구축형 R&D - 예미랩 차세대 지하 중성미자 망원경 뉴아이: νEYE (νeutrino Experiment at YEmilab)

2026년 6월 12일 고에너지물리학회 구축형 R&D 과제 소개

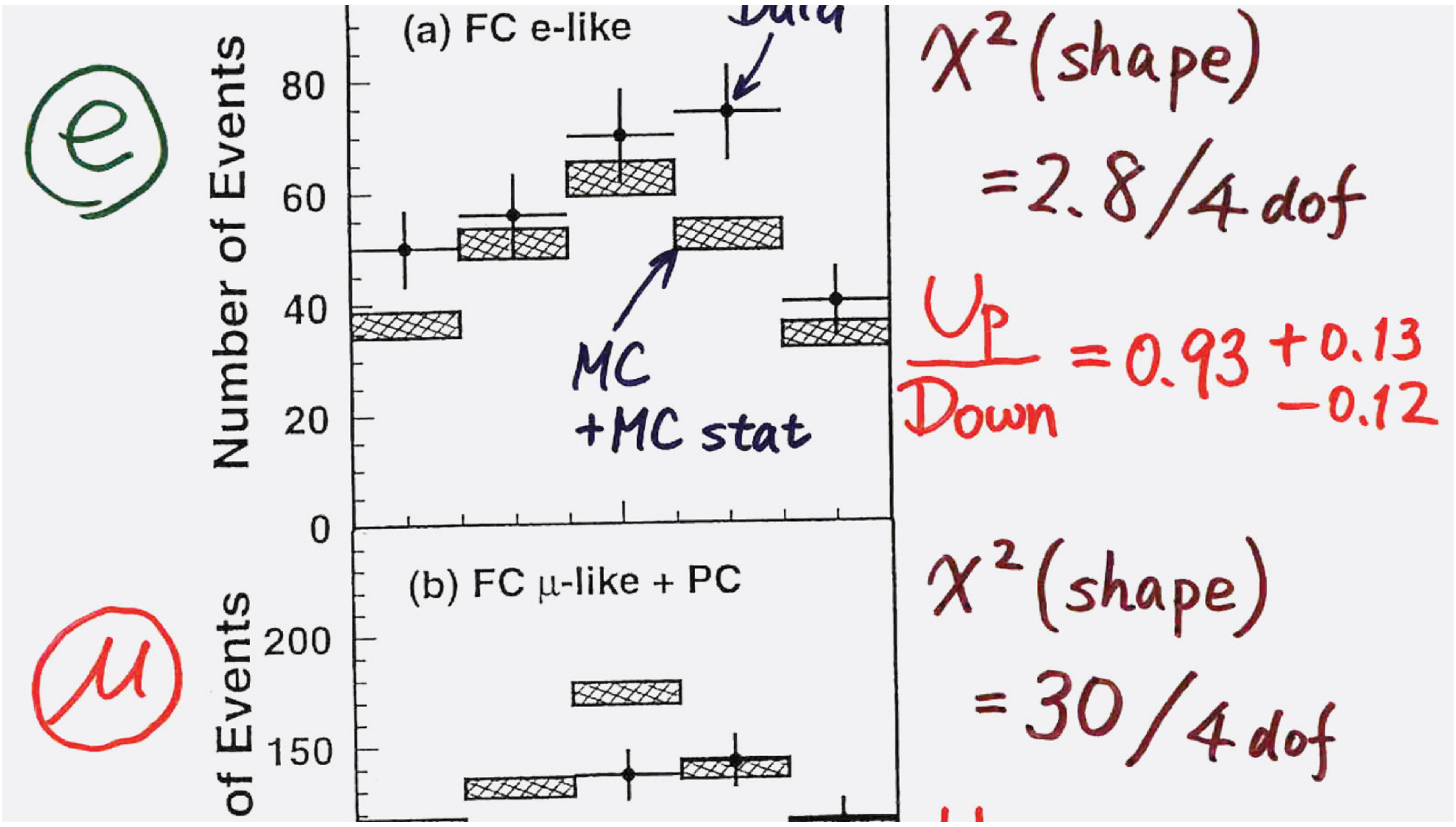
고려대학교 물리학과 원은일

CDR - arXiv:2601.12569, web - https://sites.google.com/korea.ac.kr/the-nueye-telescope

Particle Physics and Neutrinos

How we do understand the fundamental interactions in Nature? SM?

Neutrino oscillations: unique hint of **new physics** beyond SM of particle physics.



June 1998, T. Kajita, U. of Tokyo

At least two neutrinos have **non-zero mass**.

Mass terms in the Lagrangian: how do we describe them? See-saw? C. Amsler (Nucl. and Part. Physics)

$$\mathcal{L}_{\rm mass} \stackrel{?}{=}$$

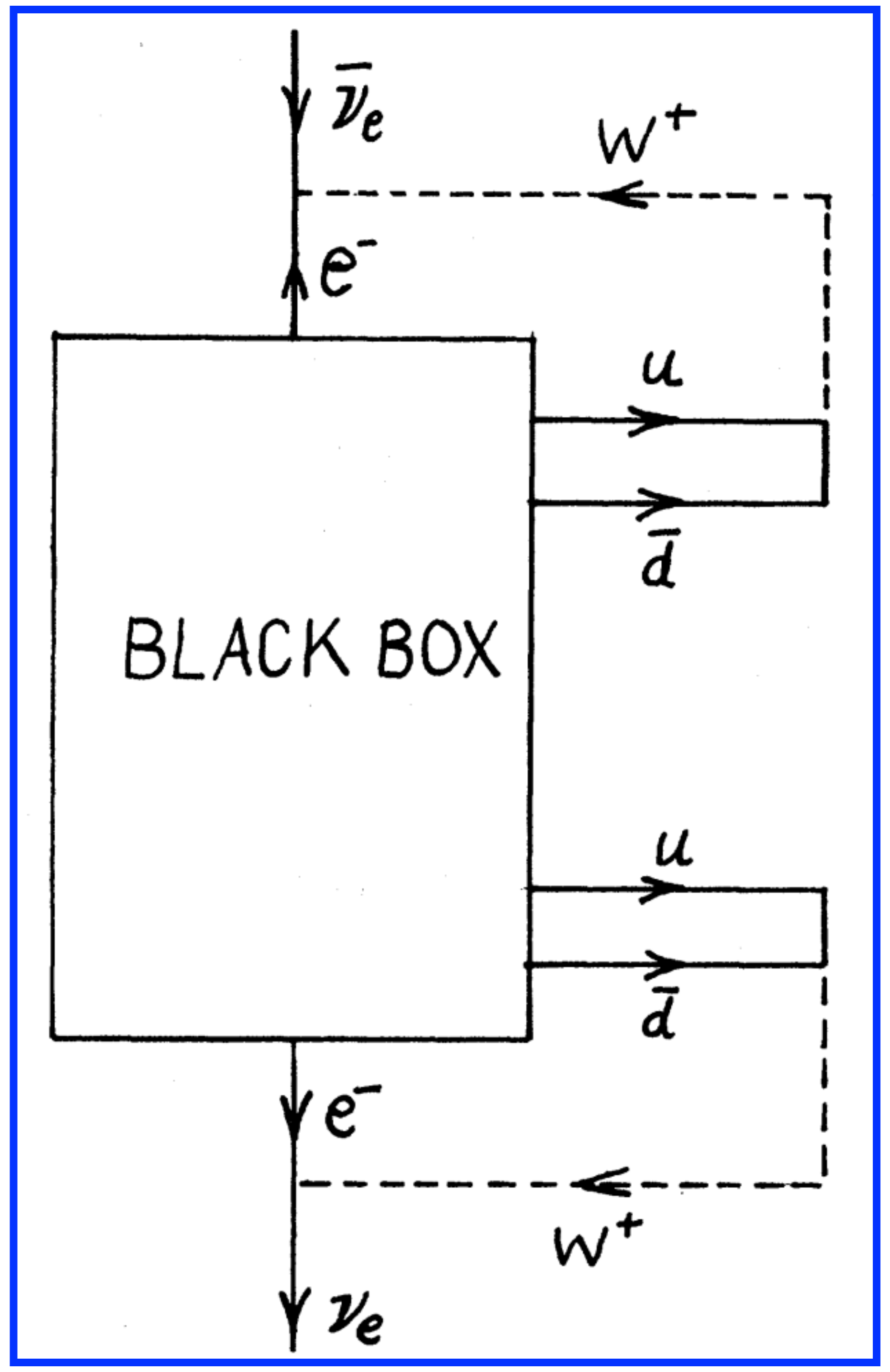
SM of particle physics **must be modified** to include the non-zero mass term.

Sterile(non-interacting, only through mixing) **neutrinos exist? Dirac or Majorana**?

Full understanding of neutrino physics is one of prime interests in particle physics.

Particle Physics and Neutrinos

Schechter and Valle, PRD 25, 2591 (1982).



Known in neutrino physics

- Three active neutrino flavors: ν_e, ν_μ, ν_τ
- Nonzero neutrino masses

$$\nu_{\{e,\nu,\tau\}} \overset{?}{\longleftrightarrow} \nu_s$$

$$\nu_k \overset{?}{\equiv} \overline{\nu}_k$$

Unknown in neutrino and particle physics

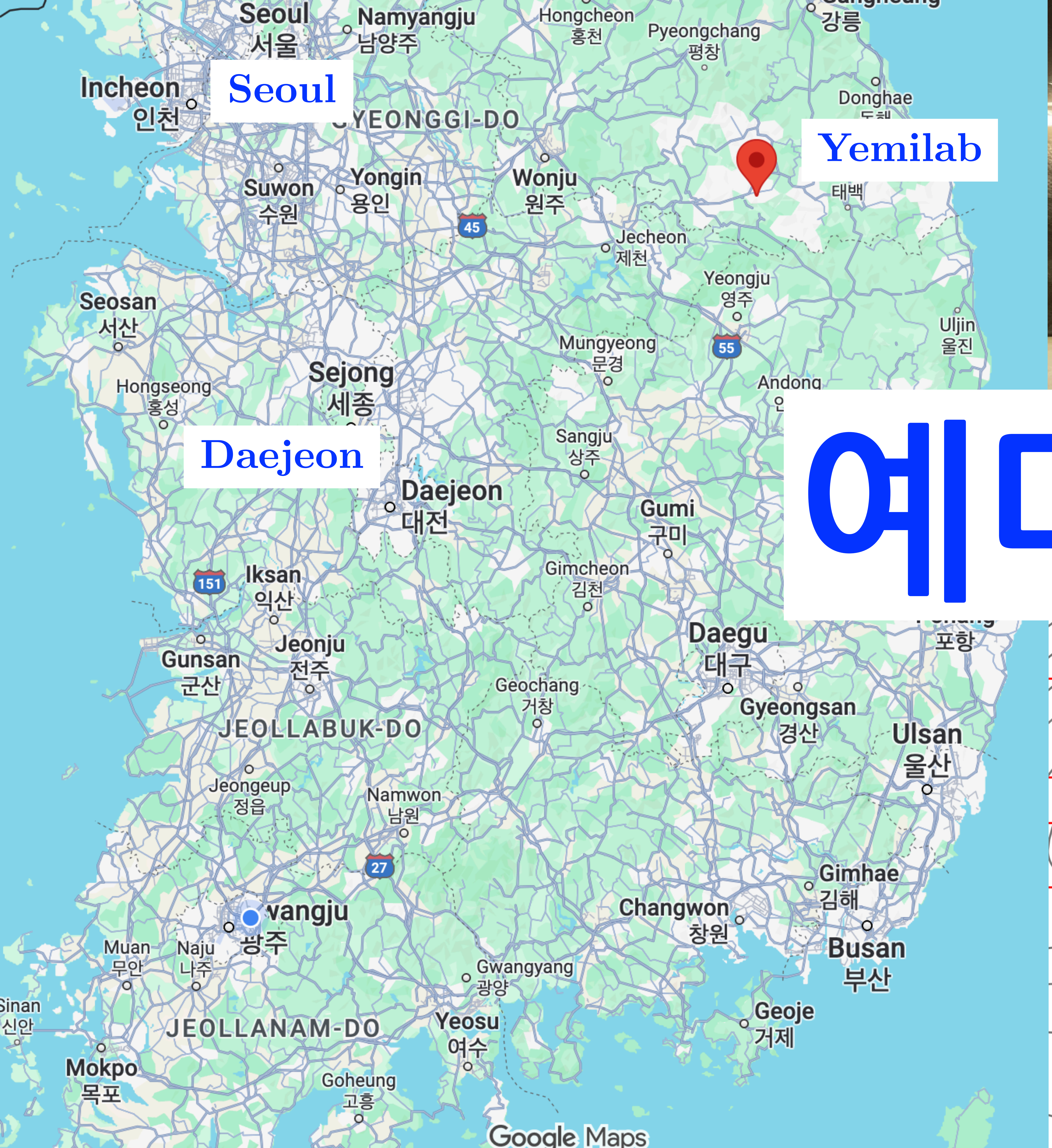
- **Existence of Sterile Neutrinos ?**
- **Property of neutrino: Dirac or Majorana particle ?**
- **Are there any Beyond SM physics phenomena?**

  Dark photon, ALPs, Low-Energy Electroweak physics and so on.

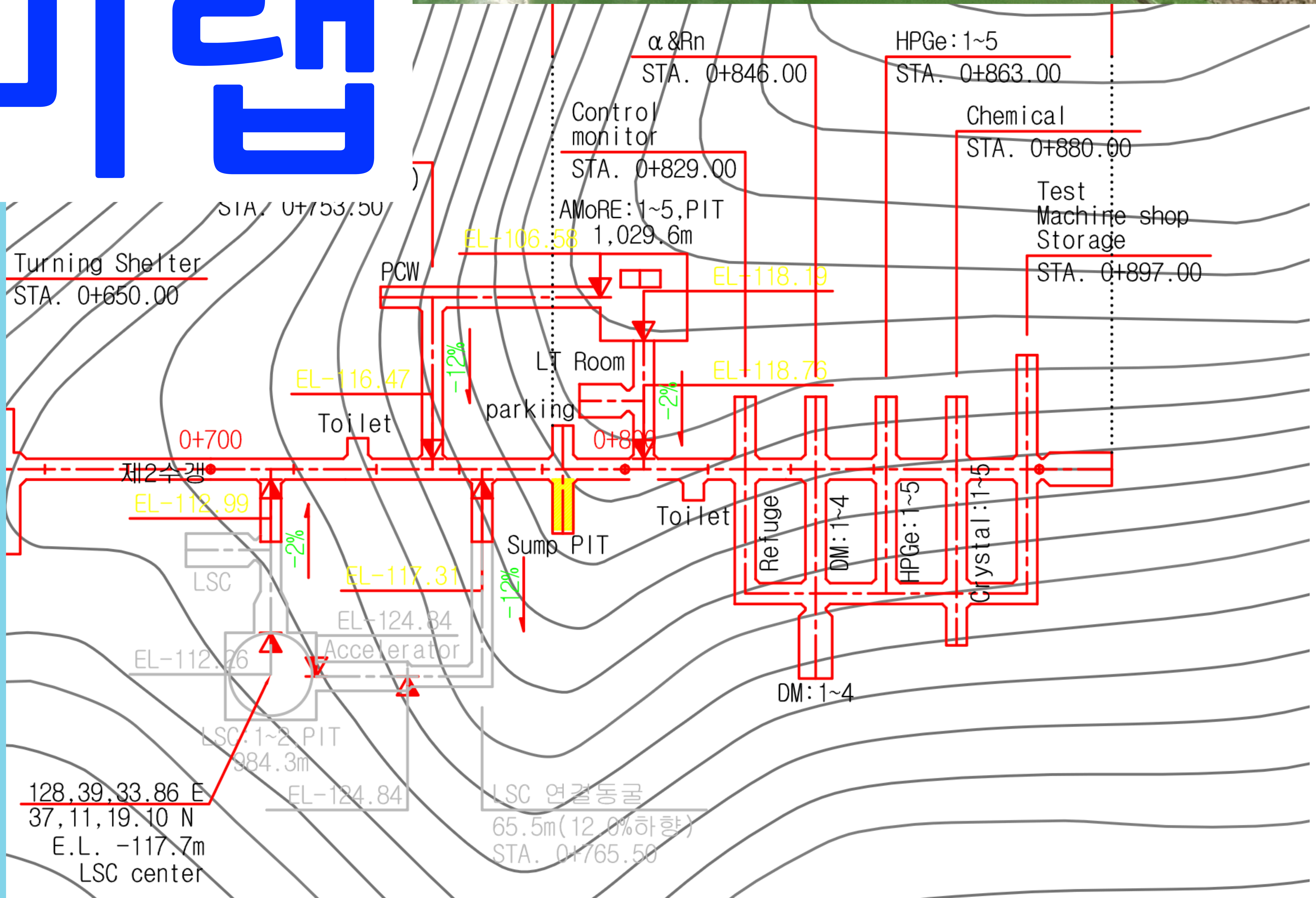
The νEYE will explore these questions!

- **CP violation and mass ordering in neutrino:**

  Hyper-K and DUNE will answer this question in about 10 years.


Seoul
Yemilab
Daejeon
Google Maps

예미랩


α &Rn
STA. 0+846.00
HPGe:1~5
STA. 0+863.00
Control
monitor
STA. 0+829.00
Chemical
STA. 0+880.00
AMoRE:1~5,PIT
1,029.6m
Test
Machine shop
Storage
STA. 0+897.00
Turning Shelter
STA. 0+650.00
PCW
LT Room
parking
Toilet
0+700
제2수갱
Sump PIT
Toilet
Refuge
DM:1~4
HPGe:1~5
Crystal:1~5
LSC
Accelerator
LSC 1~2 PIT
DM:1~4
128,39,33.86 E
37,11,19.10 N
E.L. -117.7m
LSC center
LSC 연결동굴

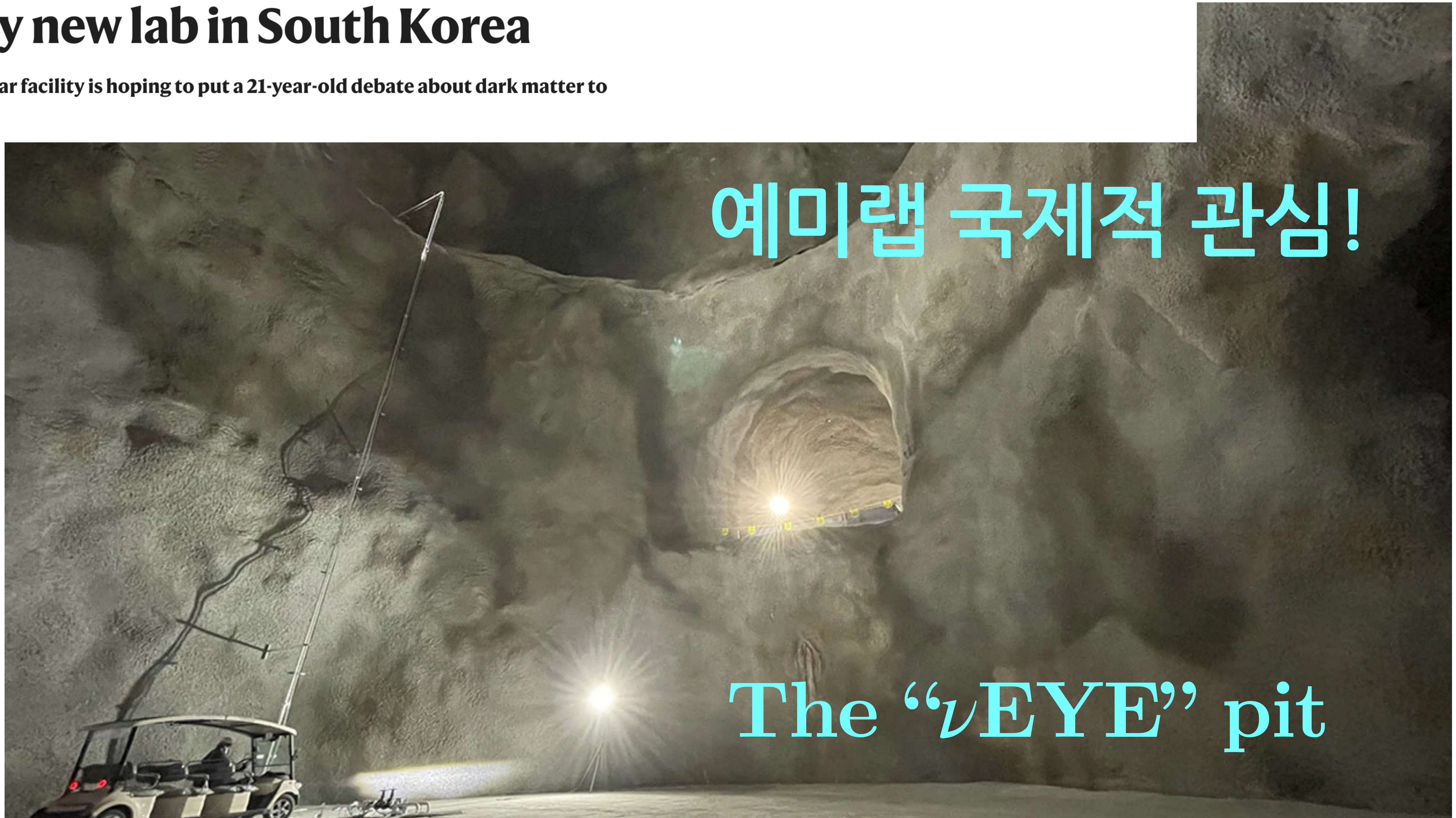
A new underground facility in Korea (1000 m deep).
(https://arxiv.org/abs/2402.13708)

Existing Yemilab pit can host $O(2)$ kilo tonne detector.

NEWS | 30 May 2024

Disputed dark-matter claim to be tested by new lab in South Korea

A multi-million dollar facility is hoping to put a 21-year-old debate about dark matter to rest.



