$N^{O}E$:

Atmospheric and long baseline Neutrino Oscillation Experiment

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Introduction

The purpose of this document is to present the long baseline experiment ($N^{O}E$) at the Gran Sasso laboratory for the measurement of neutrino masses through $\nu_\mu \to \nu_\tau$ and $\nu_\mu \to \nu_e$ oscillation mechanism.

Recent water Cerenkov experiments performed in underground laboratories show an anomaly in the contained CC neutrino interactions interpreted as a possible signal for neutrino oscillation. The existence of this phenomenon is not confirmed by calorimetric experiment. This argument is still open and requires further investigation.

This experiment allows to extend the range of investigation down and beyond the region (small Δm^2) studied by the atmospheric neutrino experiments. In addition it represents a complementary approach to the present short baseline neutrino experiments which are sensitive to small $sin^2(2\theta)$ values.

Long baseline projects are under discussion in various laboratories in the world. The proposed CERN-Gran Sasso neutrino beam setup gives the possibility to reach the sensitivity limit of 10^{-3} eV^2 in Δm^2 and $\approx 10^{-2}$ in $sin^2(2\theta)$ in three years of data taking if a $\sim$ 6 Kton active target is used.

$N^{O}E$ is a modular detector based on three type of elements: a calorimeter (4 kton), a muon detector and a tracking system. The calorimeter uses 2 mm scintillating fibers embedded in a iron ore absorber for an high intrinsic granularity.

The main aim of the experiment is the measurement of neutrino oscillations using as a source the long baseline beam and atmospheric neutrinos, anyway the high granularity might allow its use for other physics items, such as neutrino astronomy, nucleon decay and muon physics.

This document will discuss in details the physics motivations, the proposed detector, its performances and the physical goal that can be in principle reached in 3-4 years of data taking.

A comprehensive simulation work is in progress. To date it is not totally completed and further results will be presented in an addendum devoted to the crucial item of the possibility of detecting directly the leptons produced by neutrinos not present in the original beam.

The apparatus proposed here has to be considered a reference design, in which some parameters are still subject to optimization, depending also on the physical simulation and prototype tests.

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