Dipole evolution and the proton structure

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At a glance

Space-time structure of MPIs which:

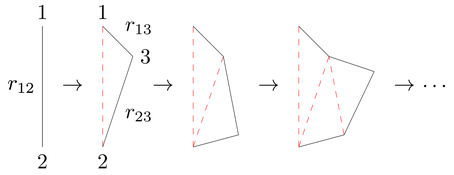
- Predicts eccentricities and normalized symmetric cumulants.
- Is not fitted to flow measurements.
- Is theoretically well motivated.

Dipole evolution

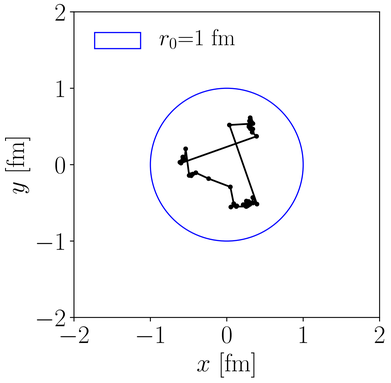
The proton sub-structure is calculated using the Mueller dipole model for QCD. A proton is approximated by three dipoles, evolved in rapidity according to:

$$\frac{\mathrm{d}\mathcal{P}}{\mathrm{d}y\ \mathrm{d}^2\vec{r}_3} = \frac{N_c\alpha_s}{2\pi^2}\frac{r_{12}^2}{r_{13}^2 r_{23}^2}\Delta(y_{\min}, y),$$

where r_{ij} denotes transverse sizes as in the sketch, and Δ is a Sudakov form factor.

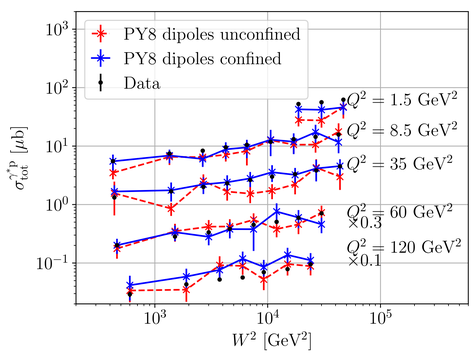


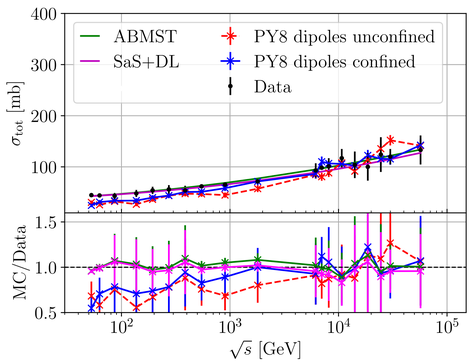
The result is a proton Fock state.



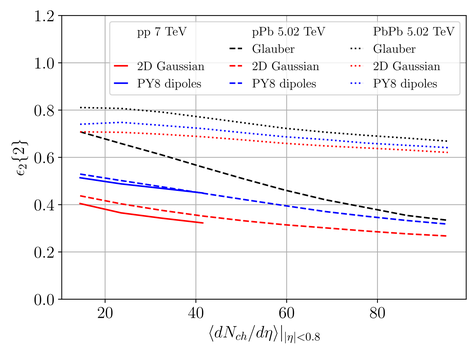
Results

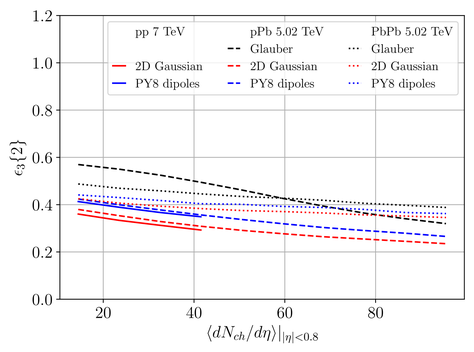
All model parameters are tuned to e**p and pp cross sections**.



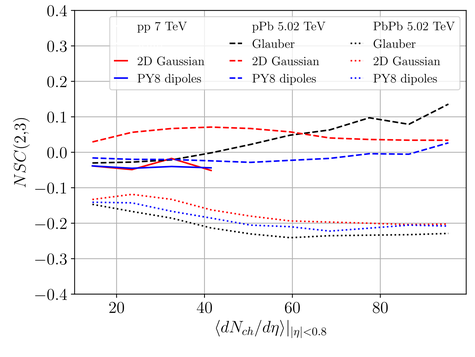


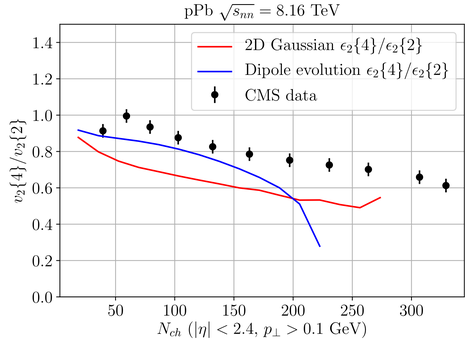
Flow coefficients $v_{2,3} \propto \epsilon_{2,3}$ (eccentricities) in a fluid scenario. Peripheral/small systems differentiates between models. Dipole model predicts $\epsilon_{2,3}$ equal for pp and pPb.





Normalized symmetric cumulants and **flow fluctuations** can inform directly about geometry. Best discriminative power in pPb collisions.



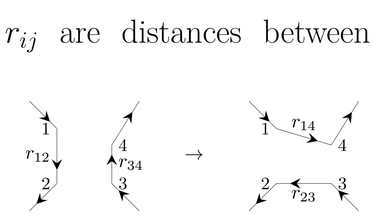


Matching to MPIs

Pythia MPIs are given a vertex position in transverse space. Either randomly from a 2D-Gaussian, inspired by the proton mass distribution, or according to the dipole evolution. The interaction probability of projectile-target dipole pairs is given at LO by:

$$f_{ij} = \frac{\alpha_s^2}{2}\log^2\left(\frac{r_{13}r_{24}}{r_{14}r_{24}}\right).$$

where r_{ij} are distances between dipole ends.



MPIs are placed on dipole interaction vertices with the hardest MPI linked to the most probable interaction.

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