Latest results from JUNO

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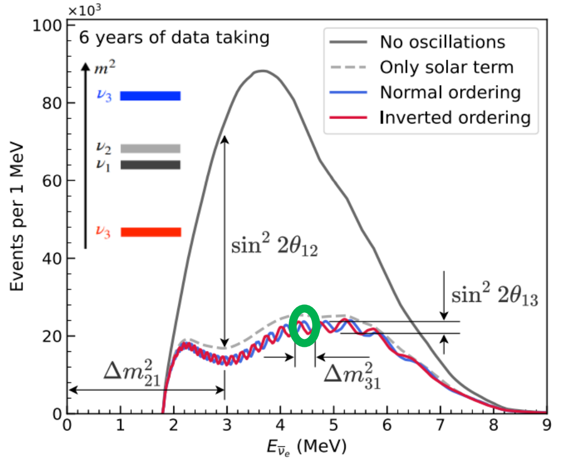
On behalf of the JUNO collaboration

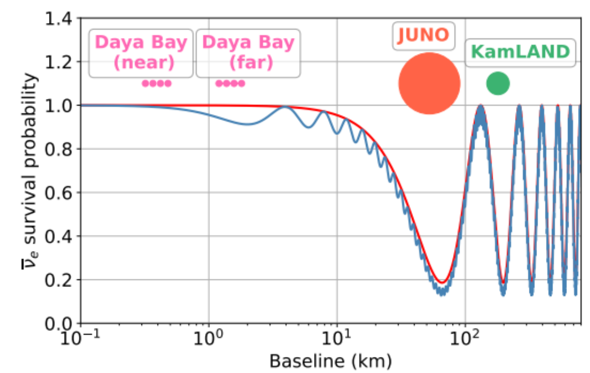
March 17, 2026

Jiangmen Underground Neutrino Observatory

JUNO studies how reactor $\overline{\nu}_e$'s oscillate (disappear) into other flavors

$$P_{\bar{\nu}_e \to \bar{\nu}_e}(L,E) = 1 - \sin^2 2\theta_{12} \cos^4 \theta_{13} \sin^2 \frac{\Delta m^2_{21} L}{4E} - \sin^2 2\theta_{13} \left(\cos^2 \theta_{12} \sin^2 \frac{\Delta m^2_{31} L}{4E} + \sin^2 \theta_{12} \sin^2 \frac{\Delta m^2_{32} L}{4E} \right)$$



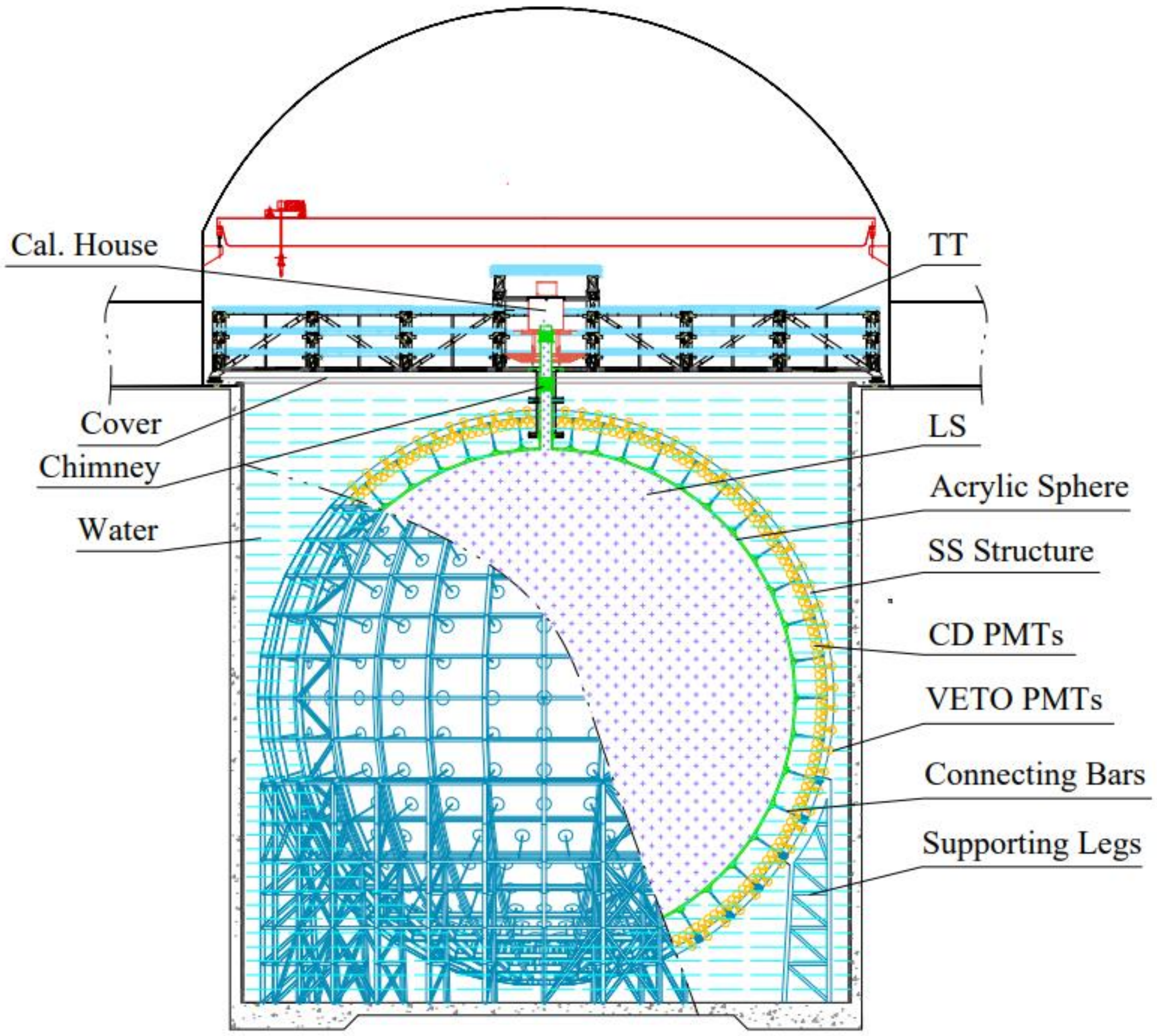


JUNO collaboration

= 70 institutes， > 700 participants

Country	Institute	Country	Institute	Country	Institute
Armenia	YerPhI	China	SDU	Italy	INFN-CT
Belgium	ULB	China	SJTU	Italy	INFN-FE
Chile	SAPHIR	China	SUSTech	Italy	INFN-LNF
Chile	UNAB	China	SYSU	Italy	INFN-MI
China	BISEE	China	THU	Italy	INFN-MIB
China	CDUT	China	UCAS	Italy	INFN-PD
China	CNPRI	China	WHU	Italy	INFN-PG
China	CUGB	China	WuYiU	Italy	INFN-Roma3
China	DGUT	China	XJTU	Pakistan	PINSTECH (PAEC)
China	ECUT	China	XMU	Russia	JINR
China	GXU	China	ZZU	Slovakia	FMFI-UK
China	HIT	Czech	Charles U.	Taiwan-China	NCTU
China	HunanU	Finland	JyU	Taiwan-China	NKNU
China	IGGCAS	France	CPPM	Taiwan-China	NTU
China	IHEG-CAGS	France	IJCLab	Taiwan-China	NTUT
China	IHEP	France	IPHC	Thailand	CHULA
China	IMP	France	LP2iB	Thailand	NARIT
China	JNU	France	Subatech	Thailand	SUT
China	JXNU	Germany	EKUT	U.K.	U. Liverpool
China	KNRC	Germany	GSI	U.K.	U. Warwick
China	Nankai U.	Germany	U. Hamburg	USA	UCI
China	NCEPU	Germany	JGUMainz	USA	UMD-G
China	NJU	Germany	RWTH-AC		
China	RNCG	Germany	TUM		

