Muon related background at JUNO–TAO

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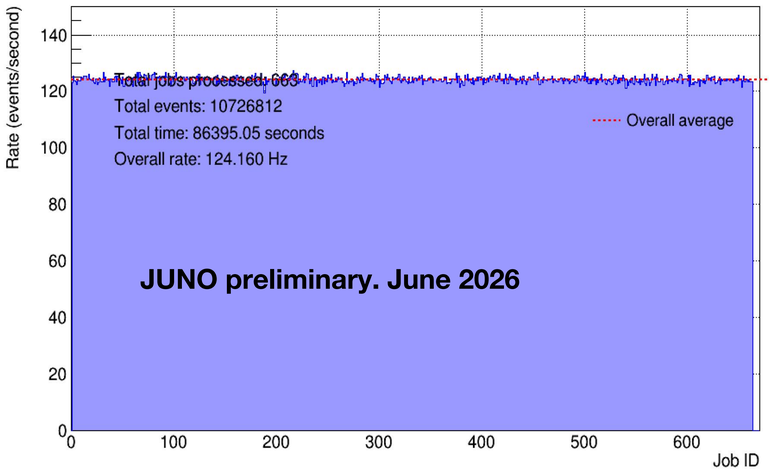
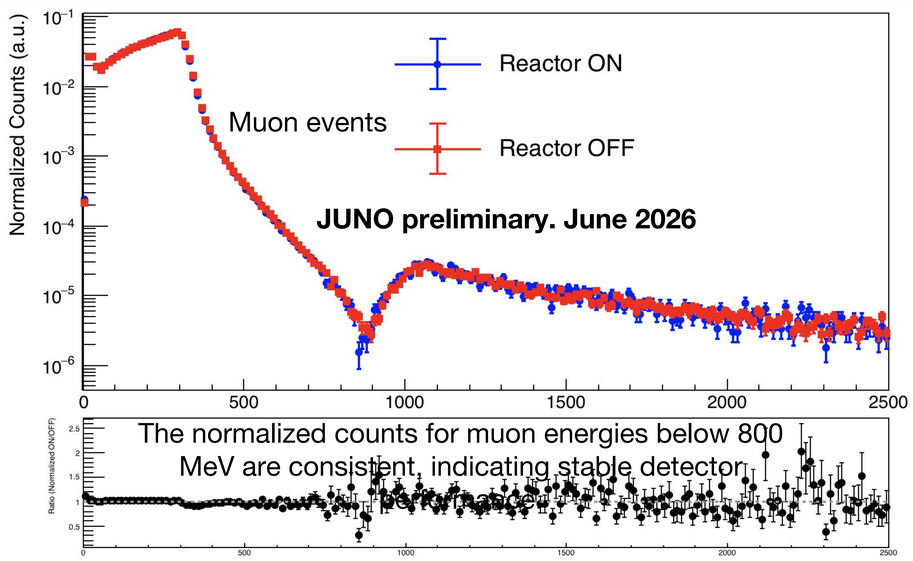
1. Abstract

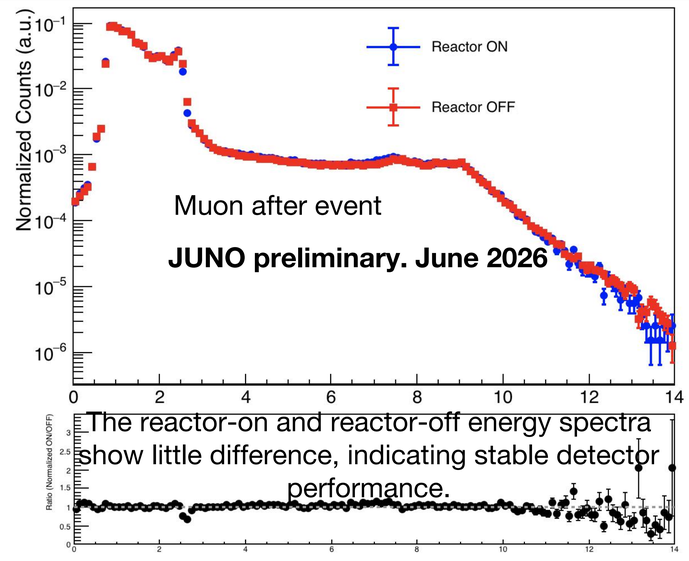
As a satellite detector of the Jiangmen Underground Neutrino Observatory (JUNO), Taishan Antineutrino Observatory (TAO/JUNO-TAO) is positioned ~ 44 meters from a reactor core of the Taishan Nuclear Power Plant. Its ton-scale liquid scintillator detector, instrumented with high-coverage Silicon Photomultipliers (SiPMs) operating at cryogenic temperatures, achieves an exceptional light yield and outstanding energy resolution for precision reactor antineutrino spectroscopy via inverse beta decay. A key challenge in achieving this goal is the characterization and mitigation of muon-induced backgrounds. Cosmic-ray muons and their secondary products can create signals mimicking the antineutrino interaction.
Muon-related backgrounds constitute one of the primary background sources at the TAO, an integral component in the overall analysis chain. This poster presents an overview of muons and their associated backgrounds at TAO.

