Simulation of direct photons production in d+d collisions at $\sqrt{s_{NN}} = 13.5$ GeV and $\sqrt{s_{NN}} = 27$ GeV

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Introduction
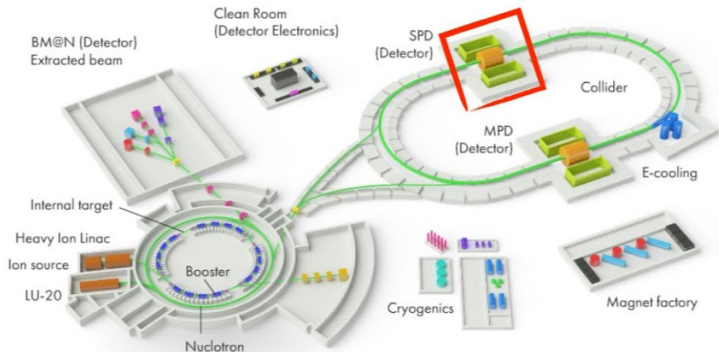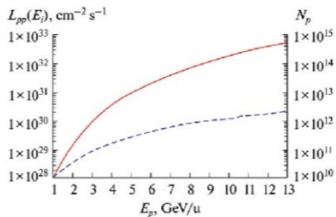
Source of photons
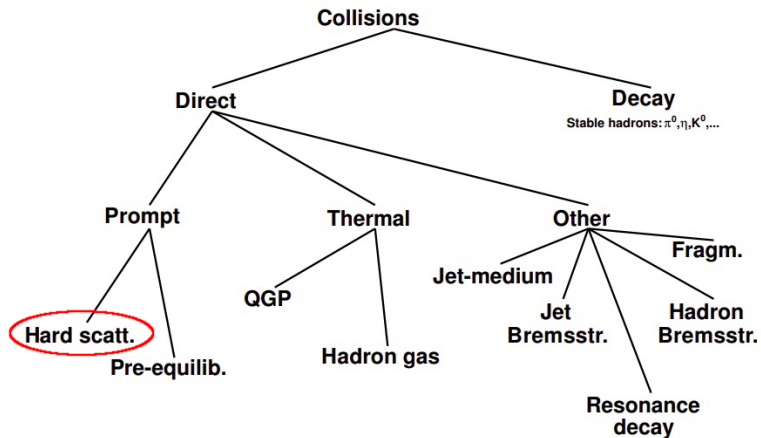
Hard scattering photons

$$q\bar{q} \to g\gamma \qquad\qquad q(\bar{q})g \to q(\bar{q})\gamma$$

PDF

Parton distribution function (PDF) $f_i^A(x, Q^2)$

Methods

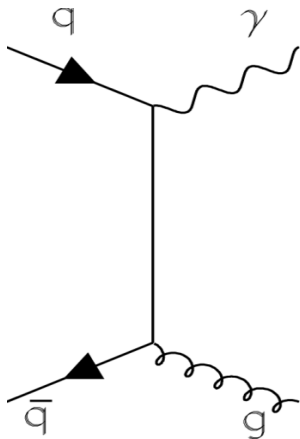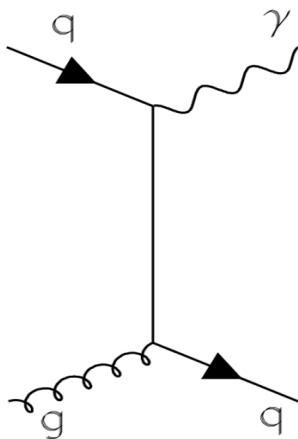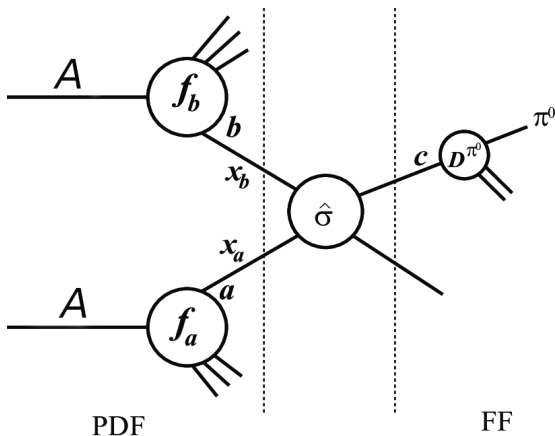1. Using nuclear PDFs for $d + d$ collisions (which includes nuclear effects: shadowing, EMC effect, Fermi motion and etc.)

2. Using proton PDFs, but $d + d = (1/4) \cdot (pp + pn + np + nn)$
   Neutron PDF related to proton PDF via isospin symmetry e.g
   $u^p = d^n$ and $u^n = d^p$

Methods

Invariant spectra of γ in d+d collisions

$$\frac{1}{2\pi p_T} \cdot \frac{d^2 N_{dd \to \gamma X}}{dp_T \, dy} = \frac{1}{2\pi p_T} \cdot \frac{1}{N_{ab}} \cdot \frac{N_{dd \to \gamma X}(\Delta p_T)}{\Delta p_T \, \Delta y} \tag{1}$$

where p_T - transverse momentum of γ; N_{ab} - number of events in ab collisions; $N_{dd \to \gamma X}(\Delta p_T)$ - number of γ in range Δp_T and Δy ($|y| < 3$).

