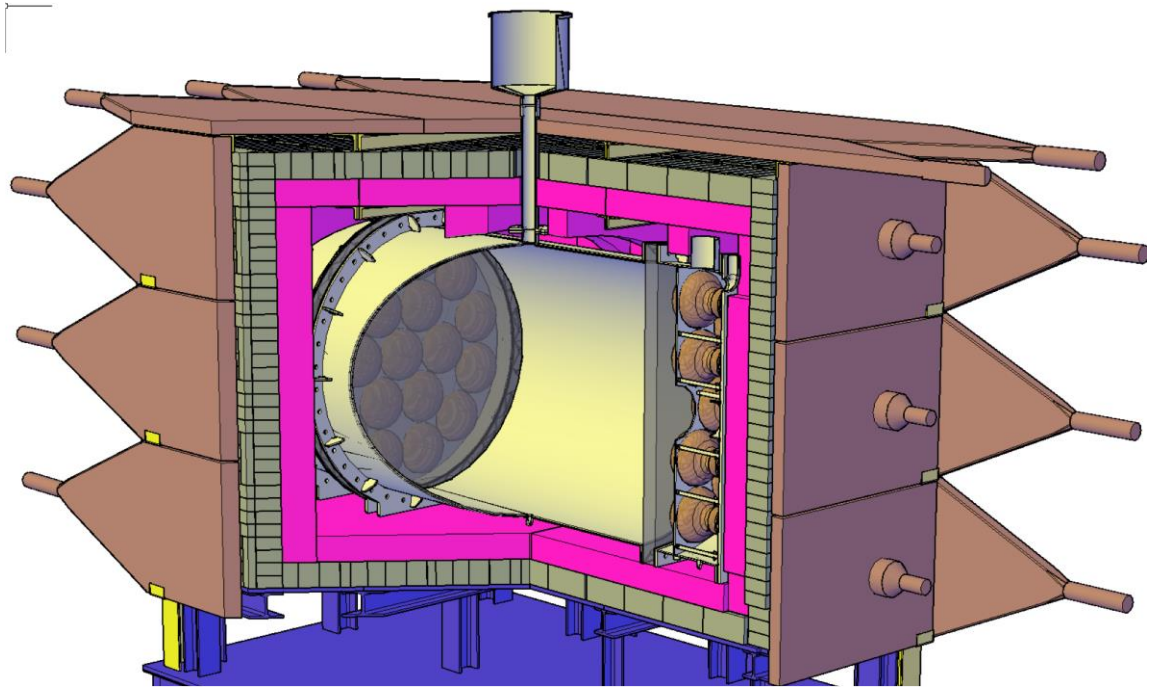
(Neutrino Experiment for Oscillation at Short baseline)



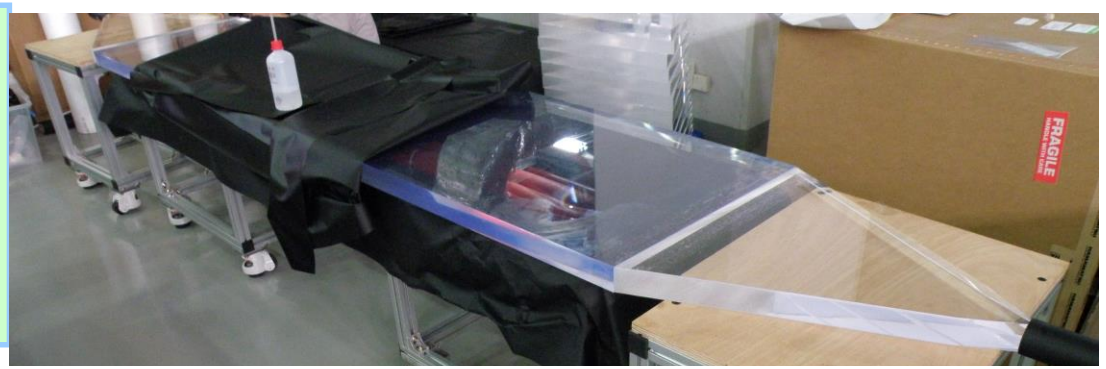


- Primary goal: search for eV scale sterile neutrino in the 4 ν framework.
- NEOS-1: Aug. 2015 - May 2016
- NEOS-2: Sep. 2018 ~ Oct. 2020

