Forward Jets in pA as a Sign of Saturation

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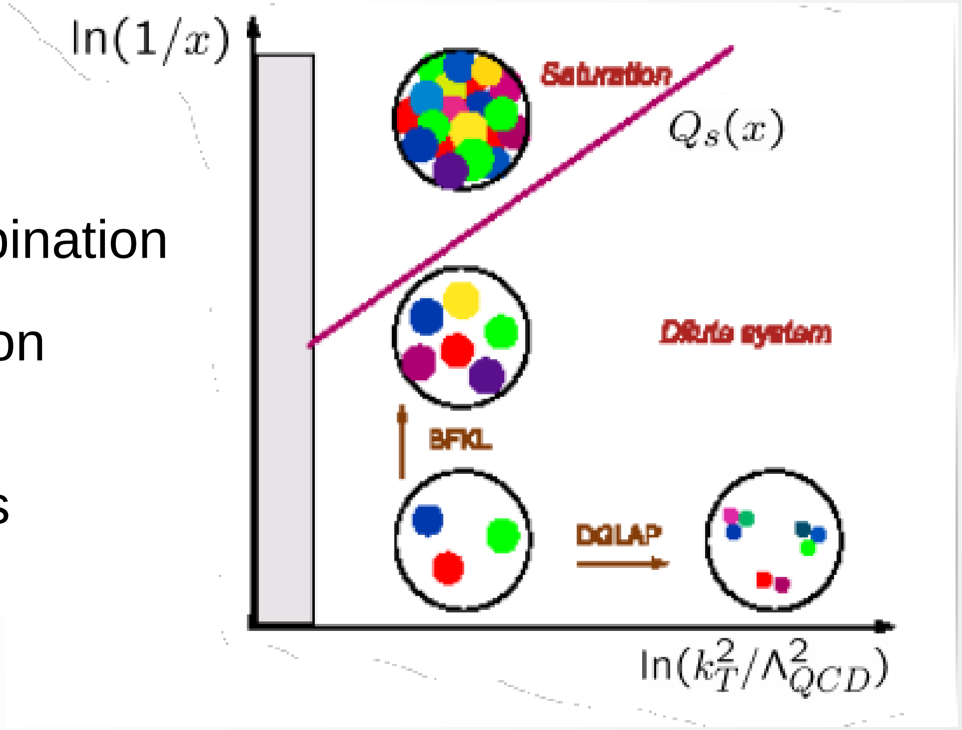
Parton Distribution

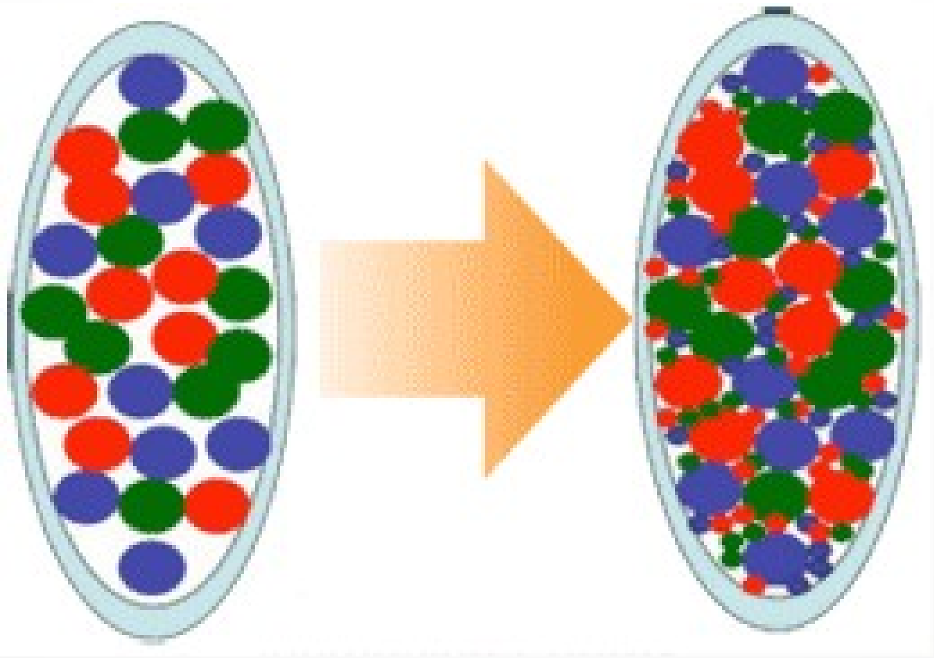
- Two defining variables for parton distribution
  - x is longitudinal momentum loss w.r.t hadronic momentum
  - k_T is the parton transverse momentum

