Recent results from CMS

Florian Damas (LLR, CNRS-IN2P3) for the CMS Collaboration

Strangeness in Quark Matter 2024
June 3 - Strasbourg, France

| Run 1 | Run 2 | Long Shutdown 2 | Run 3 | LS 3 | Run 4 | LS 4 |

PbPb
(2.2 nb^{-1})
pPb
(0.18 pb^{-1})

5.36 TeV

5.02 TeV

8.16 TeV

PbPb (6 nb^{-1})

pO/OO pilot run

CMS Phase-2
upgrades

Z. Chen, Tues 3:00

PbPb (7 nb^{-1})

pPb (0.5 pb^{-1})

Phase-3
upgrades
for Run 5+

| 2015 - 2018 | 2019 | 2020 | 2021 | 2022 | 2023 | 2024 | 2025 | 2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 |

Timeline updated from Jing Wang's overview @ SQM 2022

Overview of results from Runs 1 & 2 available now! (submitted to Physics Reports)
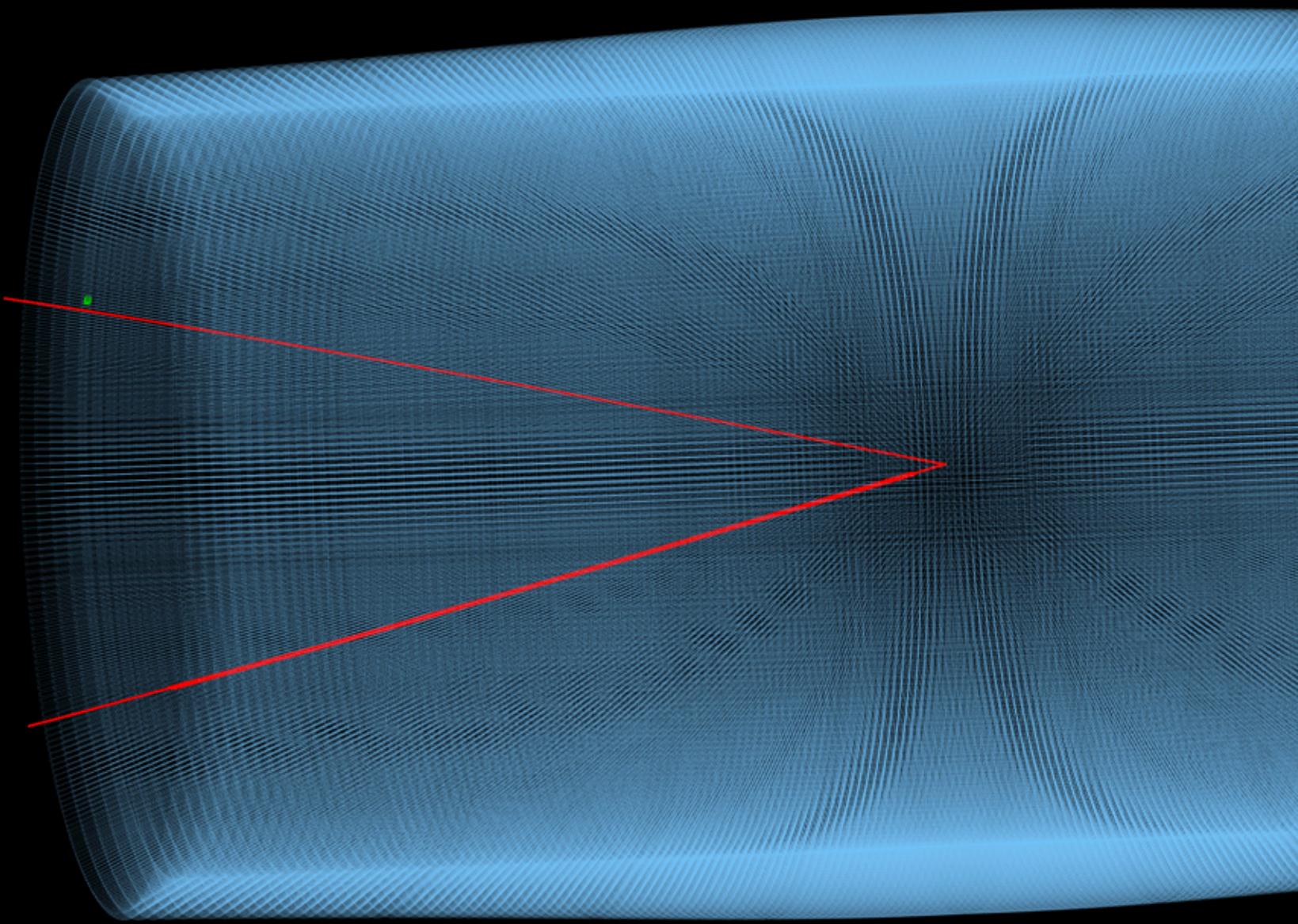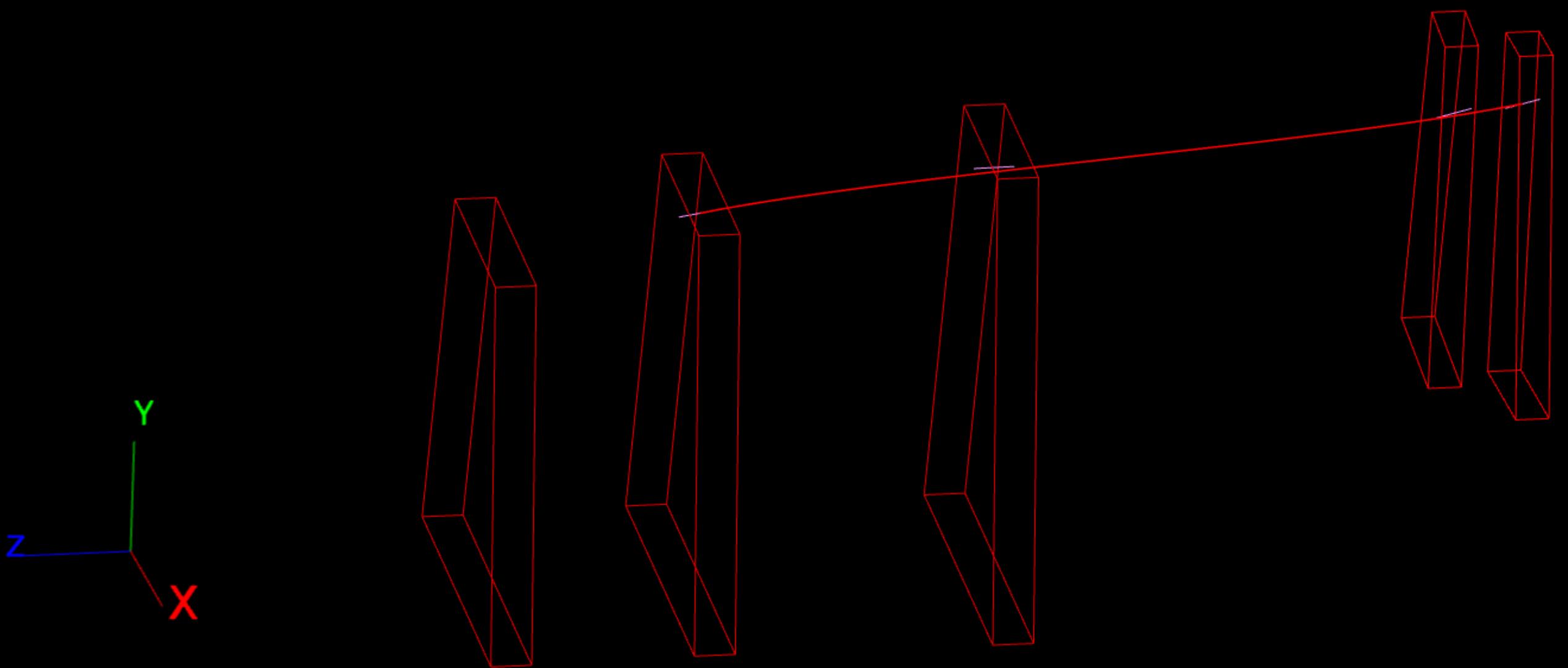
Detailed studies to draw a comprehensive picture of HIC

‣ Conditions of the system in the initial state

‣ Emerging properties and medium-induced effects

‣ Collectivity features in small collision systems

‣ Nature of exotic hadrons and rare phenomena
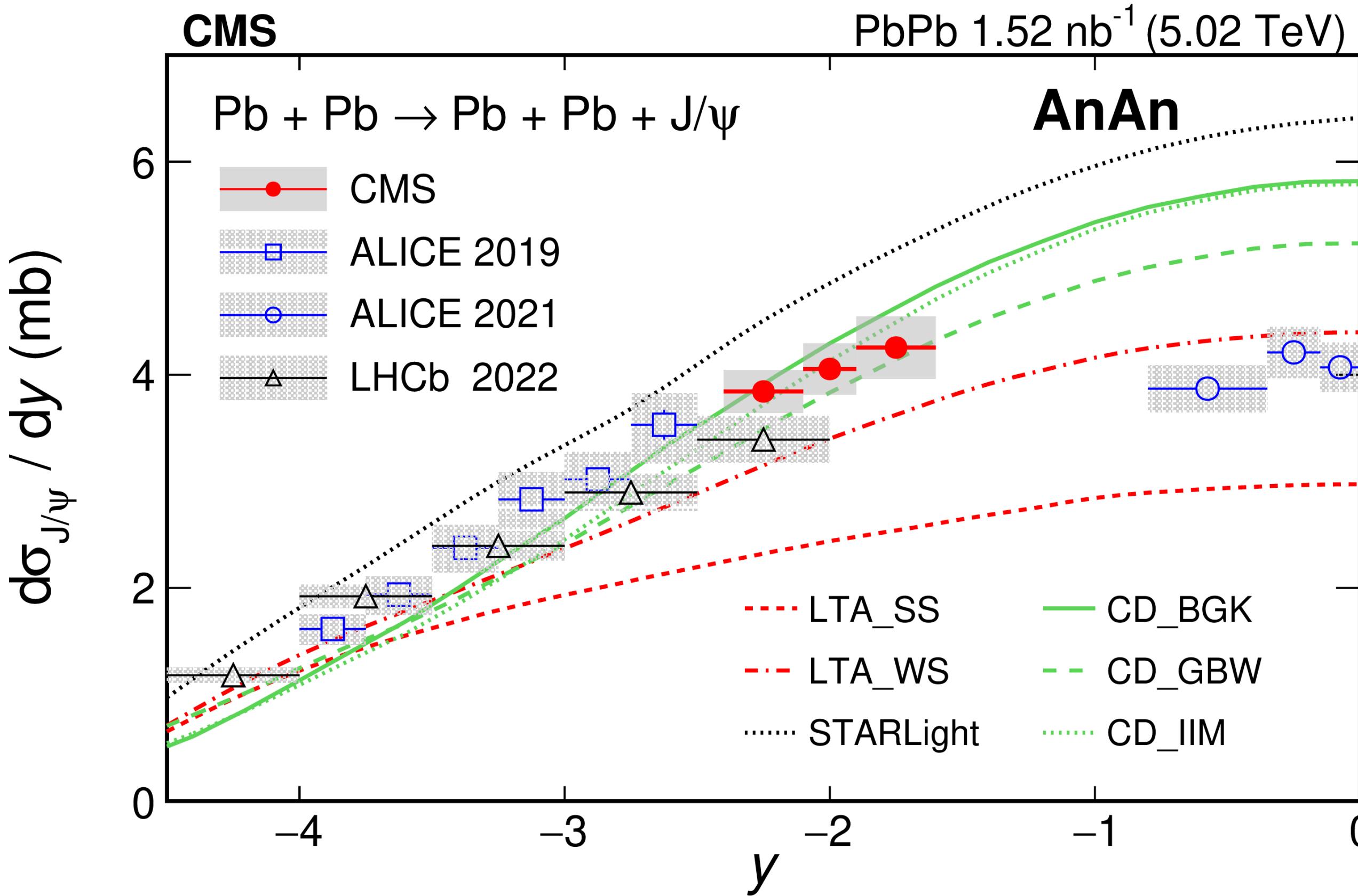
Probing the initial conditions

Pranjal Verma
HF&Q, Tues. 16:50

CMS PbPb 1.52 nb⁻¹ (5.02 TeV)

Pb + Pb → Pb + Pb + J/ψ   **AnAn**

- CMS
- ALICE 2019
- ALICE 2021
- LHCb 2022

LTA_SS   CD_BGK
LTA_WS   CD_GBW
STARLight   CD_IIM
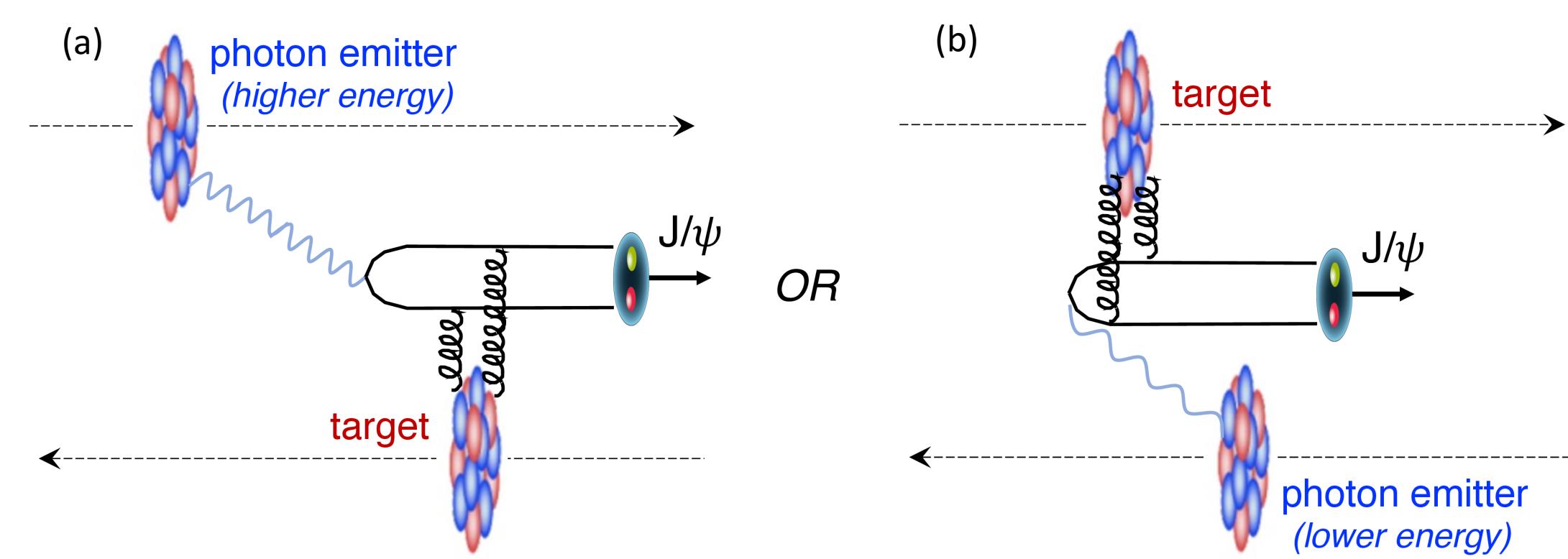
PRL 131 (2023) 262301
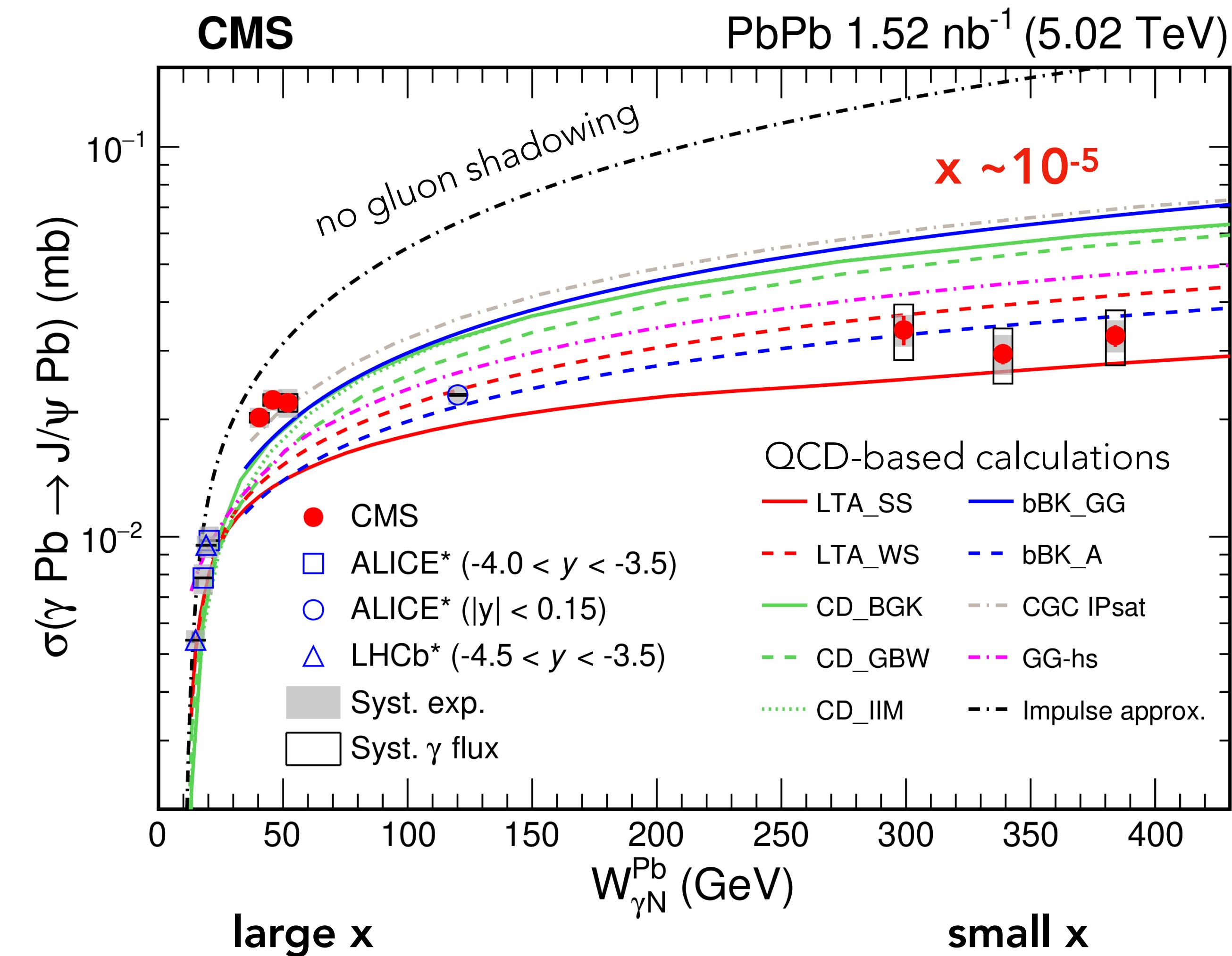
▸ Complementary rapidity coverage at the LHC

▸ Important **access to gluon distribution at low x**, but to what values *exactly*?

☞ ambiguity in the photon source and energy for a given J/ψ rapidity

(a) photon emitter *(higher energy)*

J/ψ

OR

target

(b) target

J/ψ

photon emitter *(lower energy)*

Probing the gluon distribution at low Bjorken x

▶ Photon contributions resolved by measuring $d\sigma_{coherent}(J/\psi)/dy$ per neutron emission class

▶ **Models capturing the trend vs γN energy but not low- and high-x regions together**

☞ LHC data constraining the gluon evolution down to x ~10^{-5} !

Pranjal Verma
HF&Q, Tues. 16:50

CMS   PbPb 1.52 nb^{-1} (5.02 TeV)

x ~10^{-5}

no gluon shadowing

$\sigma(\gamma\ Pb \rightarrow J/\psi\ Pb)$ (mb)

QCD-based calculations

- CMS
- ALICE* (-4.0 < y < -3.5)
- ALICE* (|y| < 0.15)
- LHCb* (-4.5 < y < -3.5)
- Syst. exp.
- Syst. γ flux

— LTA_SS   — bBK_GG
-- LTA_WS   -- bBK_A
— CD_BGK   -·- CGC IPsat
-- CD_GBW   -·- GG-hs
···· CD_IIM   -·- Impulse approx.

$W_{\gamma N}^{Pb}$ (GeV)

large x   small x

# Observation of double J/Ψ production in pPb
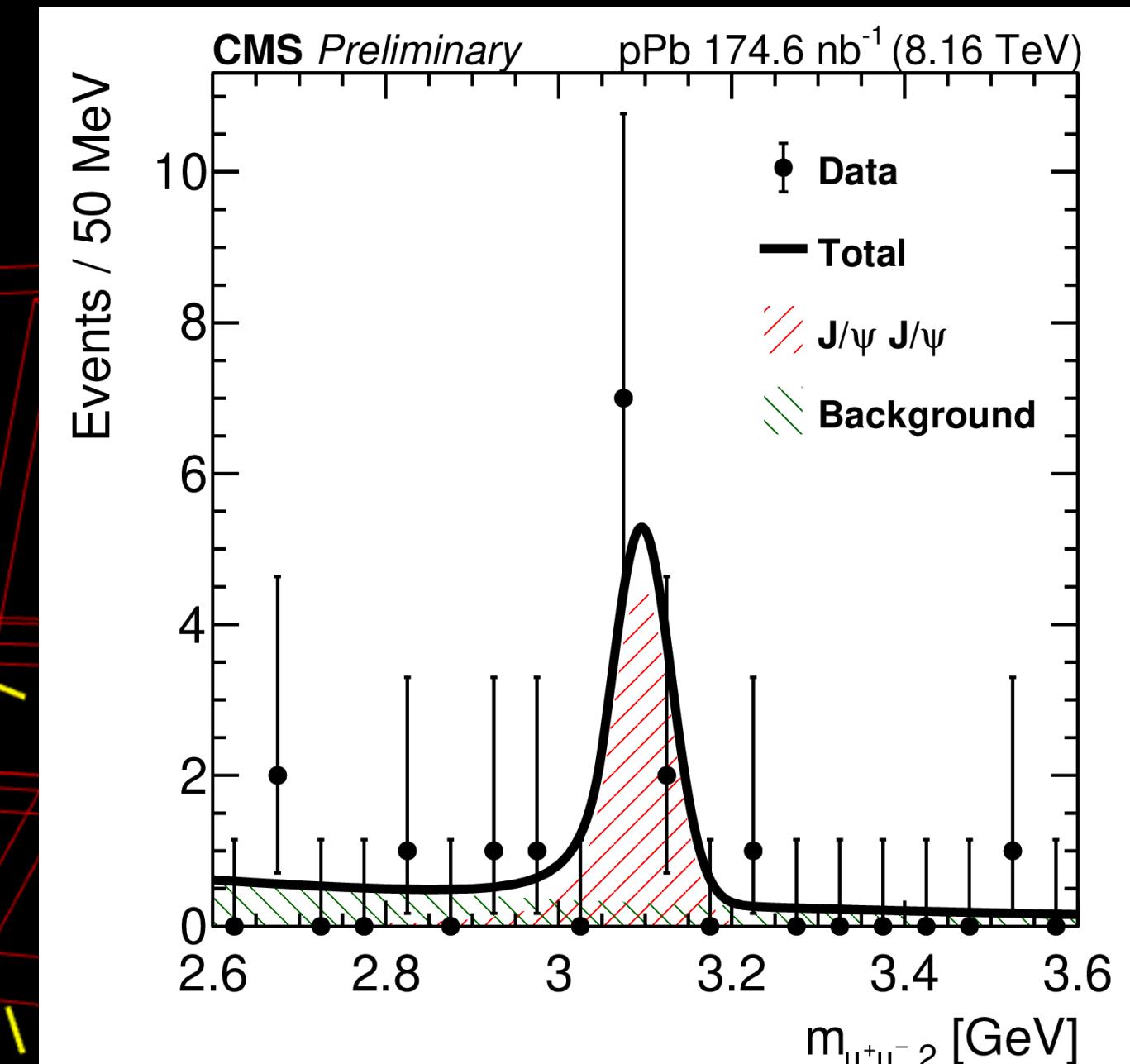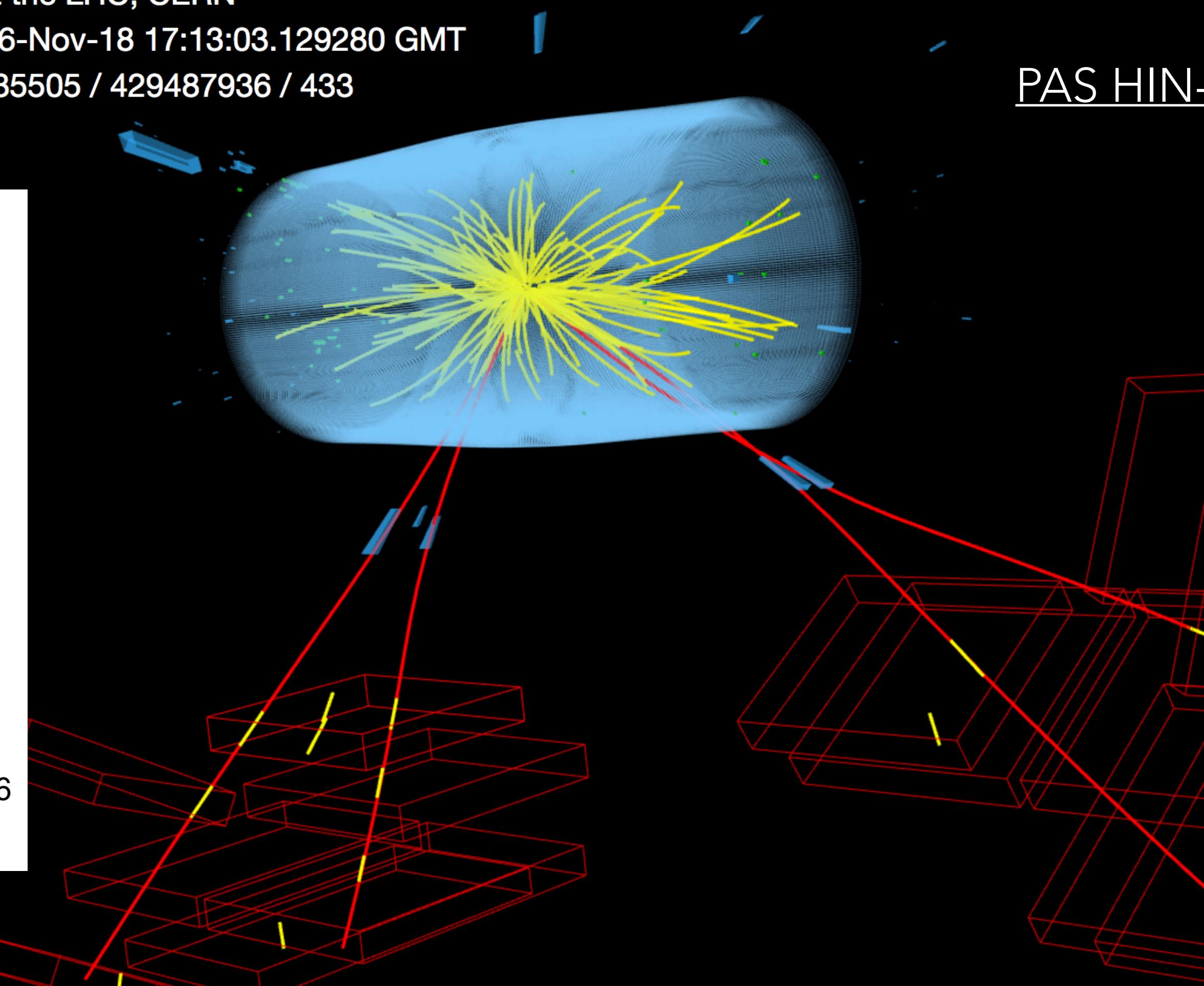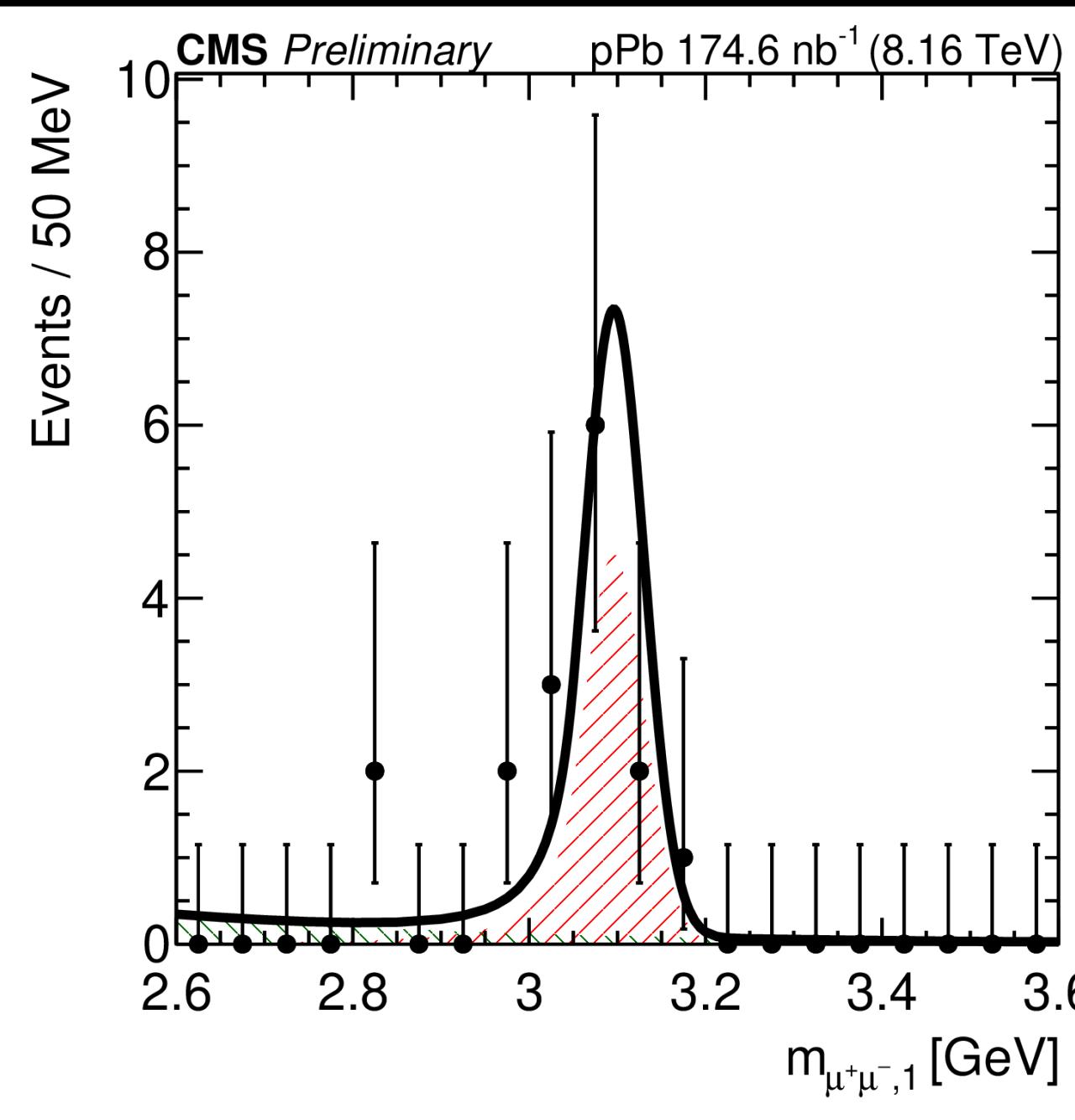
CMS Experiment at the LHC, CERN
Data recorded: 2016-Nov-18 17:13:03.129280 GMT
Run / Event / LS: 285505 / 429487936 / 433