Selected Physics Cases

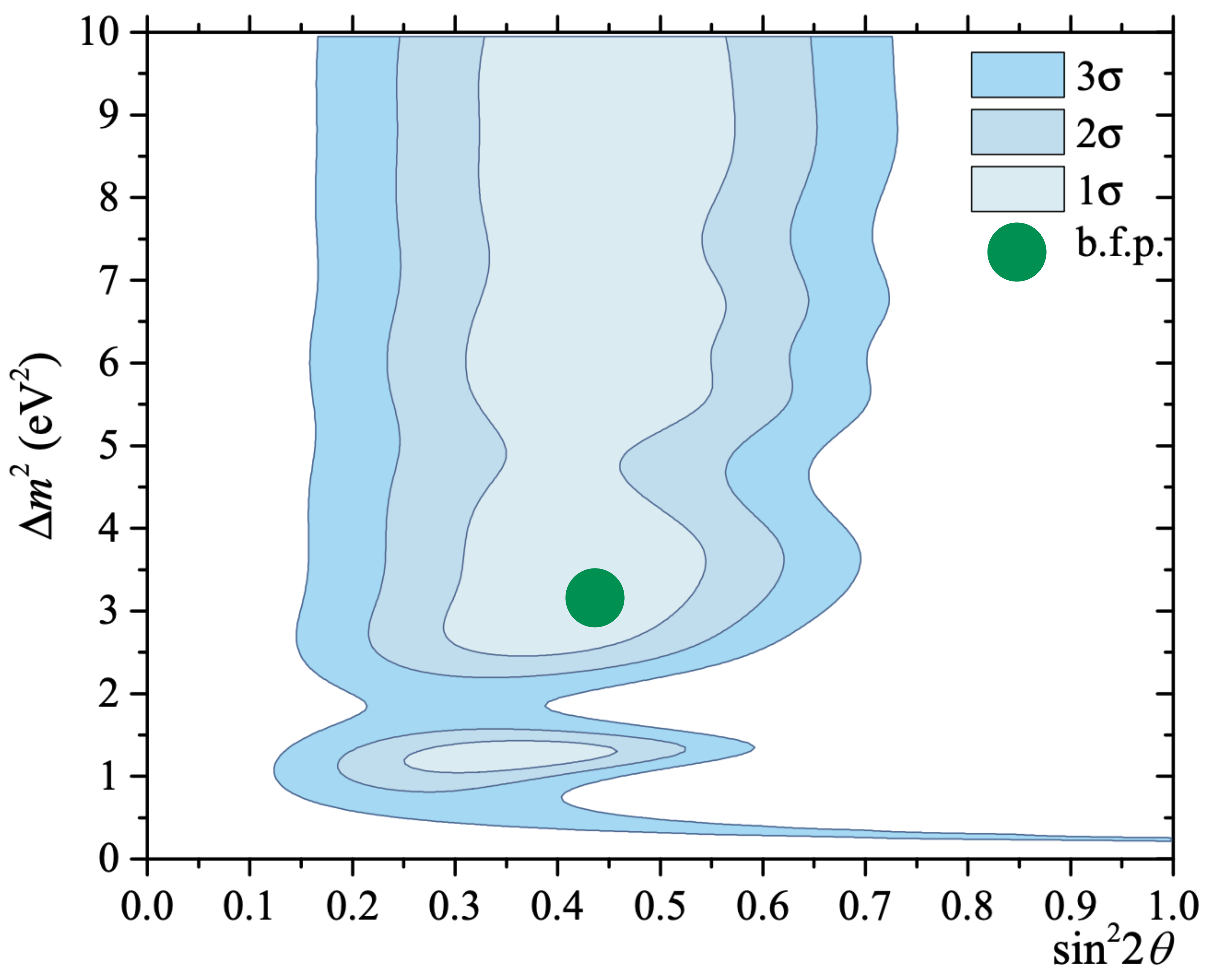
Summary of sterile neutrino search over the last 20 years

Since the LSND anomaly, a lot of efforts went into the search for the sterile neutrino.

- KARMEN (neutron spallation) did not confirm LSND.
- MiniBooNE ($\nu_e + \bar{\nu}_e$) compatible with LSND but with low energy excess.
- μBooNE disfavors MiniBooNE and LSND (not rule out completely).
- Daya Bay, RENO found deficit but likely due to flux calculation issue.
- NEOS, STEREO, PROSPECT, DANSS, SOLID: no evidence, Neutrino4 found arguable 3σ signal ($\Delta m^2 = 7$ eV^2).

- SAGE, GALLEX (solar ν_e disappearance) found Gallium anomaly.
- Most recently BEST experiment claimed 4σ signal (3.4 MCi ^{51}Cr source, **radiochemical method**)
- Recent μBooNE result, Nature 648, 64–69 (2025) disfavors a single sterile neutrino state.

원자로 실험
가속기 실험
방사선 선원 실험



Baksan Experiment on Sterile Transitions (BEST)

Phys. Rev. Lett. 128, 232501 (2022)

Sterile neutrino? (Example: two talks in Neutrino2024) - a dark matter candidate

June 21, 2024 (v1) | Presentation | Open

Sterile ν: review of positive hints

Gorbunov, Dmitry

Plenary talk at the Neutrino 2024 conference. Session 14: Re

(Talks)

ber 13, 2024

소스 기반과 가속기 기반 실험 불일치?

가속기: $\nu_\mu \to \nu_s$

선원/원자로: $\nu_e \to \nu_s$

Mixing angle parameter 다름: 두 결과 같을 이유 없음

June 21, 2024 (v1) | Presentation | Open

Sterile ν: review of negative hints

Danilov, Mikhail

Plenary talk at the Neutrino 2024 conference. Session 14: Reactor neutrinos.

Part of Neutrino 2024 (Talks)

Uploaded on September 13, 2024

High Energy Physics – Experiment

[Submitted on 14 Jan 2025]

Experiment BEST-2 with 58Co neutrino source

V.N. Gavrin, V.V. Gorbachev, T.V. Ibragimova, V.A. Matveev

The article describes a new experiment with an artificial neutrino source 58Co on a gallium target GGNT (SAGE). The goal of the experiment is to study the gallium anomaly. The experiment makes it possible to find the parameters of oscillation transitions of electron neutrinos to sterile states in a wide range of parameters. Including the parameter {\Delta}m2, the experimental determination of which usually causes significant difficulties. An important feature of the experiment is the possibility of identifying the dependence of the gallium anomaly on the neutrino energy.

Radiochemical method:

- 뉴트리노와 반응한 후 동위원소를 직접 측정하지 않음.
- 화학적으로 분리한 후 동위원소 개수를 측정.

Sterile neutrino or not ?

BEST results are to be confirmed.

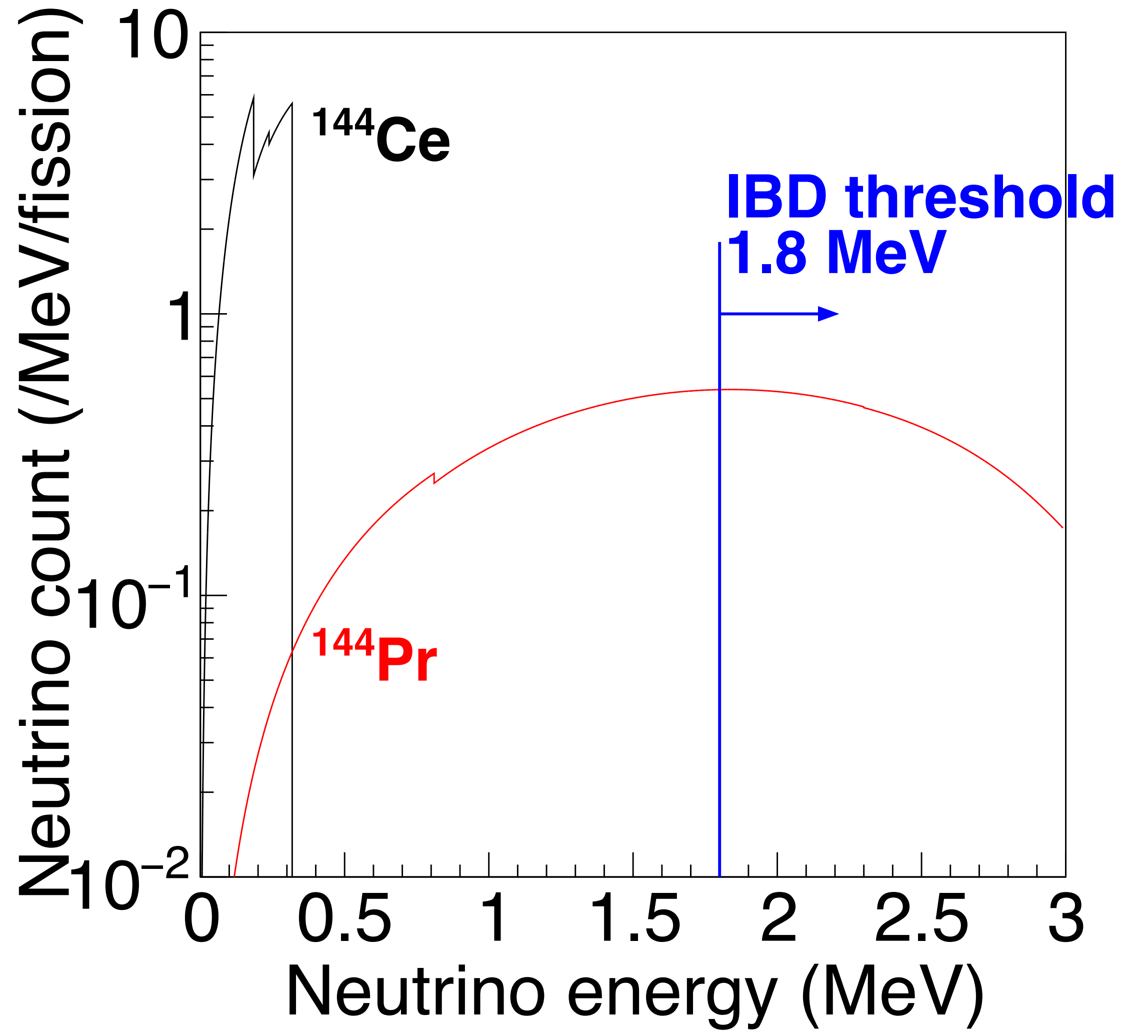
Sterile neutrino search with νEYE

Will be the first of its kind in the world!

Use high activity radioactive source (^{144}Ce or ^{51}Cr) + **in situ** detection of signal w/ νEYE.

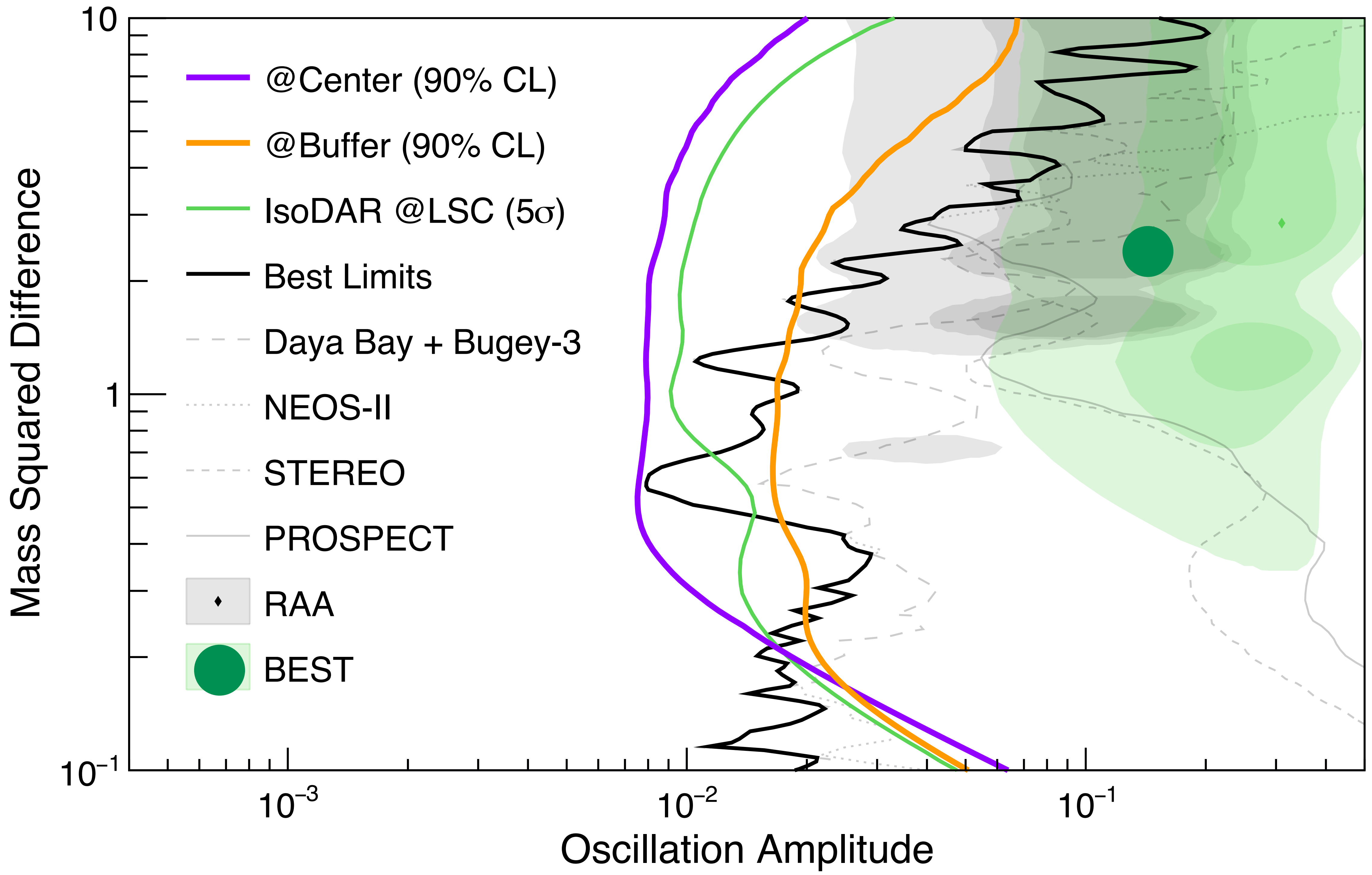
Radiochemical 방법 불필요!

^{144}Ce

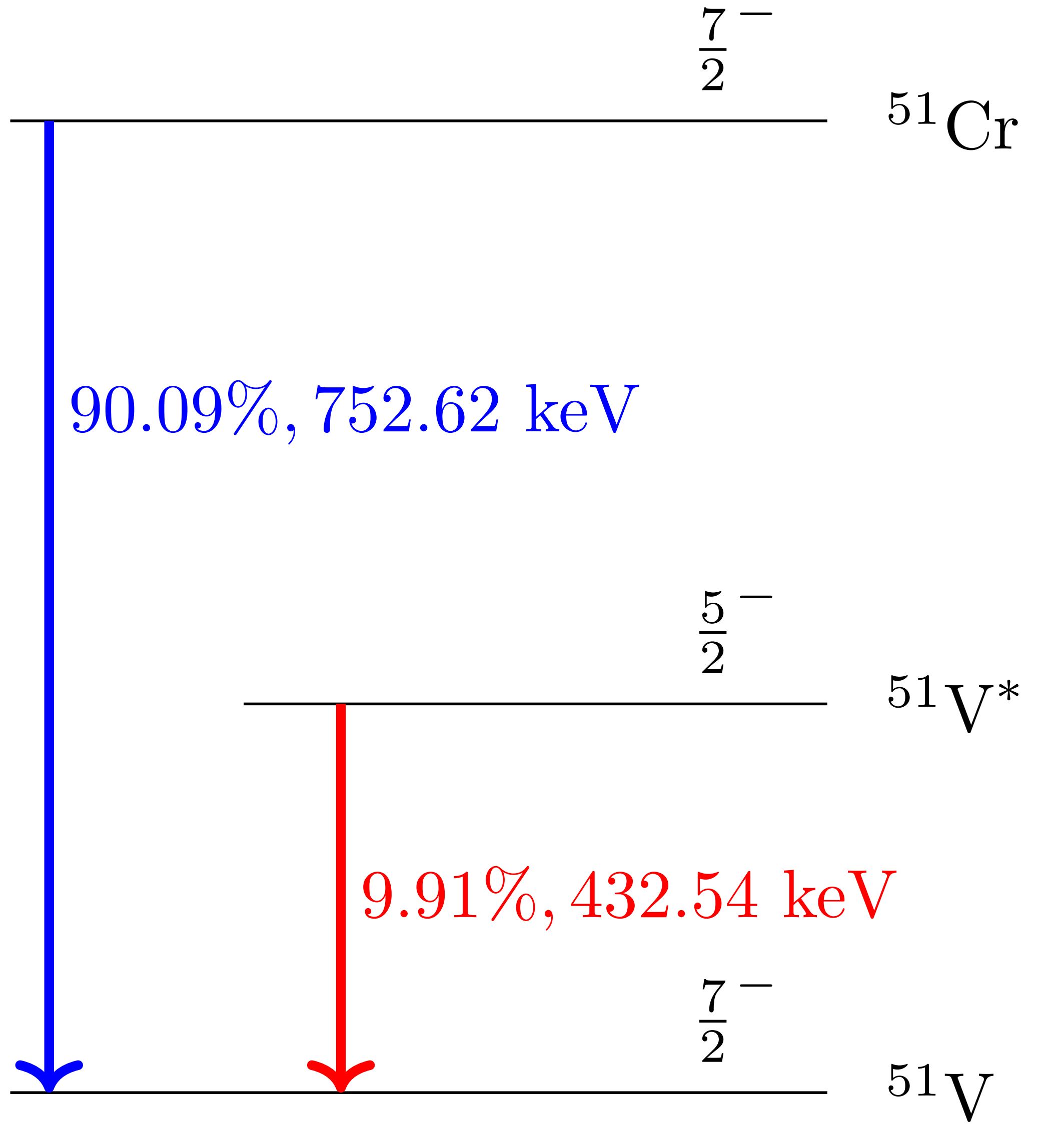


$\bar{\nu}_e$ source

Both sources show similar sensitivity (purple) to confirm or rule out BEST result.



^{51}Cr



ν_e source

High Radioactive Source in Korea?

방사선 선원 제작 (국내 제조 불가)

^{144}**Ce:** nuclear waste 로 부터 추출 (많은 국가에서 제약). 과거 Borexino 시도.

^{51}**Cr:** 원자로 근처에서 sample activation (비교적 용이). **기존 실험에서 사용됨.**

한국원자력안전재단 통하여 수출입 통관 진행

밀봉 방사선동위원소 사용허가 + 시설 검사 등 필요

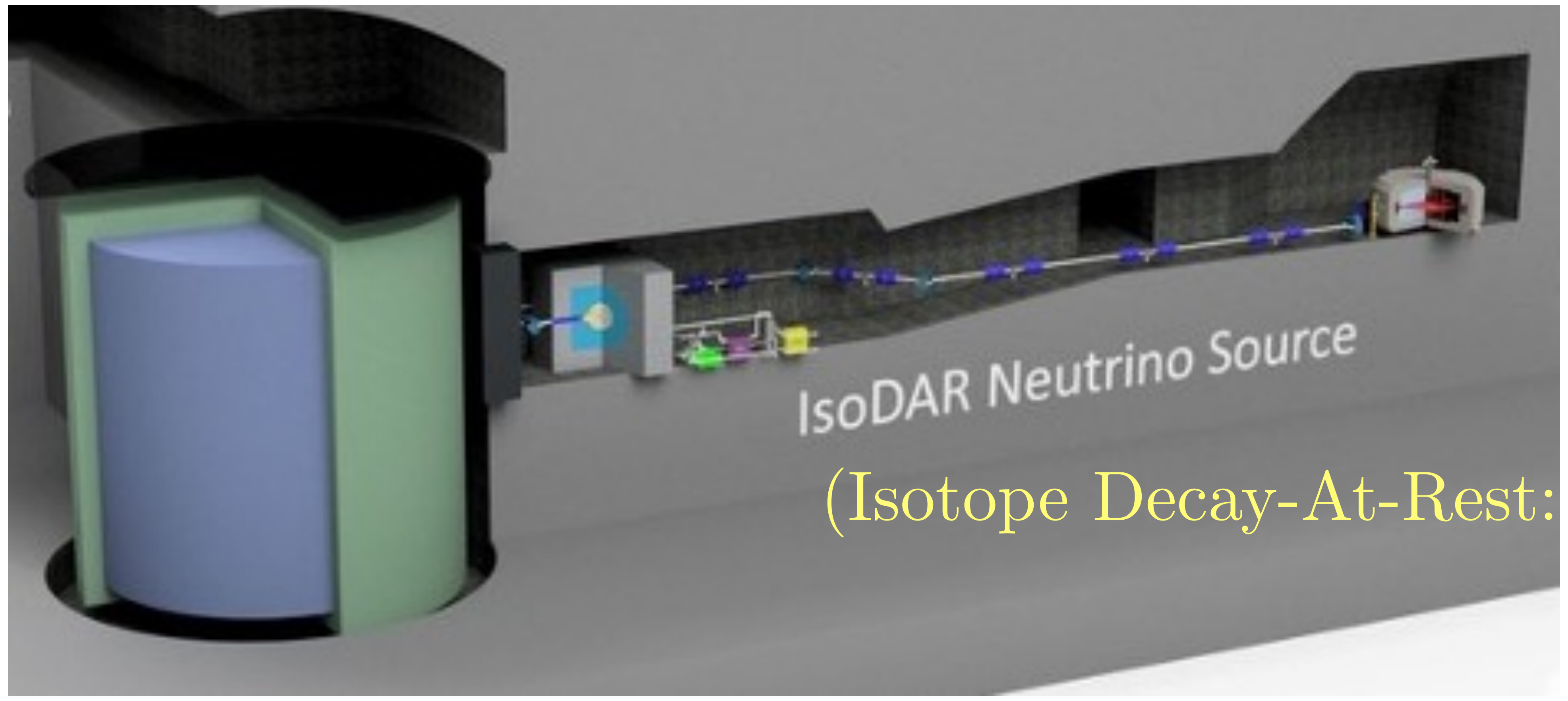
수출입 통관 대행 회사와 미팅 진행 (2024.07, MR Solutions Inc.)

