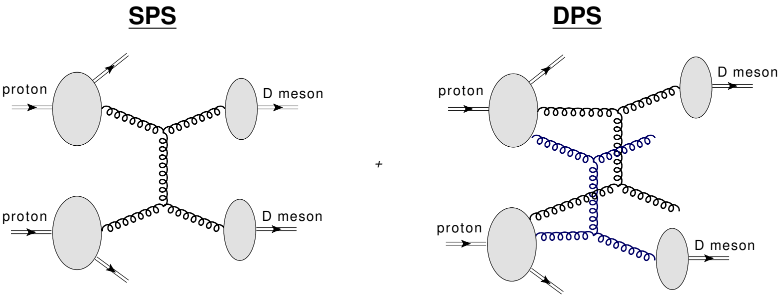
Double-D production

- Simultaneous production of two D mesons from single- (SPS) and double-parton scattering (DPS)



- The cross section is of the form

$$\frac{\mathrm{d}\sigma_{AB\to a+b+X}}{\mathrm{d}^3\vec{p}^a\mathrm{d}^3\vec{p}^b} = \sigma^{\mathrm{sps}}_{AB} + \sigma^{\mathrm{dps}}_{AB} = AB\frac{\mathrm{d}\sigma^{\mathrm{sps}}_{nn\to a+b+X}}{\mathrm{d}^3\vec{p}^a\mathrm{d}^3\vec{p}^b} + m\frac{AB}{\sigma^{AB}_{\mathrm{eff}}}\frac{\mathrm{d}\sigma^{\mathrm{sps}}_{nn\to a+X}}{\mathrm{d}^3\vec{p}^a}\frac{\mathrm{d}\sigma^{\mathrm{sps}}_{nn\to b+X}}{\mathrm{d}^3\vec{p}^b}$$

- $m = 1/2$ if $a = b$, otherwize $m = 1$
- sps = no MPI

Double-D production

- Measurements indicate 10 mb $< \sigma_{\rm eff}^{\rm pp} < 25$ mb [e.g. PLB 790 (2019) 595]
- For larger nuclei, one can derive [Adv.Ser.Direct.High Energy Phys. 29 (2018) 159, PLB 800 (2020) 135084]

$$\frac{1}{\sigma_{\rm eff}^{AB}} \approx \frac{1}{\sigma_{\rm eff}^{\rm pp}} + \frac{(B-1)}{B^2}\int {\rm d}^2\vec{B}\left[T_B(\vec{B})\right]^2 + \frac{(A-1)}{A^2}\int {\rm d}^2\vec{B}\left[T_A(\vec{B})\right]^2$$
$$+ \frac{(A-1)(B-1)}{(AB)^2}\int {\rm d}^2\vec{B}\left[T_{AB}(\vec{B})\right]^2 ,$$

where $T_A(\vec{B})$ and $T_{AB}(\vec{B})$ are the standard nuclear thickness and overlap functions.

$\Longrightarrow$ In p-Pb collisions, an enhanced DPS signal theoretically expected, $\frac{\sigma_{\rm eff}^{\rm pp}}{\sigma_{\rm eff}^{\rm pPb}} \approx 2.5 \ldots 4.8$

Application to double-D production – p-Pb predictions

- Azimuthal correlations

$$\frac{\mathrm{d}\sigma_{AB\to a+b+X}}{\mathrm{d}p_T^a\mathrm{d}y^a\mathrm{d}p_T^b\mathrm{d}y^b d\Delta\phi} = AB\frac{\mathrm{d}\sigma^{\mathrm{sps}}_{nn\to a+b+X}}{\mathrm{d}p_T^a\mathrm{d}y^a\mathrm{d}p_T^b\mathrm{d}y^b d\Delta\phi} + \frac{m}{\pi}\frac{AB}{\sigma^{AB}_{\mathrm{eff}}}\frac{\mathrm{d}\sigma^{\mathrm{sps}}_{nn\to a+X}}{\mathrm{d}p_T^a\mathrm{d}y^a}\frac{\mathrm{d}\sigma^{\mathrm{sps}}_{nn\to b+X}}{\mathrm{d}p_T^a\mathrm{d}y^b}$$

