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A New 1-ton Prototype Neutrino Detector at CJPL- Ⅰ

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1. Motivation

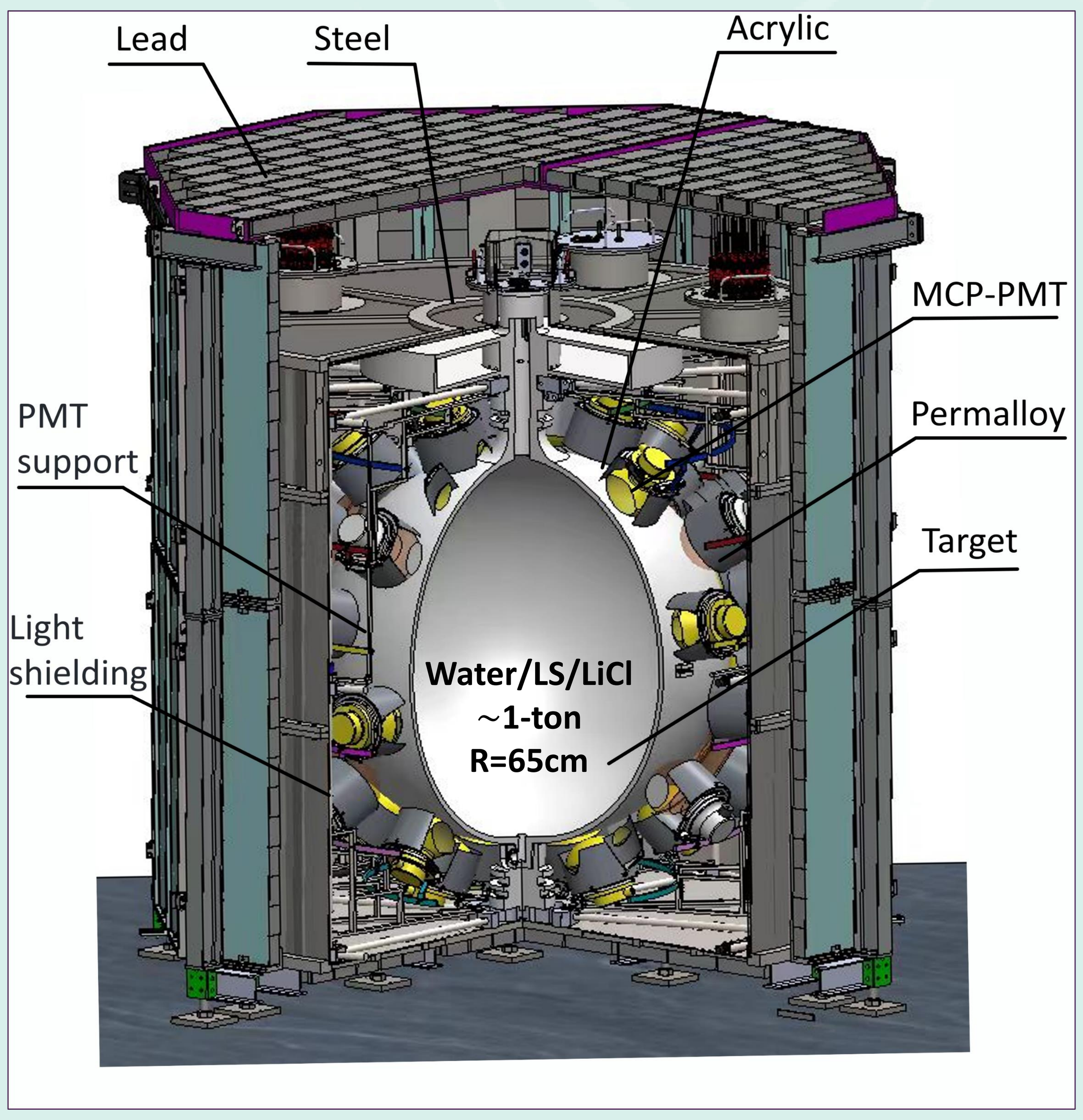
a. This is a prototype detector for the future 500 tons solar neutrino experiment, the Jinping neutrino experiment.
b. To test the new 60 MCP-PMTs and self-developed DAQ systems, determining their performance and stability.
c. Improved the performance of the previous 1-ton detector[1] for separating Cherenkov and scintillator light.

