

# Overview of Recent CMS Results

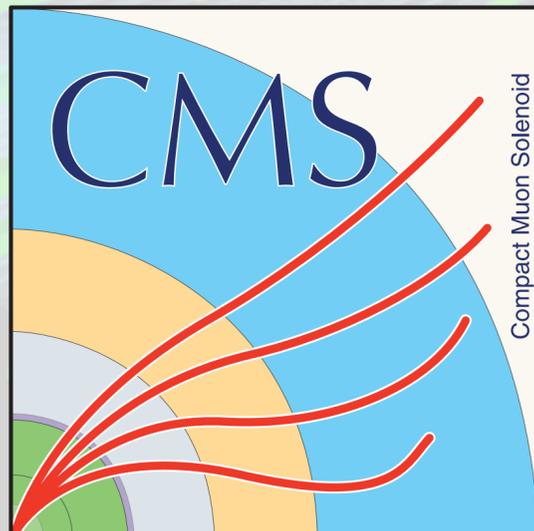
**Austin Baty**

On behalf of the CMS Collaboration

September 4th  
Houston, Texas



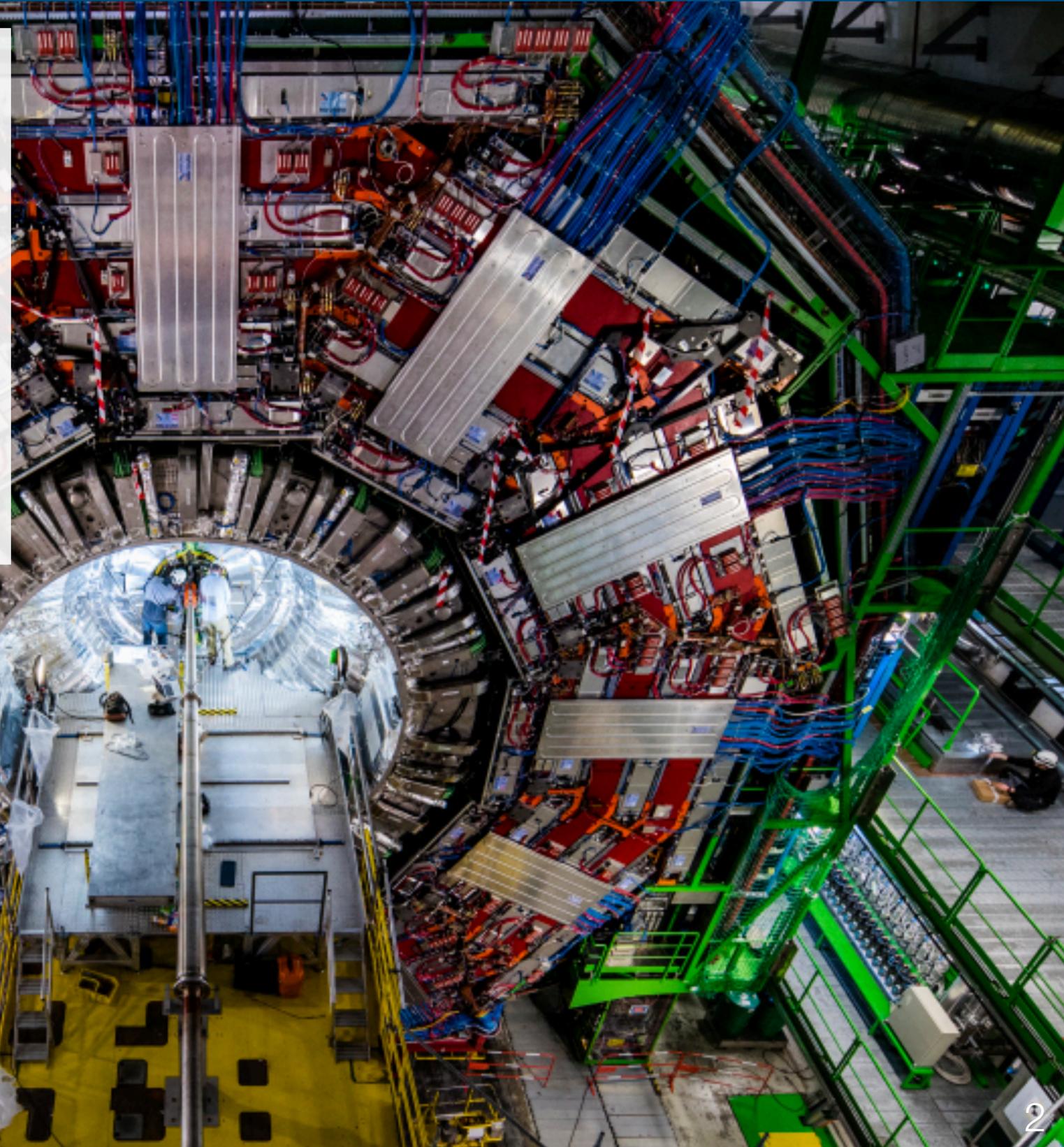
UNIVERSITY OF  
**ILLINOIS CHICAGO**



 **Quark Matter 2023**

# Introduction

- **Heavy ion collisions**
  - **Produce QGP**
    - **Sensitive to the initial state**
    - **Complex hydrodynamic-like behavior**
    - **Jet quenching**
  - **Study hadronization and hadron structure**
- **Small systems studies (pp, pPb data)**
- **Quasi-real photons for UPC studies**



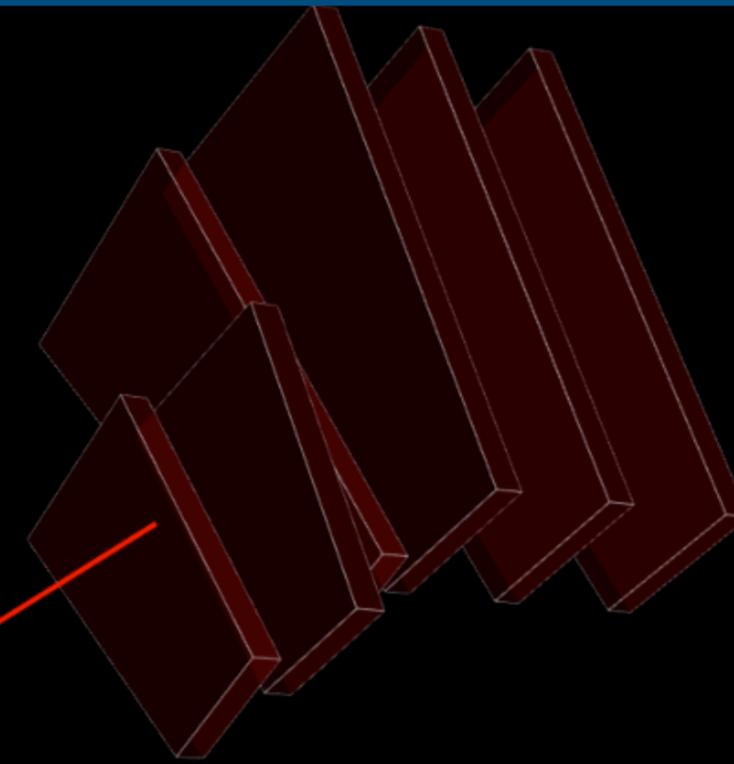
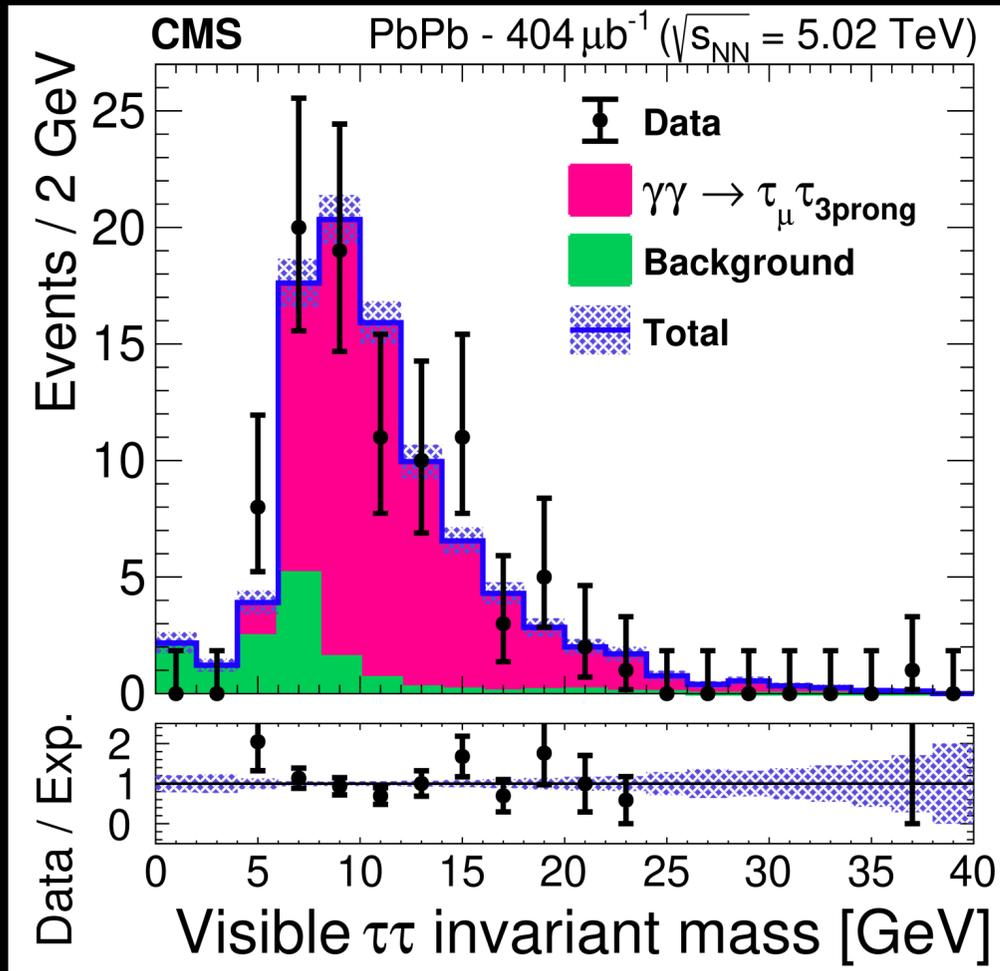
# Observation of $\gamma\gamma \rightarrow \tau\tau$ in AA



