$$\mathcal{L}(\vec{\mu},\vec{\nu}) = \prod_{c=1}^{N_C}\prod_{b=1}^{N_B^c} \mathrm{Poiss}(n_{cb}; n_{cb}^{\mathrm{exp}}(\vec{\mu},\vec{\nu})) \prod_{e=1}^{N_E} p_e(y_e;\nu_e)$$

Exp. events per bin

NP constraints

$$p_{\mathrm{L,S}} = \mathcal{N}(y_{\mathrm{L,S}};\nu_{\mathrm{L,S}},1)$$

$$p_{\mathrm{G}} = \mathrm{Poiss}(y_{\mathrm{G}};\nu_{\mathrm{G}})$$

$$p_{\mathrm{B}} = \begin{cases} \mathcal{N}(y_{\mathrm{B}};\nu_{\mathrm{B}},1) & \nu_{\mathrm{B}} \in \mathrm{Gaussian} \\ \mathrm{Poiss}(y_{\mathrm{B}};\nu_{\mathrm{B}}) & \nu_{\mathrm{B}} \in \mathrm{Poisson} \end{cases}$$

$$p_\rho = \begin{cases} \mathcal{N}(y_\rho;\nu_\rho,\sigma_\nu) \\ \text{Uniform on } [\mathrm{a},\mathrm{b}] \end{cases}$$

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

Physics model scaling

Process norm.

Process templates

MC stats

Barlow-Beeston

"lite"

$$E_{cb}(\vec{\mu},\vec{\nu},\nu) = \nu\left(\sum_p (e_{cpb}N_{cp}M_{cp}(\vec{\mu},\vec{\nu}))^2\right)^{\frac{1}{2}}$$

full

$$E_{cb}(\vec{\mu},\vec{\nu},\vec{\nu}_\alpha,\vec{\nu}_\beta) = \sum_{\alpha}^{\mathrm{Poisson}} \left(\frac{\nu_\alpha}{y_\alpha} - 1\right)\omega_{c\alpha b}N_{c\alpha}M_{c\alpha}(\vec{\mu},\vec{\nu}) + \sum_{\beta}^{\mathrm{Gaussian}} \nu_\beta e_{c\beta b}N_{c\beta}M_{c\beta}(\vec{\mu},\vec{\nu}),$$

Gamma

Log-normal

Asymmetric log-normal

rateParams

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

$$N_0 = \frac{\nu_G}{y_G}$$

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

Interpolation between up and down variations (norm)

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

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

Shape uncert. norm. change factored out

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

Vertical morphing

$$f_b = \omega_b / \sum \omega_b$$

$$\omega^0 = \sum \omega_b^0,\ \delta^{\pm} = f_i^{\pm} - f_i^0, \text{ and } \Delta^{\pm} = \ln\left(\frac{f_i^{\pm}}{f_i^0}\right)$$

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

$$\nu' = \nu\epsilon_s$$

$$\bar{\nu} = \frac{\nu'}{q}$$

$$q = \min_s \epsilon_s$$

Interpolation between up and down variations (shape)