High-Mass Diffraction in Pythia (6 & 8)

- $\sigma_{\text{diff}}$ obtained from parametrizations (Schuler-Sjöstrand) $\sim dM/M^2$ with exponential $t$ slope, and fudge parameters
  - 1) $(1-M^2/s)$ to kill distribution at edge of phase space. 2) Smeared-out enhancement in resonance region (no attempt to model individual resonances separately). 3) DD: Suppression for systems overlapping in rapidity.
  - String fragmentation. Constrained by LEP, but diffraction is different. **Could we constrain multiplicity distributions and momentum ($x$) spectra, identified-particle ratios (e.g. $K/\pi$, $K^*/K$, $p/\pi$, $\Lambda/p$) directly in diffractive processes (as function of $M$)?**

- P8: $M>10$ GeV (user-definable) modeled as Pomeron-proton collision
  - $M$ and $t$ distribution depends on Pomeron flux: several parametrizations

- MPI allowed inside Pomeron-proton system (amount depends on $\sigma_{Pp}$)
  - Default $\sigma_{Pp} \sim 10$ mb (larger than nominal value of 2 mb, which would give too much activity). Perceive as effective parameter that lumps together many effects. Includes gap survival.
  - Gap always survives (no MPI involving Pomeron’s $p$ remnant)
  - **To constrain, need data on event shapes in diffractive events, such as multiplicity distributions, UE in diffractive jets. (Still useful if only in restricted fiducial regions.)**

- Colour reconnections can mimic large gaps, but now without constraint of no net quantum number transfer $\rightarrow$ measurable?
The diffractive cross sections are given by
\[
\frac{d\sigma_{sd(BX)}(s)}{dt \, dM^2} = \frac{g_{3P}}{16\pi} \beta_{AIP} \beta_{BIP}^2 \frac{1}{M^2} \exp(B_{sd(BX)} t) \, F_{sd},
\]
\[
\frac{d\sigma_{sd(AX)}(s)}{dt \, dM^2} = \frac{g_{3P}}{16\pi} \beta_{AIP} \beta_{BIP}^2 \frac{1}{M^2} \exp(B_{sd(AX)} t) \, F_{sd},
\]
\[
\frac{d\sigma_{dd}(s)}{dt \, dM_1^2 \, dM_2^2} = \frac{g_{3P}}{16\pi} \beta_{AIP} \beta_{BIP}^2 \frac{1}{M_1^2} \frac{1}{M_2^2} \exp(B_{dd} t) \, F_{dd}.
\]

The slope parameters are assumed to be
\[
B_{sd(BX)}(s) = 2b_B + 2\alpha' \ln \left(\frac{s}{M^2}\right),
\]
\[
B_{sd(AX)}(s) = 2b_A + 2\alpha' \ln \left(\frac{s}{M^2}\right),
\]
\[
B_{dd}(s) = 2\alpha' \ln \left(\frac{e^4 + \frac{ss_0}{M_1^2 M_2^2}}{M_1^2 M_2^2}\right).
\]

The fudge factors are:
\[
F_{sd} = \left(1 - \frac{M^2}{s}\right) \left(1 + \frac{c_{res} M_{res}^2}{M_{res}^2 + M^2}\right),
\]
\[
F_{dd} = \left(1 - \frac{(M_1 + M_2)^2}{s}\right) \left(1 + \frac{c_{res} M_{res}^2}{M_{res}^2 + M_1^2 M_2^2}\right),
\]
\[
\times \left(1 + \frac{c_{res} M_{res}^2}{M_{res}^2 + M_1^2}\right) \left(1 + \frac{c_{res} M_{res}^2}{M_{res}^2 + M_2^2}\right).
\]