2. Muon events and muon after events

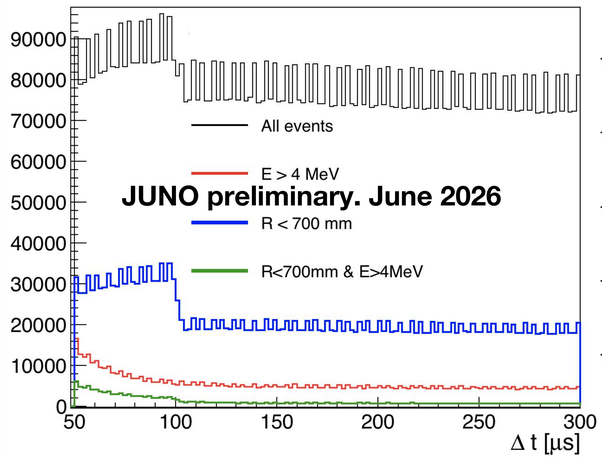


The muon event rate remains stable at about 124 Hz over RUN (i.e., time).

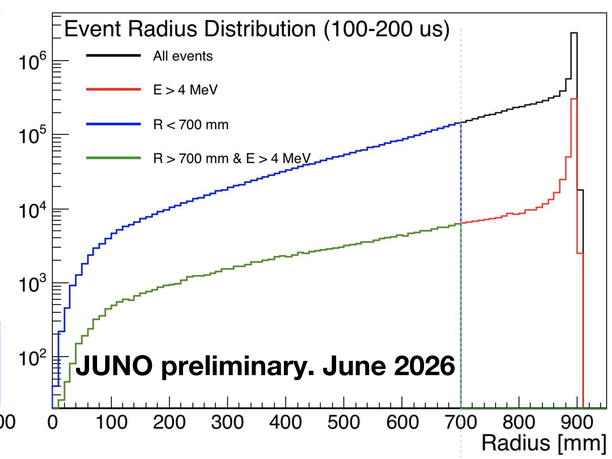




3.Spallation neutron study

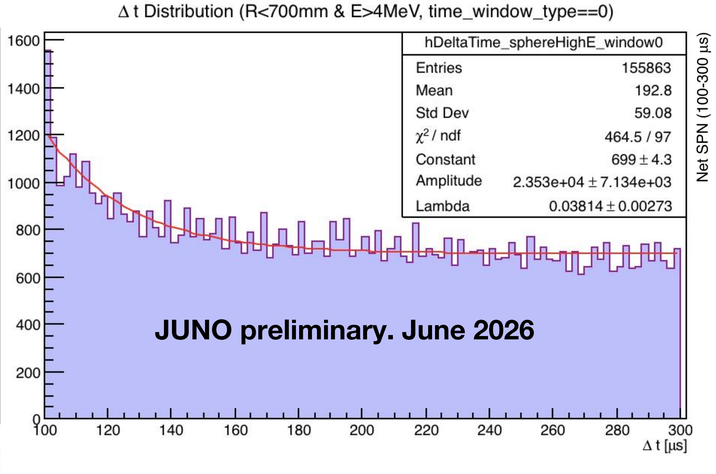


Delta distribution of muon after events under radius cuts and energy cuts.

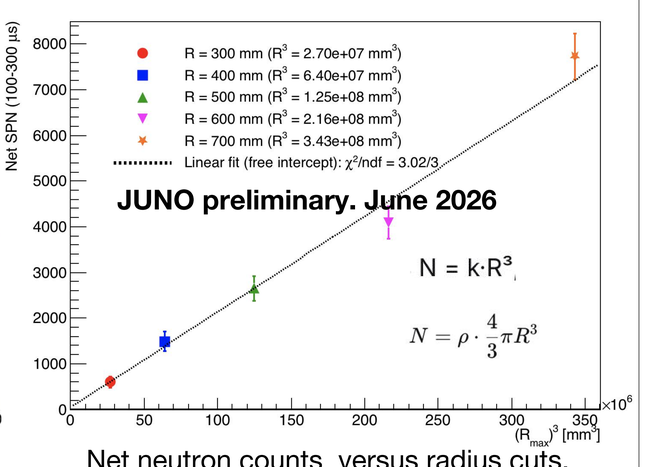


Radius distribution of reconstructed event vertices under radius cuts and energy cuts.

f(t) = Constant+Amplitude *Lambda exp(-Lambda* t)



The neutron lifetime is obtained by fitting with the above f(t)



Net neutron counts versus radius cuts.

Slope → measures uniform net neutron yield per unit volume.

4. Summary

- With reactor on and off, the muon event rate, energy spectra, and muon-induced spectra remain consistent, and the muon background does not depend on reactor power — confirming stable detector operation and reliable background characterization.
- Net neutrons scale linearly with R^3; Spallation neutrons are produced uniformly in the detector volume, demonstrating good linearity and uniform response, which further reflect detector's overall performance.