

JUNO experiment: status report and perspectives

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Understanding neutrino behavior and properties is crucial for developing a complete description of matter and forces at the smallest scales. On June 10, JUNO's first physics result based on the analysis of valid data collected over 59 days from August 26 to November 2, 2025 was formally released. This analysis achieved a high-precision measurement of two key neutrino oscillation parameters $\sin^2 \theta_{12}$ and Δm^2_{21} , reducing the associated uncertainties by a factor of 1.6 compared to the world-average values from previous experiments. This initial analysis provides confidence that the detector will be able to determine the neutrino mass ordering (NMO). This first result from JUNO marks the beginning of a new era of precise measurements of neutrino oscillations and promises new discoveries in the study of the properties of these enigmatic fundamental particles.

JUNO is a unique, liquid scintillator detector. It has an unprecedentedly large effective ultra-low background 20 kt liquid scintillator target formed by 35.4-meter acrylic spherical vessel and shielded from external background by 700 m underground location and cylindrical 30 kt ultra-pure water pool playing a role of active muon veto. 20,000 20-inch photomultiplier tubes (PMTs) and 25,600 3-inch PMTs operate simultaneously to capture scintillation light in a wide dynamic range.

The experiment is fully operational now and ready to pursue its physics goals, such as NMO with an expected significance of 3–4 sigma in about six years, to measure three out of the six neutrino mixing parameters to a precision better than 1%, and conduct studies on supernova neutrinos, geo-neutrinos, solar neutrinos, atmospheric neutrinos, etc.. The phenomenon will be observed by resolving the fine structure in the energy spectrum of oscillating reactor electron antineutrinos. The anti-neutrino flux is emitted from 8 nuclear reactors at a baseline of about 52.5 km. To tune the reconstruction of antineutrino spectrum in JUNO, the satellite small JUNO-TAO reactor antineutrinos spectrometer provides the reference spectrum.

JUNO has been collecting data since August 2025. As data accumulates, numerous new results will be released sequentially, gradually unlocking new mysteries of neutrinos.