PAS HIN-23-013

Stefanos Leontsinis
HF&Q, Tues. 14:40

$$N(J/\psi\ J/\psi \rightarrow 2\ \mu^+\mu^-) = 8.5 \pm 3.4 \text{ events}$$

$$\sigma_{fiducial}(pPb \rightarrow J/\psi\ J/\psi) = 22.0 \pm 8.9 \text{ (stat)} \pm 1.5 \text{ (syst) nb}$$
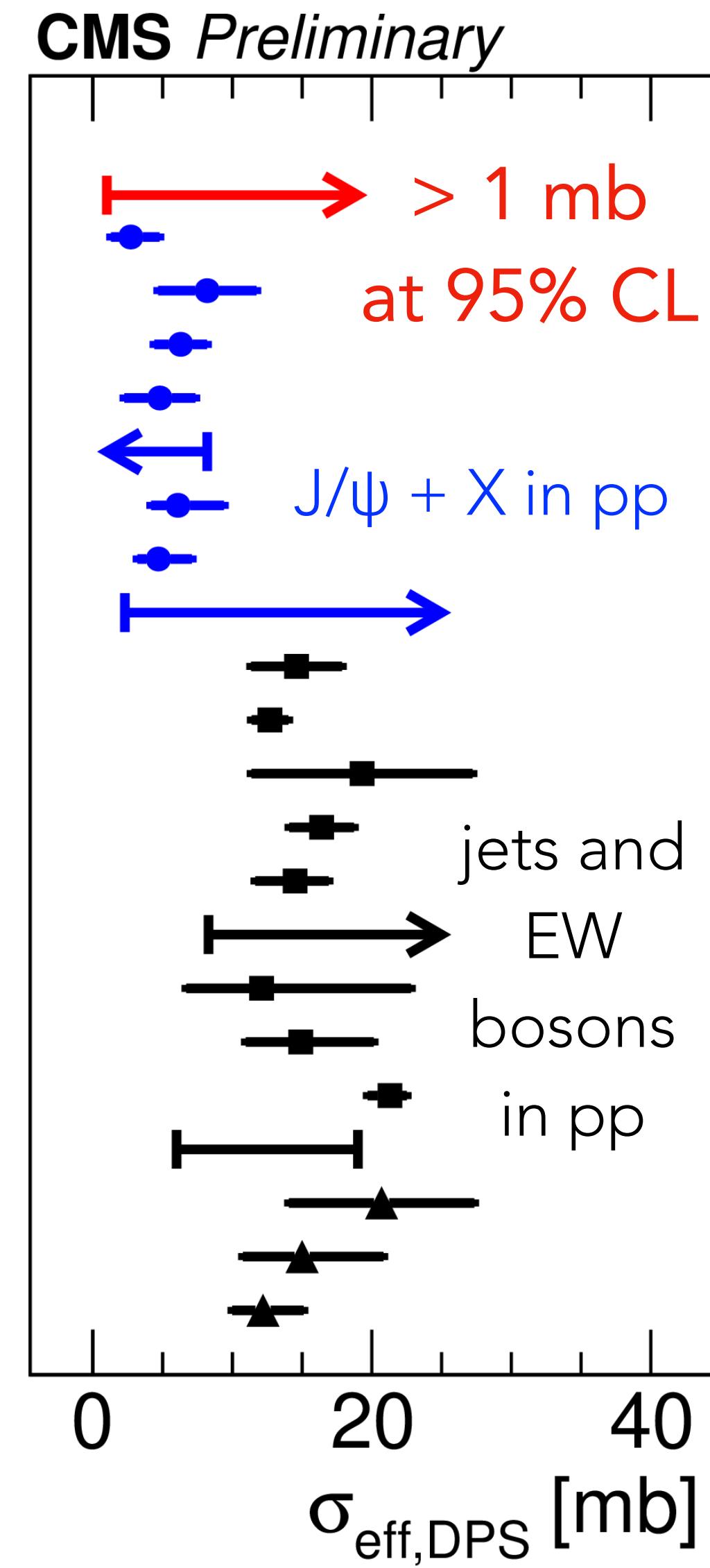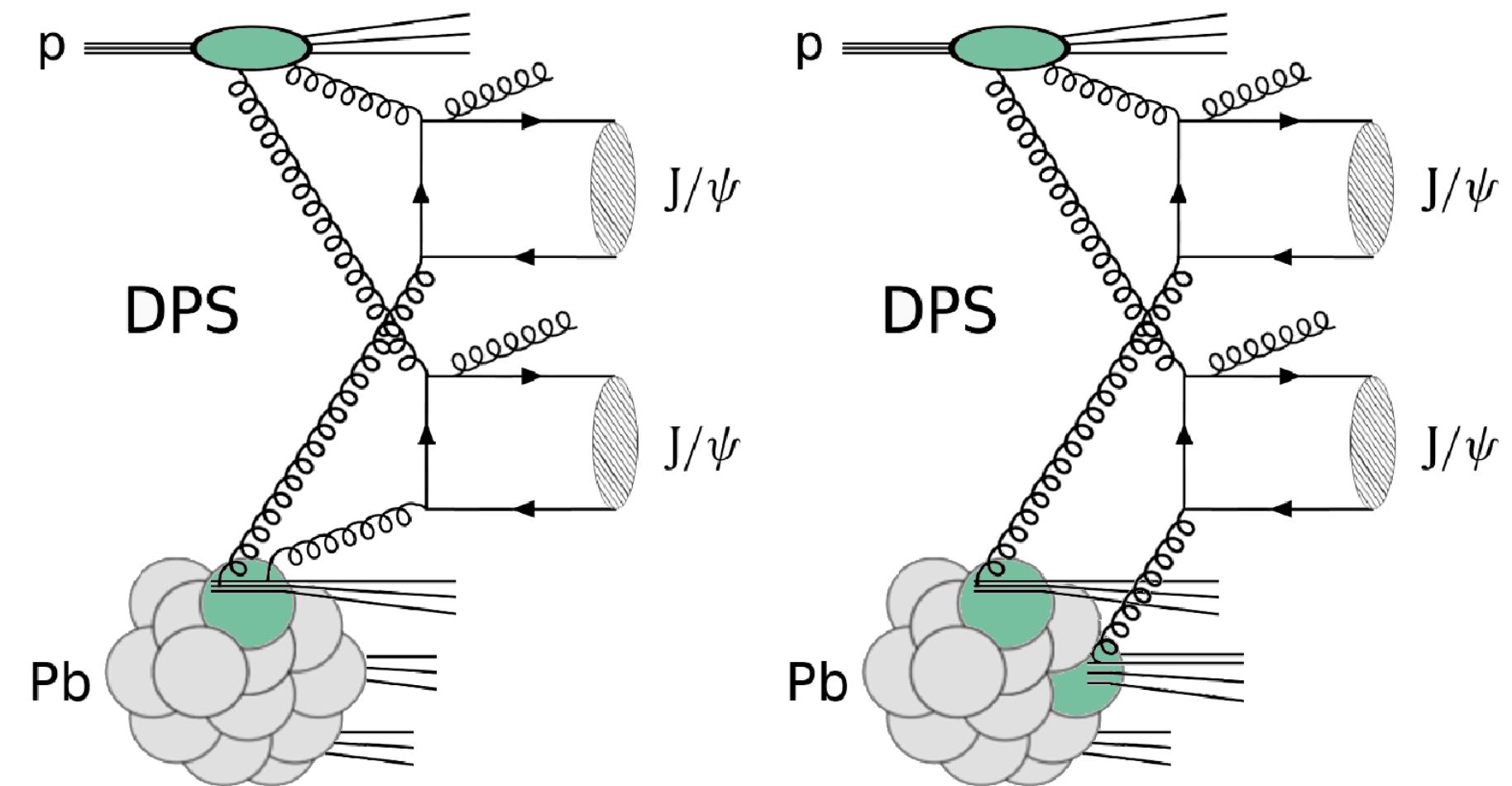
DPS effective cross section from pA data

Double parton scattering (DPS) greatly enhanced in pPb

▸ Probing the impact parameter dependence of nPDFs

▸ New system for correlation studies in the proton

$$\sigma_{DPS}(pPb \rightarrow J/\psi\, J/\psi) = 5.4 \pm 6.2\ (stat) \pm 0.4\ (syst)\ nb$$
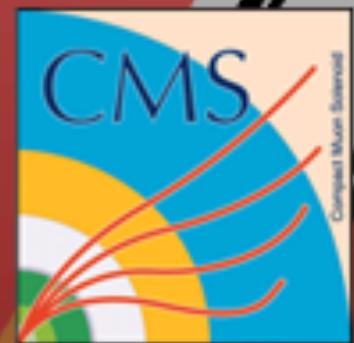
☛ First extraction of $\sigma_{eff,DPS}$ with nuclear collision data!

CMS *Preliminary*

> 1 mb
at 95% CL

J/ψ + X in pp

jets and
EW
bosons
in pp

$\sigma_{eff,DPS}$ [mb]

PAS HIN-23-013

CMS, $\sqrt{s_{NN}}$=8.16 TeV, J/ψ+J/ψ
CMS, √s=13 TeV, J/ψ+J/ψ+J/ψ
CMS*, √s=7 TeV, J/ψ+J/ψ
ATLAS, √s=8 TeV, J/ψ+J/ψ
D0, √s=1.96 TeV, J/ψ+J/ψ
D0*, √s=1.96 TeV, J/ψ+Y
ATLAS*, √s=7 TeV, W+J/ψ
ATLAS*, √s=8 TeV, Z+J/ψ
ATLAS*, √s=8 TeV, Z+b→J/ψ
D0, √s=1.96 TeV, γ+b/c+2-jet
D0, √s=1.96 TeV, γ+3-jet
D0, √s=1.96 TeV, 2-γ+2-jet
D0, √s=1.96 TeV, γ+3-jet
CDF, √s=1.8 TeV, γ+3-jet
UA2, √s=640 GeV, 4-jet
CDF, √s=1.8 TeV, 4-jet
ATLAS, √s=7 TeV, 4-jet
CMS, √s=7 TeV, 4-jet
CMS, √s=13 TeV, 4-jet
CMS, √s=7 TeV, W+2-jet
ATLAS, √s=7 TeV, W+2-jet
CMS, √s=13 TeV, WW

CMS Experiment at the LHC, CERN
Data recorded: 2018-Dec-01 00:10:01.732160 GMT
Run / Event / LS: 327516 / 441991631 / 827

Properties and effects of the hot medium

Original idea from F. Gardim et al, [PLB 809 (2020) 135749]

Impact parameter (b)

$$c_s^2 = \frac{dP}{d\varepsilon} = \frac{d(\ln T)}{d(\ln s)} = \frac{d(\ln\langle p_T\rangle)}{d(\ln N_{ch})}$$

$b \approx 0$

Temperature (T ≈ ⟨p_T⟩/3)

Entropy density (s), # of charged particles (N_{ch})

‣ **Speed of sound (c_S) of the QGP** unconstrained from experimental data

‣ Non-trivial hydrodynamic prediction leading to a simple relation between measurable quantities

☛ **direct extraction of c_S^2 from the multiplicity dependence of mean p_T in ultracentral collisions**

arXiv:2401.06896

Michael Murray
Bulk&Phase, Tues. 12:00

Measurement of $\langle \mathbf{p_T} \rangle$ **vs multiplicity**, normalized by their values in the 0–5% most central events
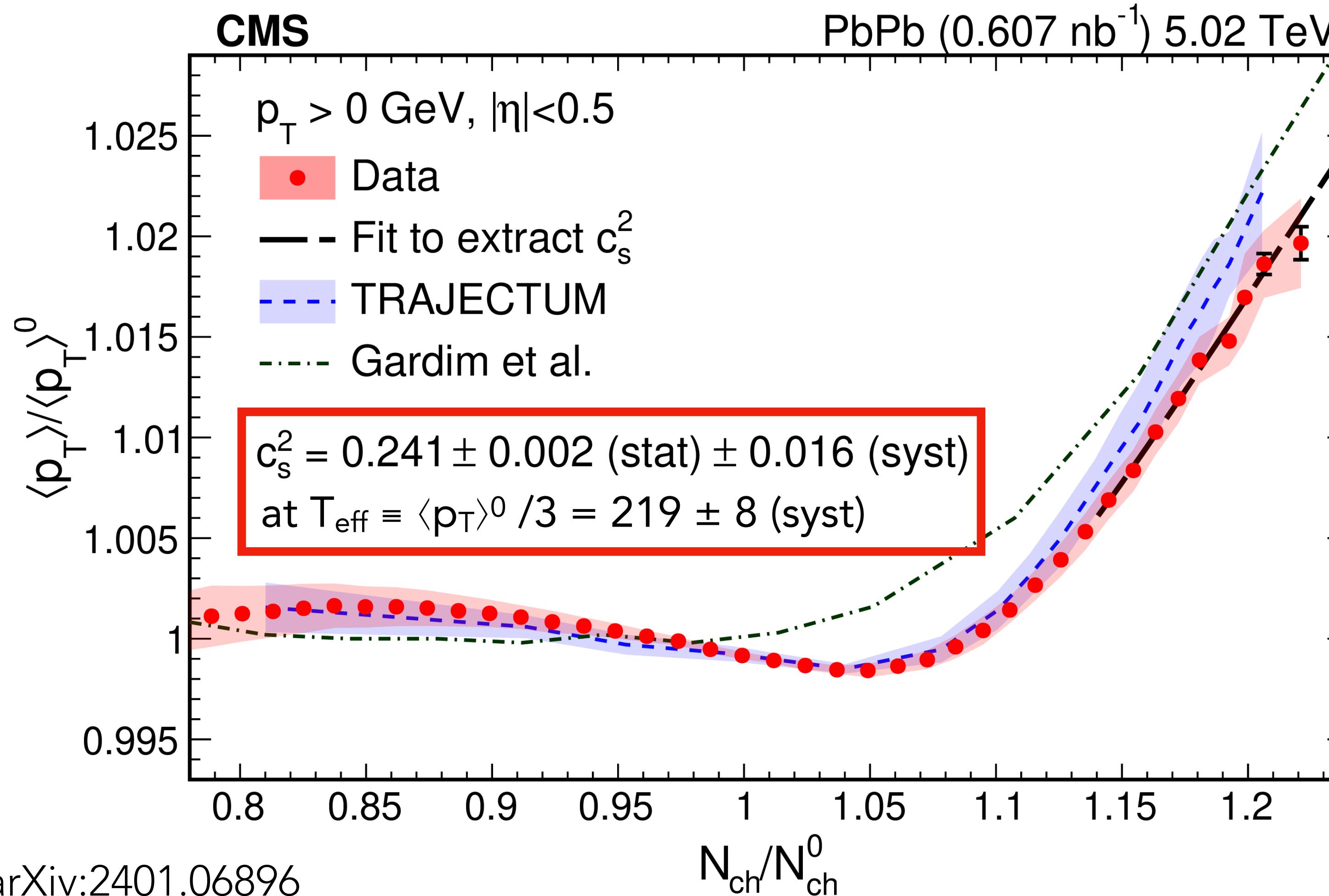
Steep rising trend matching the hydrodynamic model predictions

arXiv:2401.06896

Measurement of $\langle p_T \rangle$ **vs multiplicity**, normalized by their values in the 0–5% most central events

CMS

PbPb (0.607 nb^{-1}) 5.02 TeV

$p_T > 0$ GeV, $|\eta| < 0.5$

- Data
- Fit to extract c_s^2
- TRAJECTUM
- Gardim et al.

$c_s^2 = 0.241 \pm 0.002$ (stat) ± 0.016 (syst)
at $T_{eff} \equiv \langle p_T \rangle^0 / 3 = 219 \pm 8$ (syst)

Y-axis: $\langle p_T \rangle / \langle p_T \rangle^0$

X-axis: N_{ch}/N_{ch}^0
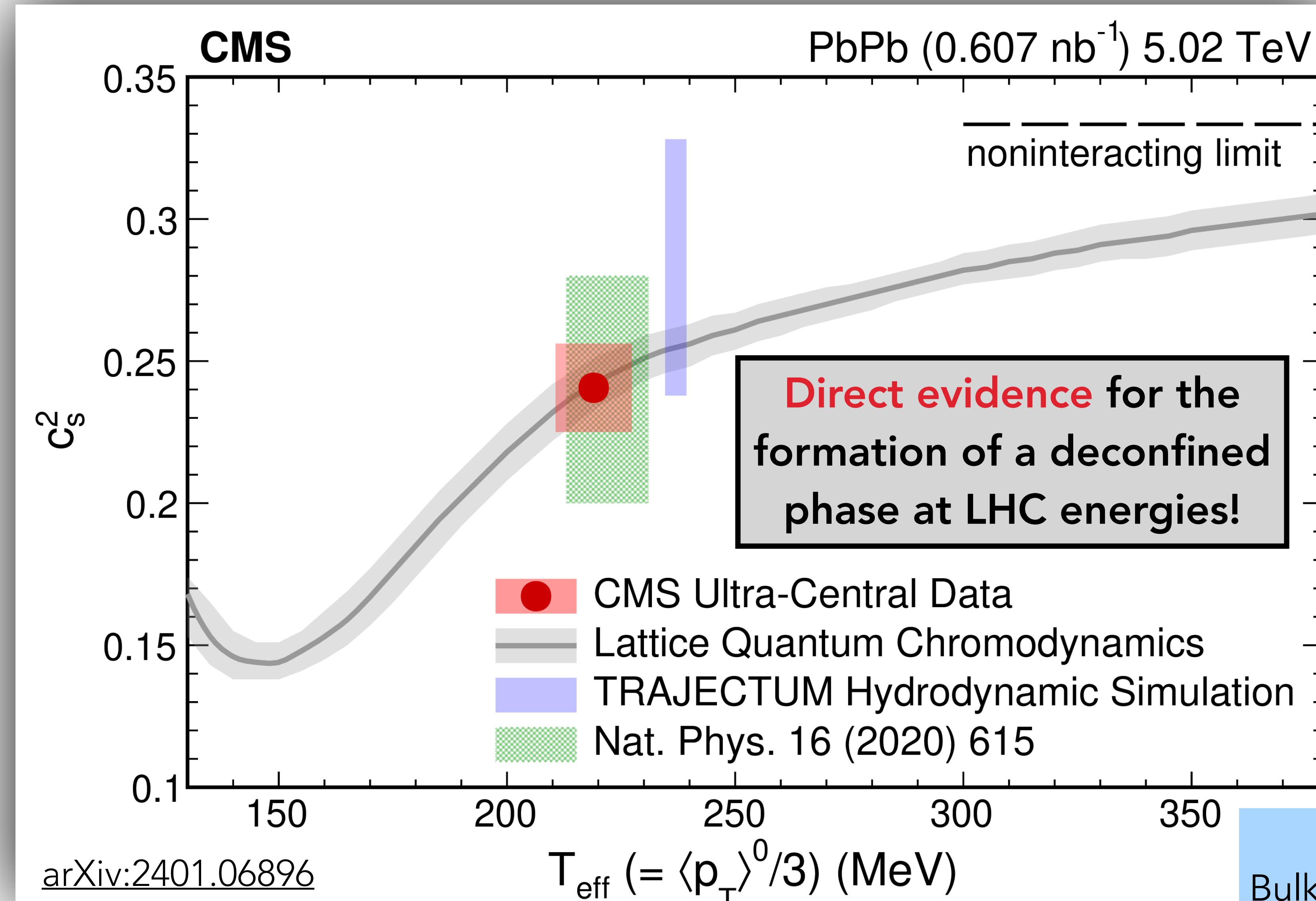
Steep rising trend matching the hydrodynamic model predictions

☞ **c_s^2 fitted as the data slope** with T_{eff} estimated from $\langle p_T \rangle^0$ (hydrodynamic correspondence)

arXiv:2401.06896

Michael Murray
Bulk&Phase, Tues. 12:00

CMS
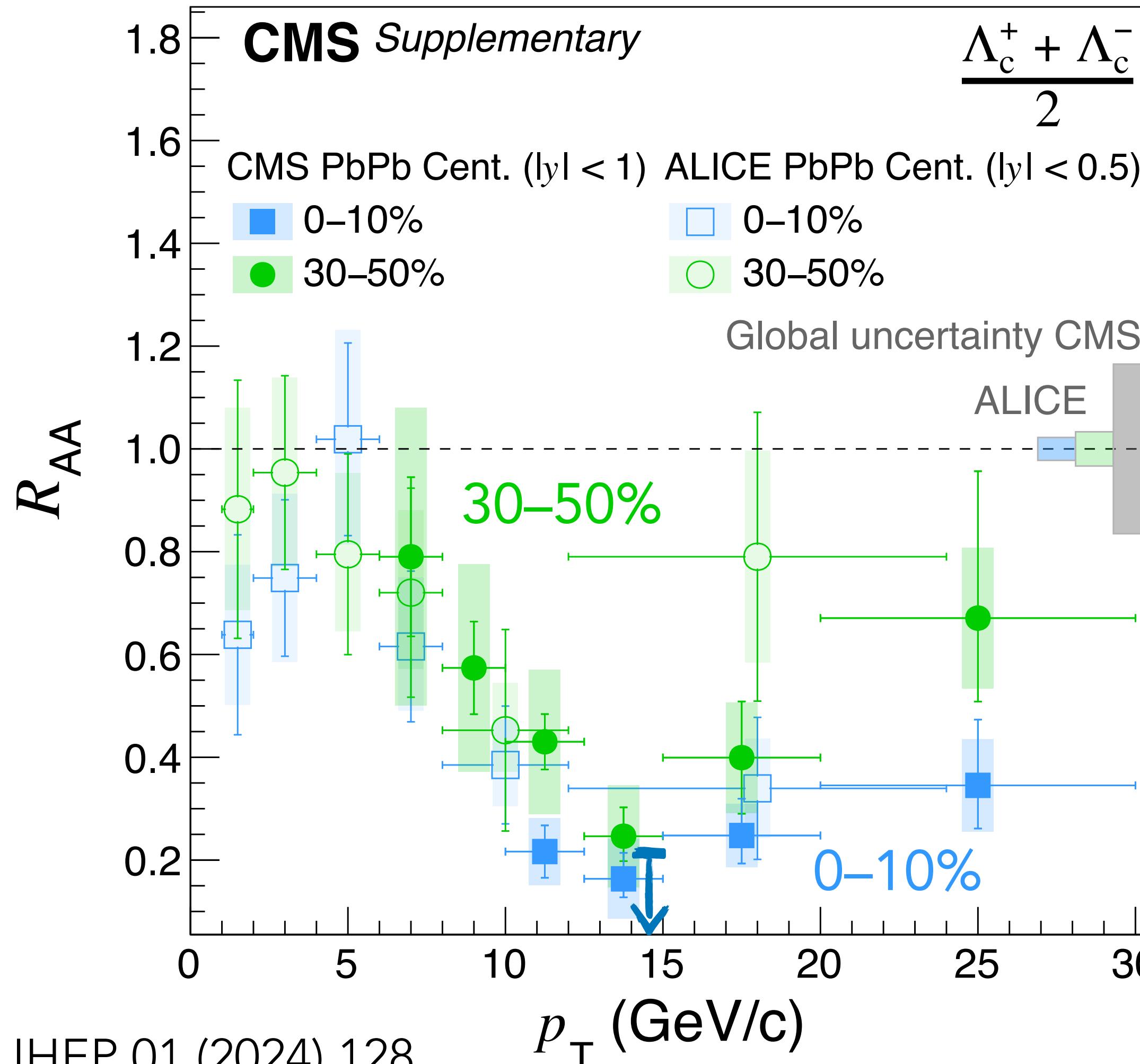
PbPb (0.607 nb^{-1}) 5.02 TeV

noninteracting limit

Direct evidence for the formation of a deconfined phase at LHC energies!

