

The JUNO experiment: detector and first results



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Introduction

The Jiangmen Underground Neutrino Observatory (JUNO) is a multipurpose neutrino experiment located in Kaiping (south China), ~53 km distant from Yangjiang and Taishan Nuclear Power Plants, with the main goal of determining the Neutrino Mass Ordering (NMO).

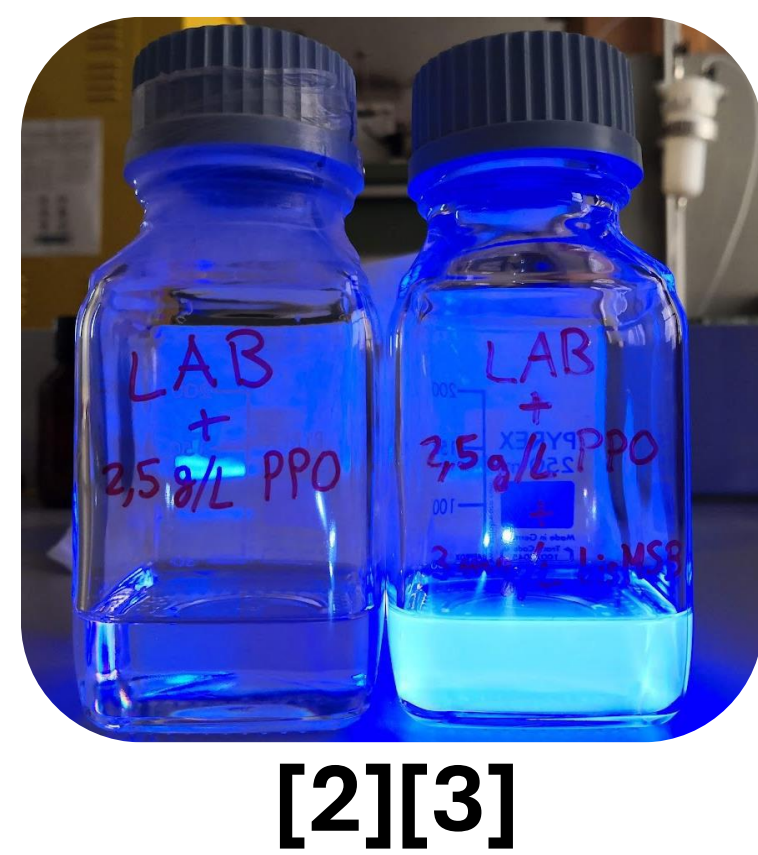
JUNO has recently started its data taking on August 2025. So far it released the first simultaneous high-precision determination of two neutrino oscillation parameters ($\sin^2 \theta_{12}$ and Δm^2_{21}) improving the precision with respect to the state-of-the-art by a factor of 1.6. In this poster I will present an overview of the JUNO detector and report the first science results on neutrino oscillation physics.

Where did I give my contribution?

