

Search for gluon saturation at Bjorken- $x \in [10^{-6}, 10^{-4}]$ with the LHCb detector (ID:39)

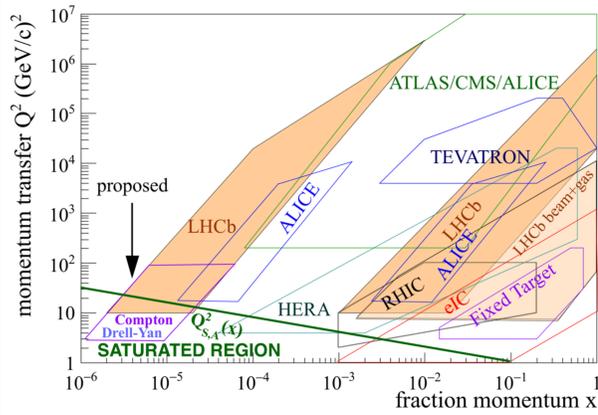
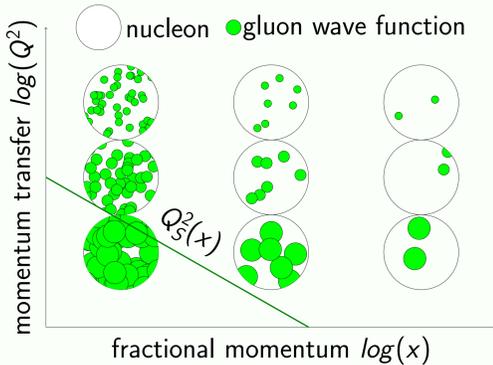


CESAR LUIZ DA SILVA¹ FOR THE LHCb COLLABORATION

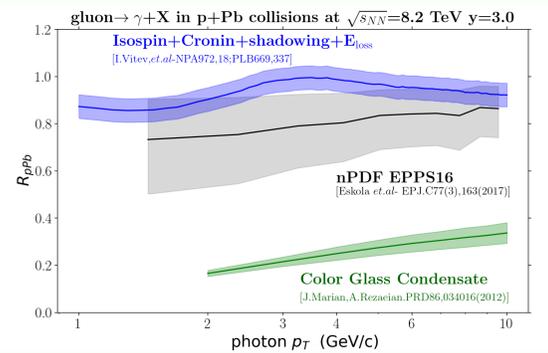
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Gluon saturation and where to search

- how QCD matter behaves when gluon wave functions overlap?
- similarly to other bosons, gluons can form a condensate with collective quantum behavior



