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Machine learning-based particle identification of atmospheric neutrinos in JUNO

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The Jiangmen Underground Neutrino Observatory (JUNO) is a next-generation large (20 kton) liquid-scintillator neutrino detector, which is designed to determine the neutrino mass ordering from its precise reactor neutrino spectrum measurement. Moreover, high-energy (GeV-level) atmospheric neutrino measurements could also improve its sensitivity to mass ordering via matter effects on oscillations, which depend on the capability to identify electron (anti-)neutrinos and muon (anti-)neutrinos against each other and against neutral current background, as well as to identify neutrinos against antineutrinos. However, this particle identification task has never been attempted in large homogeneous liquid scintillator detectors like JUNO.
This contribution presents a machine learning approach for the particle identification of atmospheric neutrinos in JUNO. In this method, several features relevant to event topology are extracted from PMT waveforms and used as inputs to the machine learning models. Moreover, the features from captured neutrons could also provide the capability of neutrinos versus anti-neutrinos identification. Two independent strategies are developed to utilize neutron information and to combine these two types of inputs information in different machine learning models. Preliminary results based on Monte Carlo simulations show promising potential for this approach.

Significance

In this contribution, we provides a multi-purpose machine learning method for atmospheric neutrino reconstruction and particle identification in large unsegmented liquid scintillator detectors like JUNO. Specifically, for this particle identification task, our models' architecture are updated to utilize the extra neutron information that could help classifying neutrinos and anti-neutrinos.

References

https://indico.cern.ch/event/1264216/contributions/5548526/attachments/2702032/4731931/ML_FlavorIdent_IPRD_Fanrui.pdf

Experiment context, if any

Jiangmen Underground Neutrino Observatory (JUNO)

Primary authors: ZENG, Fanrui (China, Shandong University); DUYANG, Hongyue (Shandong University); LIU, Jiaxi; Dr LI, Teng (Shandong University, CN); MA, Wing Yan (SDU); 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: LIU, Jiaxi

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