NEOS

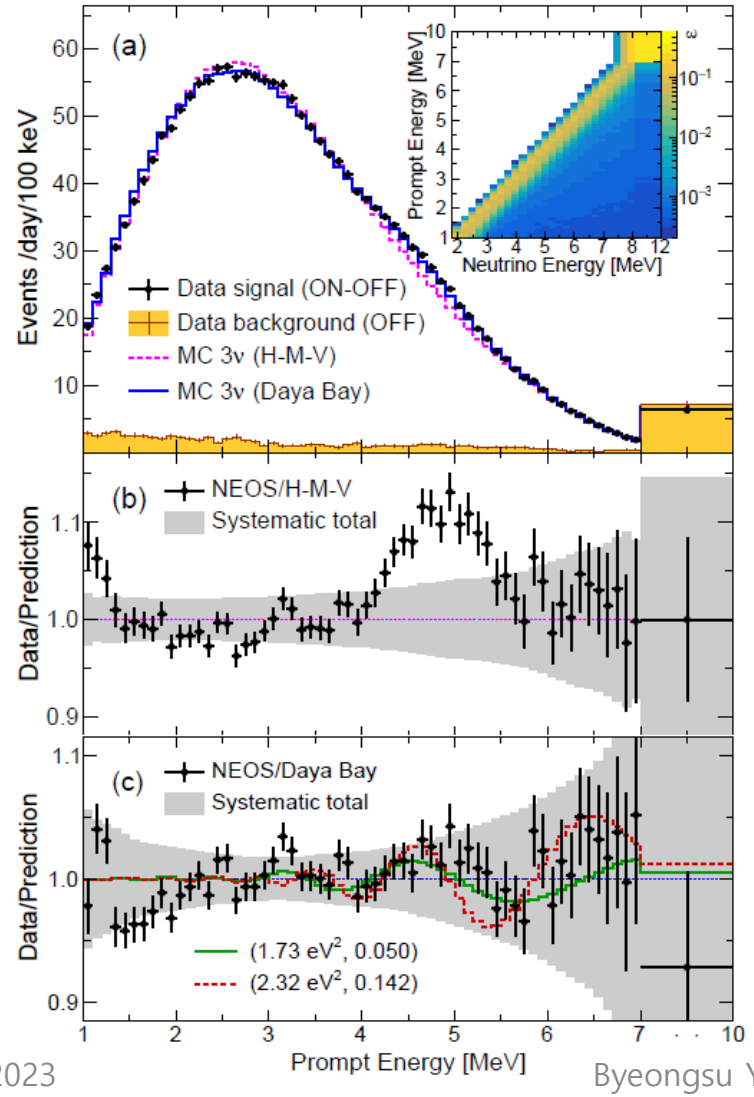


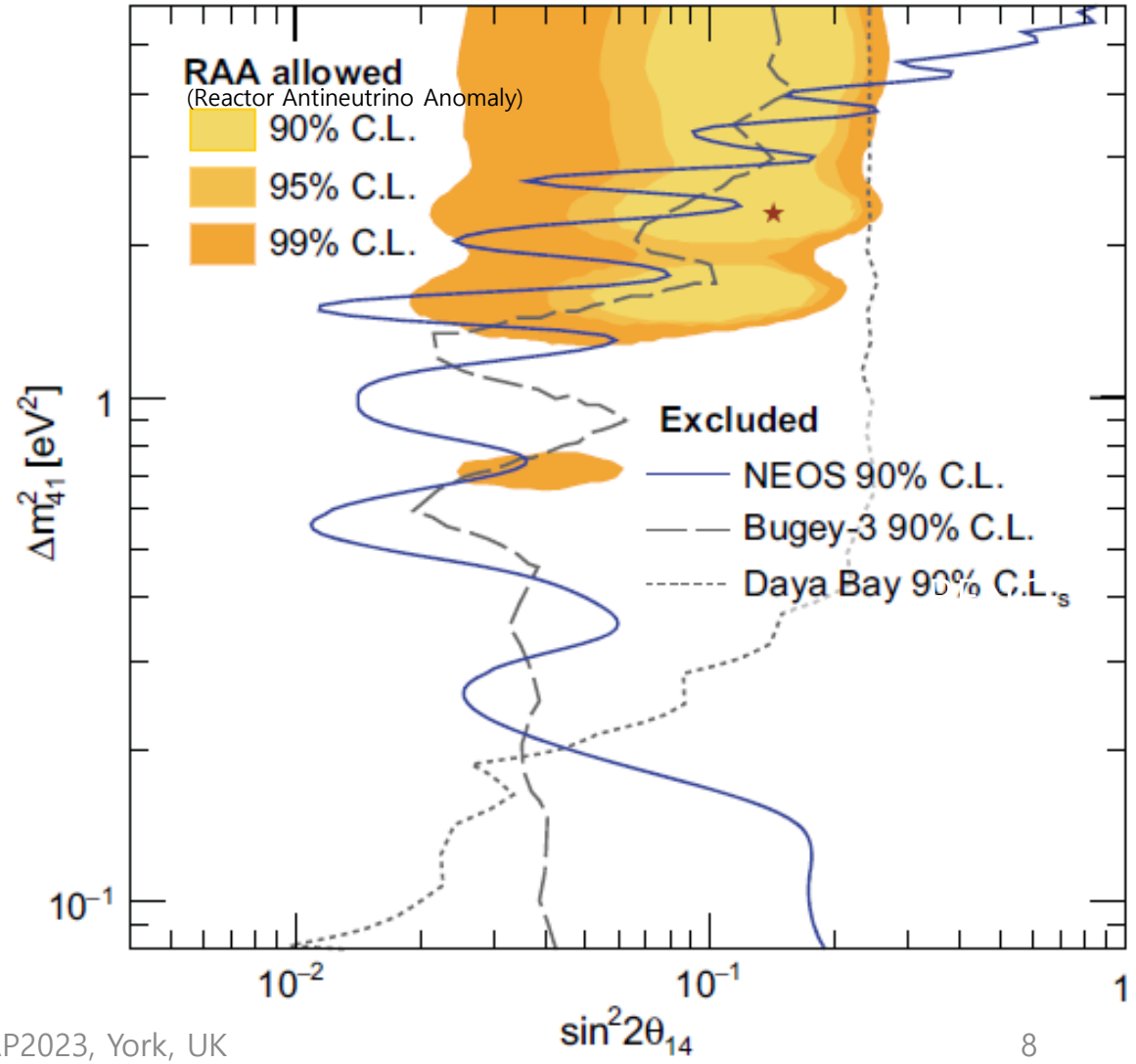
- Target: 0.5 % Gd-LS ~1 kL. R = 51.5 cm, H = 121 cm
- Buffer: mineral oil. 38 PMTs installed
- Shielding: 10 cm borated polyethylene and 10 cm Pb
- Veto: 15 plastic scintillators with PMTs except for the bottom side



