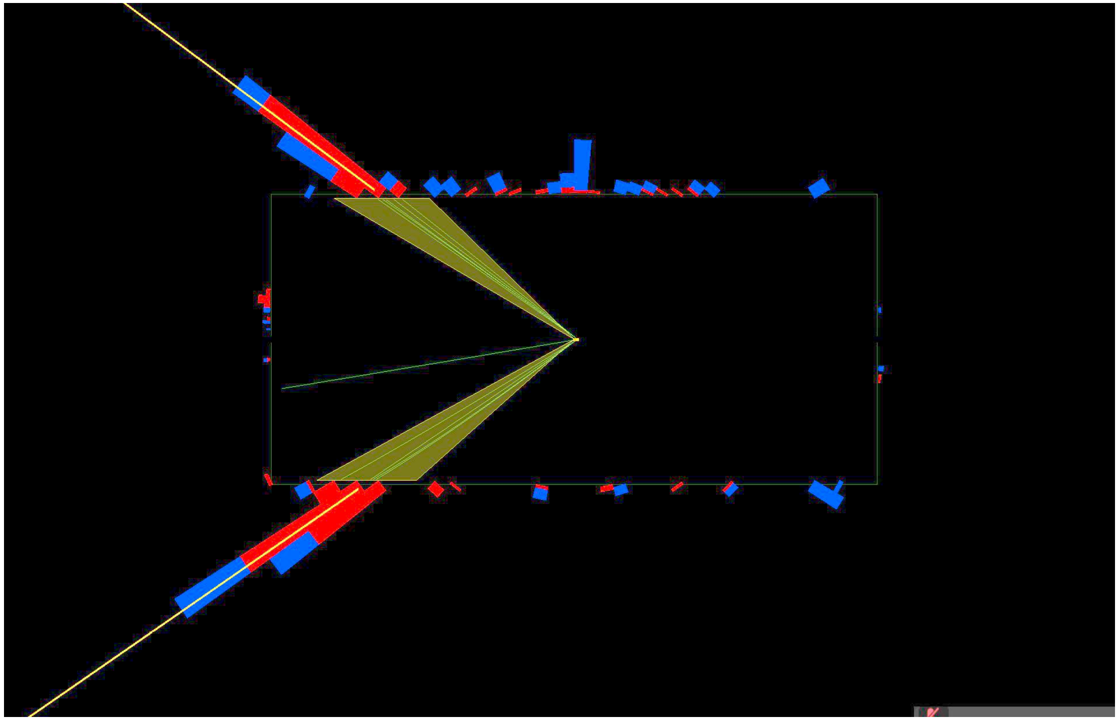
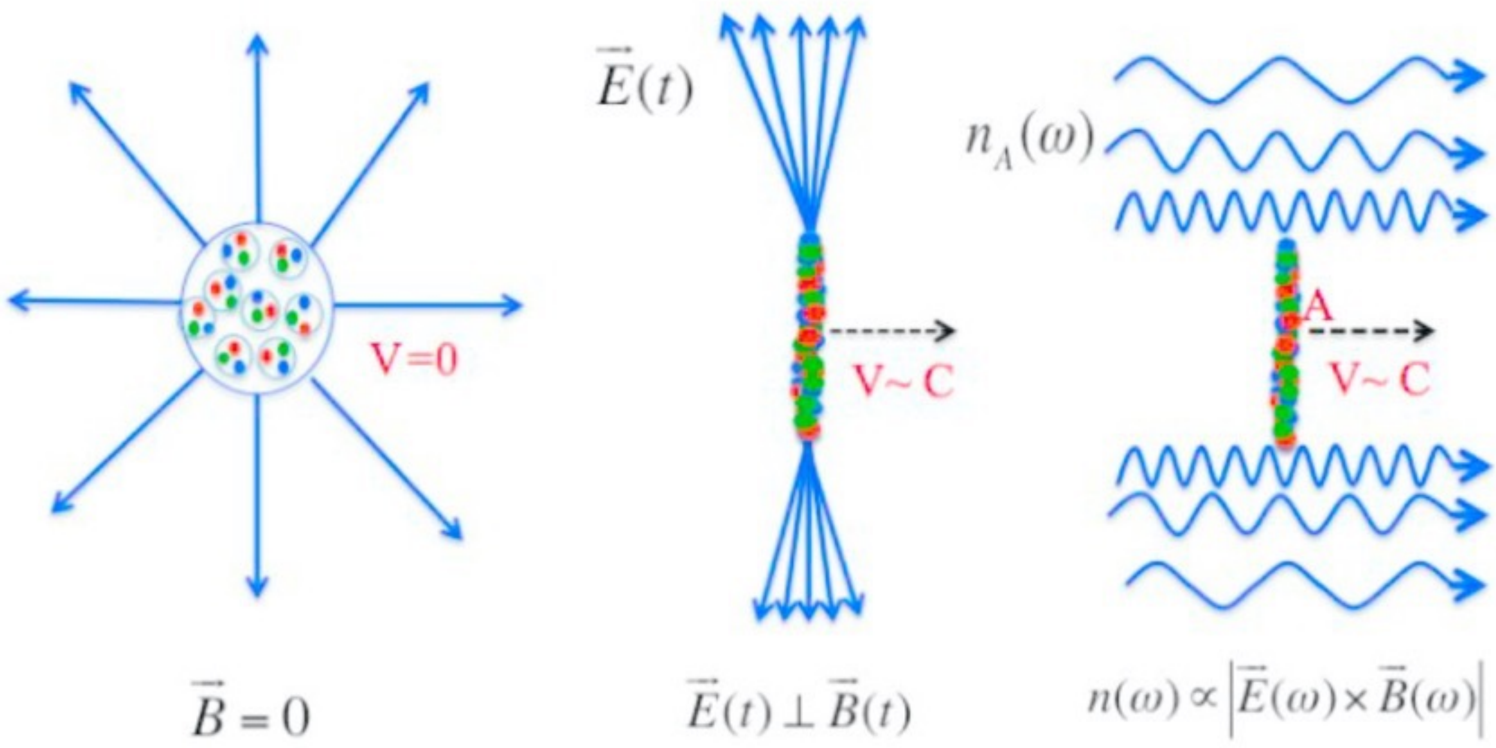
Angular correlations within dijets from photon lead collisions



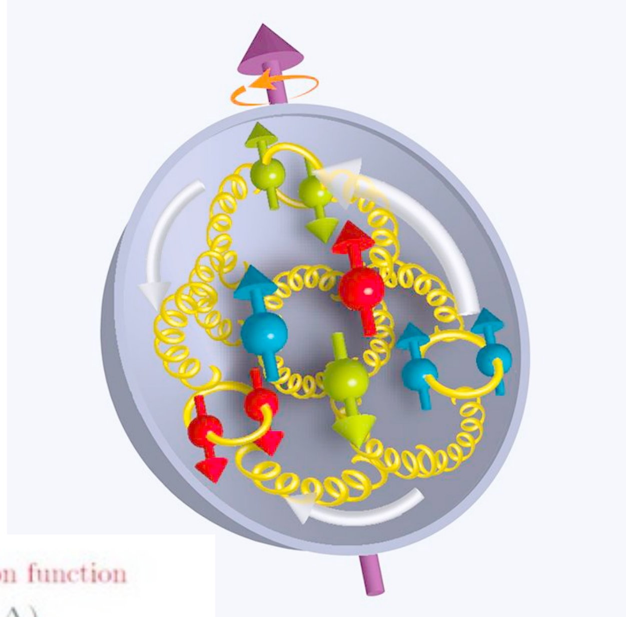
CMS-HIN-18-011, https://arxiv.org/abs/2205.00045 submitted to PRL