JUNO detector

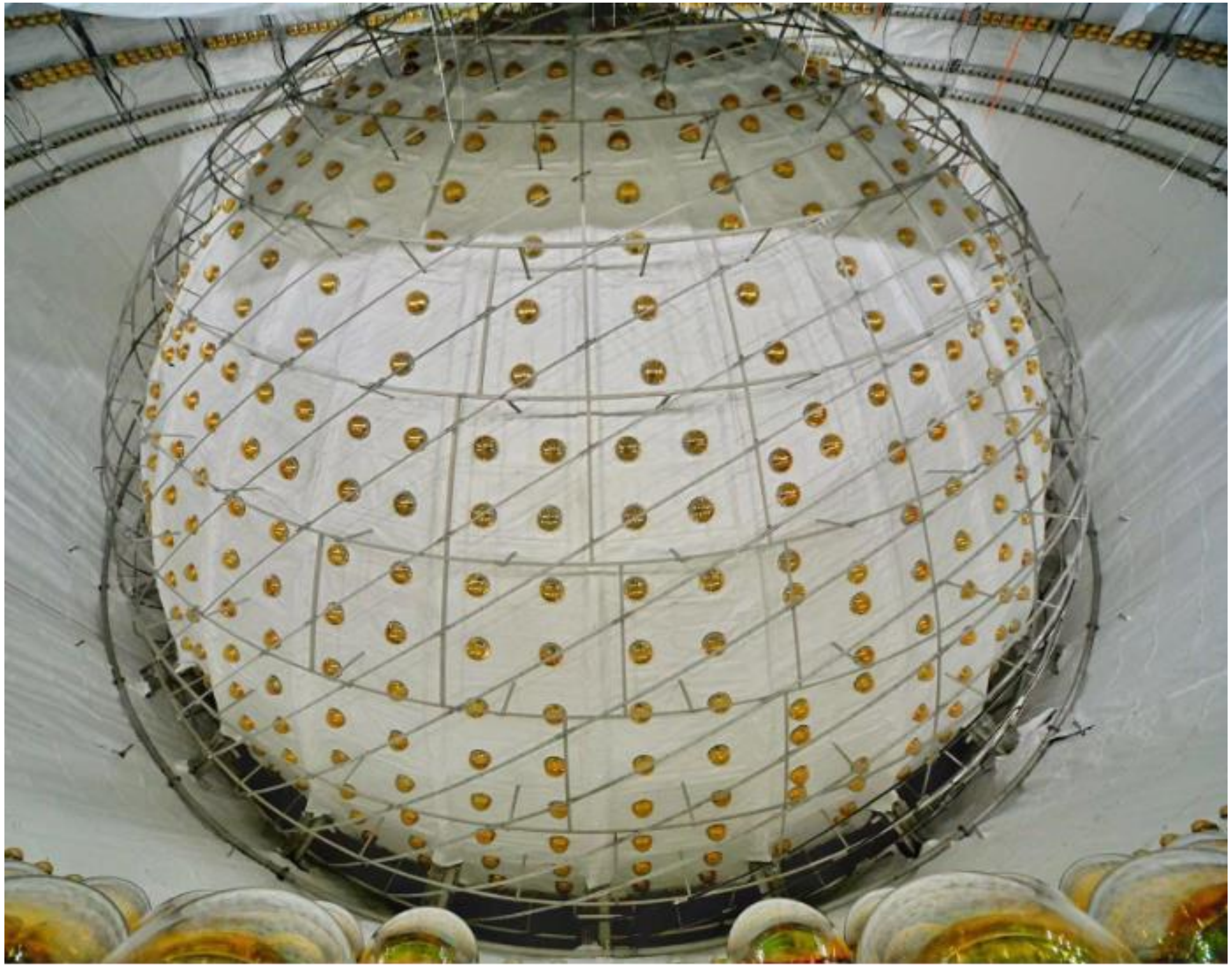


- **Stainless Steel structure**
  - Finished in June 2022
- **Acrylic sphere with 35.4m diameter**
  - Done in Oct. 2024
- **20,012 20” PMTs + 25,600 3” PMTs**
  - Installation finished in Dec. 2024
  - PMTs + electronics working well
- **20kt Liquid scintillator**
  - Filling finished on Aug. 22, 2025

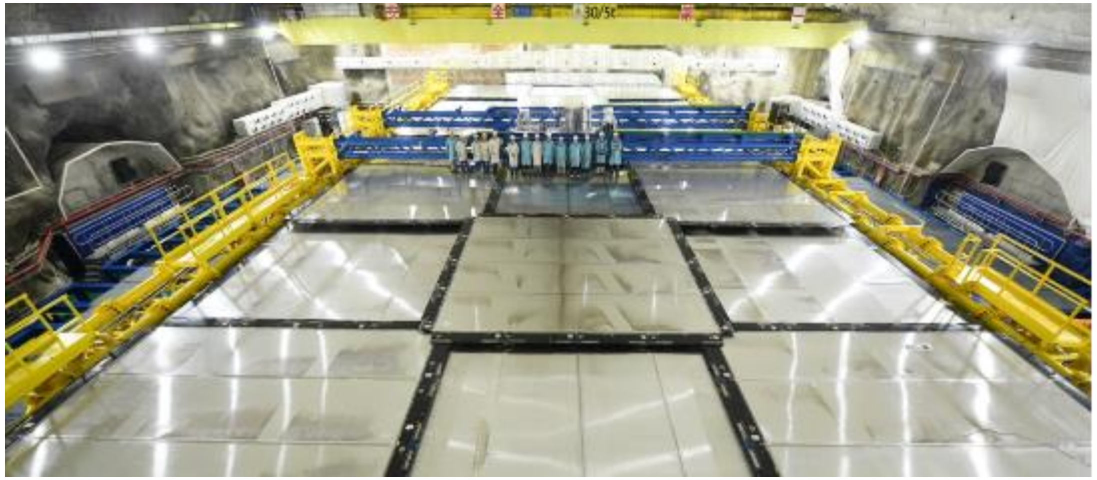
Group photo on Dec. 4, 2024

More detector photos

2024.12: detector assembled, filling start soon



2025.6 Top tracker installation finished



Liquid filling

Four purification plants to achieve target radio-purity <10^{-15} g/g U/Th and 20 m attenuation length

5000 m^3 LAB tank

1) Al_2O_3 for optical

2) Distillation for radiopurity

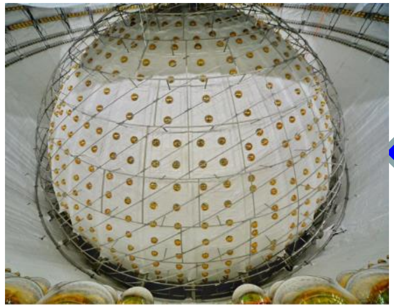
Mixing PPO and bis-MSB

SS pipes to underground

3) Water extraction to remove radioactive impurities

4) Gas stripping to remove Rn and O_2

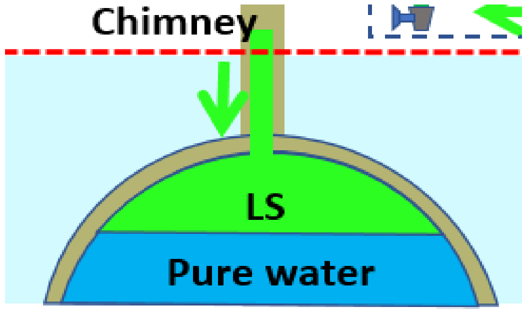
CD FOC system



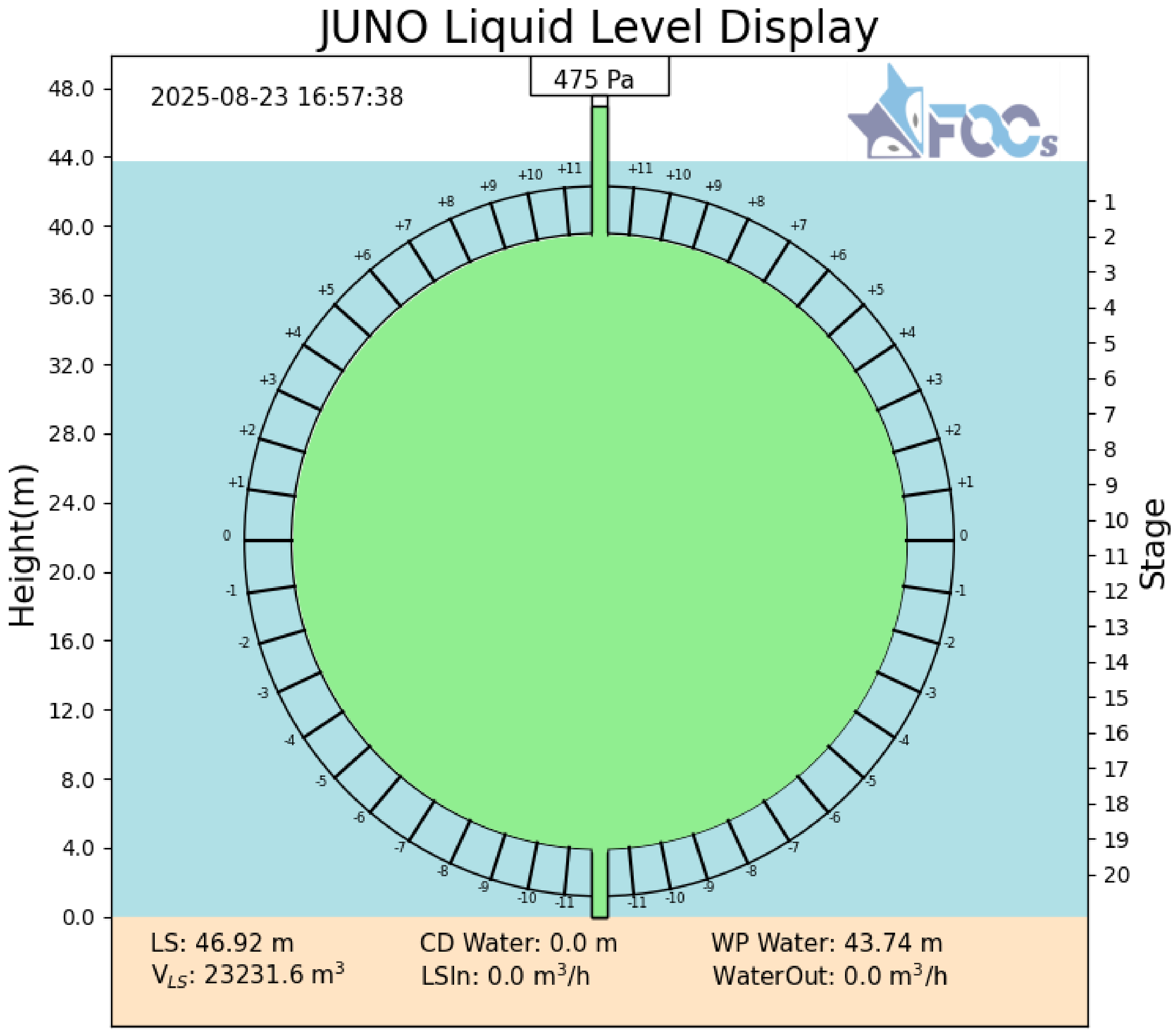
JUNO detector

Filling strategies:

- ⇨ Leakage (single component < 10^{-6} mbar·L/s)
- ⇨ Cleaning vessel before filling
- ⇨ Clean environment
- ⇨ Water/LS filling