NEOS Result for sterile neutrino

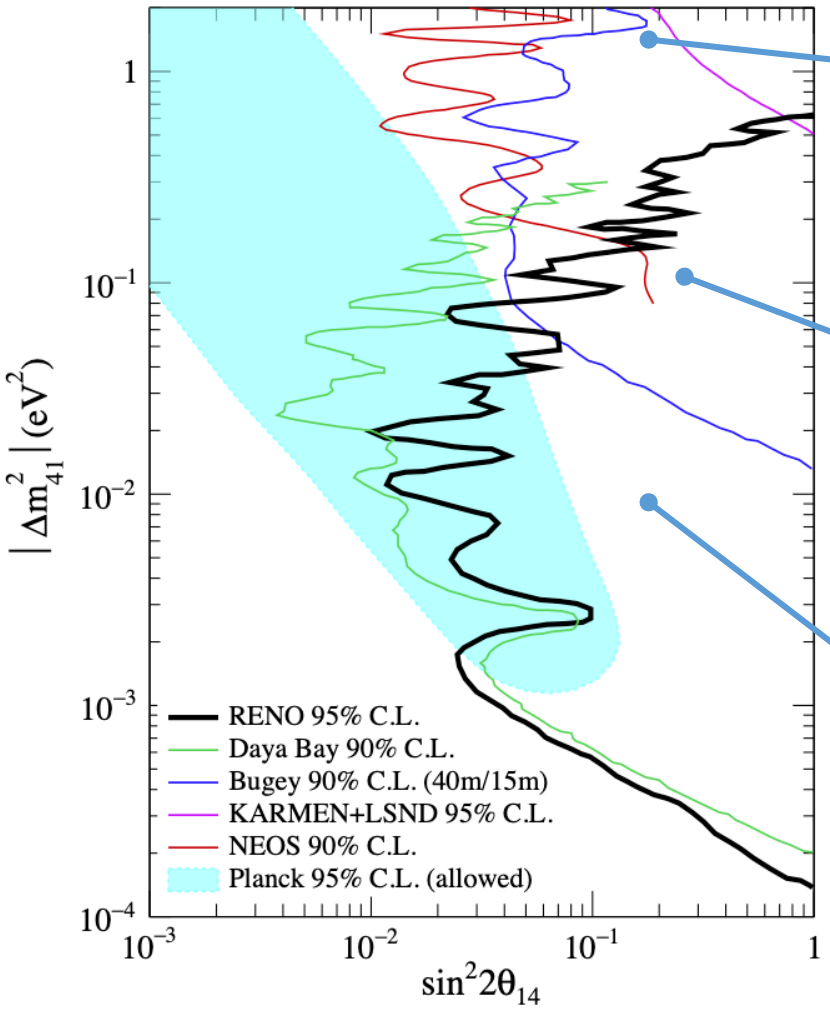
PRL 118 (2017) 121802

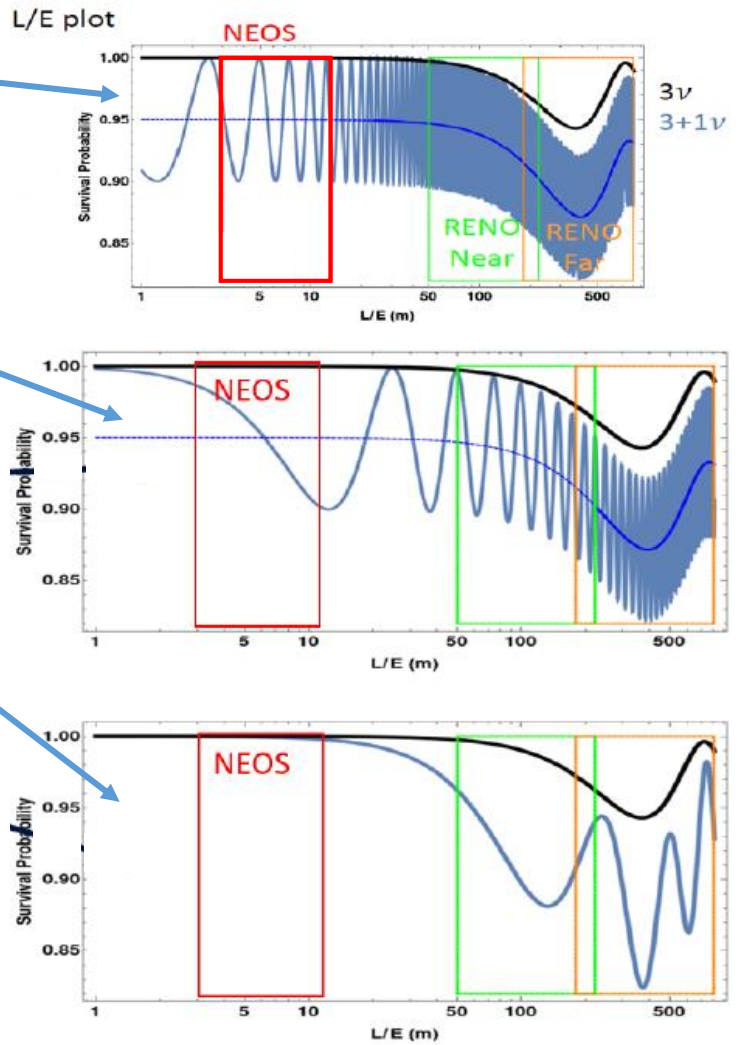




RENO and NEOS joint analysis

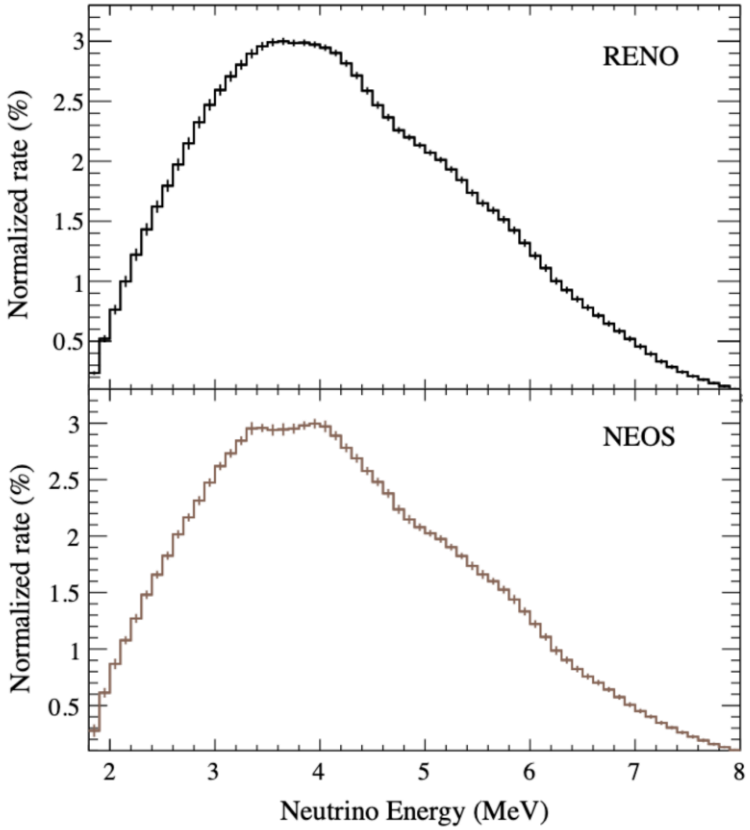
- Search for eV scale sterile neutrino in the 4 ν framework.
- Comparison of spectra of RENO near detector and NEOS
- Well-understood systematic uncertainties of both experiments



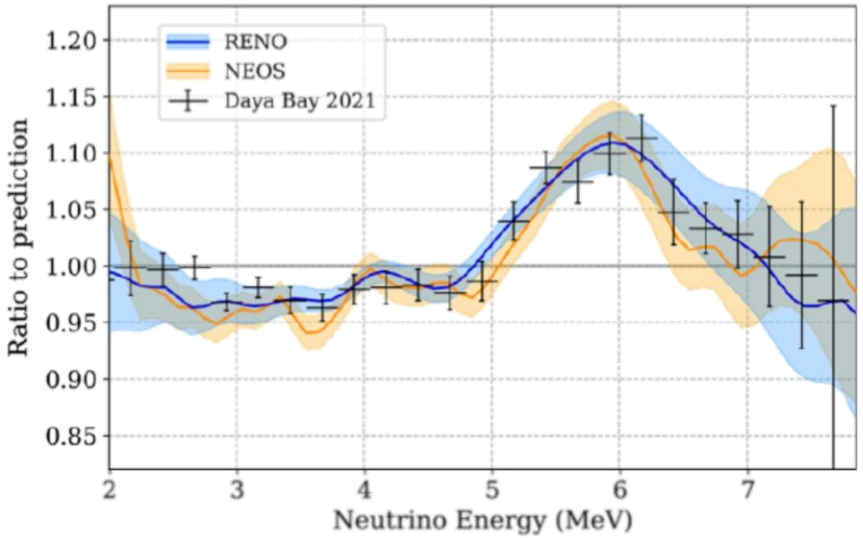


RENO and NEOS joint analysis

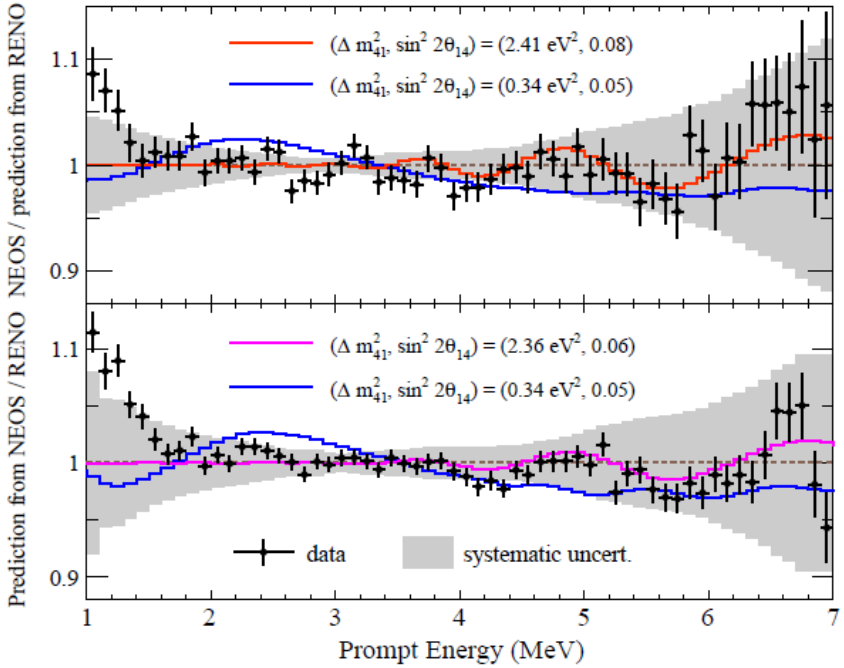
Reactor antineutrino spectra unfolded from RENO and NEOS data