- BFKL and DGLAP govern parton distribution dependence on x and k_T
  BK evolution needed to describe recombination
- At low x we expect to see gluon saturation effect
- $Q_s(x)$ is saturation scale which separates dilute and dense compositions



Gluon Saturation

- Gluon saturation is the balance between gluon radiation and recombination which occurs at low x
- Important for understanding proton makeup
- We look in pA collisions because we want as dense an object as possible

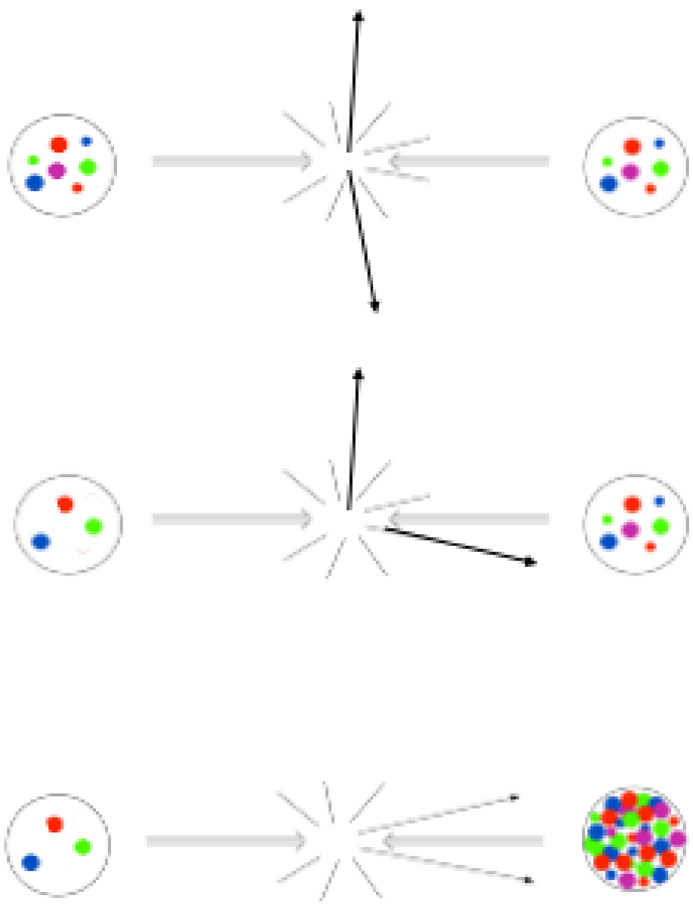


Di-hadron final-state kinematics

final state : $k_1, y_1 \quad k_2, y_2$

$$x_p = \frac{k_1 e^{y_1} + k_2 e^{y_2}}{\sqrt{s}} \qquad x_A = \frac{k_1 e^{-y_1} + k_2 e^{-y_2}}{\sqrt{s}}$$

scanning the wave functions:



$$x_p \sim x_A < 1$$

central rapidities probe moderate x

x_p increases | x_A ~ unchanged

$$x_p \sim 1,\ x_A < 1$$

forward/central doesn't probe much smaller x

x_p ~ unchanged | x_A decreases

$$x_p \sim 1,\ x_A << 1$$

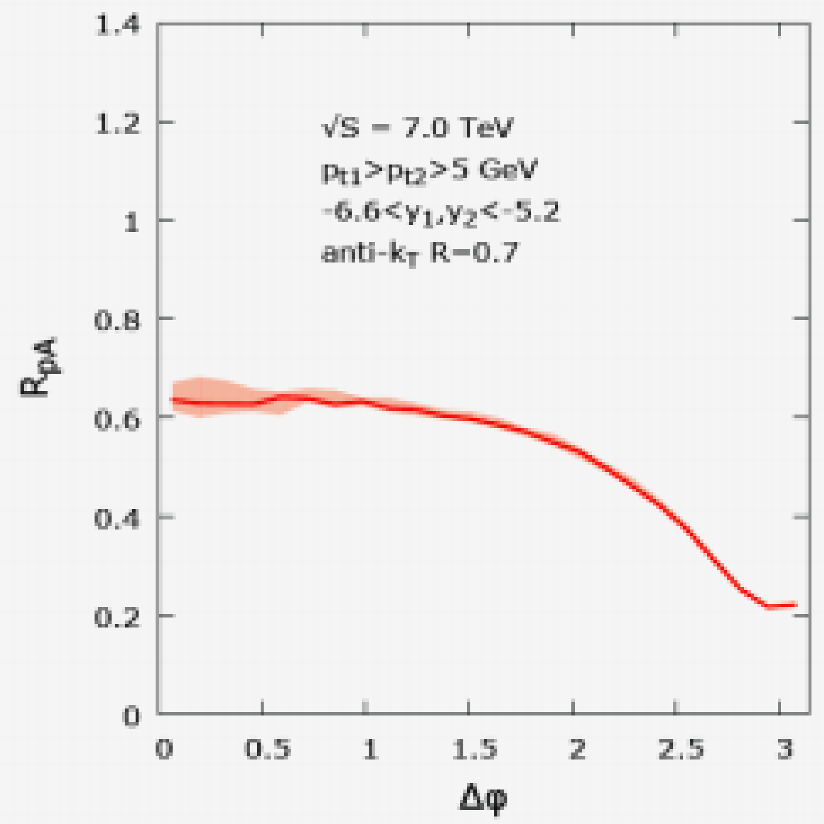
forward rapidities probe small x

[1]

Nuclear Modification Factor

- R_{pA} measures initial and final state effects in nuclear collisions
- R_{pA} = 1 means absence of nuclear effects or no gluon saturation

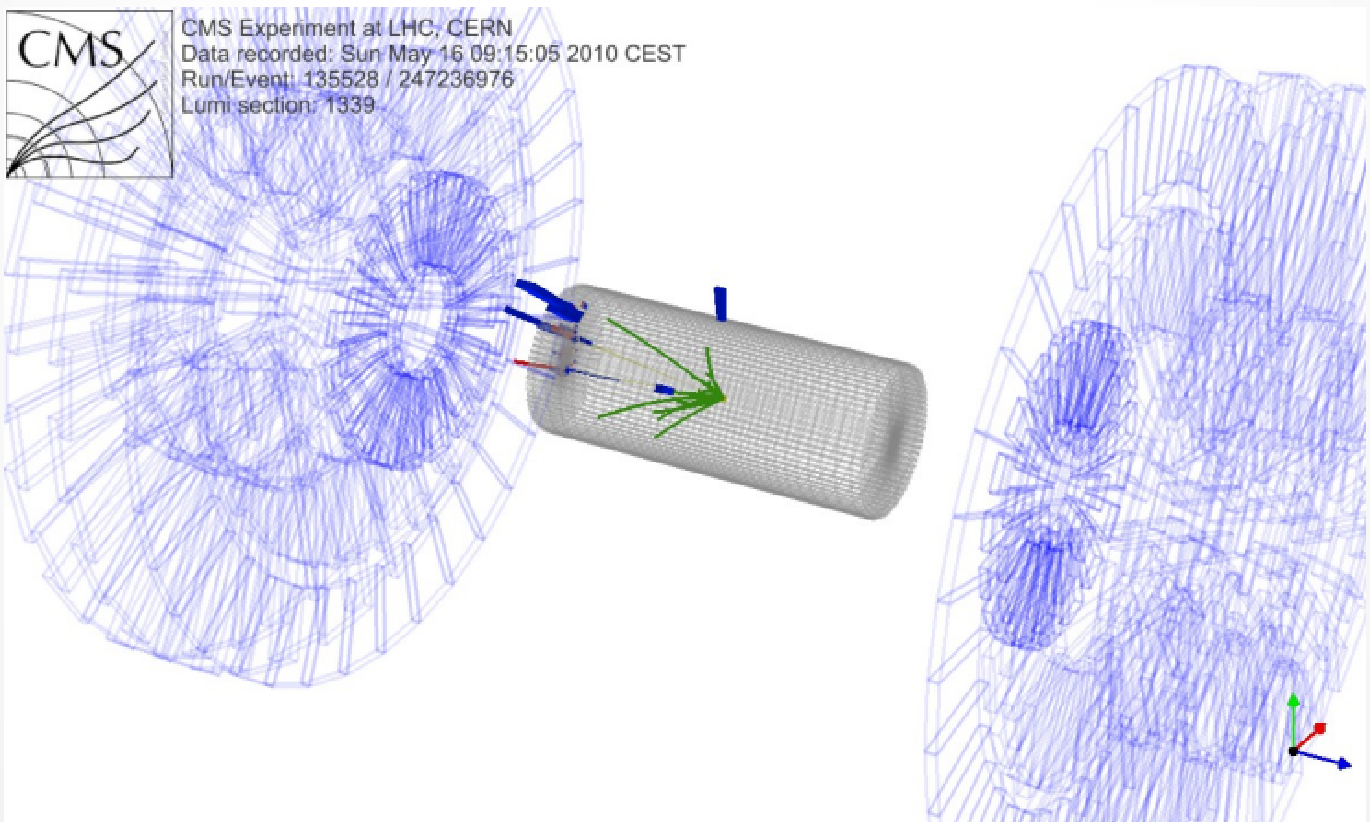
$$R_{pA} = \frac{1}{< T_{pA} >} * \frac{\frac{\mathrm{d}N_{pA}}{\mathrm{d}p_T}}{\frac{\mathrm{d}\sigma_{pp}}{\mathrm{d}p_T}}$$