CMS Experiment at the LHC, CERN

Data recorded: 2015-Dec-06 21:41:27.033612 GMT

Run / Event / LS: 263400 / 88515785 / 849

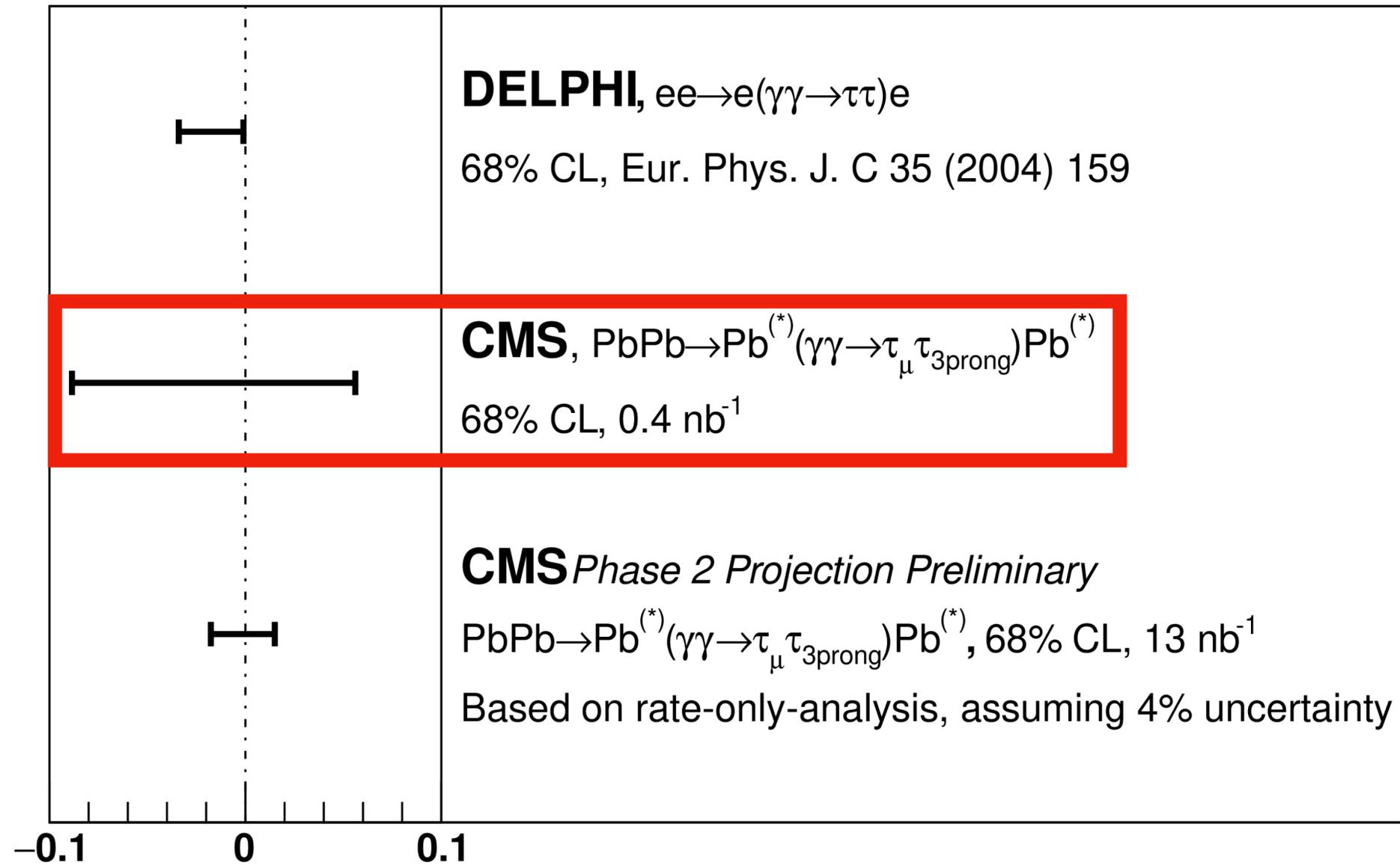


**HIN-21-009**  
Accepted by PRL



# Tau g-2

CMS Experiment at the LHC, CERN

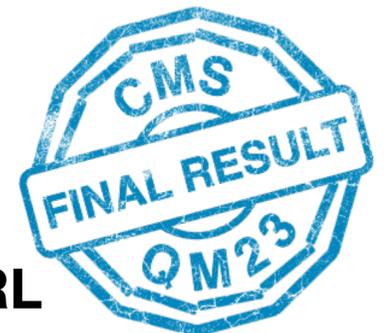


**See Matthew Nickel's Poster!**

**Future sensitivity to BSM Physics!**

$$a_{\tau} = (g - 2)/2$$

**HIN-21-009**  
Accepted by PRL

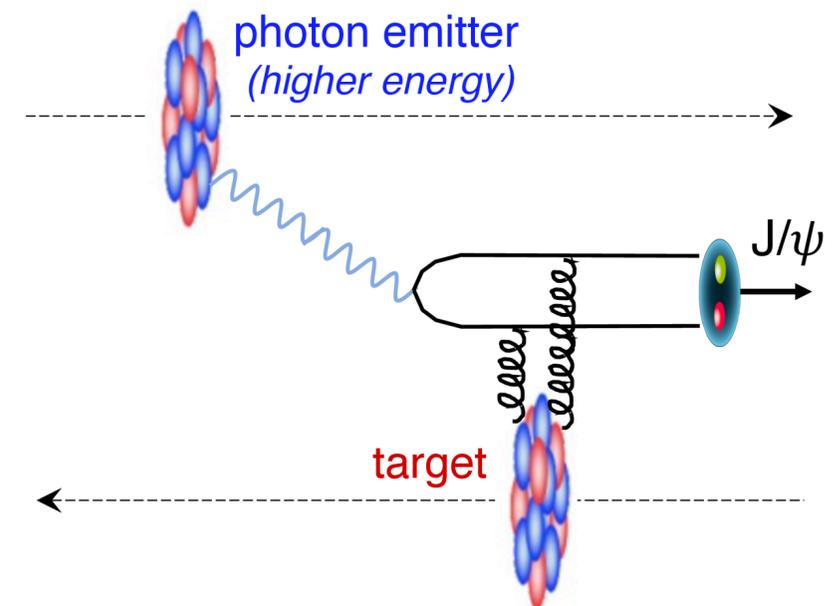
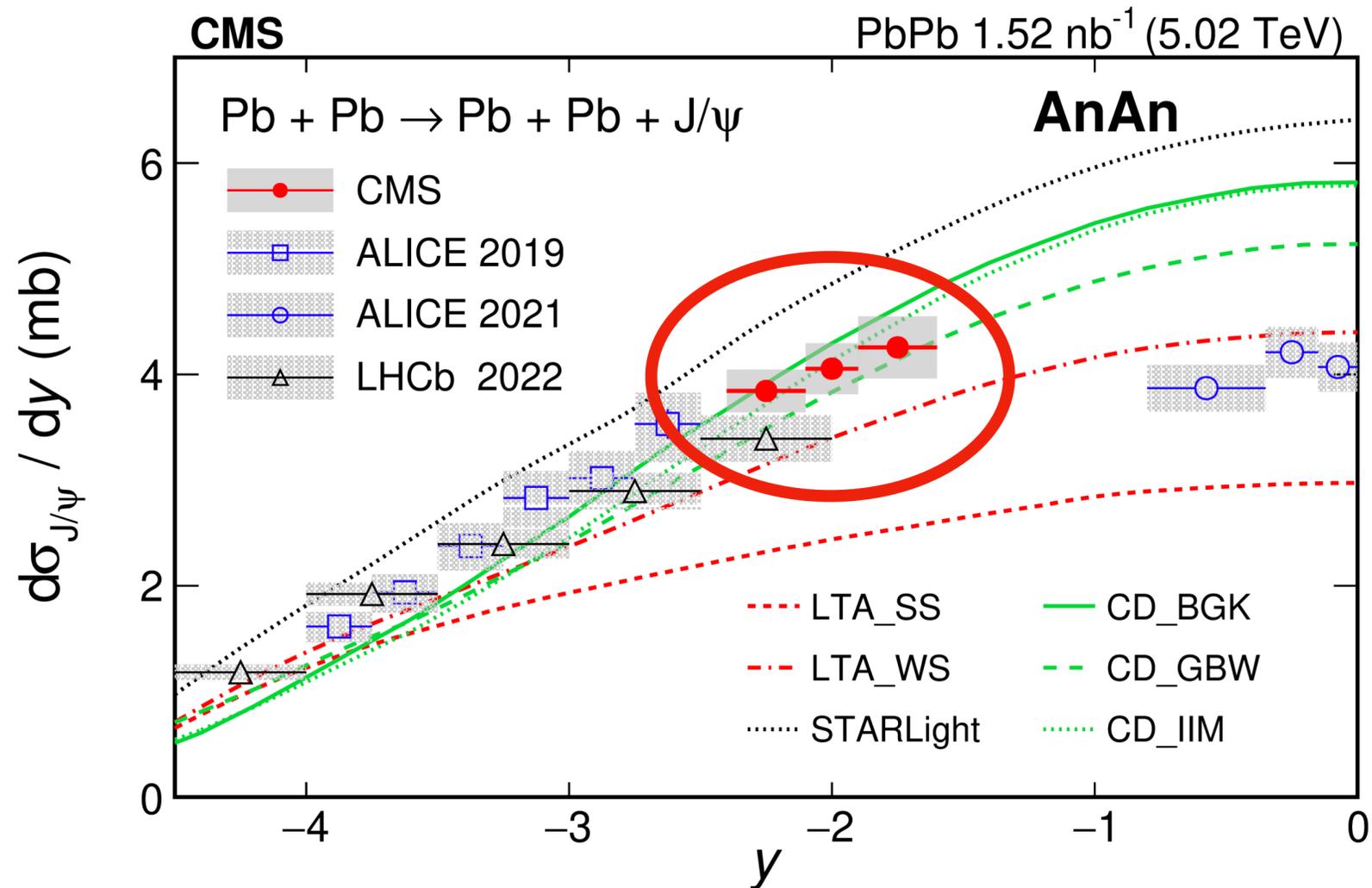


# CMS Coherent $J/\Psi$ in UPC

- Cross section of UPC Coherent  $J/\Psi$

HIN-22-022 Submitted to PRL

**Jiazhao Lin's talk**  
**Wed. 8:30, Ballroom A**

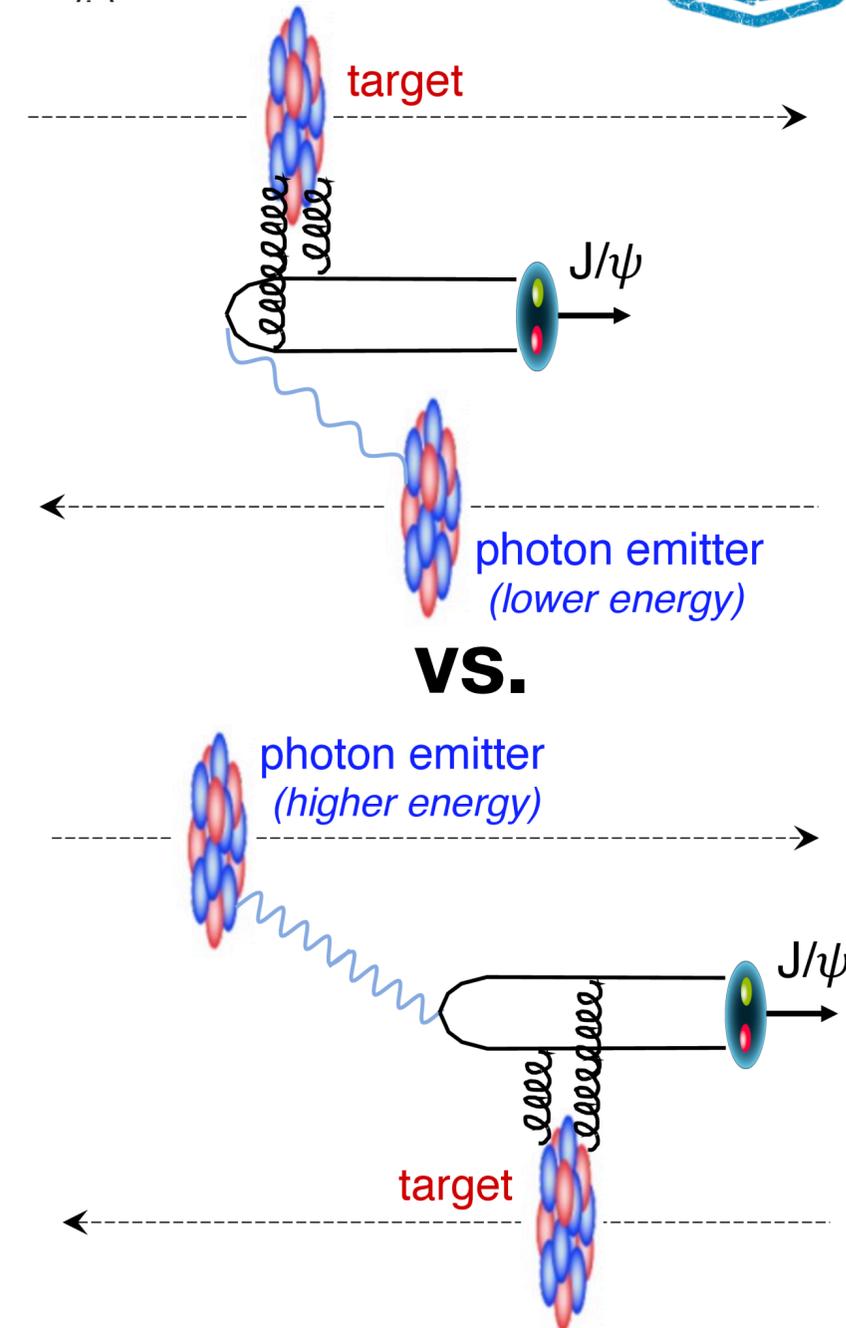
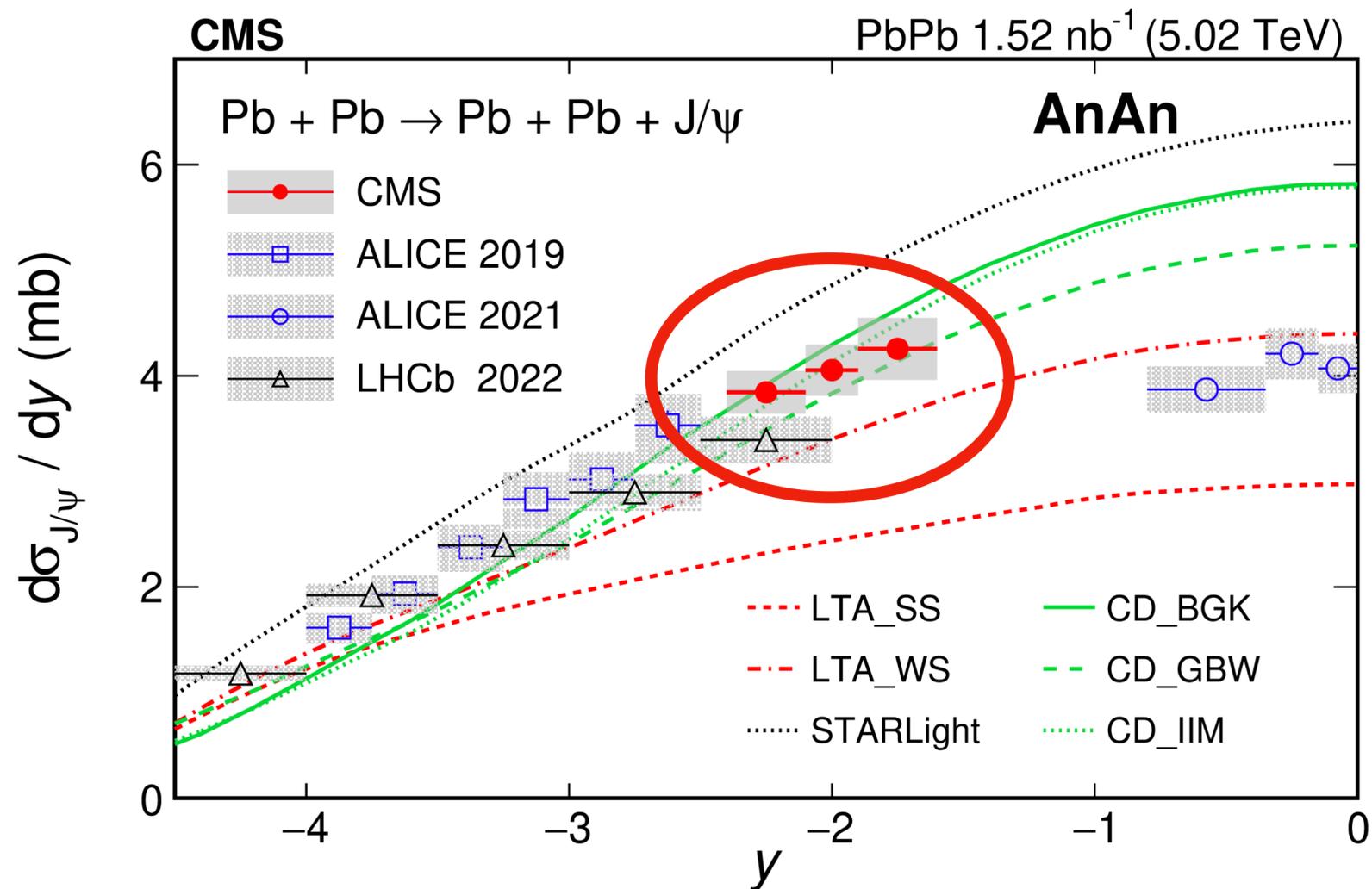


# Two-way ambiguity of photon energy

- Cross section of UPC Coherent  $J/\psi$
- Mixture of 2 initial photon energies at given  $y$