Comparison of neutrino energy spectra among RENO, NEOS and Daya Bay

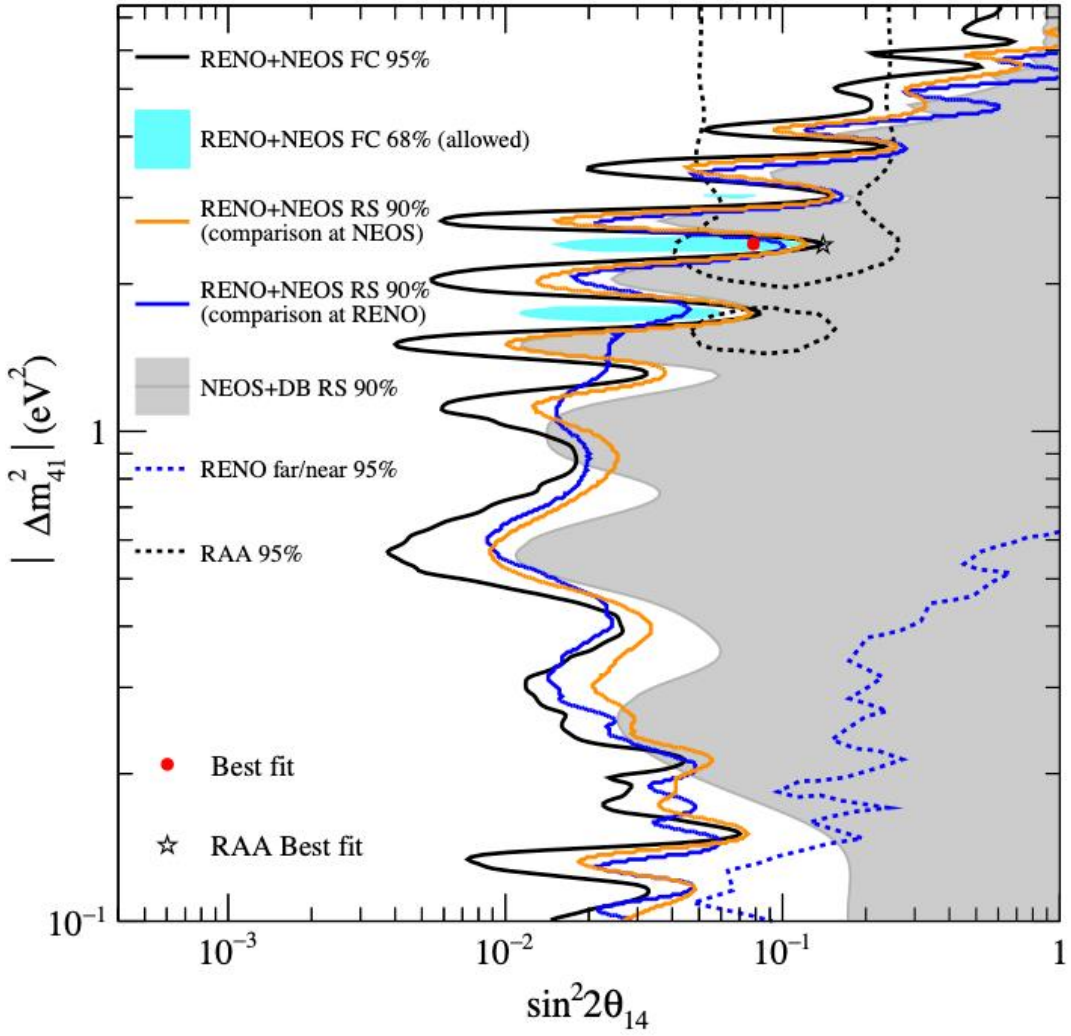


Comparison with spectra of 4 ν models



RENO and NEOS joint analysis

- RENO+NEOS best fit at (0.08, 2.4 eV^2) around the RAA best fit
- 4 ν min χ^2/DOF = 47.45/58
  3 ν min χ^2 /DOF = 56.24/60
- $\Delta\chi^2$ = 8.8, p=8.5%



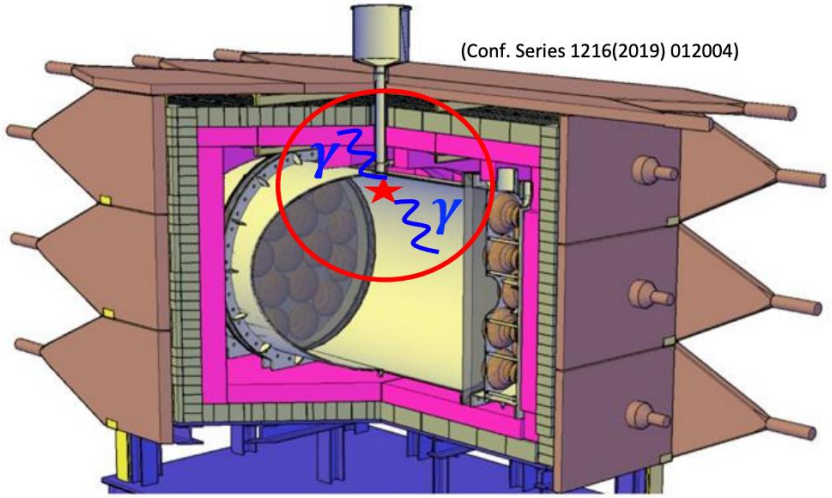
RENE project

- Primarily aiming to search for the sterile neutrino oscillation at $\Delta m^2_{41} \sim 2\ eV^2$, hinted by RENO-NEOS joint analysis
- RENE Collaboration is formed (Nov. 2022)
  - About 30 members ~11 institutions

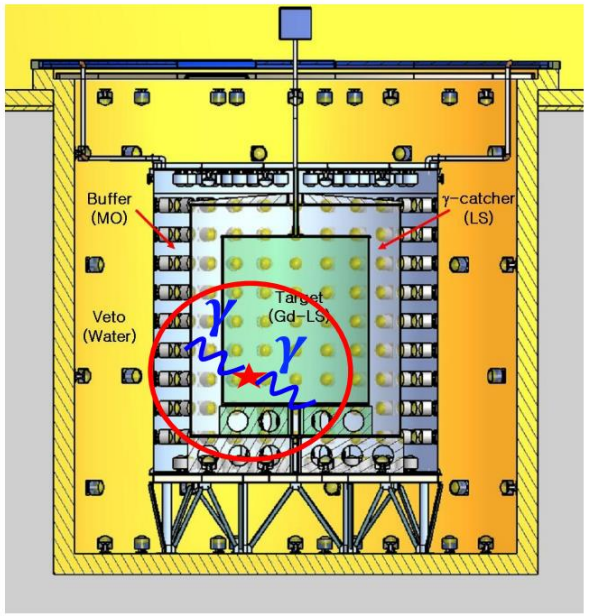
- Chonnam National University
- Dongshin University
- Gwangju Institute of Science and Technology
- Jeonbuk National University
- Institute for Basic Science
- Kyungpook National University
- Kyung Hee University
- Sejong University
- Seoul National University
- Seoyeong University
- Sungkyunkwan university

Detector structure and prompt energy spectra of RENO and NEOS

NEOS

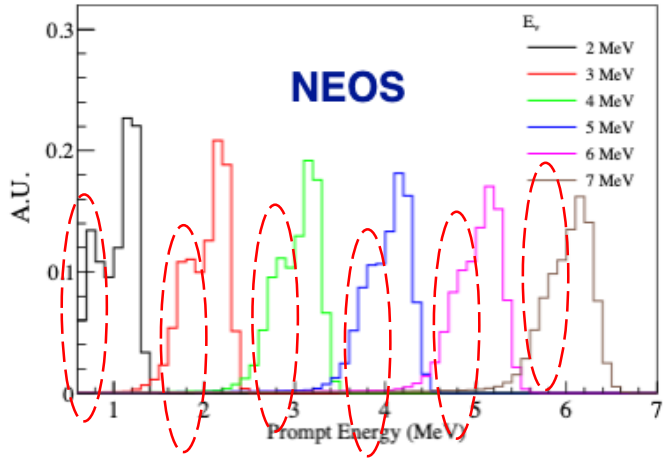


RENO

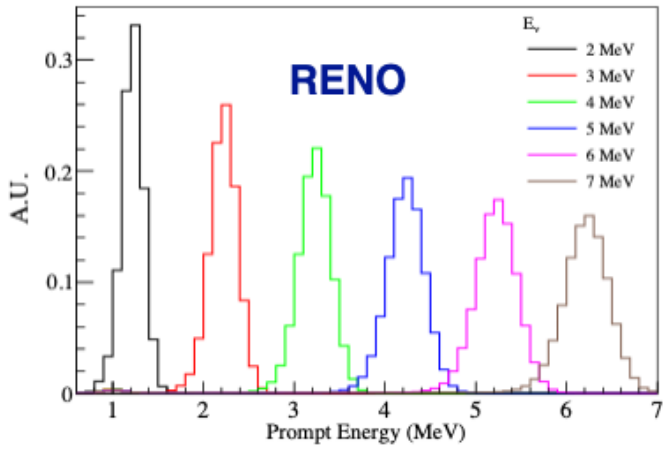


- 2nd small peaks in NEOS prompt energy spectra for monochromatic neutrinos due to escaping gamma rays from target