- CMS Ultra-Central Data
- Lattice Quantum Chromodynamics
- TRAJECTUM Hydrodynamic Simulation
- Nat. Phys. 16 (2020) 615

c_s^2

T_{eff} (= $\langle p_T \rangle^0 / 3$) (MeV)

arXiv:2401.06896
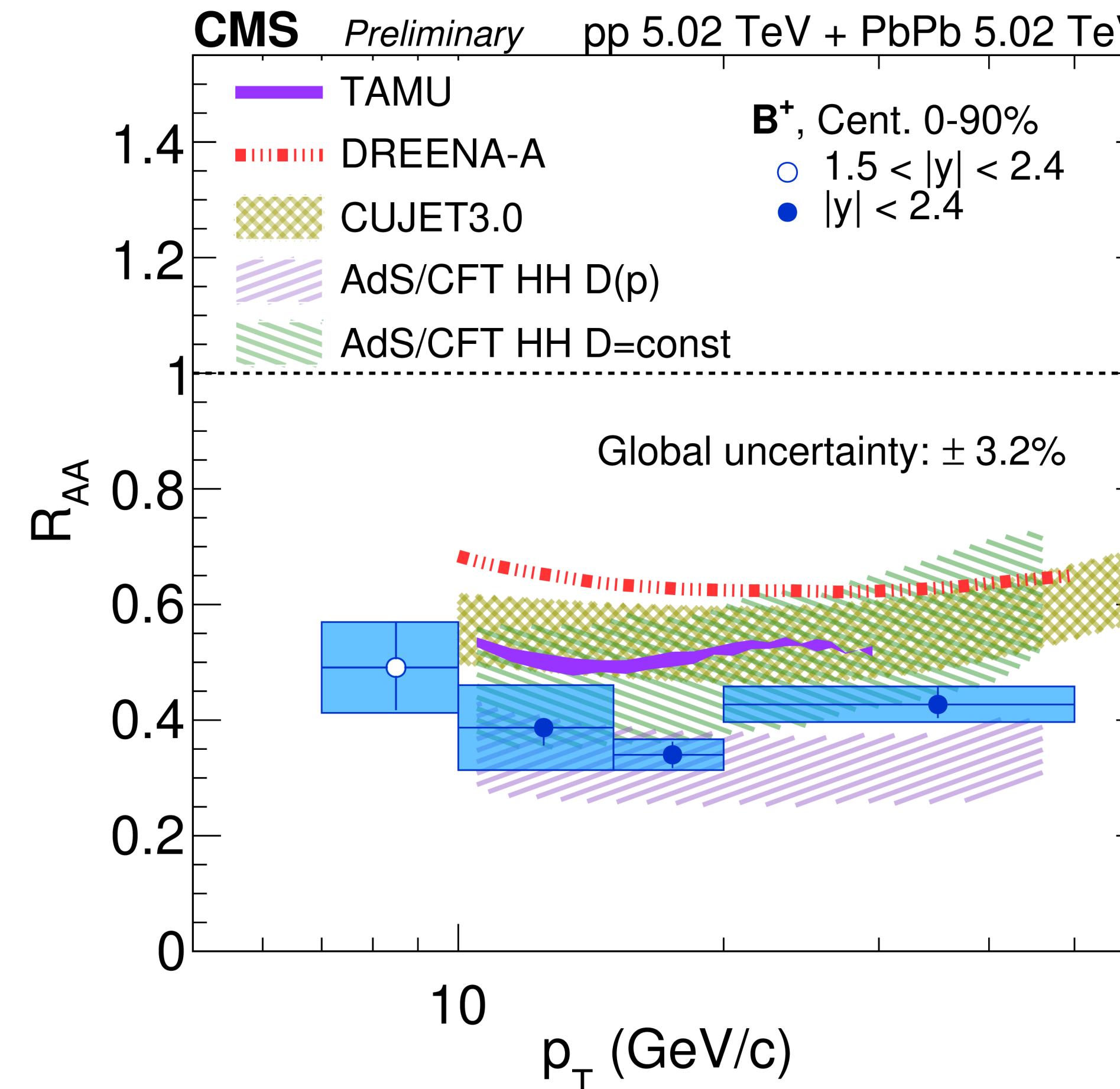
Michael Murray
Bulk&Phase, Tues. 12:00

Soumik Chandra
HF&Q, Tues. 17:50

PbPb 0.607 nb^{-1}, pp 252 nb^{-1} (5.02 TeV)

▸ Significant suppression of prompt Λ_c production up to $p_T = 30$ GeV/c

- **stronger for the most central events**
- energy loss of charm quarks

▸ Minimum of R_{AA} shifted to higher p_T compared to D^0

JHEP 01 (2024) 128

CMS FINAL RESULT SQM24

Soumik Chandra
HF&Q, Tues. 17:50

PbPb 0.607 nb^{-1}, pp 252 nb^{-1} (5.02 TeV)

CMS
$|y| < 1$

- pp
- 0–90% PbPb
- 0–10% PbPb
- PRL124 (2020) 042301
  Cent. 0–20%

Global uncertainty
pp: 6.6%
PbPb: 7.3%

PbPb

pp

$(\Lambda_c^+ + \Lambda_c^-) / (D^0 + \overline{D^0})$

p_T (GeV/c)

▶ Significant suppression of prompt Λ_c production up to p_T = 30 GeV/c

  • stronger for the most central events

  • energy loss of charm quarks

▶ Minimum of R_{AA} shifted to higher p_T compared to D^0

▶ Λ_c / D^0 consistent in PbPb and pp

  • similar plateau for p_T > 10 GeV/c

  ☛ **no significant contribution from coalescence**
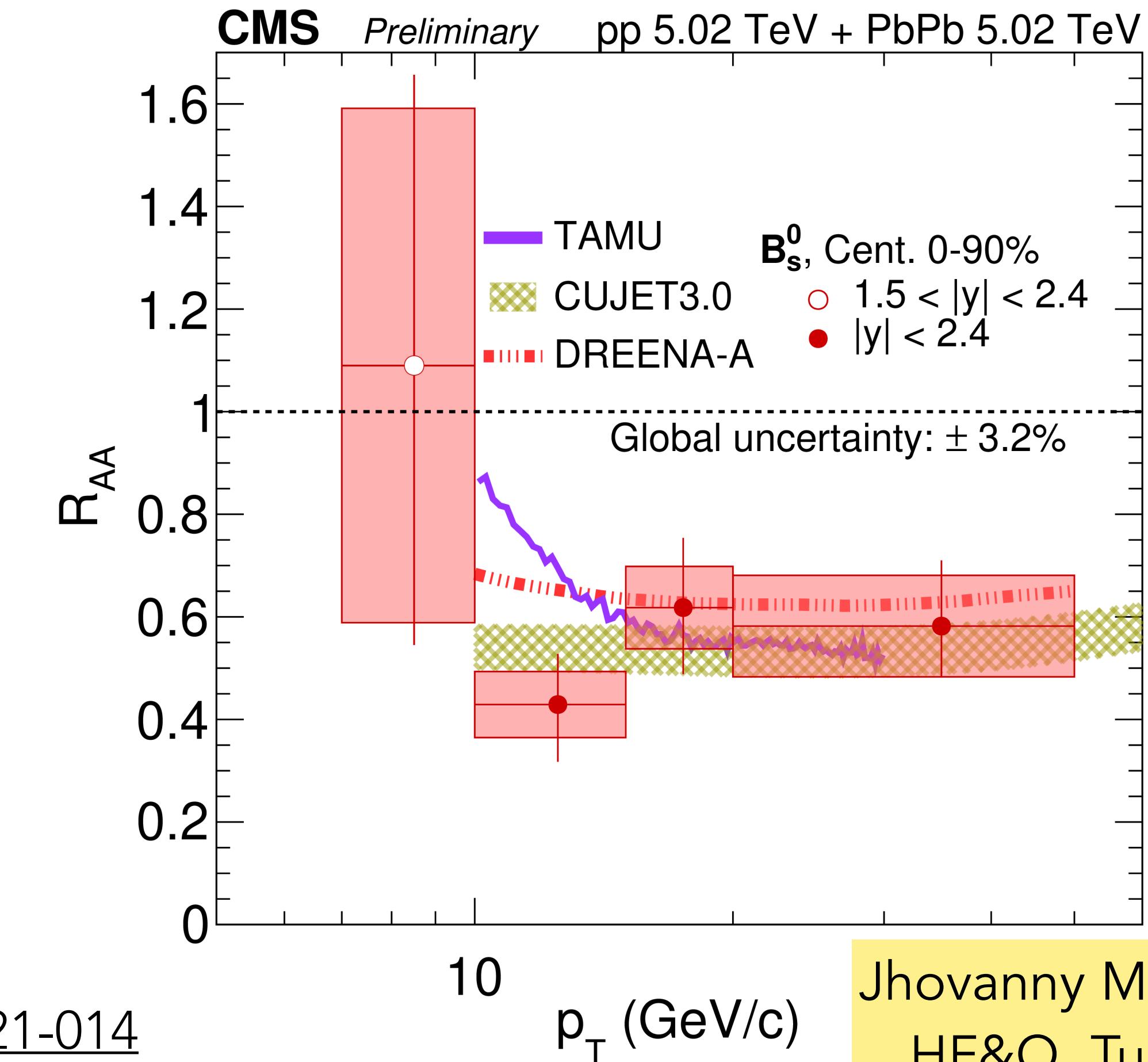
Updated **B⁺ measurement** more precise than calculations uncertainties at high p_T

Updated **B$_s$ measurement** consistent with different model approaches

PAS HIN-21-014
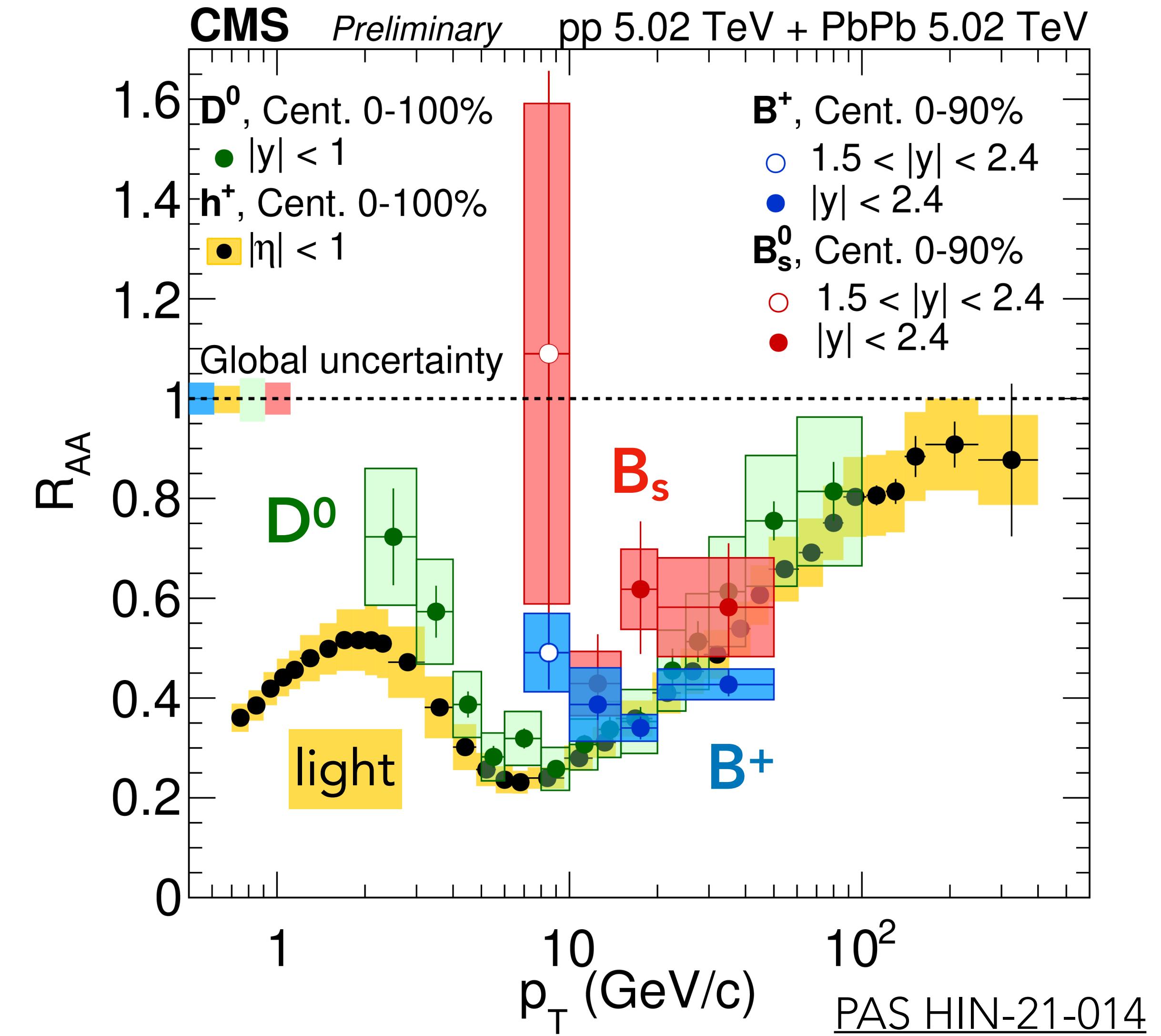
Suppression of B+ and Bs similar to lighter hadrons at high p_T

☞ mass/flavor-dependence of parton energy loss

R_{AA} of fully-reconstructed hadrons from light to beauty flavor from CMS
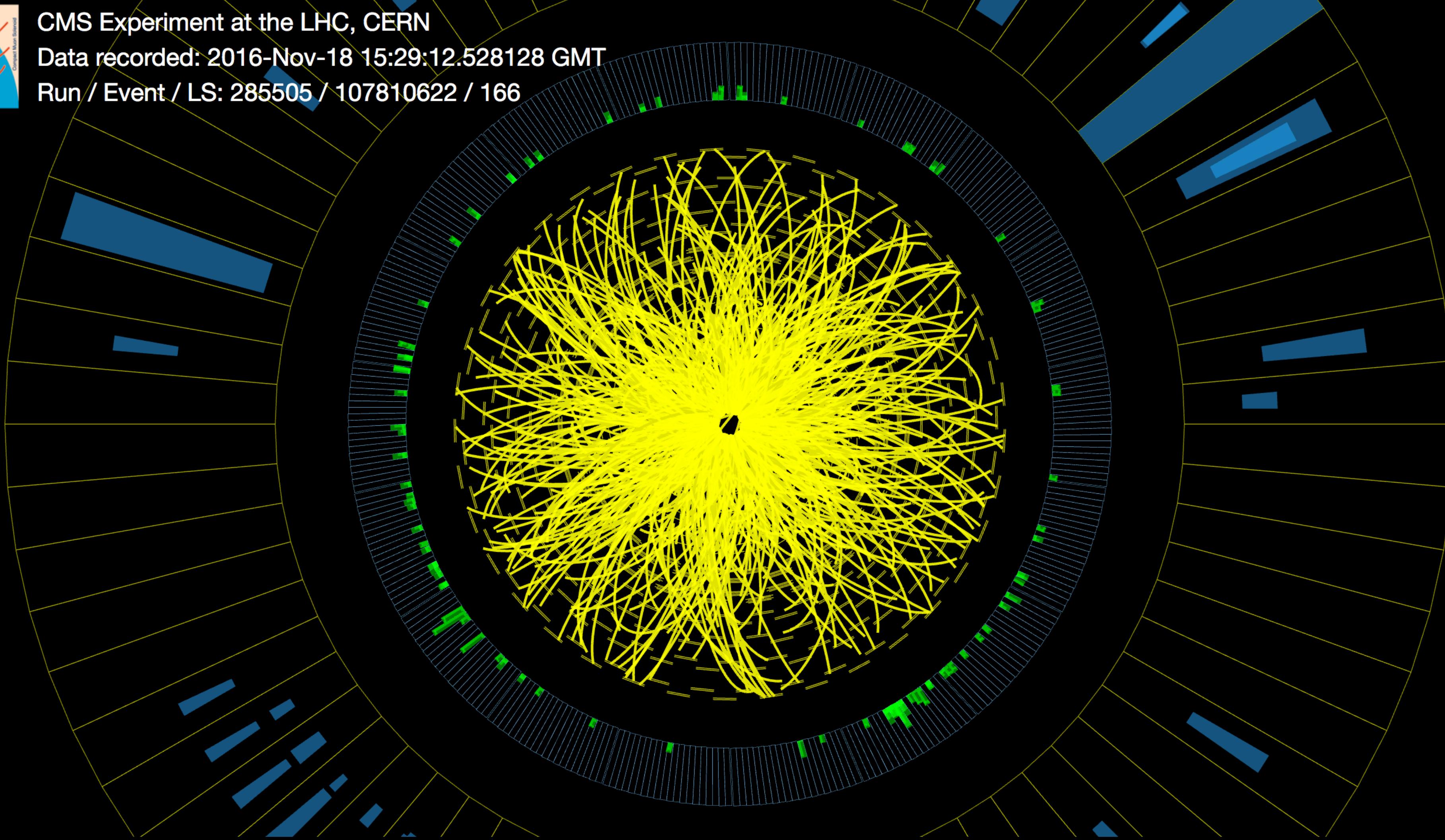
CMS *Preliminary*   pp 5.02 TeV + PbPb 5.02 TeV

D⁰, Cent. 0-100%
● |y| < 1
h⁺, Cent. 0-100%
● |η| < 1

B⁺, Cent. 0-90%
○ 1.5 < |y| < 2.4
● |y| < 2.4
B⁰ₛ, Cent. 0-90%
○ 1.5 < |y| < 2.4
● |y| < 2.4

Global uncertainty

R_{AA}

p_T (GeV/c)

Jhovanny Mejia Guisao
HF&Q, Tues. 09:50

PAS HIN-21-014
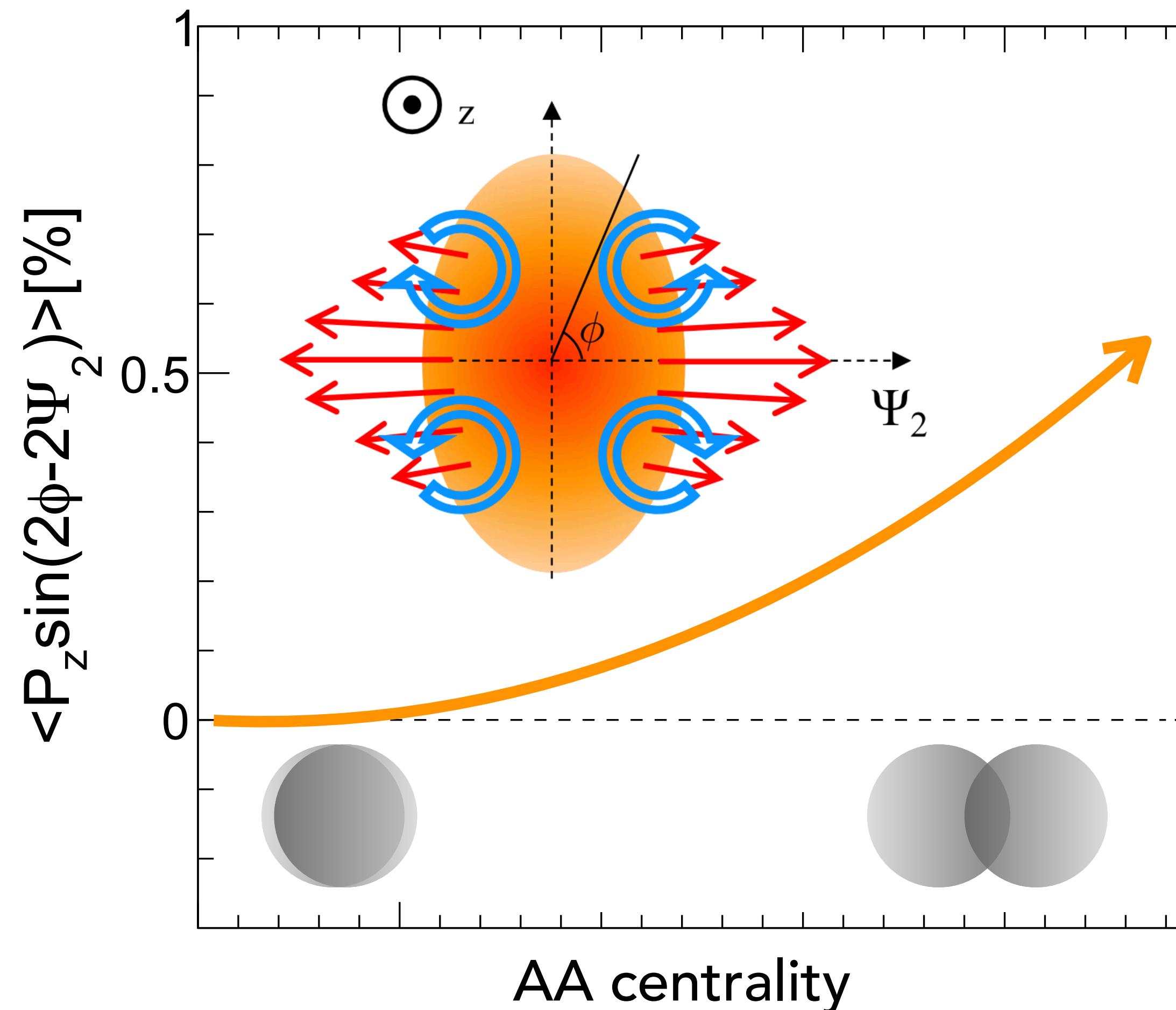
Medium-like effects in small systems

Local Polarization of Hyperons

Sketch from STAR Collaboration, PRL 131 (2023) 202301
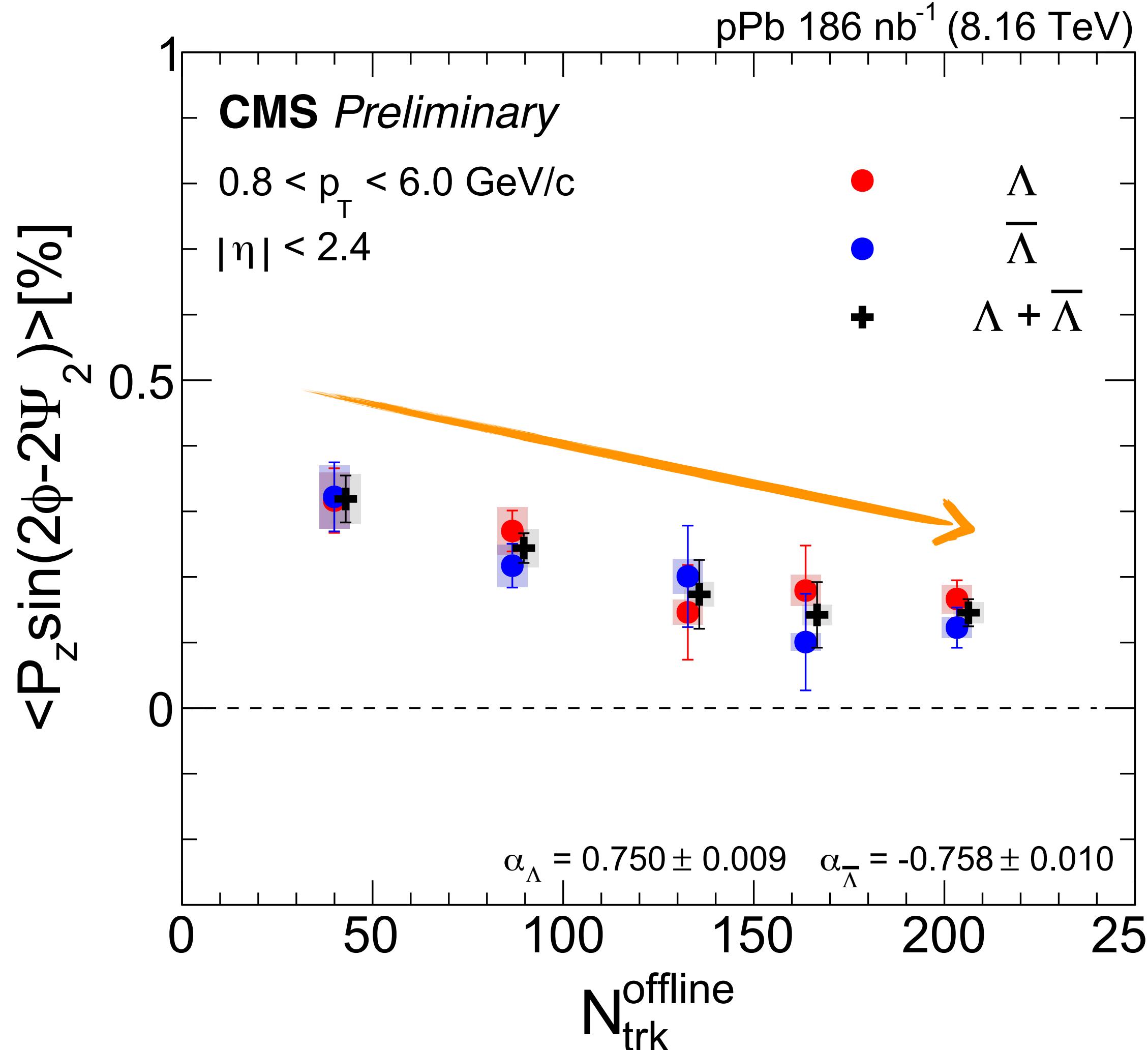
▸ **Vorticity fields** induced by the **collective flow**

- **particle polarization along the beam axis P_z** characterized by Fourier sine coefficients
- second order: $P_{z,\,s2} = \langle P_z \sin(2(\phi - \Psi_2)) \rangle$

