April 10, 2012
Young-Kee Kim for the Steering Committee

Initial set of options for working groups to consider

The physics group will provide physics reach for each option. Physics reach includes

- Mass hierarchy reach
- CP reach including "fraction of CP phase δ vs. significance of measuring δ_{CP}" and "precision of δ_{CP} vs. δ_{CP}" (For NuMI options, assume that the mass hierarchy is resolved by NOvA/T2K by 2020)
- Proton decay
- Supernovae neutrinos

The engineering/cost group will provide the cost estimate for each option. There is no time for original work, only gathering numbers, aiming for uniform criteria, commenting on reliability and risks, etc. They could start with the (rather detailed/carefully-done) Homestake numbers and make perturbations around these.

Assumptions for both SURF/LBNE Phase-1 options and NuMI options

- $\sin^2 2\theta_{13} = 0.095$
- Beam power – 700 kW = NOvA beam power (Note that for neutrino mass hierarchy and CP violation, detector mass and beam power are interchangeable. For example, physics sensitivity with 700 kW and 15kT detector is equal to that of 1.1 MW and 10kt detector)
- Far detector technology – LAr TPC (LBNE baseline technology)
- Exposure – 10 years (2021 – 2030)
- NOvA runs for 6 years through 2020 at a beam power of 700 kW
- T2K runs through 2020 at a beam power of 300 kW on average (T2K is running at 120 kW right now. The phase-1 upgrade will get to ~400 kW and the phase-2 upgrade will get to ~750 kW.)

Assumptions for all of SURF / LBNE Phase-1 options

- Beam and near detector – LBNE baseline design
- Far detector mass – 2kT and 5kT LAr (also provide information with 10kT and 34kT LAr – both physics reach and cost estimate)

Assumptions for all of NUMI options

- Far detector mass – 5kT, 10kT, 15kT, and 20kT LAr (also provide information with 34kT LAr – both physics reach and cost estimate)
- NOvA continues to run between 2021 and 2030

Initial set of options

1. Option 1
    - LBNE Phase-1: surface (not 800L)

2. Option 2
    - LBNE Phase-1: depth (4850L)

3. Option 3: NuMI On-Axis
    - Detector in the Soudan Underground Mine (2300L)
    - Low Energy Beam = current MINOS beam energy spectrum

4. Option 4: NuMI On-Axis
    - Detector on the Soudan surface
    - Low Energy Beam = current MINOS beam energy spectrum (At the Soudan site, the spectra between surface and underground are very similar)

5. Option 4: NuMI Off-Axis
    - Detector at Ash River (surface)
    - Medium Energy Beam = NOvA beam energy spectrum

6. Option 5: NuMI On-Axis and Off-Axis combination
    - Combination of a detector in the Soudan Mine and a detector at Ash River
    - Low Energy Beam = current MINOS beam energy spectrum