I. THE INTERNATIONAL DESIGN STUDY FOR A NEUTRINO FACTORY, THE IDS-NF

The baseline NF in the IDS-NF Interim Design Report (IDR) [1] remains the high-energy (E_μ=25 GeV) two-baseline facility and remains the best facility to accurately measure the remaining parameters in the 3 ν mixing parameter space, if it turns out that the value of θ_{13} is actually 3σ below the central value of the latest global fit ($\sin^2\theta_{13} > 0.005$) [2]. In the IDS IDR, in the case of large θ_{13} ($\sin^2 2\theta_{13} > 0.01$), the document describes the performance of a single baseline (L = 2000 km), lower energy facility (E_μ=10 GeV), termed the LENF that uses a 100 kT magnetized iron detector (MIND) as the far detector. At the recent IDS-NF meeting, we developed a strategy (again in the context θ_{13} being large) for a phased or staged approach for the LENF - the low-luminosity-low-energy Neutrino Factory, L^3ENF. The main points of this strategy are:

1. The facility is upgradeable to the full luminosity of the LENF (10^{21} useful μ/yr.).
2. The facility does not require a proton driver to begin the physics program (assumes the Fermilab proton improvement plan).
3. The facility does not include muon ionization cooling.
4. The facility begins with 40kT of MIND.

A schematic of the L^3ENF is given in Fig. 1. Under these assumptions, the L^3ENF has a luminosity reduction factor of 25 (0.04 of the baseline) and, as seen in Fig. 2, has a performance that is as good as or better than LBNE. This approach lowers the facility cost, reduces technical risk and allows for an earlier start. The upgrade path is then straightforward: add cooling when the technology is mature, add power when Project X in online and increase the detector mass to 100kT as funds become available.

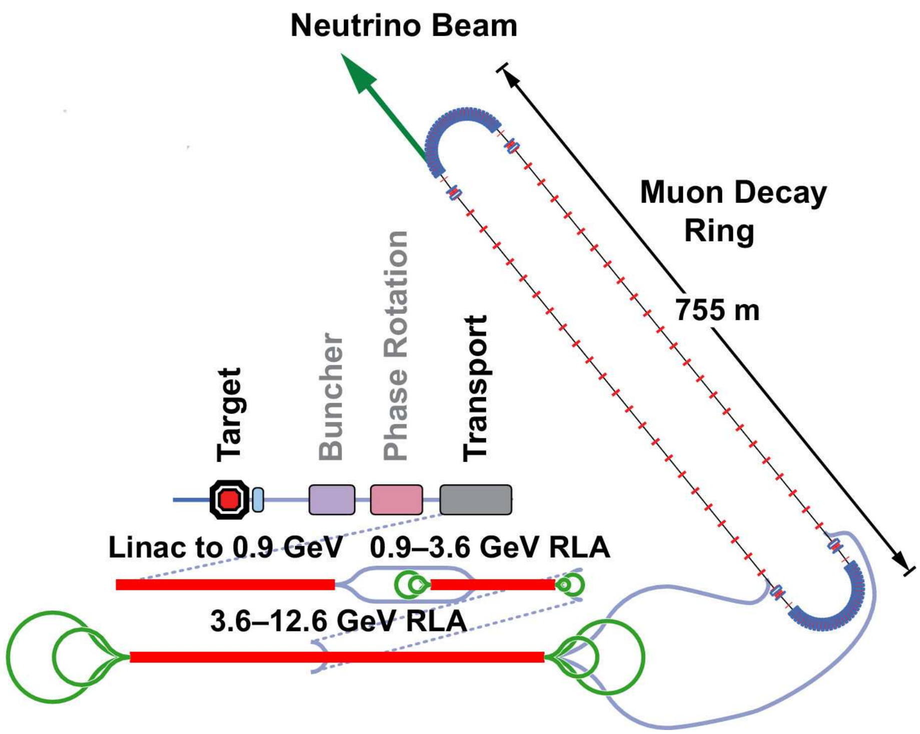

FIG. 1: Schematic of L^3ENF.