▸ **Positive signal observed for Λ in AA collisions***

- **magnitude increasing with the asymmetry**
- **what about small systems?**

*STAR Collaboration, PRL 123 (2019) 132301 and PRL 131 (2023) 202301
ALICE Collaboration, PRL 128 (2022) 172005
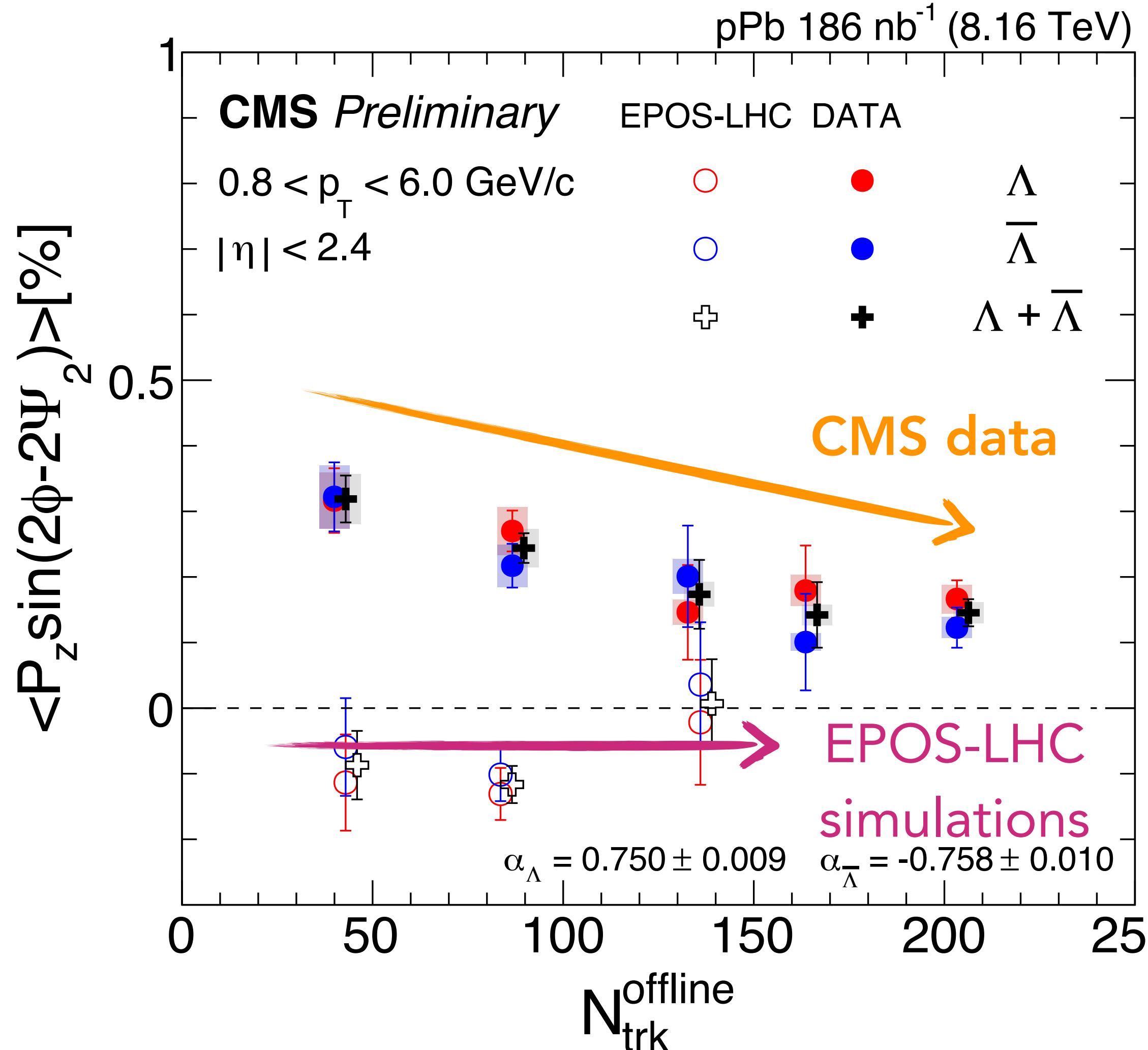
PAS HIN-24-002


- **First measurement of Λ local polarization in pPb**

- **Significant positive $P_{z,s2}$ decreasing as function of the multiplicity**
  - results consistent with 0 for Ks (spin 0)
  - trend similar to the observation in AA collisions

Chenyan Li
Bulk&Phase, Wed. 11:00
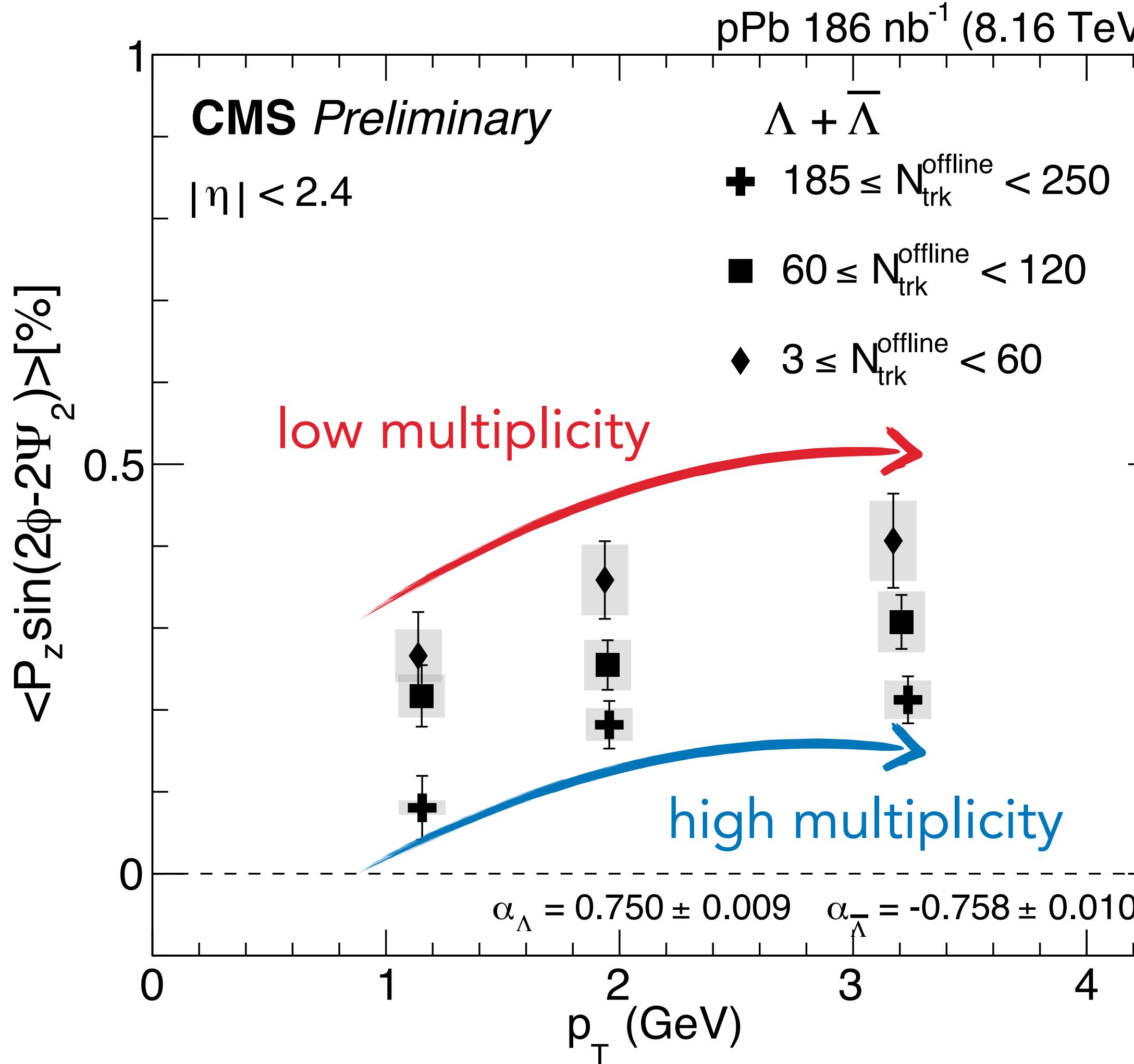
PAS HIN-24-002

pPb 186 nb^{-1} (8.16 TeV)

CMS *Preliminary*   EPOS-LHC DATA

$0.8 < p_T < 6.0$ GeV/c

$|\eta| < 2.4$

○ ● Λ

○ ● $\overline{\Lambda}$

✛ ✚ Λ + $\overline{\Lambda}$

$\langle P_z \sin(2\phi - 2\Psi_2) \rangle$ [%]

CMS data

EPOS-LHC simulations

$\alpha_\Lambda = 0.750 \pm 0.009$ $\alpha_{\overline{\Lambda}} = -0.758 \pm 0.010$

$N_{trk}^{offline}$

▸ **First measurement of Λ local polarization in pPb**

▸ **Significant positive P$_{z,s2}$ decreasing as function of the multiplicity**

  • results consistent with 0 for Ks (spin 0)

  • trend similar to the observation in AA collisions

▸ Zero if not negative signal from EPOS LHC (absence of polarization mechanism)

Chenyan Li
Bulk&Phase, Wed. 11:00

PAS HIN-24-002

pPb 186 nb^{-1} (8.16 TeV)

CMS *Preliminary*

$\Lambda + \overline{\Lambda}$

$|\eta| < 2.4$

$+$ $185 \leq N_{trk}^{offline} < 250$

$\blacksquare$ $60 \leq N_{trk}^{offline} < 120$

$\blacklozenge$ $3 \leq N_{trk}^{offline} < 60$

low multiplicity

high multiplicity

$\langle P_z \sin(2\phi - 2\Psi_2)\rangle$ [%]

$\alpha_\Lambda = 0.750 \pm 0.009$ $\alpha_{\overline{\Lambda}} = -0.758 \pm 0.010$

p_T (GeV)
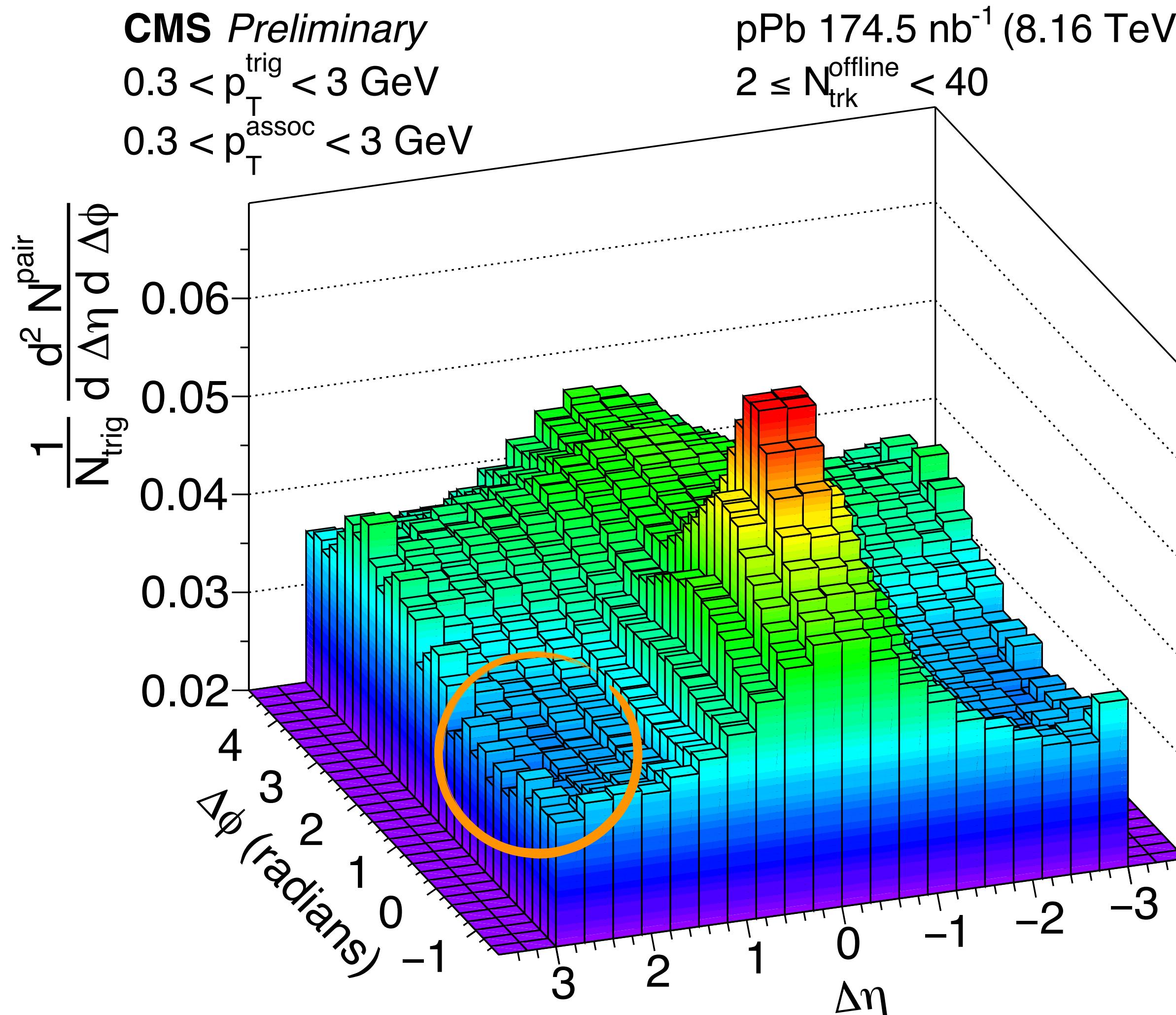
▸ **First measurement of Λ local polarization in pPb**

▸ **Positive P$_{z,s2}$ increasing with p$_T$**
  trend similar to v_2 measurements in pPb
  but different multiplicity dependence

☞ **presence of vorticity structures?**

☞ other spin polarization mechanisms?
  (e.g. polarizing fragmentation functions)

Chenyan Li
Bulk&Phase, Wed. 11:00
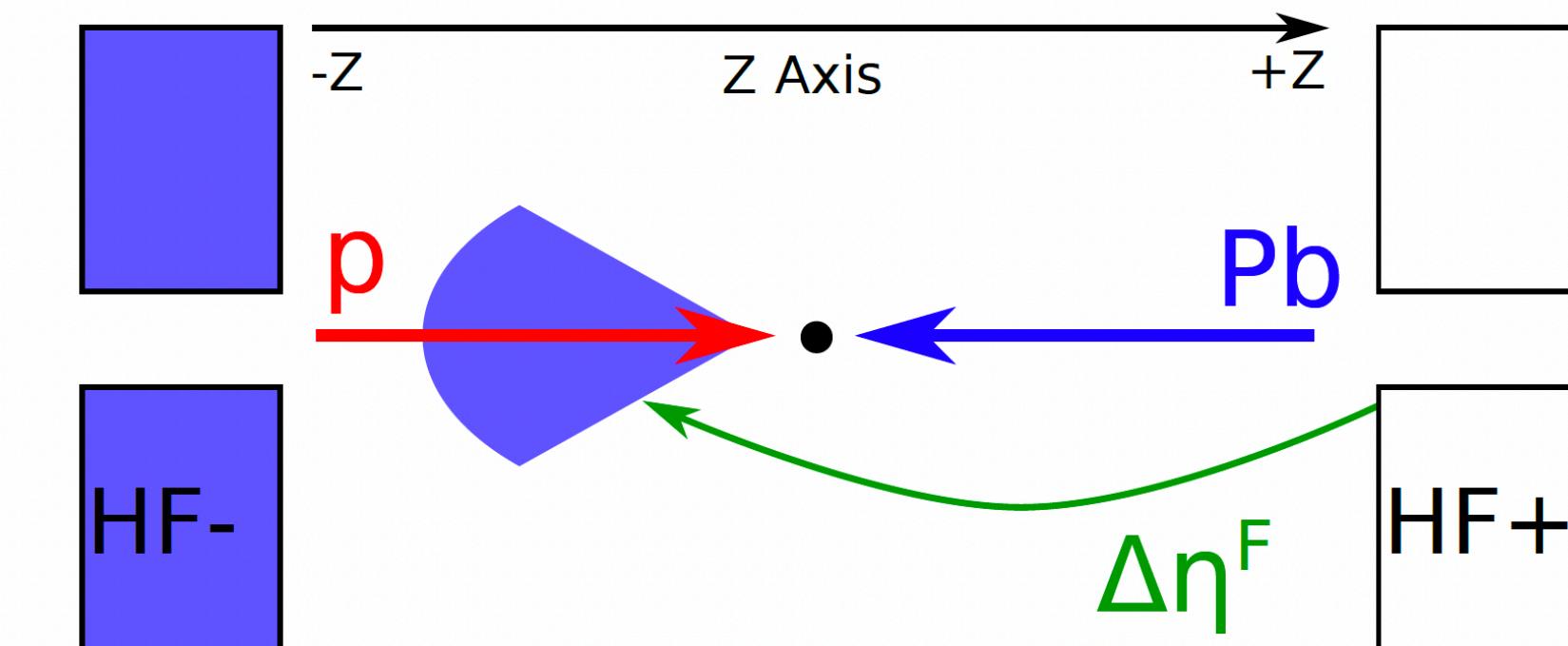
Michael Murray's poster

CMS *Preliminary*

$0.3 < p_T^{trig} < 3$ GeV

$0.3 < p_T^{assoc} < 3$ GeV

pPb 174.5 nb^{-1} (8.16 TeV)

$2 \leq N_{trk}^{offline} < 40$

PAS HIN-22-004

Two-particle correlations in events with a **large rapidity gap** on the proton-going side

☞ sample enriched in pomeron-Pb interactions, a **new 'small' system**
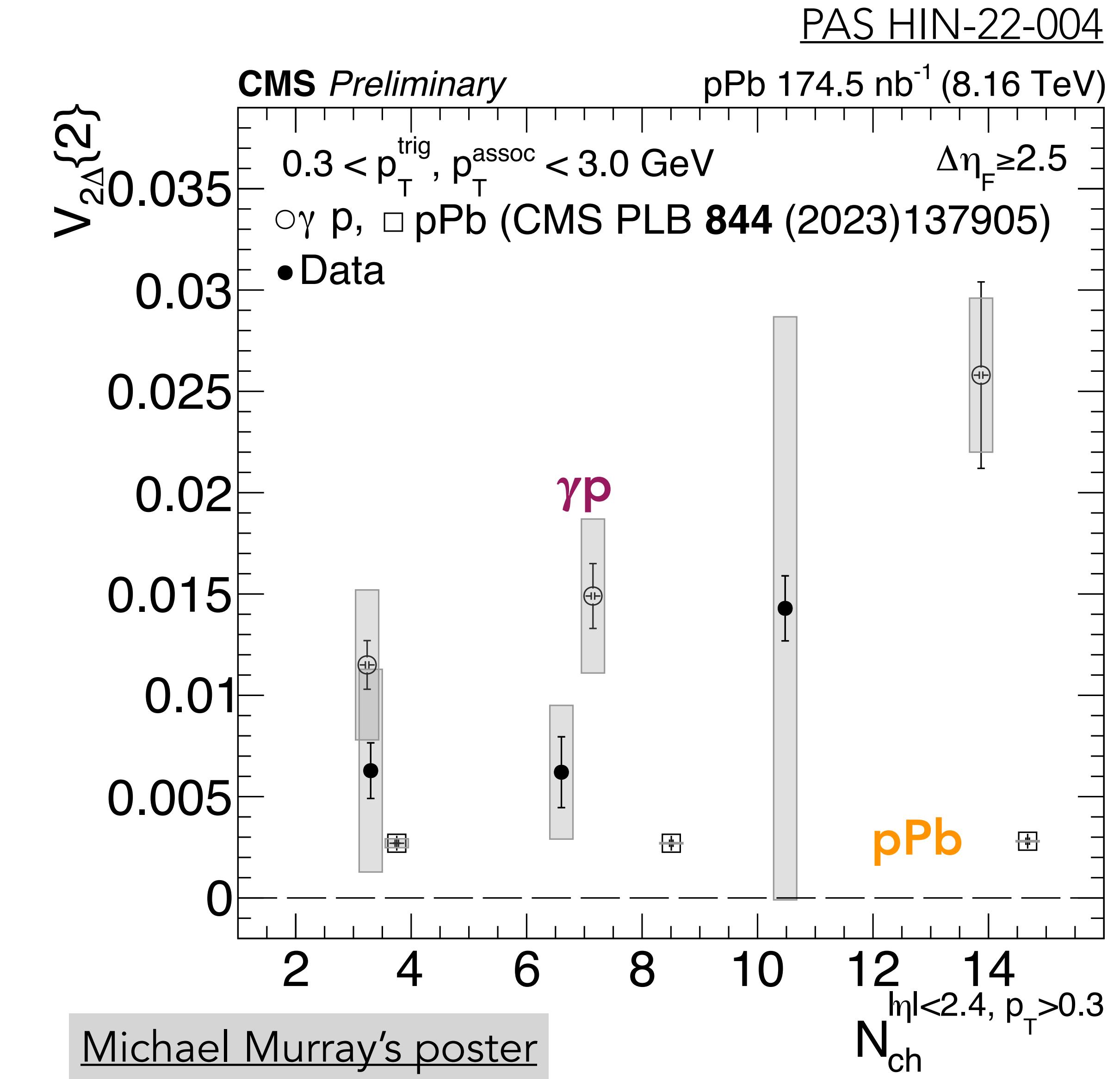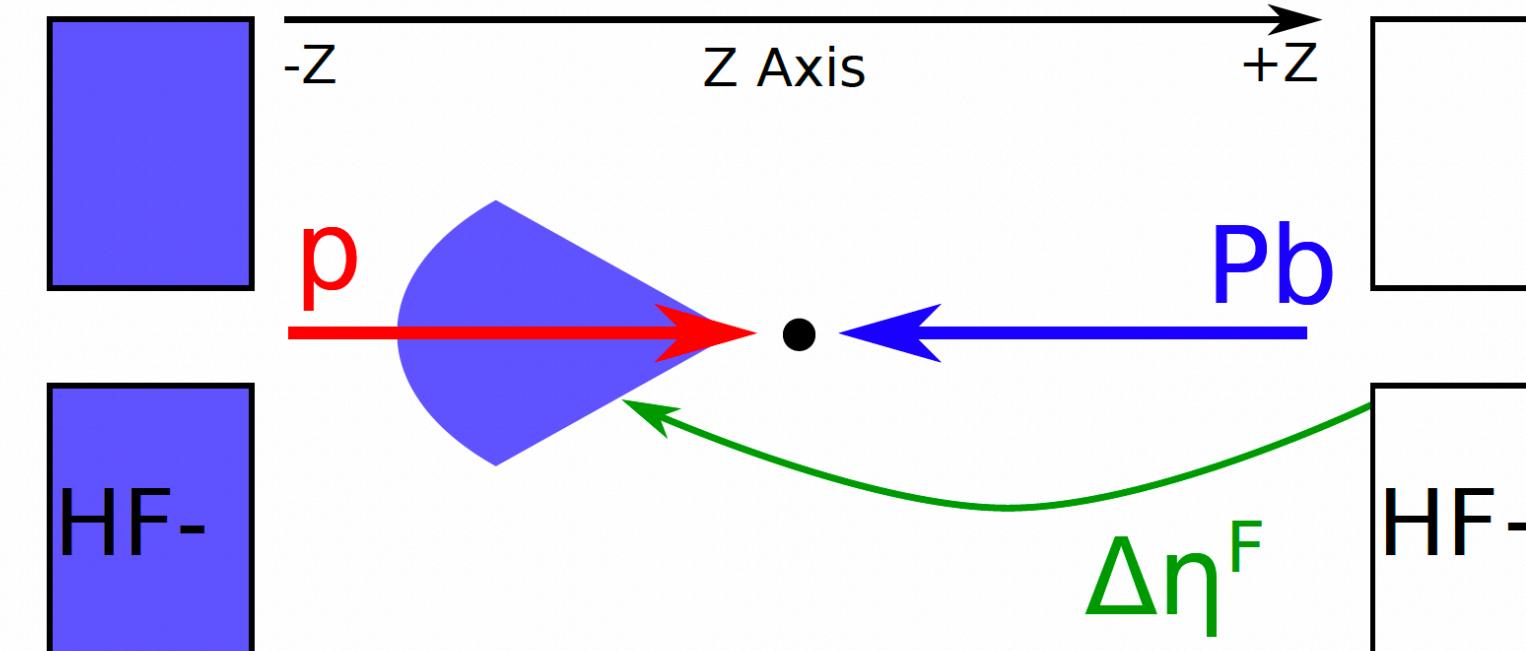
☞ **no ridge** observed in this configuration

PAS HIN-22-004
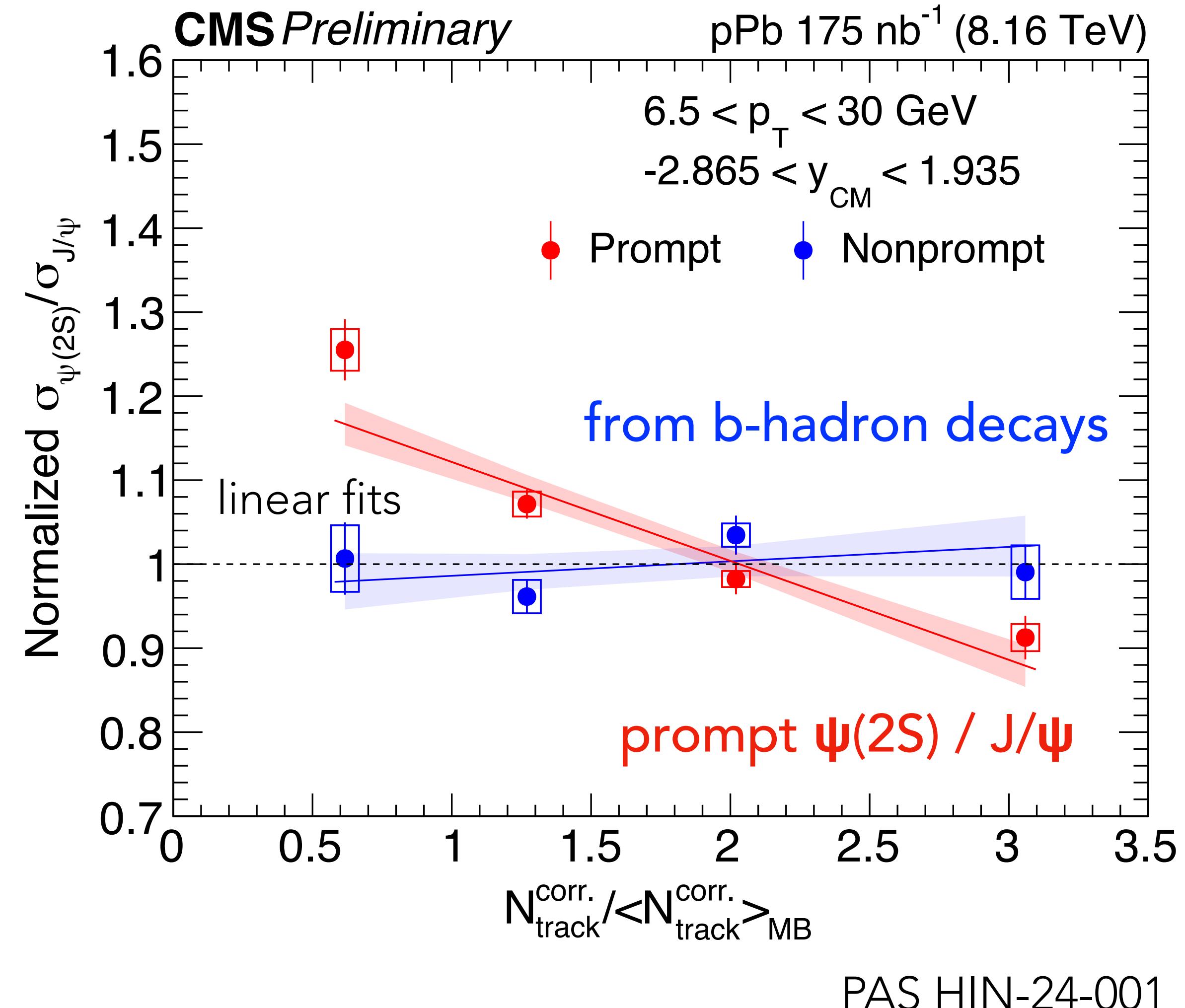
▸ Two-particle correlations in events with a
large rapidity gap on the proton-going side
☛ **no sign of non-zero v_2 signal**

▸ Complementary to measurements in
photon-proton and **diffractive pPb systems**

▸ Different rapidity gap sizes also studied

CMS *Preliminary*   pPb 174.5 nb^{-1} (8.16 TeV)

$0.3 < p_T^{trig}, p_T^{assoc} < 3.0$ GeV $\Delta\eta_F \geq 2.5$

○γ p, □ pPb (CMS PLB **844** (2023)137905)

