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Implementation of Feldman-Cousins correction and oscillation calculations in the HPC environment for the NOvA and DUNE Experiments

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Analysis of neutrino oscillation data involves a combination of complex fitting procedures and statistical corrections techniques that are used to determine the full three-flavor PMNS parameters and constraint contours. These techniques rely on computationally intensive "multi-universe" stochastic modeling. The process of calculating these contours and corrections can dominate final stages of the data analysis and become a bottleneck for examining the effect of systematic variations on the final results..

As part of the DOE SciDAC-4 sponsored research program, we present a new implementation of a neutrino oscillation fitting and Feldman-Cousins corrections calculations framework. The implementation is based on decomposition and mapping of the parameter space into MPI ranks by the DIY framework that is specifically designed and optimized to operate on modern High Performance Computing (HPC) facilities. We present the performance of the system in calculating results contours for the NOvA experiment based on their 6E20 and 9E20 protons on target (PoT) neutrino datasets and compare the performance of this new implementation run at NERSC and the Argonne Leadership Computing Facility (ALCF) to methods used previously by the NOvA collaboration running on grid computing facilities.

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