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NuPRISM: Reducing neutrino interaction model dependence for oscillation experiments

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As long-baseline neutrino oscillation parameter measurements arrive at the precision era, future experiments will be dominated by systematic rather than statistical uncertainty. The determination of the incident neutrino energy based on experimental observables relies on theoretical neutrino-nucleus interaction models, which are the dominant uncertainties for the T2K-II and HK experiments. NuPRISM is an experimental solution to constrain this uncertainty.

NuPRISM is a water Cherenkov detector that can be raised/lowered to span a continuous 1-4 degree off-axis range, relative to the neutrino beam centre. Linear combinations of the near detector flux, at different off-axis angle slices, can then be taken to match the far detector flux measurement. Oscillation parameters may then be obtained while largely reducing the neutrino interaction model dependence. NuPRISM also enables a unique measurement of the neutrino cross-section as a function of neutrino energy, as well as probing for sterile neutrinos.

NuPRISM plans to use multi-PMT modules, which are under development in Canada. The experiment will also require a data collection system capable of supporting high bandwidths, as well as an in-situ PMT calibration system. NuPRISM Phase-0 is planned to demonstrate the technology and an understanding of the detector at the 1% level. It will be located between 6 and 12 degrees off-axis where a large electron neutrino flux may be used to make a leading electron to muon flavour neutrino cross-section ratio measurement. Gadolinium doping may be used to measure neutron emissions from neutrino interactions.

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