● Data

γp

pPb

$V_{2\Delta}\{2\}$

$N_{ch}^{|\eta|<2.4,\ p_T>0.3}$

-Z   Z Axis   +Z

p   Pb

HF-   HF+

$\Delta\eta^F$

Michael Murray's poster

CMS
NEW RESULT
SQM24

$$\text{Normalized } \sigma_{\psi(2S),n} / \sigma_{J/\psi,n} = \frac{\sigma_{\psi(2S),n} / \sigma_{J/\psi,n}}{\sum_n \sigma_{\psi(2S),n} / \sum_n \sigma_{J/\psi,n}}$$

▸ Yield ratios to *cancel out* common modification from initial-state effects

▸ **Decrease with increasing multiplicity** for prompt while constant for b-hadron decay contributions

CMS *Preliminary*   pPb 175 nb^{-1} (8.16 TeV)

$6.5 < p_T < 30$ GeV

$-2.865 < y_{CM} < 1.935$

● Prompt   ● Nonprompt

from b-hadron decays

linear fits

prompt $\psi(2S) / J/\psi$

Normalized $\sigma_{\psi(2S)} / \sigma_{J/\psi}$

$N_{track}^{corr.} / \langle N_{track}^{corr.} \rangle_{MB}$

Austin Baty
HF&Q, Tues. 17:30

PAS HIN-24-001

CMS NEW RESULT SQM24

$$\text{Normalized } \sigma_{\psi(2S),n} / \sigma_{J/\psi,n} = \frac{\sigma_{\psi(2S),n} / \sigma_{J/\psi,n}}{\sum_n \sigma_{\psi(2S),n} / \sum_n \sigma_{J/\psi,n}}$$
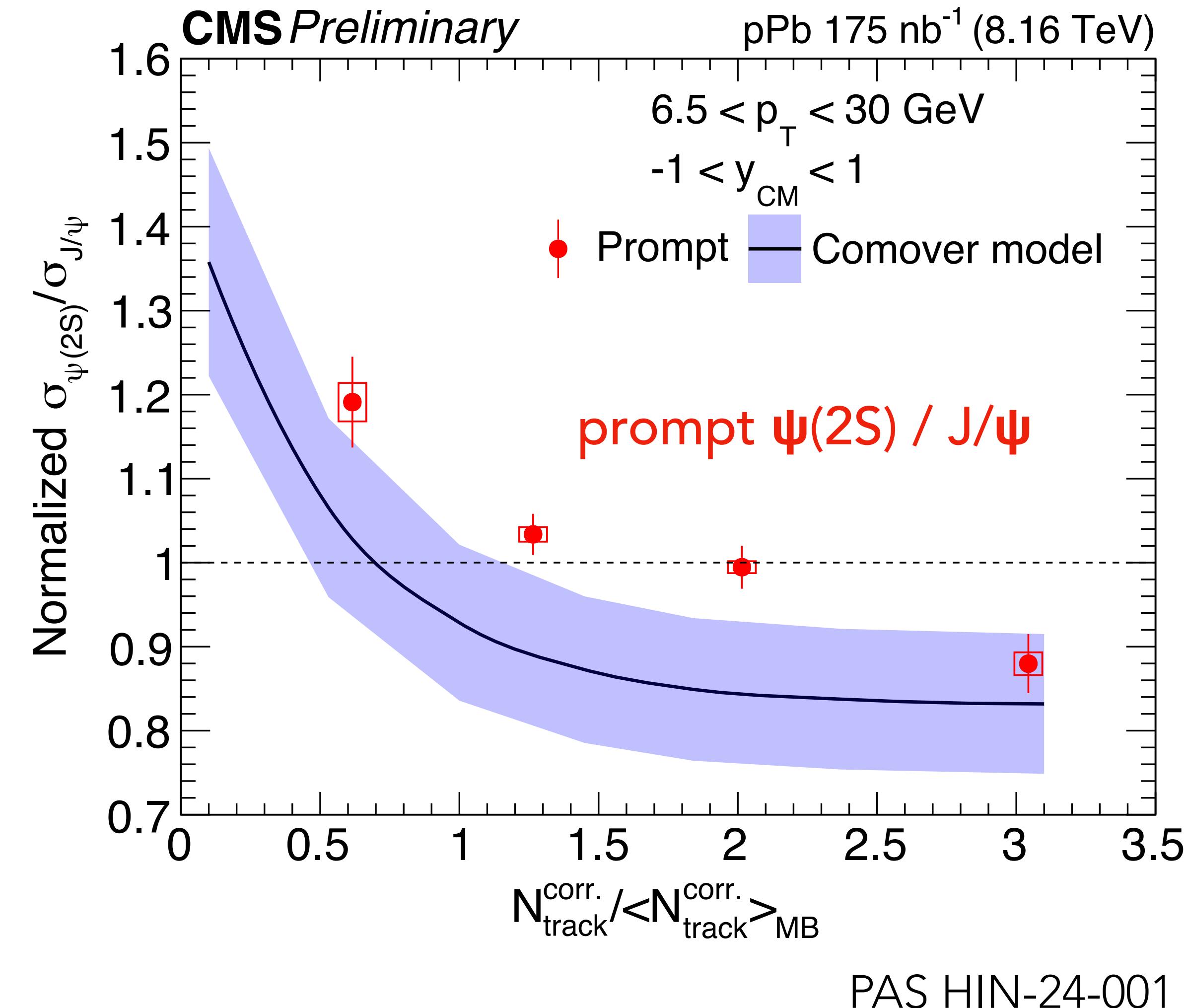
▸ Yield ratios to *cancel out* common modification from initial-state effects

▸ **Decrease with increasing multiplicity** for prompt while constant for b-hadron decay contributions

☛ **relative ψ(2S) suppression from final-state interactions** (comoving-particles picture[1])

CMS *Preliminary* — pPb 175 nb^{-1} (8.16 TeV)

$6.5 < p_T < 30$ GeV
$-1 < y_{CM} < 1$

● Prompt — Comover model

prompt ψ(2S) / J/ψ

Normalized $\sigma_{\psi(2S)}/\sigma_{J/\psi}$

$N_{track}^{corr.}/\langle N_{track}^{corr.}\rangle_{MB}$
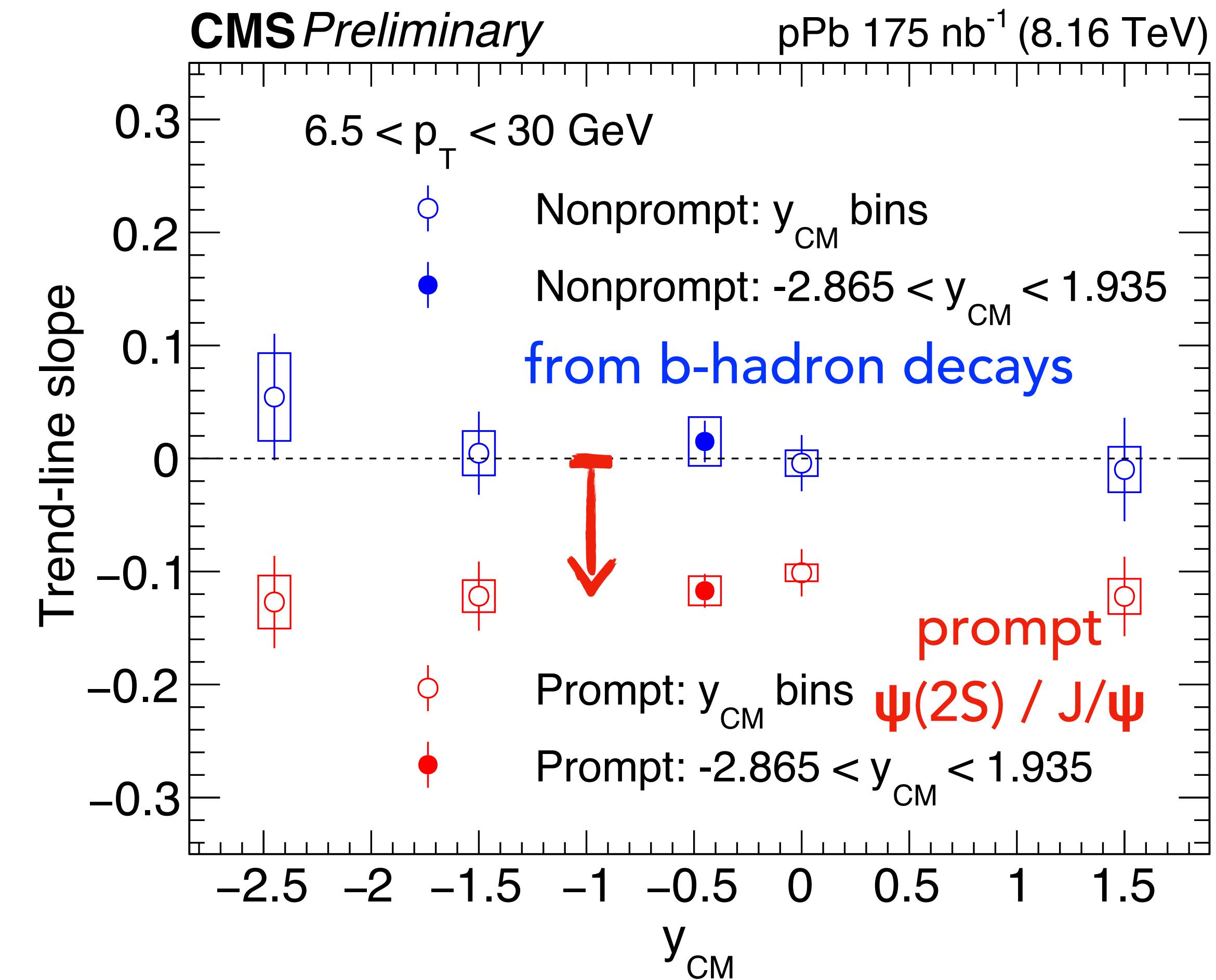
Austin Baty
HF&Q, Tues. 17:30

[1]E.G. Ferreiro, PLB 749 (2015) 98

PAS HIN-24-001
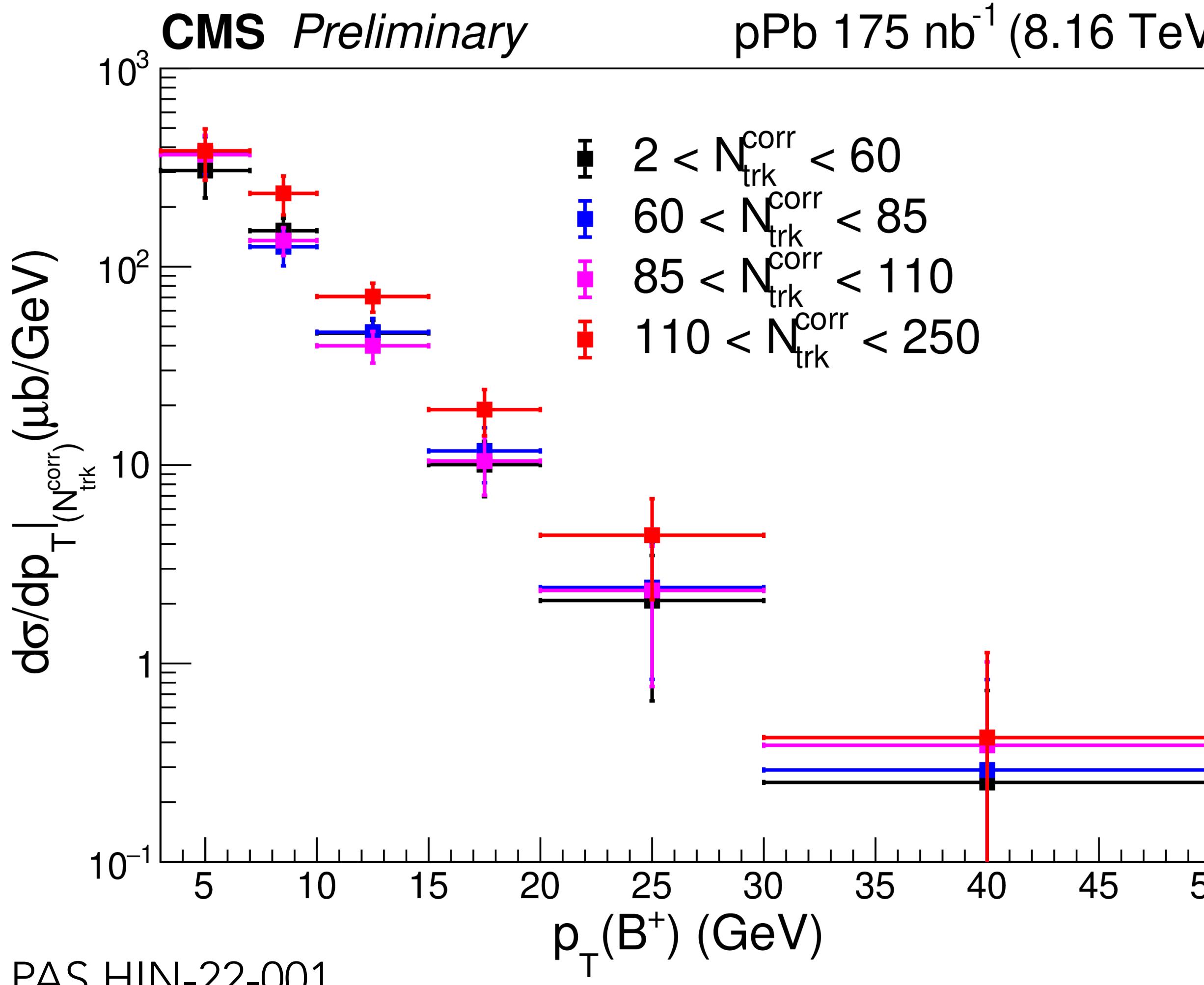
▸ Slope of normalized ψ(2S) / J/ψ vs multiplicity

☛ **decreasing trend** observed for all ψ rapidities without significant rapidity dependence

▸ B hadron contributions not affected

☛ **additional constraints on the mechanisms of hadronization and suppression in pA collisions**
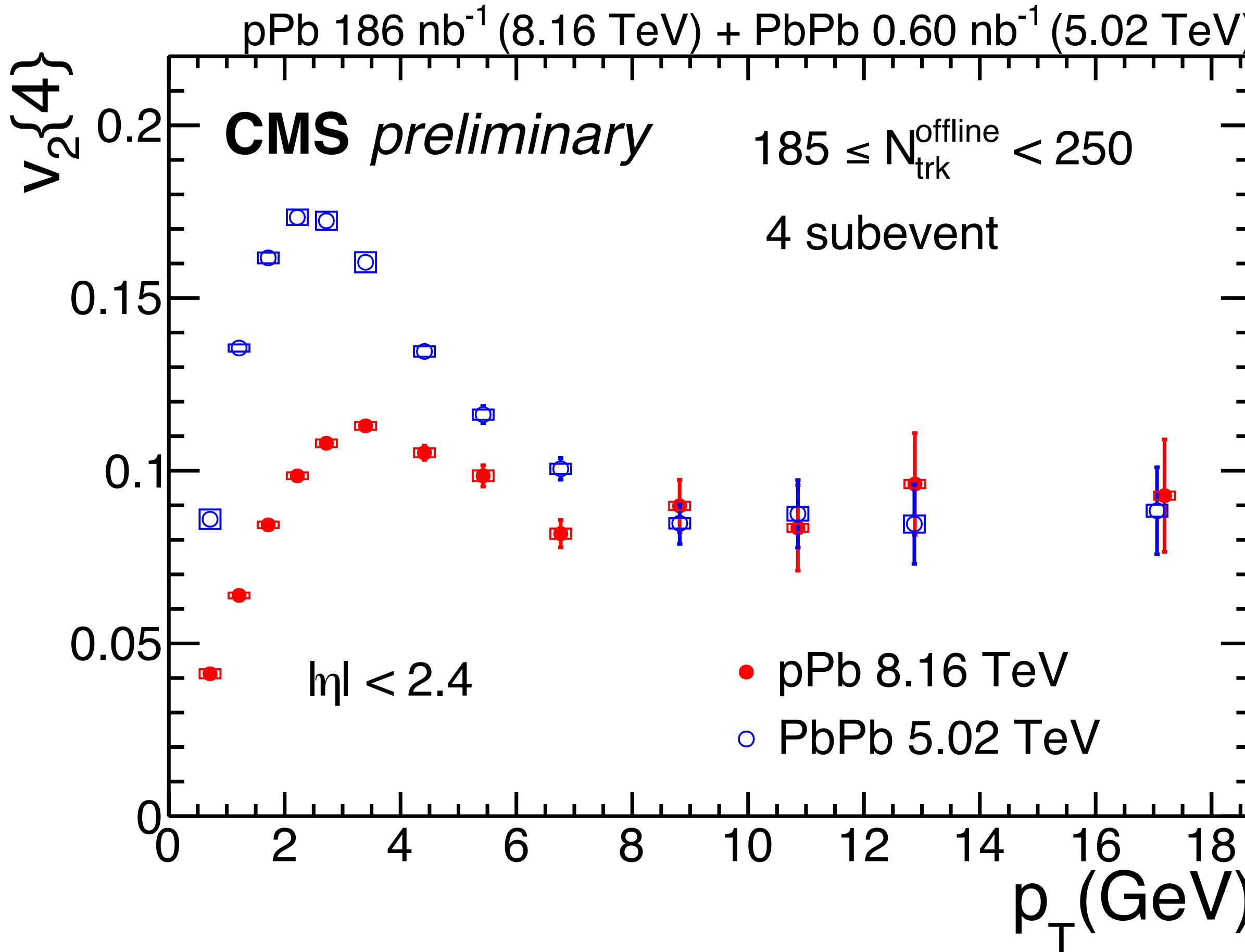
CMS *Preliminary*   pPb 175 nb^{-1} (8.16 TeV)

$6.5 < p_T < 30$ GeV

Nonprompt: y_{CM} bins

Nonprompt: $-2.865 < y_{CM} < 1.935$

from b-hadron decays

Prompt: y_{CM} bins

prompt ψ(2S) / J/ψ

Prompt: $-2.865 < y_{CM} < 1.935$

Trend-line slope

y_{CM}

PAS HIN-24-001

Jhovanny Mejia Guisao
HF&Q, Tues. 09:50

CMS *Preliminary*   pPb 175 nb^{-1} (8.16 TeV)

Legend:
- $2 < N_{trk}^{corr} < 60$
- $60 < N_{trk}^{corr} < 85$
- $85 < N_{trk}^{corr} < 110$
- $110 < N_{trk}^{corr} < 250$

y-axis: $d\sigma/dp_T|_{(N_{trk}^{corr})}$ (μb/GeV)

x-axis: $p_T(B^+)$ (GeV)

▸ p$_T$-differential measurement of B$^+$ production

▸ Studied as a function of the event multiplicity

• comparison between multiplicity classes coming soon!
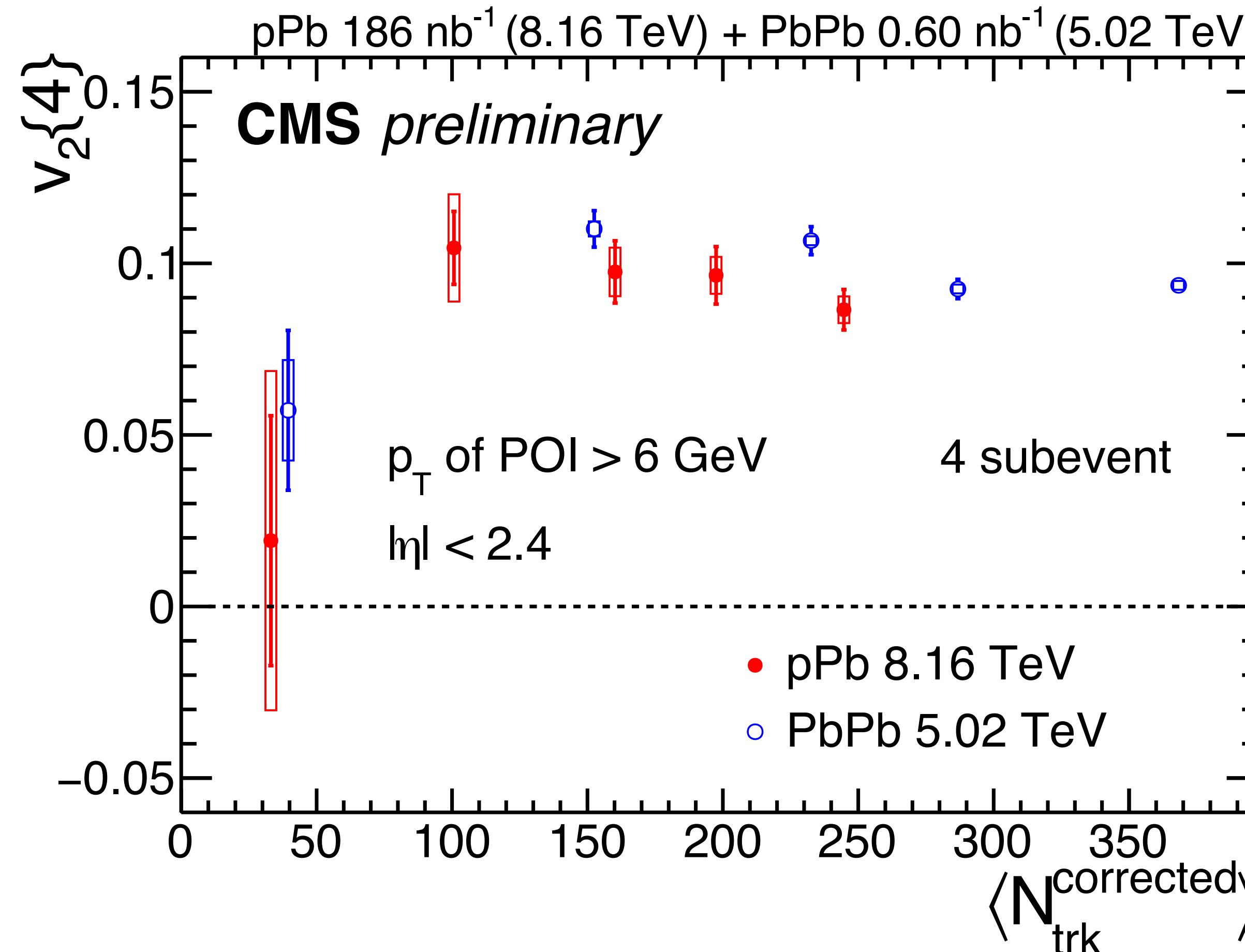
PAS HIN-22-001

Rohit Kumar Singh's poster

pPb 186 nb^{-1} (8.16 TeV) + PbPb 0.60 nb^{-1} (5.02 TeV)

CMS *preliminary*

$185 \leq N_{trk}^{offline} < 250$

4 subevent

$|\eta| < 2.4$

• pPb 8.16 TeV
○ PbPb 5.02 TeV

$v_2\{4\}$

p_T (GeV)

▸ New measurement with **4-subevent cumulant method extended to high p$_T$**

▸ **Positive v$_2$ {4} persisting up to p$_T$ ~20 GeV**
☛ similarity between **high-multiplicity pPb** and peripheral PbPb events
• magnitude and p$_T$ dependence