Nuclear modification factor

$$R_{dd \to \gamma X} = \frac{1}{<N_{coll}>} \frac{dN_{dd \to \gamma X}/dp_T \, dy}{dN_{pp \to \gamma X}/dp_T \, dy} \tag{2}$$
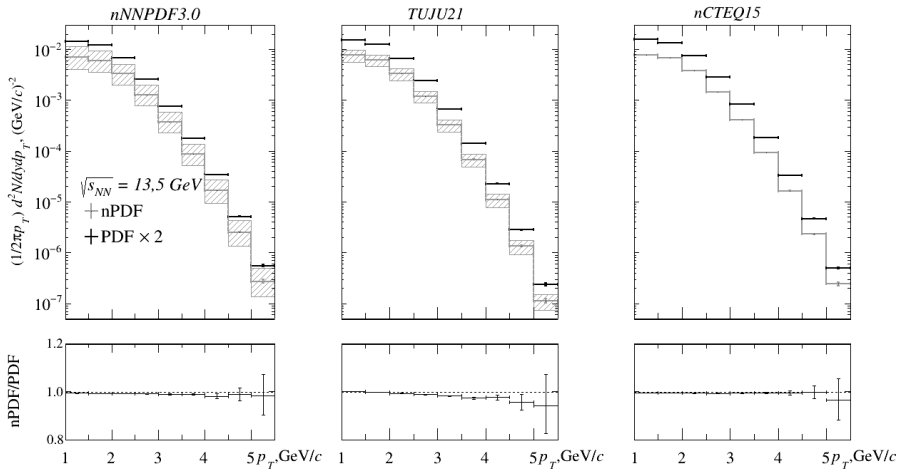
Pythia8 settings

Monte-Carlo event generator: **Pythia8**

"PromptPhoton:qg2qgamma = on"
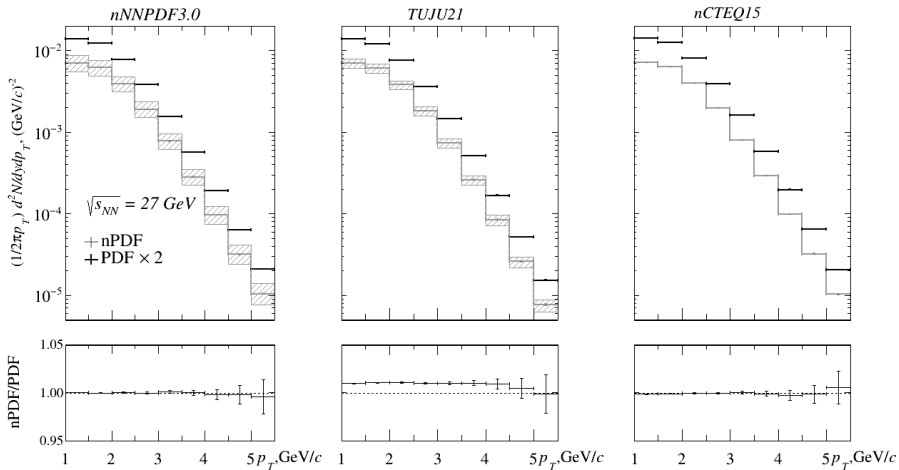"PromptPhoton:qqbar2ggamma = on"

PDF sets: **LHAPDF6**

PDF: nCTEQ15HIX_FullNuc_1_1, TUJU21_nlo_1_1,
nNNPDF30_nlo_as_0118_p
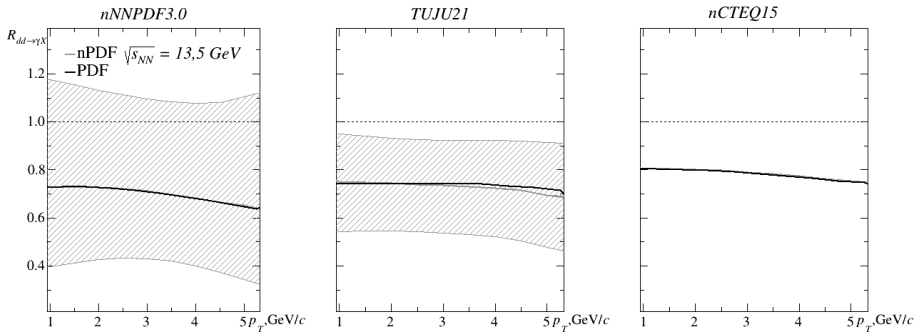nPDF: nCTEQ15HIX_FullNuc_2_1, TUJU21_nlo_2_1,
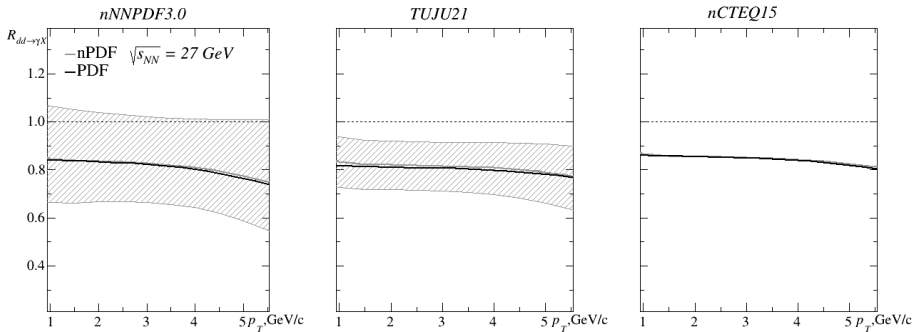nNNPDF30_nlo_as_0118_A2_Z1

Results

Results

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Conclusion

1. The minimal impact of nuclear modifications indicates that the nuclear effects associated with the bound state of proton and neutron in deuteron are small in presented nPDFs

2. For all PDF sets, the nuclear modification factors take values less than unity, which is due to the fact that the partonic cross section of direct photons production is proportional to the square of the electric charge of the quarks contained in the nucleons

Thanks for your attention!