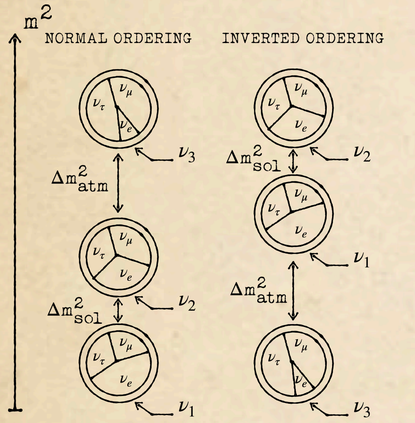
THE MUON TRACKER OF THE JUNO EXPERIMENT

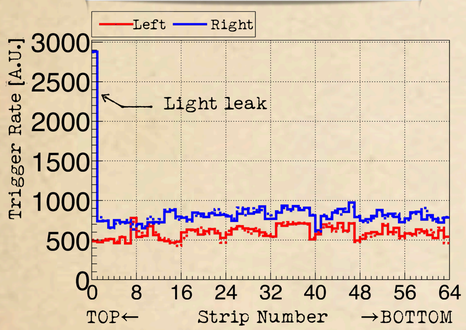
University of Strasbourg

NEUTRINO MASS ORDERING



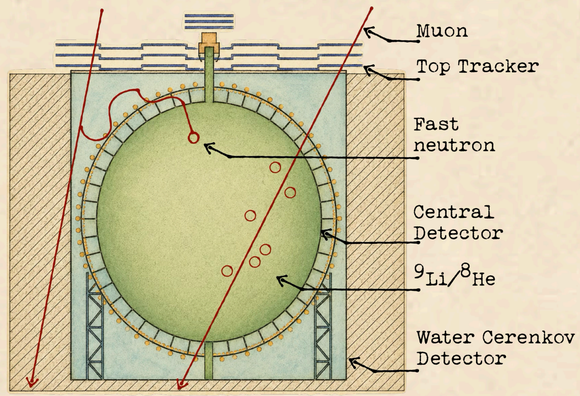
JUNO's goal is to determine the neutrino mass ordering at 3σ after 6 years of data acquisition.

INSTALLATION



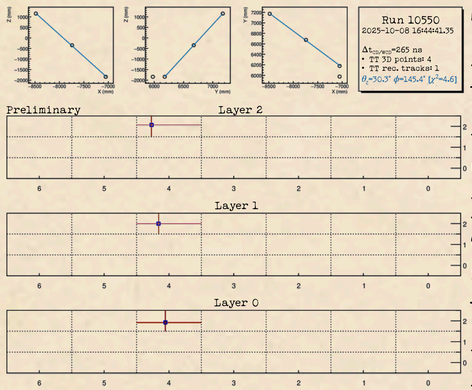
All 500 modules were inspected for potential light leaks before assembly, with a second check performed after installation. The Top Tracker was installed on site between 12/2024 and 07/2025.

JIANGMEN UNDERGROUND NEUTRINO OBSERVATORY



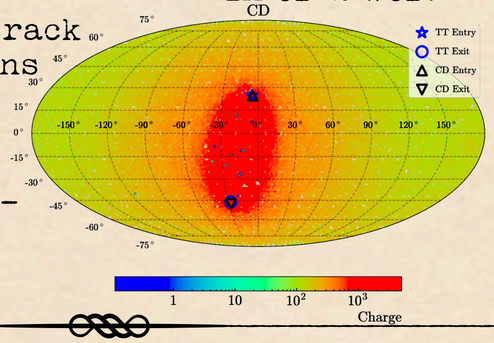
JUNO combines a 20 kton liquid-scintillator Central Detector with a dedicated muon veto system. The Central Detector (CD) is instrumented with 17,612 20-inch and 25,600 3-inch PMTs, providing 75.2% photocathode coverage. The muon veto consists of the Water Cerenkov Detector (WCD), filled with 35 kton of ultra-pure water, and the Top Tracker (TT), made of three layers of plastic scintillator strips.

TRACK RECONSTRUCTION



The TT can reconstruct tracks with a resolution of 0.2° and provides a clean muon sample to validate track reconstruction in CD & WCD.

The CD & WCD track reconstructions are in very good agreement with the TT reconstruction.



SIGNAL & BACKGROUND

Neutrinos are detected through inverse beta decay (IBD) leading to a prompt-delay signature:

$$\bar{\nu}_e + p \rightarrow e^+ + n$$

delay (~200 μs)
prompt (~ ns)

Cosmogenic isotopes with β-neutron decays (^{9}Li/^{8}He) is one of the most challenging background, because it mimics the prompt-delay signature of the IBD:

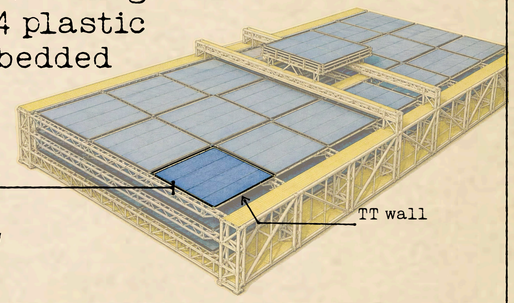
$$^9\text{Li}/^8\text{He} \rightarrow {}^8\text{Be}/^7\text{Li} + e^- + n$$

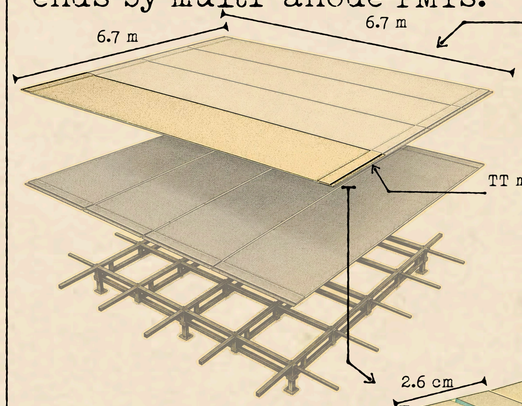
delay (~200 μs)
prompt (~ ns)

A precise reconstruction of the muon track permits to veto this background.

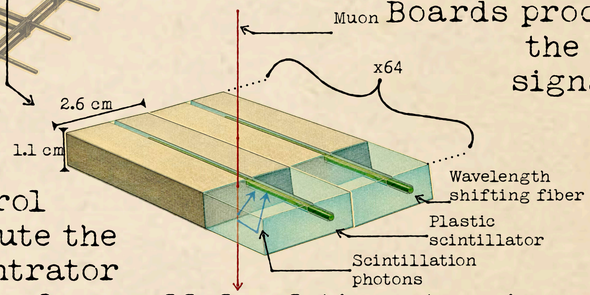
TOP TRACKER

The JUNO Top Tracker, refurbished from OPERA's Target Tracker, comprises 63 walls arranged in three layers. Each wall is built from 2 × 4 orthogonal modules, each containing 64 plastic scintillator strips with embedded wavelength-shifting fibres read out at both ends by multi-anode PMTs.





The high PMT rate is handled by a dedicated electronics: MAROC based Front-End Boards process the PMT signals,



Read-Out Boards provide slow control and power, and route the data to the Concentrator Boards. The CBs perform wall-level time stamping. Background from natural radioactivity, about 8 Mcps versus about 4 cps from muons, is suppressed by a two-level trigger requiring three-PMT coincidences within 100 ns in one wall and aligned three-layer coincidences within 300 ns.

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