Target+Buffer +Veto

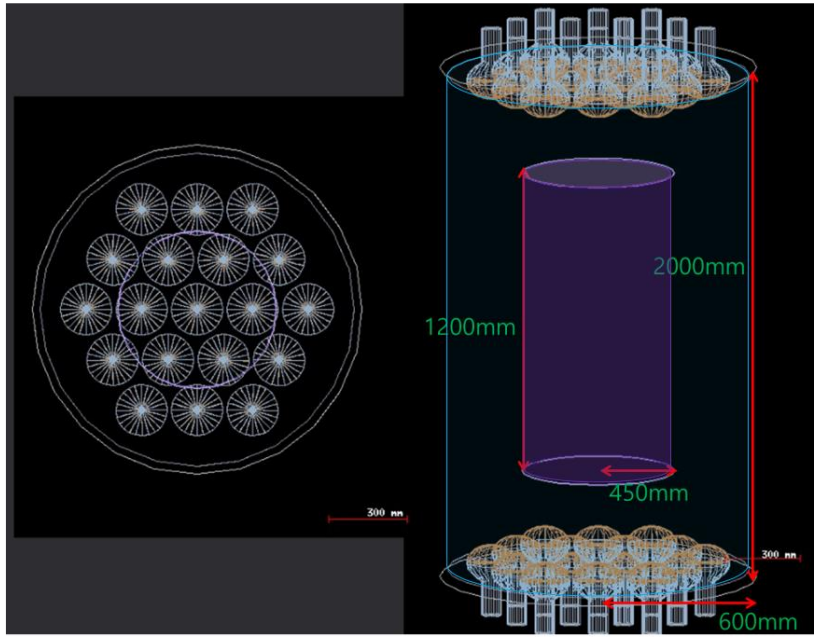


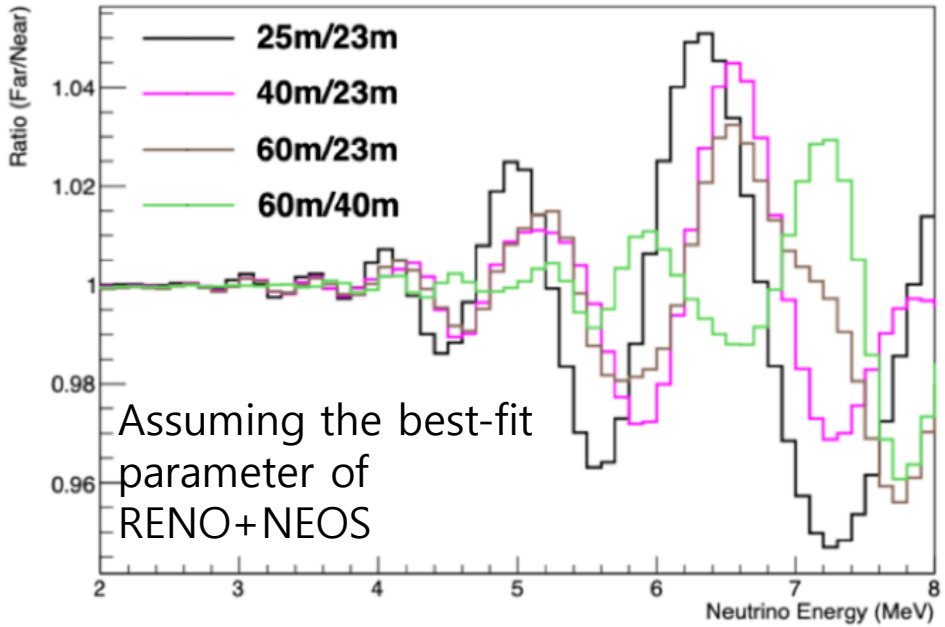
Target+Gamma catcher +Buffer+Veto



RENE detector design

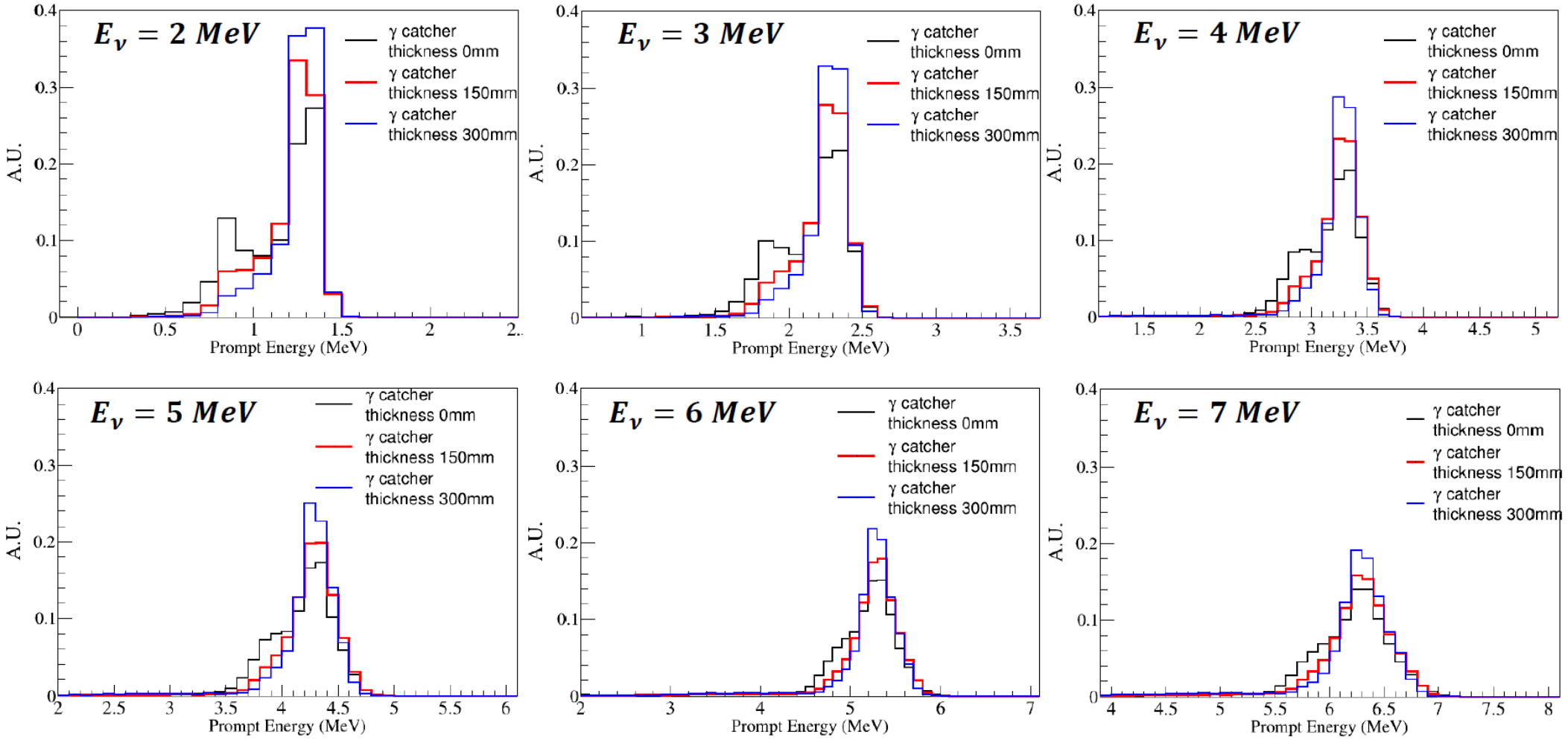
- Detector design is progressing
  - A uniform unsegmented volume detector
  - Considering the NEOS site, detector size is constrained.
  - With gamma catcher
    - Merit: With improved energy resolution
    - Demerit: Smaller target
  - Considering mobile or multiple detectors