Physics data taking started

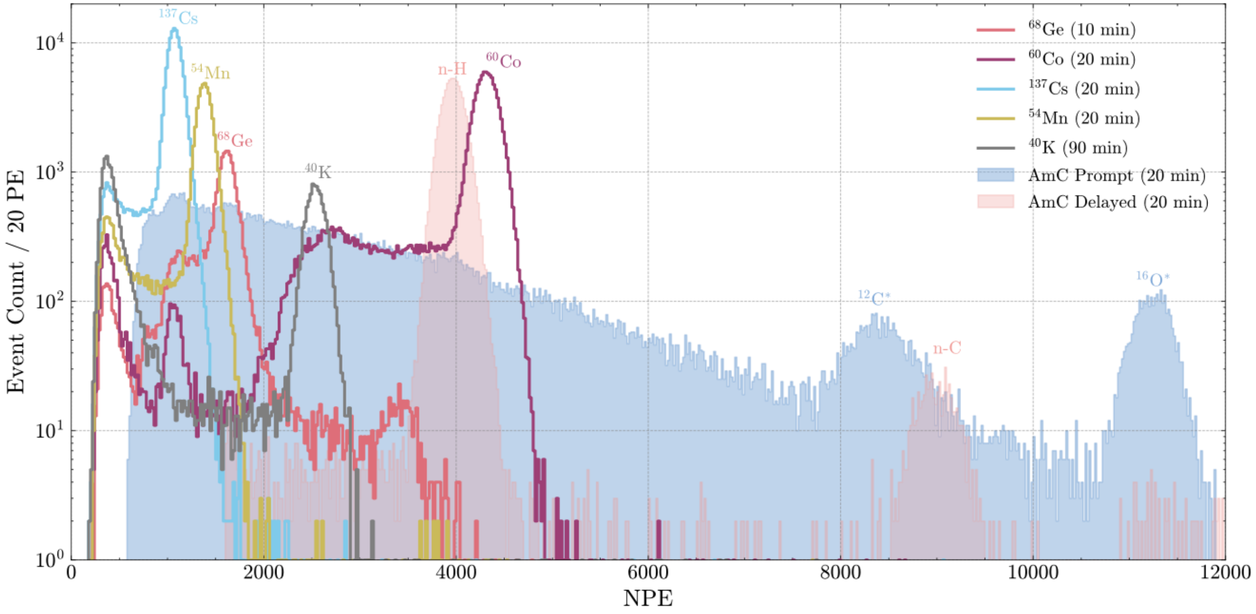


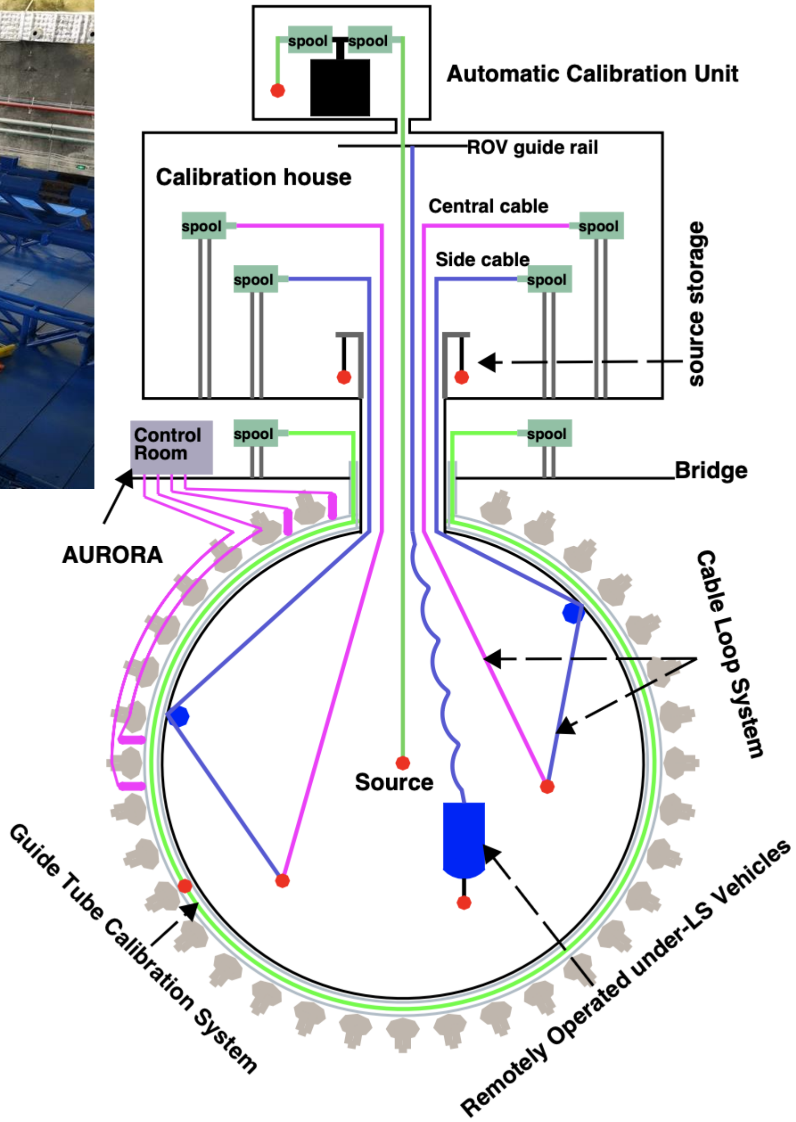
- Aug. 22, 2025, at ~22:12, water in Acrylic tank was fully replaced by LS
- ~90 t lower quality LS at the bottom were further replaced
- Calibration started at 14:00 of Aug. 23
- Data taking for physics started on Aug. 26 at 5:30 am (Beijing time)

- Total LS in CD: 23231.6 m^3
- Total water in pool: 41225.1 m^3

Calibration system

- Precise calibration to understand detector response, using multiple sources, from 1D to 3D
- No Radon leakage during routine and special calibrations

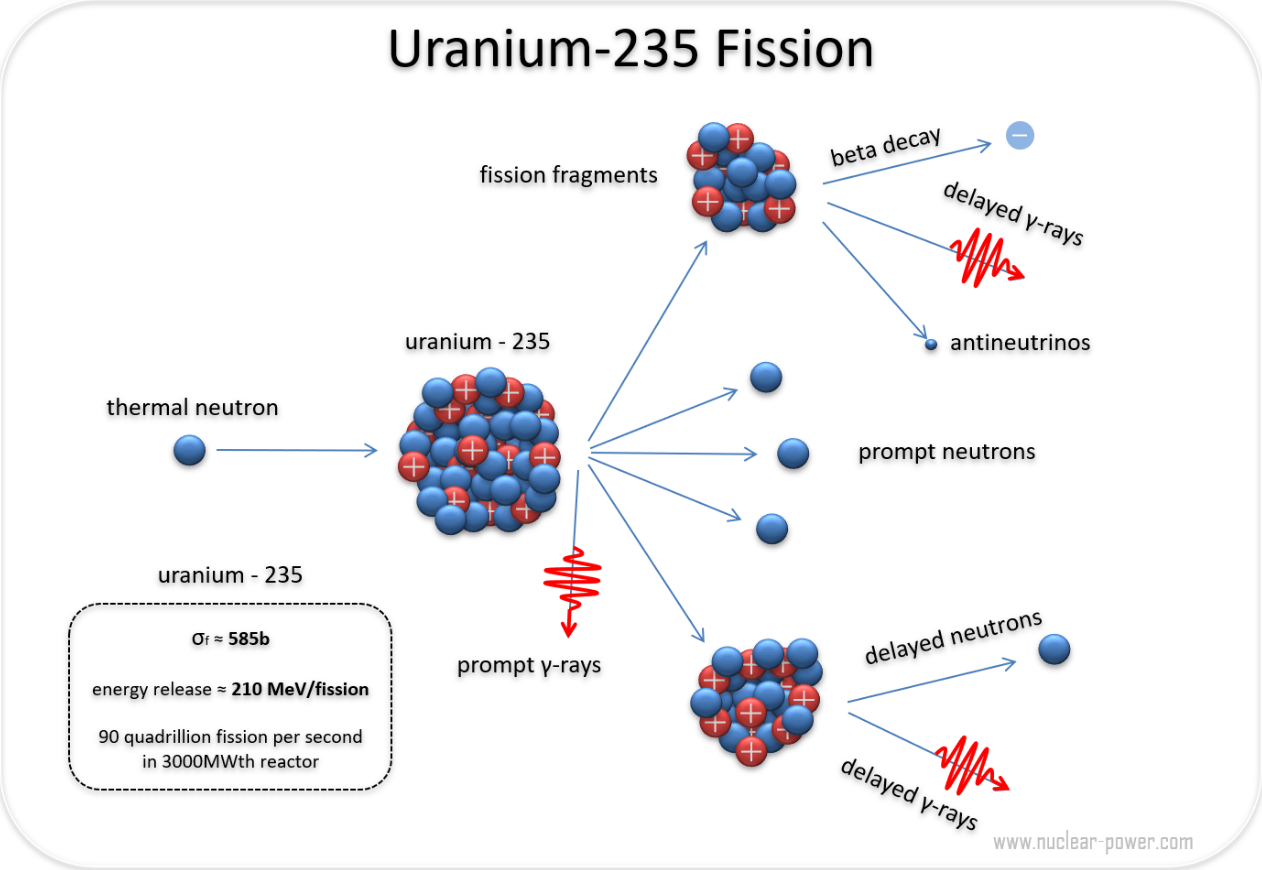




Reactor neutrinos

The strongest artificial neutrino source on the Earth

2×10^{20} ν's per second per GW thermal power, >99.7% from ^{235,238}U and ^{239,241}Pu



