Detector systematics update

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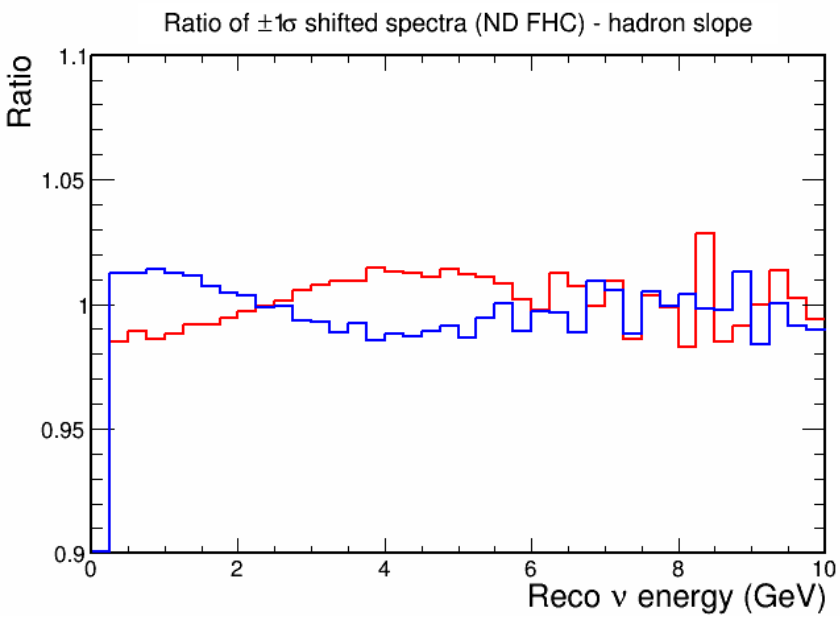
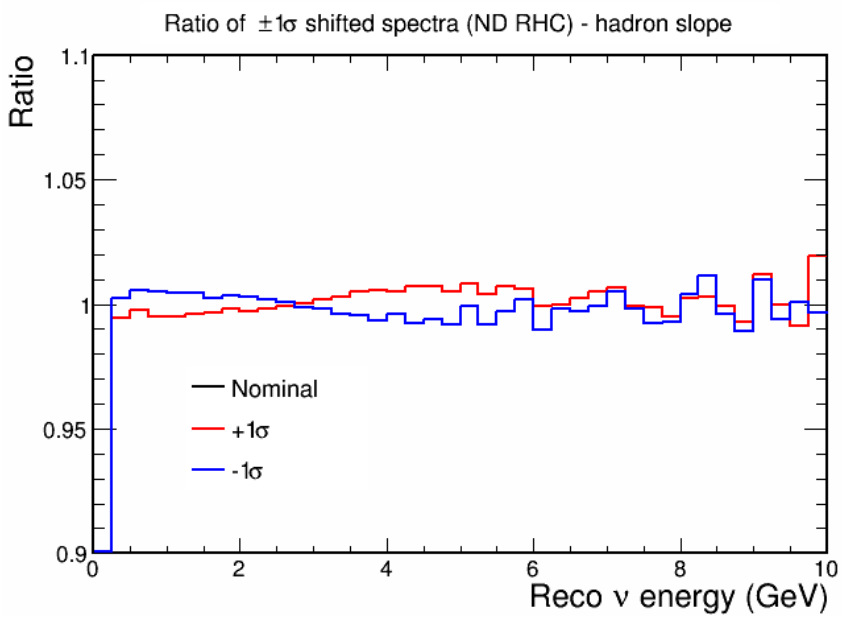
Linear energy scale systematics

- Previous energy scale systematics $\frac{\sigma_E}{E} =$ constant, for charged hadrons, π^0s, neutrons
- Now have systematics such that $\frac{\sigma_E}{E} \propto E$ for each of above species
  - Specifically, $\sigma_{E_{\nu,reco}} = 0.01\sigma \times E_{\nu,reco} \times \frac{E_p}{E_\nu} \times E_p$ where E_p is the energy of particular category of particle and E_ν is true neutrino energy
  - This is such that a 1 GeV proton will have an error on its energy of 5%
  - Exact scale can be altered if shift is too large/small

