

Hadron energy resolution as a function of plate thickness and theta resolution of hadrons at the Iron Calorimeter Detector in India based Neutrino Observatory

The study of atmospheric neutrinos is the primary goal of the proposed India based Neutrino Observatory (INO), which will make use of a magnetized Iron CALorimeter (ICAL) for this purpose. ICAL is very sensitive to muons which leave clean tracks in the detector which can be studied to calculate the properties of the incident neutrinos which interacted with the iron target to create these muon tracks. These neutrinos not only produce muons, but hadrons also and determining the energy and direction of hadrons produced in these neutrino interactions are very crucial in determining the energy and direction of the parent neutrino.

The thickness of the iron plate is a crucial factor in determining the hadron energy response in ICAL. The present study takes into account various plate thicknesses and studies the variation in hadron energy resolution as a function of plate thickness. Hadron energy response is found to be almost independent of the thickness in the energy range of interest for hadrons from atmospheric neutrinos, due to the presence of a constant residual resolution.

For the study of theta resolution of hadrons, we use three different methods called the centroid method, orientation matrix method and raw hit method. For 2 GeV pions the direction resolution using orientation matrix method is in the range $7^\circ - 12^\circ$, while for 5 GeV pions it is in the range $5^\circ - 8^\circ$ for different angular bins. The resolution for the hadron shower produced in atmospheric neutrino events is worse by up to a factor of 2 (depending on incident direction) because there can be more than one hadron in each event.

Summary

The energy resolution of hadrons as a function of iron plate thickness is studied for the proposed Iron CALorimeter (ICAL) detector to be situated at the India-based Neutrino Observatory (INO). Methods to reconstruct the hadron direction from the information obtained only as shower hits are also studied and various methods are compared.

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