국내 수입 통관 특별한 문제 없음

- MCi 통상적 통관
- (문서 준비, 장시간 소요)

Optionally, with a high-current accelerator:

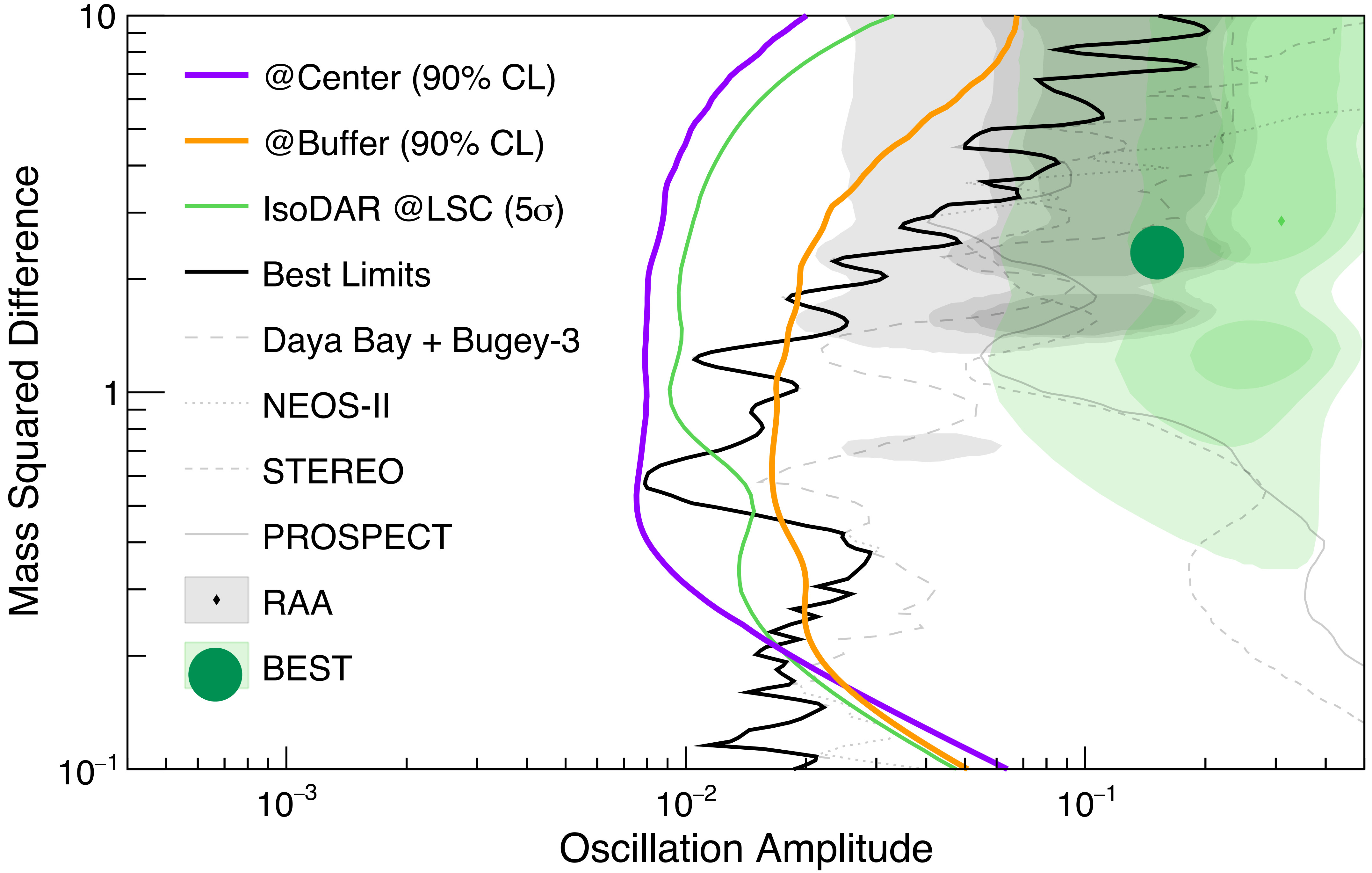
If IsoDAR is available: Generation of neutrinos with high-intensity accelerator.



(Isotope Decay-At-Rest: **US project**)

$$^{7}\mathrm{Li}(n,\gamma)^{8}\mathrm{Li}^{*},\ ^{8}\mathrm{Li} \rightarrow ^{8}\mathrm{Be}^{*} + e^{-} + \bar{e}_{\nu}$$

Both source and accelerator (green) allow us to confirm or rule out BEST result.



Massachusetts Institute of Technology

Janet Conrad
Professor of Physics

Building 26, Room 537
77 Massachusetts Avenue
Cambridge, Massachusetts
02139–4307

Email conrad@mit.edu

To whom it may concern,

As a scientist who has worked in the field of neutrino studies for more than 25 years, and has served as co-spokesperson of the MiniBooNE and IsoDAR collaborations, I am writing this letter to express my strongest support for the construction of the νEYE detector at Yemilab. νEYE is a crucial project for the international particle physics community, and my group at MIT intends to actively participate in the experiment. My own interest is in coupling νEYE with an underground accelerator, IsoDAR, that we are developing and would bring to the project, that opens up a program of physics that cannot be explored at any other site in the world. The area of high-intensity, accelerator-based underground physics has enormous potential for discovery, and IsoDAR@Yemilab would be first-of-its-kind.

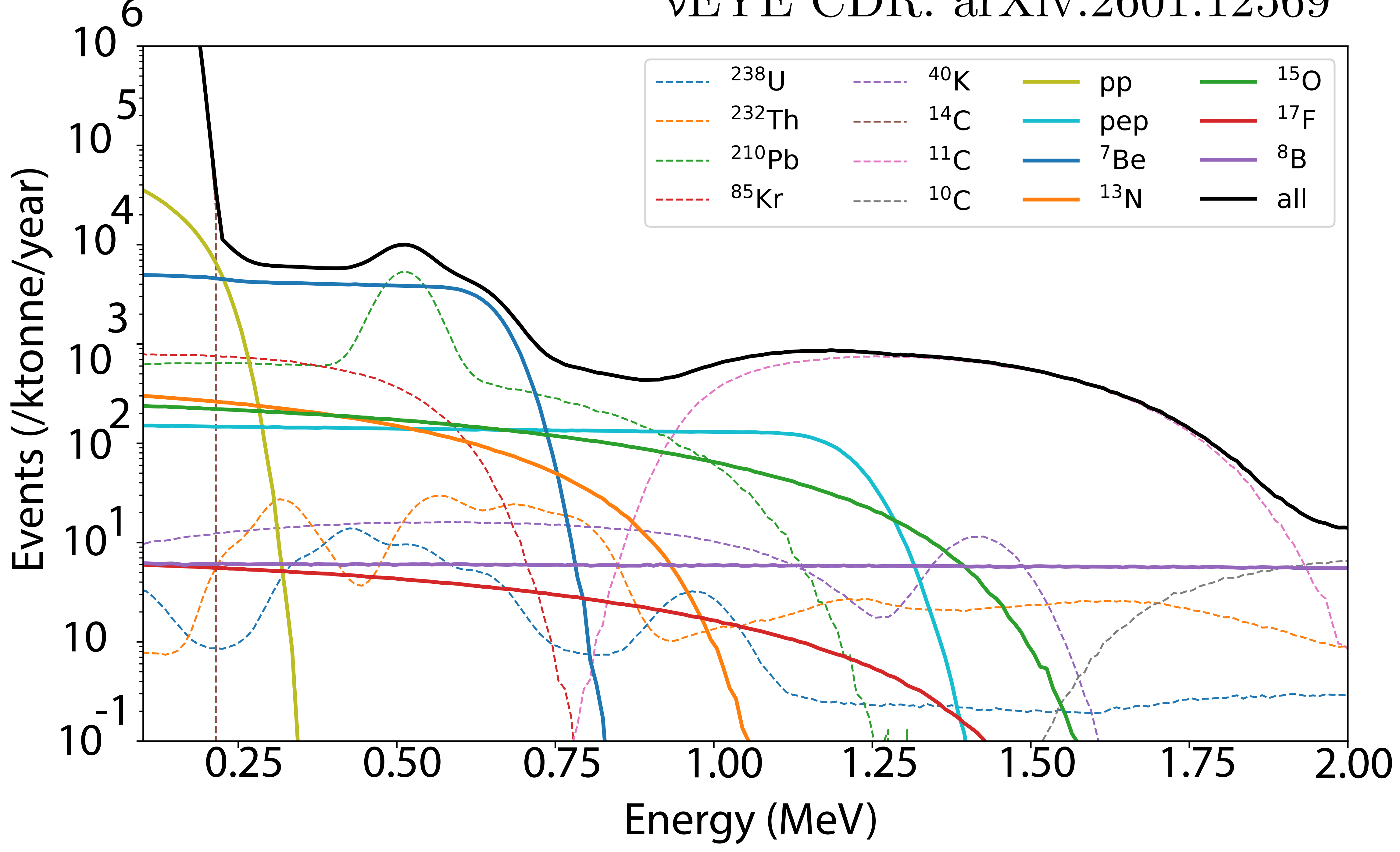
Construction of νEYE in combination with an internationally-funded high-intensity accelerator underground is a game-changing idea. At present, particle physicists build mas-

Solar neutrino physics with νEYE

Among possible topics, so called **observation of the "up-turn"** seems the most important.

- Radio-purification is required.

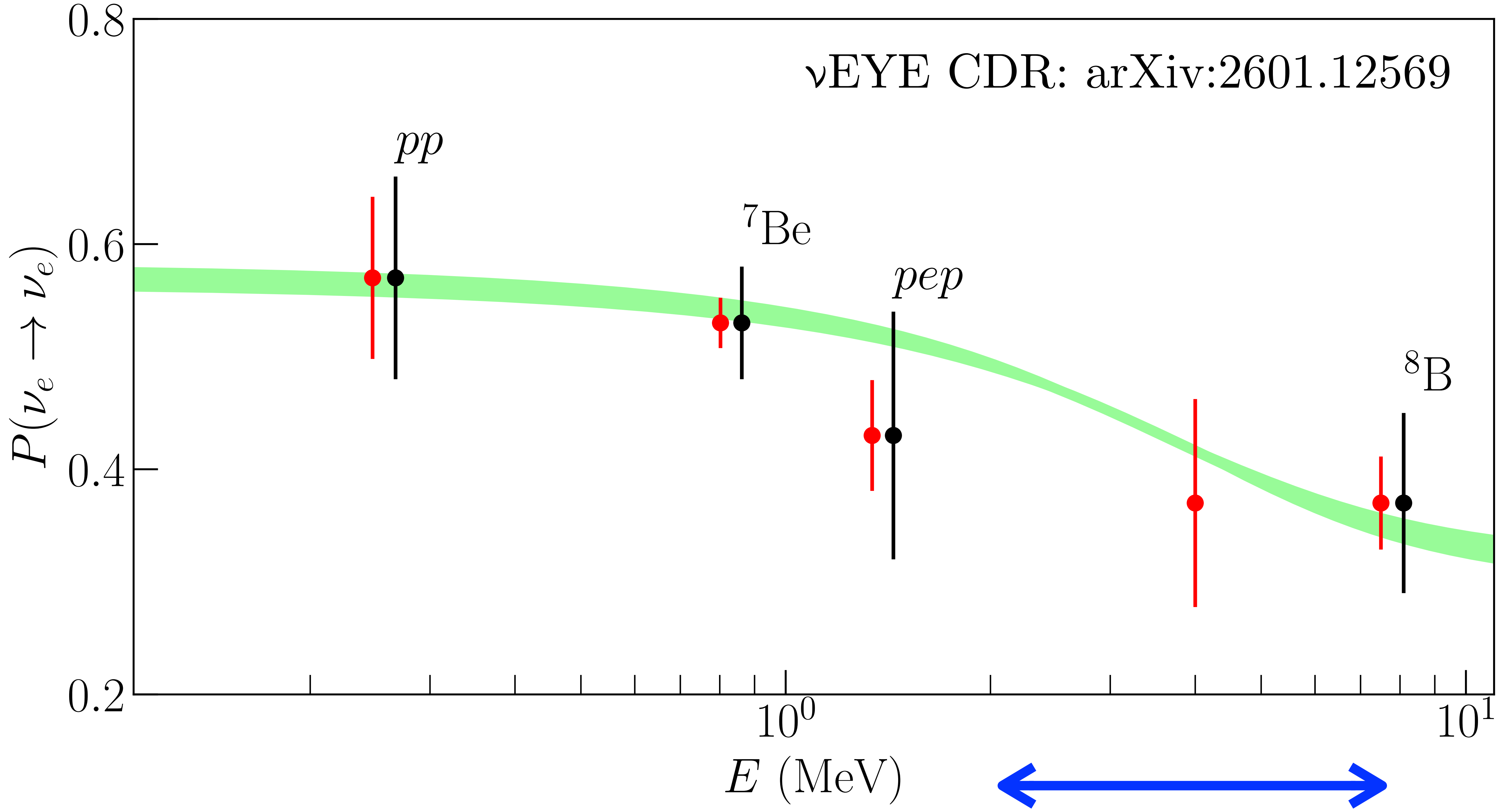
νEYE CDR: arXiv:2601.12569



Detailed understanding of signal/background (reduction of background) is critical.

For *pp*, error doesn't scale with $1/\sqrt{N}$ due to pile up of ^{14}C.

Red: νEYE
Black: Borexino



Only(*) νEYE can provide points in this region.
(5 year run here)

Neutrinoless double beta decay ($0\nu\beta\beta$) with νEYE

At the end of the experiment, the νEYE telescope can be loaded with metal to allow a $0\nu\beta\beta$ experiment.

Candidate isotopes: Tin-124 (Q=2.2 MeV) or ^{130}Te (Q = 2.54 MeV).

This topic requires a long-term R&D on the loading issues.

Current R&Ds and Sensitivity

Example from CPNR workshop of 2025.
Chang Hyun Ha (CNU)
Idea: Isotope loading and extraction

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https://indico.neutrino.or.kr/event/356/timetable/
#20251024.detailed
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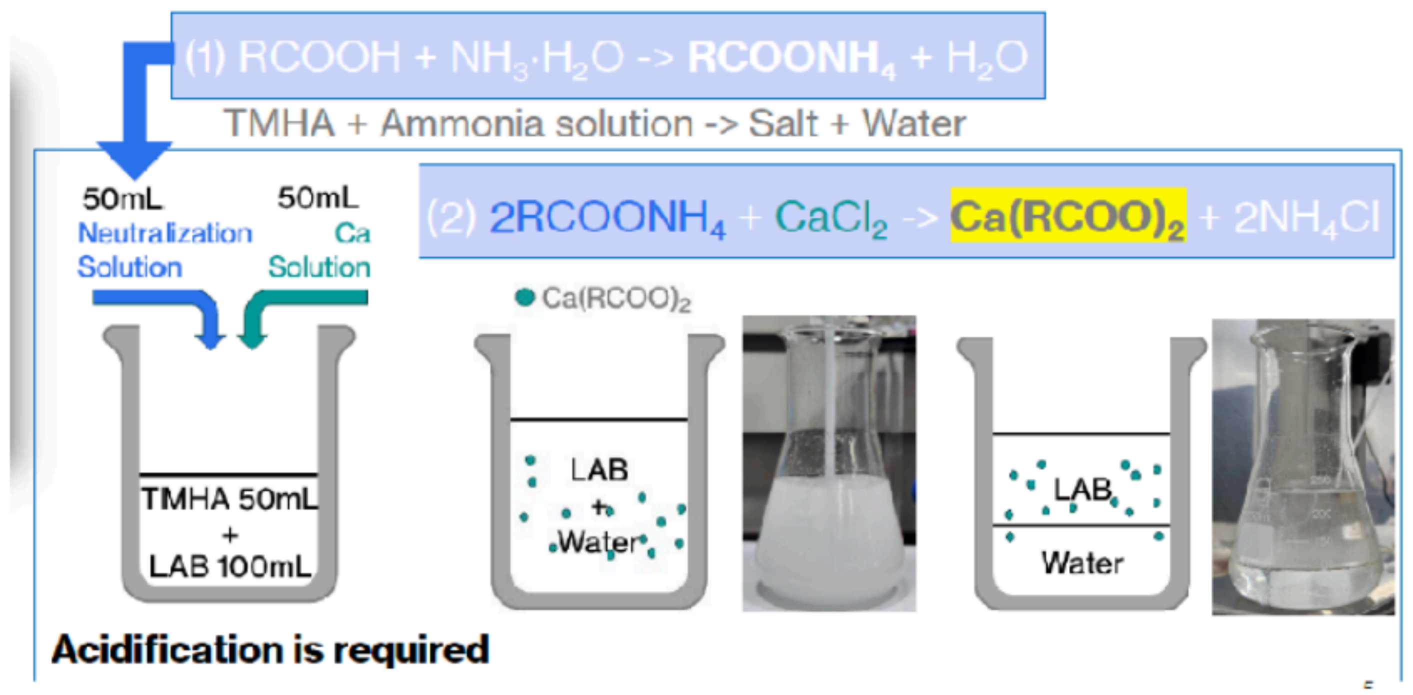
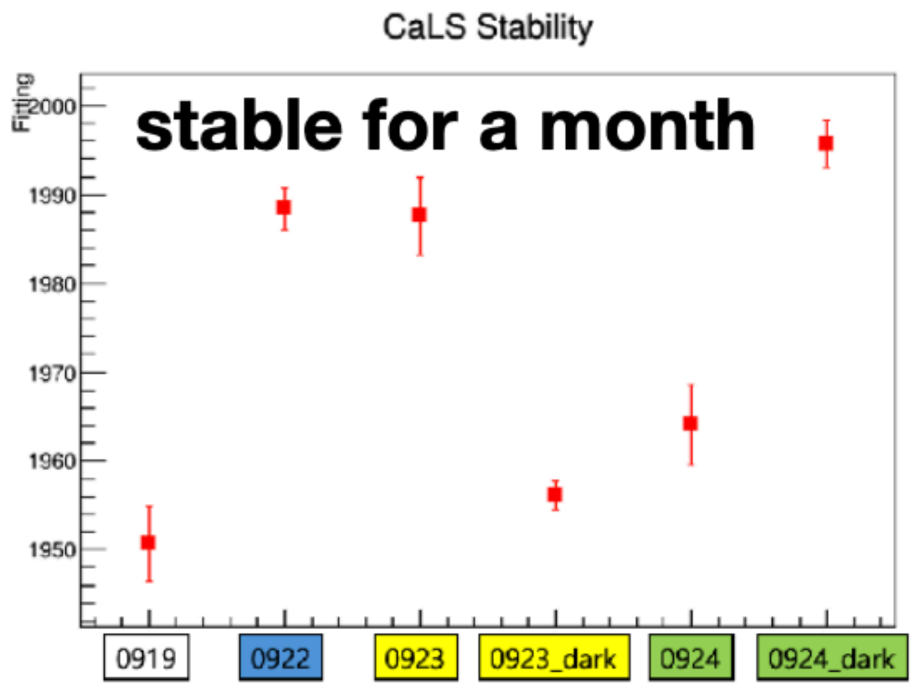
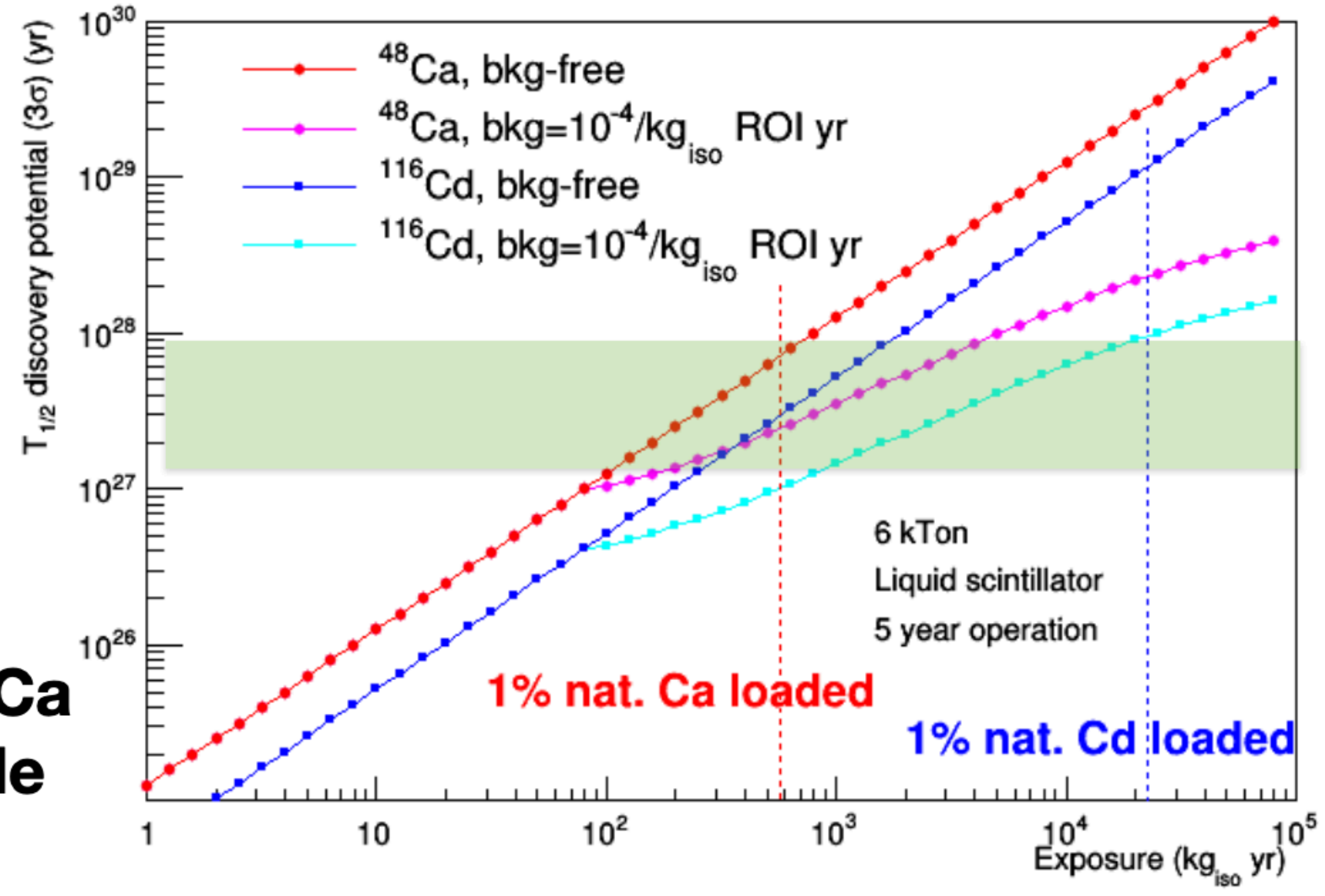
Neutrino: Dirac or Majorana particle - $0\nu\beta\beta$ 실험으로 규명 !





