Mini-LANNDD: A Very Sensitive Neutrino Detector To Measure $\sin^2(2\theta_{13})$*

David B. Cline, Stanislaw Otwinowski† and Franco Sergiampietri‡

† Center for Advanced Accelerators Department of Physics and Astronomy University of California, Los Angeles Los Angeles, California 90095-1547
‡ , INFN-Pisa, Istituto Nazionale di Fisica Nucleare, Via Livornese, 129156010 San Piero a Grado (PI), Italy

Abstract. The ICARUS Detector at the LGNS will carry out a sensitive search for a $\sin^2(2\theta_{13})$. We describe a small version for the LANNDD proton decay detector (70kT Liquid Argon) to measure $\nu_\mu \rightarrow \nu_e$ in a low energy or off-axis neutrino beam. We find an optimal detector size is 5 kT and at a distance of about 700 km from a high-energy neutrino source. This detector uses the ICARUS method.

1. Introduction

The ICARUS detector concept is now well tested and plans for a 3 KT detector at the LGNS are in place by 2005-2006 [1]. This detector with the CNGS neutrino beam will provide the most sensitive search for $\nu_\mu \rightarrow \nu_e$ that is currently planned. To go beyond this sensitivity, a new detector will be required in a different (lower energy or off-axis) beam. In this note we discuss a possible 5 kT detector based on the ICARUS method, and a smaller version of the proposed LANNDD detector. LANNDD (Liquid Argon and Neutrino and Nuclear Decay Detector) is a 70 kT magnetized detector for the WIPP Site at Carlsbad, New Mexico. Figure 1 shows a schematic of LANNDD and Figure 2 shows a schematic of the detector located at the WIPP Site[2].

In this note we provide a brief discussion of Mini-LANNDD, a 5kT detector based on the LANNDD concept. We emphasize here the use to search for In this note we provide a brief discussion of Mini-LANNDD, a 5kT detector based on the LANNDD concept. We emphasize here the use to search for $\nu_\mu \rightarrow \nu_e$ beyond the ICARUS [3] range to the level of $\sin^2(2\theta_{13}$ of 0.005.

2. Reach of ICARUS T3000

The ICARUS T600 will be installed soon in the LNGS - most likely in Hall B. A proposal has been submitted to INFN and the USA DOE to construct on additional 2400 tons of ICARUS [4]. In this proposal on analysis of the limit on $\sin^2(2\theta_{13}$ that could be reached after 8 years of operating with the CNGS beam - Table 1, lists the events rate for different channels as well as the expected ne background. A detailed analysis by Andre Rubbia [5] and his group indicates that 0.02 could be reached to 90% C.L. A schematic of the limit that one can reach compared to the background is

Table 1.

CoM energy (TeV)	0.4
P energy (GeV)	16
P/bunch	$2.5x10^{13}$
Bunches/fill	4
Rep. rate (Hz)	15
$1/\tau_\mu$	240
P power (MW)	4
μ/bunch	$2x10^{12}$
μ power (MW)	4
Wall power (MW)	120
Collider cirumference (m)	1000
$< B > (T)$	4.7
δp (%)	0.14
6-D $\eta_{6,N}(\pi m^3)$	$1.7x10^{-10}$
Rms η_n (π mm-mrad)	50
β * (cm)	2.6
σ_z (cm)	26
σ_r spot (μm)	1.0
σ_θ IP (mrad)	0.044
Tune shift	
$n_{turns}^{effective}$	700
Luminosity ($cm^{-2}s^{-1}$)	10^{33}
Higgs/year	

given Table 2. We see that a value of 0.01 is optimal and with a great deal of effort (or a very good detector)(Table 3 and 4) like mini LANNDD; 0.005 might be reached.

3. Mini-LANNDD

We have made a very preliminary design of a 5 kt LANNDD like detector to use in a NuMi like beam (or off axis CNGS beam). Fig. 3 shows one design including the Cryostat whereas Fig.4 shows a cut through of the detector. We assume 5 m drift length. In Table 5 we give some preliminary parameters of the detector.

4. The reach of Mini-LANNDD

Using some value given to us by Adam Para [6] [7] we show the signal and background for Mini-LANNDD with 20 kty exposure - Table 3 and Table 4. Neutral current will be unimportant. Mini-LANNDD can reach ultimate limit possible in the NuMi beam (or off axis CNGS) of 0.005.

We wish to thank Adam Para and Debbie Harris for requesting this study

5. References

[1] ICARUS Team, private communication
[2] Cline, D et al, ASTRO-PH/0105442.
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[7] Adam Para, private communication.