[2]

Finding Signals at LHC

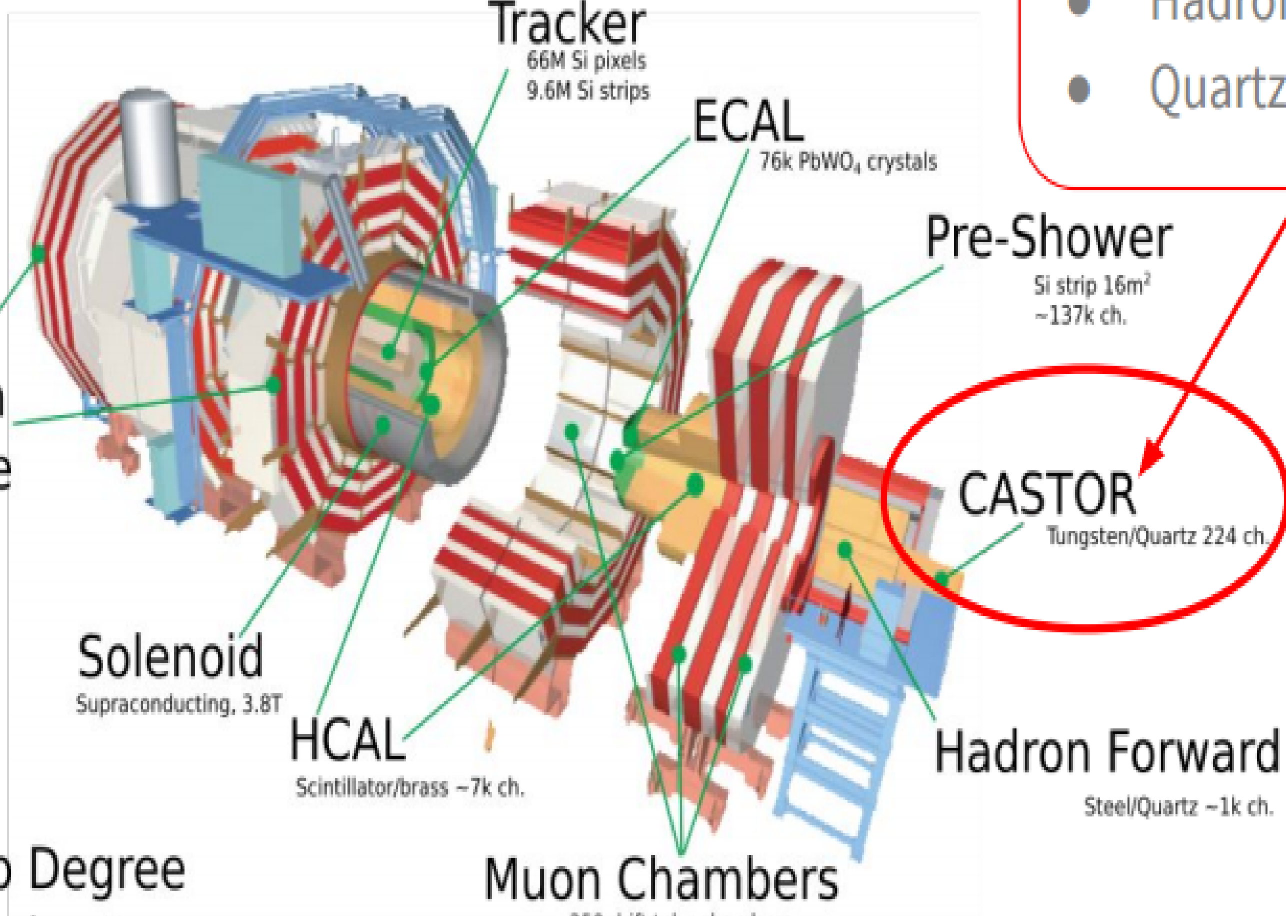
- We will be looking for suppression of di-hadron azimuthal correlation of forward dijets in pA vs pp