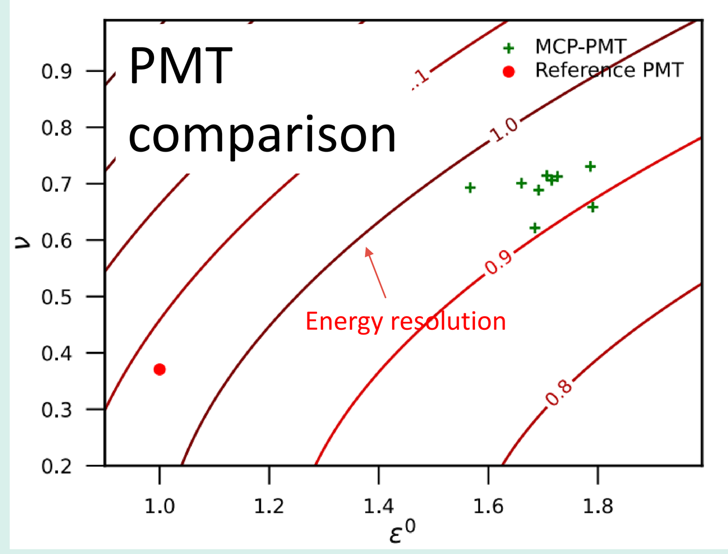
2. Structure

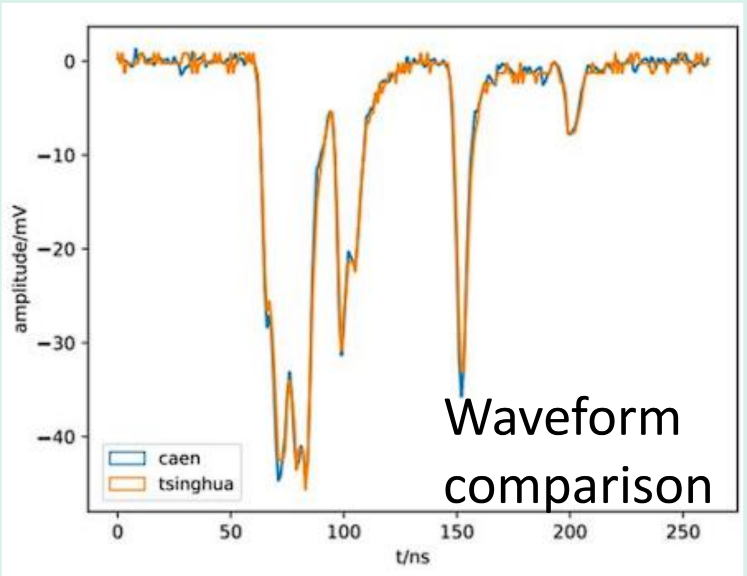
※ Three neutrino targets, including water, slow-scintillator, and LiCl aqueous solution.
※ New 60 8-inch MCP-PMTs
- High QE, low TTS, low DR, and low background[2].

※ New DAQ system
- High ENOB, low clock deviation, high transmission capability[3].

※ Clean environment, in the 2400m underground [1].
※ Complete radiation, light reflection, and magnetic shielding.