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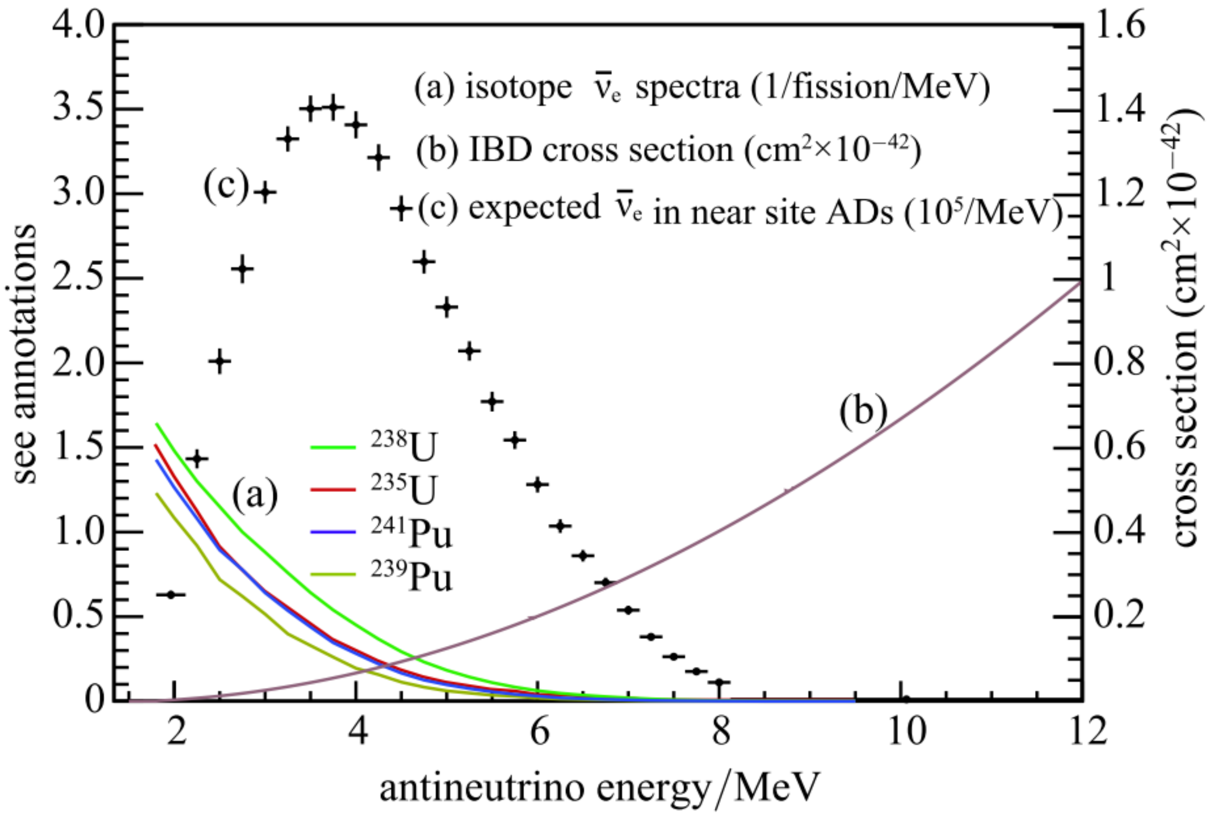
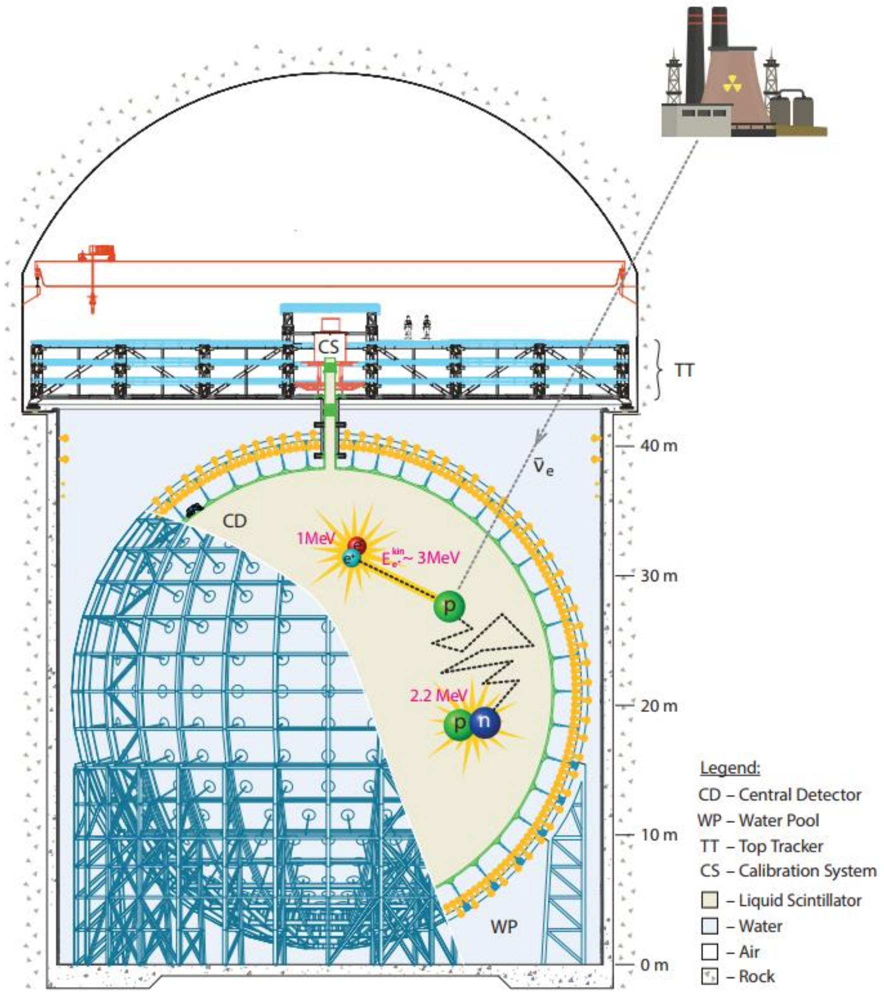
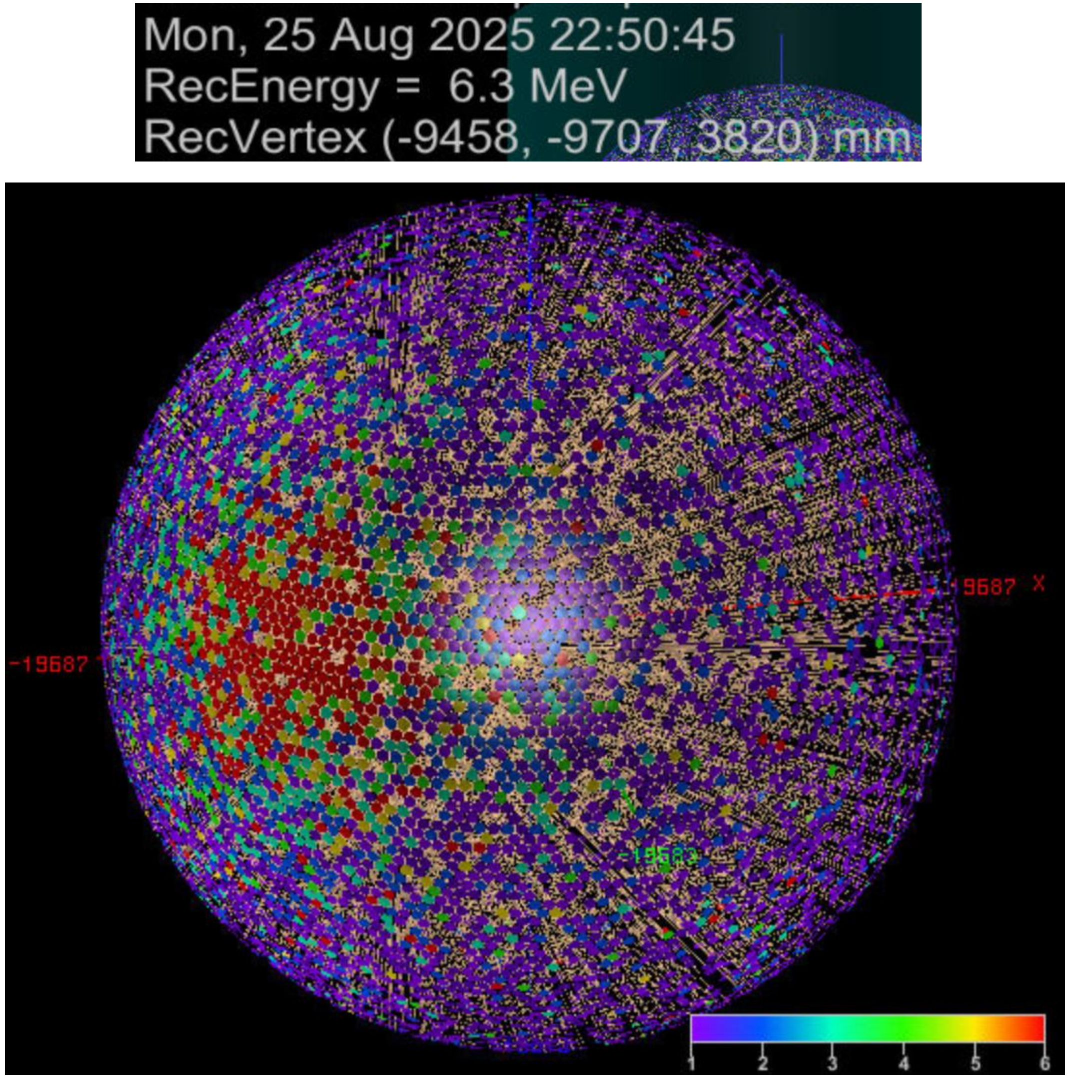
Easy to detect via the Inverse Beta Decays (IBD)