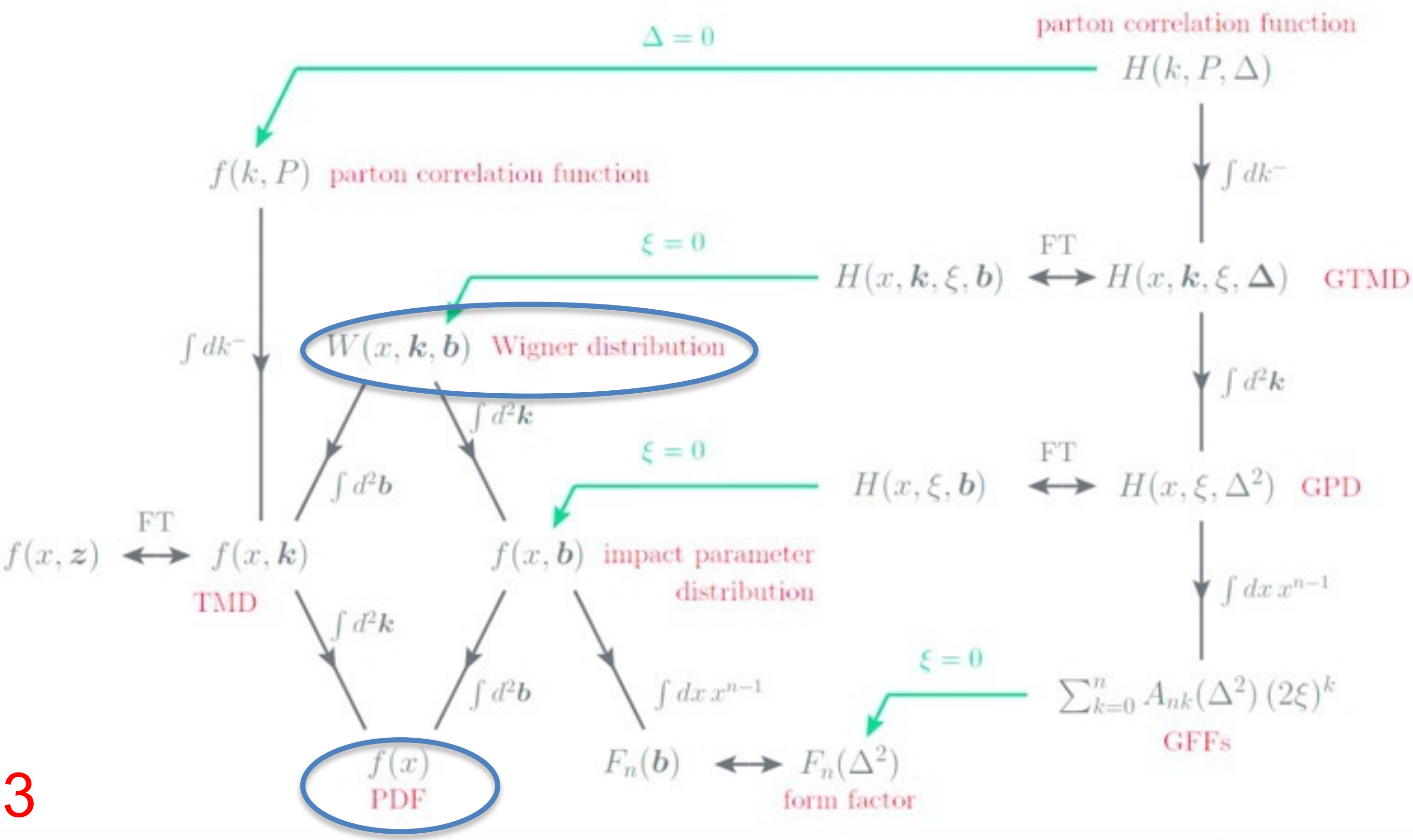
Michael Murray, DIS 2022: Santiago de Compostela