HIN-22-022 Submitted to PRL

**Jiazhao Lin's talk**  
Wed. 8:30, Ballroom A

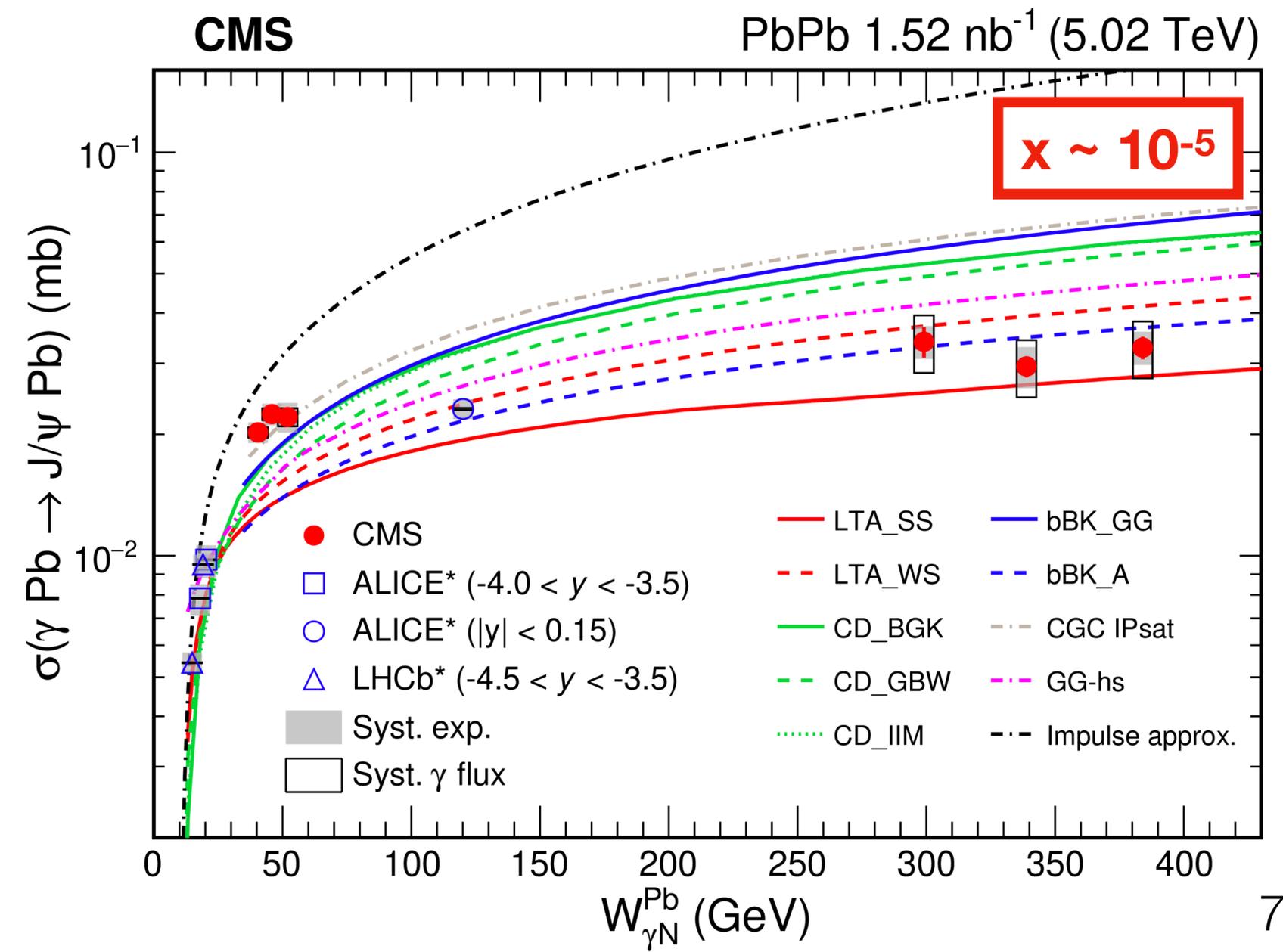
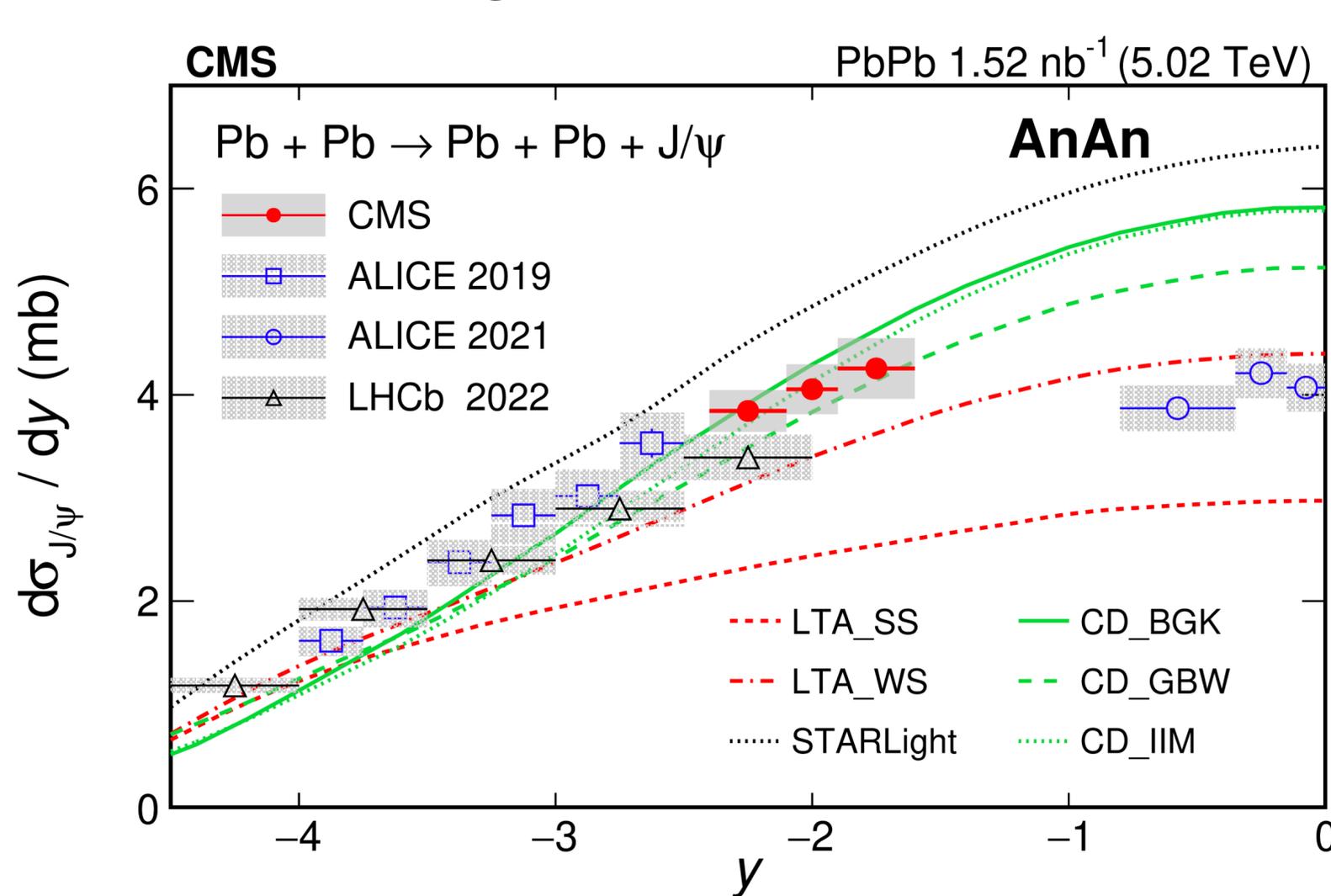


# Probing gluon nPDF at low x

- ZDC used to separate initial photon energies
- Models cannot describe data across all  $W_{\gamma N}^{Pb}$
- Evidence of gluon saturation or Black Disk Limit

HIN-22-022 Submitted to PRL

**Jiazhao Lin's talk**  
**Wed. 8:30, Ballroom A**



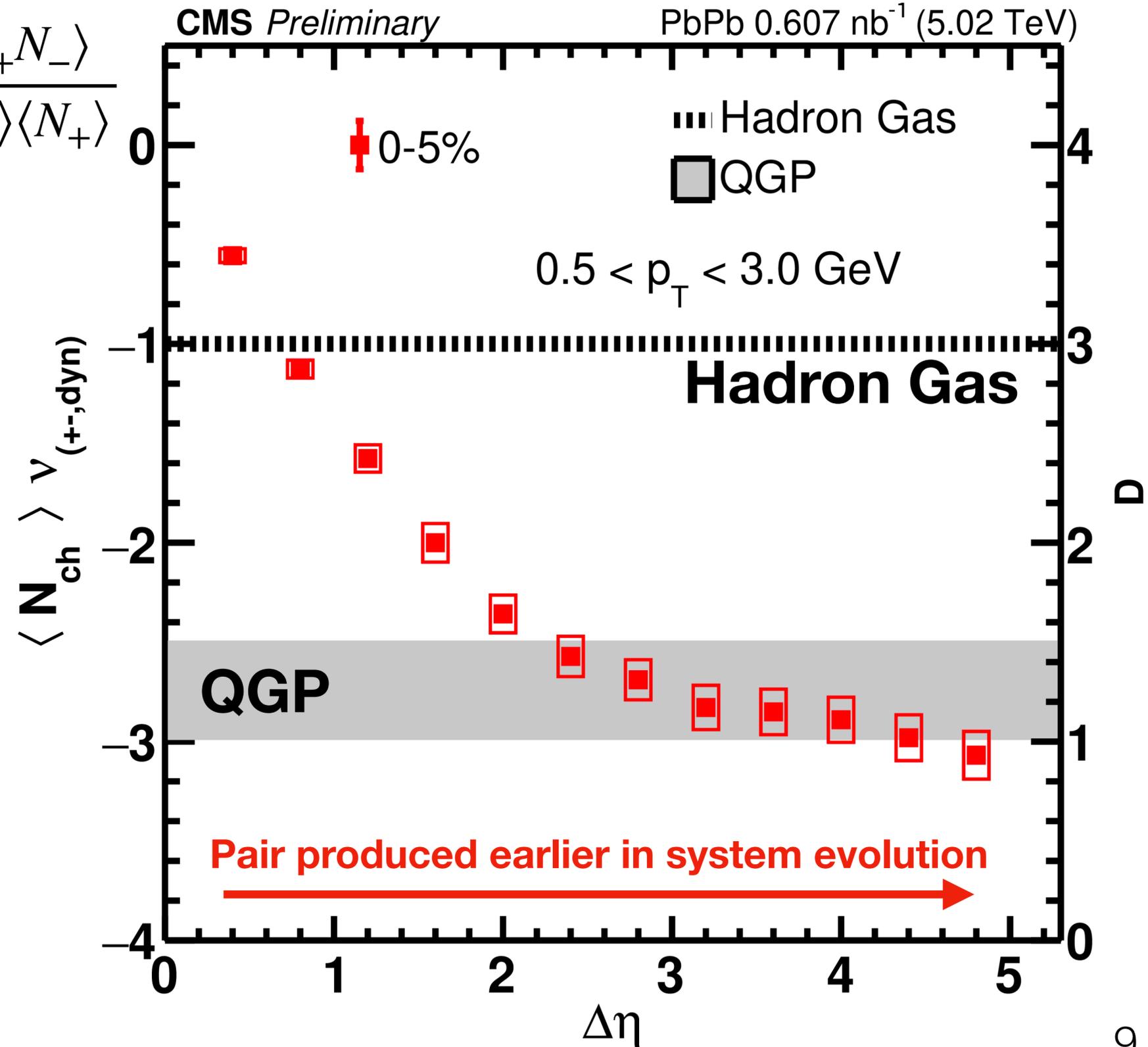
# QGP Degrees of Freedom

The background of the slide is a light gray color with a complex, abstract pattern of thin, radiating lines. These lines are primarily yellow and green, with some blue and cyan accents. The lines appear to originate from a central point and spread outwards, creating a sense of motion and energy. The overall effect is reminiscent of a starburst or a particle collision event.

# Net charge fluctuations in PbPb

$$\nu_{(+-, \text{dyn})} = \frac{\langle N_+(N_+ - 1) \rangle}{\langle N_+ \rangle^2} + \frac{\langle N_-(N_- - 1) \rangle}{\langle N_- \rangle^2} - 2 \frac{\langle N_+ N_- \rangle}{\langle N_- \rangle \langle N_+ \rangle}$$

- Net charge fluctuations vs.  $\Delta\eta$  of particle pairs
- Consistent with predictions for QGP at large  $\Delta\eta$



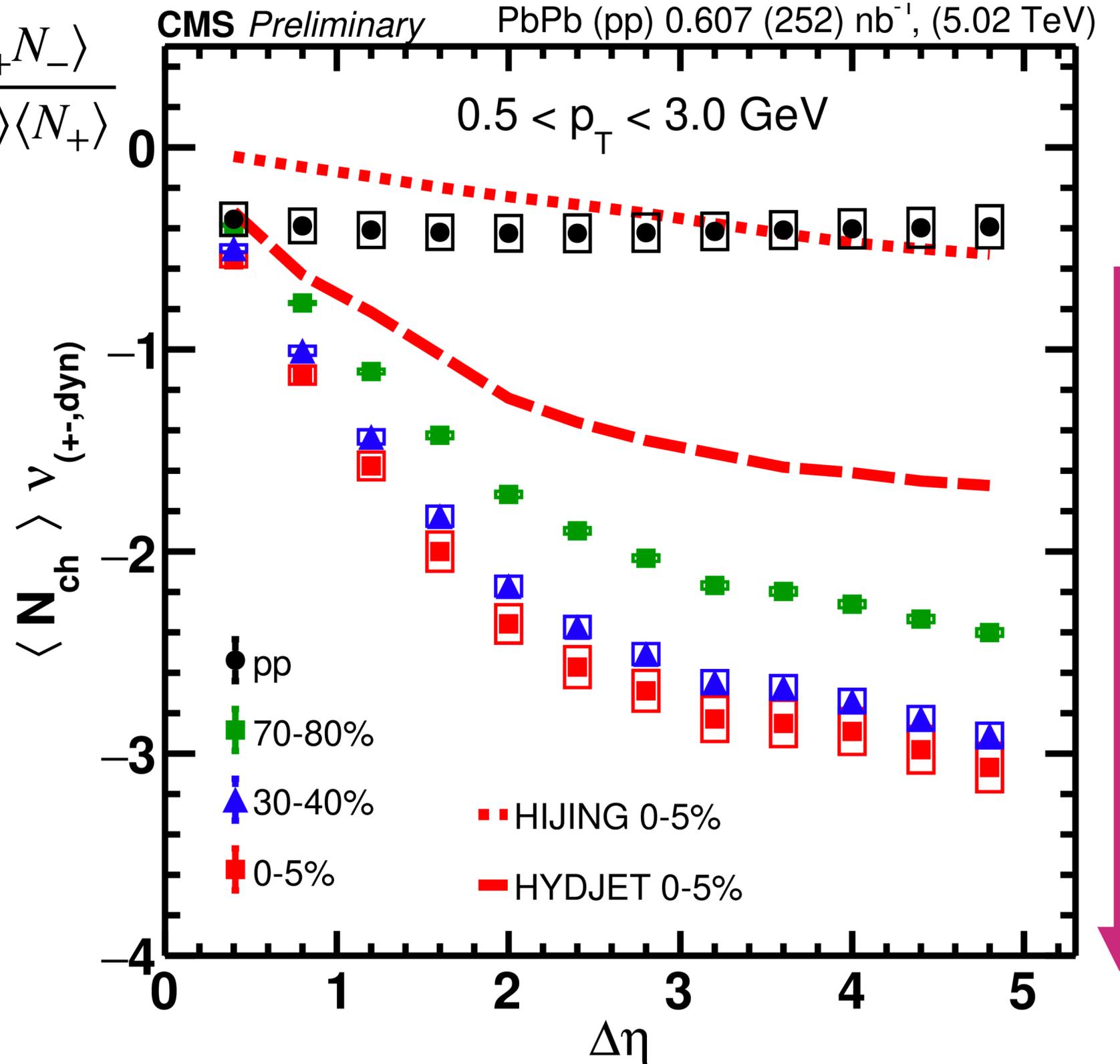
CMS PAS HIN-22-005

**Shengquan Tuo's talk**  
**Tues. 11:40, Ballroom B**

# Net charge fluctuations in PbPb

$$\nu_{(+-, \text{dyn})} = \frac{\langle N_+(N_+ - 1) \rangle}{\langle N_+ \rangle^2} + \frac{\langle N_-(N_- - 1) \rangle}{\langle N_- \rangle^2} - 2 \frac{\langle N_+ N_- \rangle}{\langle N_- \rangle \langle N_+ \rangle}$$