PAS HIN-23-002
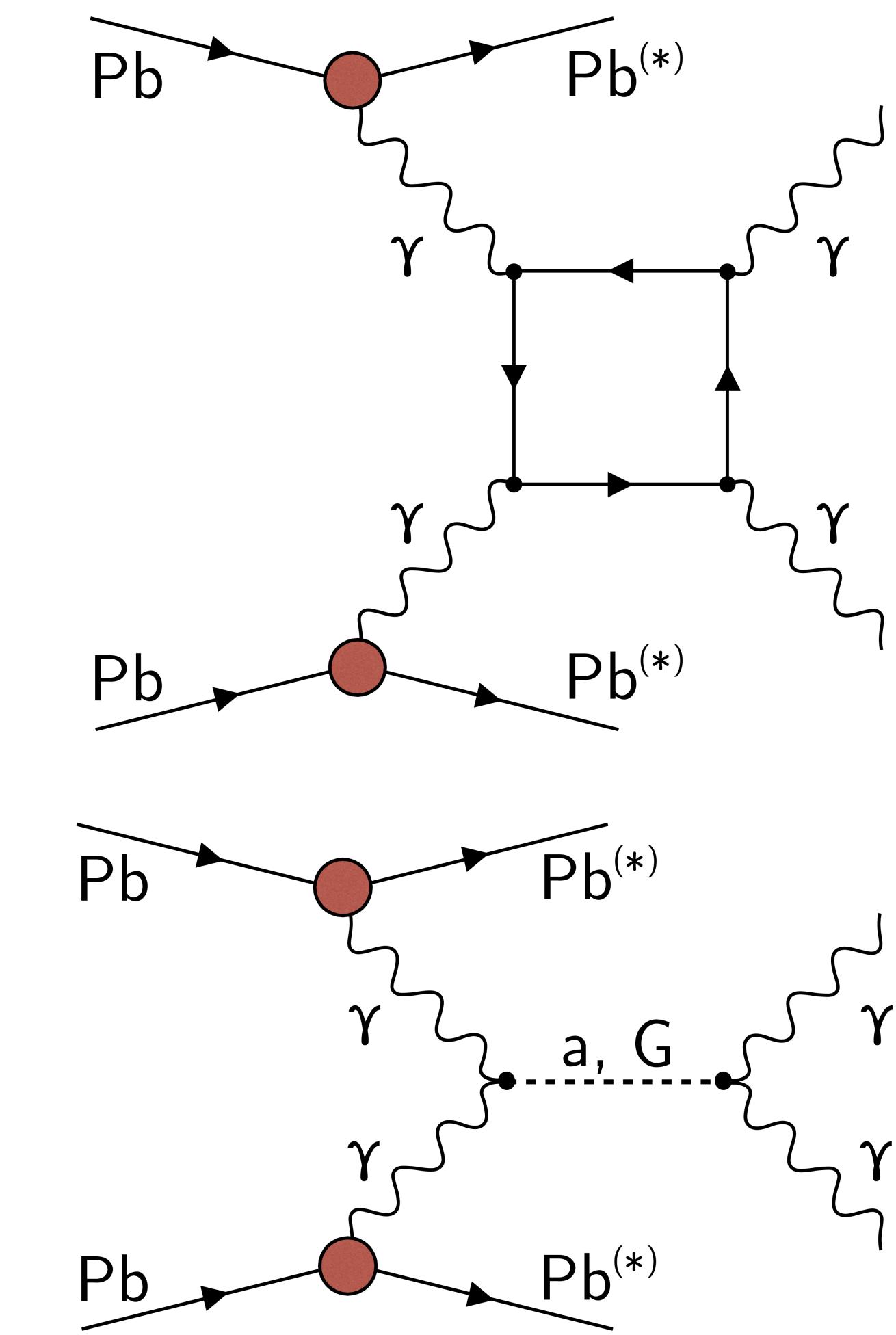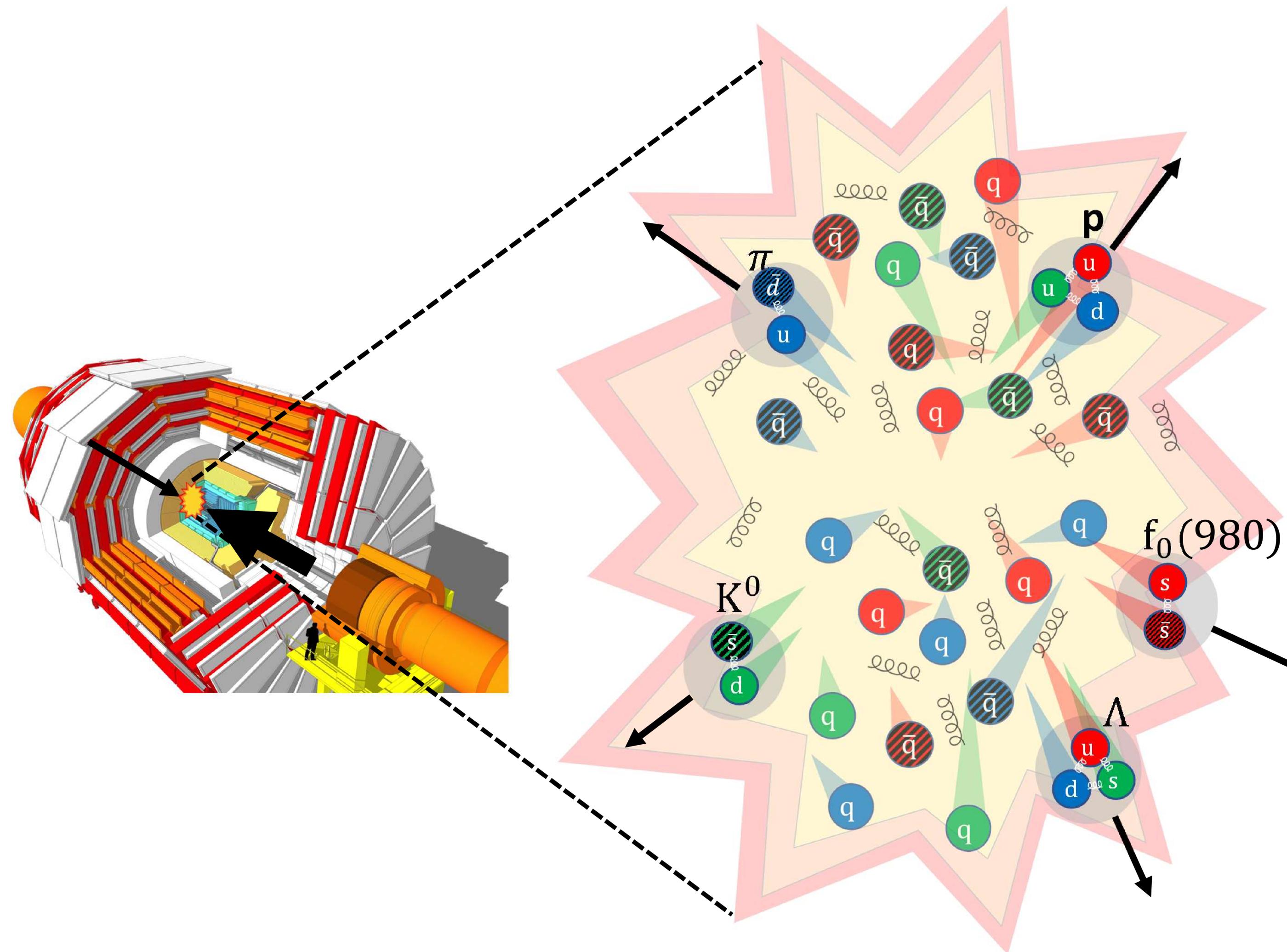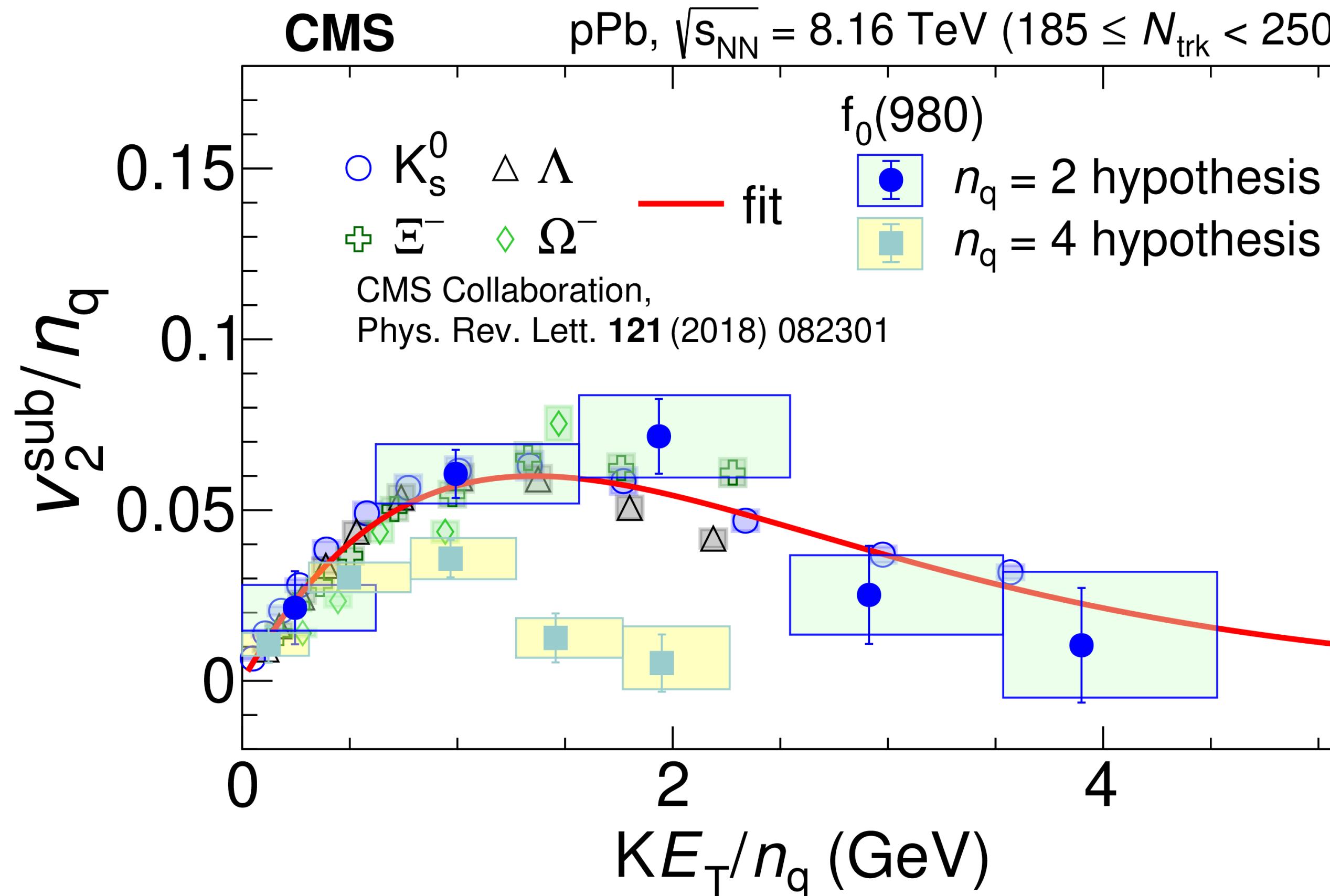
Rohit Kumar Singh's poster

pPb 186 nb^{-1} (8.16 TeV) + PbPb 0.60 nb^{-1} (5.02 TeV)

CMS *preliminary*

v$_2${4}

0.15

0.1

0.05

0

−0.05

p$_T$ of POI > 6 GeV

|η| < 2.4

4 subevent

● pPb 8.16 TeV
○ PbPb 5.02 TeV

0   50   100   150   200   250   300   350

$\langle N_{trk}^{corrected} \rangle$

▸ New measurement with **4-subevent cumulant method extended to high p$_T$**

▸ **Positive v$_2$ {4} persisting up to p$_T$ ~20 GeV**
☞ similarity between **high-multiplicity pPb** and peripheral PbPb events
• magnitude and p$_T$ dependence
• multiplicity dependence too!

☞ **flow from high-p$_T$ parton energy loss?** results calling for theory inputs!

PAS HIN-23-002

Heavy ion data beyond QGP physics
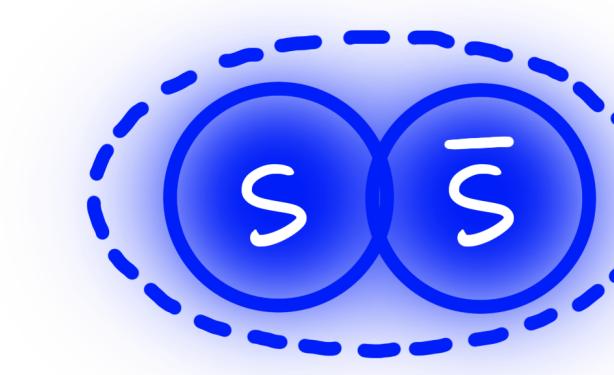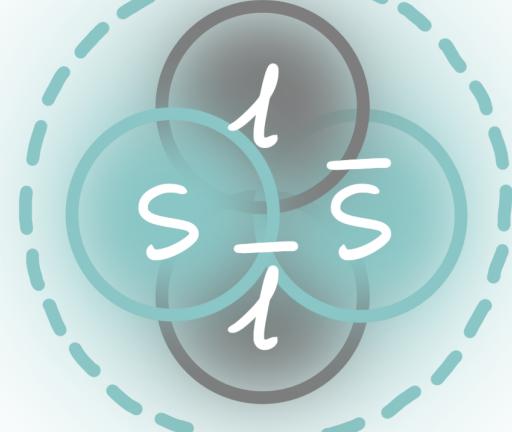
Probe structure of exotic bound states in HIC

▸ **v_2 NCQ scaling in high-multiplicity pPb**

▸ comparing **$n_q = 2$** and **$n_q = 4$** hypotheses
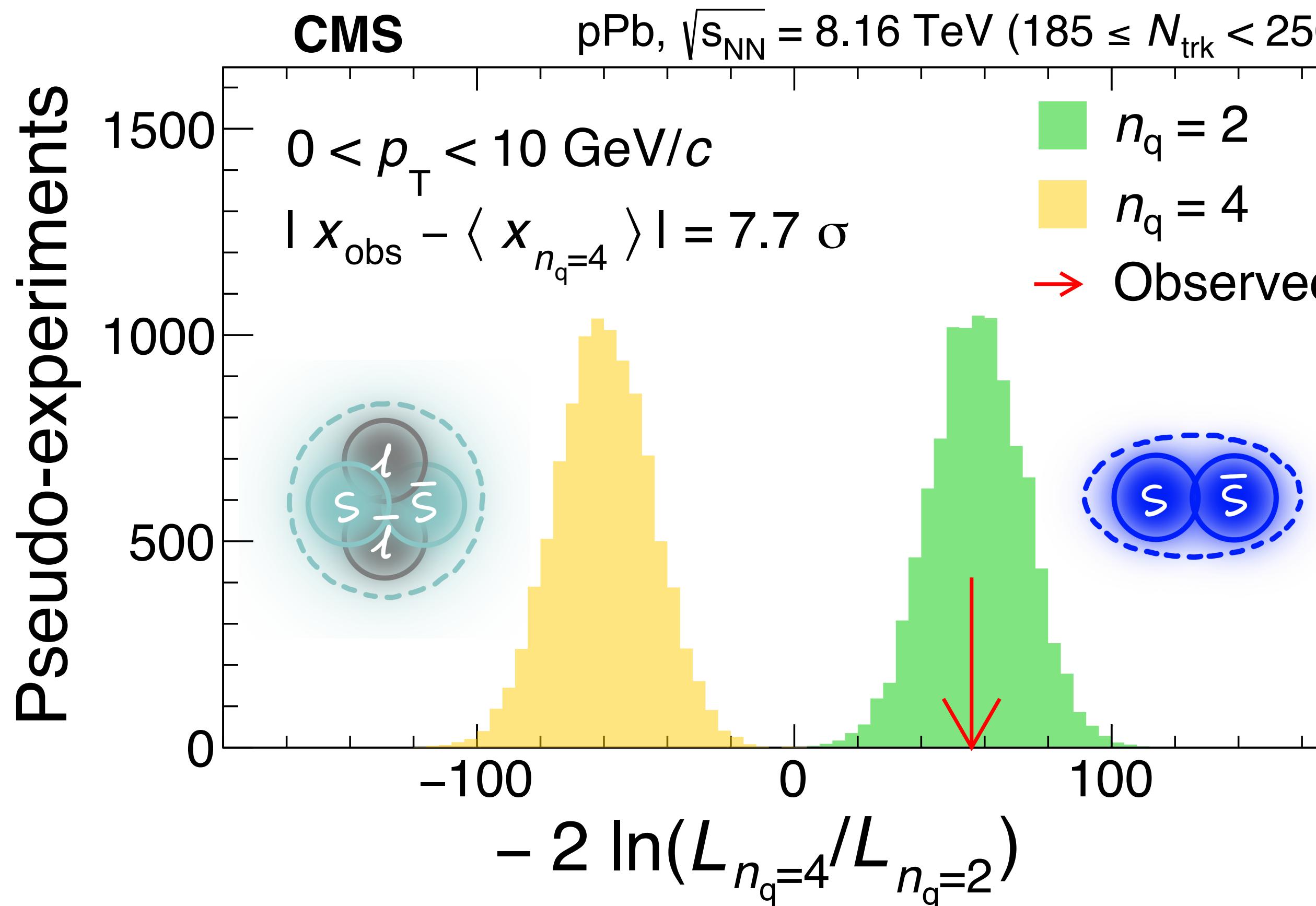
quark-antiquark?   **tetraquark?**

arXiv:2312.17092
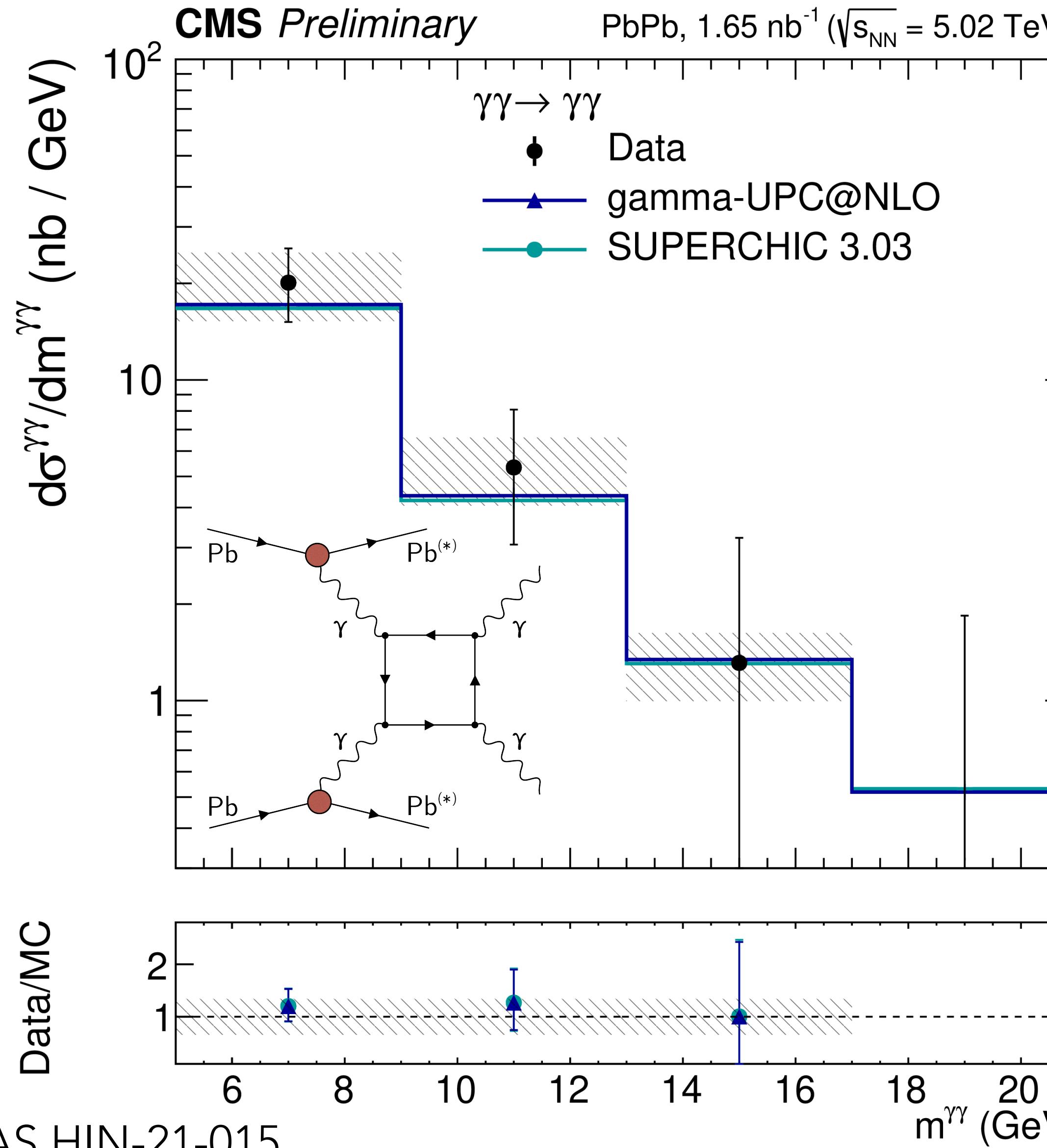
Log-likelihood ratio distributions for the n_q = 2 and 4 hypotheses from pseudo-experiments

- ▸ **v_2 NCQ scaling in high-multiplicity pPb**

- ▸ **n_q = 2 favored** over **n_q = 4 by 7.7σ** (6.3σ or 3.1σ for restricted p_T ranges)

- ▸ Independent input in addition to quantum number studies

- ☛ **novel approach for hadronic structures**
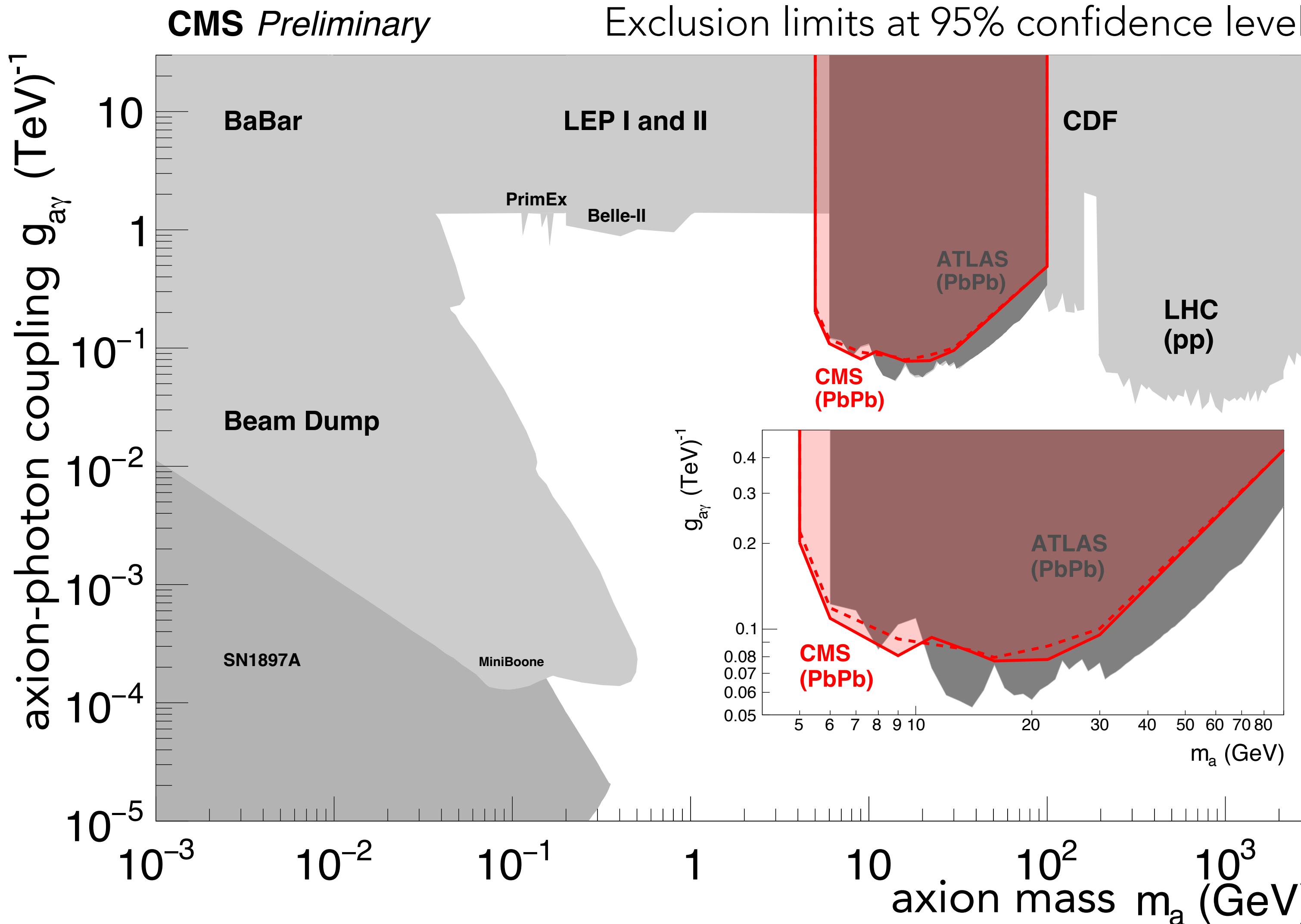
arXiv:2312.17092
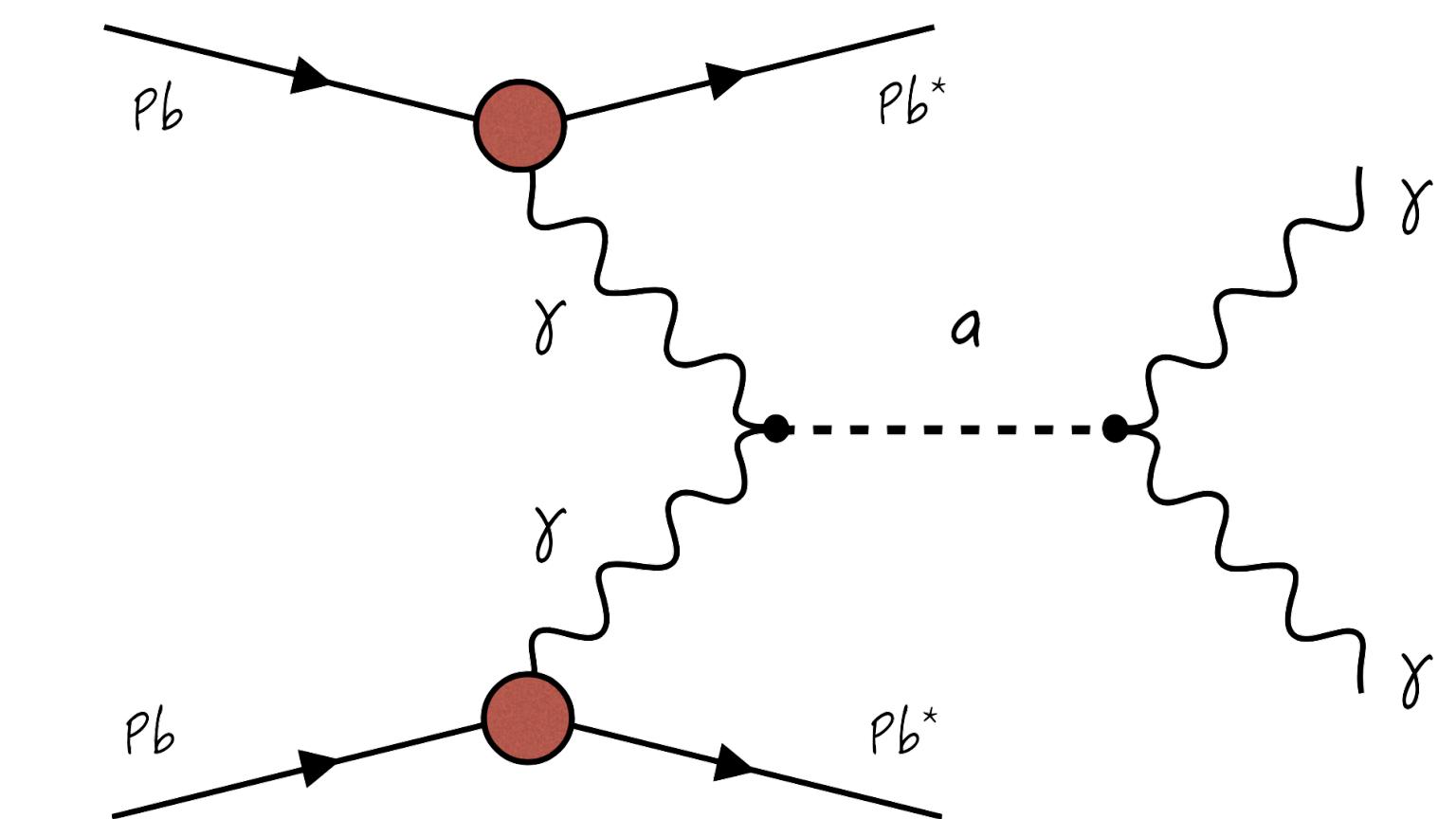
New measurement of exclusive diphoton events in ultraperipheral PbPb collisions

$$\sigma_{\text{fiducial}} (\gamma\gamma \rightarrow \gamma\gamma) = 107 \pm 33 \text{ (stat)} \pm 20 \text{ (syst) nb}$$