Relativistic ions produce polarized photons

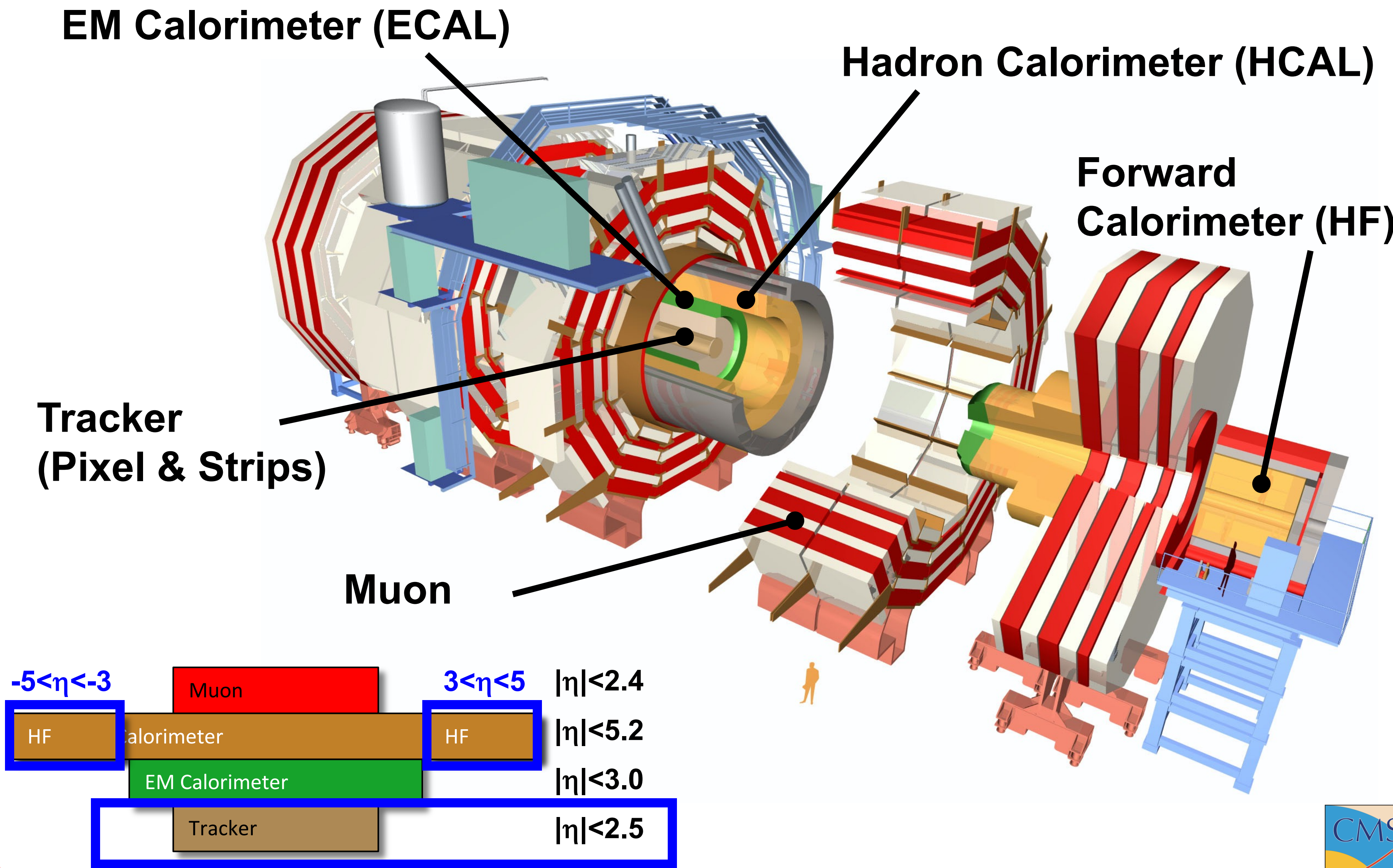


How are gluons moving in nuclei?





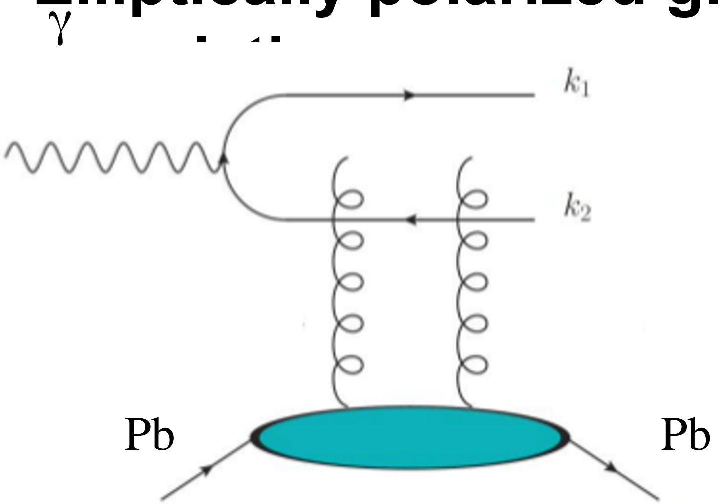
The Compact Muon Solenoid

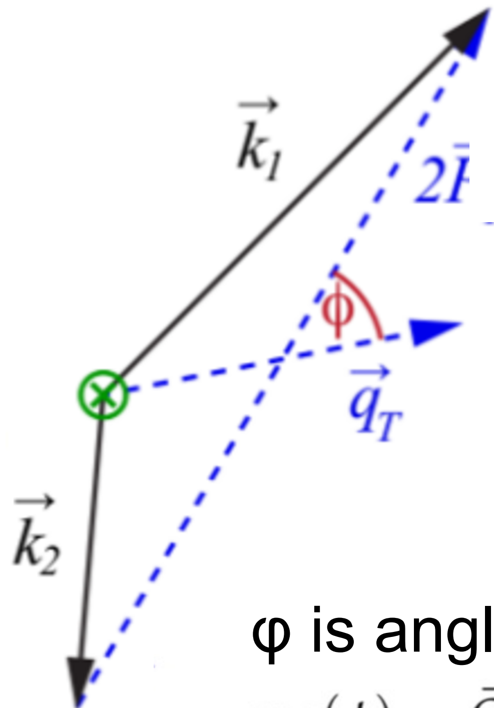


Exclusive dijets sensitive to multidimension gluon distribuiotns

(Hatta, et al, *PRL 116, 202301 (2016)*)

Elliptically polarized gluons: ↔ **Dijet azimuthal angular**





Vector sum of 2 jets:

$$\vec{Q}_T = \vec{k}_1 + \vec{k}_2$$

Vector difference of 2 jets:

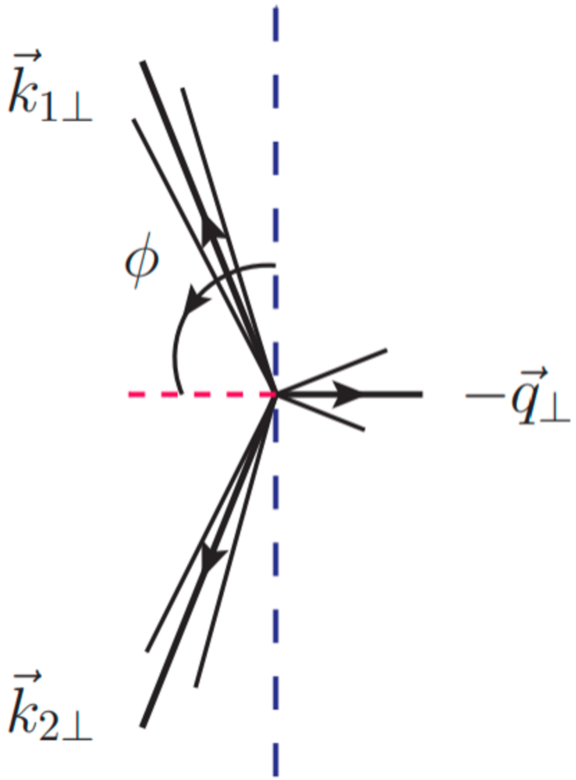
$$\vec{P}_T = \frac{1}{2}(\vec{k}_1 - \vec{k}_2)$$

