1 Background Summary Costs

Table 1: Summary of Background Fractions and Costs for different Detectors

	Water Cerenkov (UNO)[bb]	Liquid Argon (ICARUS)	Steel+readout (MINOS $\rightarrow$ THESEUS)[cc]	Scintillator[a]a (BNL-E736)
cost/kton (fiducial)[a]	0.6-0.8[b]	8[c]	3.3[d] $\rightarrow$ 20[e]	15[f]
Signal Efficiency	.7$\rightarrow$ 0.5	0.90	0.5 $\rightarrow$ 0.6[g]	
NC Background (f_b)	1% $\rightarrow$ 8%	10^{-3}	8% $\rightarrow$ 4%	
electron threshold	$0.5 \times E_\nu$	not relevant[h]	$1GeV < E_\nu < 6GeV$	$0.9GeV < E_e < 5.1$

[bb] The arrows in the table represent a 1GeV neutrino beam up compared to a multi-geV neutrino beam. For a multigeV neutrino beam I'm assuming a y cut of 0.5, which is why the efficiency would roughly be 50%. For the 1GeV neutrino beam the efficiency would be higher and the bkgd lower, and I think there's no electron energy cut really, it's more a topology cut, like ICARUS.

[cc] For this column, the left side is minos the right side is theseus. You might want to either divide this into 2 separate experiments. The theseus numbers are really only for the minos low energy beam, the cuts are optimized for keeping neutrino efficiency as high as possible between 1 and 6GeV, as is listed in the table...I can't say how they would scale with other energy beamlines.

[a] Cost/kton not including excavation costs, which have been estimated at 0.5M\$/kton/ρ [1], where ρ is the density of the target.

[b] 355M\$/450kton [1], assuming 40% pmt coverage in middle region, 10% pmt coverage in external volume. This could possibly be reduced by about 80M\$ if one assumes 10% pmt coverage everywhere, giving 0.6 M\$/kton. Note: 40% coverage is necessary for proton decay experiment which is driving force behind this proposal right now.

[c] From cost estimate: 26060MLire per module, 2200Lire/Dollar=13M\$/module, each module is 1.9kTon of Liquid Argon Mass, assume loss of 10% from fiducial cuts, giving 1.6kTon per module. (from [2])

[d] assume 5.4ktons and 17.6M\$, from MINOS detector [3]

[e] assume 20M\$ for 1kTon, for Theseus/Soudan [7]

[f] assume 3M\$ for 0.2kton, used in BNL-E736 [8]

[g] soudan efficiency for electron neutrinos, etc: NuMI-L-562

[h] all the neutral current rejection can be made with dE/dX type cuts which are 90% efficient for the ν_e charged current signal. Additional electron energy cuts are not required for NC rejection, although total energy cuts might be applied to reduce intrinsic ν_e background.