☛ in agreement with (N)LO QED predictions

PAS HIN-21-015

CMS *Preliminary*   Exclusion limits at 95% confidence level

Search for narrow resonances in the diphoton invariant mass distribution

☛ **most stringent constraints in the 5–10 GeV mass range**
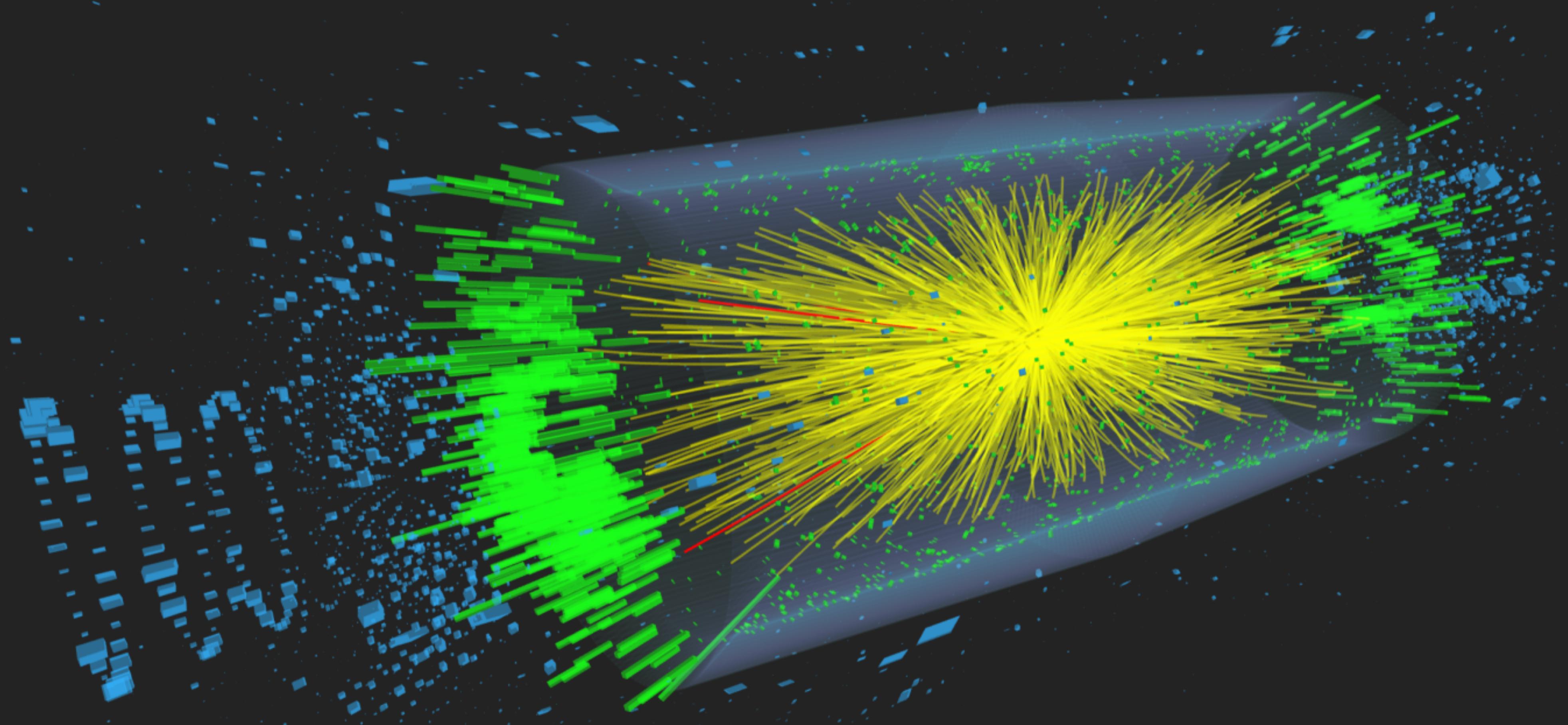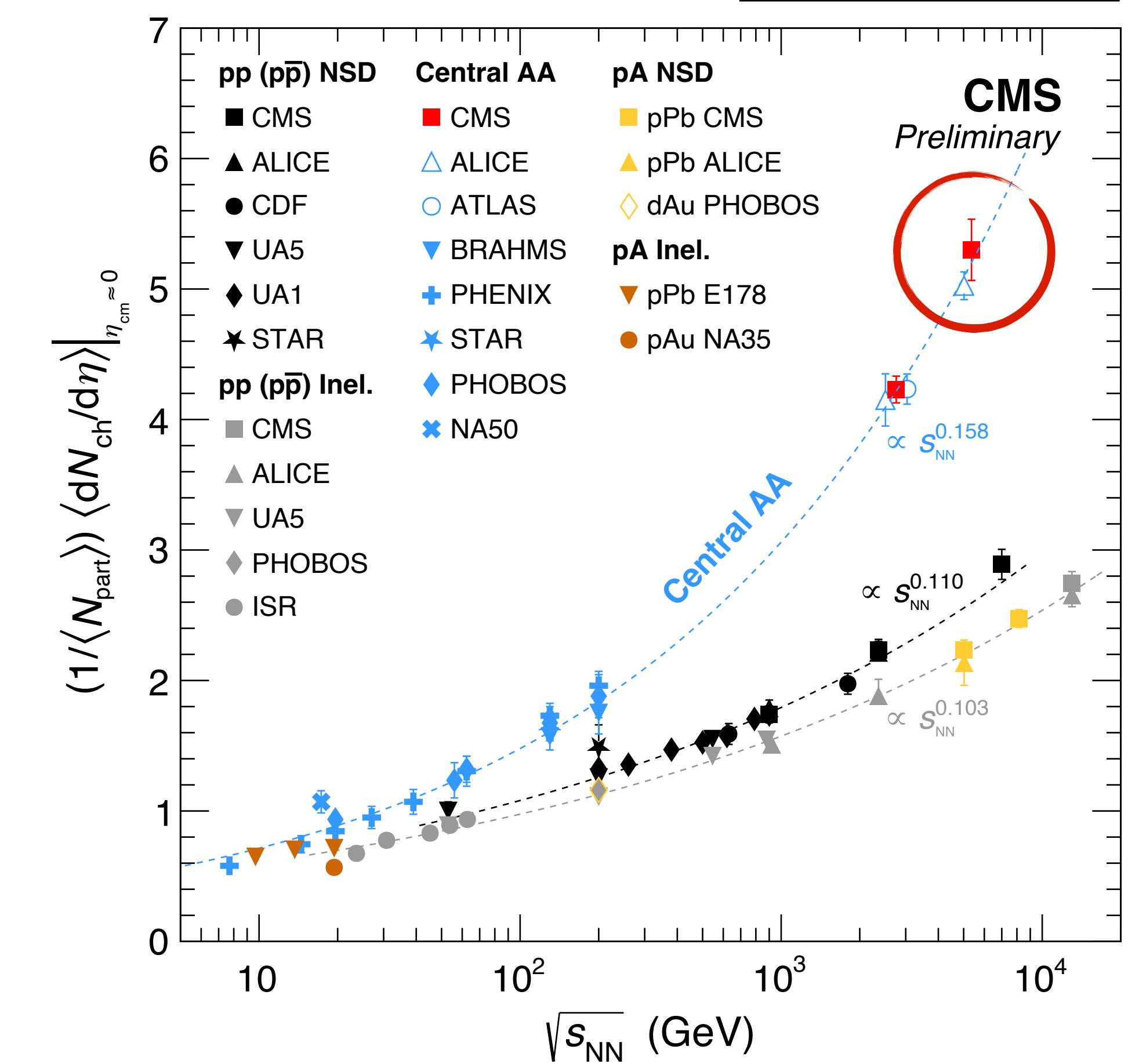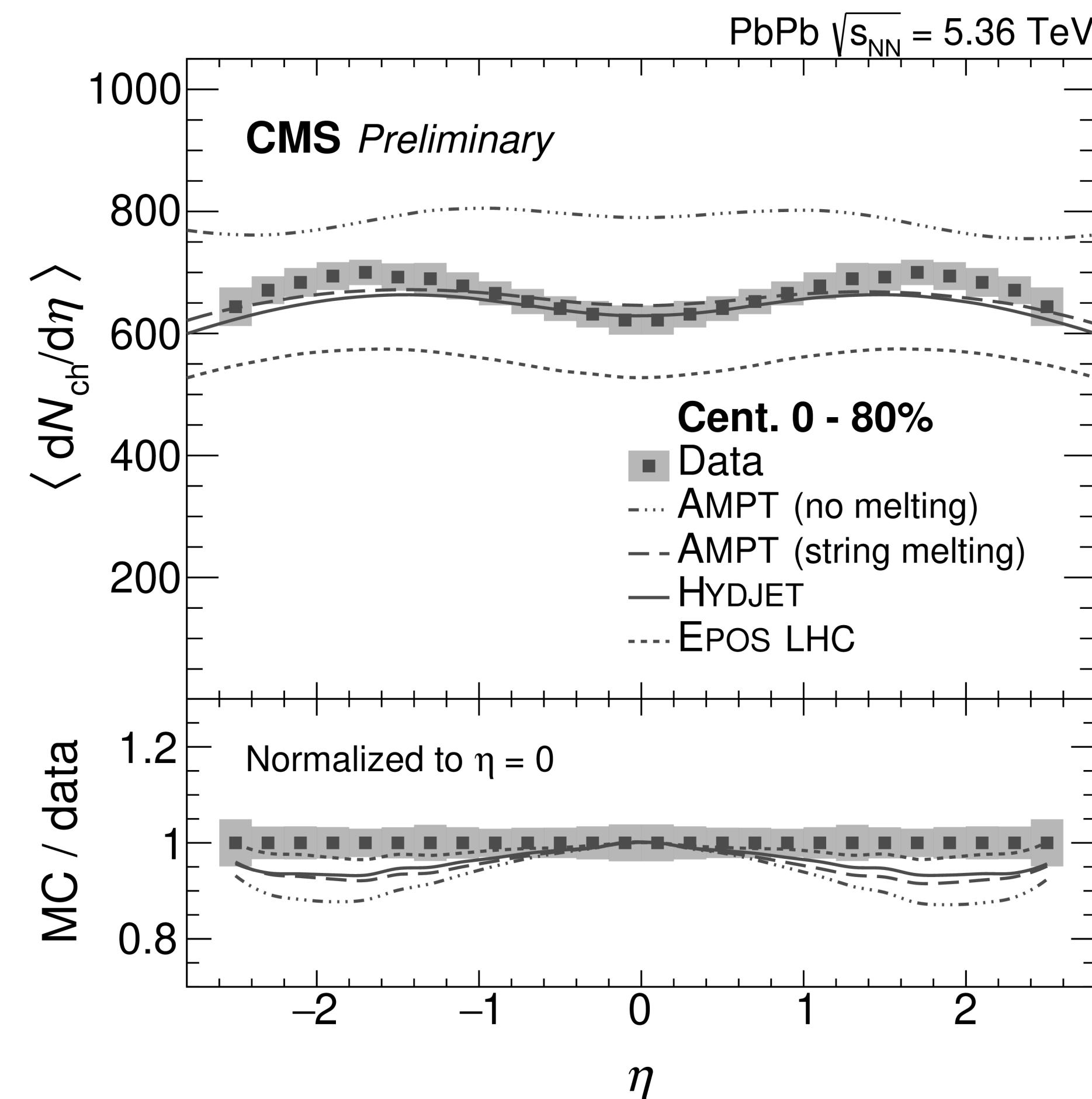
PAS HIN-21-015

Run 3: Higher energy and luminosity

PAS HIN-23-007
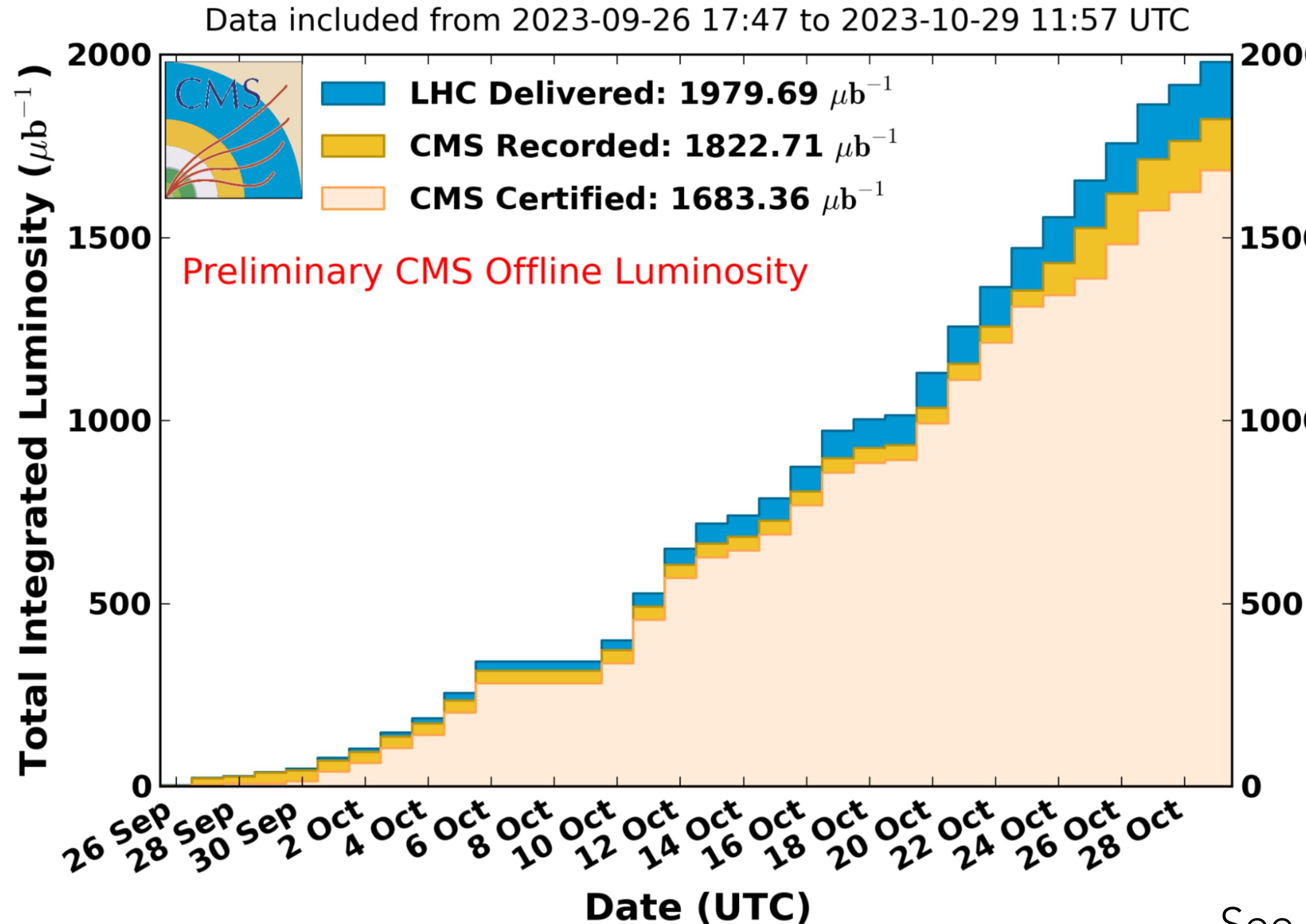
- ▸ dN$_{ch}$/dη in **PbPb collisions at unprecedented √s$_{NN}$ = 5.36 TeV** from the 2022 test run
- ▸ Event generators not describing the data accurately ☛ important input to tune MC for Run 3
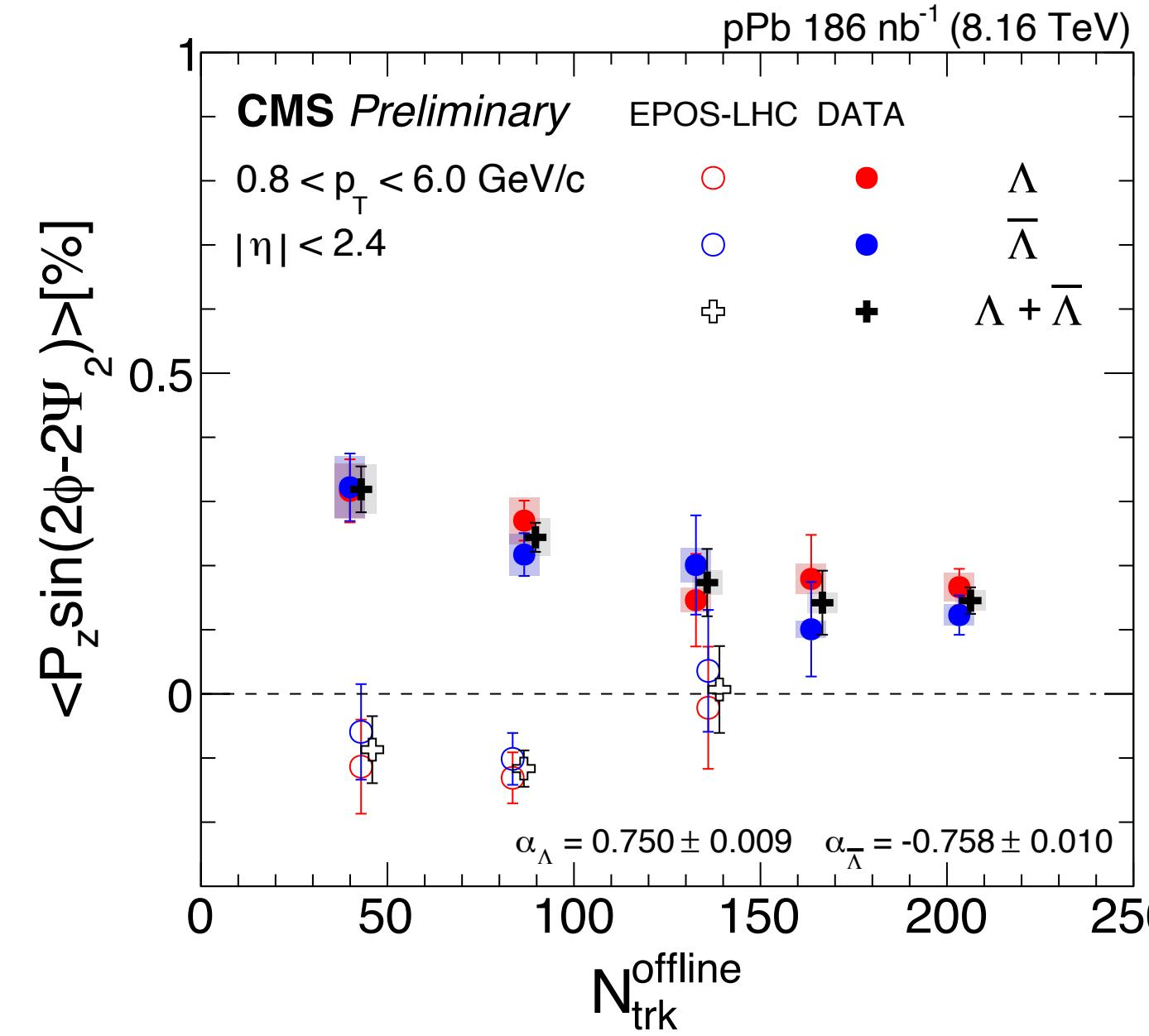
CMS Integrated Luminosity, PbPb, 2023, $\sqrt{s_{NN}} = $ **5.36 TeV**

Data included from 2023-09-26 17:47 to 2023-10-29 11:57 UTC

LHC Delivered: 1979.69 μb^{-1}
CMS Recorded: 1822.71 μb^{-1}
CMS Certified: 1683.36 μb^{-1}

Preliminary CMS Offline Luminosity
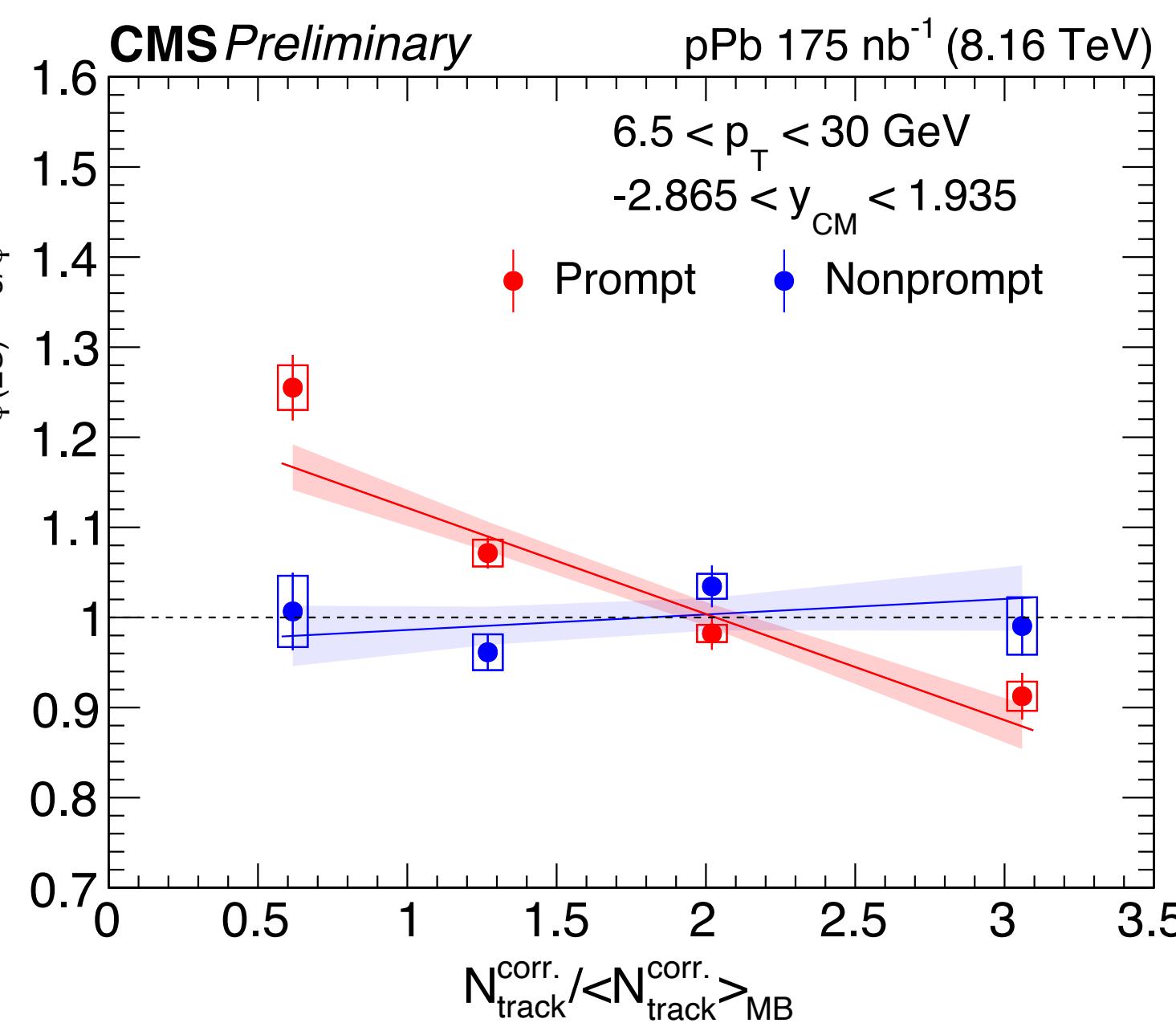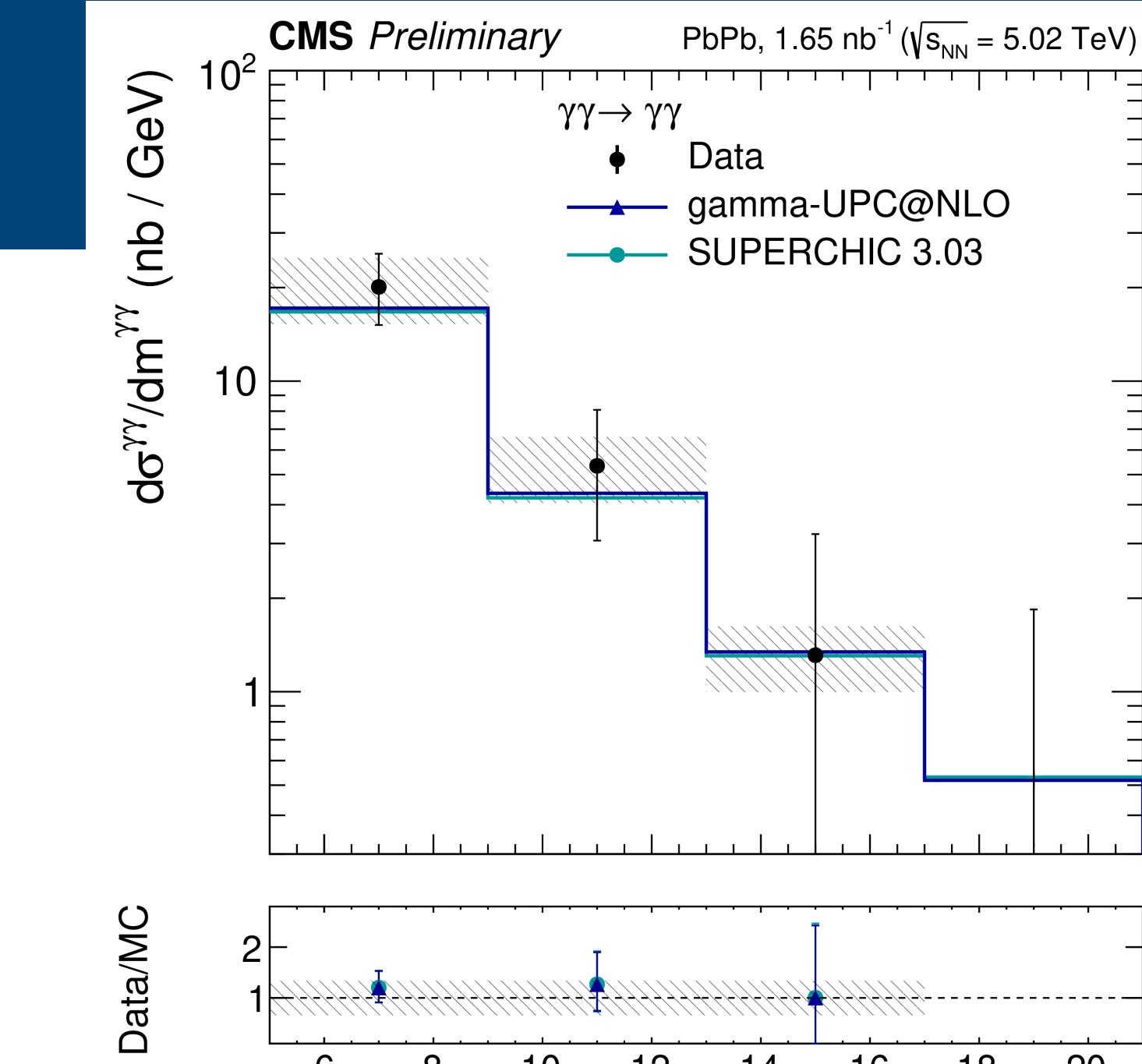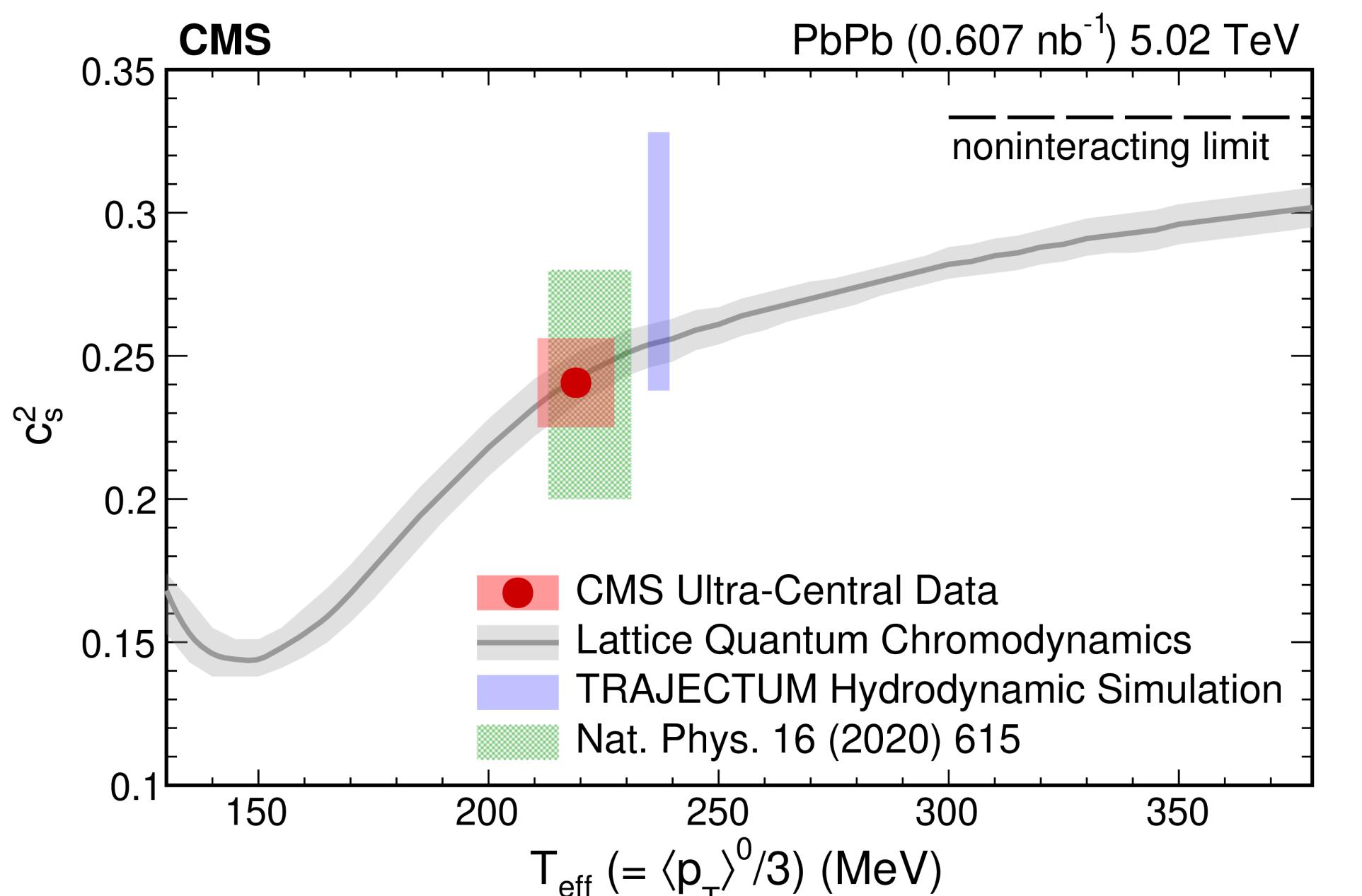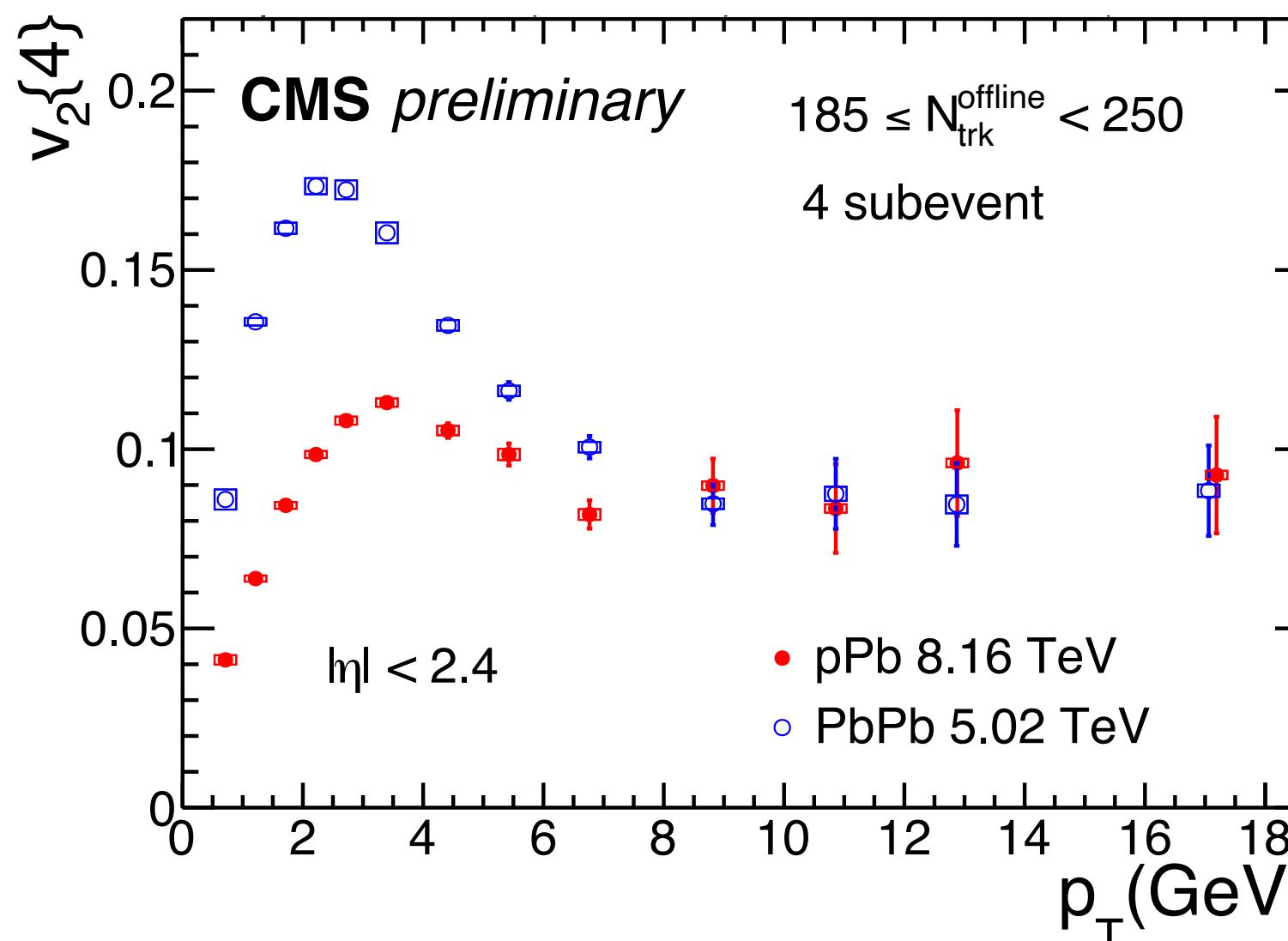
▸ Long-awaited first heavy-ion physics data taking since 2018!