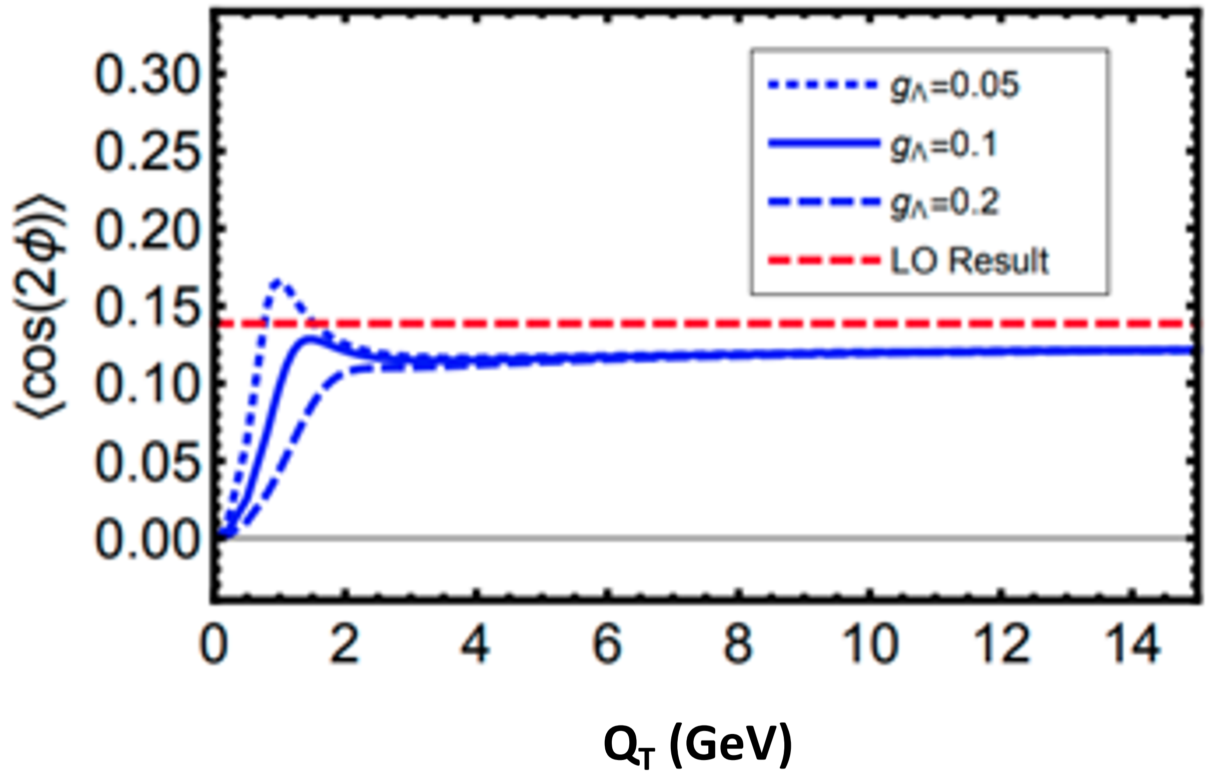
φ is angle between P_T and Q_T

$$\cos(\phi) = \vec{Q}_T \cdot \vec{P}_T / (|| \vec{Q}_T || \cdot || \vec{P}_T ||)$$

Soft gluon radiation can induce a <cos(2ϕ)>

Y. Hatta et al. PRL 126, 142001 (2021) (After preliminary results).
Standard TMD framework used for re-summation.





Wigner gluon distribution is neglected

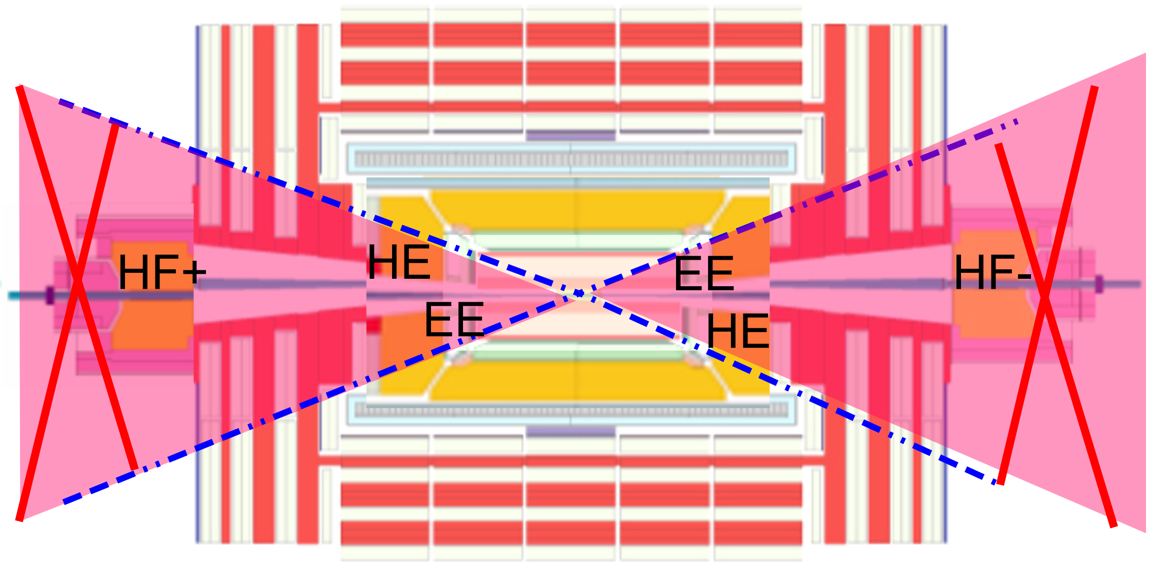
Event selection

–At least one track in the central tracker

–Search for particle flow anti-k_T jets with $R = 0.4$

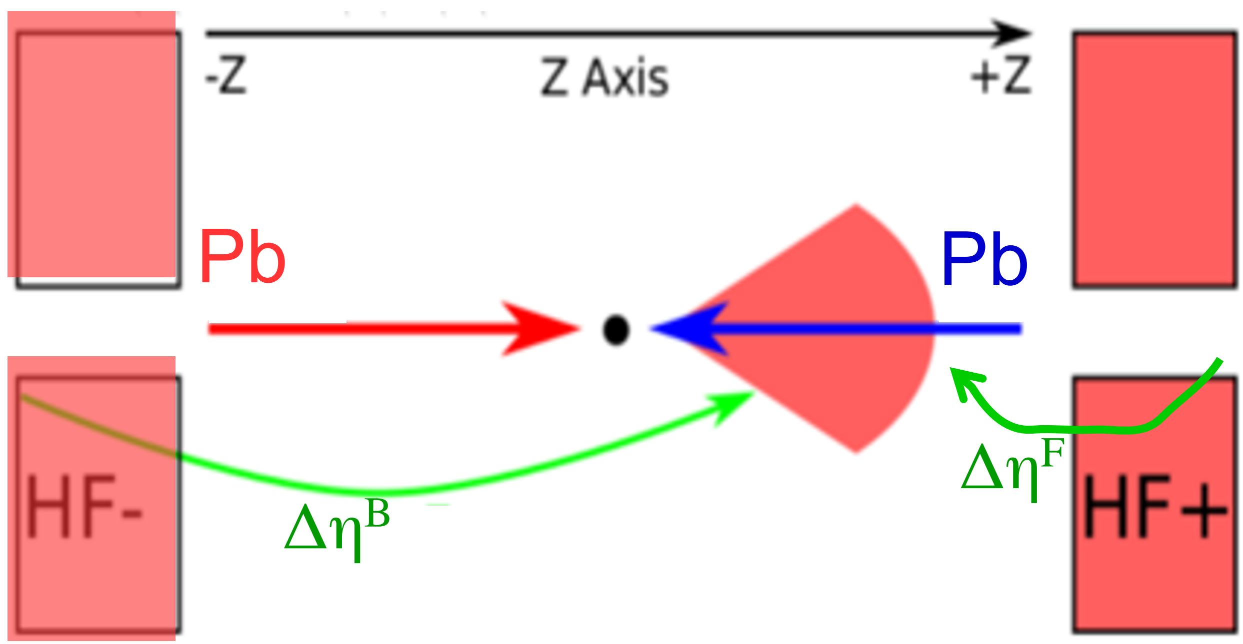
–Exactly two jets $|\eta_{lab}| < 2.4$, $p_{T,1} > 30$ GeV, $p_{T,2} > 20$ GeV

–Veto forward activity ($2.8 < |\eta| < 5.2$):