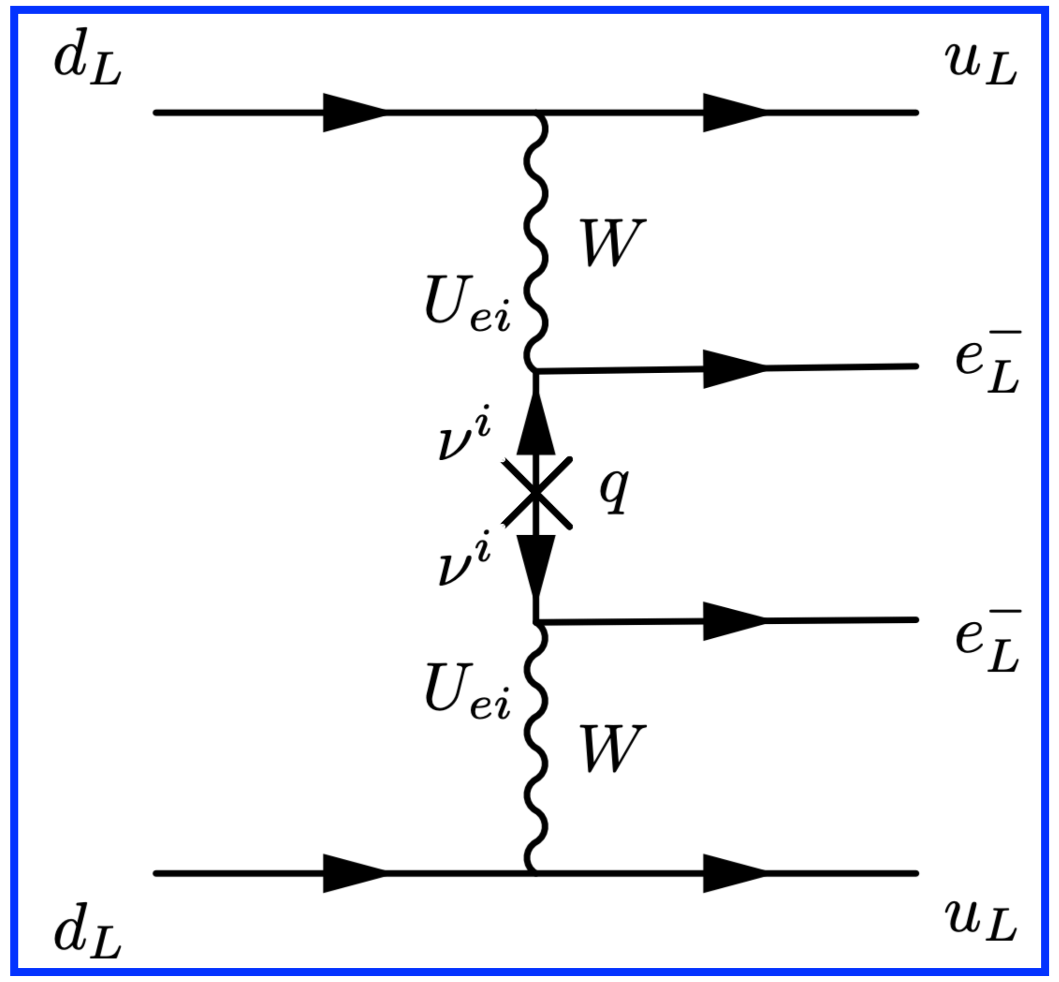
R&D with KNU shows 2.8 g/L Ca loading possible



1% nat. Ca loading would give us 114kg * 5yr Exposure (bkg. better, mass lower)
For Cd, 22,500 kg yr exposure (higher mass, a bit of bkg will not be competitive),
For Se and Mo, somewhere in between.

Neutrinoless double beta decay (0νββ) with νEYE

https://arxiv.org/pdf/1507.00170



Q: 장기간의 R&D 이후 실험을 진행하는 것이 연구의 시급성에 비해 너무 늦은 것이 아닌가?

Observation of 0νββ:

- Massive Majorana fermions
- Lepton number violation
- New mass creation mechanism
- New mass scale

- With ν**EYE** or 다른 방법으로 검출기와 타겟이 동일한 물질인 실험 (예: LEGEND, nEXO) 기초 연구 시작.
- 가장 빨리 진행되고 있는 차세대 이중베타붕괴 실험인 LEGEND-1000 실험의 경우에도 **실제 1000 kg 실험이 진행되는 것은 2035년.**
- **0νββ 실험 스케쥴은** sensitivity **향상에 초점이 맞춰져 있음.**

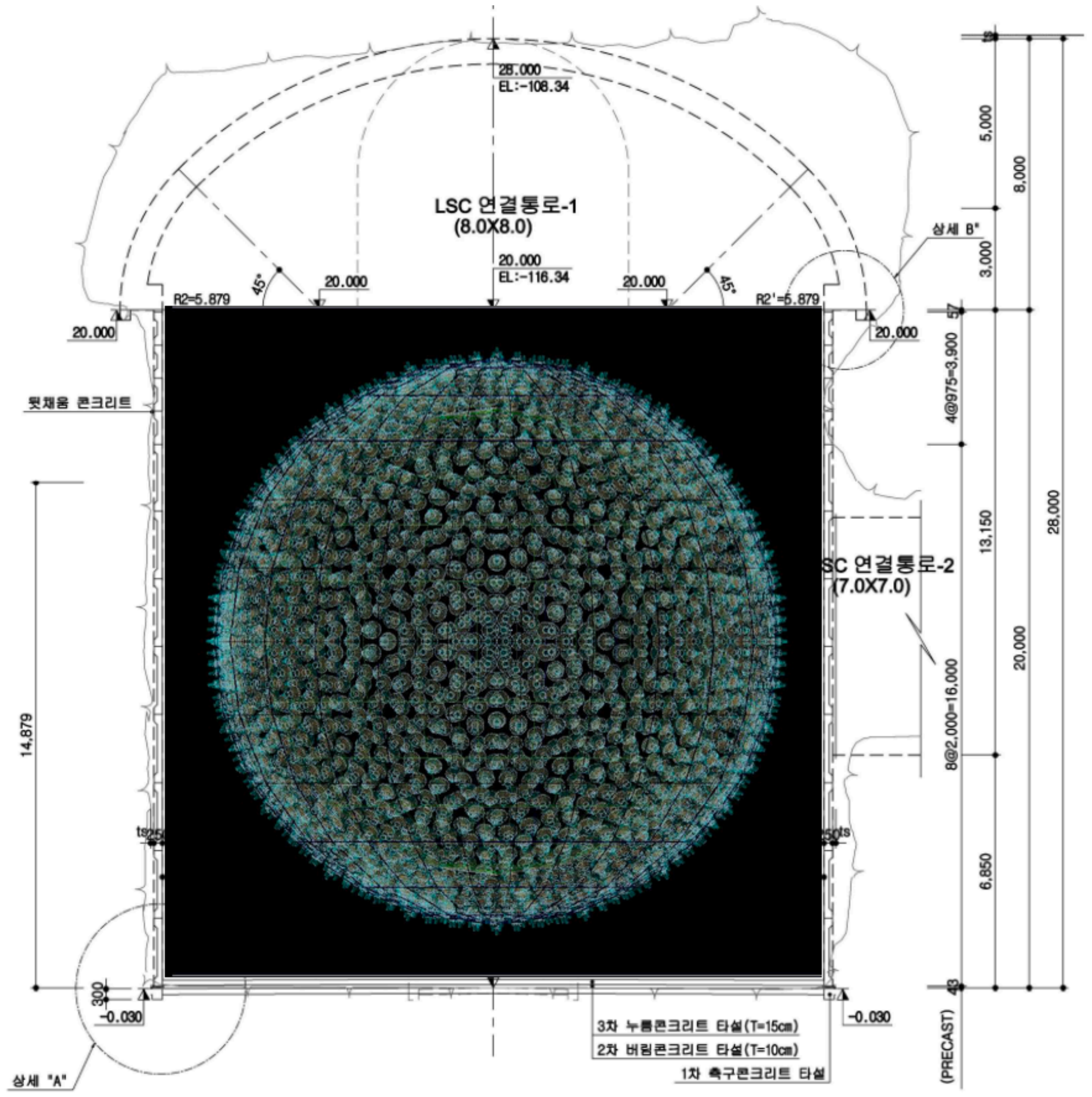
$$\Gamma^{0\nu} \propto \left| \sum_i U_{ei}^2 m_i \right|^2$$

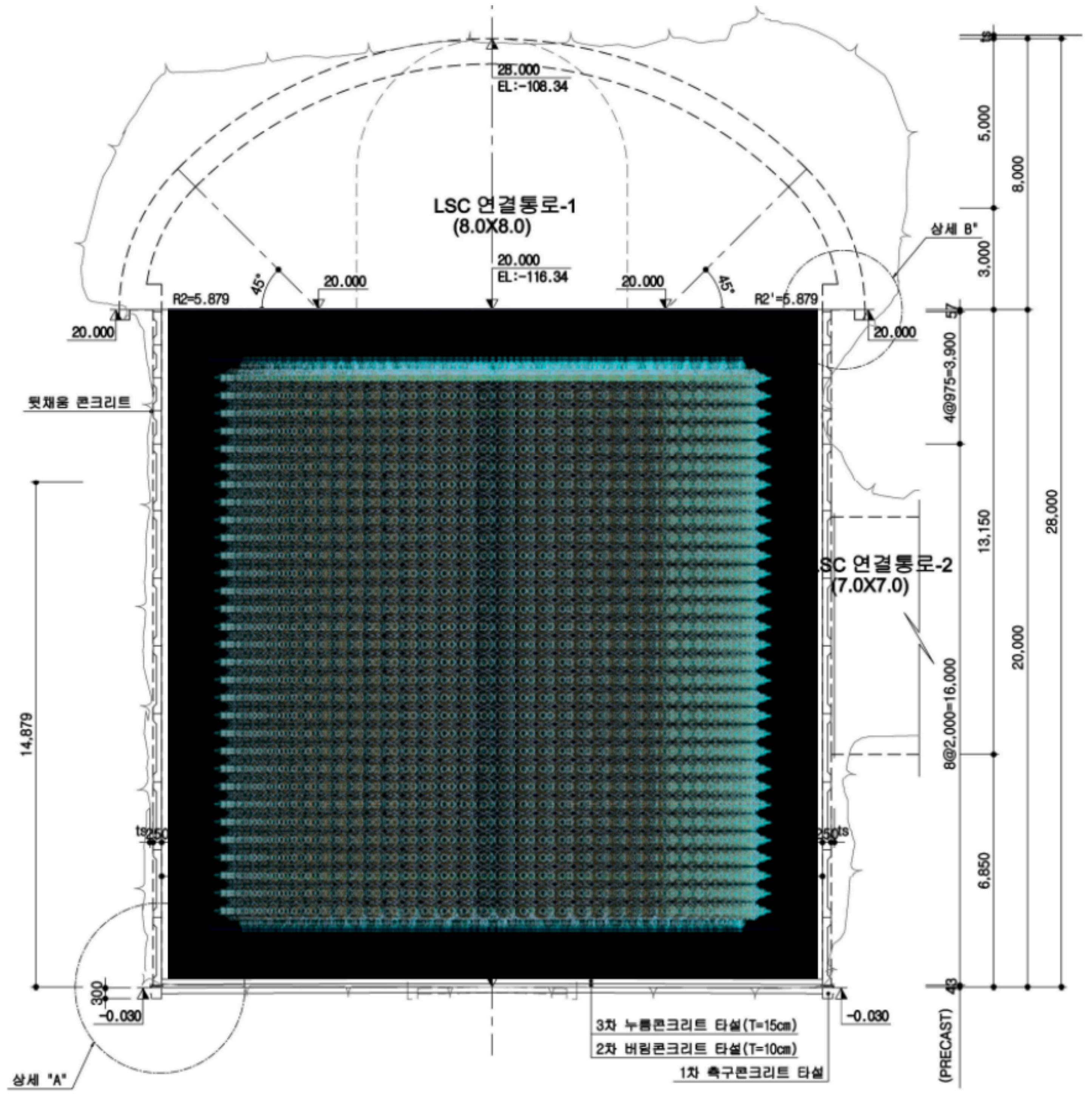
Detector Design

Detector concept

A 2 kilo tonne liquid scintillator (the actual target-mass is smaller).
At this moment, we consider two options: **spherical** or **cylindrical**.

νEYE CDR: arXiv:2601.12569



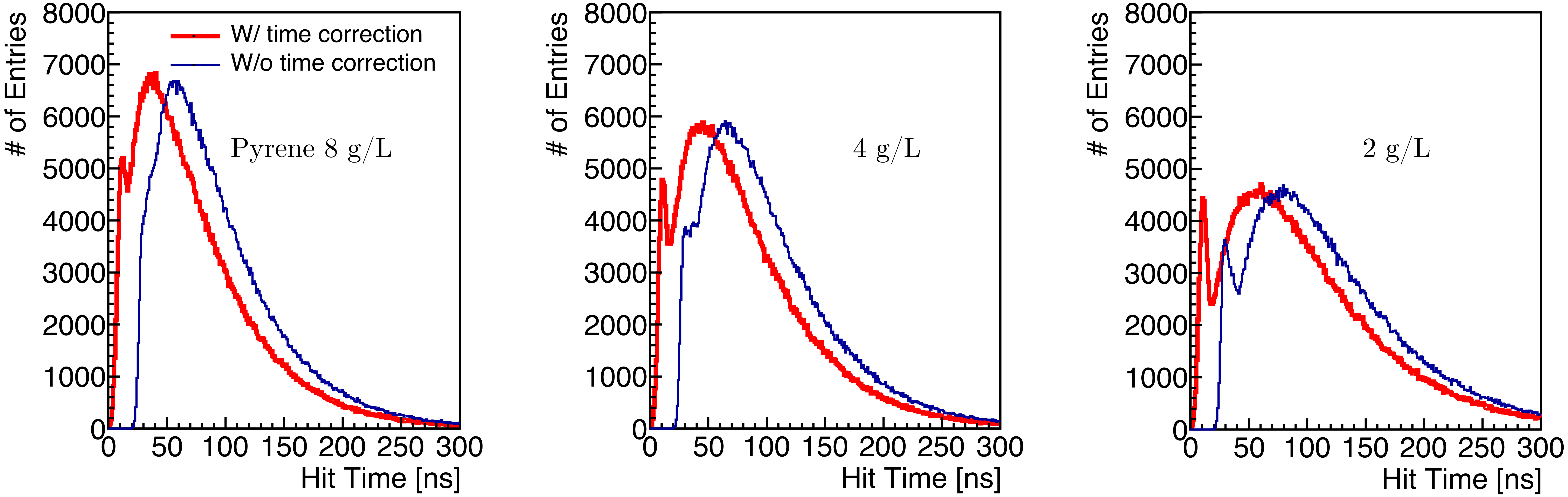


Shape	Cylindrical	Spherical
Radius (m)	7	7.25
Height (m)	14.5	-
Volume (m^3)	2232	1596
Mass (kg)	1920	1373
Number of PMTs	3700	3000

Size of buffer volume is under optimization.

Target liquid scintillator

Our primary choice is "**slow scintillator**", to separate Cherenkov from scintillation.
A chemical lab was constructed to initiate this R&D @ Yemilab.



Hit time distribution from Geant4 simulation

Cherenkov separation is enhanced with 2 g/L option.

Detailed R&D status can be found from
: https://sites.google.com/korea.ac.kr/the-nueye-telescope/pubpresentations

Photodetector

Our primary choice for the photodetector is **photomultiplier** technology.
Another possible option: LAPPD - complication of readout, cost issues have to be resolved.
(https://sites.google.com/korea.ac.kr/the-nueye-telescope/pubpresentations)

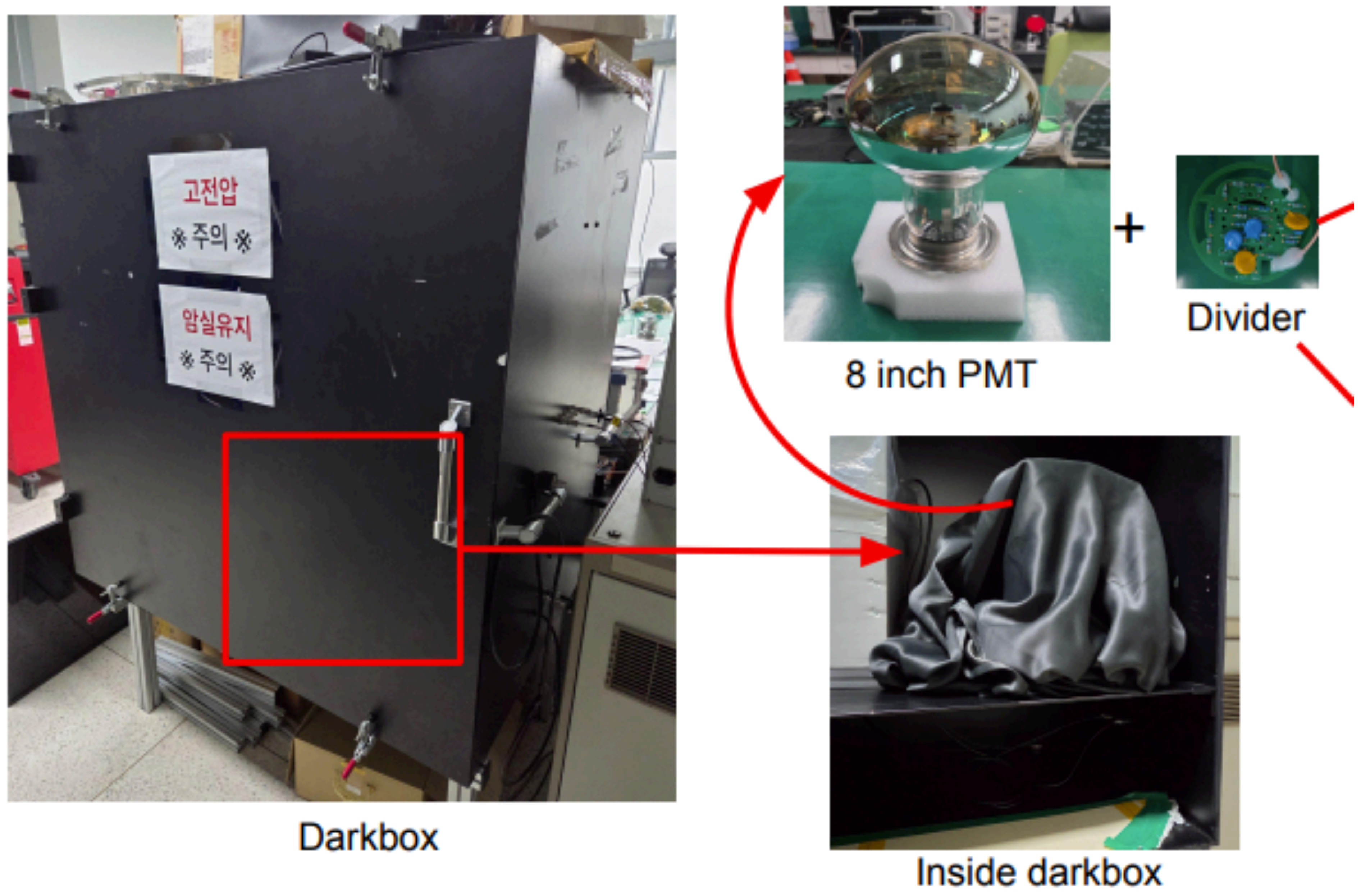
In the market, we have three major choices.
- R12860 is our primary choice for this project.

Model	R12860	N6203	N6082
Size (inch)	20	20	8
Peak wavelength (nm)	420	380	380
HV (V)	2000	1900	1750
Q.E. (%)	30	30	30
TTS (ns)	2.4	5	1.6
Supplier	Hamamatsu	NVT	NVT

All well studied by community:

We have samples of all and R&D is underway.

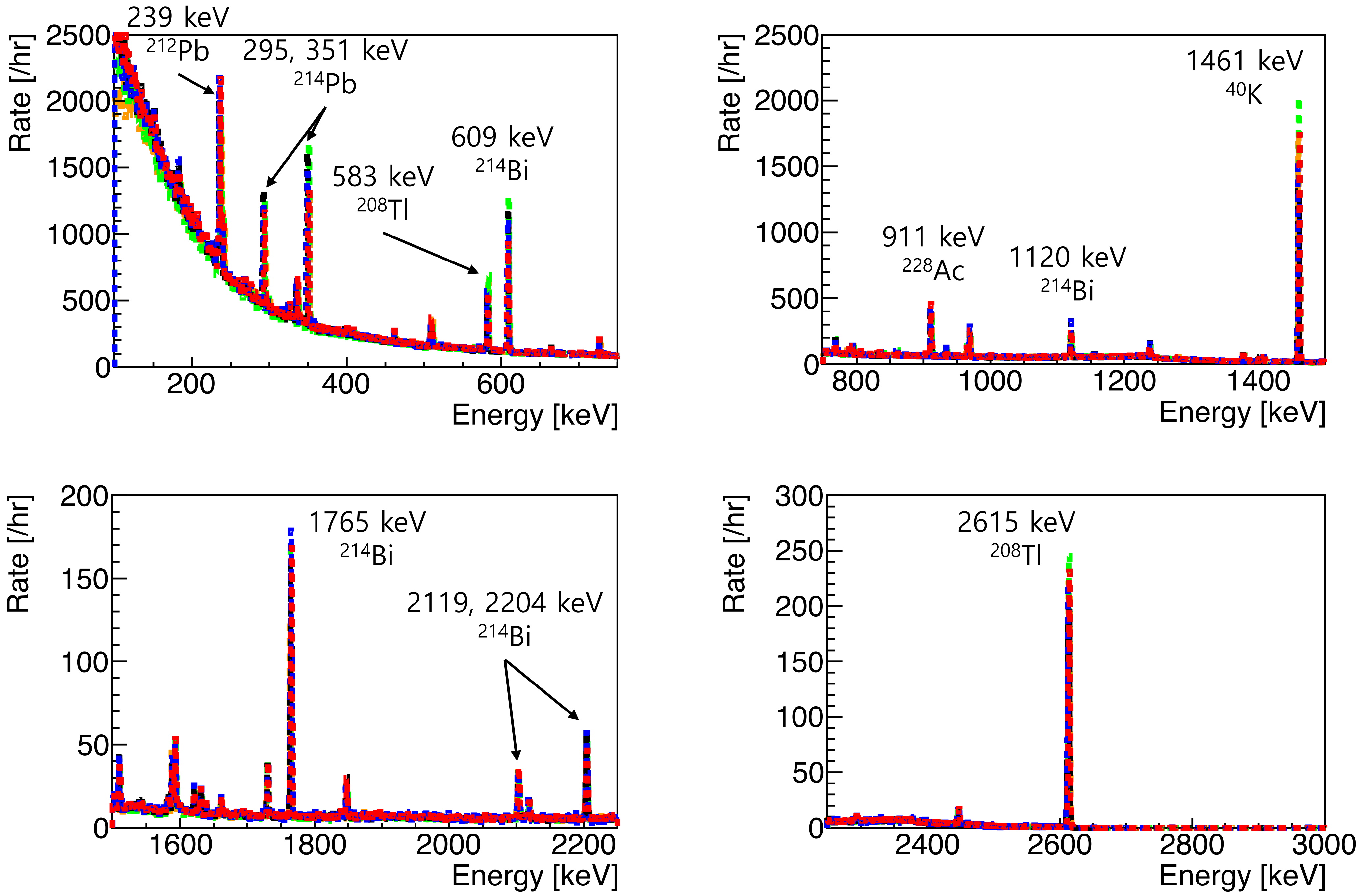
8 inch MCP PMT Test setup to see Dark



Environmental backgrounds @ Yemilab

At the Yemilab site, HPGe is utilized, to measure the radioactive background from rocks.

