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Reconstruction of atmospheric neutrinos and muons using Machine Learning-based methods in JUNO

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The Jiangmen Underground Neutrino Observatory (JUNO), located in Southern China, is a multi-purpose neutrino experiment that consists of a 20-kton liquid scintillator detector. The primary goal of the experiment is to determine the neutrino mass ordering (NMO) and measure other neutrino oscillation parameters to sub-percent precision. Atmospheric neutrinos are sensitive to NMO via matter effects and can improve JUNO's total sensitivity in a joint analysis with reactor neutrinos; Atmospheric muons contribute to one of the most important background sources to neutrino signals. Good capability of reconstructing atmospheric neutrinos and muons in JUNO is crucial for its physics goal.

In this contribution, we present a novel multi-purpose reconstruction method for atmospheric neutrinos, muons and other physics events at similar energies (few GeV to tens of GeV) by combining PMT waveform analysis and machine learning techniques. Multiple machine learning approaches, including planer, spherical, and 3-dimensional models, as well as other novel techniques in improving reconstruction precision, are discussed and compared. We show the performance of reconstructing atmospheric neutrino's directionality and energy using Monte-Carlo simulations, and demonstrate that this method can achieve unprecedented reconstruction precision for multiple physics quantities and fulfils the needs of JUNO. This method also has the potential to be applied to other liquid scintillator detectors.

Significance

References

Experiment context, if any

Jiangmen Underground Neutrino Observatory (JUNO)

Primary author: MA, Wing Yan (SDU)

Co-authors: ZENG, Fanrui (China, Shandong University); DUYANG, Hongyue (Shandong University); LIU, Jiaxi; Dr LI, Teng (Shandong University, CN); LUO, Wuming (Institute of High Energy Physics, Chinese Academy of Science); HE, Xinhai (The Institute of High Energy Physics of the Chinese Academy of Sciences)

Presenter: MA, Wing Yan (SDU)

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