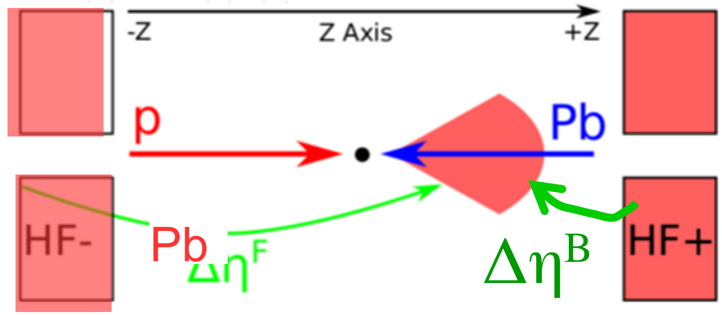
Exclusive events have rapidity gaps

Forward Rapidity Gap, $\Delta\eta^F = 2.4 - \eta_{max,}$
η_{max} defined by first track with $p_T > 0.2$ GeV

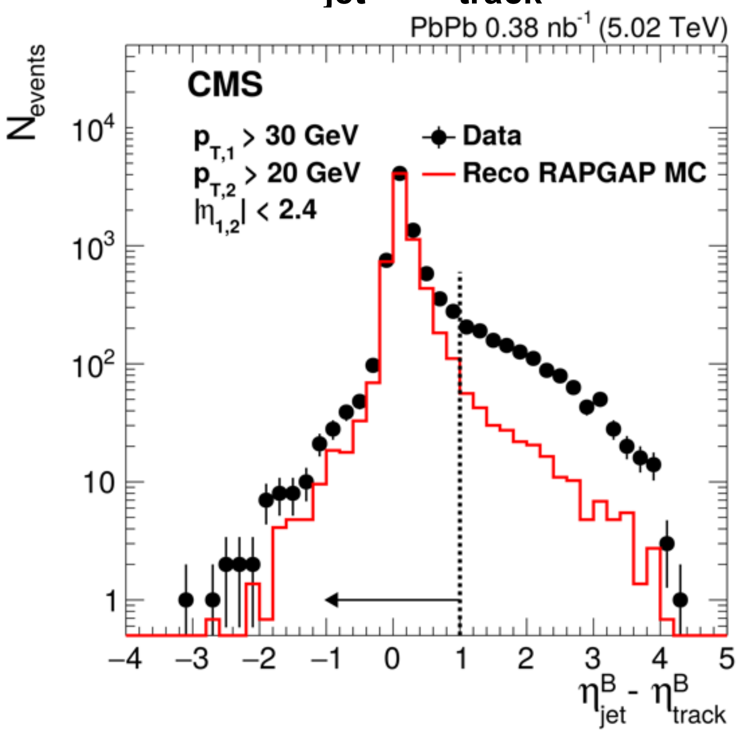


Merge samples from two hemispheres of detector.