- Net charge fluctuations vs.  $\Delta\eta$  of particle pairs
- Consistent with predictions for QGP at large  $\Delta\eta$
- **Increasing centrality** approaches QGP prediction faster

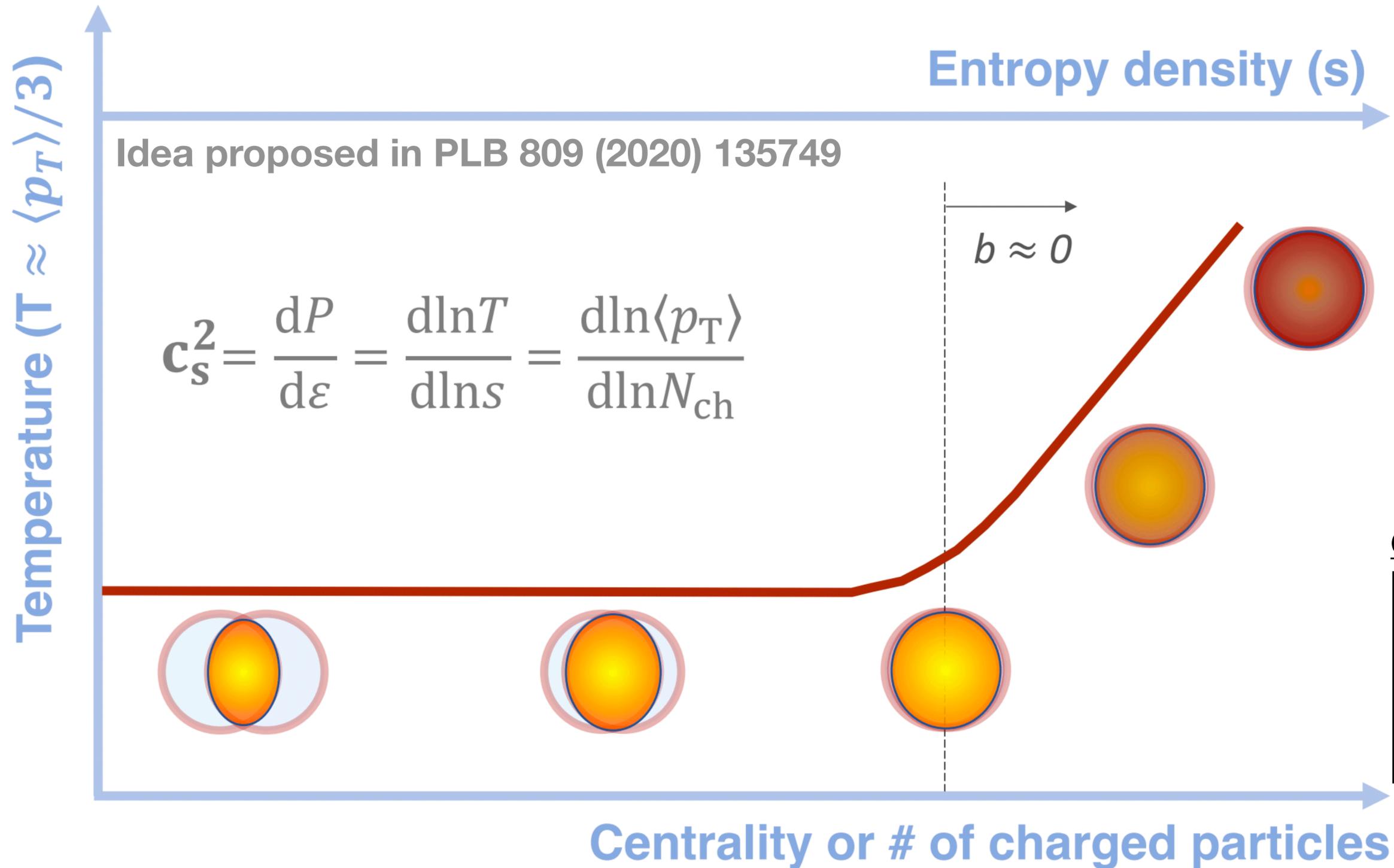


CMS PAS HIN-22-005

**Shengquan Tuo's talk**  
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# Speed of Sound in QGP

- QGP speed of sound can be extracted from measurements of  $\langle p_T \rangle$  vs  $N_{ch}$



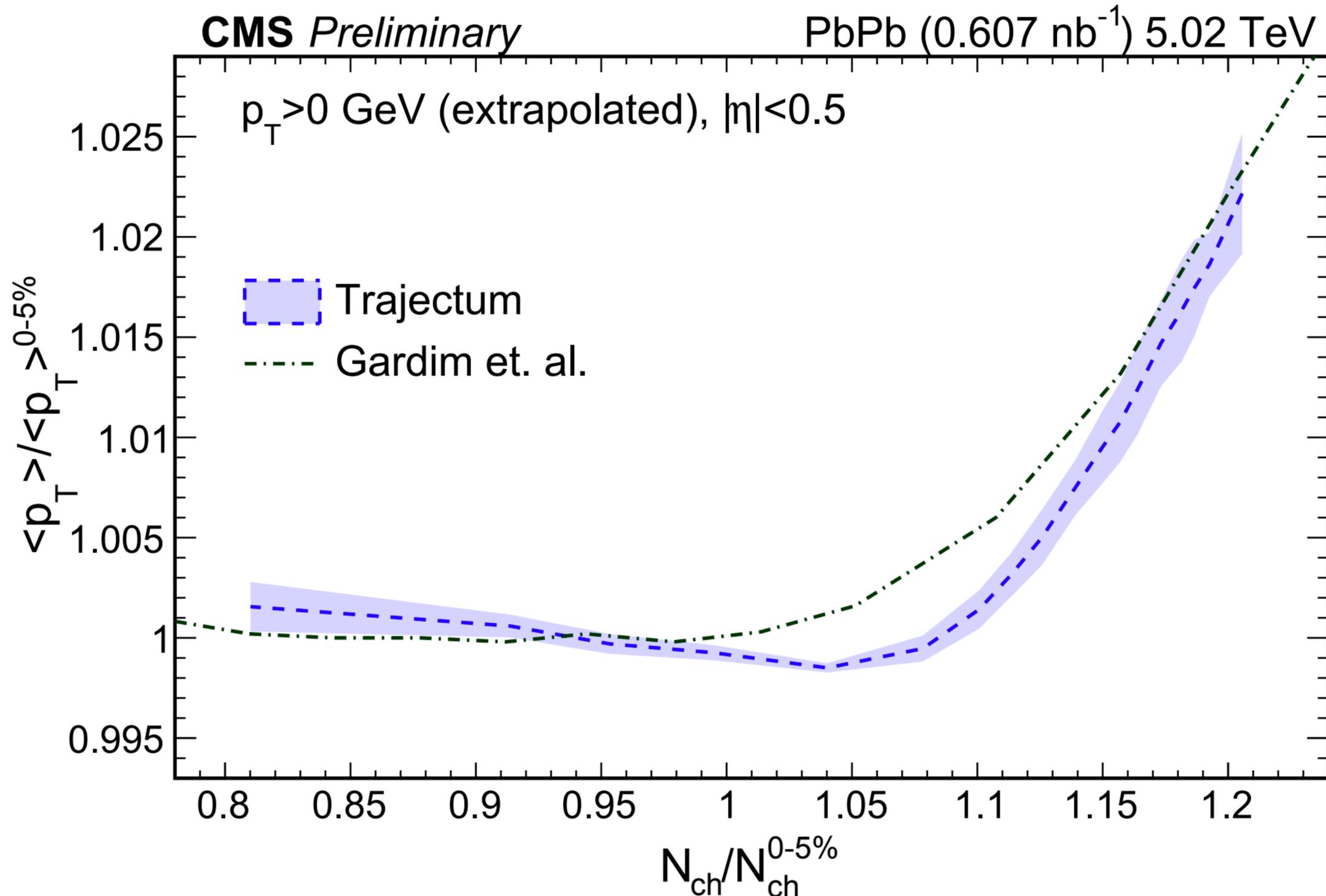
CMS PAS HIN-23-003

**Cesar  
Bernardes's talk**  
Wed. 15:40,  
Ballroom C



# Speed of Sound in QGP

- Hydrodynamic models predict rising slope at large  $N_{ch}$



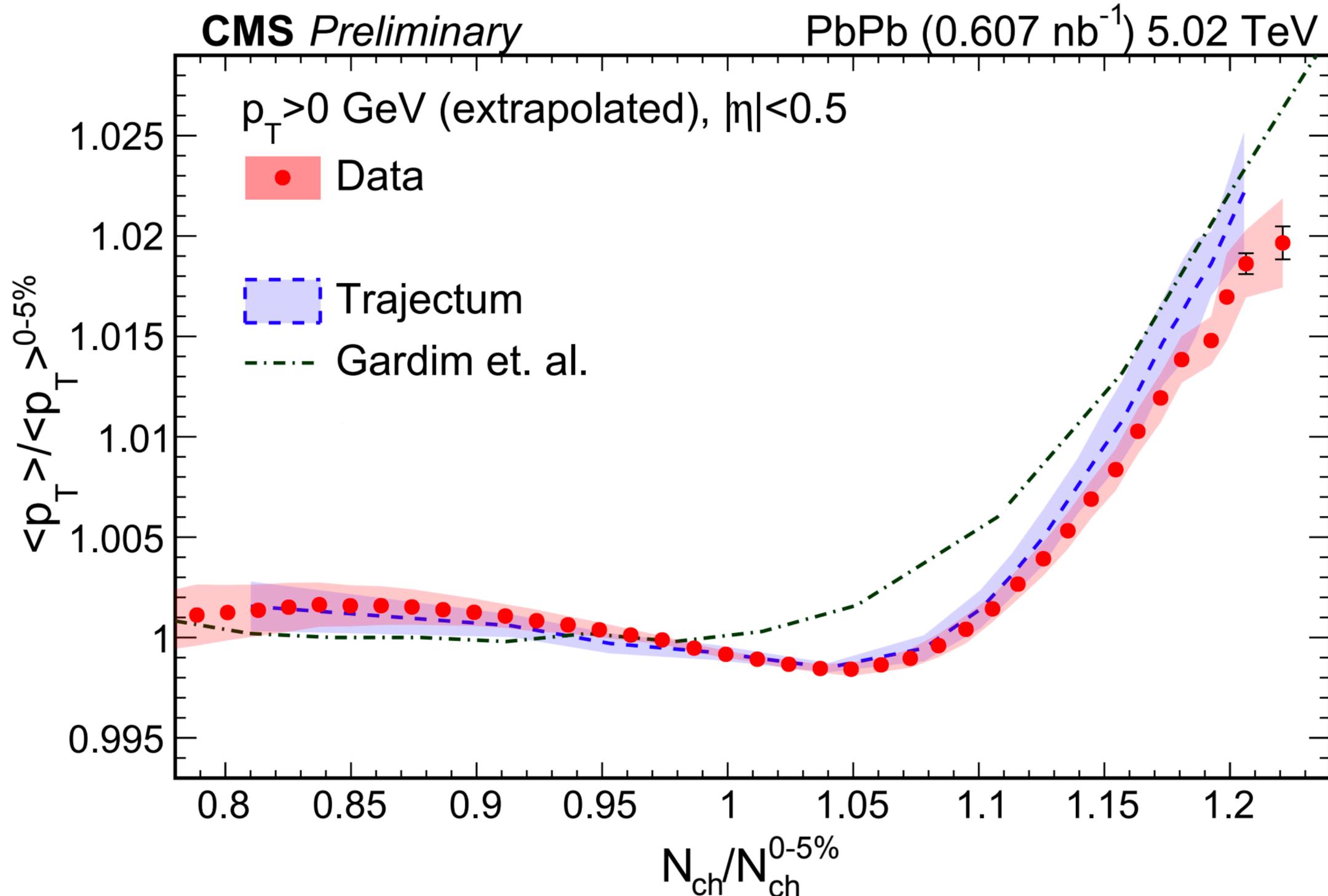
CMS PAS HIN-23-003

**Cesar  
Bernardes's talk**  
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# Speed of Sound in QGP

- Slope of **data** matches models closely!