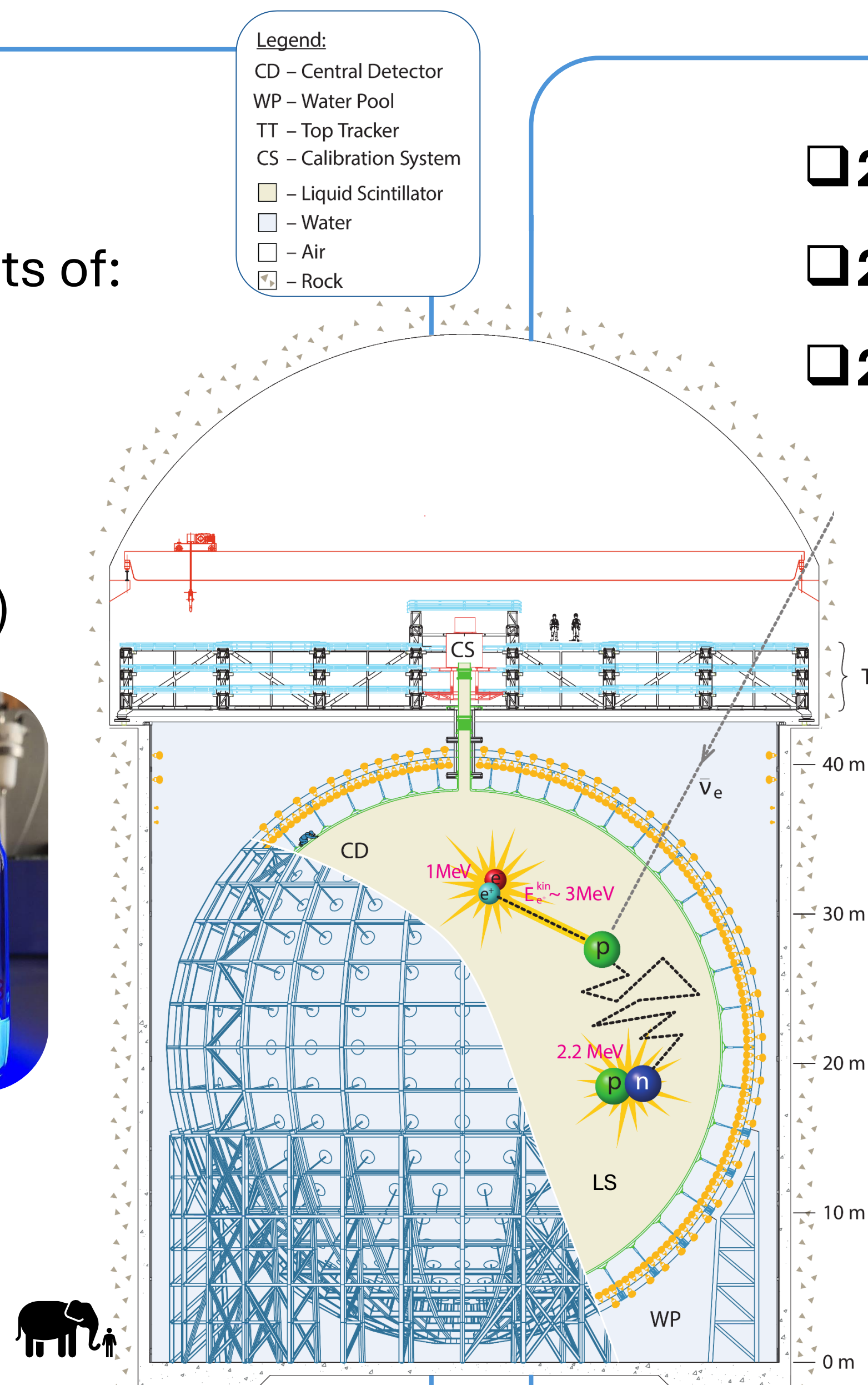
Detector

The JUNO detector is located ~ 650 m underground. The main detector consists of:

- ☐ ~ 35 m diameter central transparent acrylic sphere (CD)
- ☐ ~ 43000 photomultiplier tubes (PMT)
- ☐ 20 kton of organic ultrapure liquid scintillator (LS) [1]
- LAB**
- + 2.5 g/L PPO**
- + 3 mg/L bis-MSB**

