TAO detector as a unique antineutrino spectrometer for fundamental and applied research

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In the 90s of the XX century, it was experimentally proved that antineutrino spectrometers based on liquid scintillators can monitor the power of a nuclear reactor and the isotopic composition of a burning fuel. These capabilities provide a complementary way of nuclear power plant reactor monitoring with respect to the standard methods. Moreover, such capability offers a promising tool for studying the dynamics of fuel burnout and changes in its isotopic composition in experimental industrial reactors of the 4th generation.
The Taishan Antineutrino Observatory (TAO) is a compact liquid-scintillation antineutrino spectrometer created as a satellite experiment of the Jiangmen Underground Neutrino Observatory (JUNO). To tune the reconstruction of antineutrino spectrum in JUNO the TAO detector will provide the reference reactor spectrum with extremely precise resolution of 2%@1MeV (1.5% statistical uncertainty). TAO is located at a baseline of 44 m from the reactor core of one of the twins EPR Taishan 4.6 GWth reactors (Taishan, Guangdong Province, China). The detector is under commissioning now. The start of data taking is scheduled for the July 2025.
Unprecedented energy resolution of TAO-detector is expected due to over 90% of scintillation light collection, symmetrical construction, low temperature scintillator and cooled photo sensors together with comprehensive active and passive shielding and fast original Front-End and DAQ electronics and software. Ten square meters of SiPM photons sensors with more than 50% photon detection efficiency observe the spherical volume of cooled liquid scintillator with 4500 photoelectrons per MeV light yield in TAO. SiPMs dark current rate is suppressed by 3 orders of magnitude due to operation at minus 50 degrees Celsius. The detector will capture about 2000 reactor antineutrinos within the

fiducial volume per day via Inverse Beta Decay (IBD) reaction. It is designed to be well shielded from cosmogenic and ambient backgrounds to have the background-to-signal ratio better than 10%. The unprecedented spectral properties allow to use the TAO detector as a unique instrument for fundamental and applied research. The combination of most modern technologies together with big experience from previous experiments such as Daya Bay, BOREXINO, iDREAM used in TAO opens the new generation of liquid organic scintillation detectors.