	^{238}U	^{40}K	^{232}Th
		Bq/kg	
Shotcrete	16.7 ± 0.6	447 ± 16	25.3 ± 0.6
Rock # 1	19 ± 2	618 ± 69	22 ± 2
Rock # 2	18 ± 2	872 ± 98	26 ± 2
Rock # 3	13 ± 1	561 ± 63	15 ± 1

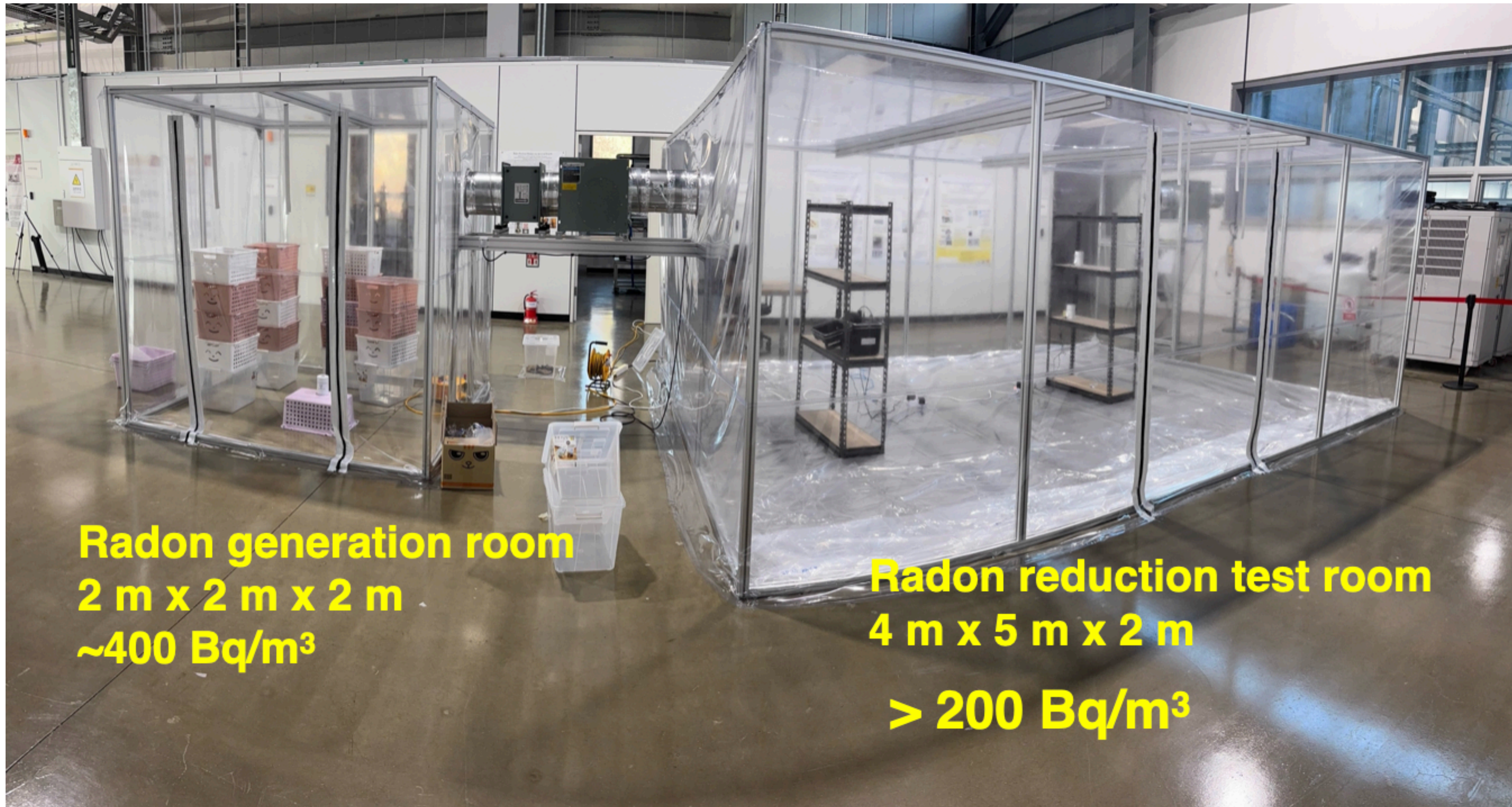


Measured Radon activity

Location	Radon level (Bq/m^3)
Up	68 ± 14
Middle	84 ± 19
Middle (opposite)	118 ± 12
Middle (low)	125 ± 21
Hall center	148 ± 17

Dedicated Radon reduction system is required.

We are exploring a new method: silver-ion exchanged zeolite (PTEP 2024 023C01) @ Korea U Sejong campus.



Software developments

- Early study: K. Lee et al, J. Korean Phys. Soc. **85**, 381–388 (2024), https://arxiv.org/abs/2401.13215

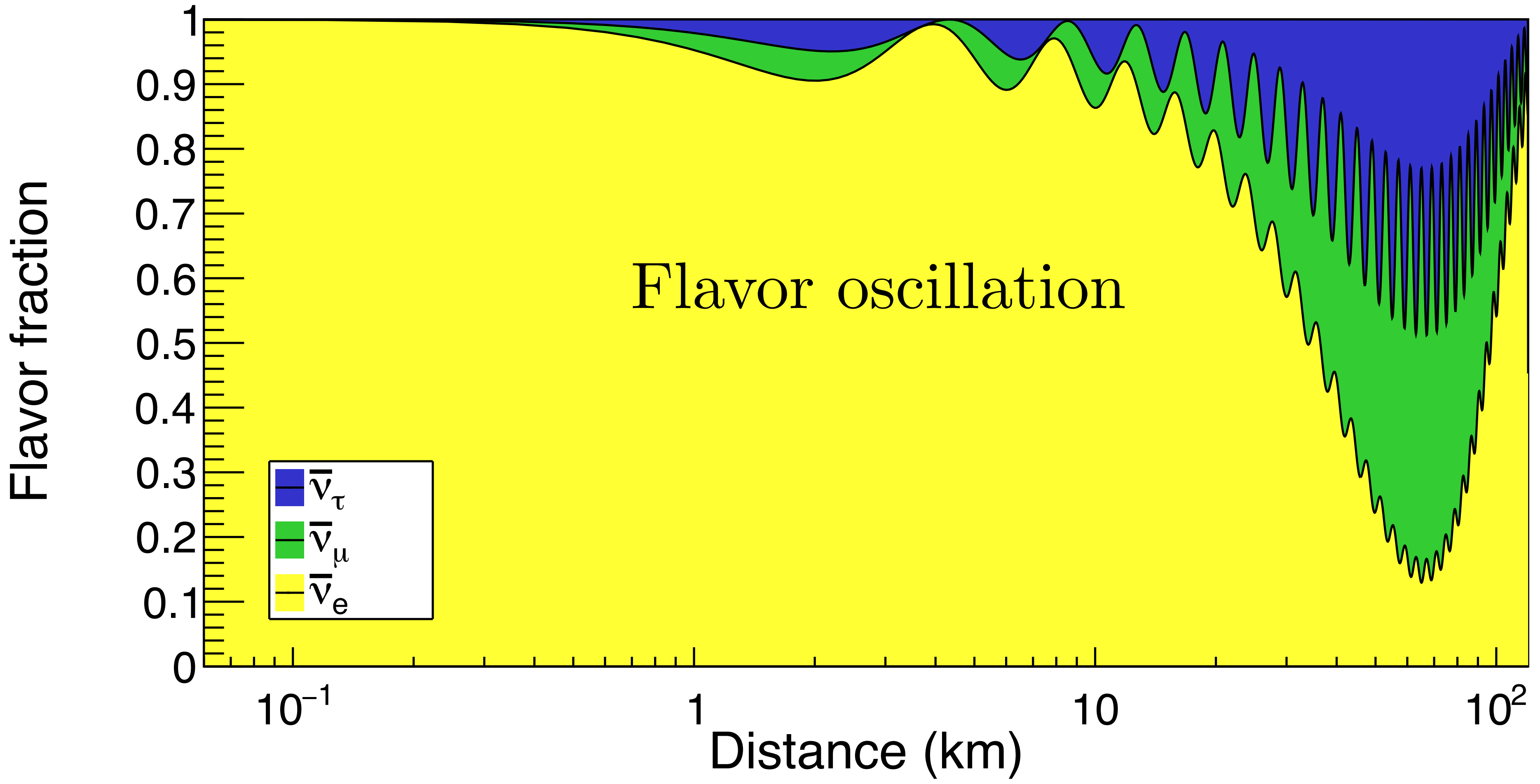
νOscillation: a software package for computation and simulation of neutrino propagation and interaction

νOscillation

Seong-hyeok Jang,[1] Eun-Ju Jeon,[2] Youngju Ko,[2] Kyungmin Lee,[1] and Eunil Won[1]

Physics, Korea University, Seoul 02841, Korea

hysics, Institute for Basic Science, Daejeon 34047, Korea



only phenomenon that cannot be explai
sterious neutrino interactions observed
nd ongoing or planned neutrino experi
ely on precise computations of neutrino

from the sun, and the oscillation of

the neutrino oscillation with assuming a reactor located at 53 km away from the detector.

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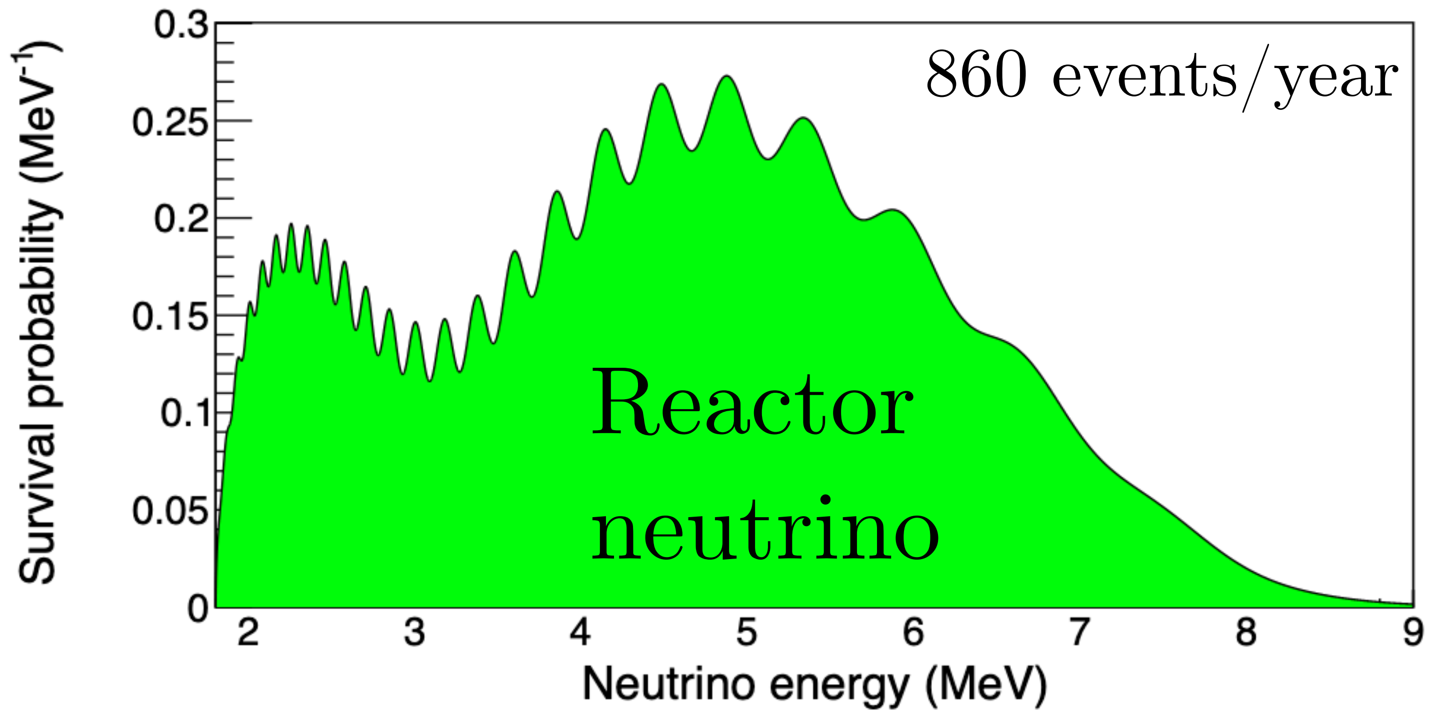
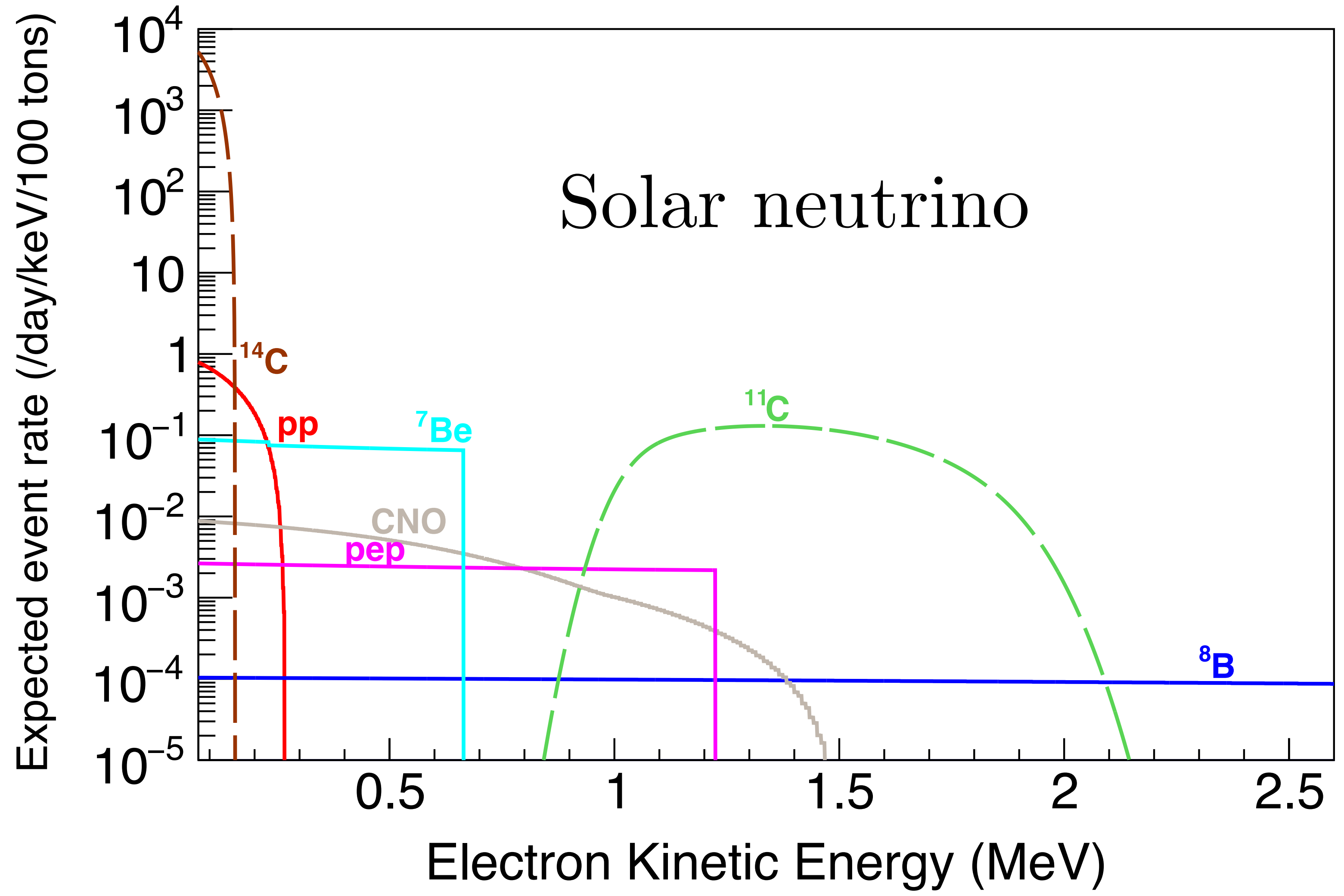
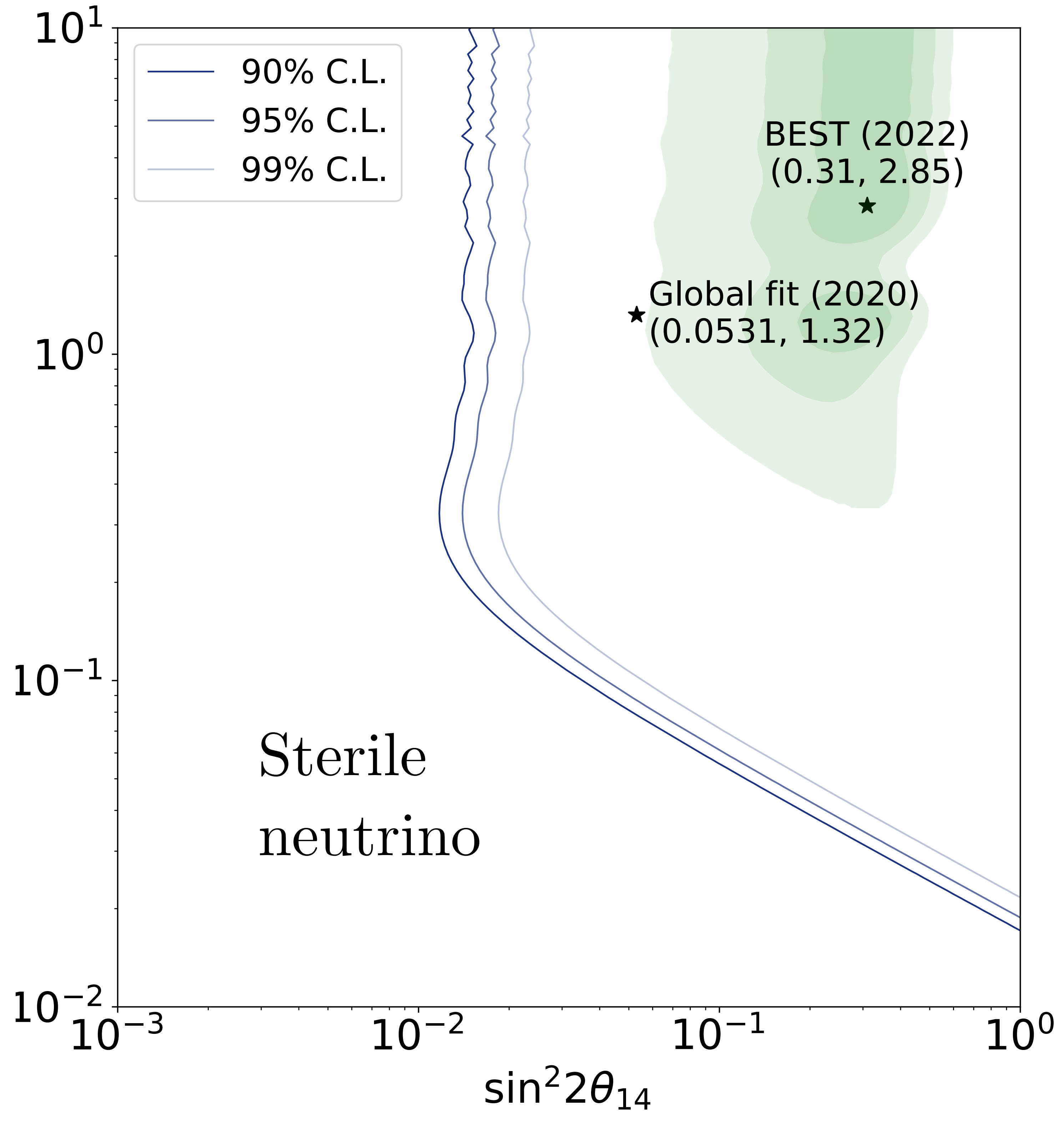