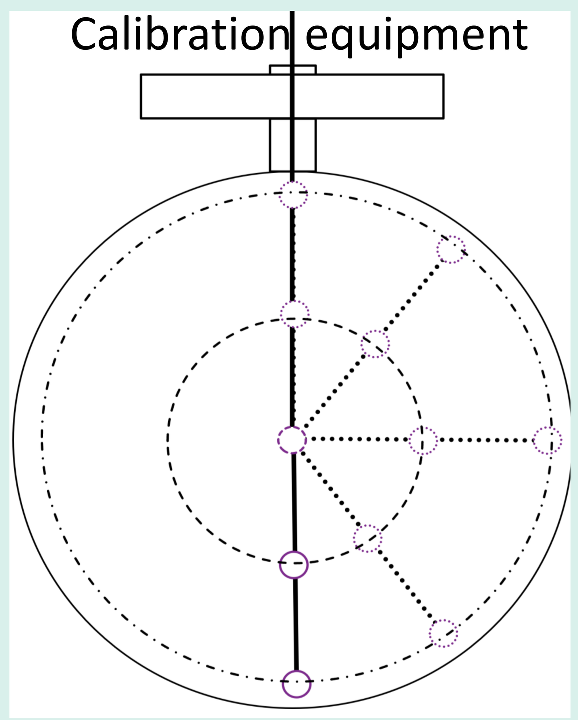


3. Time and energy calibration

※ Utilizing a diffuser laser ball to time calibration.
- For the position reconstruction and light separation research.

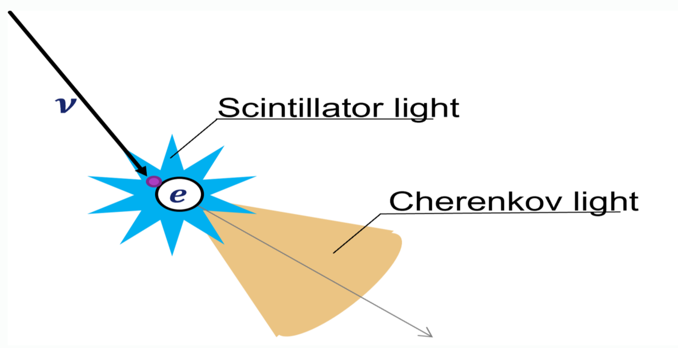
※ Utilizing the multiple radiation calibration sources for energy calibration.
- The radiation source includes ^{60}Co,^{137}Cs,^{22}Na, and ^{90}Sr/^{90}Y(β).
- Directly study the response of electrons inside the detector [4].

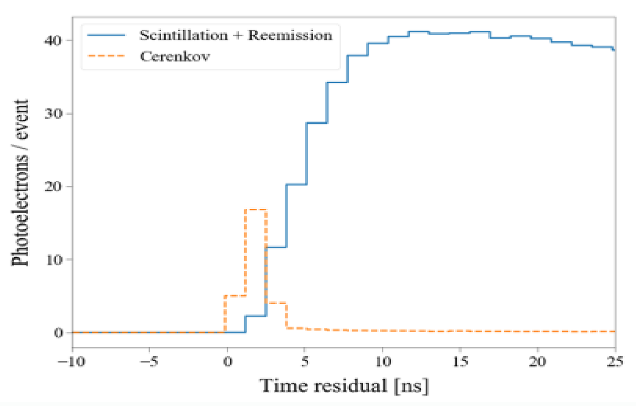
Source	Energy
Laser	405nm
^{60}Co(γ)	1.33MeV
^{137}Cs(γ)	0.66MeV
^{22}Na(γ)	1.27MeV
^{90}Y (β) endpoint	2.29MeV



4. Light separation analysis

Light	Source	Characteristic		Yield
		Time	Space	
Cherenkov	Radiation	Faster	Directional	Low
Scintillation	Fluorescence	Slower	Uniform	High