▸ **Billions of hadronic and UPC events collected** for precise measurements!

See Detector Performance note 2024-02 to find out more

Summary

- J/ψ probing low-x parton densities
- Direct constraints on the QCD EoS
- In-medium behavior of heavy quarks
- Signs of medium effects in pPb systems
- First Run 3 results and more to come!
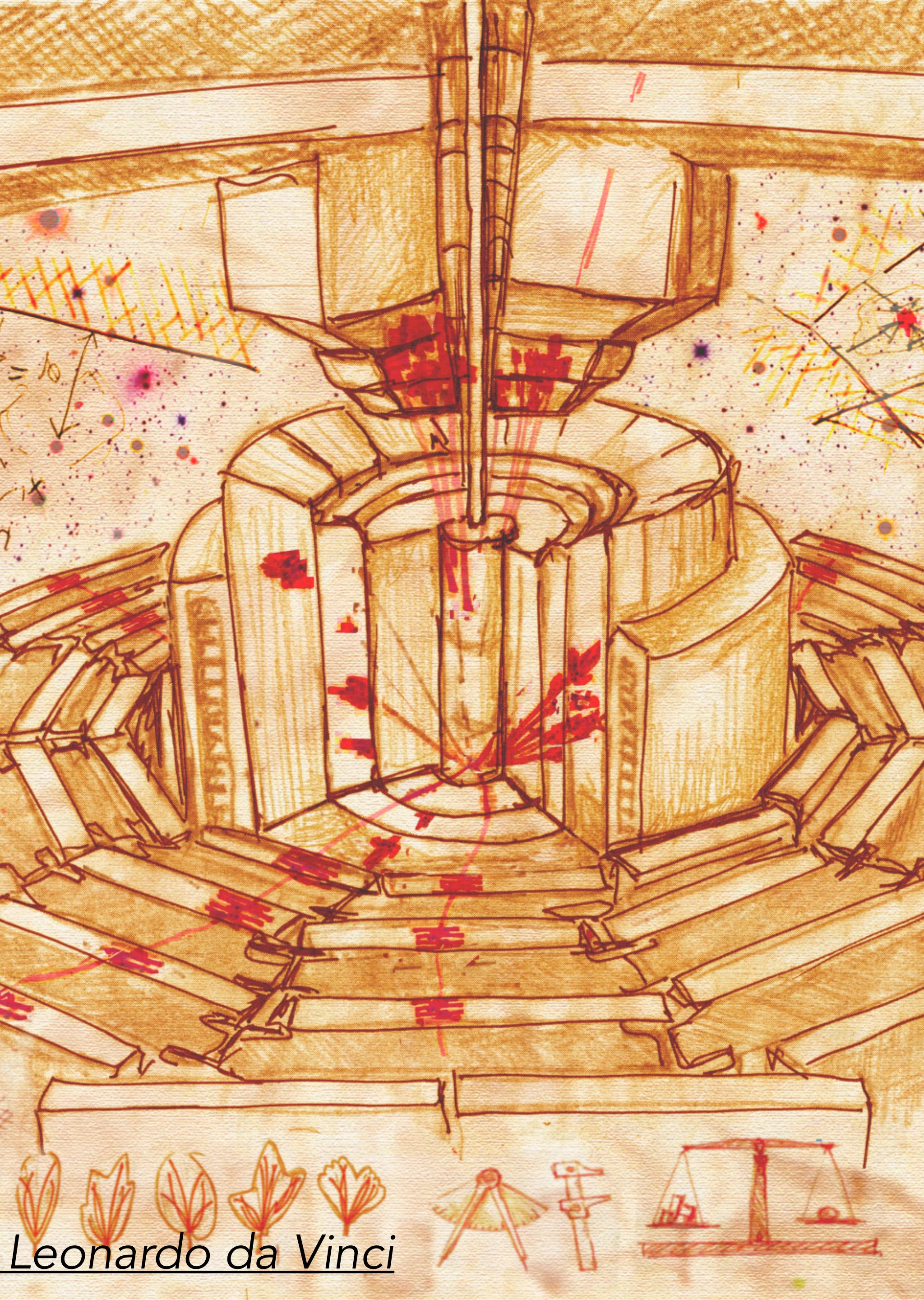
Enjoy SQM with the CMS Collaboration!

Talk	Speaker	Time	Room
Investigating bottom quark energy loss, hadronization, and B meson nuclear modification factors	Jhovanny Mejia Guisao	Tuesday 9:50	Rome
Observation of double J/psi production in pPb collisions	Stefanos Leontsinis	Tuesday 14:40	Rome
Detailed study of the production of Y mesons in PbPb collisions	Prabhat Ranjan Pujahari	Tuesday 15:20	Rome
Probing a new regime of ultra-dense gluonic matter using high-energy photons	Pranjal Verma	Tuesday 16:50	Rome
Measurement of the multiplicity dependence of charm hadron production in pPb collisions	Austin Baty	Tuesday 17:30	Rome
Study of charm quark and QGP medium interactions via Lambda c and D0 production and collective flow	Soumik Chandra	Tuesday 17:50	Rome
Measuring the speed of sound in the QGP	Michael Murray	Tuesday 12:00	Bruxelles
Measurement of strange particle femtoscopic correlations	Raghunath Pradhan	Tuesday 17:50	Bruxelles
Hyperon polarization along the beam direction in pPb collisions	Chenyan Li	Wednesday 11:00	Bruxelles
Using Multivariate Cumulants to Constrain the Initial State in PbPb collisions	Aryaa Dattamunsi	Tuesday 11:40	Londres
Measurement of azimuthal anisotropy at high pT using subevent cumulants in pPb collisions	Rohit Kumar Singh	Tuesday evening	Poster!
Physics of heavy flavors and strangeness with a time-of-flight PID upgrade at CMS at the high-luminosity LHC	Zhenyu Chen	Tuesday 15:00	Londres

All HIN Preliminary results, Publications, Overview of Runs 1 & 2 studies
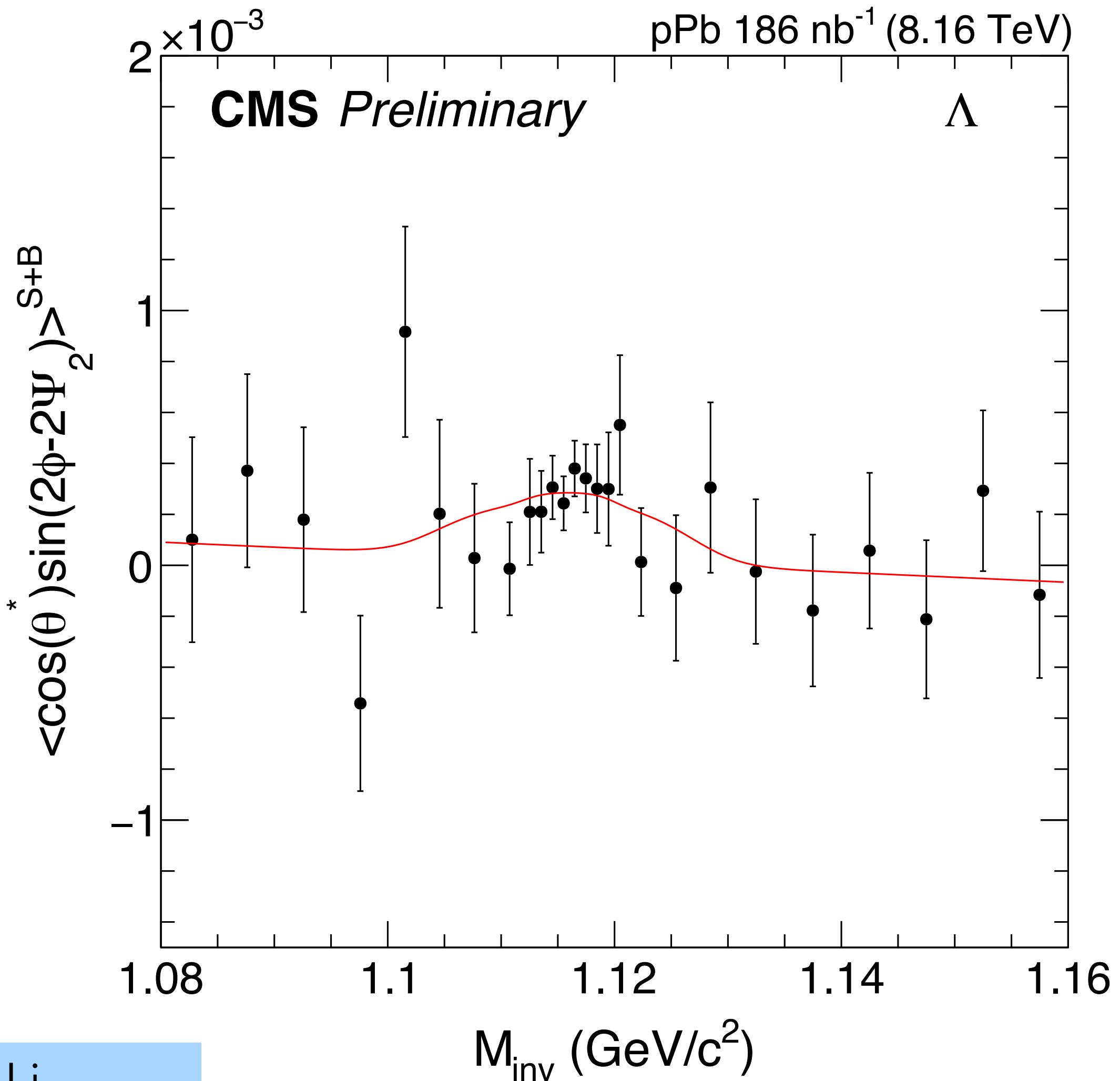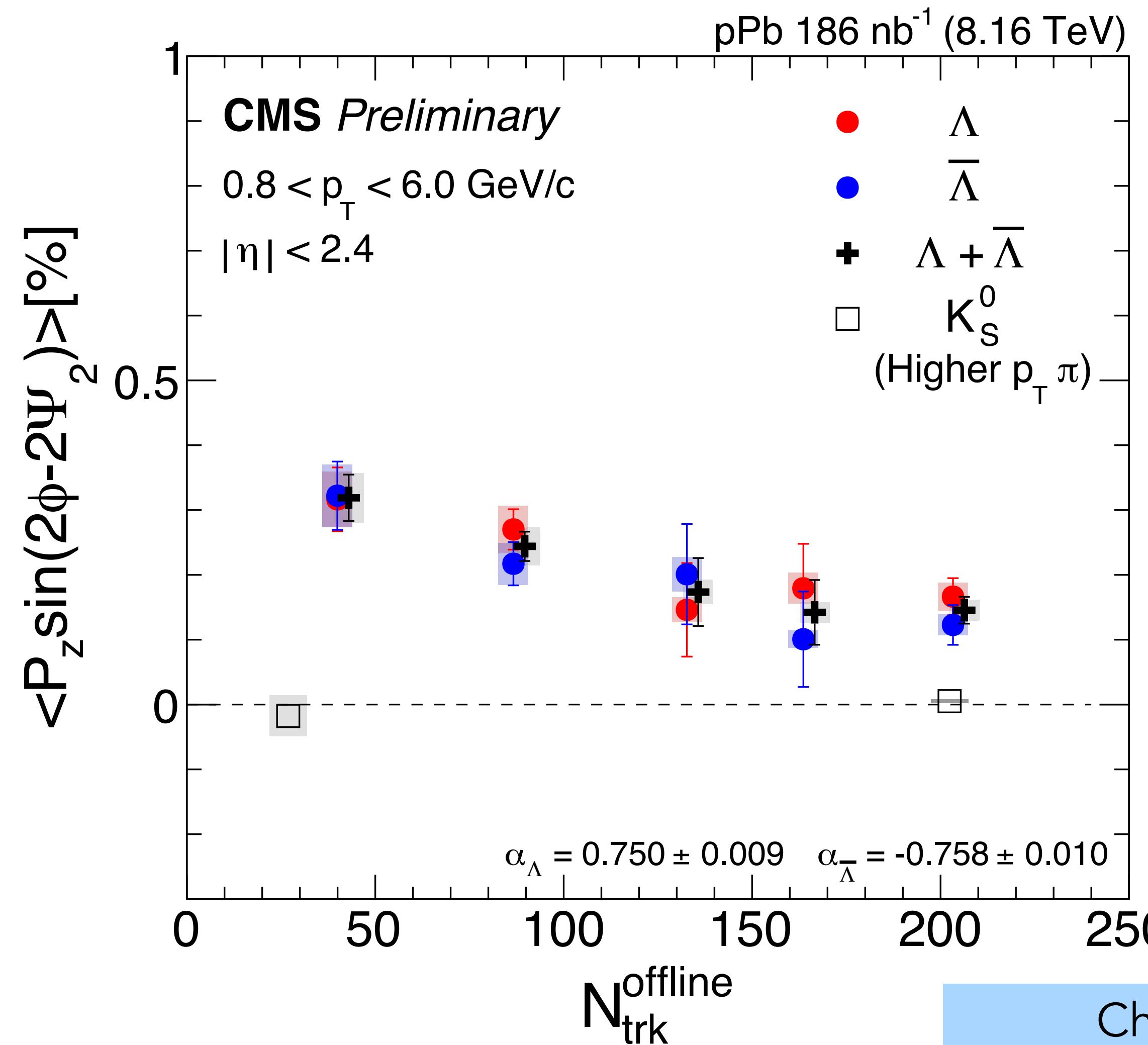
Supplementary material

Drawings of the elements of the CMS detector in the style of Leonardo da Vinci
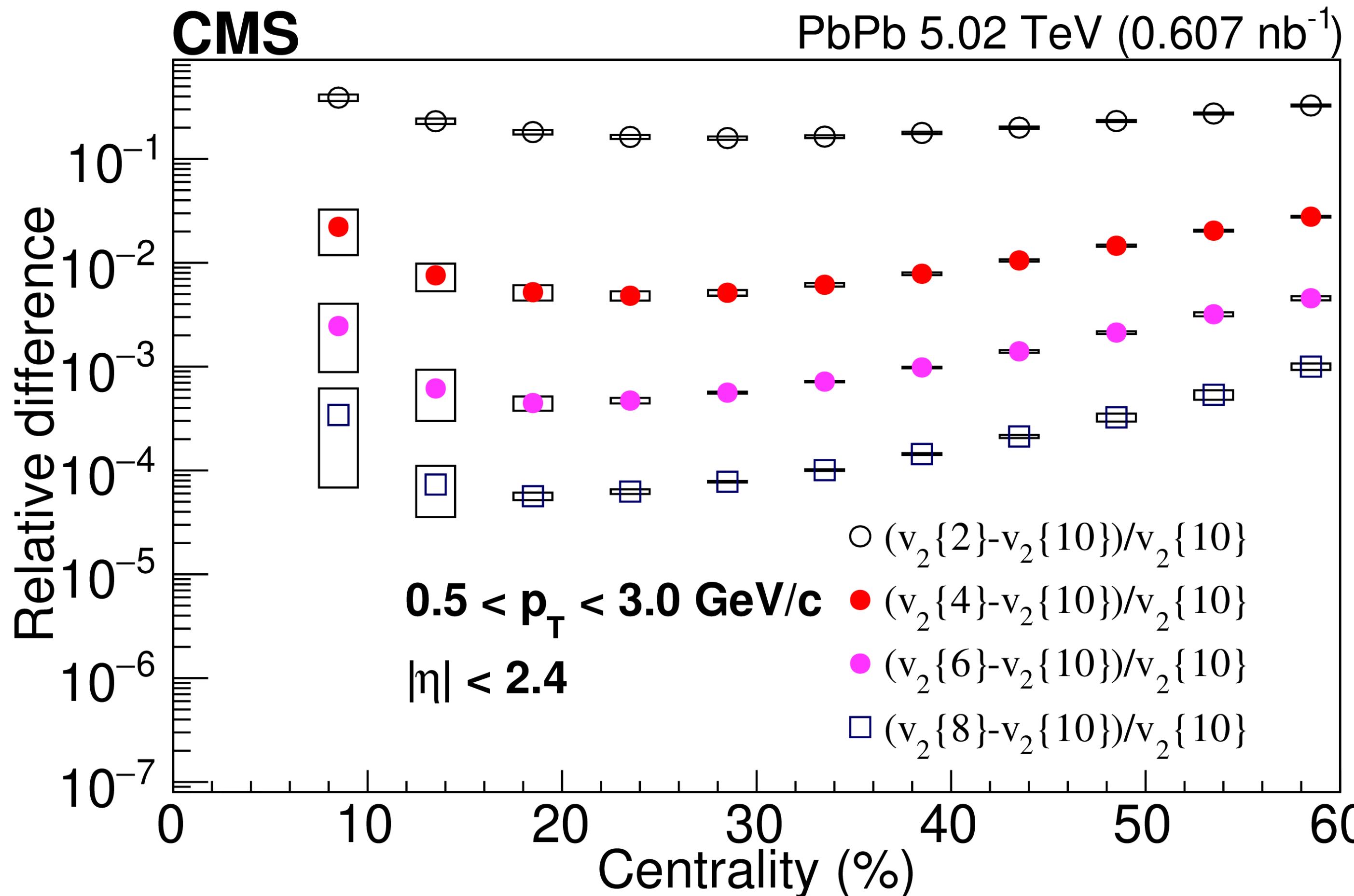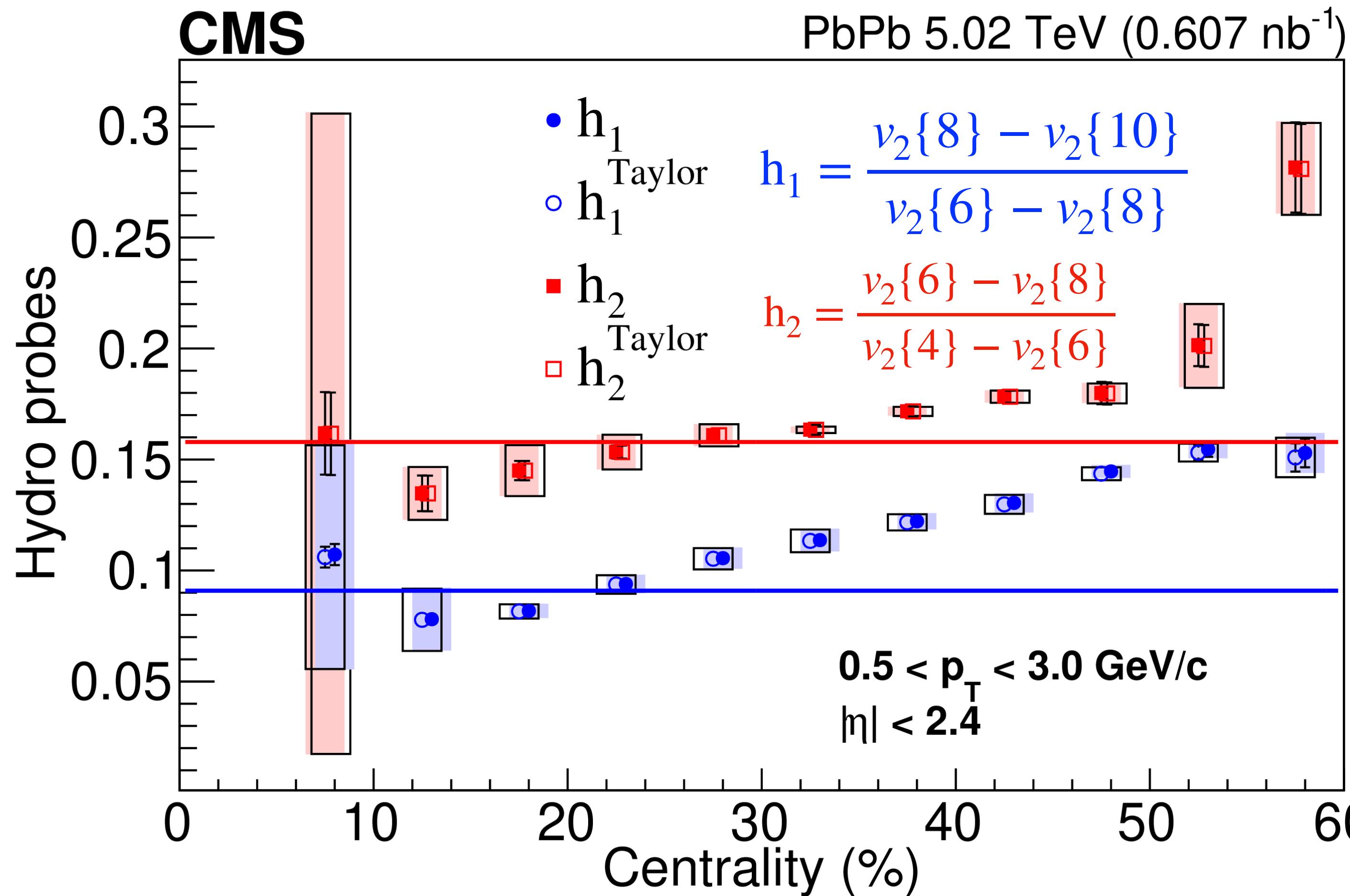
PAS HIN-24-002

CMS PbPb 5.02 TeV (0.607 nb^{-1})

Relative difference vs Centrality (%)

$0.5 < p_T < 3.0$ GeV/c
$|\eta| < 2.4$

- ○ $(v_2\{2\} - v_2\{10\})/v_2\{10\}$
- ● $(v_2\{4\} - v_2\{10\})/v_2\{10\}$
- ● $(v_2\{6\} - v_2\{10\})/v_2\{10\}$
- □ $(v_2\{8\} - v_2\{10\})/v_2\{10\}$

▸ **First measurement of $v_2\{10\}$** enabling detailed studies of high-order terms

▸ Clear ordering and fine splitting attributed to flow fluctuations

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Aryaa Dattamunsi
Small Systems, Tues. 11:40

CMS PbPb 5.02 TeV (0.607 nb^{-1})

Hydro probes

Legend:
- h_1
- h_1^{Taylor}
- h_2
- h_2^{Taylor}

$$h_1 = \frac{v_2\{8\} - v_2\{10\}}{v_2\{6\} - v_2\{8\}}$$

$$h_2 = \frac{v_2\{6\} - v_2\{8\}}{v_2\{4\} - v_2\{6\}}$$

0.5 < p$_T$ < 3.0 GeV/c
|η| < 2.4

Centrality (%)

▸ Higher-order moments of v$_2$ necessary to describe the centrality dependence

▸ Novel constraints on non-Gaussian fluctuations in the initial-state geometry used by hydrodynamic calculations

Aryaa Dattamunsi
Small Systems, Tues. 11:40

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