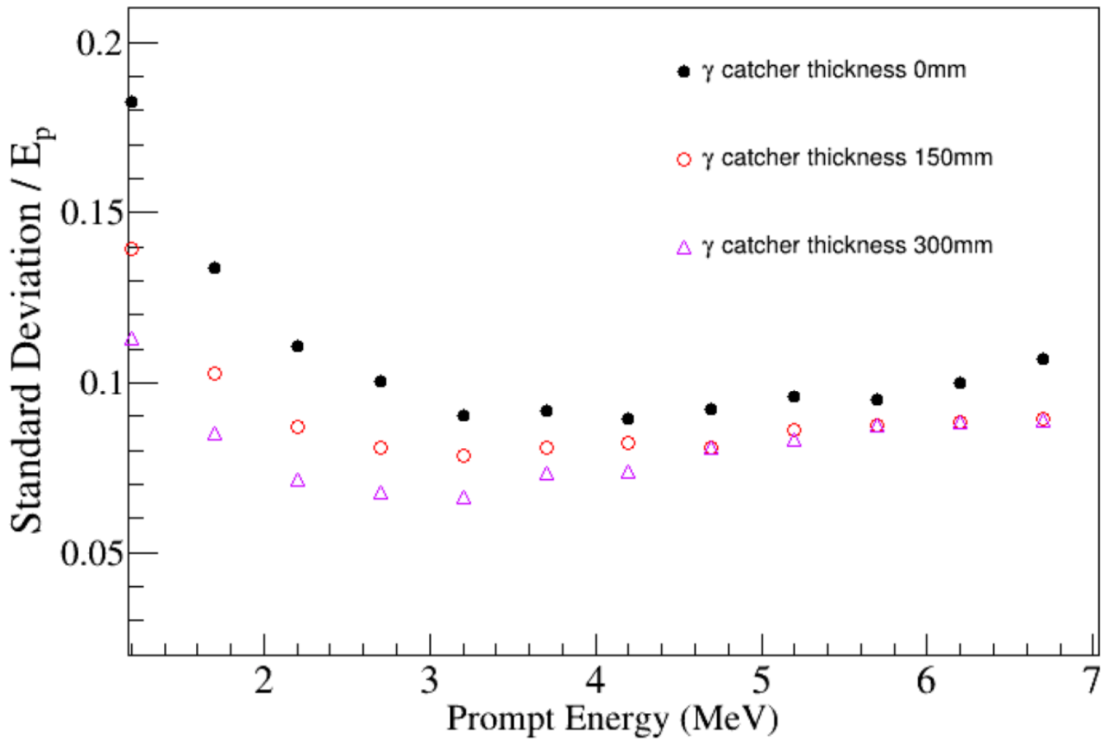
RENE detector design

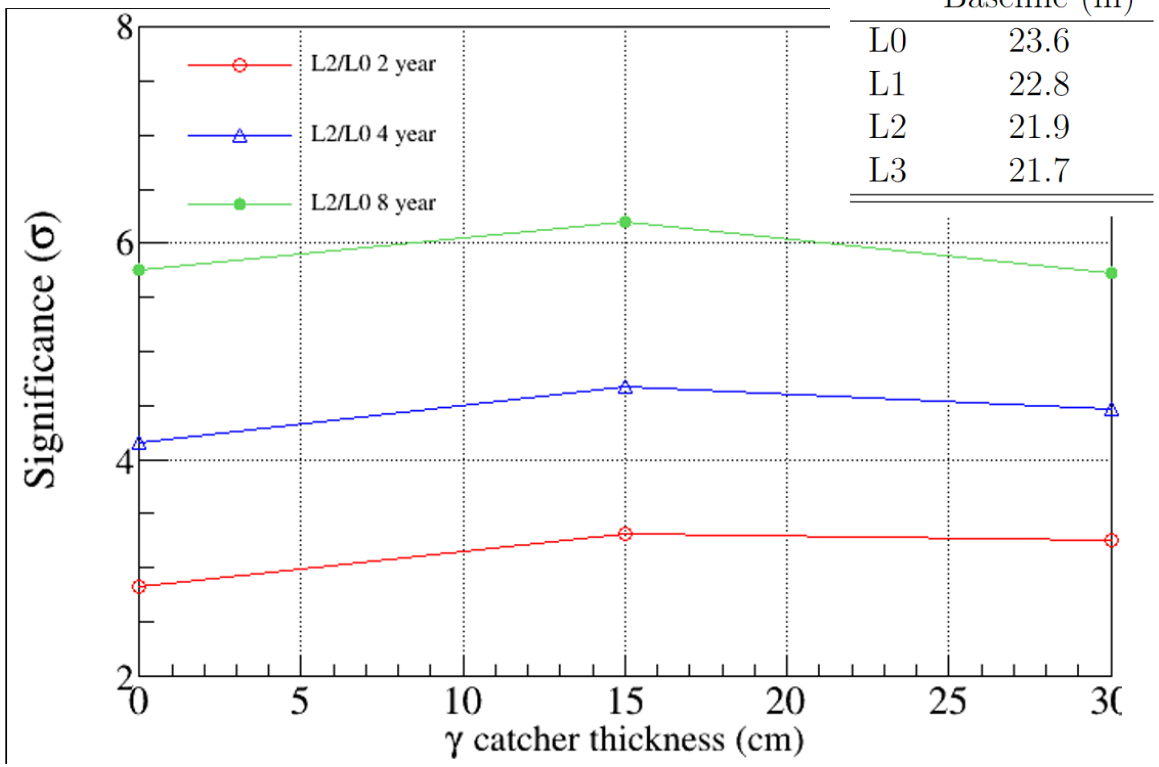
Prompt energy spectra for monochromatic neutrino energy depending on gamma catcher thickness



RENE detector design

- Under detector size constraint, a 150 mm gamma catcher is the best choice considering statistics.



