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Enhancing the reach of INO-ICAL using correlated muon and hadron information

The magnetized iron calorimeter (ICAL) at the India-based neutrino observatory (INO) aims at distinguishing the neutrino mass hierarchy as well as determining the atmospheric neutrino parameters with a fine precision. The ICAL can detect muons with good reconstruction
efficiency and momentum (E_μ, $\cos\theta_\mu$) resolution. It is also capable of measuring the hadron energy $E'_{had} = E_\nu - E_\mu$, by calibrating the hadron shower hits. For a given neutrino event, the correlation between E'_{had} and E_μ is an important property, which may be used for improving the oscillation parameter estimation. We take care of this correlation by bining the events in the three observables (E_μ, $\cos\theta_\mu$, E'_{had}). A χ^2 analysis is performed after incorporating the ICAL muon and hadron response, obtained from GEANT4 simulation. We find that, with an exposure of 500 kt - year, the ICAL can rule out the wrong hierarchy with a $\Delta\chi^2 \approx 9.5$, which marks an enhancement of about 40\% compared with the muon-only analysis. The inclusion of hadron information also improves the precision bounds on $|\Delta m^2_{32}|$, θ_{23} and its octant. We show that 10 years of ICAL exposure would be able to measure $\sin^2\theta_{23}$ and $|\Delta m^2_{32}|$ to a relative 1σ precision of 12\% and 2.9\% respectively.

WG3: Accelerator Physics (Yes/No)

No

WG2: Neutrino Scattering Physics (Yes/No)

No

WG4: Muon Physics (Yes/No)

No

WG1: Neutrino Oscillation Physics (Yes/No)

Yes

Type of presentation

Poster

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