The NOvA Experiment

**Long Baseline Neutrino Oscillation Experiment**
- Measures neutrino mixing angles, $\delta_{CP}$, and $\Delta m_{32}^2$ [1,2]
- Functionally-identical near and far detectors reduce correlated uncertainties

**Detectors**
- Near: 290 ton, Far: 14 kton
- Tracking calorimeter
- Optimized for electron and muon ID
- Alternating planes of PVC pixels filled with liquid scintillator
- 3D tracking

**Neutrino Flux**
- NuMI Beam
  - 120 GeV Proton Accelerator [3]
  - Focusing horns enable neutrino- and antineutrino-enriched flux

**Neutrinos at NOvA**
- Intrinsic $\nu_e$ component from muon and kaon decay (0.5%)
- 14e20 POT Neutrino Mode
- 12e20 POT Antineutrino Mode

Data-Driven Signal Estimation

**Template Fit Signal Extraction**
- Signal and background templates are fitted to data
- Minimize $-2 \ln L = (x - \mu)^T \Sigma^{-1} (x - \mu)$
- Extract $a_{\nu,CC}$ as signal normalization
- Extends to many dimensions

**NueID Templates**
- Optimized BDT to distinguish NC from $\bar{\nu}_eCC$
- No ability to distinguish $\bar{\nu}_eCC$ from $\nu_eCC$ [4]
- Templates normalized within bins of electron kinematics
- Parameters vary independently

**Extrapolating from Neutrino-mode Data**
- Neutrino-mode data is used to constrain the significant $\nu_eCC$ using a novel data-driven extrapolation included in the fitting model
- Covariance matrix relates template normalizations between neutrino- and antineutrino samples
- Leverages flux model and systematically-shifted simulation

Cross Section Measurement

**Double-differential $\nu,eCC$ Inclusive**
- Electron energy and scattering angle
- Expected $\approx 10,000$ measured signal events!
- Average $20\%$ systematic uncertainty
- First ever measurement of its kind

**Joint-fit Fake Data Results**
- Fake Data: Randomly varied $\nu - A$ model parameters
- Reduced error on selected events
- Well-constrained $\nu_eCC$ and $\bar{\nu}_eCC$ template normalization
- Enables simultaneous measurement of $\nu_eCC$ and $\bar{\nu}_eCC$ cross sections for ratio

**Outlook**
- Developed data-driven signal extraction and efficiency estimation
- Analyze largest sample of $\bar{\nu}_eCC$ for first-ever double-differential cross-section measurement
- Enables future measurement of $\sigma_{\nu_eCC}/\sigma_{\bar{\nu}_eCC}$ with NOvA

References


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