

Precise reactor antineutrino spectrum measurement with TAO detector

M. B. Gromov^{1,2} (on behalf of the JUNO collaboration)

¹Skobeltsyn Institute of Nuclear Physics M. V. Lomonosov Moscow State University, Moscow, Russia

²Joint Institute for Nuclear Research, Dubna, Russia

e-mail: gromov@physics.msu.ru, mgromov@jinr.ru

The Taishan Antineutrino Observatory (TAO or JUNO-TAO) is a small near detector for the large far Jiangmen Underground Neutrino Observatory (JUNO) in the reactor antineutrino experiment. The idea of JUNO is to determine the neutrino mass ordering by investigating the fine structure of the oscillated reactor antineutrino energy spectrum. TAO provides JUNO with the corresponding initial, model-independent spectrum and flux. The near detector is designed with a better energy resolution than its far counterpart. After finishing the commissioning phase and starting physics data taking in February 2026, the TAO detector demonstrates a resolution that is significantly superior to JUNO's 3,4% resolution at 1 MeV. This unprecedented result for scintillation detectors was achieved due to using 4024 silicon photomultiplier (SiPM) tiles that have high photon detection efficiency exceeding 50% and cover almost 95% of the inner surface of the TAO Central Detector. To suppress the SiPM dark count rate, the scintillator target is cooled to -50 °C. Antineutrinos are detected via inverse beta decay (IBD). This approach significantly reduces the background level. Additionally, the scintillator is doped with gadolinium and the fiducial volumes of about 1 t and 2 t are applied that helps in suppressing the background. There are also two external muon veto systems, namely a water Cherenkov detector (the Water Tank, WT) and a top veto tracker (TVT) made of plastic scintillator strips.

The TAO detector is located 44 m and 217 m from the two 4,6 GW_{th} cores of Units 1 and 2 of the Taishan Nuclear Power Plant, respectively. TAO was successfully launched and has been working reliably for more than six months now. About half of this time, the data was collected with both power units turned off. This provides a clean and quite detailed background spectrum which is subtracted from the full spectrum. The talk will present TAO's detector performance, its first precise measurement and prospects. The further physics program will also be discussed, including testing nuclear databases and different spectrum models, studying the 5 MeV spectral excess («bump»), measuring the isotopic composition of the burning fuel, monitoring nuclear reactor operational modes, evaluating the thermal power of the reactor, and searching for light sterile neutrinos.