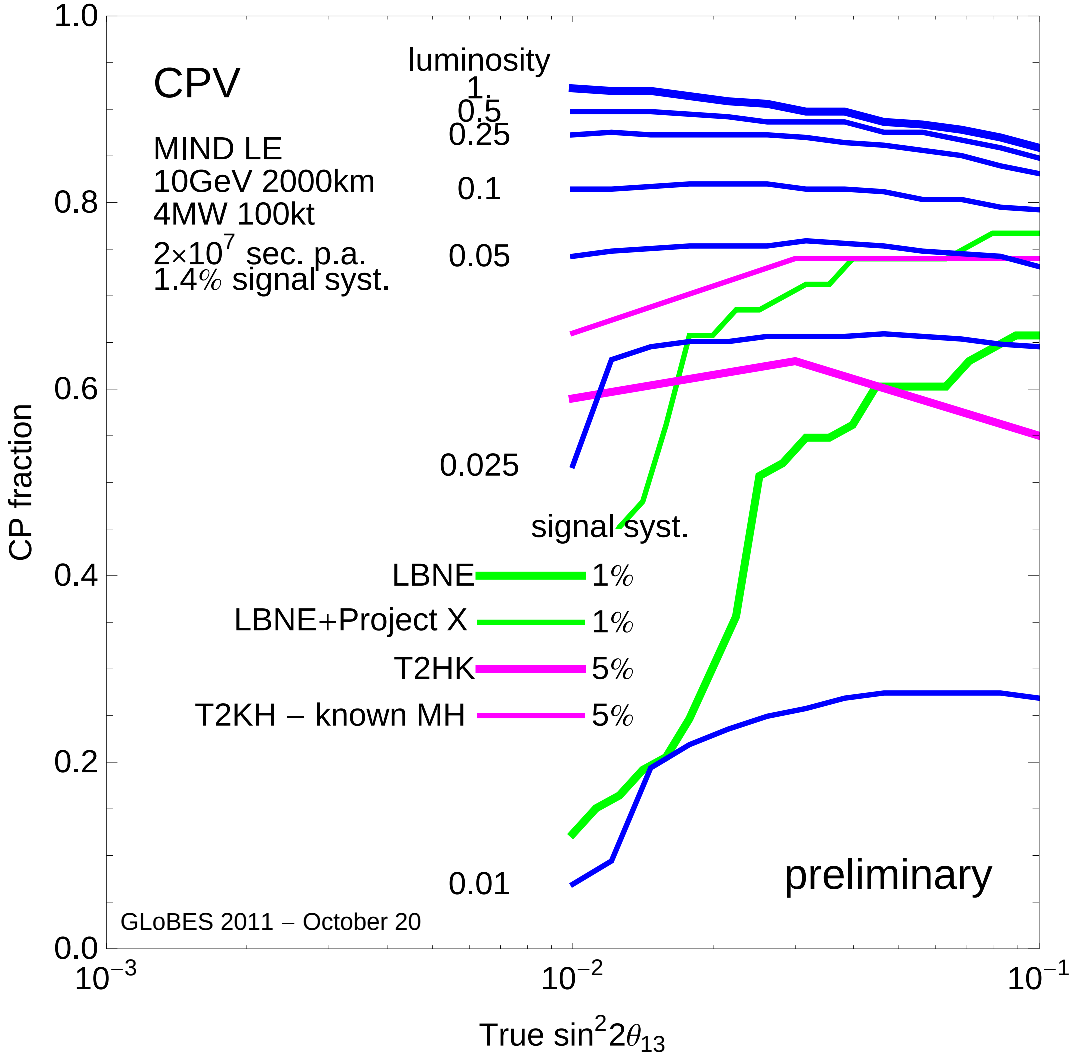

FIG. 2: CP fraction vs. true $\sin^2 2\theta_{13}$.

II. THE VERY-LOW-ENERGY NEUTRINO FACTORY (VLENF)

The Very-low-energy Neutrino Factory (VLENF) was also discussed at this meeting in the context of a near-term, relatively inexpensive facility that could:

1. Address the large δm^2 regime (LSND and MiniBooNE).
2. Make precision ν_e and $\bar{\nu}_e$ cross-section measurements.
3. Provide a technology test demonstration and μ decay ring instrumentation test bed.

The facility is very simple and consists of a conventional target station, a capture and transport section and injection into a race track ring with a straight length of between 50-75m, see Fig. 3 for a schematic of the facility. A number of decay ring designs have been studied, but a race-track FFAG with a center momentum of 2 GeV/c and a momentum acceptance of ± 20% looks very promising [3]. Fig. 4 shows the appearance sensitivity for this facility assuming 10^{21} protons on target, a 2 GeV/c center momentum FFAG race-track decay ring and an 800T

MIND-like detector at a baseline of 600m. At this point, the uncertainty on the backgrounds was assumed to be 20%. As can been see from Fig. **??**, this facility has the potential to give unprecedented performance in the large δm^2 regime. In addition, the μ storage ring presents the only way to obtain large samples of ν_e events for cross-section measurements and presents the only experiment that can measure ν_e and ν_μ cross-sections in the same experiment. The next generation of long-baseline oscillation experiments will face a significant challenge in order to get systemtic errors to the 1% level. Gaining a better understanding of ν_e and $\bar{\nu_e}$ cross sections will be crucial to these future experiements. The energy range of interest is between 1 and 3 GeV and the VLENF is well suited to cover this range.