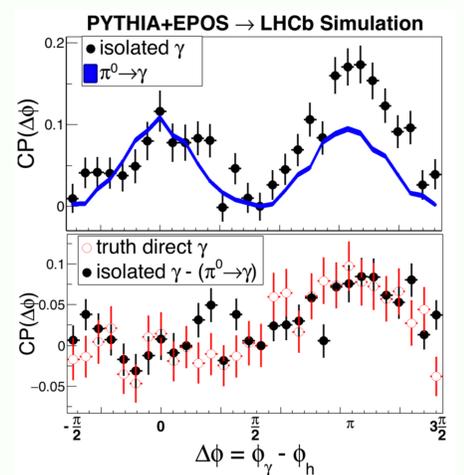
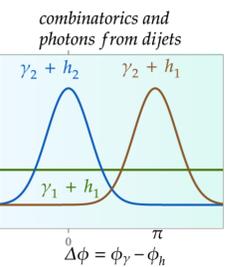
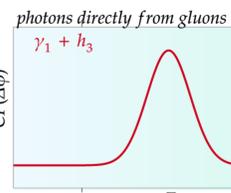
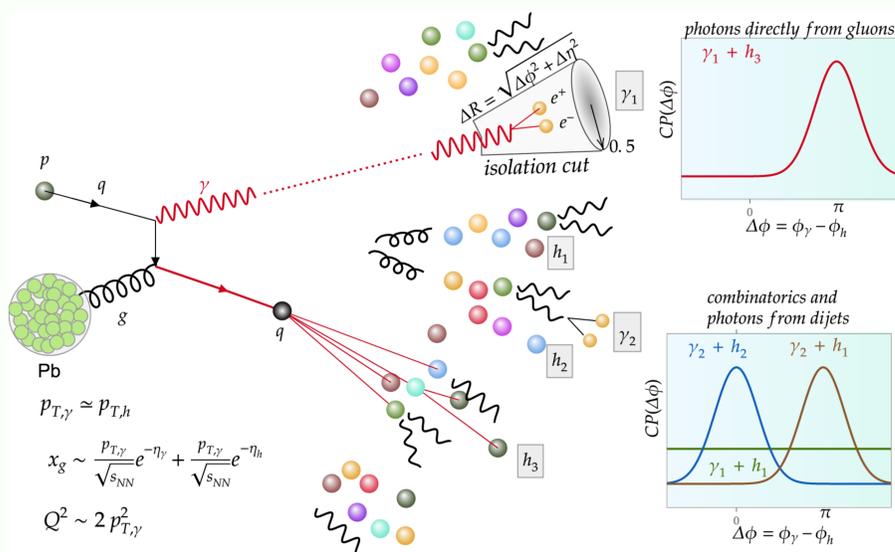
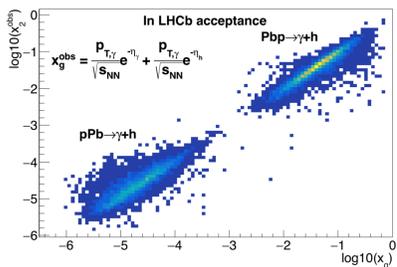
- $Q_S^2(x)$: HERA data extrapolation [PRD59, 014017(1998)]
- $Q_{S,A}^2 = A^{1/3} Q_S^2$ [PRL100,022303(2008)]



- strong gluon \rightarrow X suppression in saturated region (Color-Glass Condensate effective theory)
- saturation suppression stronger than regular pQCD effects at small-x

Probing gluons in the nucleus with direct photons from Compton process

- inverse Compton provides direct access to the gluon kinematics



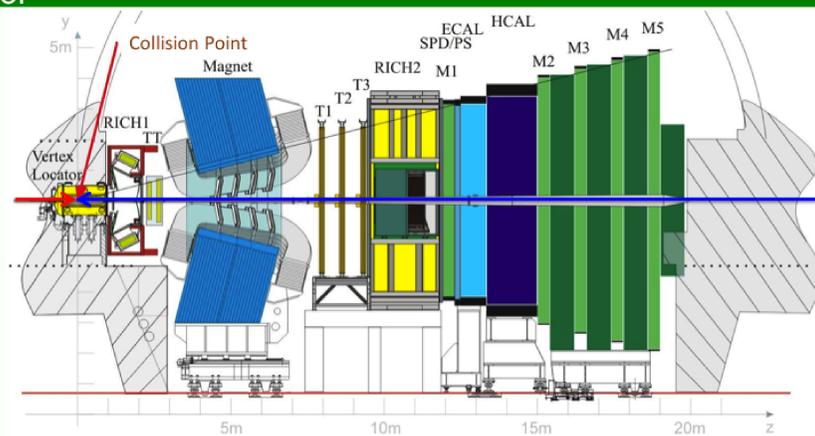
- Compton obtained after subtracting $(\pi^0 \rightarrow \gamma) + h$ (profile for dijet)

Angular correlation function:

$$CP(\Delta\phi) = \frac{dN/d\Delta\phi}{N_\gamma} \frac{N_{\text{norm}}}{dN_{\text{mix}}/d\Delta\phi}$$

- mixed event $\frac{dN_{\text{mix}}}{d\Delta\phi} / N_{\text{norm}}$ accounts for acceptance and uncorrelated pairs