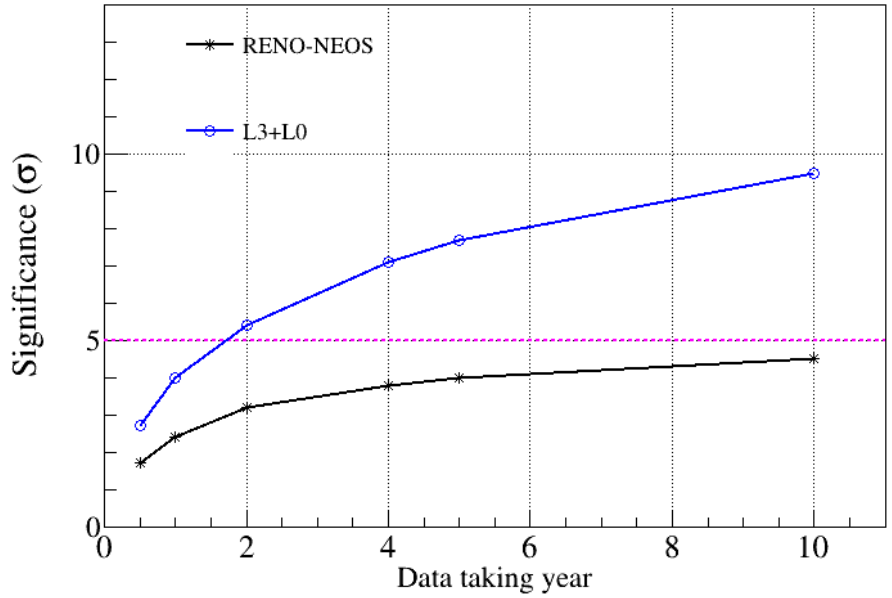


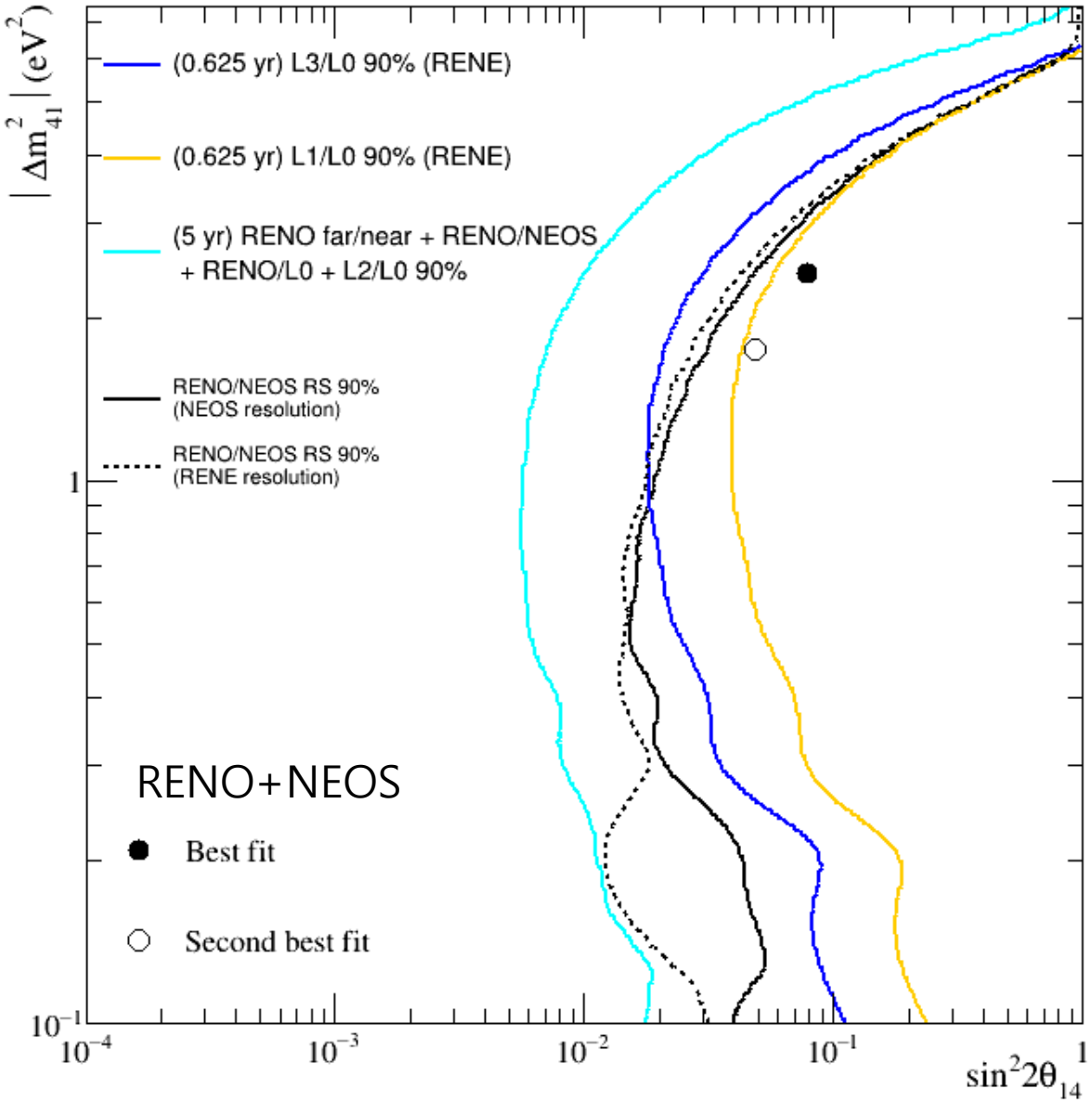
	Baseline (m)
L0	23.6
L1	22.8
L2	21.9
L3	21.7

Expected sensitivity

- Considering mobile or multiple detectors around the NEOS site

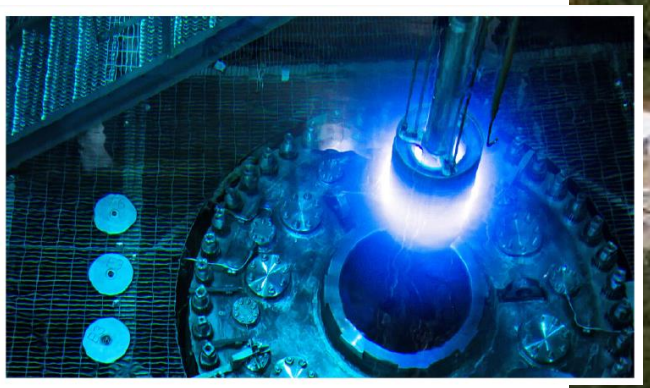
	Baseline (m)
L0	23.6
L1	22.8
L2	21.9
L3	21.7