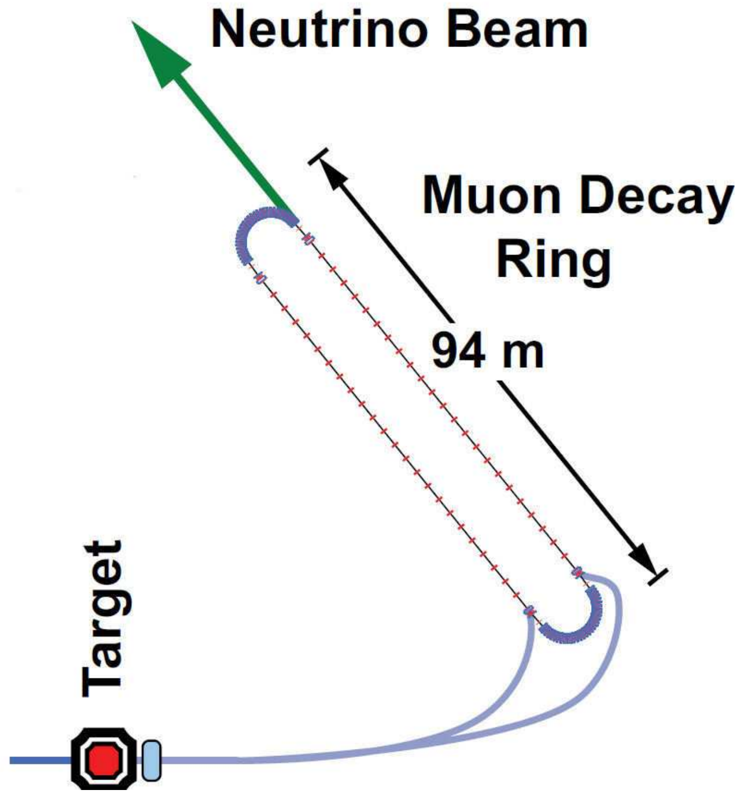

FIG. 3: Schematic of the VLENF.

[1] The Interim Design Report for a Neutrino Factory, FERMILAB-PUB-11-581-APC.
[2] G. Fogli, et al., Evidence of $\theta_{13} > 0$ from global neutrino data analysis, arXiv: 1106.6028.
[3] Y. Mori, 7th IDS-NF Plenary Meeting, 17-19 October 2011, Virginia Tech Research Center in Arlington, VA. https://www.ids-nf.org/wiki/VTECH-2011-10-17/Agenda.

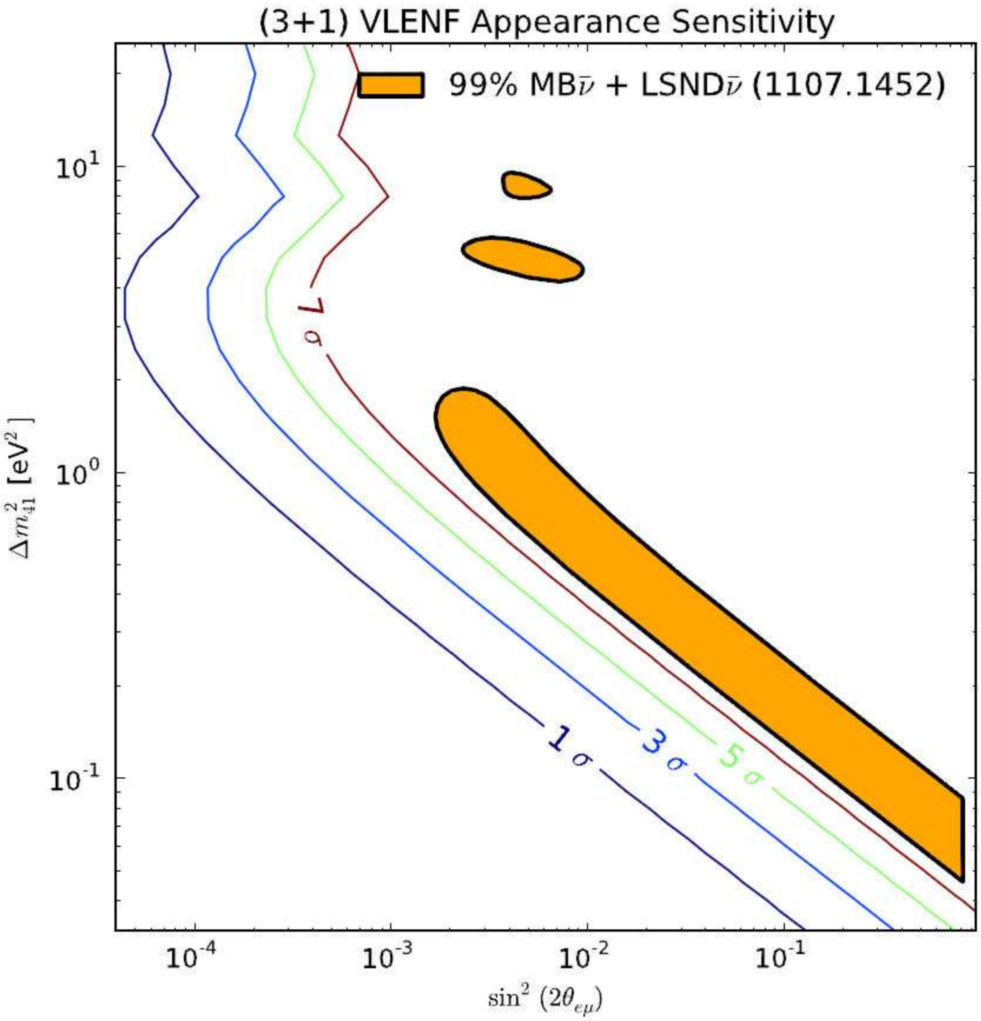

FIG. 4: 3+1 VLENF appearance sensitivity.