Overview of the JUNO-TAO detector
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JUNO-TAO \cite{1}, Taishan Antineutrino Observatory, is a ton level detector at \textapprox 30 m from a reactor core of the Taishan Nuclear Power Plant (4.6 GW). It measures the reactor antineutrino spectrum with sub-percent energy resolution by Inverse Beta Decay collecting the lights via \textapprox 4000 SiPMs.

Motivation
- Measuring the energy spectrum of reactor-\(\nu\) to reduce the impact from reactor flux model uncertainties and improve JUNO capability to discover the Mass Ordering
- Providing a benchmark spectrum to short-lived isotopes to nuclear database
- Searching for light sterile neutrino
- Reactor monitoring

Liquid Mass PPO reactor with SiPMs

GdLS
- A new recipe of liquid scintillator for low temperature composed of: LAB (Linear Alkyl Benzene) doped with Gadolinium + 3 g/L PPO + 2 mg/L bis-MSB + 0.5\% DPM
  - High light yield, flash point and transparency at -50 °C
- Plan to dope LAB buffer with Gd to reduce the neutron background
  - Compatibility with materials at -50 °C confirmed
- A.L. (Attenuation Length) of GdLS >10 m (11 m at 480 nm)

Detector
- 2.8 ton of Liquid Scintillator doped with Gadolinium (GdLS) in a spherical vessel with 1.8 m diameter
  - Expected 4000 IBD/Day (2000 with 1 ton fiducial volume)
  - \textapprox 10 m\textsuperscript{2} of SiPMs (more than 4000 x 8 SiPMs arrays)
  - Operate at -50 °C to reduce SiPM dark noise
  - From the center to the outside: GdLS \(\rightarrow\) Acrilic vessel \(\rightarrow\) SiPMs and support \(\rightarrow\) LAB Buffer \(\rightarrow\) Cryogenic system \(\rightarrow\) water and HDPE shield \(\rightarrow\) muon veto
  - High energy resolution: \(< 2 \% \sqrt{E}\) [MeV]

SIPMs
- R&D on SiPMs conducted in the last years
- Strict requirements to reach the sensitivity goal
- 4624 tiles from HPK
- 8000 channels with ≤15 \% charge resolution
- Cooled by the copper shell support
- Electronics ready to be produced

Calibration System
JUNO-TAO calibration system is composed by [2]:
- Automated Calibration Unit (ACU)
  - Can deploy 3 different sources inside the detector alongside the z-axis while a turntable revolves to a specific angle
    - An ultraviolet (UV) light source
    - a \(^{4}\text{He}\) source
  - A combined source that contains multiple gamma sources and one neutron source
- Cable Loop System (CLS)
  - Designed with a single radioactive source, that can be deploy to off axis position

Muon Veto and Shielding
The detector is not underground → active and passive shielding is required
- Top Plastic Scintillator
  - 4 layers, each 2 cm thickness, 1 mm gap between strips
  - Muon VETO efficiency > 95\%
- Light seen by SiPM
- Water Tank
  - Dodecagon, 1.2 m thickness
  - Light seen by 3° PMT

Conclusion
- JUNO-TAO will measure the reactor antineutrino spectrum looking its fine structure
  - 1.1 prototype in summer 2022
  - JUNO-TAO starts commissioning in 2023