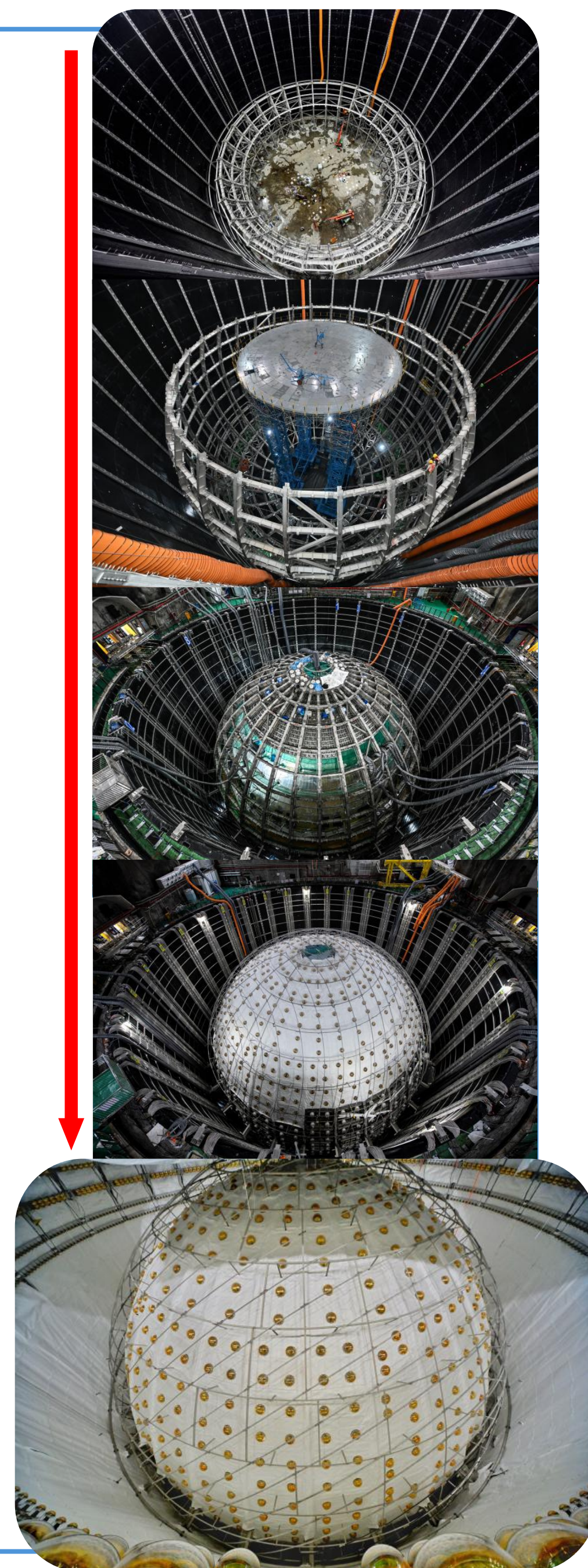
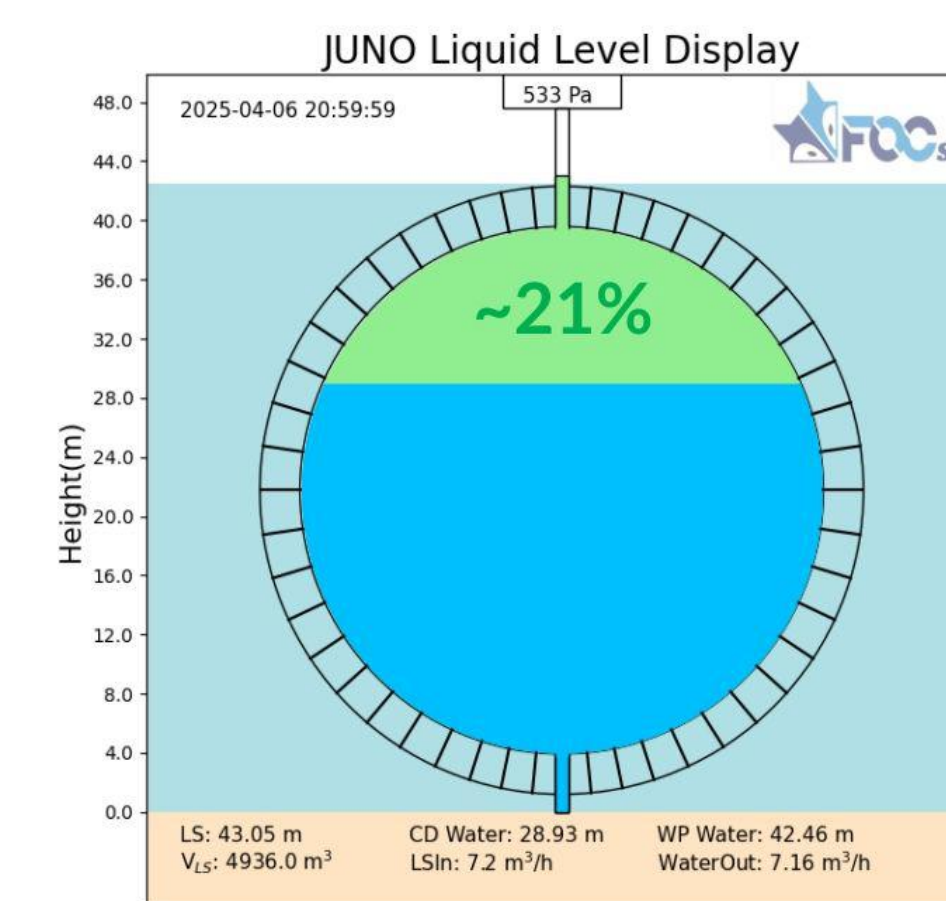


