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The need for an early anti-neutrino run of NOνA

The moderately large value of θ_{13}, measured recently by reactor experiments, is very welcome news for upcoming accelerator experiments. In particular, the NOνA experiment, with 3 years of ν run followed by an equal $\bar{\nu}$ run, will be able to determine the mass hierarchy if one of the following two favorable combinations is true: normal hierarchy with $-180^\circ \leq dcp \leq 0$ or inverted hierarchy with $0 \leq dcp \leq 180^\circ$. In this work, we study the hierarchy reach of the first 3 years of NOνA data. Since $\sin^2 2\theta_{23}$ is measured to be non-maximal, θ_{23} can be either in the lower or higher octant. The true octant of θ_{23} has a deep impact on the hierarchy reach of early NOνA data. With the present uncertainty of 10% in $\sin^2 2\theta_{13}$, equal 1.5 year ν and $\bar{\nu}$ runs have better hierarchy determination capability compared to a pure 3 year ν run. Daya Bay expects to reduce the uncertainty in $\sin^2 2\theta_{13}$ to 5%. Such a reduction improves the hierarchy reach of a 3 year ν run for two of the four octant-hierarchy combinations, but still fails to give any sensitivity for the other two. However, equal 1.5 year ν and $\bar{\nu}$ runs have reasonable hierarchy sensitivity for all four combinations.

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