

Detectors for leptonic CP violation at the Neutrino Factory

The Neutrino Factory is the most powerful of the proposed facilities to search for CP violation in the lepton sector via neutrino oscillations. It delivers a well known beam of electron neutrinos and muon-antineutrinos from positive muon decay (electron-antineutrinos and muon neutrinos from negative muon decay) produced in the straight sections of the storage rings in which the muons are confined at an energy of 25 GeV. Studies carried out in the framework of the International Design Study for the Neutrino Factory (the IDS-NF) show that the sensitivity to the CP violating phase and the last unknown mixing angle θ_{13} is maximised when two far detectors (at 4000 km and 7500 km) optimised to detect the sub-leading ν_e to ν_μ oscillation are combined. Several technologies are being discussed for these detectors: magnetised iron calorimeters; giant liquid argon TPCs; and totally active scintillating detectors. The IDS-NF baseline option –as a compromise between feasibility, cost, and performance –consists of two, 100 Kton magnetised iron sampling calorimeters, similar to the existing MINOS detector, but with 20 times more mass and improved performance. The other far-detector options, which have better granularity, offer an improved energy threshold and energy resolution, may be able to detect additional oscillation channels, thus improving the overall performance of the facility. However, these options are likely to be more expensive and require significant R&D. A near detector of much smaller mass for precise measurement of neutrino flux and neutrino cross-sections will be situated close to the end of the muon storage ring straight section. The various detector options will be discussed, covering the most important aspects: performance; technological challenges; as well as the R&D program and cost drivers.

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