The CD is immersed in a water pool (WP) which work as muons veto system.



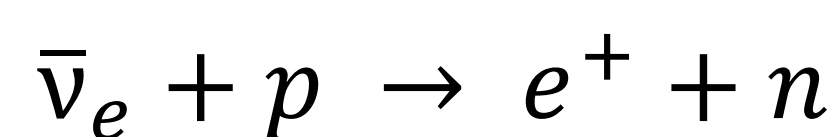
JUNO time line

- ☐ 2013: project approved
- ☐ 2014: collaboration established
- ☐ 2015: site & detector construction
- ☐ 12/2024: WP and CD water filling
- ☐ 2/2025: LS filling of CD
- ☐ 8/2025: end of filling and start full data taking
- ☐ 11/2026: First physics results [4]



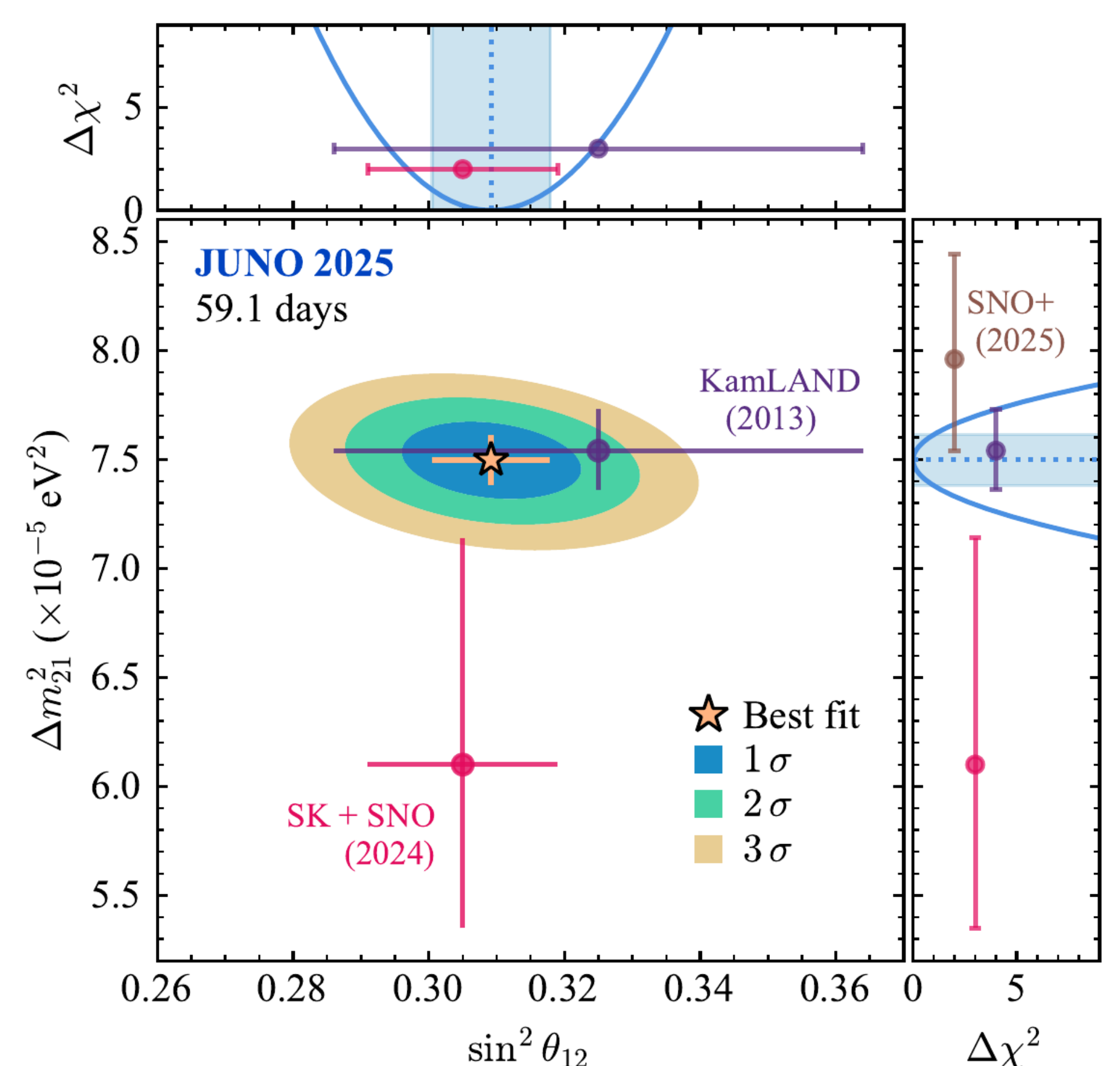
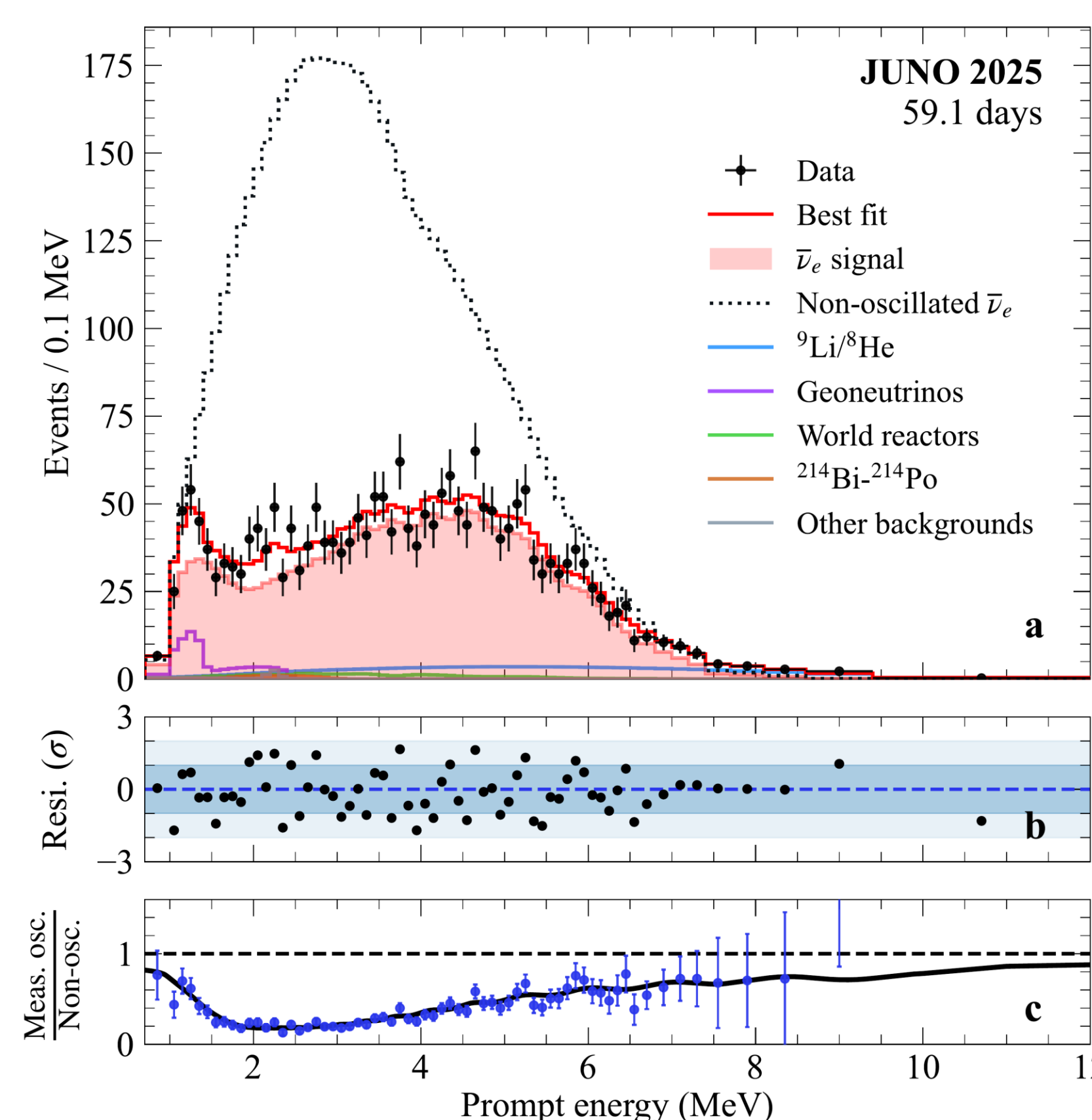
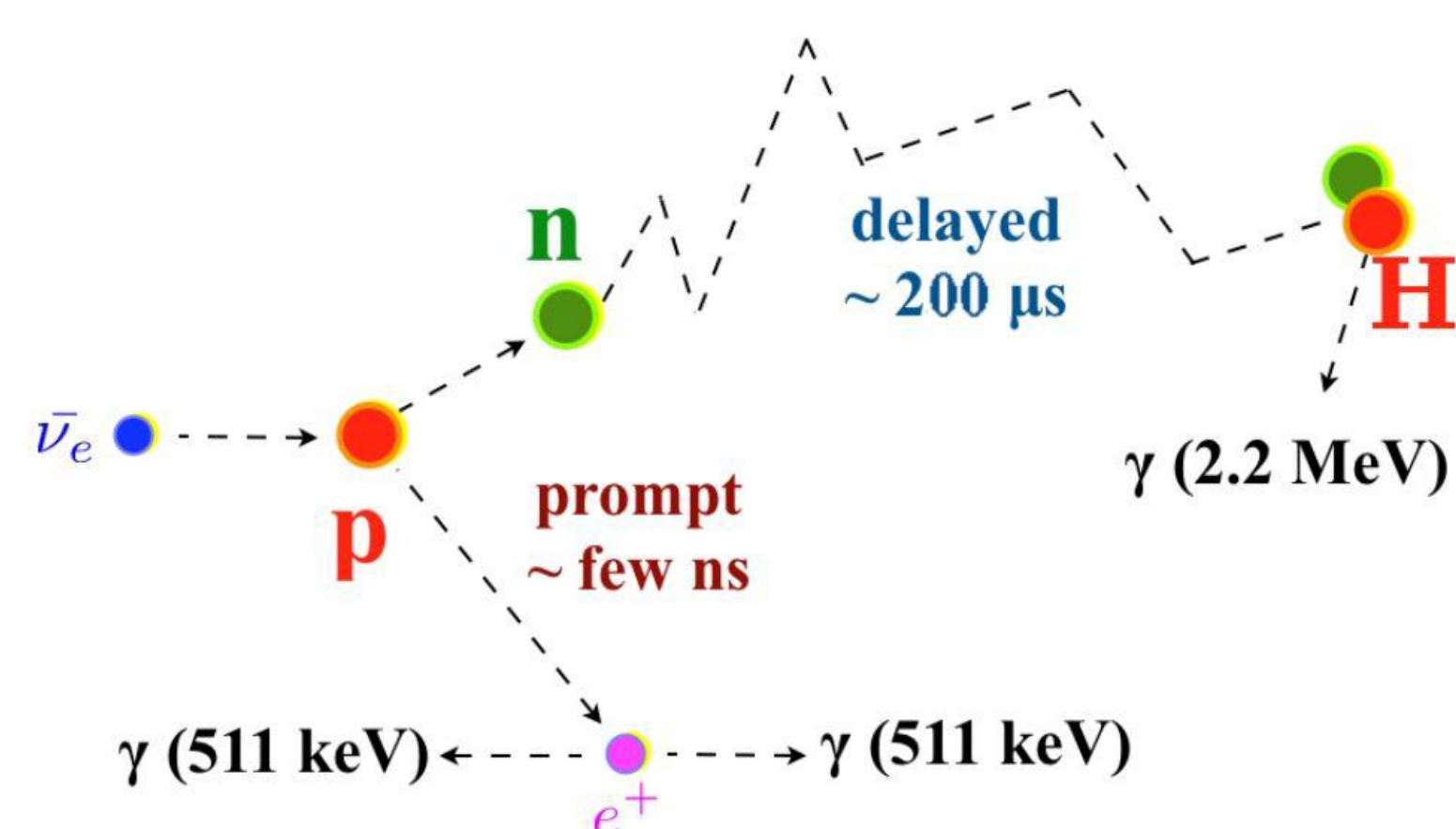
Method and results