Integrate over the p_T and y bins

$$\frac{\mathrm{d}\sigma_{AB\to a+b+X}}{d\Delta\phi} = AB\frac{\mathrm{d}\sigma^{\mathrm{sps}}_{nn\to a+b+X}}{d\Delta\phi} + \frac{m}{\pi}\frac{AB}{\sigma^{AB}_{\mathrm{eff}}}\sigma^{\mathrm{sps}}_{nn\to a+X}\times\sigma^{\mathrm{sps}}_{nn\to b+X}$$

Divide by the azimuthal-integrated cross section,

$$\sigma^{\mathrm{AB}} = \int_0^\pi \mathrm{d}\Delta\phi\frac{\mathrm{d}\sigma^{\mathrm{AB}}}{\mathrm{d}\Delta\phi},$$

Application to double-D production – p-Pb predictions

$$\frac{1}{\sigma^{\mathrm{AB}}}\frac{\mathrm{d}\sigma^{\mathrm{AB}}}{\mathrm{d}\Delta\phi} = \alpha \times \left[\frac{1}{\sigma^{\mathrm{pp}}_{\mathrm{sps}}}\frac{\mathrm{d}\sigma^{\mathrm{pp}}_{\mathrm{sps}}}{\mathrm{d}\Delta\phi}\right] + \beta/\pi\,, \quad \sigma^{\mathrm{AB}} = \int_0^\pi \mathrm{d}\Delta\phi \frac{\mathrm{d}\sigma^{\mathrm{AB}}}{\mathrm{d}\Delta\phi}\,, \quad \sigma^{\mathrm{pp}}_{\mathrm{sps}} = \int_0^\pi \mathrm{d}\Delta\phi \frac{\mathrm{d}\sigma^{\mathrm{pp}}_{\mathrm{sps}}}{\mathrm{d}\Delta\phi}$$

Coefficients α and β

$$\alpha = \frac{\sigma^{\mathrm{sps}}_{\mathrm{AB}}}{\sigma^{\mathrm{sps}}_{\mathrm{AB}} + \sigma^{\mathrm{dps}}_{\mathrm{AB}}}\,, \quad \beta = \frac{\sigma^{\mathrm{dps}}_{\mathrm{AB}}}{\sigma^{\mathrm{sps}}_{\mathrm{AB}} + \sigma^{\mathrm{dps}}_{\mathrm{AB}}}$$

$$\sigma^{\mathrm{sps}}_{\mathrm{AB}} = AB \int_{\mathrm{bin}} \mathrm{d}p_T^a \mathrm{d}y^a \mathrm{d}p_T^b \mathrm{d}y^b \frac{\mathrm{d}\sigma^{\mathrm{sps}}_{nn\to a+b+X}}{\mathrm{d}p_T^a \mathrm{d}y^a \mathrm{d}p_T^b \mathrm{d}y^b}$$

$$\sigma^{\mathrm{dps}}_{\mathrm{AB}} = m\frac{AB}{\sigma^{AB}_{\mathrm{eff}}} \left(\int_{\mathrm{bin}} \mathrm{d}p_T^a \mathrm{d}y^a \frac{\mathrm{d}\sigma^{\mathrm{sps}}_{nn\to a+X}}{\mathrm{d}p_T^a \mathrm{d}y^a}\right) \left(\int_{\mathrm{bin}} \mathrm{d}p_T^b \mathrm{d}y^b \frac{\mathrm{d}\sigma^{\mathrm{sps}}_{nn\to b+X}}{\mathrm{d}p_T^b \mathrm{d}y^b}\right)$$