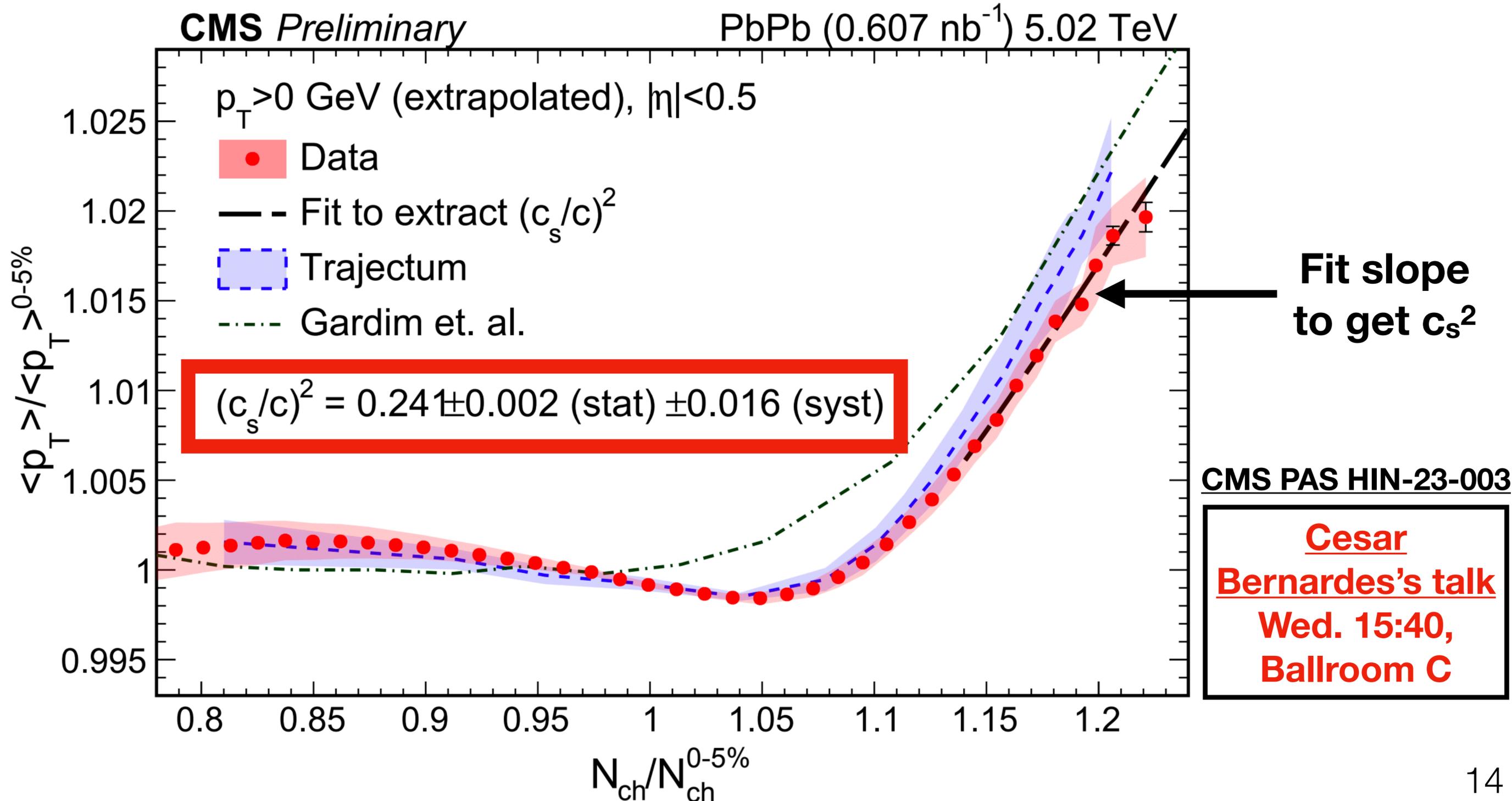
CMS PAS HIN-23-003

**Cesar  
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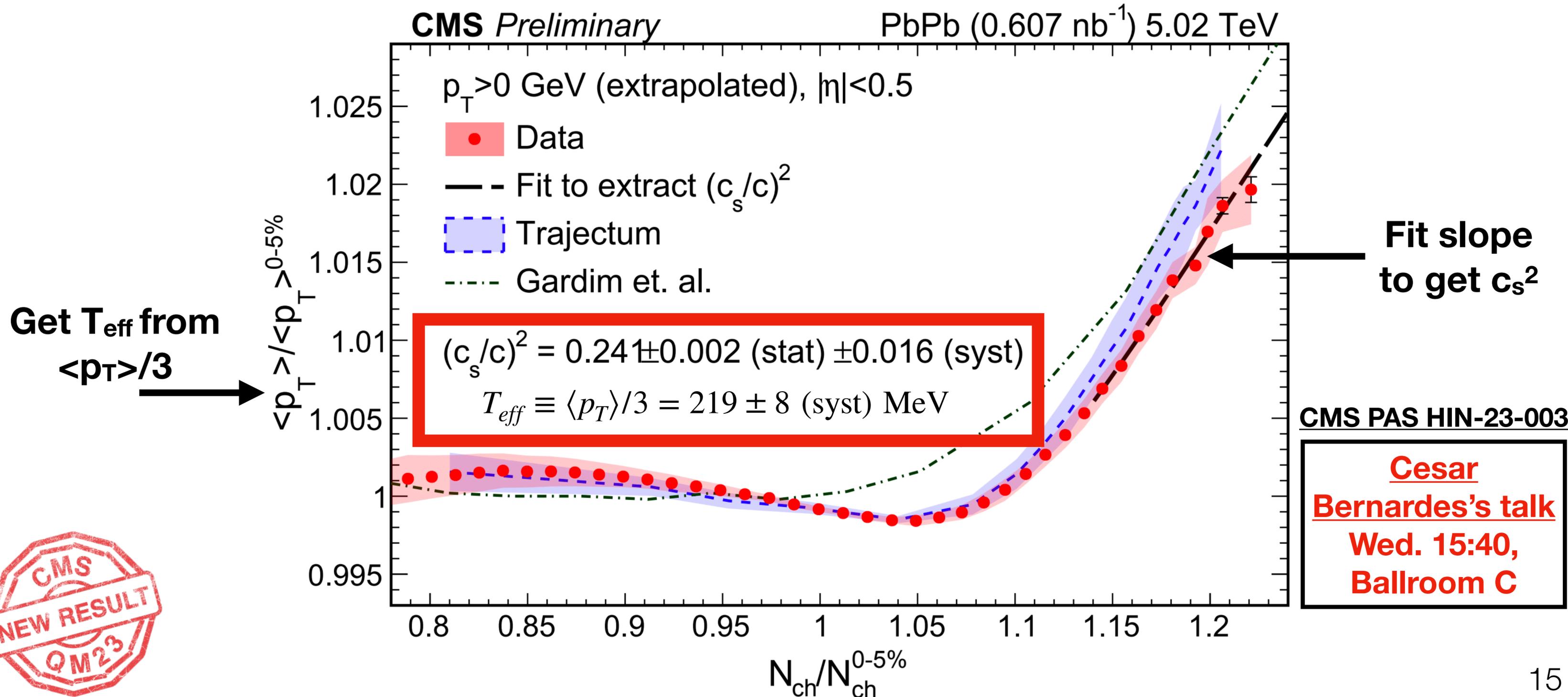
# Speed of Sound in QGP

- Slope of **data** matches models closely!



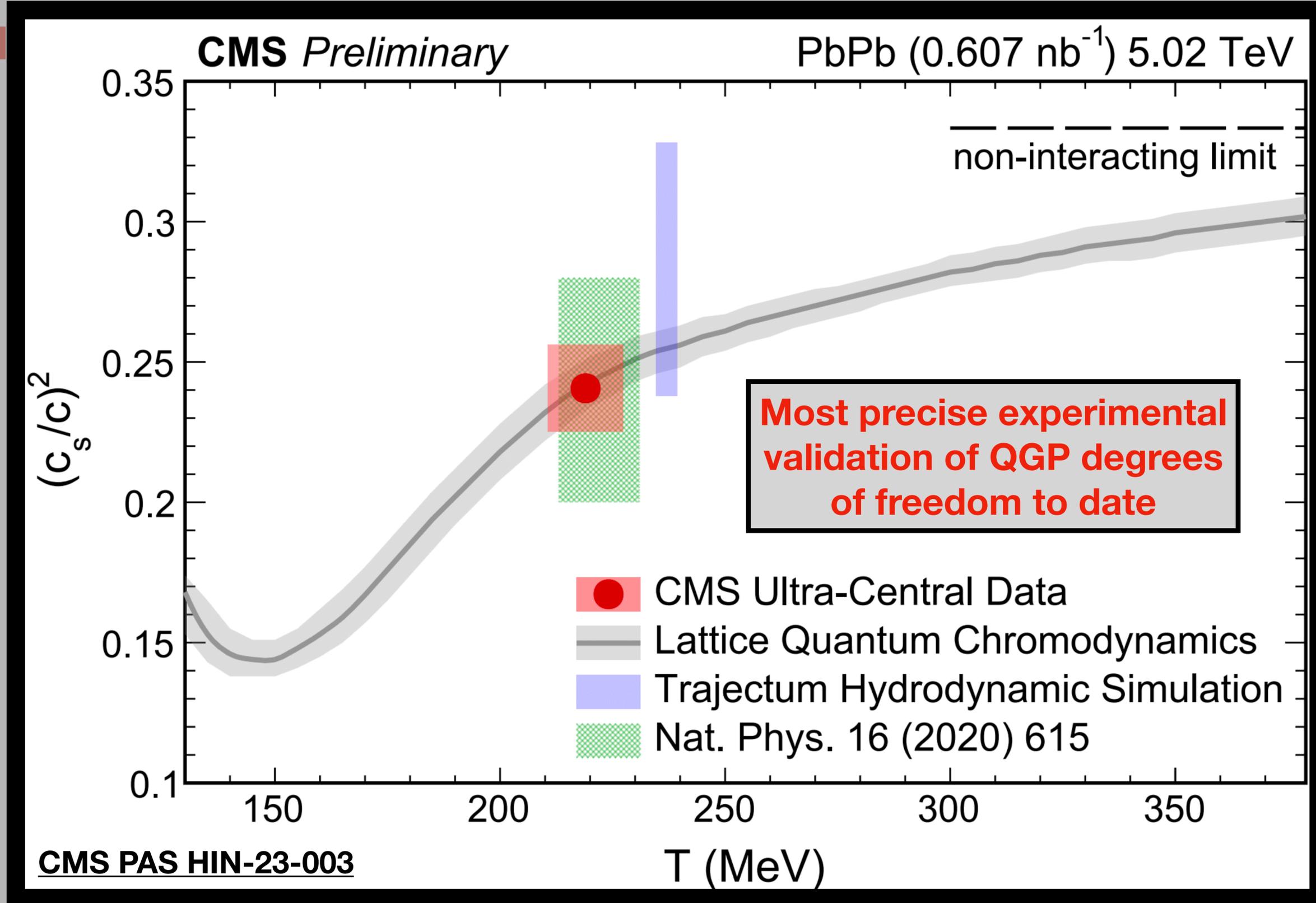
# Speed of Sound in QGP

- Slope of **data** matches models closely!