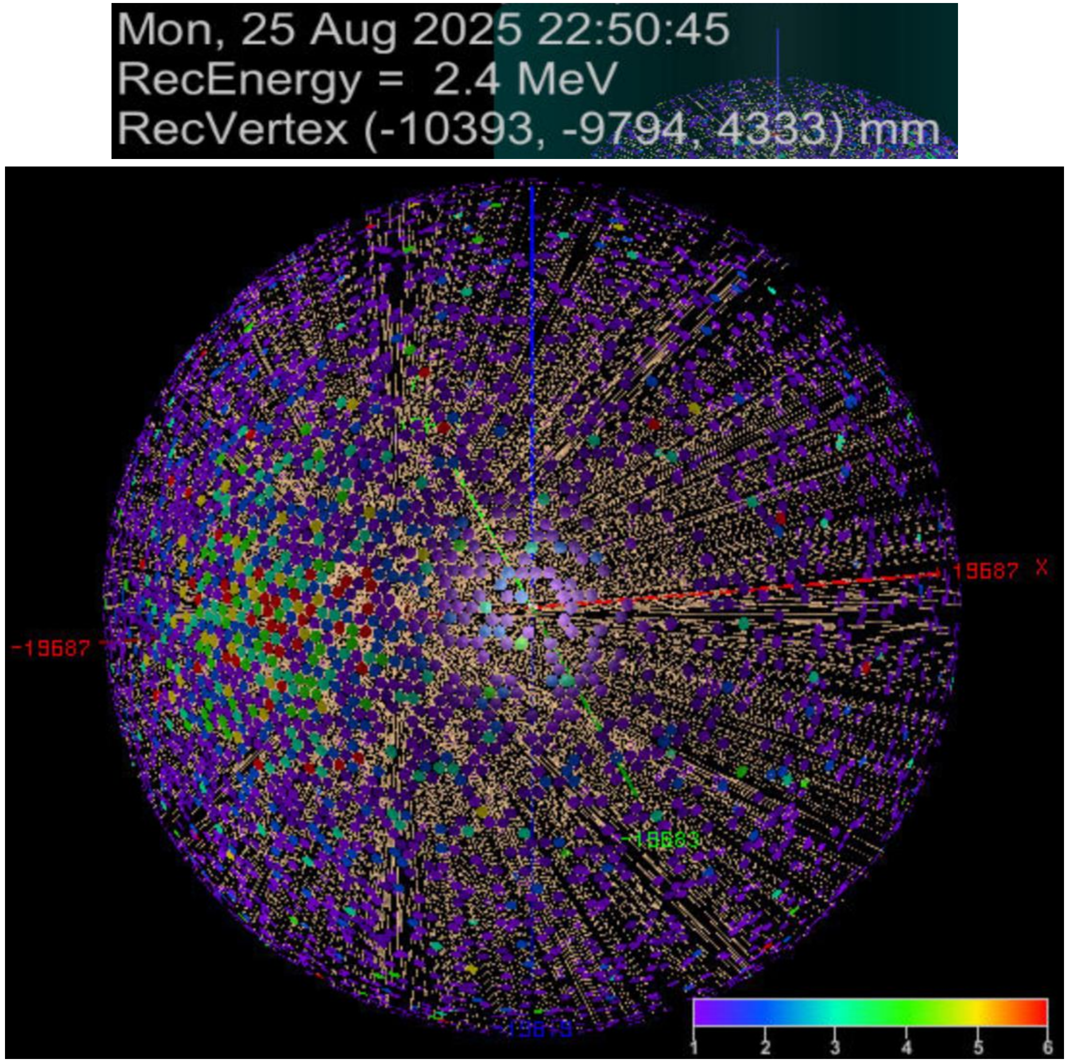




A Golden Reactor Neutrino Event



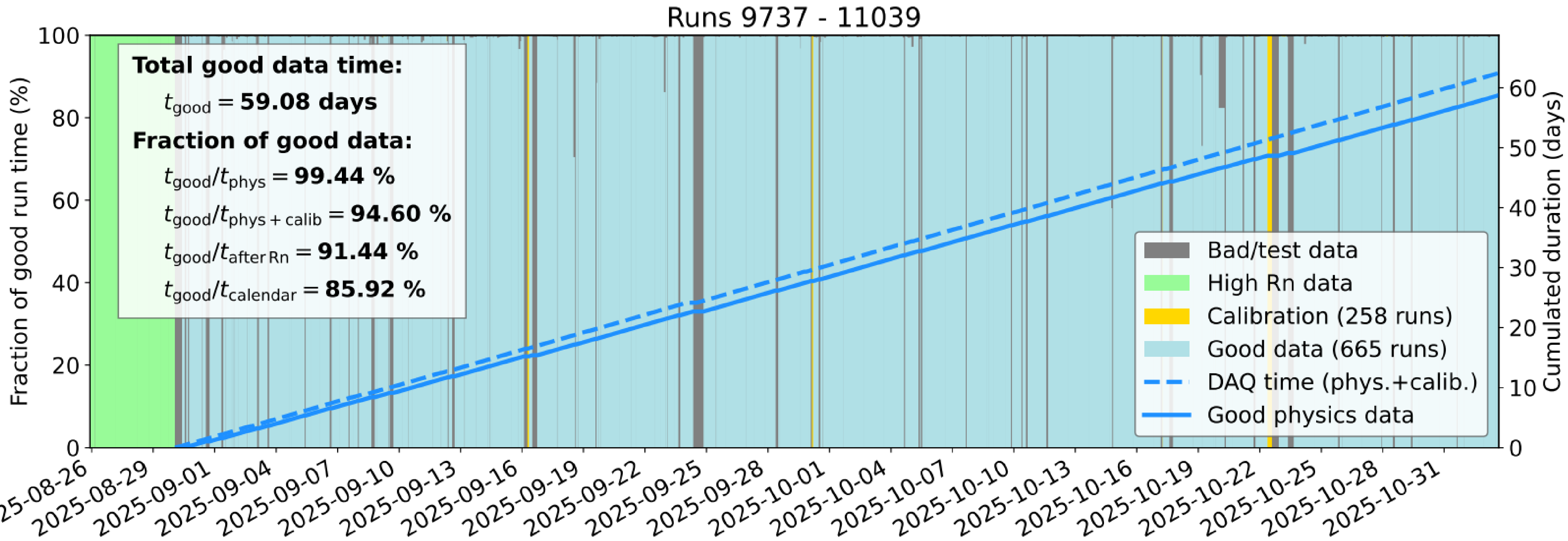
Prompt e+ signal



Delay neutron signal

Keys to Physics: stable operation

- **Data taking time larger than 98%**
  - **Usually two times of calibration per week**
  - **Detector maintenance occupied with the calibration source moving**
- **Physics data taking time larger than 92%**



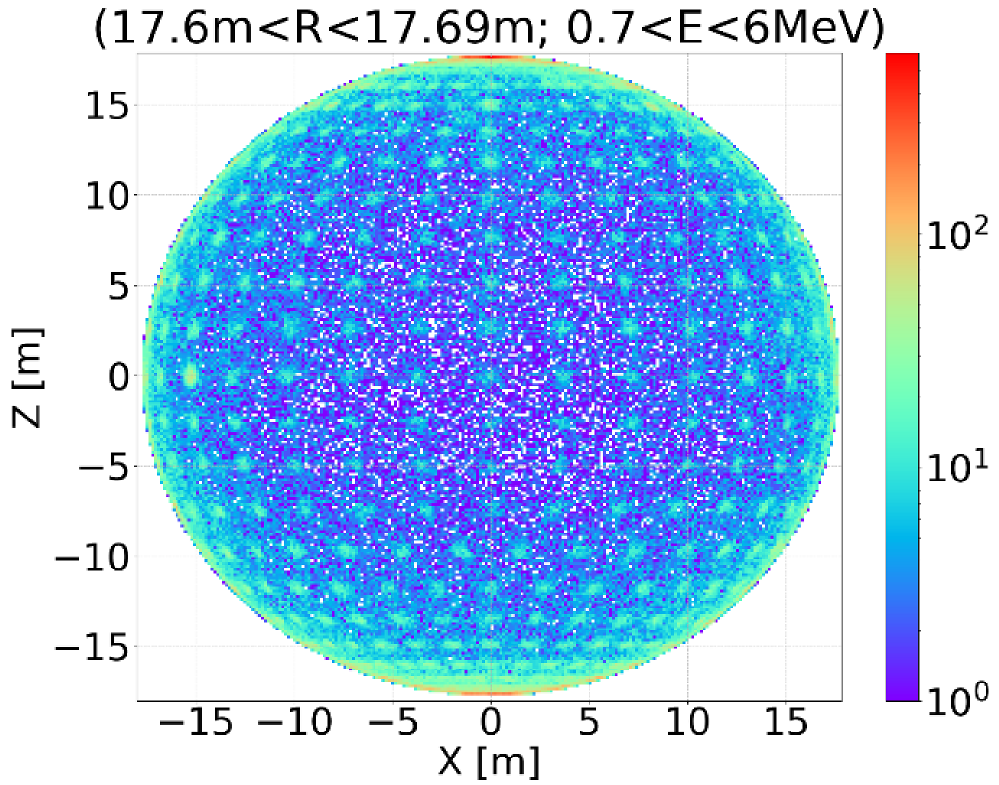
Keys to Physics: clean detector

Measured radioactivity in LS and water better than specification

- Radiopurity control of raw material, cleaning of inner surface, ^{222}Rn control