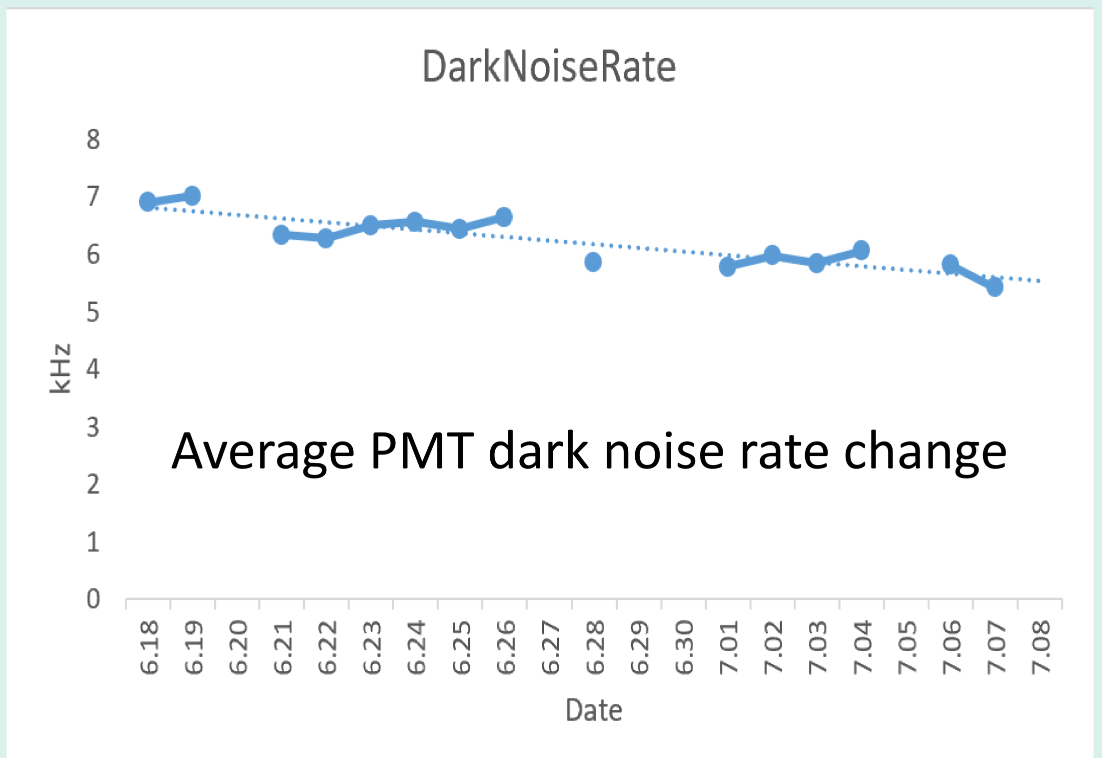


※ By separating Cherenkov from scintillation light, it is possible to improve the accuracy of CNO neutrinos measurement and enhance sensitivity in $0\nu\beta\beta$[4]

5. Status and plan

※ From May 16 to June 12, 2024, the equipment installation in the steel sphere was completed.
※ From June 12 to now, 2024, a dry run has been conducted to check the stability of the PMT and DAQ systems.
※ Here is our next plan:

Phase	Time	Target	Research contents
Phase-I	Aug.→Dec. 2024	Water	Calibration, Cherenkov light
Lead shielding installation and new DAQ system upgrade			
Phase-II	Jan.→Jun. 2025	Slow-scintillator	Calibration, light separation
Phase-III	Jul.→Dec. 2025	LiCl solution	Performance and stability



[1].Yiyang Wu, Performance of the 1-ton Prototype Neutrino Detector at CJPL-I, Nucl.Instrum.Meth.A 1054 (2023) 168400 [2]. Aiqiang Zhang, Performance evaluation of the 8-inch MCP-PMT for Jinping Neutrino Experiment Nucl. Instrum. Meth .A 1055 (2023) 168506, [2]. Lin Jiang, A newly developed multi-kilo-channel high-speed and precision waveform digitization system for neutrino experiments ArXiv:2404.10373 [4] Jack Dunger,. Slow-fluor scintillator for low energy solar neutrinos and neutrinoless double beta decay, PHYSICAL REVIEW D 105, 092006 (2022).