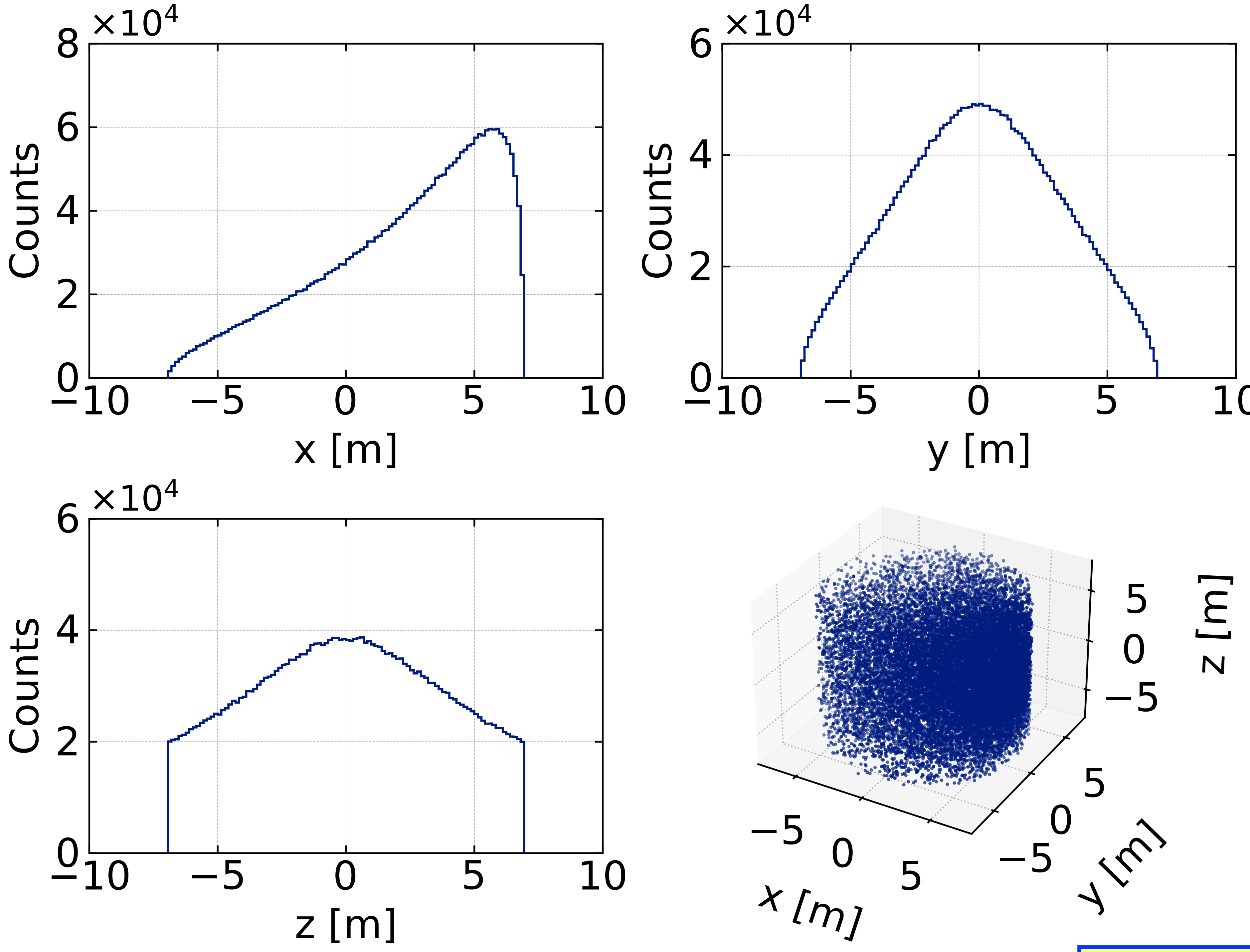


Software developments with Geant4

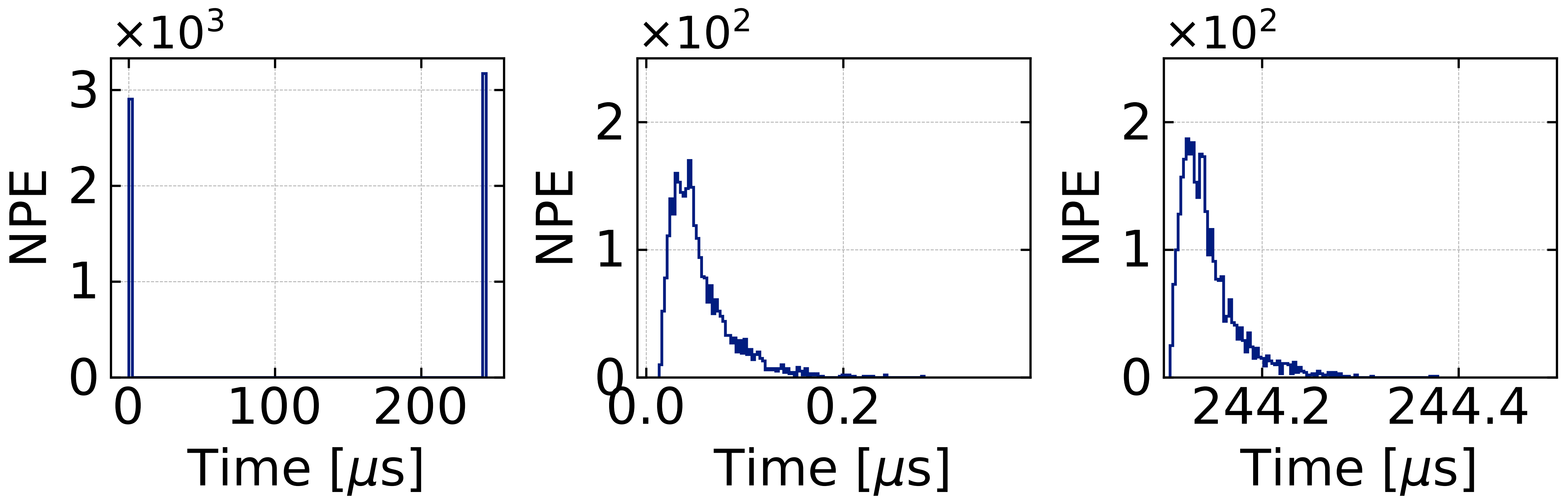
^{144}Ce $\bar{\nu}_e$ production simulation (Geant4) and reconstruction of inverse beta decays (IBD)

νEYE CDR: arXiv:2601.12569

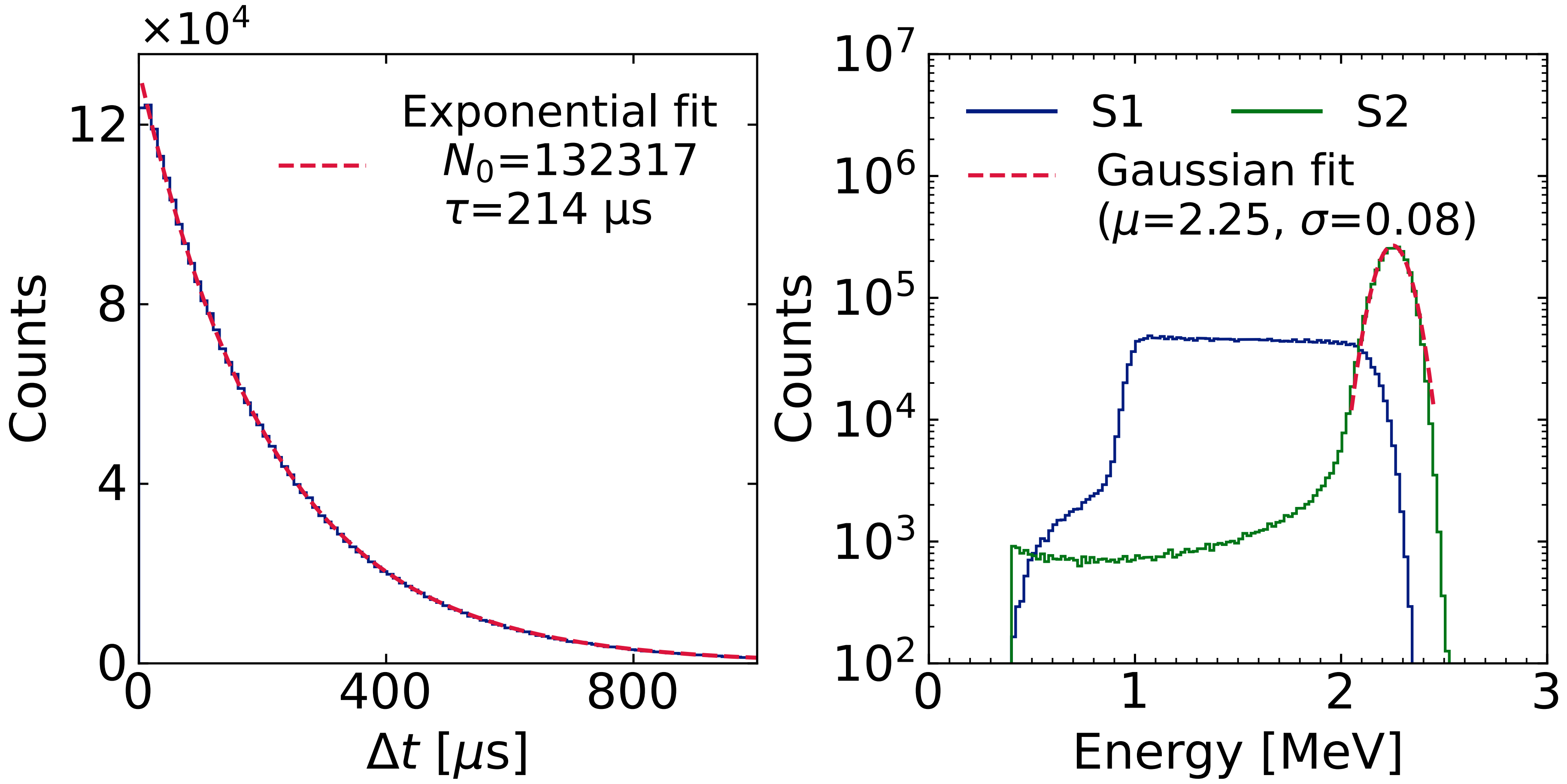
^{144}Ce at (9,0,0) m



Hit time distributions (S1, S2 together, S1 and S2 respectively)



Time difference btw S1 and S2 (left) and energy deposit (right)



No issues with IBD reconstruction

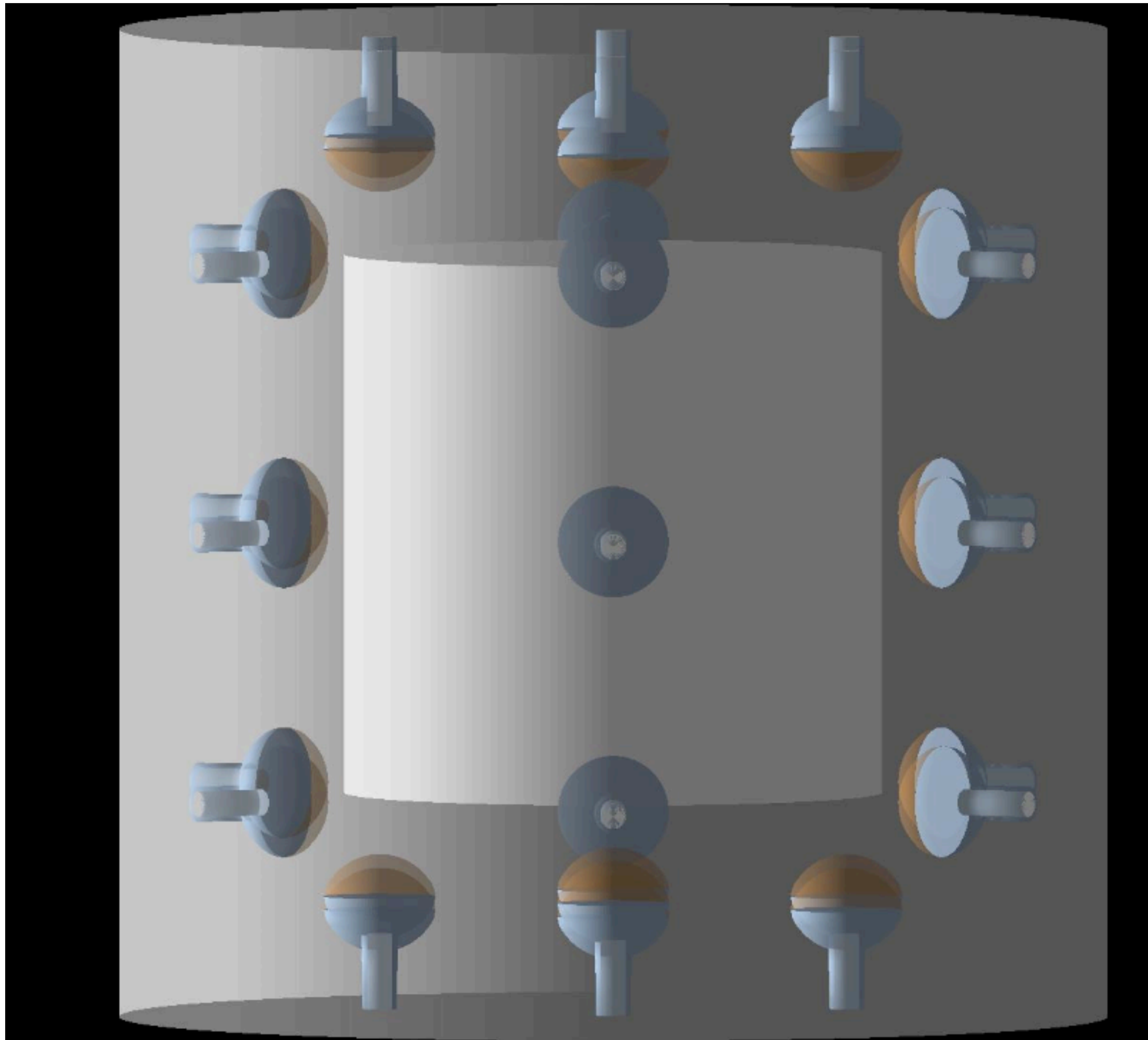
IBD events trigger

- Require hits in 200 ns
- If NPE > 400, all hits in 500 ns constitute first cluster (S1)
- Search for the second cluster (same condition, S2)

A prototype νEYE (1 tonne) construction

Volume : 1.2 m x 1.2 m acrylic tank: $O(1)$ tonne of LS.
Buffer : pure water or mineral oil.
PMTs : 31 PMTs of 10" R7081.

DAQ and HV
FADC: 500 MHz (from Notice Korea).
CAEN A7435SP



Purpose

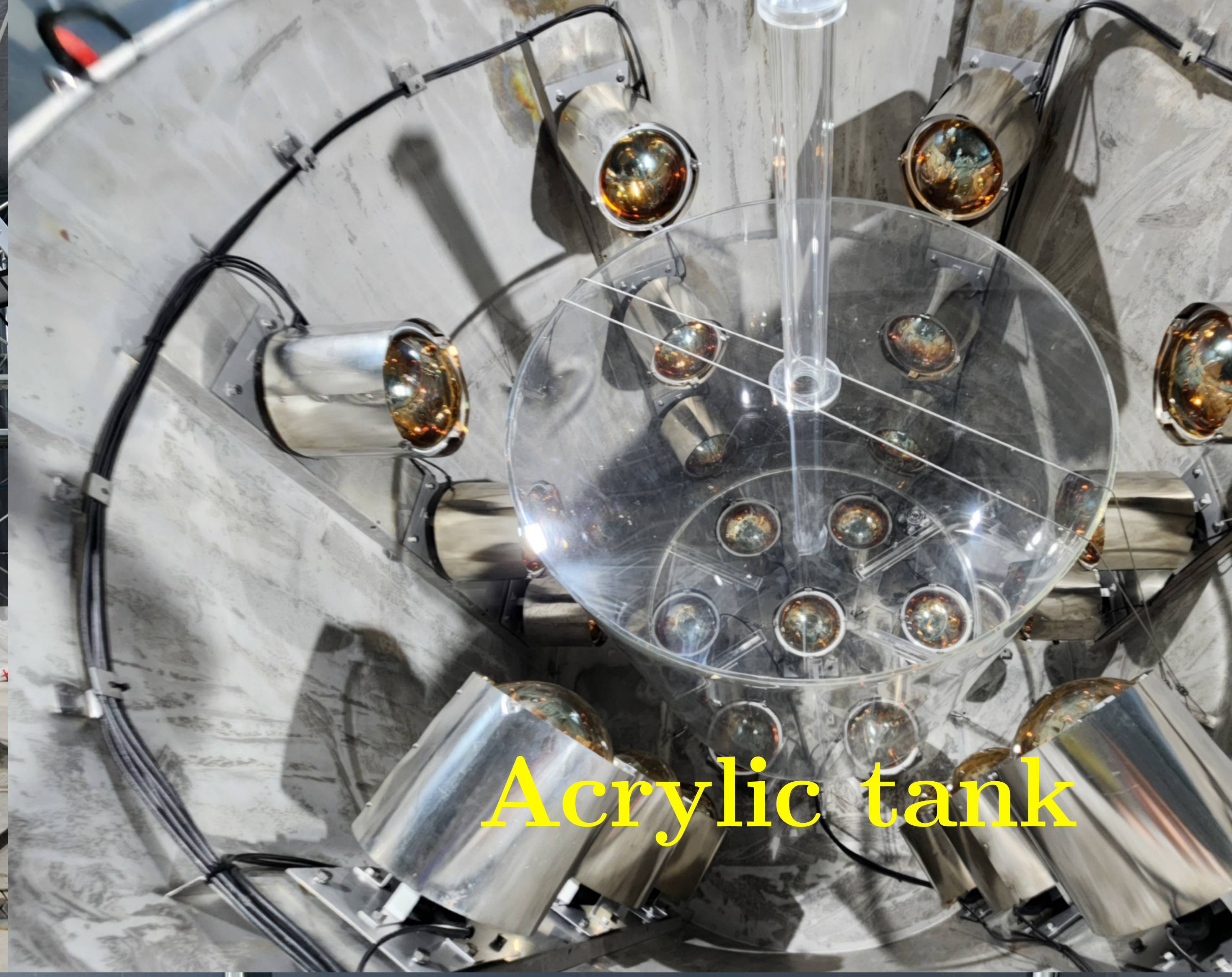
Study and optimize LS.
Measure the intrinsic background : $10^{-13 \text{ or } -14}$ g/g.

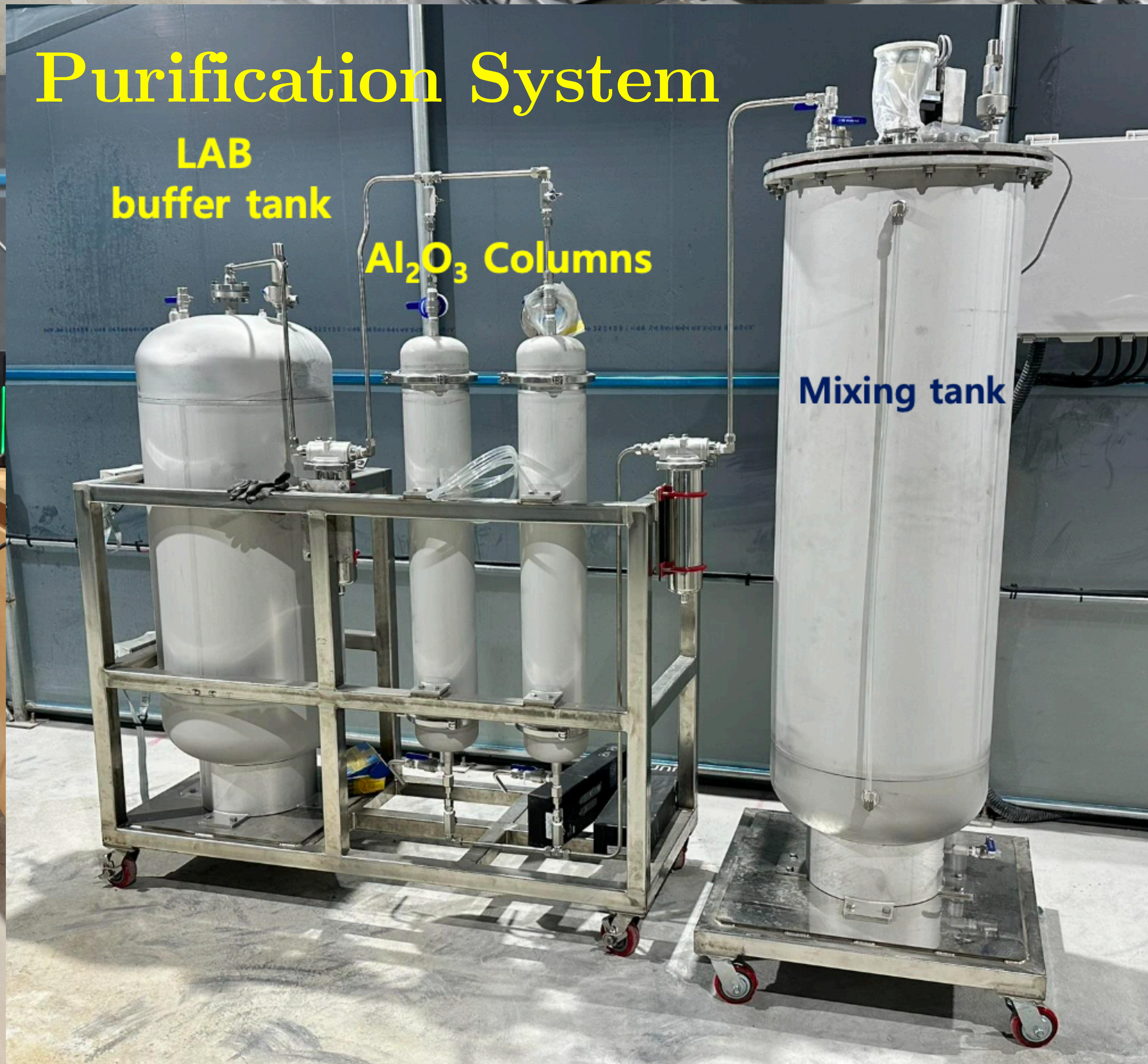
To provide feedback to full scale νEYE detector.
Optimize and validate the Geant4 simulation.

Construction started from summer of 2025.