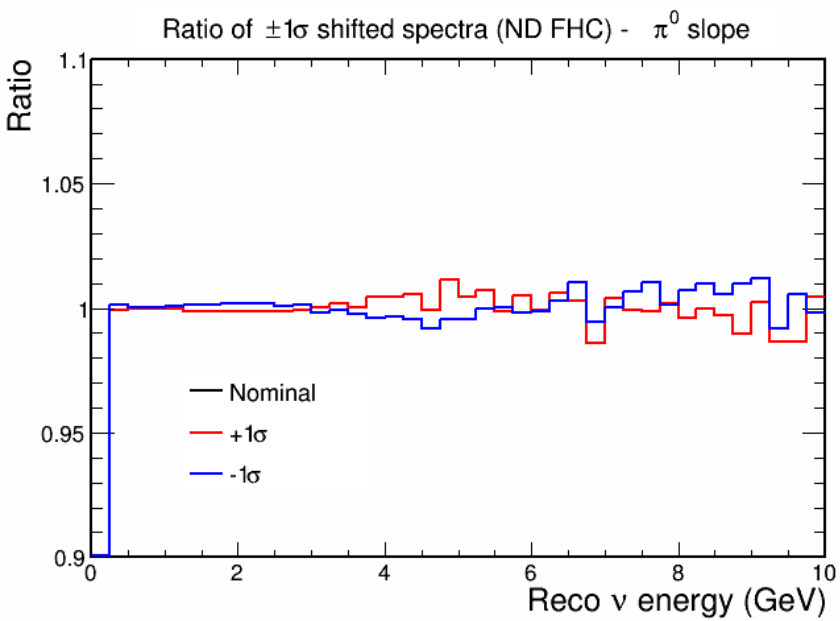
Results: Charged hadrons

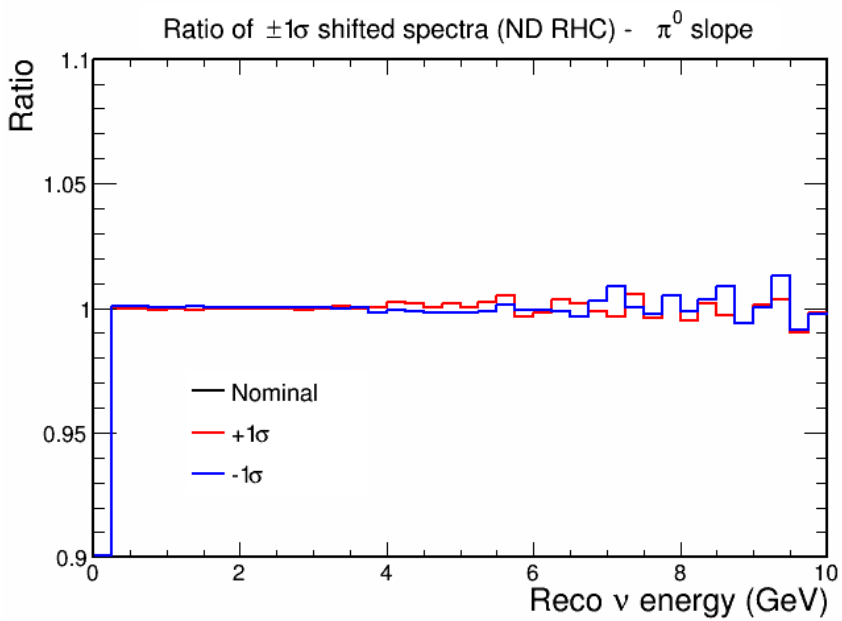




- Left is FHC, right is RHC

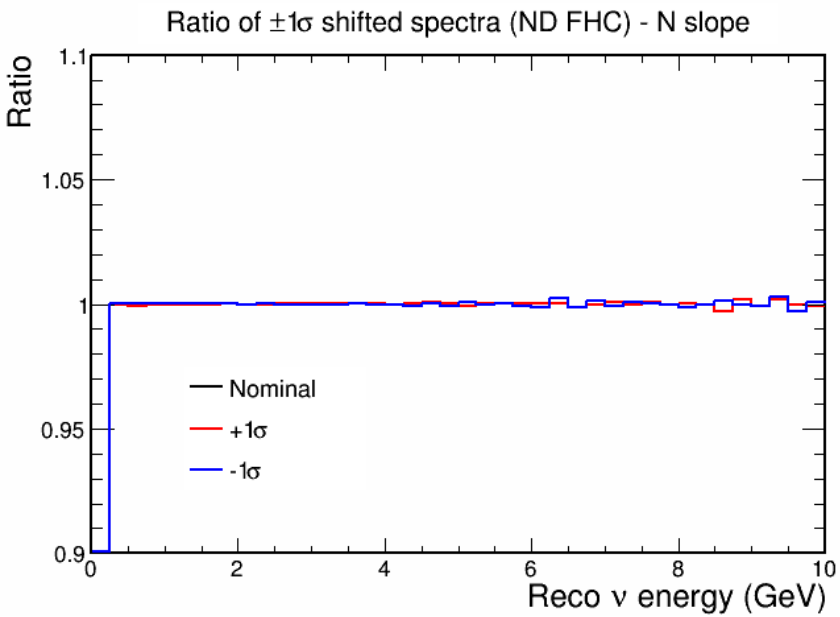
Results: π^0s

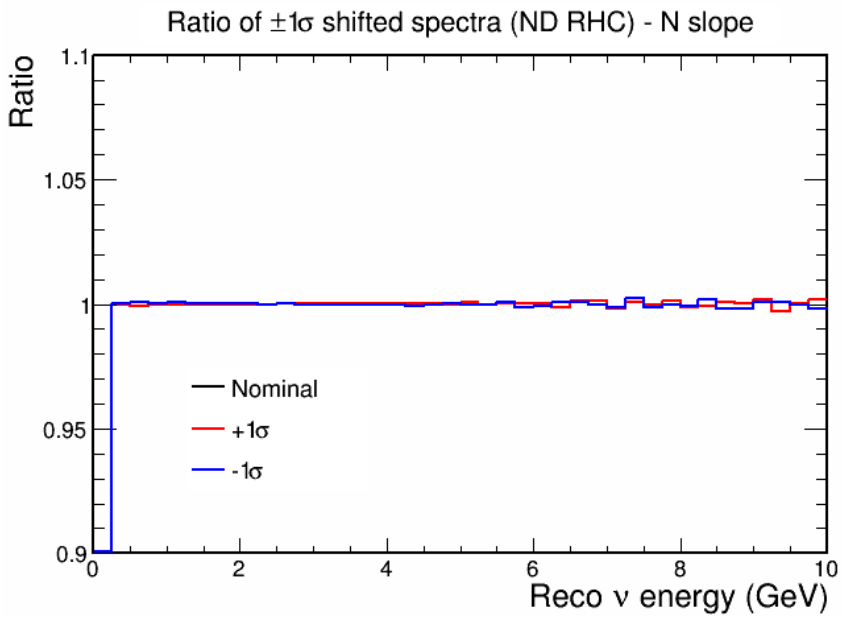




- Left is FHC, right is RHC

Results: Neutrons



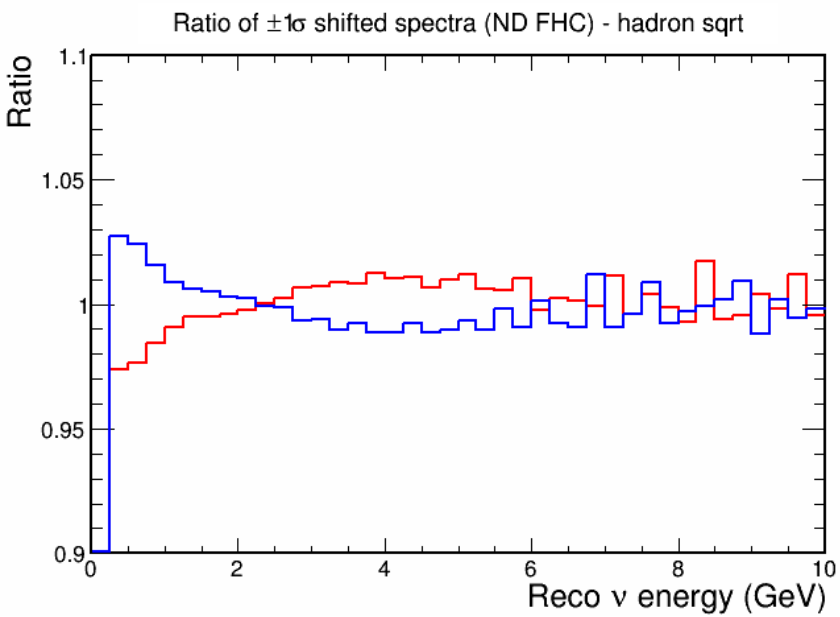


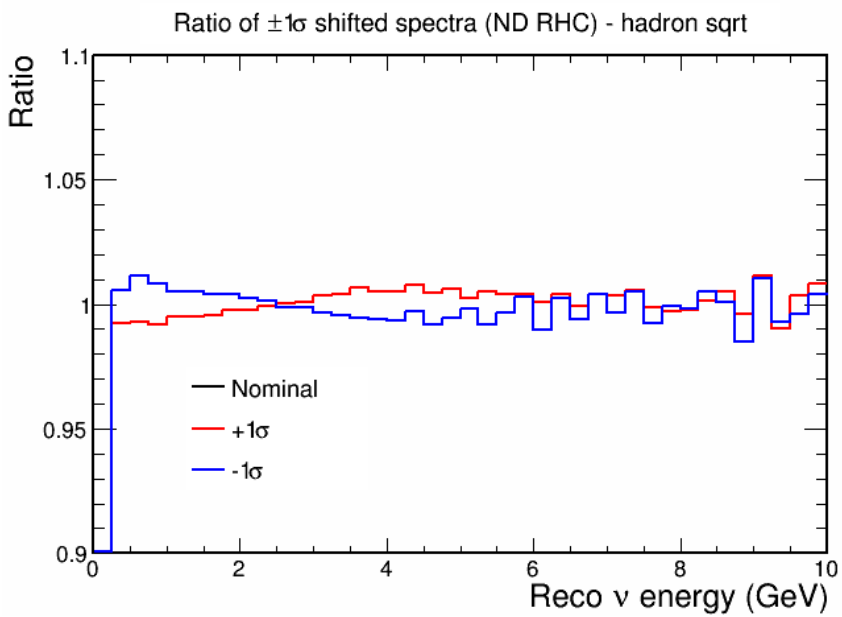
- Left is FHC, right is RHC

Inverse square root scale energy systematic

- Now, introduce syst such that $\frac{\sigma_E}{E} \propto \frac{1}{\sqrt{E}}$ for each of the previously mentioned categories of particles
  - Specifically, $\sigma_{E_{\nu,reco}} = 0.01\sigma \times E_{\nu,reco} \times \frac{E_p}{E_\nu} \times \frac{1}{\sqrt{E_p+1}}$ where E_p is true energy of a particular type of particle and E_ν is true neutrino energy
  - E.g. for 1GeV proton, have $\sigma_E = \frac{5}{\sqrt{2}}\%$
  - Exact scale can be altered if shift is too large/small