# Constraining QCD Equation of State

- Slope of  $d$



Fit slope to get  $c_s^2$

PAS HIN-23-003

Cesar  
arnardes's talk  
Wed. 15:40,  
Ballroom C



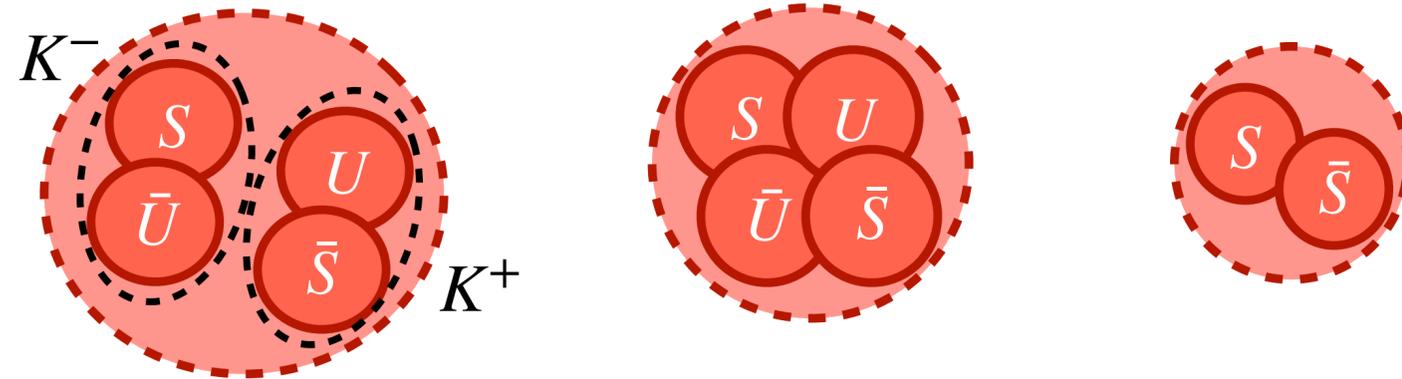


# Hadronization and Heavy Flavor

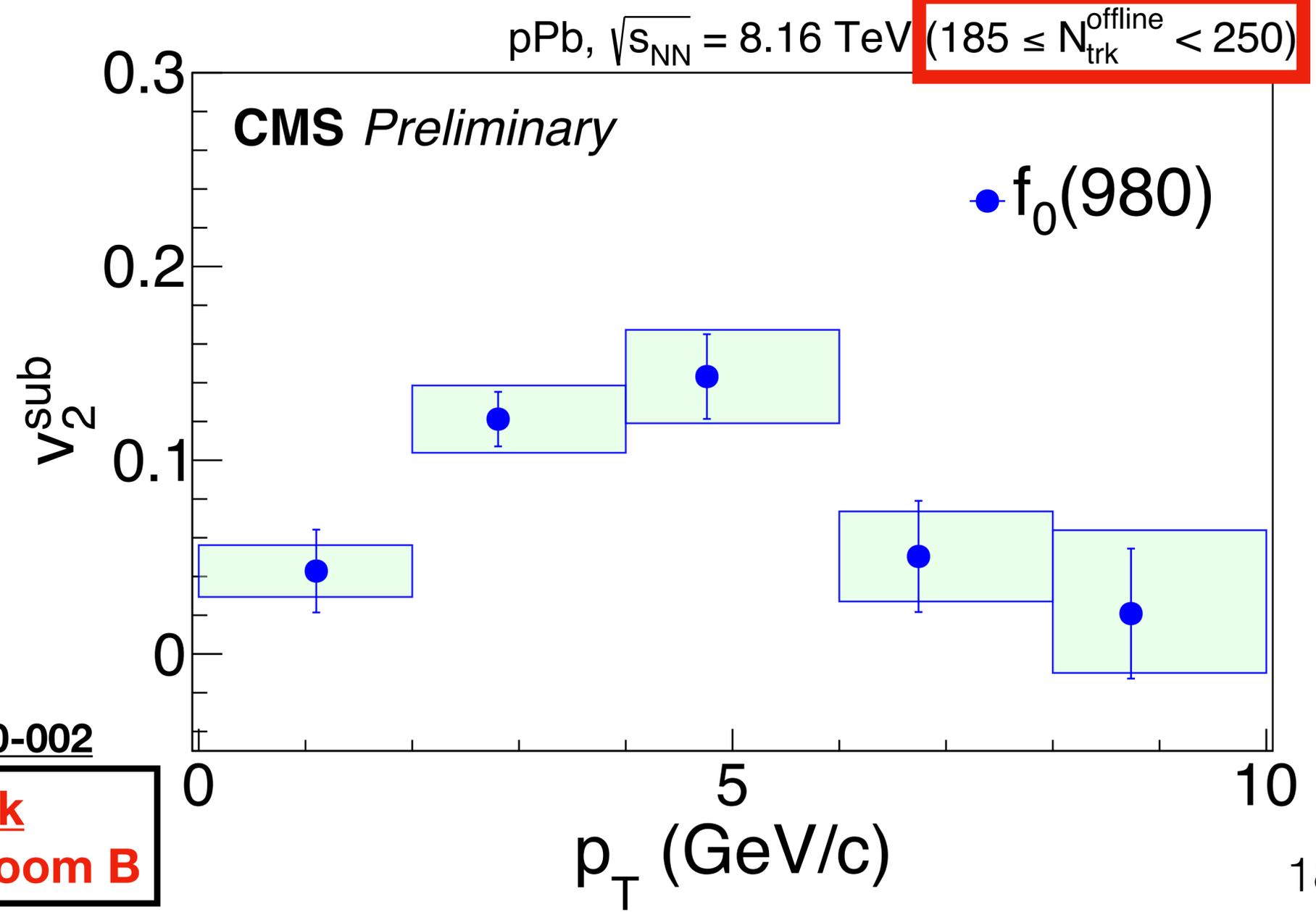
# $v_2$ of $f_0(980)$ in pPb

- $f_0(980)$  structure unknown

- Diquark
- Tetraquark
- K-K molecule



- $v_2$  of  $f_0(980)$  measured in pPb



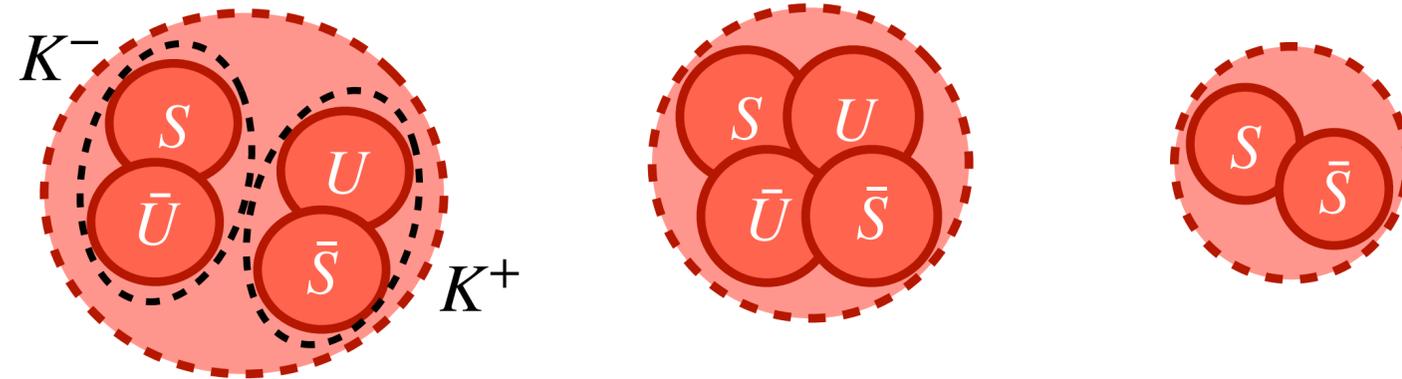
CMS PAS HIN-20-002

**An Gu's talk**  
**Tues. 9:30, Ballroom B**

# Constituent Scaling of $v_2$

- $f_0(980)$  structure unknown

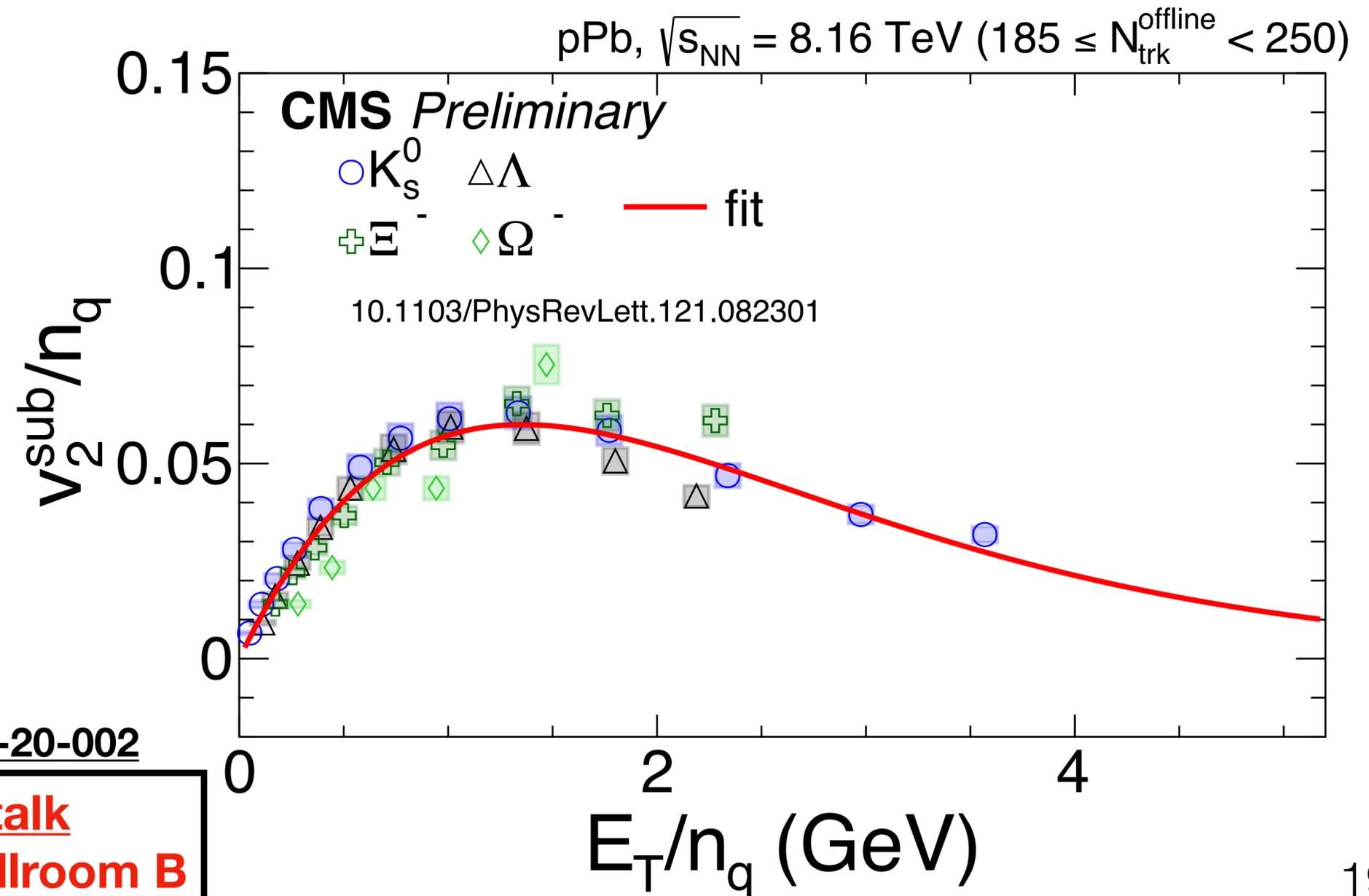
- Diquark
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- $v_2$  of  $f_0(980)$  measured in pPb

- Use **constituent quark scaling** to extract number of quarks

$$v_2(E_T)/n_q = v_{2,q}(E_T/n_q)$$



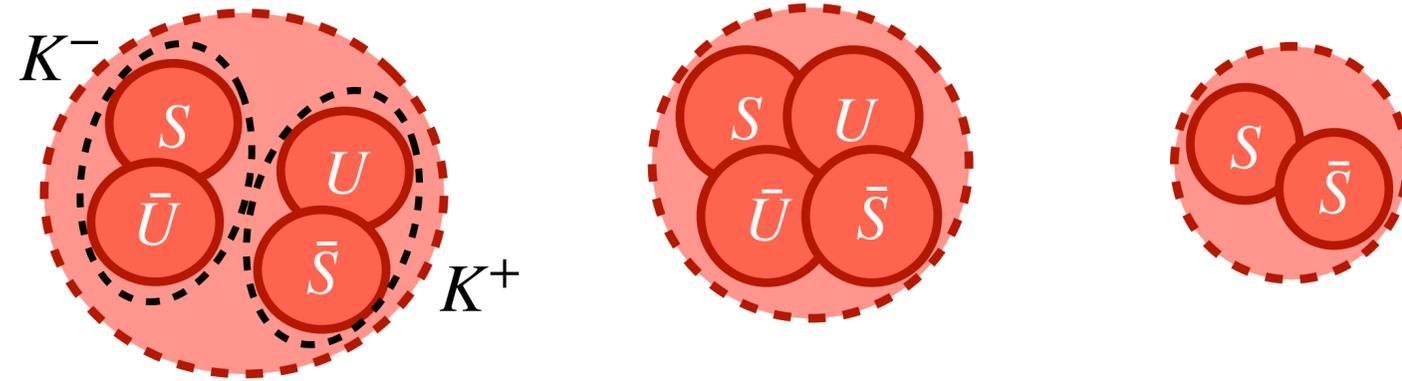
CMS PAS HIN-20-002

**An Gu's talk**  
**Tues. 9:30, Ballroom B**

# $f_0(980)$ Quark Content

•  $f_0(980)$  structure unknown

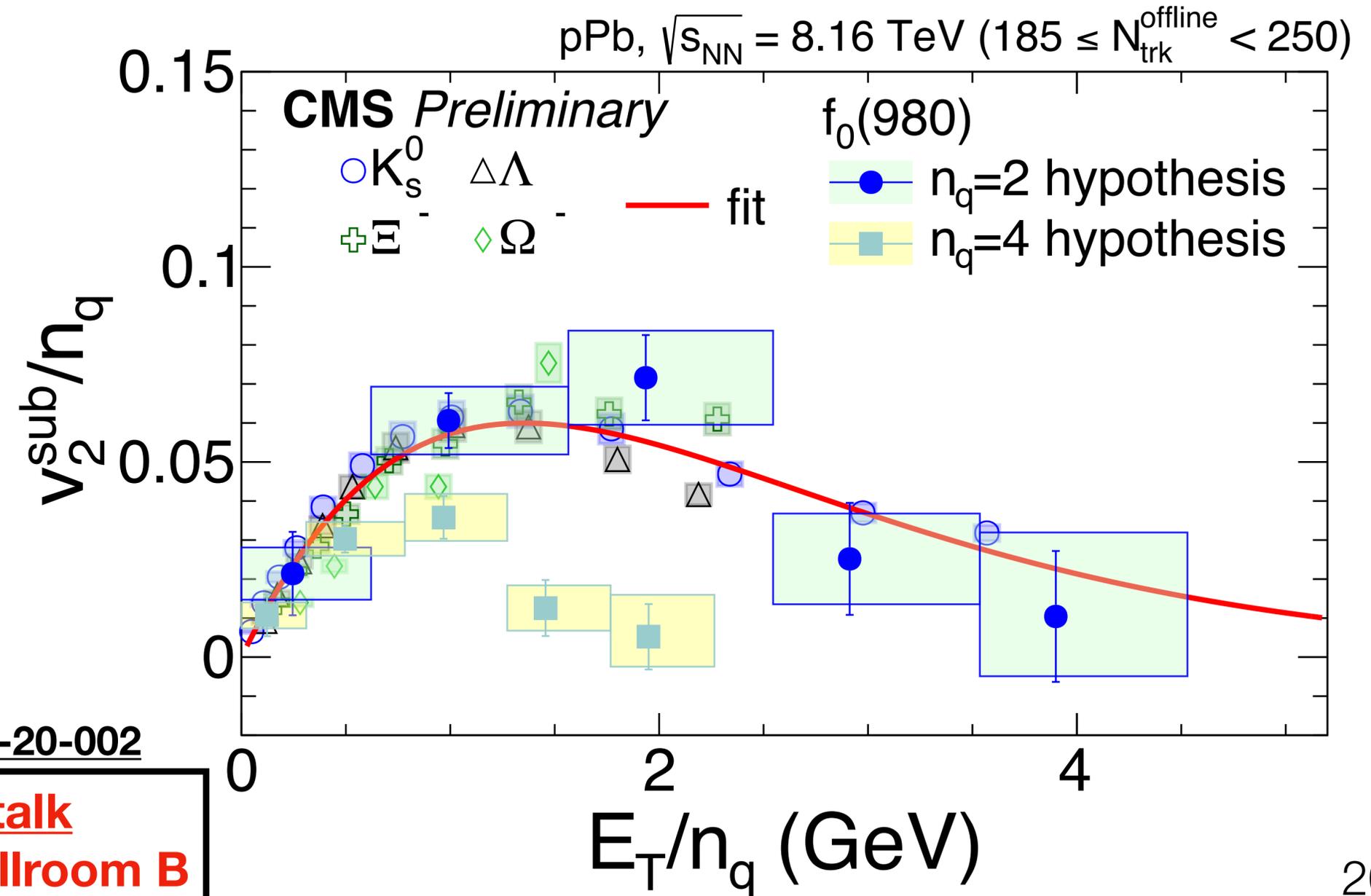
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CMS PAS HIN-20-002