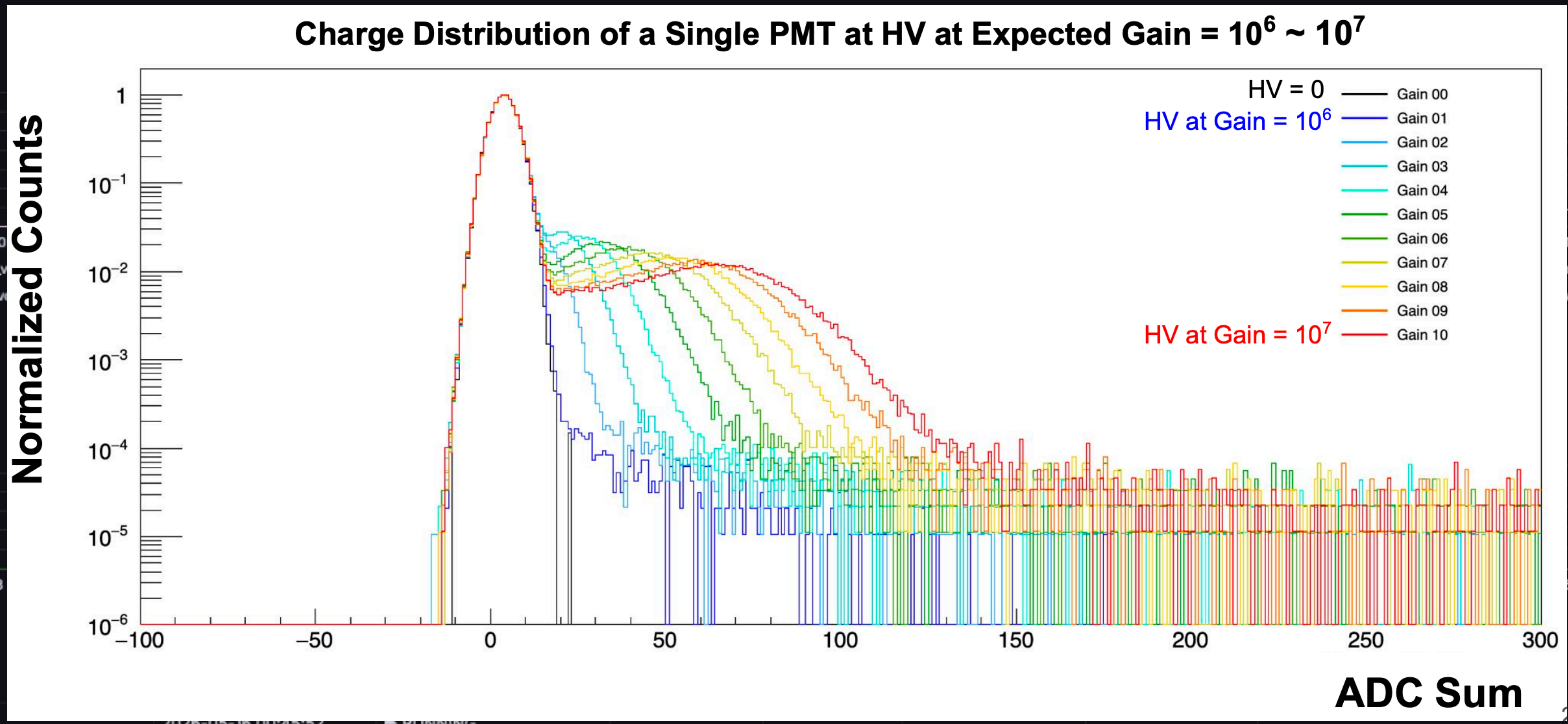
- 1 톤 prototype preparation

Tent, outer/iner containers
Purification system
Readout/DAQ all prepared.





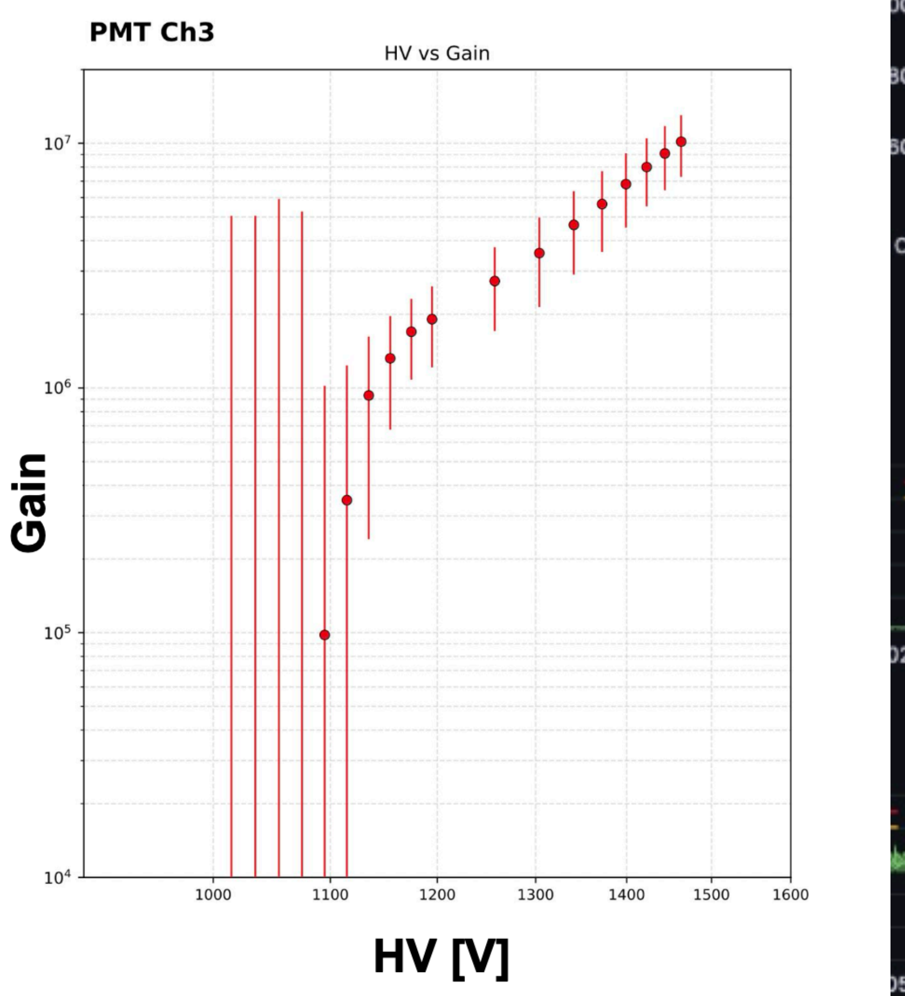
- 1 톤 prototype dry run: May 2026
- 6월 15일 경 물 채울 예정.
- 7월 Liquid Scintillator 채울 예정.



Run control and Monitoring

PMT SPE Charge & Gain at HV at Expected Gain = $10^6 \sim 10^7$

HV [V]	Expected Gain / 10^6	Gain / 10^6
1015	0.548	0.000170
1035	0.639	0.00000290
1055	0.744	0.0000249
1075	0.864	0.00000934
1095	1	0.0979
1115	1.15	0.348
1135	1.33	0.932
1155	1.53	1.32
1175	1.75	1.70
1195	2	1.91
1257	3	2.73
1304	4	3.56
1341	5	4.64
1372	6	5.64
1399	7	6.81
1423	8	7.99
1444	9	9.09
1463	10	10.2



2026 년 가을 물리학회에 자세한 실험 내용 보고 예정

Conceptual Design Report

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CDR - arXiv:2601.12569

Uploaded in Jan. 2026

Important for future!

The νEYE Neutrino Telescope: Conceptual Design Report

CDR - arXiv:2601.12569

Shaomin CHEN [1], YangHwan Ahn[2], Davide Franco [3], Fabio Mantovani[4], Aldo Ianni[5],
Jiyong Choi [6], S. Gwon [6], K. K. Joo [7], Chang Hyon Ha [8], Kim Siyeon [8],
Jong-Chul Park [9],
Young Ju Ko [1
Park [16], Gihan
Won [17], Jae Hyeok
Sin Kyu Kang
V.I. Tretyak [22,23], Steve Elliott [24], Jose R. Alonso [25], Janet M. Conrad [25], Michael H. Shaevitz [26], Joshua Spitz [27], and Daniel Winklehner [25]

Home » Physics Opportunities of Large Liquid Scintillator Detectors

Physics Opportunities of Large Liquid Scintillator Detectors

Panel Discussion	Optimizing detector design for a broad physics program	Nigel Smith, Eunil Won, Ray Bunker, Hiro Tanaka, Ed Blucher
Closing Talk	Closing talk: International Programmatic Landscape	Hitoshi Murayama

June 19-20, 2026

[1]Center for High Er

Discussion in June Neutrino2026 Satellite session: Future LS

University, Beijing, China

νEYE web: https://sites.google.com/korea.ac.kr/the-nueye-telescope

νEYE The NuEYE Telescope

Home Science Detector CDR Pub/Presentations Contact us

The NuEYE Experiment at Yemilab

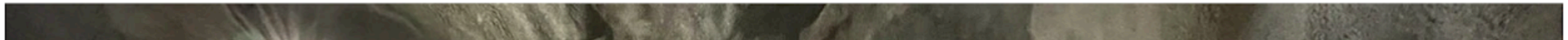
In September 2022, a new underground laboratory, Yemilab, was completed in Jeongseon, Gangwon Province in South Korea, with a depth of 1,000 m. In the laboratory, the largest site is the LSC Hall, combining a square dome measuring 22 m (width) by 22 m (length) by 8 m (height) on top, with a cylindrical pit having a diameter and depth of 20 m. The pit has a volume of 6,200 m^3 and serves as a multipurpose space for detectors. For a liquid type, about a 2 kilo-tonne detector can be hosted as an expample. The NuEYE experiment is a new proposed underground neutrino telescope at Yemilab for a multi-purpose neutrino science.

NEWS | 30 May 2024

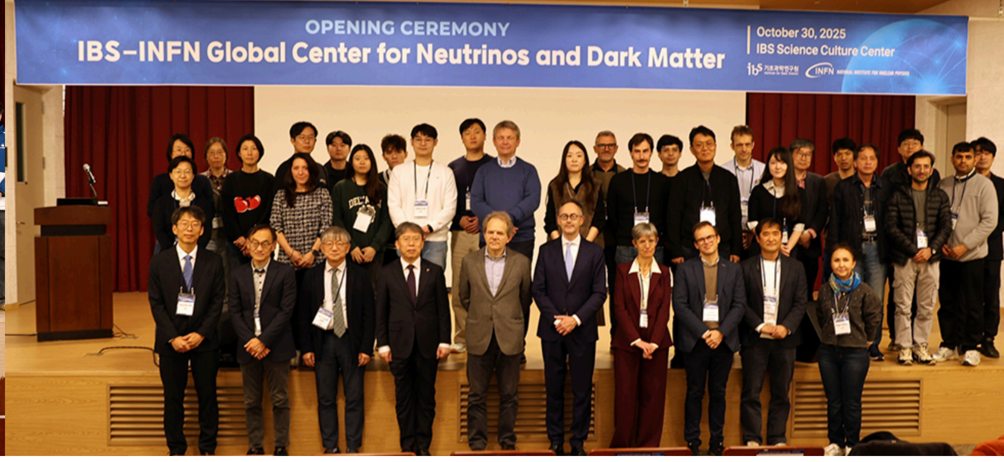
Disputed dark-matter claim to be tested by new lab in South Korea

A multi-million dollar facility is hoping to put a 21-year-old debate about dark matter to rest.

By Gemma Conroy



International Collaboration and R&D



Through workshops we collaborate w/ Borexino and INFN: 2024, 2025. (2026 Nov. in Gran Sasso planned.)

- Detector design optimization
- Liquid Detector R&D, radioactive source preparation
- State-of-the-art purification

https://indico.ibs.re.kr/event/709/
https://indico.ibs.re.kr/event/1036/

3. Review of Borexino Physics and beyond
Aldo Ianni
11/18/24, 11:30 AM

6. The SOX experiment and physics
Davide Franco
11/18/24, 2:30 PM

5. BEST
Steven Elliott
11/18/24, 1:30 PM

10. Scintillator purification technology
Paolo Lombardi
11/19/24, 9:00 AM

13. JUNO
Liang Zhan

12. Jinping Neutrino Detector
Shaomin Chen
11/19/24, 11:30 AM

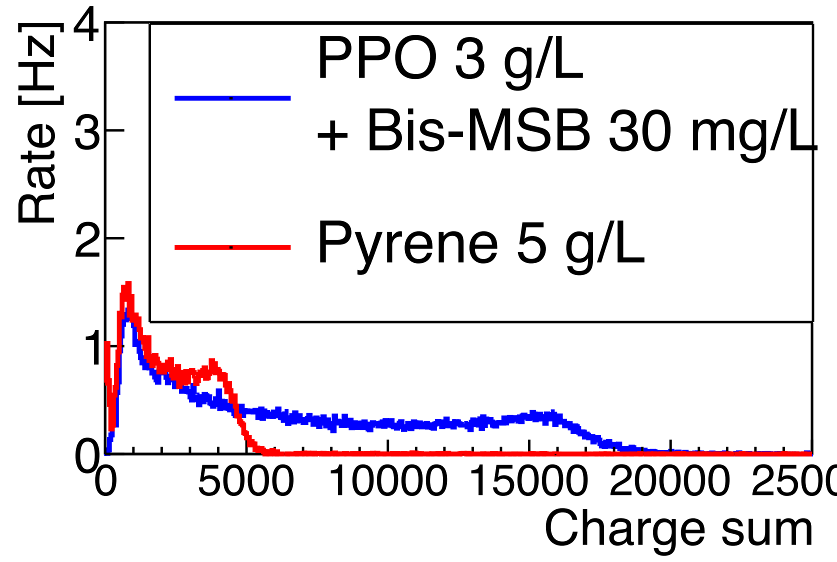
11. Review on high-purity nitrogen technology and special techniques
Gregorz Zuzel

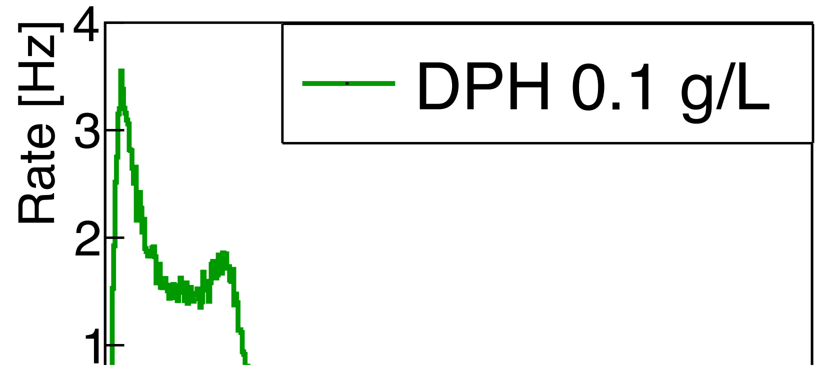
19. LRT
Matthias Laubenstein
10/31/25, 3:20 PM

20. ICP-MS
Stefano Nisi
10/31/25, 3:40 PM

17. Res-NOVA
Luca Pattavina

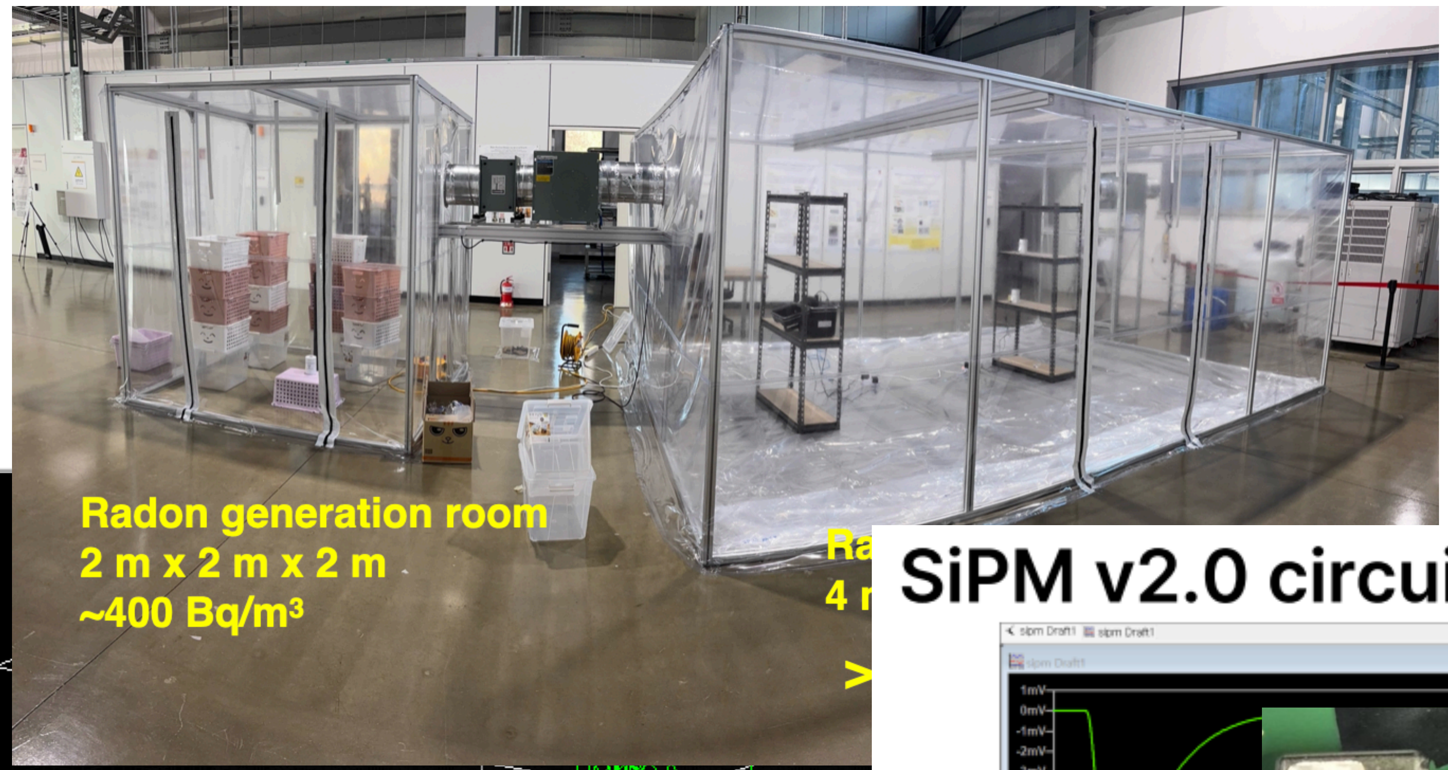
9. CLOUD: Resolving the reactor puzzle(s) at Chooz?
Anatael Cabrera (CNRS)
10/28/25, 10:40 AM
(through Dark World conf.)





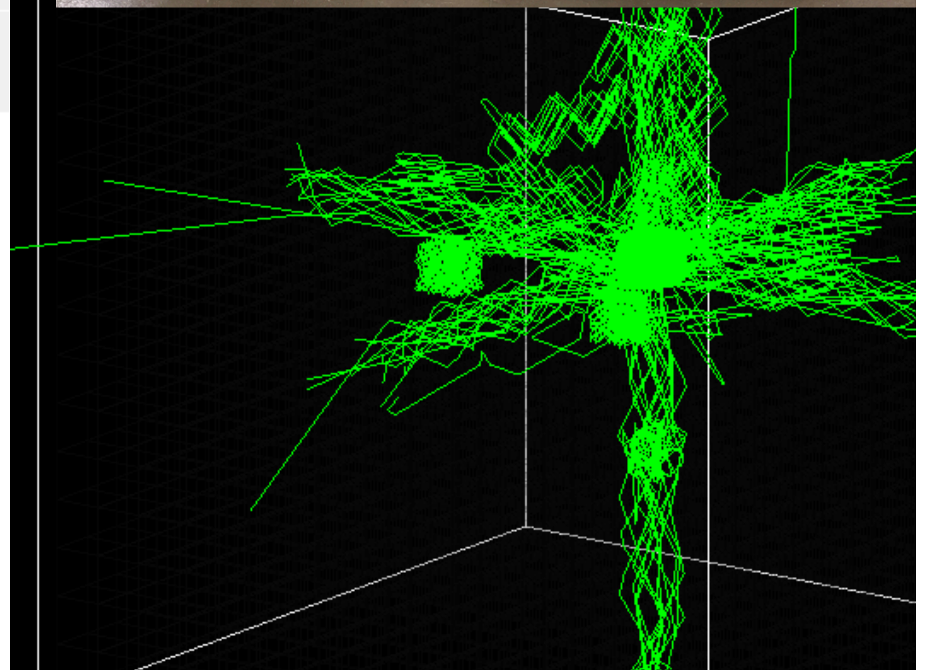
Discussions with IsoDAR (MIT, U of Michigan, BNL)

- Bi-monthly (last one on June 5, 2026)
- Installation scenario (cyclotron in ramp way: ~~main issue~~)

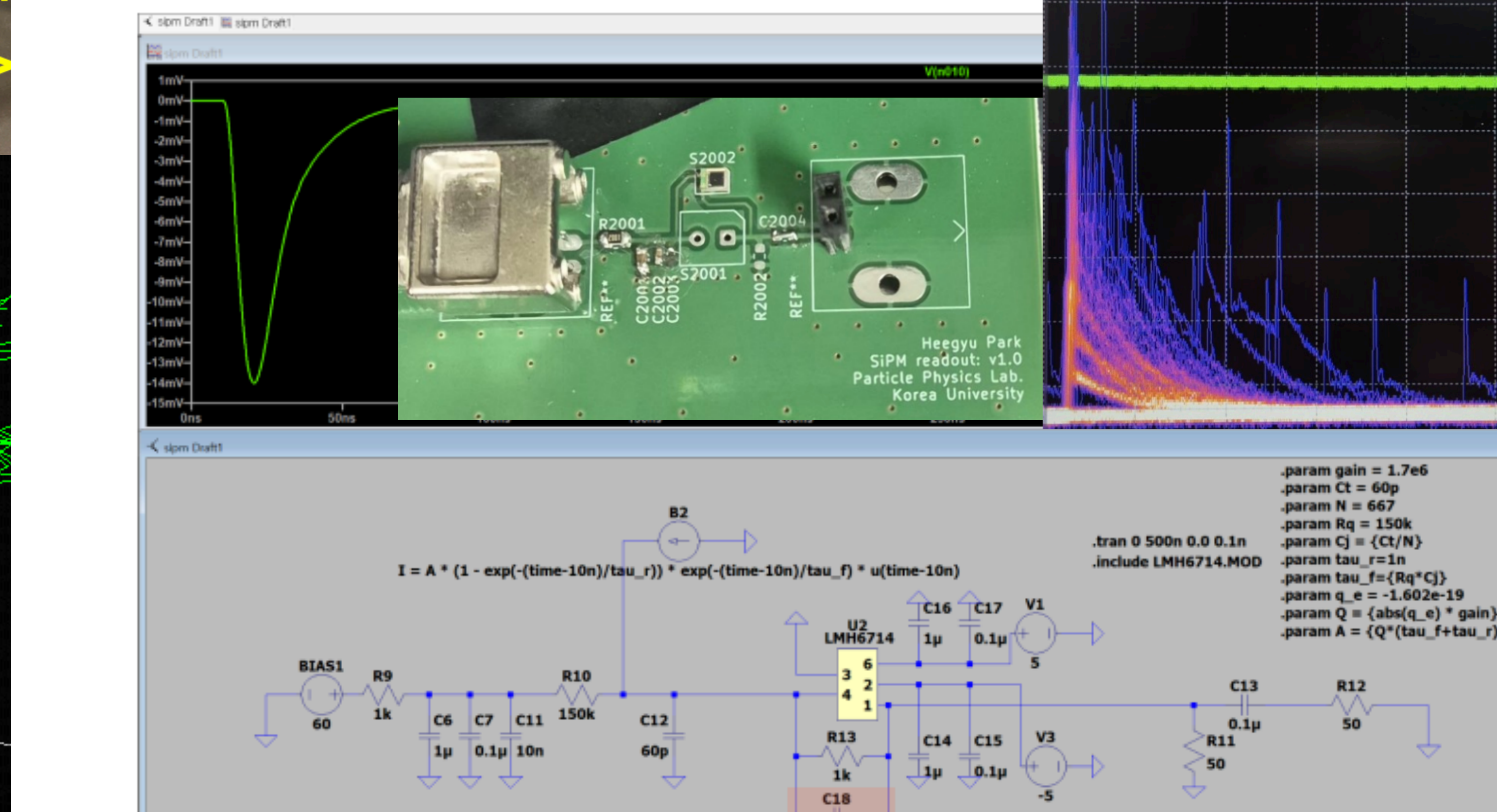


R&D activities

왁스가 녹은 온도
불투명 온도
재가열 시 투명 온도



SiPM v2.0 circuit simulation for 1p.e. pulse



- "Slow LS"
- Opaque LS+fiber based (LiquidO type). Or segmented.
- New Radon reduction technology, $0\nu\beta\beta$.