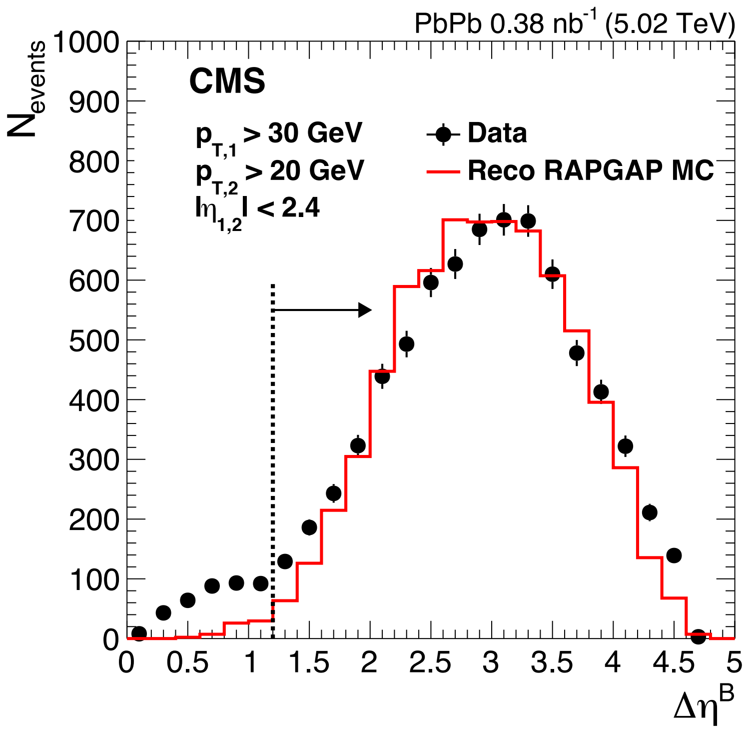
Veto tracks far from jets



$\eta_{jet} - \eta_{track} < 1$,



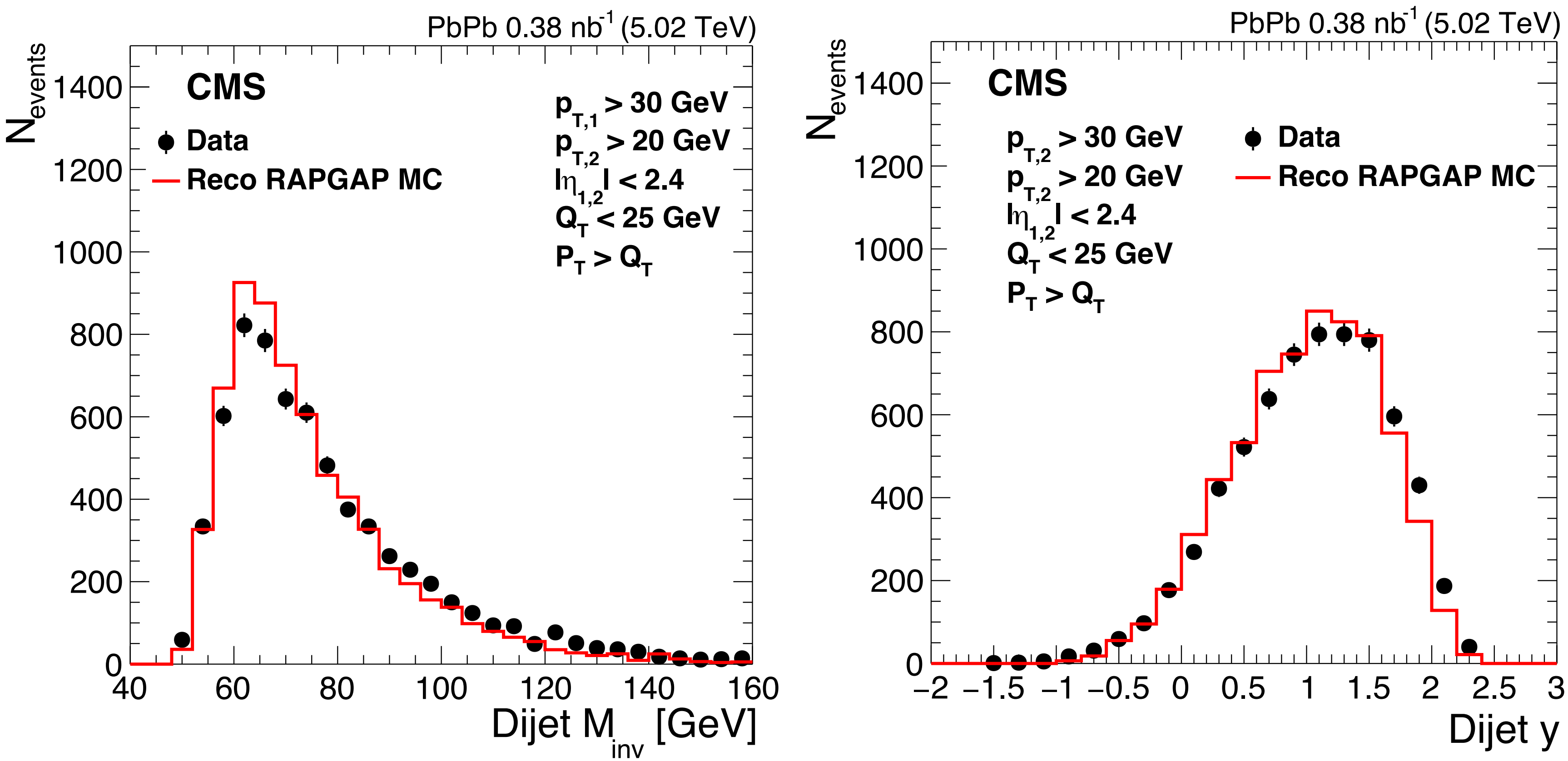
$\Delta\eta^B > 1.2$



Cuts keep 99% of signal (according to RAPGAP*), but significantly reduce background

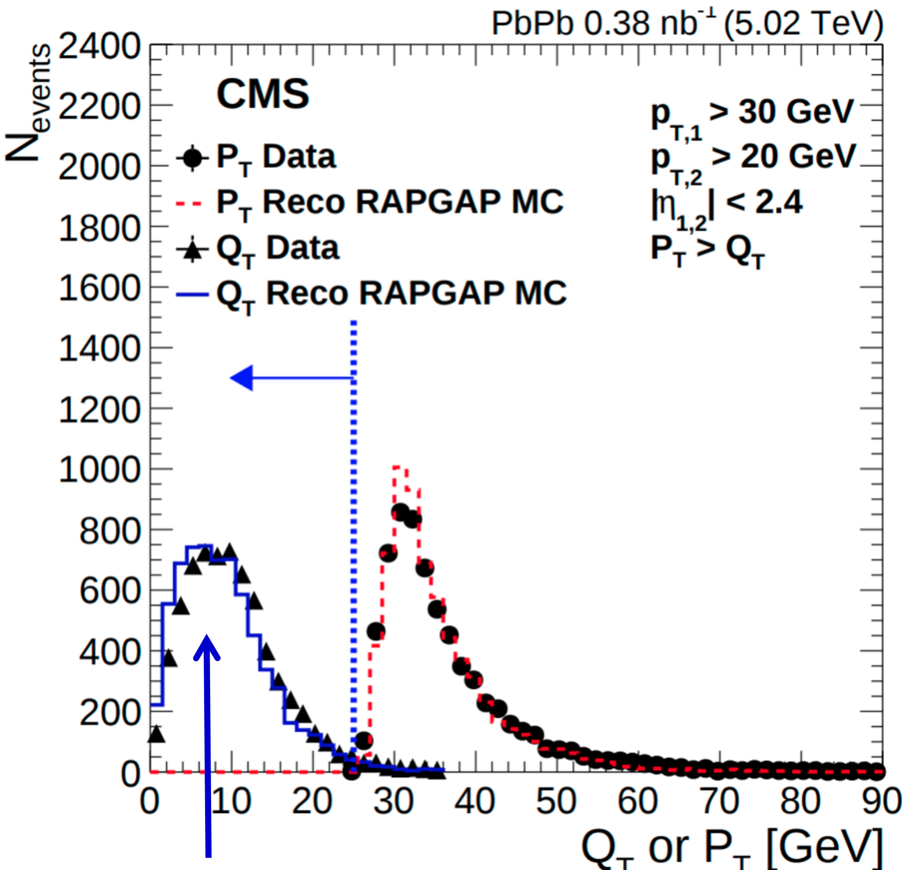
*Comput. Phys. Commun. 86 (1995) 147

Jet kinematics match expectations

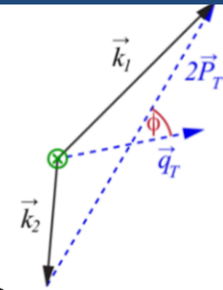


Good agreement between data and RAPGAP after photon flux re-scaled for PbPb.

Dijets have large momentum transfer



Large momentum transfer regime (DIS-like)

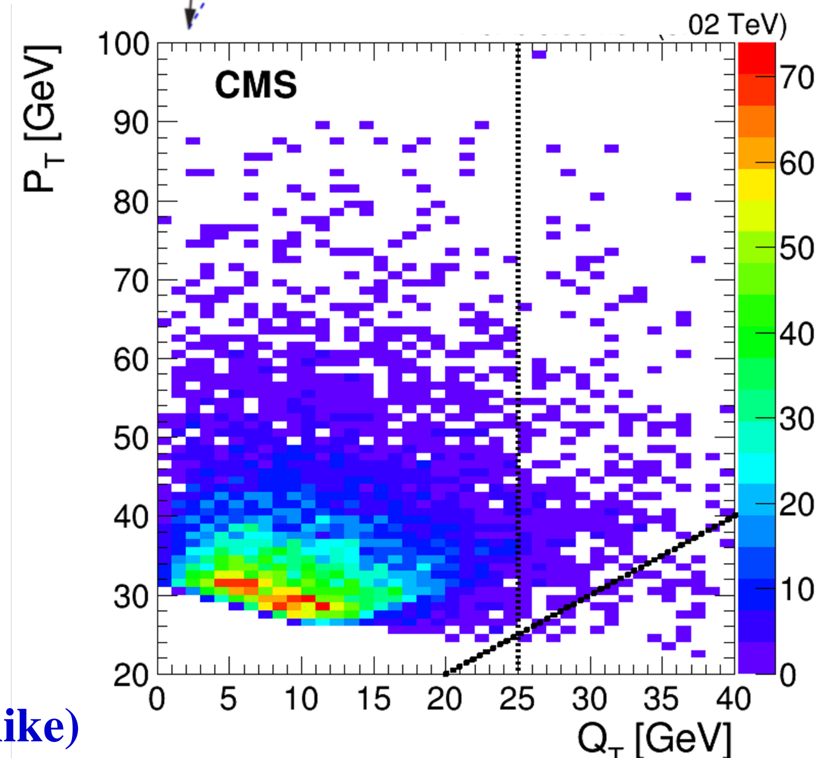


Vector sum of 2 jets:

$$\vec{Q}_T = \vec{k}_1 + \vec{k}_2$$

Vector difference of 2 jets

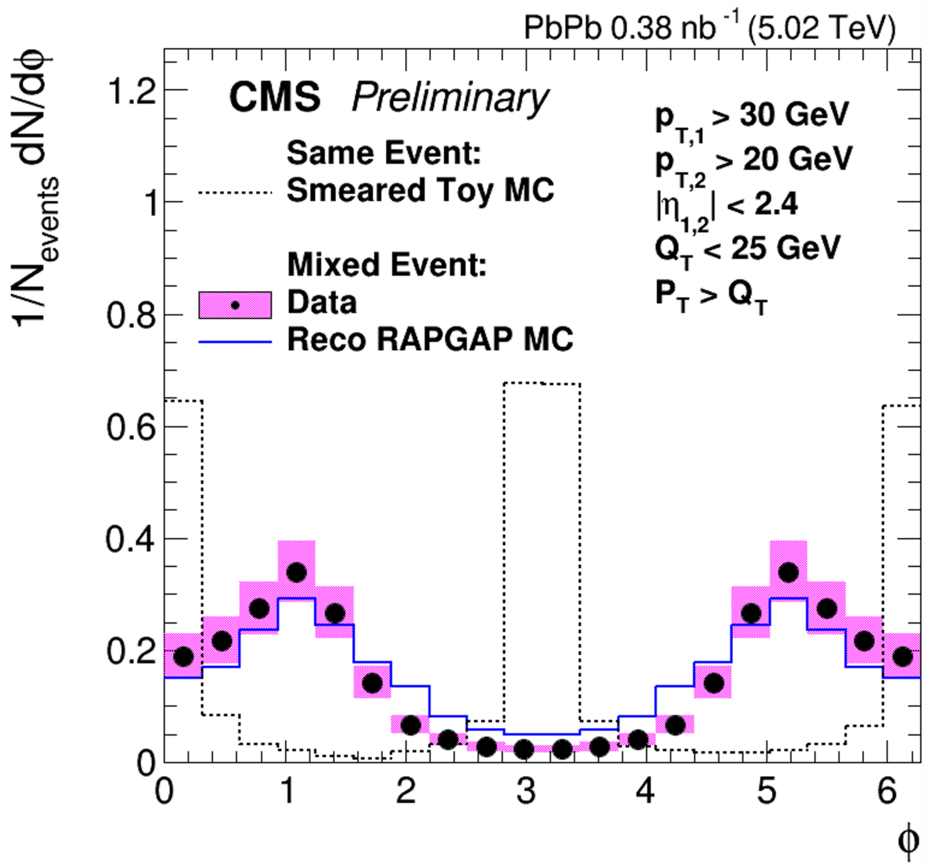
$$\vec{P}_T = \frac{1}{2}(\vec{k}_1 - \vec{k}_2)$$

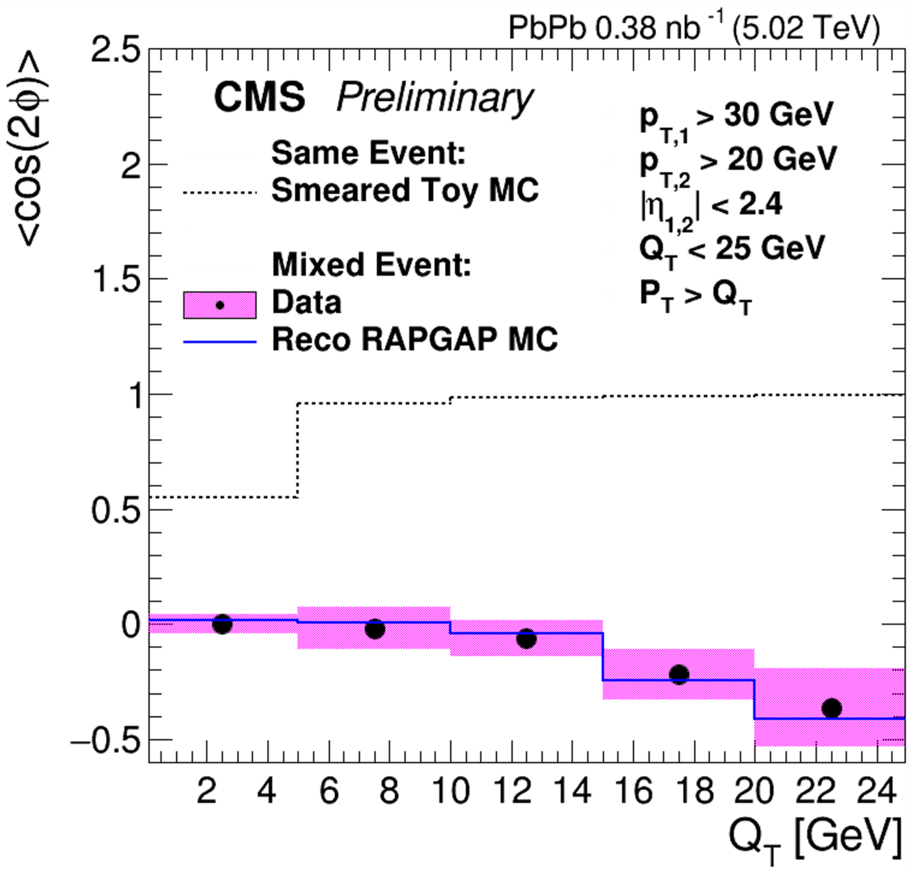


$P_T > Q_T$: "back-to-back limit", $Q_T < 25$ GeV,

6785 events remain after all cuts.