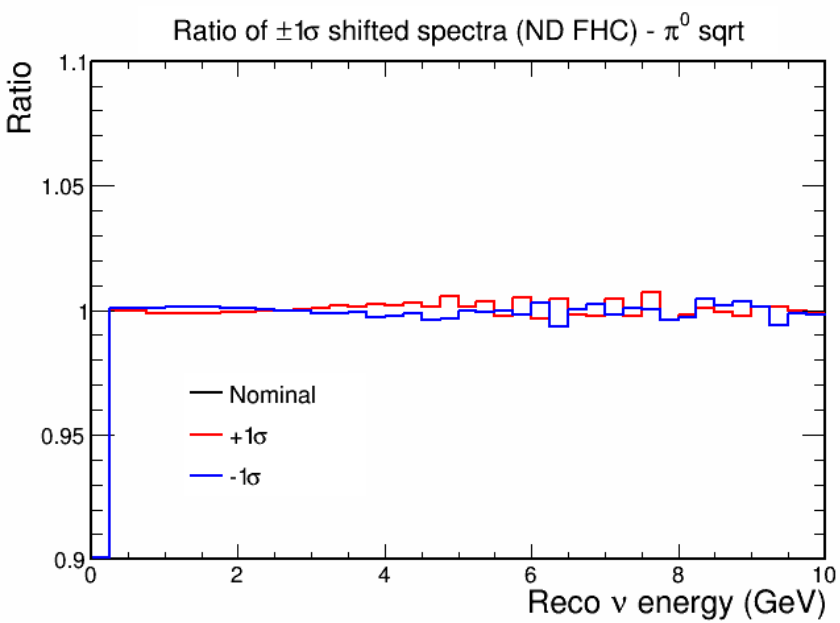
Results: Charged hadrons

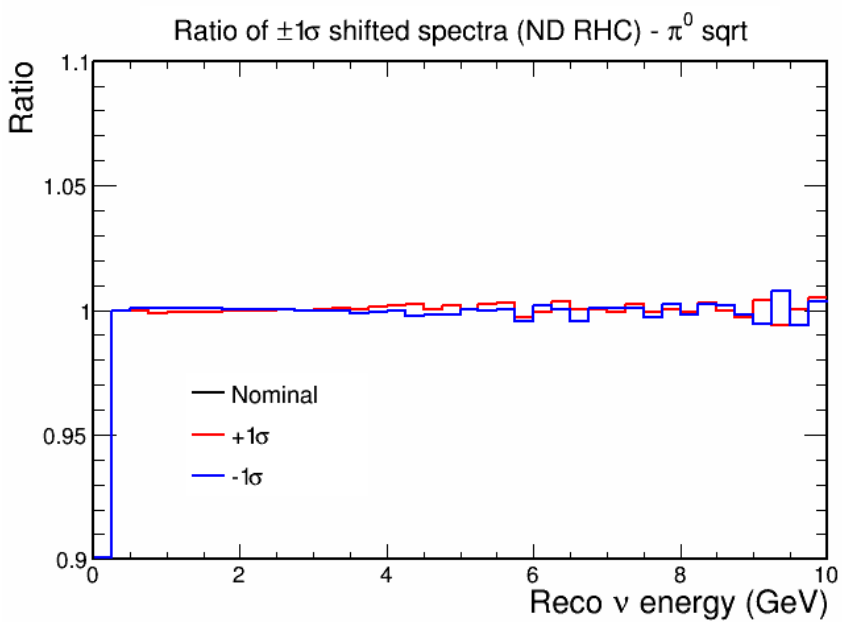




- Left is FHC, right is RHC

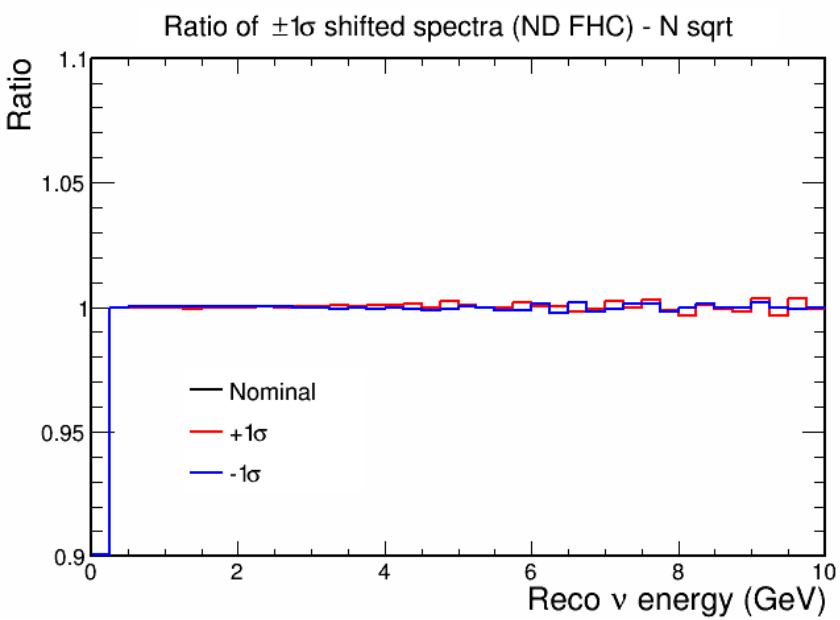
Results: π^0s

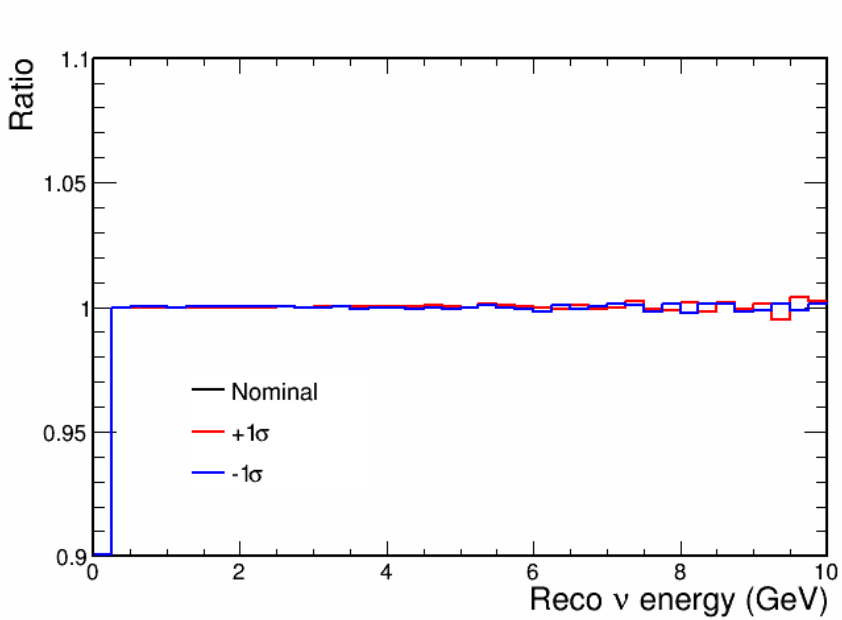




- Left is FHC, right is RHC

Results: Neutrons





- Left is FHC, right is RHC

Reworking of energy scale systematics

- Previously, for various particles species had 3 systematics – correlated part (between FD & ND), uncorrelated ND, uncorrelated FD
- Had the effect of causing the fitter to find local minima
- Have now replaced the two separate ND & FD systs with a single anti-correlated systematic