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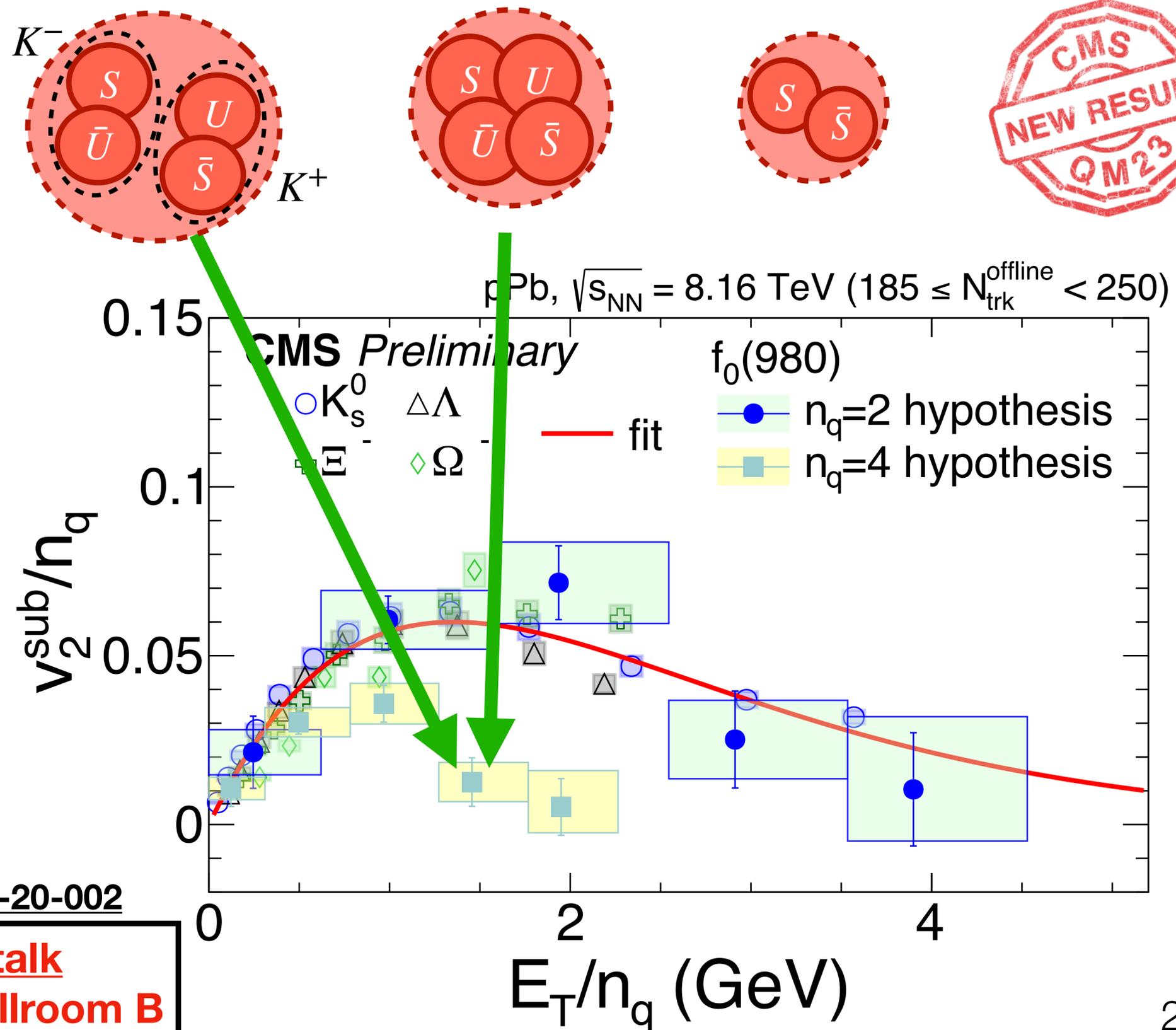
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$$v_2(E_T)/n_q = v_{2,q}(E_T/n_q)$$

- $n_q = 4$  excluded at  $\geq 3.1\sigma$



CMS PAS HIN-20-002

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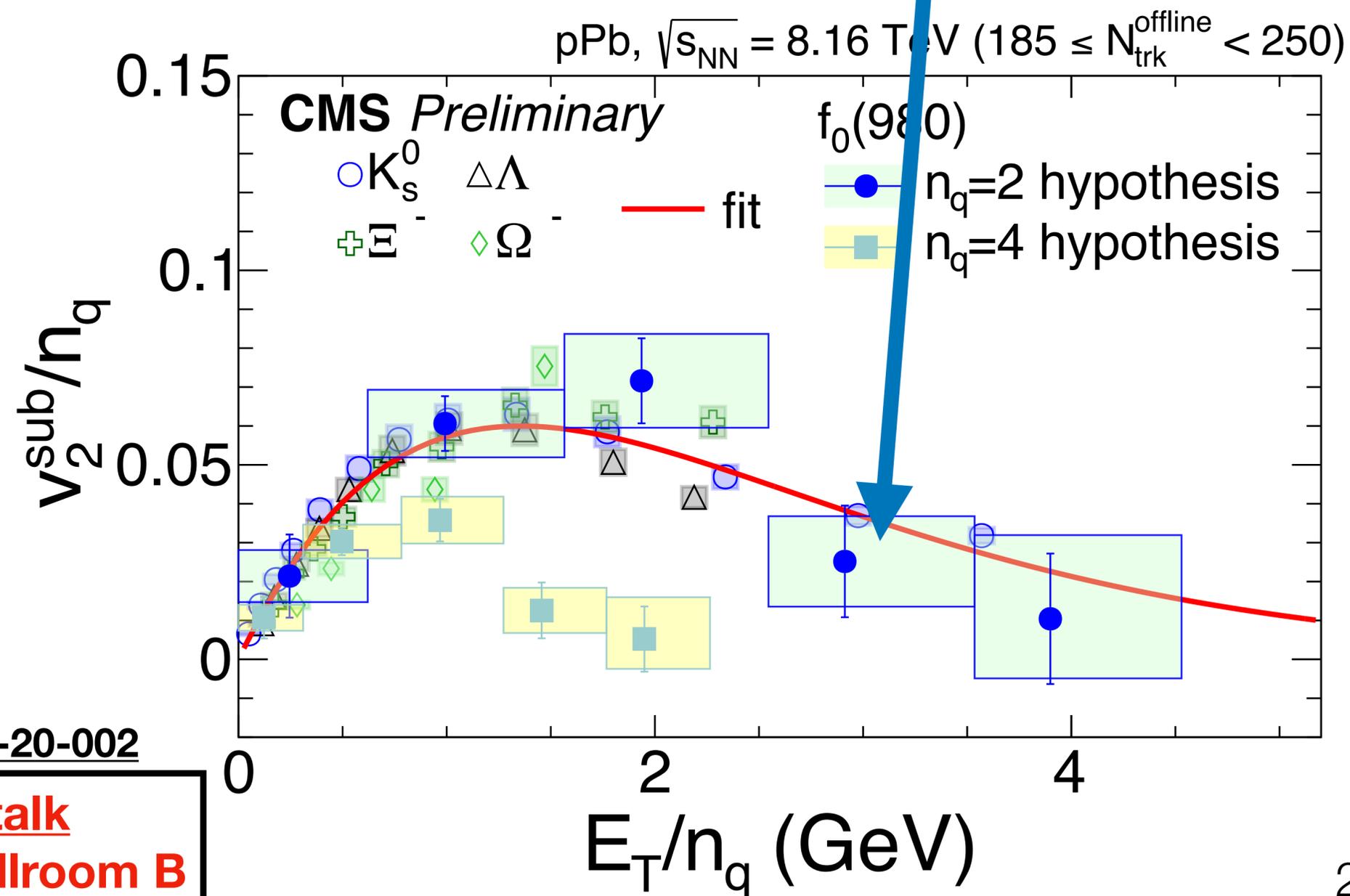
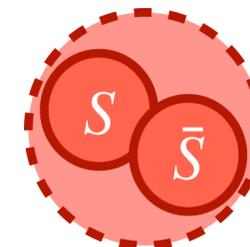
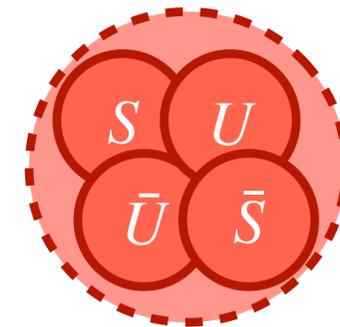
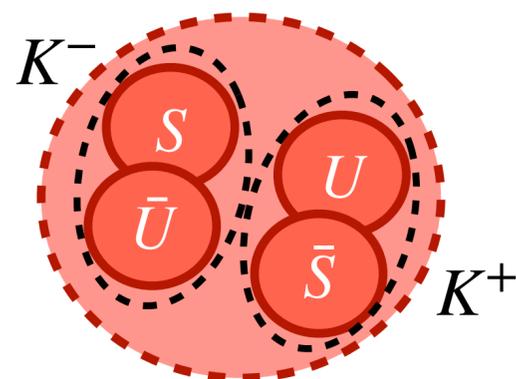
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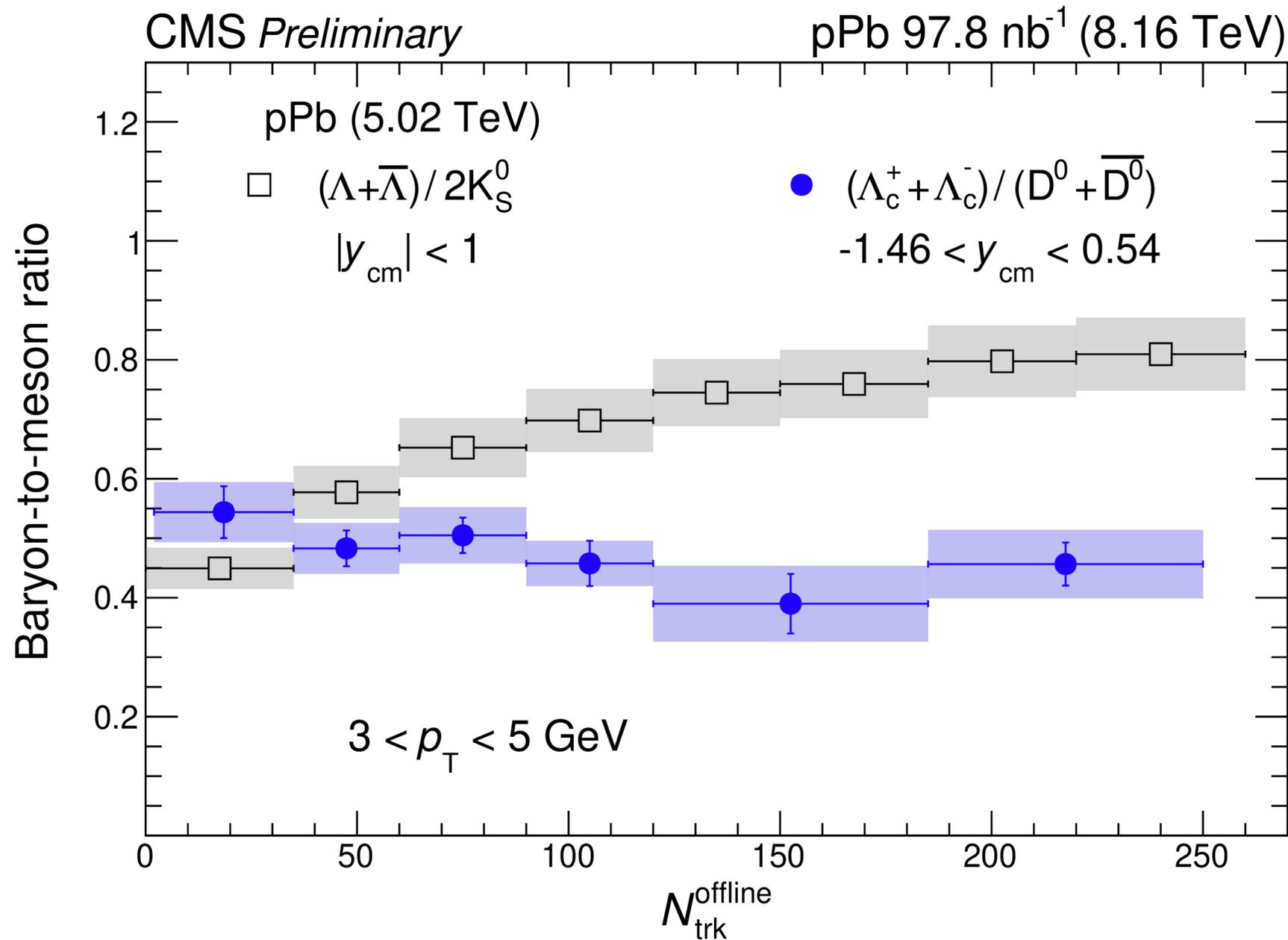
- $n_q = 2$  favored



CMS PAS HIN-20-002

**An Gu's talk**  
Tues. 9:30, Ballroom B

# $\Lambda_c^+ / D^0$ Ratio vs. pPb multiplicity



CMS PAS HIN-21-016

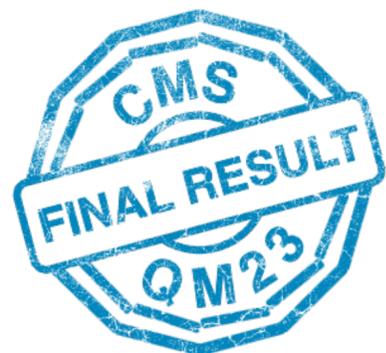
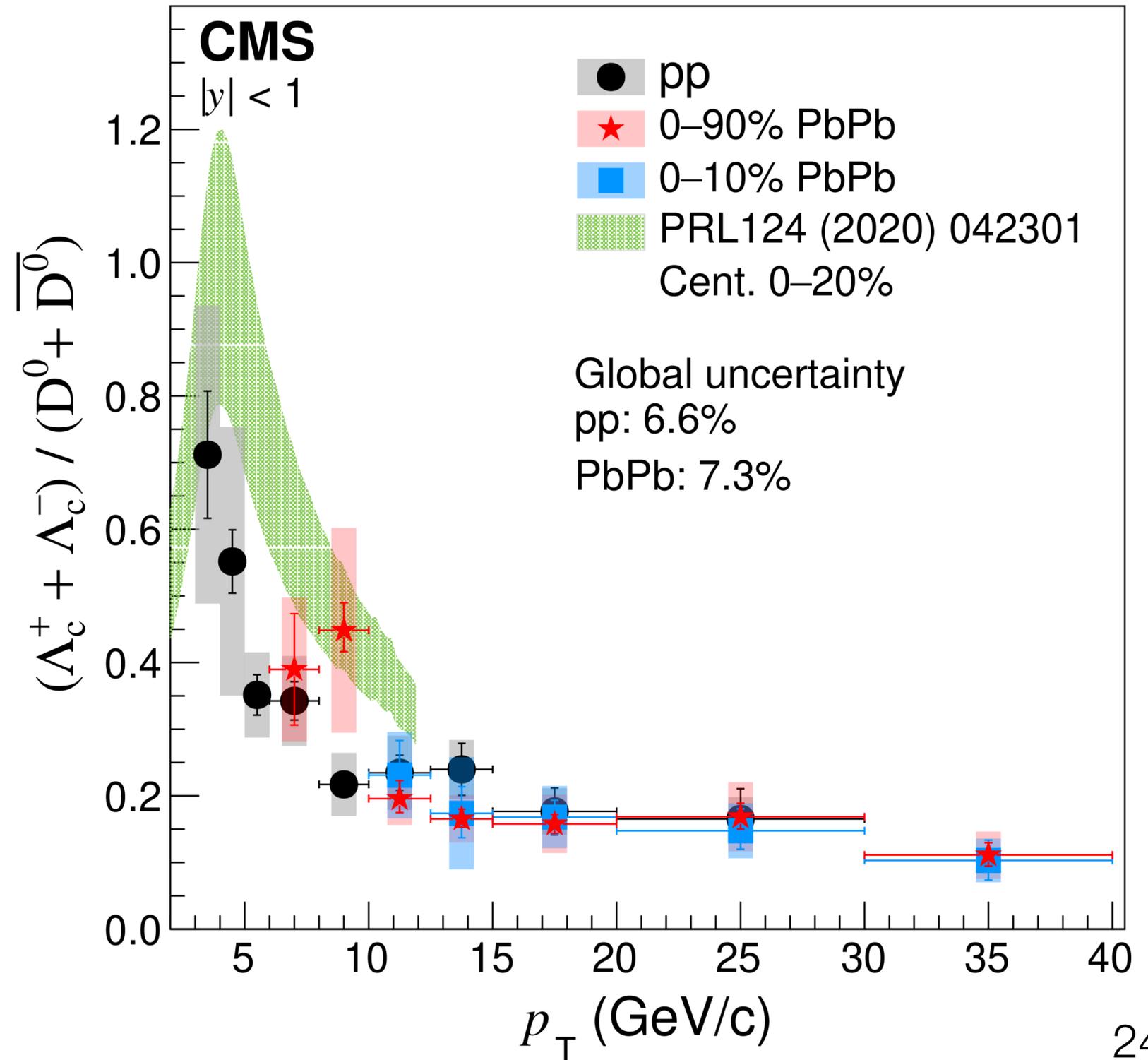
**Soumik Chandra's talk**  
**Tues. 9:30, Ballroom D**