Budget

No civil engineering cost for the site preparation: 이미 pit (갱도) 확보.

We expect 6 years of construction and $>$ 15 years of operation.

Significant parts of the budget:

- PMT + fast FADC based readout.
- LS, detectors, and the ultra-purification system.
- Human resources.

약 1500 억원 수준의 예산이 예상됨.

Timeline

2017-2018 **초기 논의: 천체, 핵, 입자 위한 지하 가속기, 중성미자 검출 액체 섬광기.**

2019 2 킬로톤 액체 섬광 검출기 옵션 논의.

2022.09 **예미랩 건설 완료.**

2023.09 서울대학교, 지하실험 워크샵, 2 킬로톤 검출기 논의.

2024.07 방사선 선원 국내 수입 논의.

2024.11 The first IBS-INFN workshop: “the radioactive source meeting”

2025.06 **One tonne prototype 설계 완료 및 건설 시작.**

2025.10 INFN GRC opening, LS 공동 R&D 논의.

2026.01 **νEYE CDR release: arXiv:2601.12569**

2026.05,06 **구축형 R&D 사업 지원, 고에너지물리학회**

Summary

Neutrino: gateway to physics beyond Standard Model of Particle Physics.

The νEYE neutrino telescope: a multi-purpose, 2 kilo tonne LS detector @ Yemialb.

- **In situ search for sterile neutrino**: unique with νEYE.
- New physics search: **dark sector/ALP+in ElectroWeak physics**.
- **Solar neutrino: "up-turn"** in the survival probability to be explored.
- Reactor neutrino: Yemilab is **at the first minimum** of Hanul reactor.
- Ultimately, The νEYE will **probe the Majorana nature of neutrinos** with **$0\nu\beta\beta$** experiment.

From 2025, construction of **one-tonne prototype νEYE** was started.

뉴아이 프로젝트는 국내 리더십 + 국제공동 실험으로 진행될 예정입니다.
Please join us for future !

감사합니다.

고에너지물리학회 구축형 R&D 사업 설명회

고려대학교 물리학과 원은일

New physics program with IsoDAR + νEYE

Intense beams of **nuclei, mesons,** e^+, e^-, γ allow **competitive new physics programs.**

Dark photon (A'): spin-1 massive gauge boson, kinetic mixing with SM photons.

Production: Meson decay (ex: $\pi^0 \to \gamma A'$), proton brem. ($p + N \to p + N + A'$), annihilation ($e^+e^- \to \gamma A'$)

Decay: $A' \to e^+e^-$, $A' \to \chi\bar{\chi}$ (χ: dark matter)

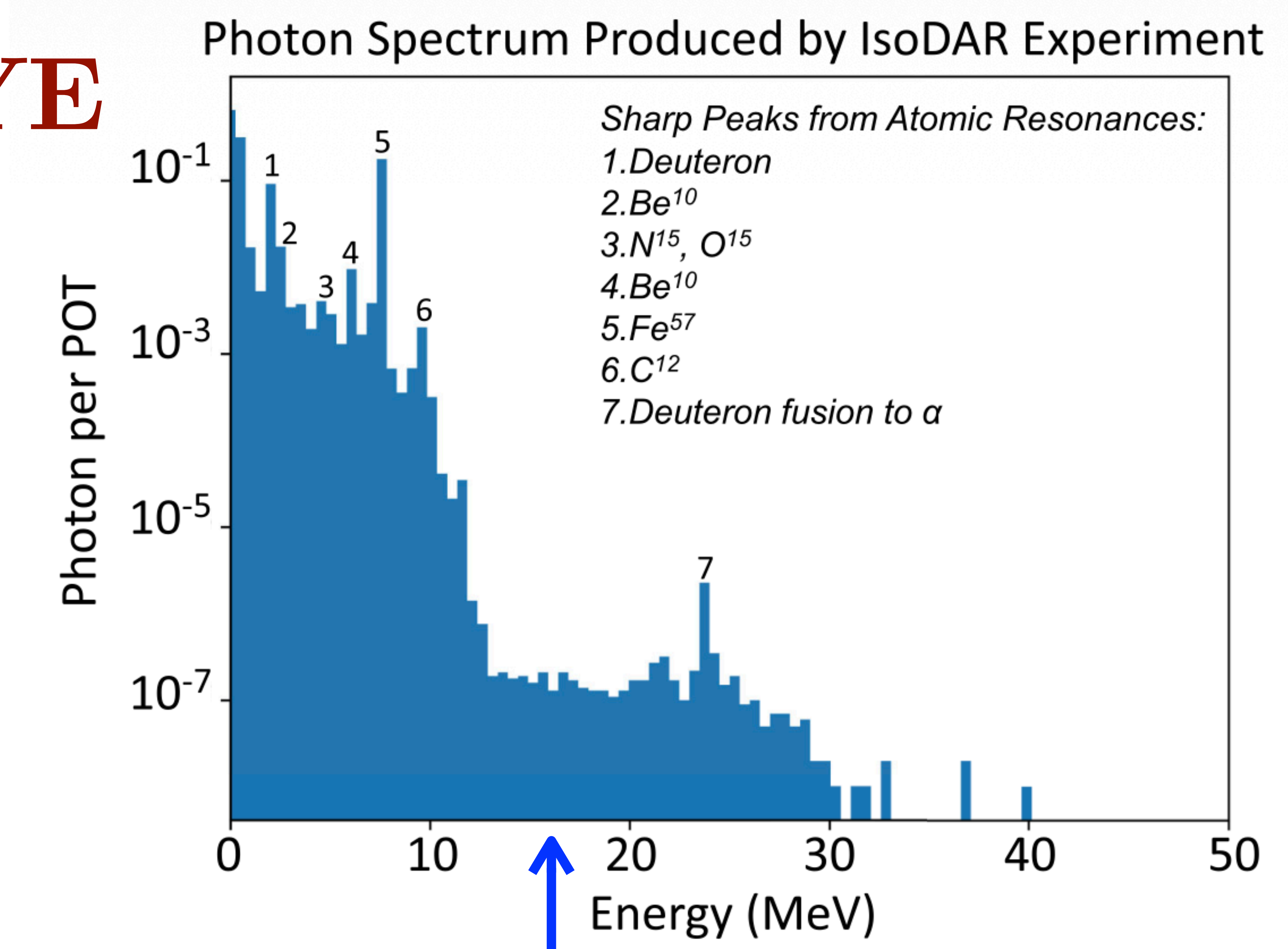
Axion Like Particle: light pseudoscaler, 10^{-22} eV - GeV.

Production: Primakoff production ($\gamma + N \to a + N$), meson decay (ex: $\pi^0 \to \gamma a$), electron brem.

Decay: $a \to \gamma\gamma$, $a \to e^+e^-$

PRD **105** 052009 (2022)

New physics program with IsoDAR + νEYE



Atomki anomaly region

***X* boson** (low mass mediator) decay to $\nu_e\bar{\nu}_e$ (ex: $N^* \to NX \to \nu_e\bar{\nu}_e$).

Atomki anomaly: reported excess of e^+e^- pairs from 18 MeV Be* in ^{7}Li$(p,n)^8$Be* - PRL **116**, 042501 (2016).

5 MeV bump?

If Huber-Mueller of reactor is incorrect, Li should not see it.

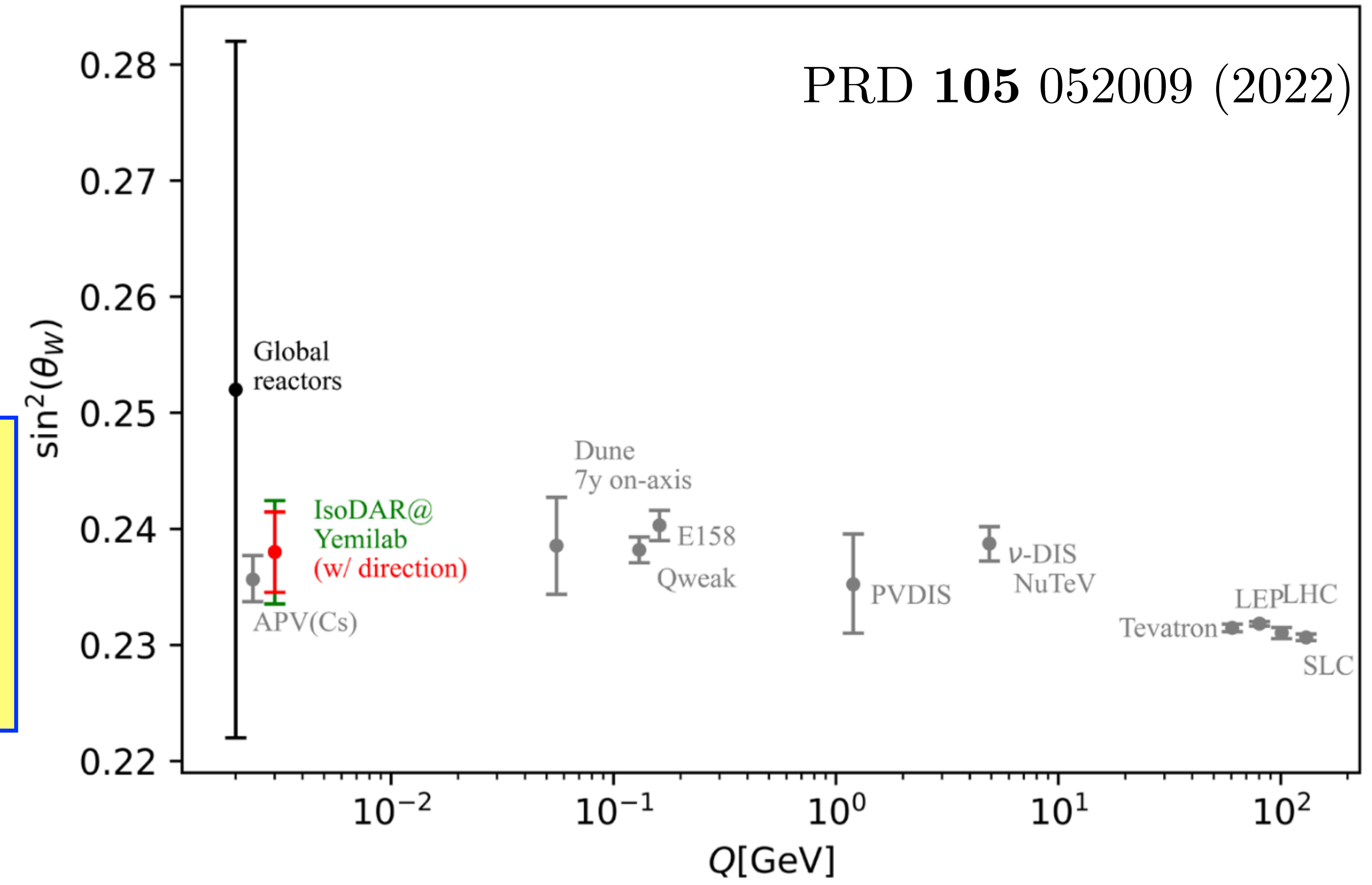
If IsoDAR@Yemilab sees it, can be from ^{13}C$(\bar{\nu},\bar{\nu}')^{12}$C* :PRD 99, 055045 (2019).

* Seodong. Shin, PRD 112, 055046 (2025)

$\bar{\nu}_e - e^-$ scattering

Non Standard Interactions in weak mixing angle:

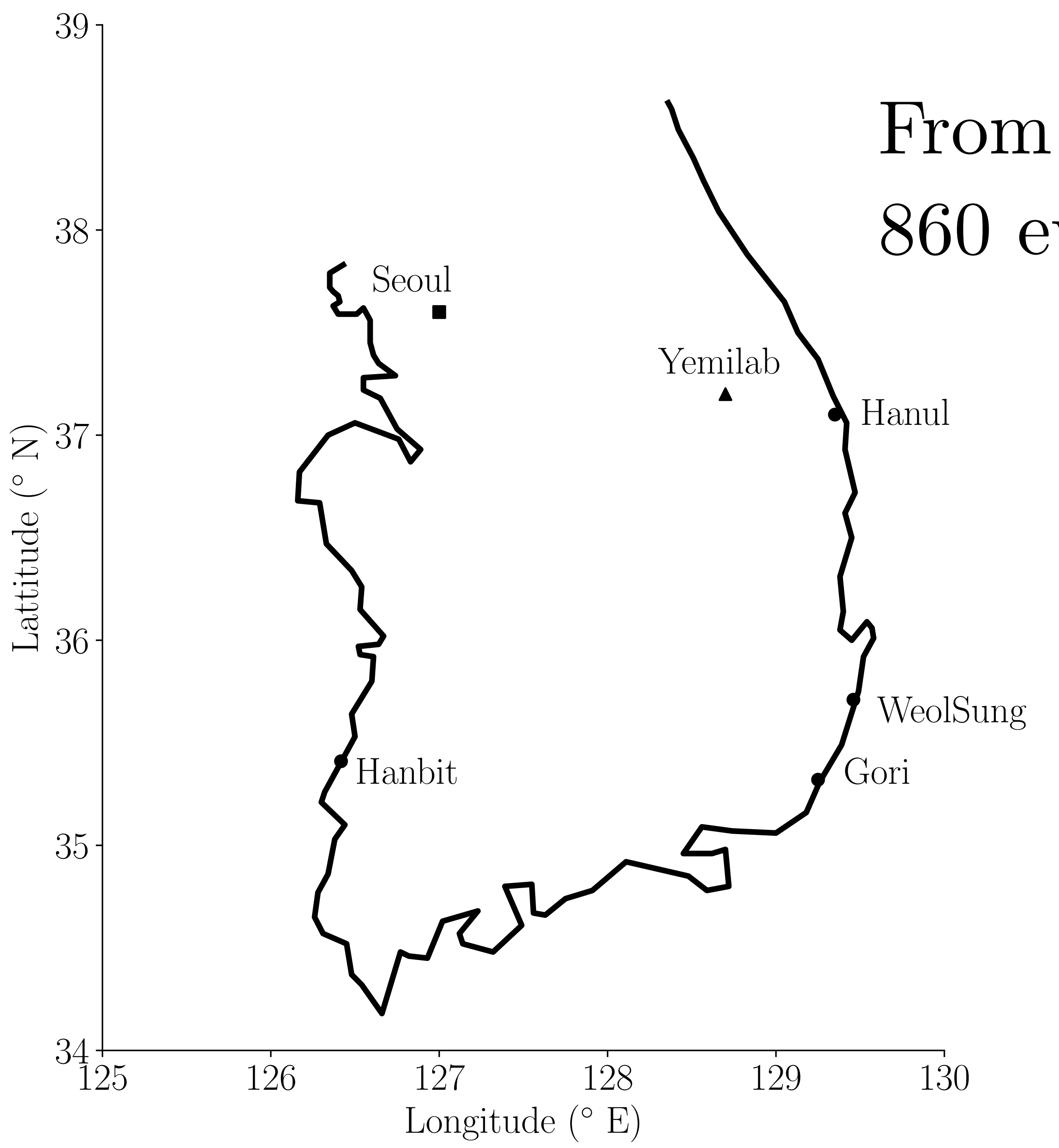
Similar study with source in progress (Both $\bar{\nu}_e$ and ν_e available)



More on new physics cases in PRD **105** 052009 (2022)

Reactor neutrino with νEYE

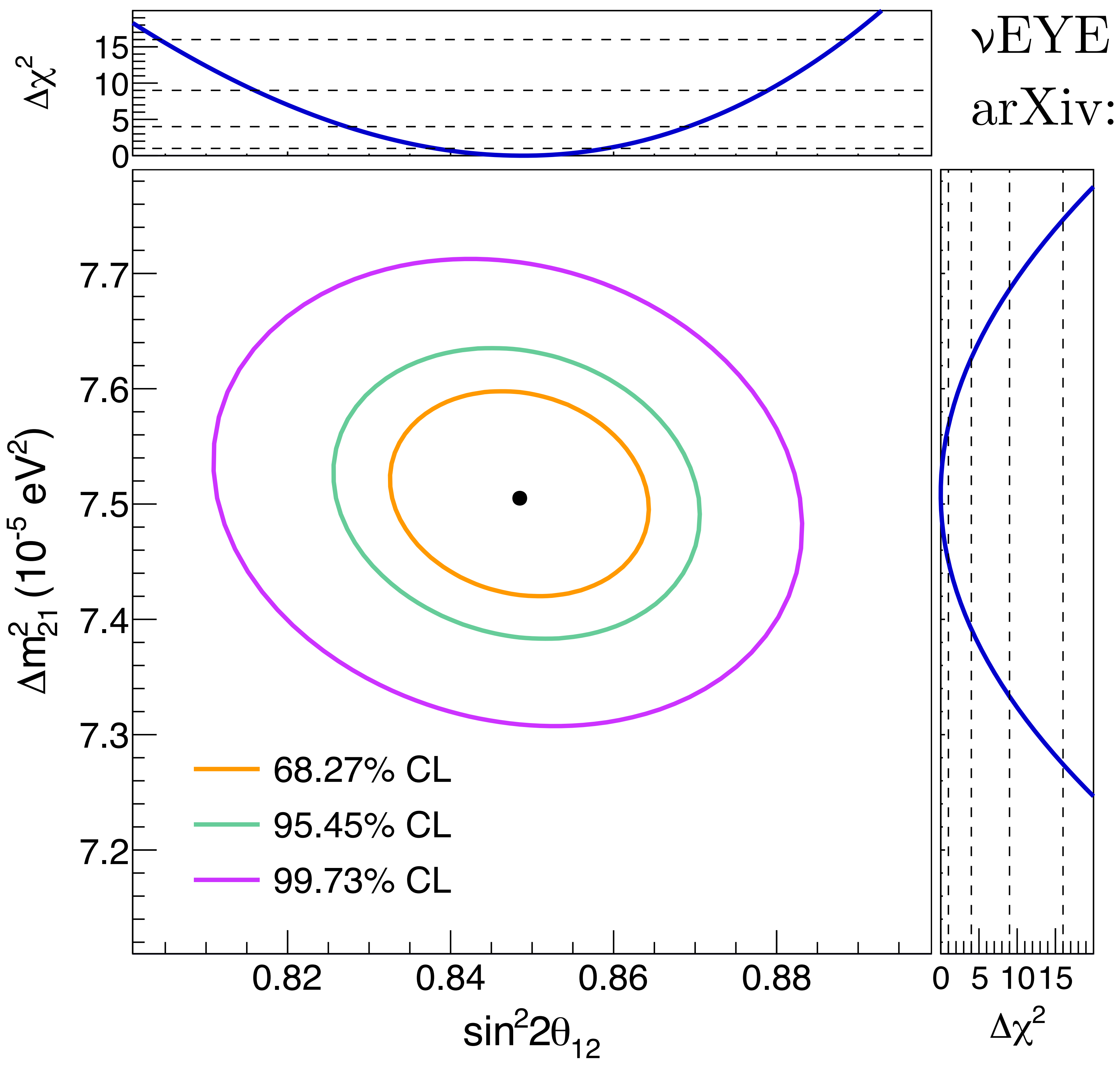
The JUNO experiment will measure 3-ν oscillation parameters with high precision.
But JUNO findings **need to be validated**: the νEYE is also at the first minimum.



From Hanul, we expect 860 events per year.

	Hanul	Wolsong	Gori	Hanbit
Thermal Power (GW)	20.8	11.8	21.3	16.9
Baseline (km)	65	180	216	282

νEYE sensitivity on Δm^2_{21} and $\sin^2 2\theta_{12}$



νEYE CDR: arXiv:2601.12569

$\Delta m^2_{21} = (7.51 \pm 0.06) \times 10^{-5}$ eV^2 and $\sin^2 2\theta_{12} = 0.848 \pm 0.010$ (all statistical error only)

Radio-purification (for one tonne)

Filtration

Removes optical impurities.

Removal of U/Th and K.

Water extraction

Removes dissolved radioactive metal ions

K, U, Th, Pb removal

Inorganic impurities

Water extraction

Custom build.

Nitrogen gas stripping

Remove dissolved gases

Vacuum Distillation

Removes high boiling point impurities

Metal & Oxide, U/Th, K, Bi, Po/Pb

Now @ Yemilab

Glove box (see the picture on the right)

Other components are being purchased.