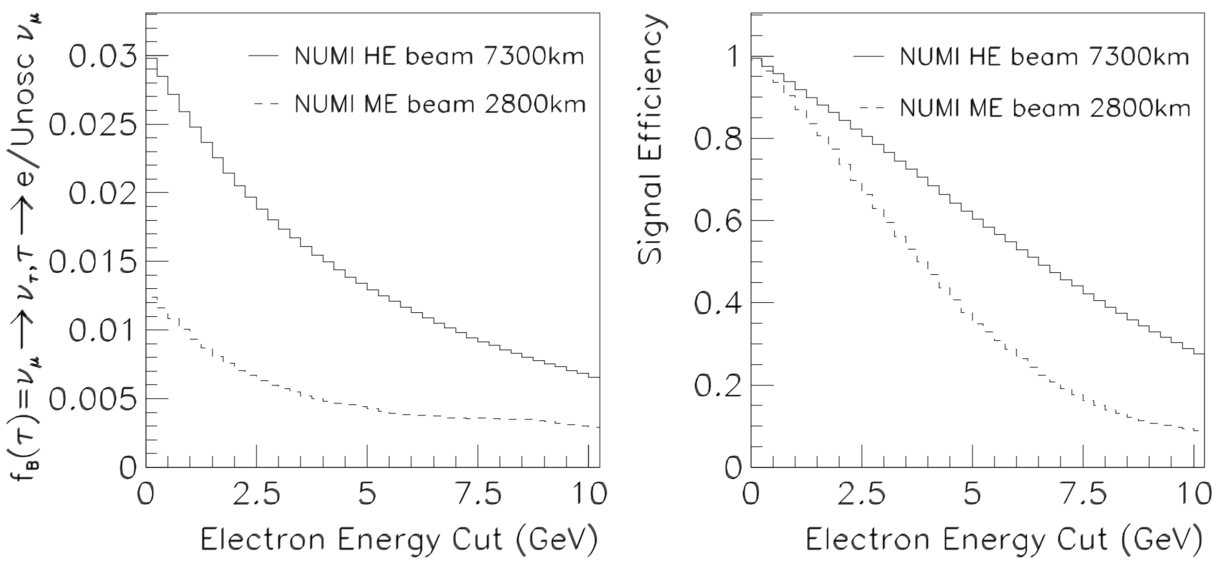

Figure 1: Left: Number of events where $\nu_\mu \to \nu_\tau$ followed by $\tau \to e$ for standard mixing scenario divided by number of ν_μ charged current events in the absence of any oscillations, as a function of the cut on the final state lepton energy. Energy resolution assumed for electrons is $\sigma(E_e)/E_e = 5\%/\sqrt{E_e(GeV)}$. Right: The efficiency of a cut on electron energy for two different beamlines: NUMI-ME and NUMI-HE.

(Mention in section 5.2.2: liquid argon TPC: $f_B(NC)$ can be reduced to about .001, at the cost of a modest reduction in the dataset size D of 0.9 arising mostly from the π^0 and photon topology cuts.)

[a] a Read Ahrens et al, Phys. Rev. D volume 31, (2732) 1985 to fill in the rest of these blanks...

2 Tau Background Summary

Table 2: Summary of Tau neutrino backgrounds–for this table the entire ν_μ beam spectrum was used, assuming that $\delta m^2_{23} = 3.5 \times 10^{-3} eV^2$, and that $\sin^2 2\theta_{23} = 1$???. The electron energy resolution assumed was $\sigma(E_e)/E_e = 5\%/\sqrt{E_e(GeV)}$, as is expected for the ICARUS detector.

Beam	Distance	$f_B(\tau)$ no cut	$f_B(\tau)$ with cut	cut value	Signal Efficiency
NUMI-LE	732km	0.1%	0.1%	$E_e > 0GeV$	100%
NUMI-ME	2800km	1.3%	0.6%	$E_e > 3GeV$	60%
NUMI-HE	7300km	3.1%	1.3%	$E_e > 5GeV$	60%

References

[1] C.K.Jung,FEASIBILITY OF A NEXT GENERATION UNDERGROUND WATER CERENKOV DETECTOR: UNO `hep-ex/0005046`

[2] F.Arneodo *et al.* (ICARUS and NOE Collab.), "ICANOE: Imaging and calorimetric neutrno oscillation experiment" CERN/SPSC 99-25, Addendum 1: Preliminary Technical Design & Cost Estimates,CERN/SPSC 99-39, both of which can be found at `http://pcnometh4.cern.ch`

[3] MINOS Technical Design Report NuMI-L-337 October 1998

[4] NumI Facility Technical Design Report NuMI-346 March 1998

[5] Milind Diwan, private communication ???

[6] L.A.Ahrens, *et al*, BNL-E736 Collaboration, Phys. Rev. **D31** 2732 (1985).

[7] M.Goodman, private communication–ask him for reference!

[8] Bob Shrock will know whom to quote on this