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PISCES two-detector covariance matrix fit for the NOvA Experiment

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NOvA is a long-baseline neutrino oscillation experiment with two functionally identical detectors, a Near Detector (ND) at Fermilab, placed 1km from the neutrino source, and a Far Detector (FD) located 810 km away from the ND in Minnesota. NOvA's primary physics goals are to measure the neutrino oscillation parameters θ_{23} and Δm^2_{32} with high precision, determine the neutrino mass hierarchy, and constrain the value of δ_{CP}, primarily via the study of muon neutrino to electron neutrino oscillation. Furthermore, NOvA is also able to probe sterile neutrino oscillations via the study of neutrino events depletion in neutral current interactions between the Near and Far Detector. Extracting values for oscillation parameters from fits to data usually relies on treating systematic uncertainties as nuisance parameters, which suffers from poor scalability as the number of uncertainties becomes larger. In this poster, we present PISCES (Parameter Inference with Systematic Covariance and Exact Statistics), a novel method that circumvents this scalability problem by encoding systematic uncertainties into a covariance matrix. PISCES utilizes a nested minimization in which optimal systematic pulls are first computed using the covariance matrix, then the oscillation parameters are profiled with a fitter. As it solves for each oscillation channel within each sample independently, PISCES also has the advantage of supporting complex fits, such as a joint Near and Far detector fit. Moreover, it treats statistical uncertainties with a Poisson Likelihood term, so it is ideal for the inclusion of low-statistic samples in the fits. This method has been used to produce the most recent results from NOvA's search for sterile neutrinos, presented in this poster. The PISCES two-detector fit can also be applied to the NOvA three-flavor analysis where extensive robustness tests of the method have been carried out and the resulting performance is presently shown.

Poster prize

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