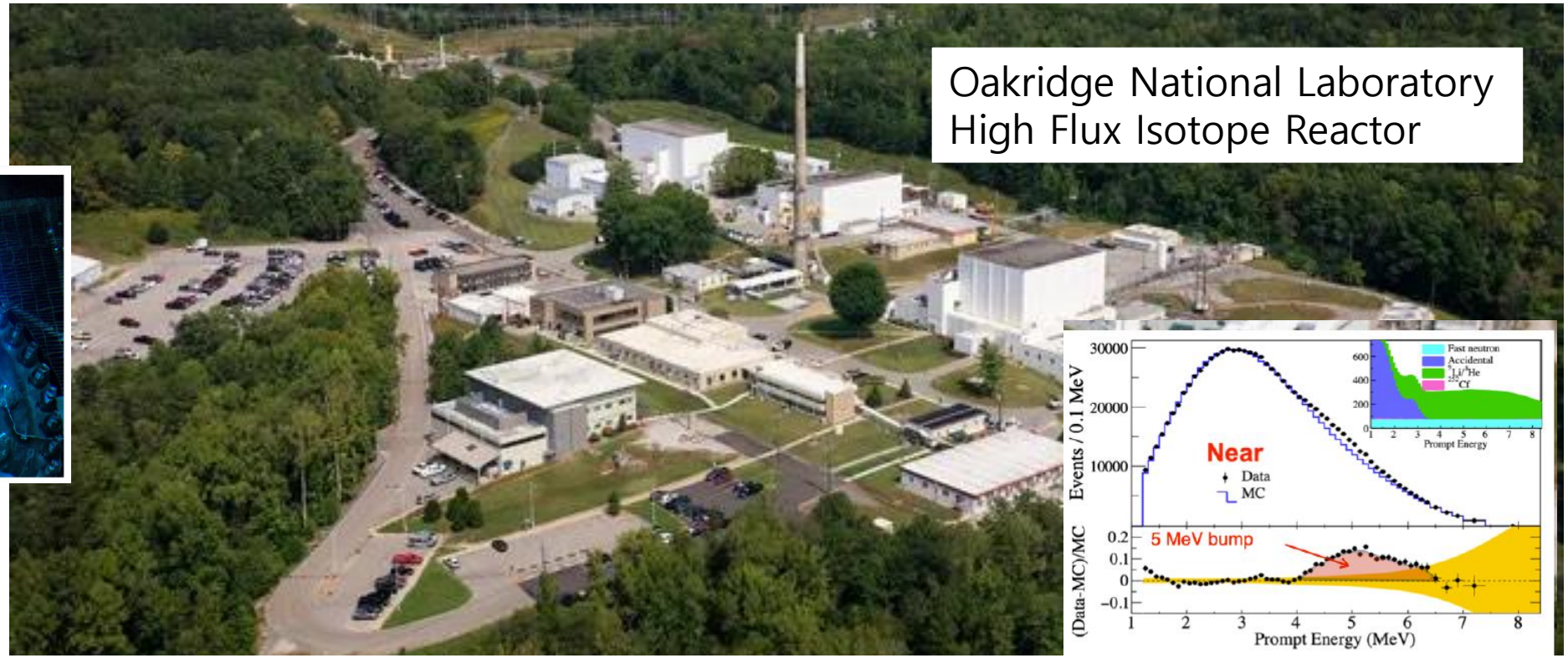




RENE Phase-2 (Provisional)

- Precise measurements of the flux and spectrum of reactor electron antineutrinos
- Separation of the reactor neutrino spectrum into those from ^{235}U and ^{239}Pu.





Summary

- RENO-NEOS joint analysis shows an interesting hint for the existence of the sterile neutrino at $\Delta m^2_{41} \sim 2$ eV^2.
- RENE (Reactor Experiment for Neutrino and Exotics) collaboration aims to search for the sterile neutrino oscillation around $\Delta m^2_{41} \sim 2$ eV^2.
- Detector designing is ongoing.

Backup

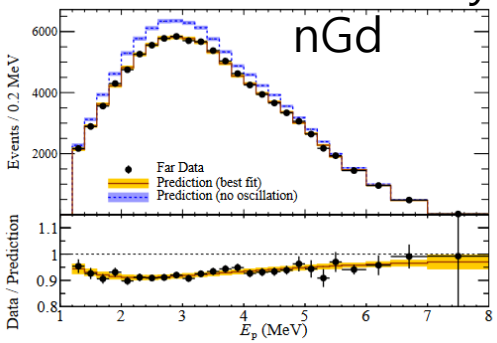
RENO results

Measurement of θ_{13}

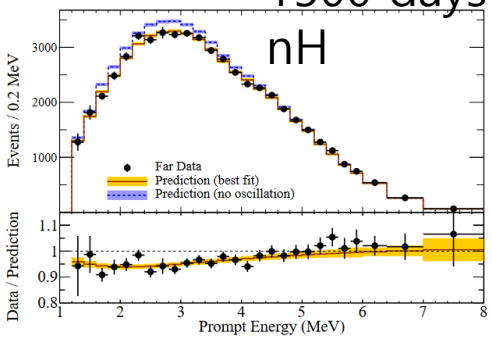
Phys.Rev.Lett. 121 (2018), 201801

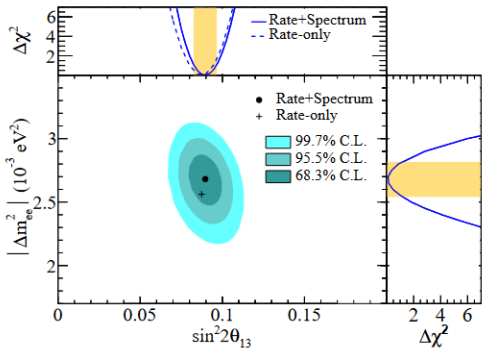
JHEP 04 (2020) 029

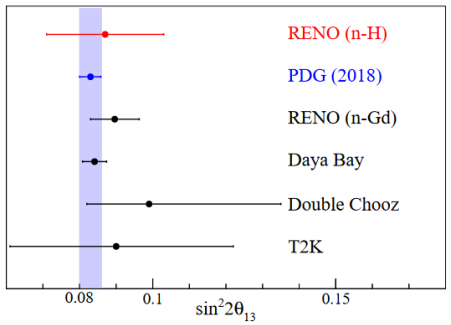
2200 days nGd



1500 days nH

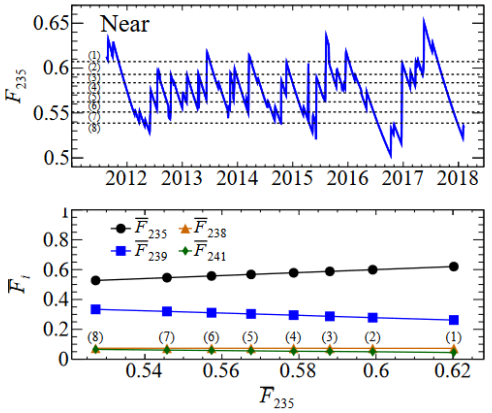


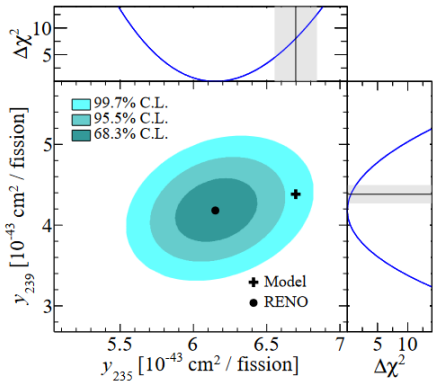




Measurement of fuel fraction and yield of reactor neutrino IBD yield

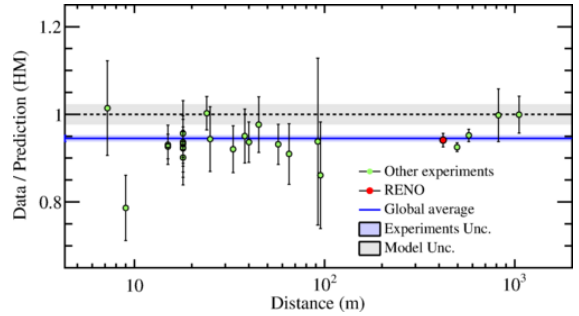
Phys.Rev.Lett. 122 (2019), 232501

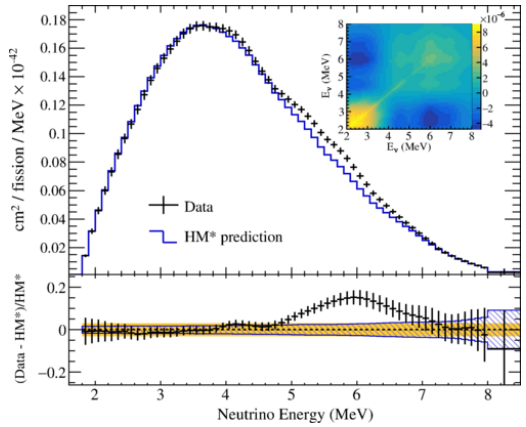




Measurement of reactor neutrino spectrum

Phys.Rev.D 104 (2021) L111301





Cosmogenic yield of Li^9 and He^8