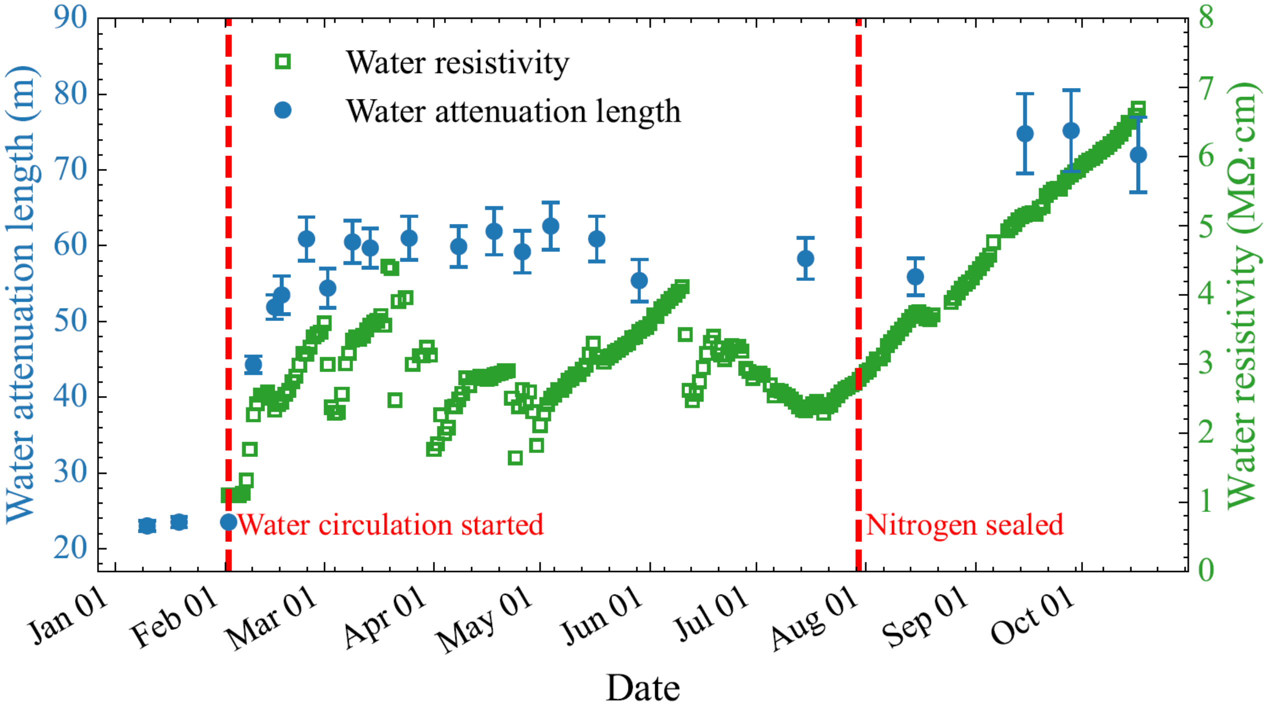
Central Detector	Specification	Measure
Singles Rate (Hz)	< 7.2 Hz	< 7 Hz
^{238}U/^{232}Th ($\times 10^{-15}$ g/g)	< 1	< 0.1
^{210}Po ($\times 10^{4}$ cpd/kt)	< 8	< 5

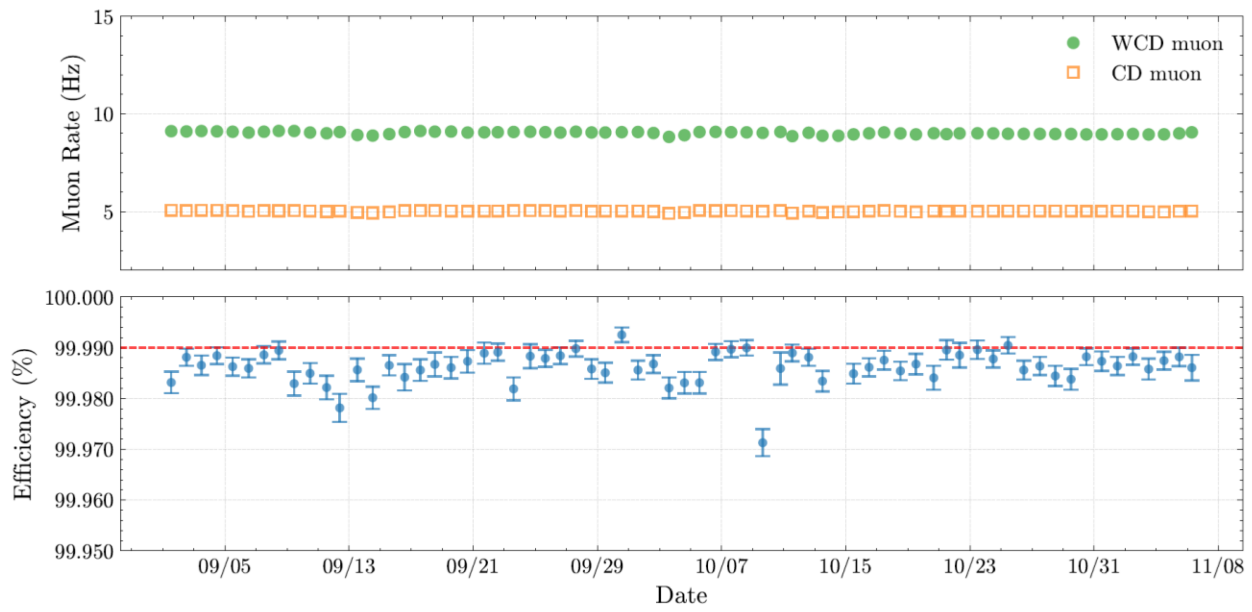
Muon Veto Detector	Specification	Measure
^{222}Rn (mBq/m^3)	< 10	<10
^{226}Ra (mBq/m^3)	< 1	< 0.01
U/Th ($\times 10^{-15}$ g/g)	<10	<0.4



Keys to Physics: muon tagging

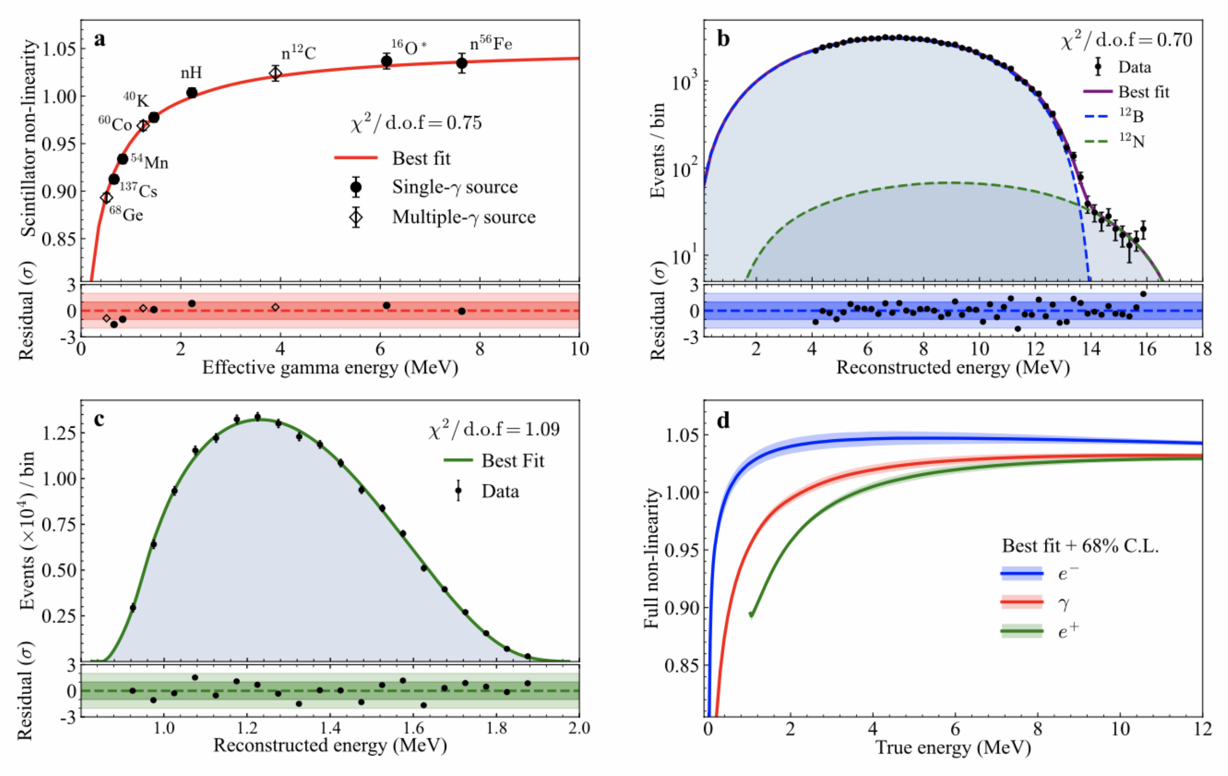
- **Water attenuation length at 405nm wavelength longer than 75m**
- **Muon tagging efficiency of Water Cherenkov detector > 99.95%**
  - Untagged muons enter CD via chimney, Top Tracker detector helps to tag

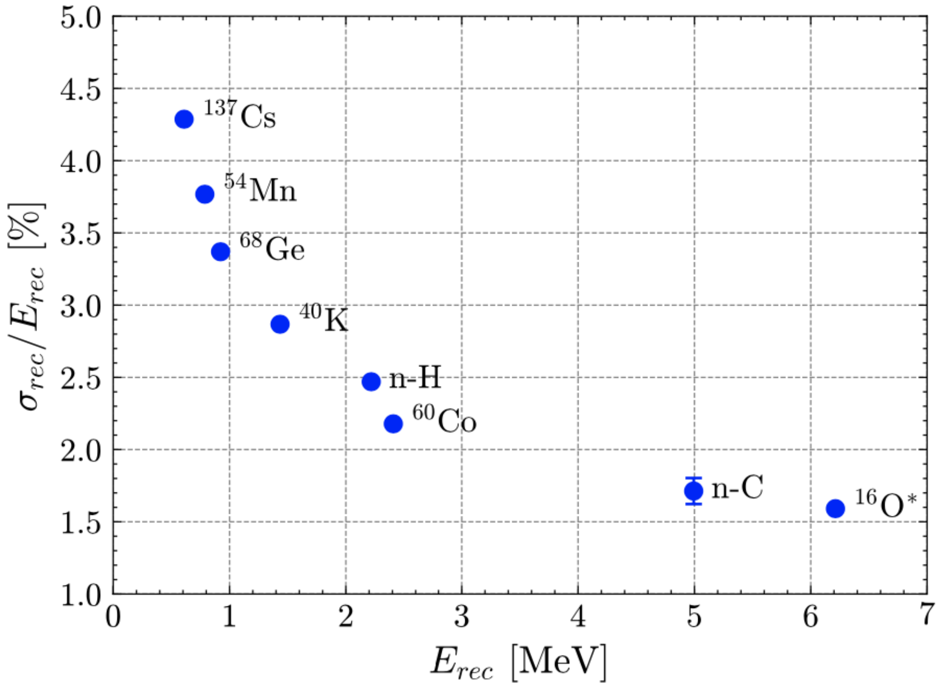




Keys to Physics: precise energy

- **Energy nonlinearity calibrated to better than 1% precision**
- **Energy resolution is near the design level**
  - Keep improving from comprehensive calibration and better reconstruction algorithms