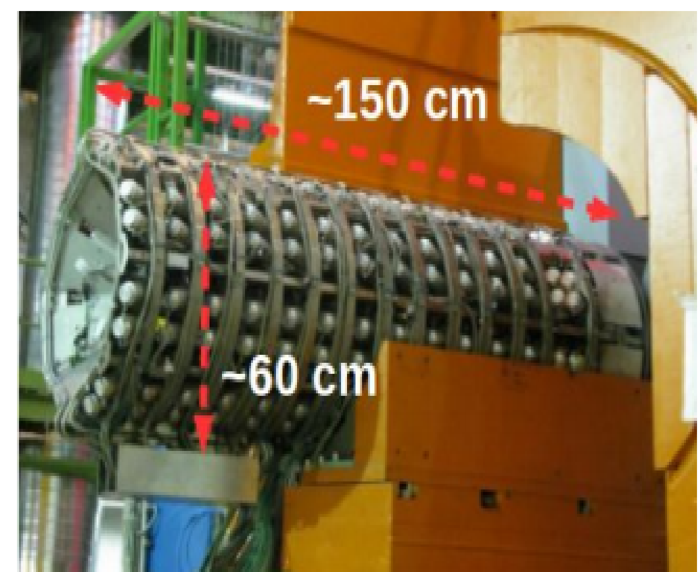
Very forward calorimeter CASTOR in CMS

- Acceptance: $-6.6 < \eta < -5.2$
- E.M. section: 20 X_0, 32 channels
- Hadronic section: 10 λ_I, 192 channels
- Quartz-Cherenkov calorimeter

Total weight: 14000t
Overall diameter: 15m
Acceptance: $-6.6<\eta<5.2$, $|\eta|>8.2$



Zero Degree Calorimeter
Tungsten/Quartz 16 ch.
Located in TAN at +- 120m



The CMS experiment at the CERN LHC , JINST 3 (2008) S08004

Going Forward

- Studying possible L1 triggers for pPb
- pPb data taken at the end of this year will provide enough data to begin looking for gluon saturation effects
- Implementing saturation effects in Monte Carlo

References

[1] Cyrille Marquet “Confirming RHIC saturation signals at the LHC”

[2] A. van Hameren, P. Kotko, K. Kutak,C. Marquet, E. Petreska, S. Sapeta, arXiv:1607.0312; P. Kotko, K. Kutak, C. Marquet, E. Petreska, S. Sapeta, A. van Hameren, JHEP 1509 (2015) 106

[3] Christophe Royon for CMS-CASTOR group “Jets, diffraction & CASTOR”