Simple approach

measurement

$$\chi^2 = \sum_i \frac{(\mu_i - \hat{m}_i)^2}{\Delta_i^2} + \sum_\alpha b_\alpha^2$$

uncorrelated error

sum over correlated systematic sources

theory

nuisance parameter

$$\hat{m}_i = m_i + \sum_\alpha \Gamma_{i\alpha}\, b_\alpha$$

correlated error

Full covariance matrix approach

$$\chi^2 = (\boldsymbol{\mu} - \boldsymbol{m})^{\mathrm{T}}\, C^{-1}\, (\boldsymbol{\mu} - \boldsymbol{m})$$

$$= \sum_{ij} (\mu_i - m_i)\, C_{ij}^{-1} (\mu_j - m_j)$$

statistical

uncorrelated

correlated

$$C = C^{\mathrm{stat}} + C^{\mathrm{unc}} + C^{\mathrm{syst}}$$

$$C_{ij}^{\mathrm{stat}} = \mathrm{Corr}_{ij}^{\mathrm{stat}}\, \Delta_i^{\mathrm{stat}} \Delta_j^{\mathrm{stat}} \qquad C_{ij}^{\mathrm{unc}} = \delta_{ij}\, \Delta_i^{\mathrm{unc}} \Delta_j^{\mathrm{unc}} \qquad C_{ij}^{\mathrm{syst}} = \sum_\alpha \Gamma_{i\alpha} \Gamma_{j\alpha}$$