Exp. events per bin

$$\mathcal{L}(\vec{\mu},\vec{\theta}) = \prod_{c=1}^{N_C}\prod_{b=1}^{N_B^c} \mathrm{Poiss}(n_{cb}|n_{cb}^{\mathrm{exp}}(\vec{\mu},\vec{\theta})) \prod_{e=1}^{N_E} p_e(\tilde{\theta}_e|\theta_e)$$

NP constraints

$$p_{\mathrm{L,S}} = \mathcal{N}(\theta_{\mathrm{L,S}}|\tilde{\theta}_{\mathrm{L,S}})$$

$$p_{\mathrm{G}} = \mathrm{Poiss}(\theta_{\mathrm{G}}|\tilde{\theta}_{\mathrm{G}})$$

$$p_{\mathrm{B}} = \begin{cases} \mathcal{N}(\theta_{\mathrm{B}}|\tilde{\theta}_{\mathrm{B}},1) & \theta_{\mathrm{B}} \in \mathrm{Gaussian} \\ \mathrm{Poiss}(\theta_{\mathrm{B}}|\tilde{\theta}_{\mathrm{B}}) & \theta_{\mathrm{B}} \in \mathrm{Poisson} \end{cases}$$

$$p_\rho = \begin{cases} \mathcal{N}(\theta_\rho|a,b) \\ \mathrm{constant} \end{cases}$$

$$n_{cb}^{\mathrm{exp}} = \max(0, \sum_p M_{cp}(\vec{\mu}) N_{cp}(\vec{\theta}_L,\vec{\theta}_S,\vec{\theta}_G,\vec{\theta}_\rho) y_{cbp}(\vec{\theta}_S) + E_{cb}(\vec{\theta}_B))$$

Physics model scaling

Process norm.

Process templates

MC stats

Barlow-Beeston

"lite"

$$E_{cb}(\theta) = \theta \left(\sum_p (e_{cpb}N_{cp}M_{cp}(\vec{\alpha}))^2\right)^{\frac{1}{2}}.$$

full

$$E_{cb}(\vec{\theta}) = \overbrace{\sum_i}^{\mathrm{Poisson}} \left(\frac{\theta_i}{\tilde{\theta}_i} - 1\right) y_{cib}N_{ci}M_{ci}(\vec{\alpha}) + \overbrace{\sum_j}^{\mathrm{Gaussian}} \theta_j e_{cjb} N_{cj} M_{cj}(\vec{\alpha}),$$

Gamma

Log-normal

Asymmetric log-normal

rateParams

$$N = N_0(\theta_G) \prod_n \kappa_n{}^{\theta_{L,n}} \prod_a \kappa_a^{\mathrm{A}}(\theta_{L(S)}^a, \kappa_a^+, \kappa_a^-)^{\theta_{L(S)}^a} \prod_r F_r(\theta_{\rho,r})$$

$$\kappa^{\mathrm{A}}(\theta,\kappa^+,\kappa^-) = \begin{cases} \kappa^+, & \text{for } \theta \geq 0.5 \\ 1/\kappa^-, & \text{for } \theta \leq -0.5 \\ \exp\left(\frac{1}{2}\left((\ln\kappa^+ + \ln\kappa^+) + \frac{1}{4}(\ln\kappa^+ - \ln\kappa^-)I(\theta)\right)\right), & \text{otherwise} \end{cases}$$

Interpolation between up and down variations (norm)

$$I(\theta) = 48\theta^5 - 40\theta^3 + 15\theta$$

$$\kappa_s^\pm = \frac{\sum_b y_b^{s,\pm}}{\sum_b y_b^0}.$$

Shape uncert. norm. change factored out

$$y_b(\vec{\theta}_{\mathrm{S}}) = \begin{cases} \max\left(0, y^0\left(f_b^0 + \sum_s F(\theta_s, \delta_b^{s,+}, \delta_b^{s,-}), \epsilon_s\right)\right) & \text{(direct)}, \\ \max\left(0, y^0 \exp\left(\ln(f_b^0) + \sum_s F(\theta_s, \Delta_b^{s,+}, \Delta_b^{s,-}, \epsilon_s)\right)\right) & \text{(logarithmic)}, \end{cases}$$

Vertical morphing

$$F(\theta,\delta^+,\delta^-) = \begin{cases} \frac{1}{2}\theta'\left((\delta^+ - \delta^-) + \frac{1}{8}(\delta^+ + \delta^-)(3\bar{\theta}^5 - 10\bar{\theta}^3 + 15\bar{\theta})\right), & \text{for } -q < \theta' < q; \\ \theta'\delta^+, & \text{for } \theta' \geq q; \\ -\theta'\delta^-, & \text{for } \theta' \leq -q; \end{cases}$$

$$\theta' = \theta\,\epsilon_s$$
$$\bar{\theta} = \theta'/q$$
$$q = \min_s \epsilon_s$$

Interpolation between up and down variations (shape)