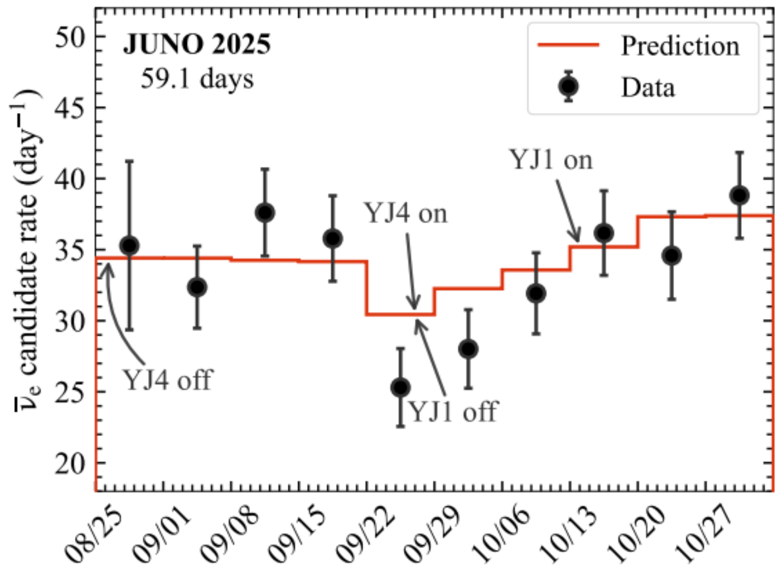


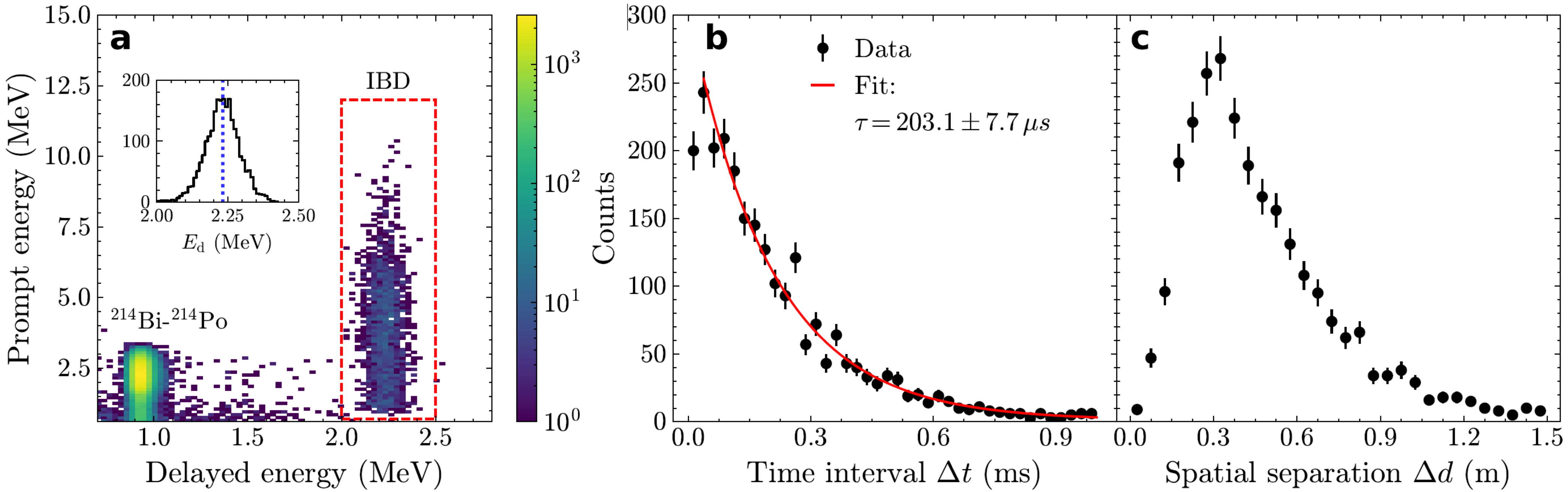


More details in Mingxia's flash talk

Reactor neutrino sample

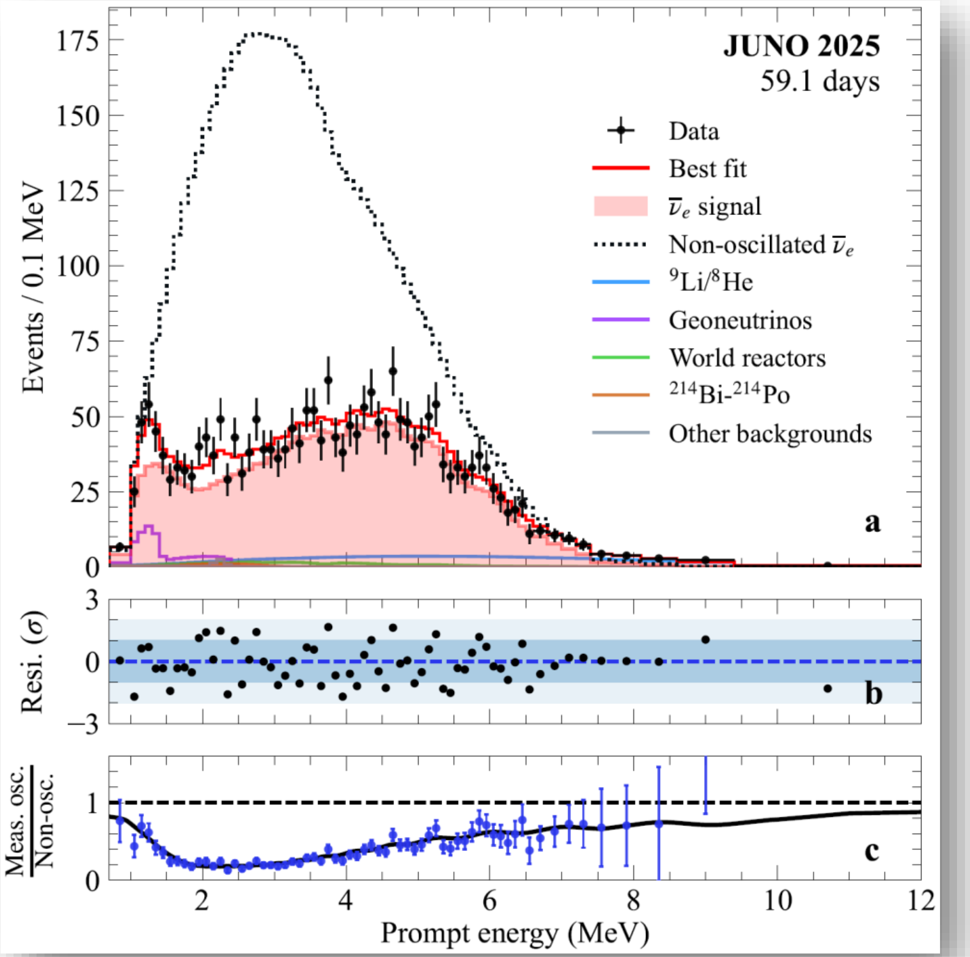
- **Reactor neutrinos are selected according to the time, space and energy correlations**
- **Neutrino rates consistent with power prediction**
- More details in Mingyuan's flash talk





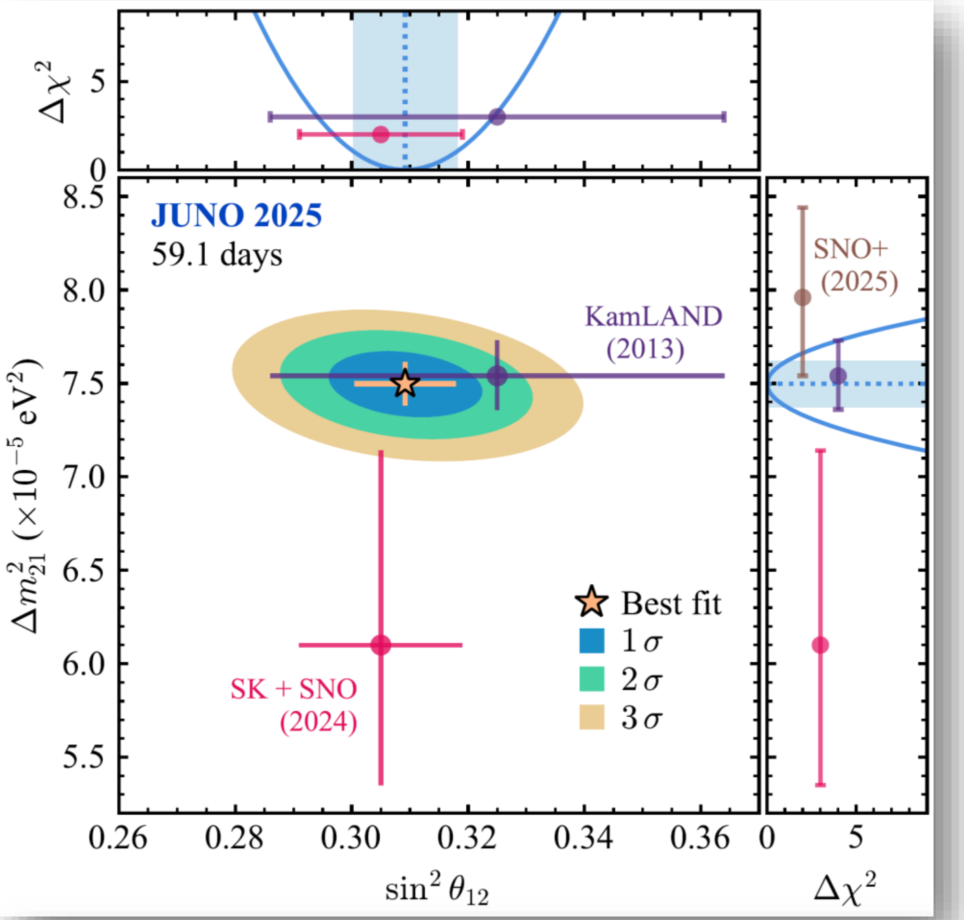
Oscillated spectrum

- **Residual ^{9}Li background will be reduced by veto along muon tracks**
- **Reasonable good efficiency, will be improved with larger fiducial volume**