$\bar{\nu}_e$ event selection trough Inverse Beta Decay (IBD)



selection based on time and spatial coincidence:

- ☐ Prompt: positron annihilation
- ☐ Delayed: neutron capture



Best-fit values:

$$\sin^2 \theta_{12} = 0.3092 \pm 0.0087 \text{ (2.81\%)} \quad \Delta m^2_{12} = (7.50 \pm 0.12) \times 10^{-5} \text{ eV}^2 \text{ (1.55\%)}$$

References

- [1] C. Landini et al., Distillation and gas stripping purification plants for the JUNO liquid scintillator, Nucl. Instrum. Meth. A 1069 (2024) 169887 [10.1016/j.nima.2024.169887].
- [2] M. Beretta et al., Fluorescence emission of the JUNO liquid scintillator, Journal of Instrumentation 20 (2025) P05009 [10.1088/1748-0221/20/05/P05009].
- [3] H.S. Zhang et al., Refractive index in the JUNO liquid scintillator, Nucl. Instrum. Meth. A 1068 (2024) 169730 [10.1016/j.nima.2024.169730].
- [4] The JUNO Collaboration. Measurement of reactor neutrino oscillation with the first JUNO data. Nature 654, 343-348 (2026). [https://doi.org/10.1038/s41586-026-10538-z]

Conclusions

JUNO is a massive neutrino experiment, which construction required about 10 years of design and engineering efforts. On August 2025 it started its data taking, which led to its first scientific results on November 2025, based on 59.1 days of data. In particular the experiment performed the simultaneous highest-precision determination of $\sin^2 \theta_{12}$ and Δm^2_{21} . These results validate the detector's design, and confirm JUNO's readiness for its primary goal of resolving the neutrino mass ordering.