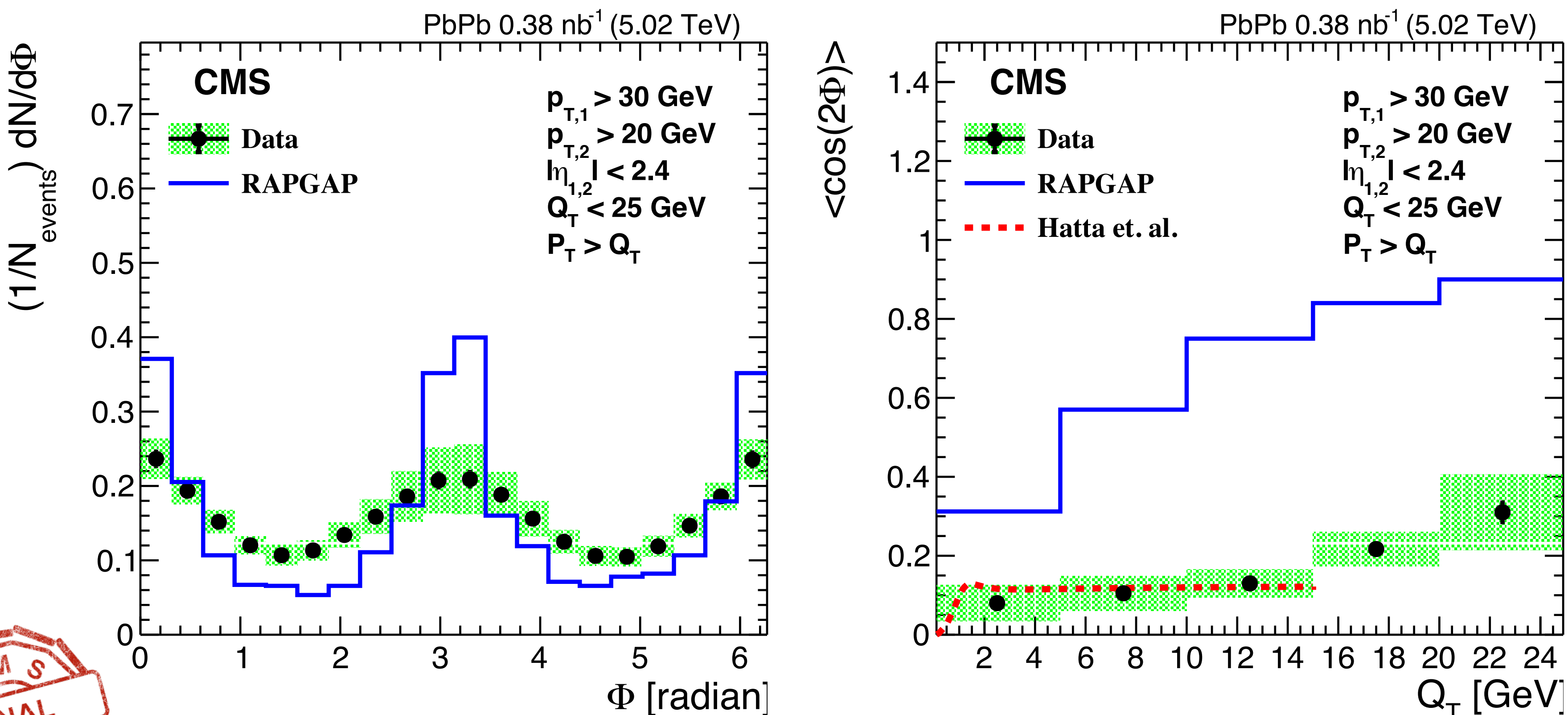
Test with toys models and mixed events





Toy MC: back-to-back jets with detector resolution effects $\langle\cos(2\varphi)\rangle \rightarrow 1$
Mixed events have only acceptance affects and have $\langle\cos(2\varphi)\rangle$ negative

Angular correlations are present in data



<cos(2ϕ)> in data is below back-to-back expectation and RAPGAP prediction

<cos(2ϕ)> constant for $Q_T > 2$ GeV in the Hatta calculations which just include soft radiation and no effect from elliptic gluons.

Summary

- First data on <cos(2φ)> from γPb => dijets
- <cos(2φ)> increases with jet momentum
- RAPGAP (tuned to ep) overestimates correlations
- Calculation by Hatta et al. which soft-gluon radiation from final-state jets agrees with data for dijet momentum less than 15 GeV.
- However, calculation is flat in momentum in contrast of the steady rise observed in the data

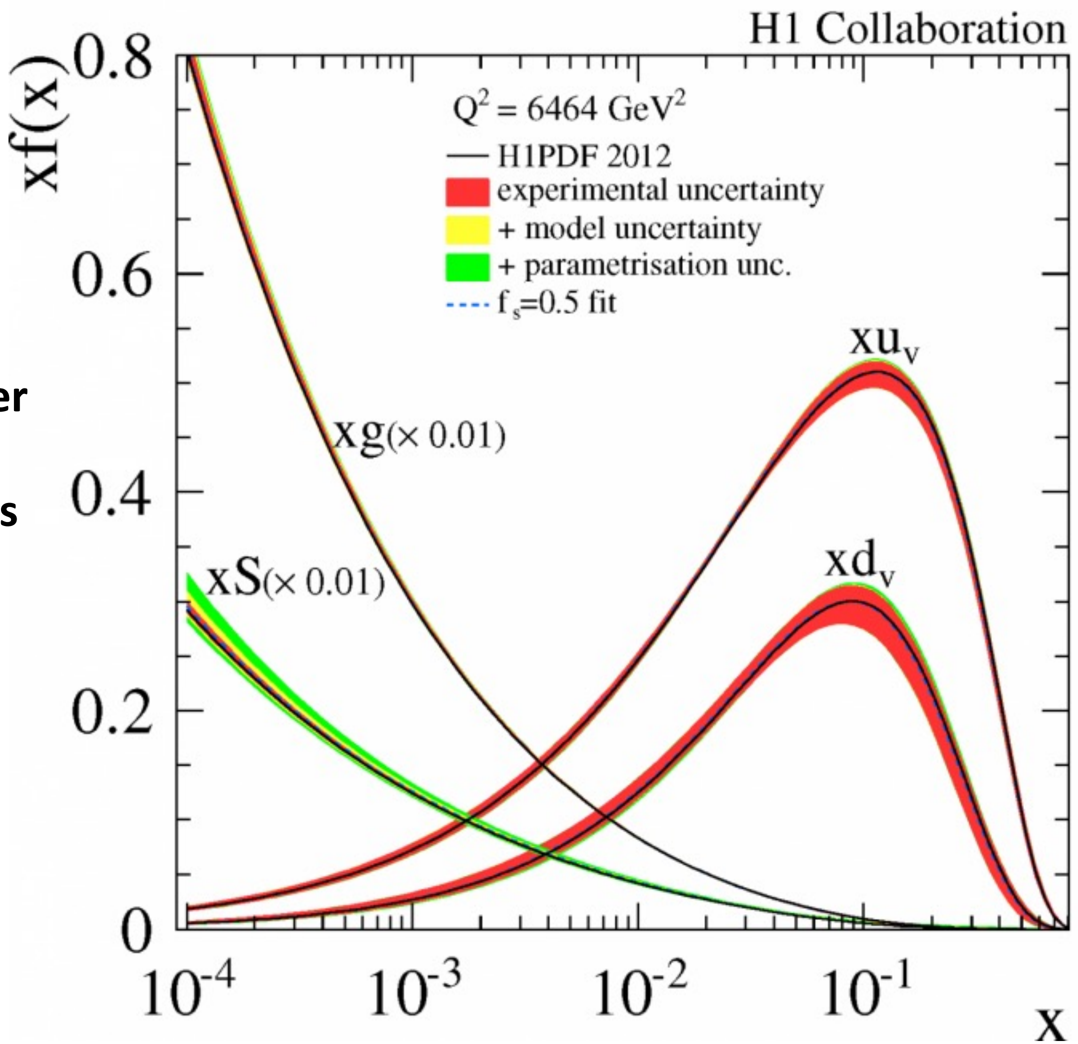
Backup

Systematic Uncertainties

Table 1: Table of $\langle \cos(2\Phi) \rangle$ systematic uncertainties (absolute values). The individual components are discussed in the text.

Q_T [GeV]	JES	JESnc	JER	JAR	PUR	TR	Total
0-5	0.018	0.004	0.002	0.004	0.002	0.004	0.019
5-10	0.012	0.006	0.005	0.003	0.002	0.003	0.015
10-15	0.010	0.008	0.007	0.002	0.002	0.001	0.014
15-20	0.009	0.008	0.014	0.002	0.002	0.001	0.018
20-25	0.005	0.018	0.056	0.001	0.002	0.002	0.059

Lots of glue inside the proton



Number of objects

Momentum of quark or gluon

EPJC 75 (2015) 580