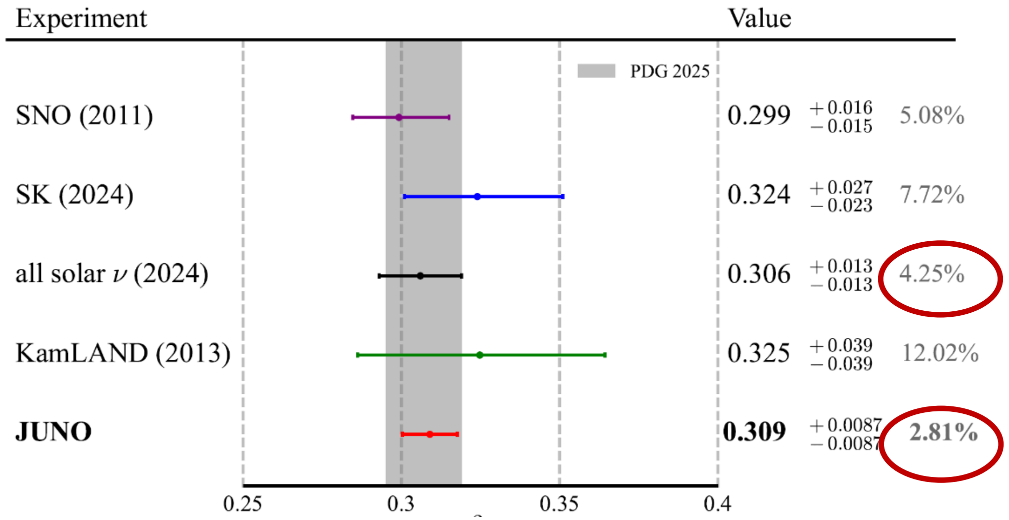


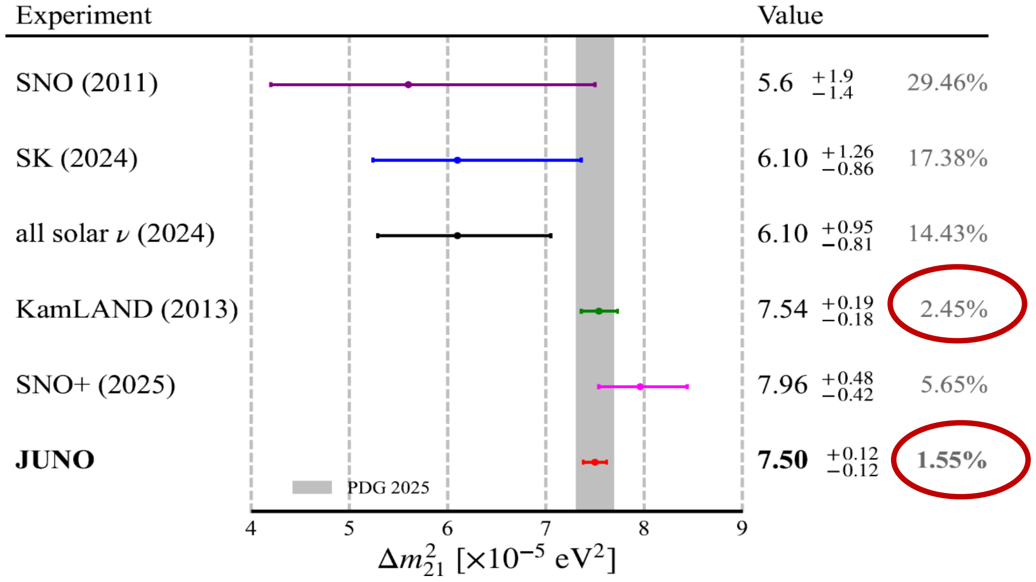
Antineutrinos ($\overline{\nu}_e$) Candidates Summary		
DAQ live time (days)	59.1	
$\overline{\nu}_e$ candidates	2379	
Selection Efficiencies (%)	ε	σ_{rel}
Fiducial volume	80.6	1.6
PMT flasher rejection	>99.9	negligible
μ veto	93.6	negligible
Multiplicity	97.4	negligible
Prompt-delayed coinc.	95.1	0.13
Total efficiency (ε_{tot})	69.9	1.6
$\overline{\nu}_e$ signal (cpd[1])		
w/o ε_{tot} corrected	33.5 ± 1.7	
w/ ε_{tot} corrected	47.9 ± 2.6	
Non-oscillated $\overline{\nu}_e$	150.9 ± 2.7	
Backgrounds (cpd)	Pre-fit	Best-fit
^{9}Li/^{8}He	4.3 ± 1.4	3.9 ± 0.6
Geoneutrinos	1.2 ± 0.5	1.4 ± 0.4
World reactors	0.88 ± 0.09	0.88 ± 0.09
^{214}Bi-^{214}Po	0.18 ± 0.10	0.20 ± 0.10
^{13}C(α, n)^{16}O	0.04 ± 0.02	0.04 ± 0.02
Fast neutrons	0.02 ± 0.02	0.02 ± 0.02
Double neutrons	0.05 ± 0.05	0.07 ± 0.05
Atmospheric neutrinos	0.08 ± 0.04	0.07 ± 0.04
Accidentals ($\times 10^{-2}$)	4.9 ± 0.3	4.9 ± 0.3

First physics result



$$\sin^2\theta_{12} = 0.3092 \pm 0.0087\,,$$
$$\Delta m^2_{21} = (7.50 \pm 0.12) \times 10^{-5}\ \mathrm{eV}^2$$





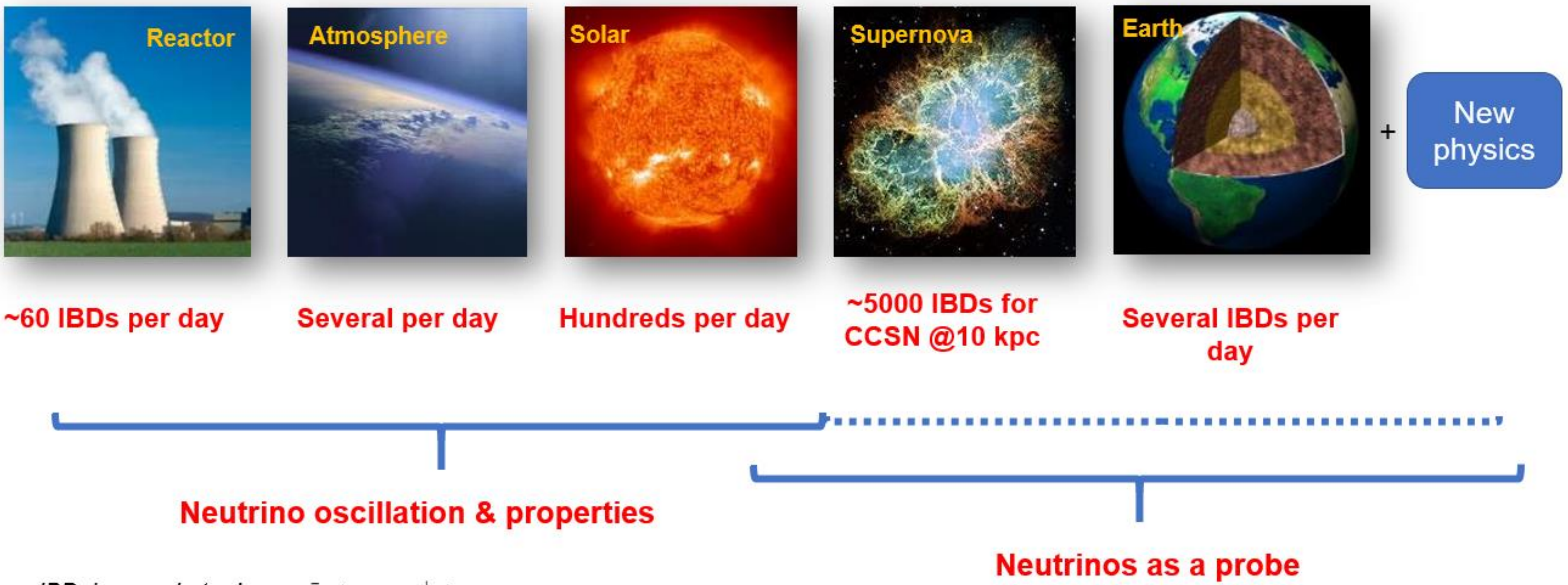
Consistent results from three independent analyses

arXiv: 2511.14593

Stay tuned!

Neutrino oscillations, mass ordering (3-4 σ), precision measurement (<0.5%)

Astro-particle physics, supernovae neutrinos, geo and solar neutrinos



IBD: inverse beta decay $\bar{\nu}_e + p \rightarrow e^+ + n$

CCSN: core-collapse supernova

Thanks!


龍年大吉
山中安裝戰猶酣
金雞鳴唱迎龍吟
JUNO
江門中微子實驗
Jiangmen Underground Neutrino Observatory