

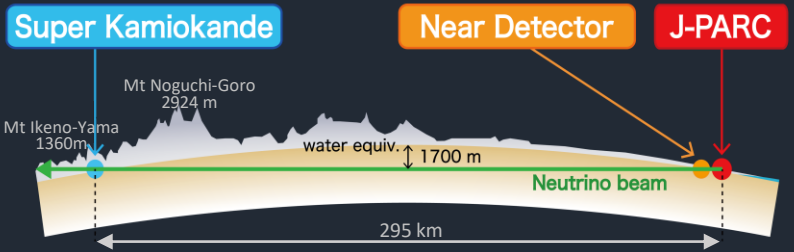
Spline-ification of T2K Near Detector Systematic Errors



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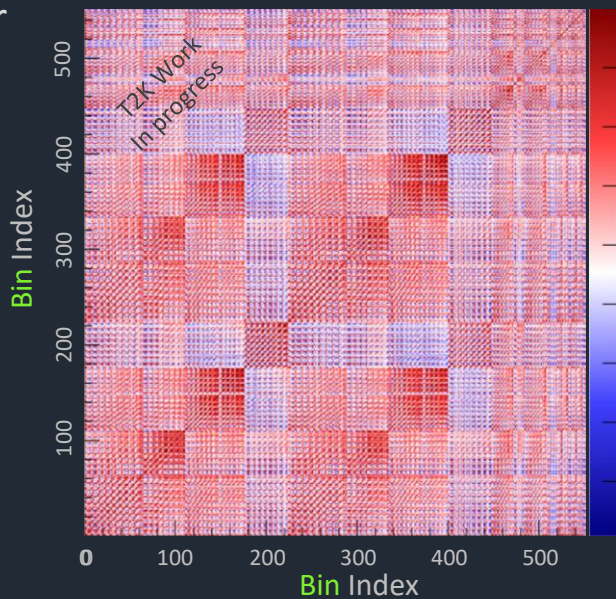
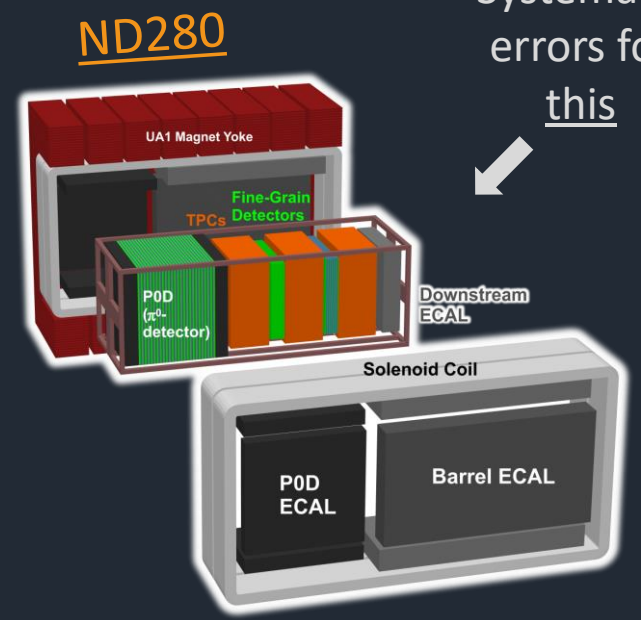
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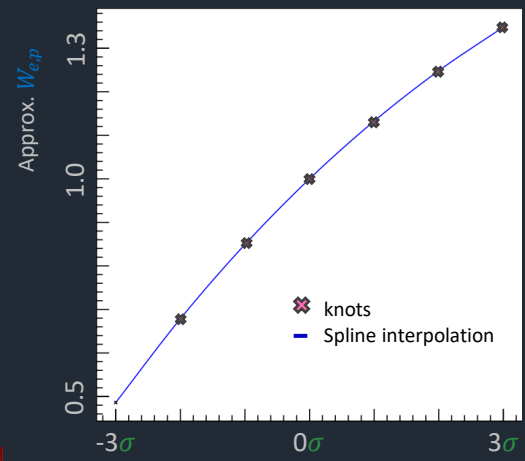
Used to be treated like this

Correlations

Systematic errors for this



Example Response Spline for a typical systematic parameter



Are now treated like this

- Number of fit parameters:
726 → 434
- Fit parameters now more interpretable

Come here to find out more!

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- The T2K Experiment**
 - Long baseline neutrino beam experiment in Japan
 - Neutrino beam from J-PARC is characterised at the Near Detectors then measured again after travelling 295 km at the Far Detector
- The ND280 Analysis**
 - The main goal of the ND280 fit in the oscillation analysis is to constrain ν flux and cross section model parameters by fitting un-oscillated MC predictions to ND280 data
 - This is done by tuning MC event weights to minimise a Poissonian Log Likelihood for each sample
 - The fits performed for this work were done using Bayesian Markov Chain Monte Carlo
- Detector Systematic Uncertainties**
 - ND280 detector systematics parameterise errors on physical aspects, and efficiency of the detector
 - They are accounted for using event by event weights
 - Express variations of these parameters in terms of their prior uncertainty, σ_p
- Spline-ified Systematic Approach**
 - Pre-calculate $W_{e,p}$ for each event to each parameter at fixed points, called knots, using the same full - but slow - weight calculation as before
 - During the fit, we can then estimate the $W_{e,p}$ on the fly using cubic piecewise polynomial (spline) interpolation for any variation, σ
 - Can see direct impact of parameters on events
 - No. of parameters reflects actual model parameters
- Fit Results**
 - Can now see which parameters in the fit are more strongly constrained and which have little impact
 - Fits to fake ND280 data were performed with the new systematic treatment using the same samples as in the 2022 oscillation analysis
 - Significantly reduced No. of fit parameters (cross section + flux uncertainty + detector): 726 using old treatment to 434 using splines
 - Can now for first time inspect post fit uncertainties on individual detector parameters (examples shown to the right)