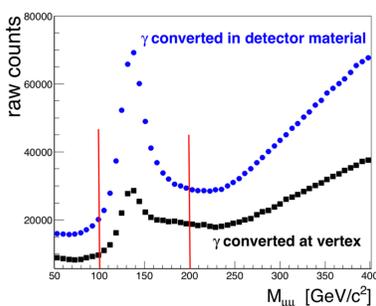
The LHCb detector



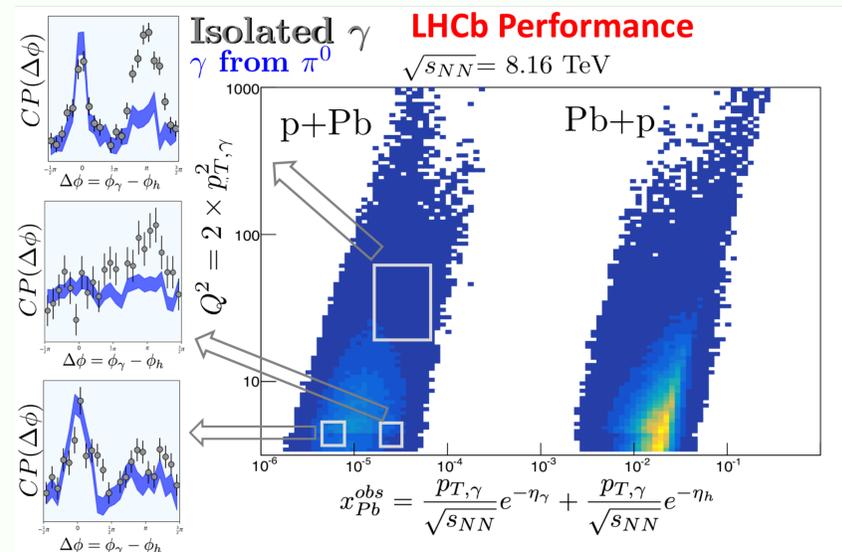
- $1.9 < \eta < 5.1$
- K, π, p, μ, e identification for $p > 1$ GeV/c
- operating in collider and fixed-target configurations
- γ measured by ECAL and $\gamma \rightarrow e^+e^-$ conversions, at vertex and in the detector material
- 1 MHz data acquisition, 40 MHz after LHC long-shutdown II
- LHCb covers the smallest x region today and foreseen future

Status of the 2016 data Analysis

- 2016 pPb and PbPb has $\int \mathcal{L} = 34 \text{ nb}^{-1}$. This analysis uses Minimum Bias trigger which corresponds to 1/60 of the total luminosity
- only $\gamma \rightarrow e^+e^-$ conversions, better $A\epsilon$ and p_T resolution than ECAL for low- p_T γ s
- isolation cut uses a likelihood function accounting for the activity $\in \Delta R < 0.5$
- $p_{T,h} < p_{T,\gamma}$



- dijet profile obtained with photons from measured $\pi^0 \rightarrow \gamma + (\gamma \rightarrow e^+e^-)$ (left figure)
- dijet profile is normalized according to near-side peak $\int_{-\pi/2}^{\pi/2} d\Delta\phi CP(\Delta\phi)$ (right panels), where only dijet contribution is present



Conclusions and outlook

- Away-side peak magnitude in isolated $\gamma+h$ sample is larger than scaled dijet sources over a broad x_{Pb}^{obs} and Q^2 range. Consistent with Compton process simulation
- this sample may probe saturated gluons and the transition to a dilute system Q_S^2
- a clear evidence for saturation will be a distinct Compton yield suppression, stronger than any regular pQCD and nPDF estimations
- detector simulations and data-driven validations ongoing
- goal is to obtain Compton yield vs. x_{Pb}^{obs} and Q^2

Proposing R&D for a complete gluon saturation search and heavy ion program in LHCb, including:

- development of an isolated γ high-level trigger for the next pp and pPb runs
- R&D for a scintillator-based tracker inside the LHCb magnet to improve momentum resolution of low- Q^2 particles

Acknowledgments
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