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Implementation of a Feldman-Cousins Framework on Supercomputers and the Impact on NOvA Oscillation Results

The NOvA long-baseline neutrino and anti-neutrino oscillation results, by the nature of the measurements, feature low event counts in both the appearance and disappearance channels. When the low event counts are combined with the form of the fits that are needed to describe PMNS mixing, physical boundaries develop and have the potential to skew the statistical behavior of extracted parameters away from typical Gaussian behavior.

To determine the statistical significance of our results and account for the non-Gaussian nature of the statistics, the NOvA collaboration performs a procedure involving the empirical determination of the confidence interval. This procedure referred to as the "Feldman-Cousins" prescription, is an empirical, multi-universe approach that accounts for all the statistical correlations in our fits and includes the effects of the systematics and nuisance parameters.

We present here the implementation of the Feldman-Cousins calculations that was designed to run on High Performance "Super" Computers (HPC) and which was run on the NERSC facility's Cori-1, Cori-2 and Edison supercomputer in May 2018 to obtain the latest NOvA oscillation results. This implementation was able to perform the Feldman-Cousins corrections, that were projected to more than 5 months of dedicated computing on conventional HEP facilities, in 16 hours using the largest dedicated computing pool ever used in High Energy Physics. We also present the evolution of this approach that leverages the Theta supercomputer at the Argon Leadership Computing Facility (ALCF) and expands to the calculations to use an adaptive MPI based approach.

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