- Comparison of **charm** and **strange** baryon-to-meson ratio
- Multiplicity-dependence not observed in charm sector

# $\Lambda_c^+ / D^0$ Ratio in PbPb

- New measurement of  $\Lambda_c^+$  in pp and PbPb collisions
- Rising trend in  $\Lambda_c^+ / D^0$  ratio at low  $p_T$

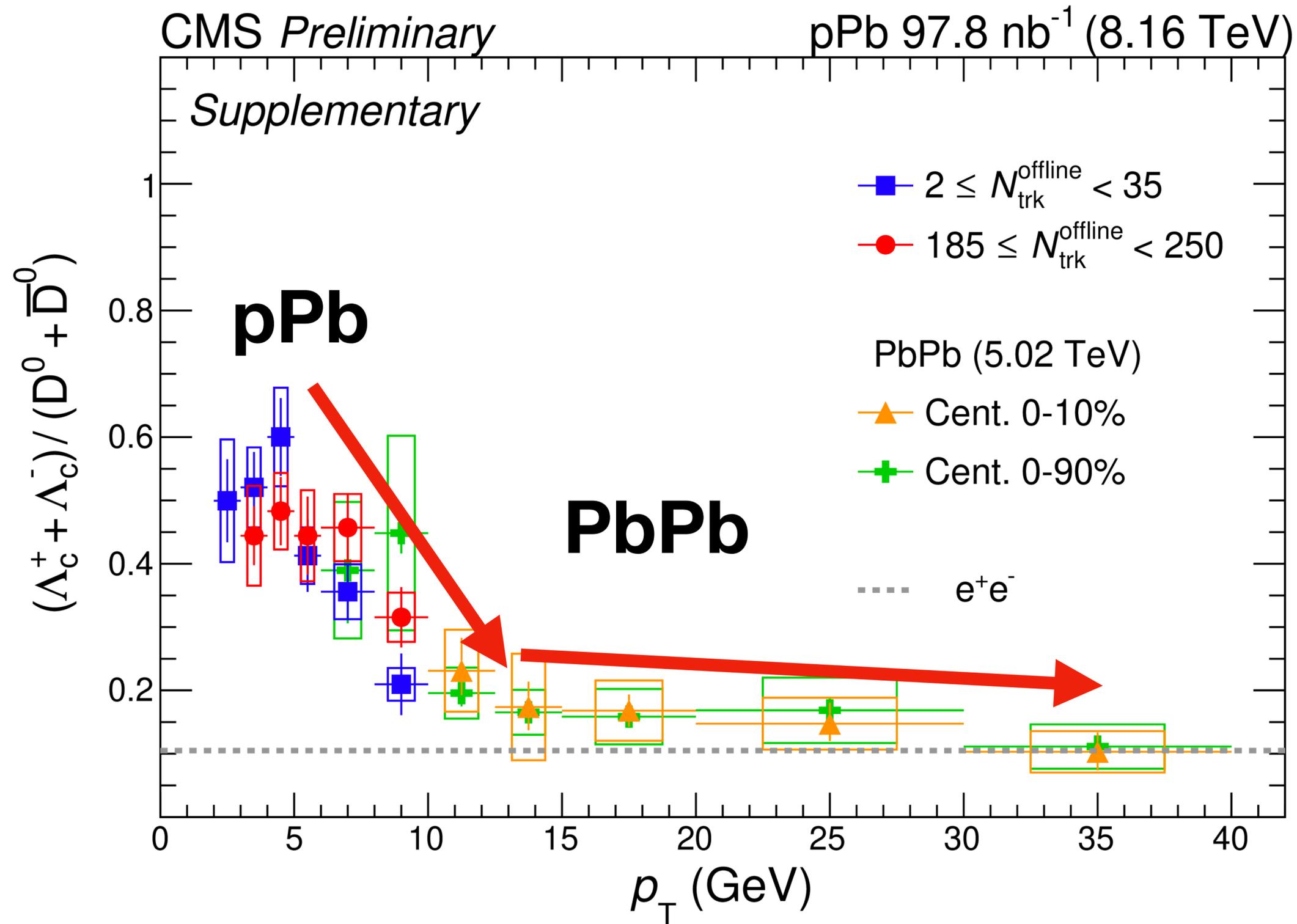
PbPb 0.607 nb<sup>-1</sup>, pp 252 nb<sup>-1</sup> (5.02 TeV)



HIN-21-004 Submitted to JHEP

**Soumik Chandra's talk**  
**Tues. 9:30, Ballroom D**

# $\Lambda_c^+ / D^0$ Compilation



- **Similar trend vs  $p_T$  regardless of multiplicity in pPb and PbPb**
- **High- $p_T$  behavior close to  $e^+e^-$  baseline**

CMS PAS HIN-21-016  
HIN-21-004 Submitted to JHEP

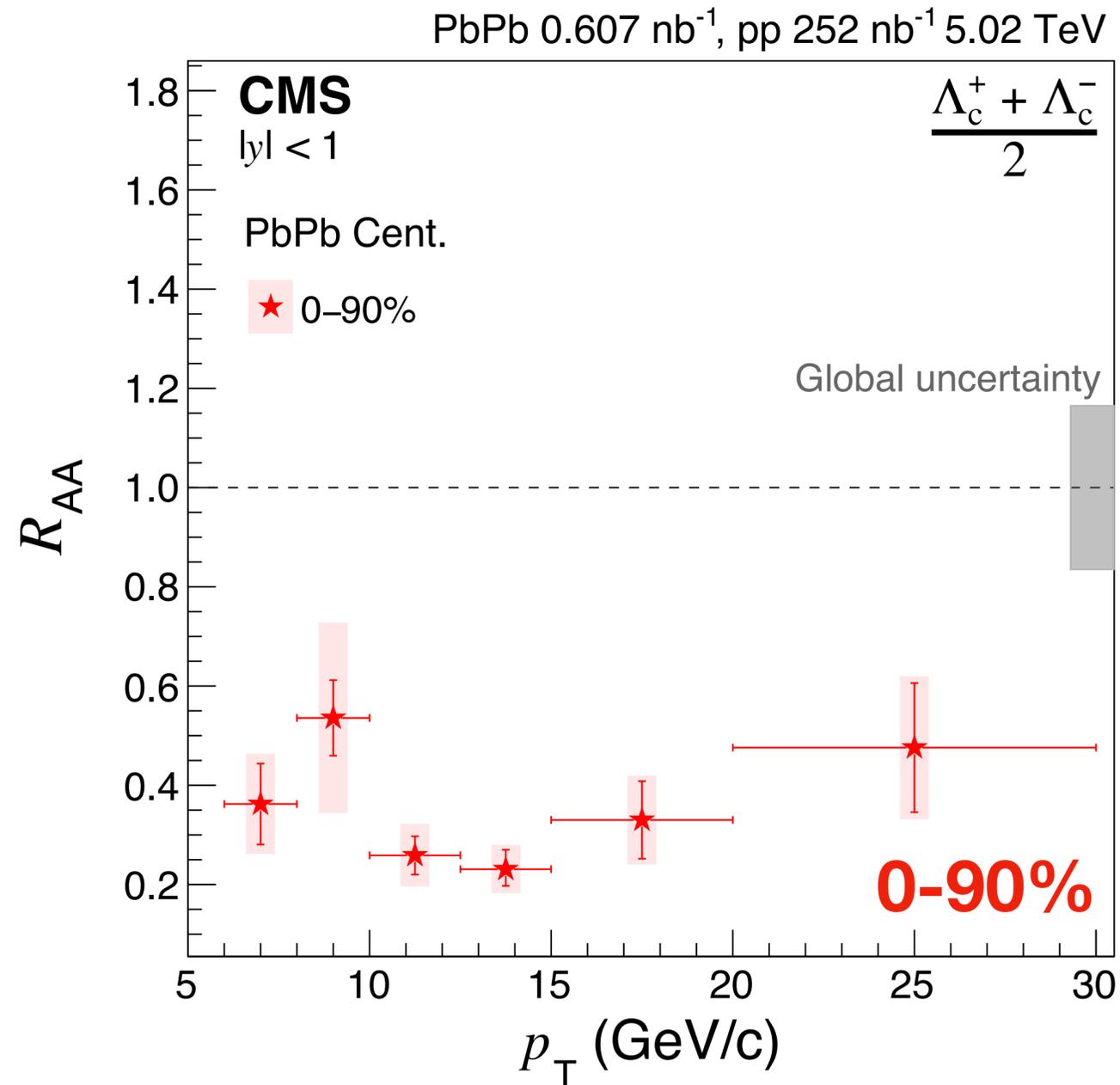
**Soumik Chandra's talk**  
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# $\Lambda_c^+$ $R_{AA}$

- $\Lambda_c^+$  heavily suppressed

HIN-21-004 Submitted to JHEP

**Soumik Chandra's talk**  
**Tues. 9:30, Ballroom D**

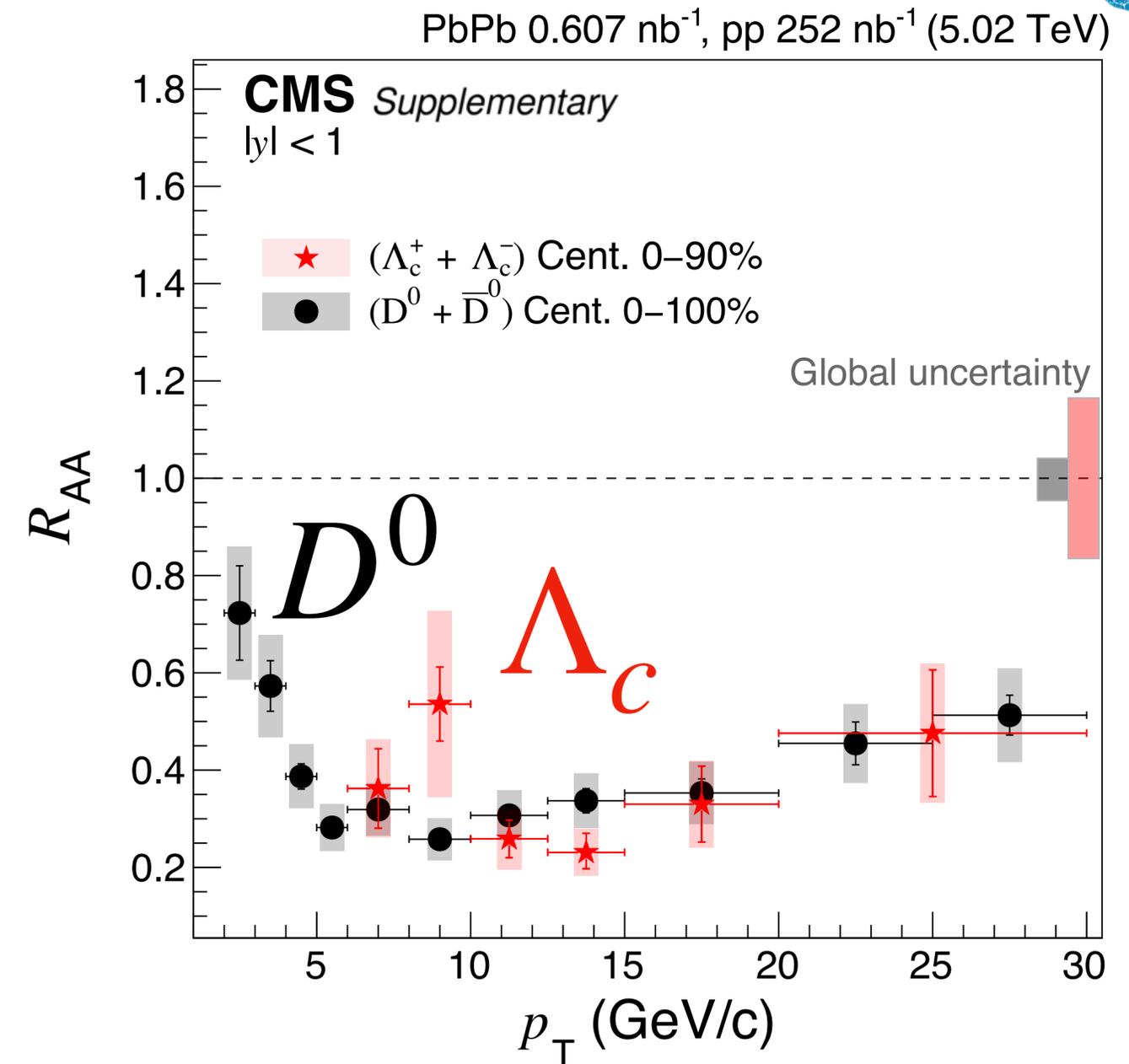
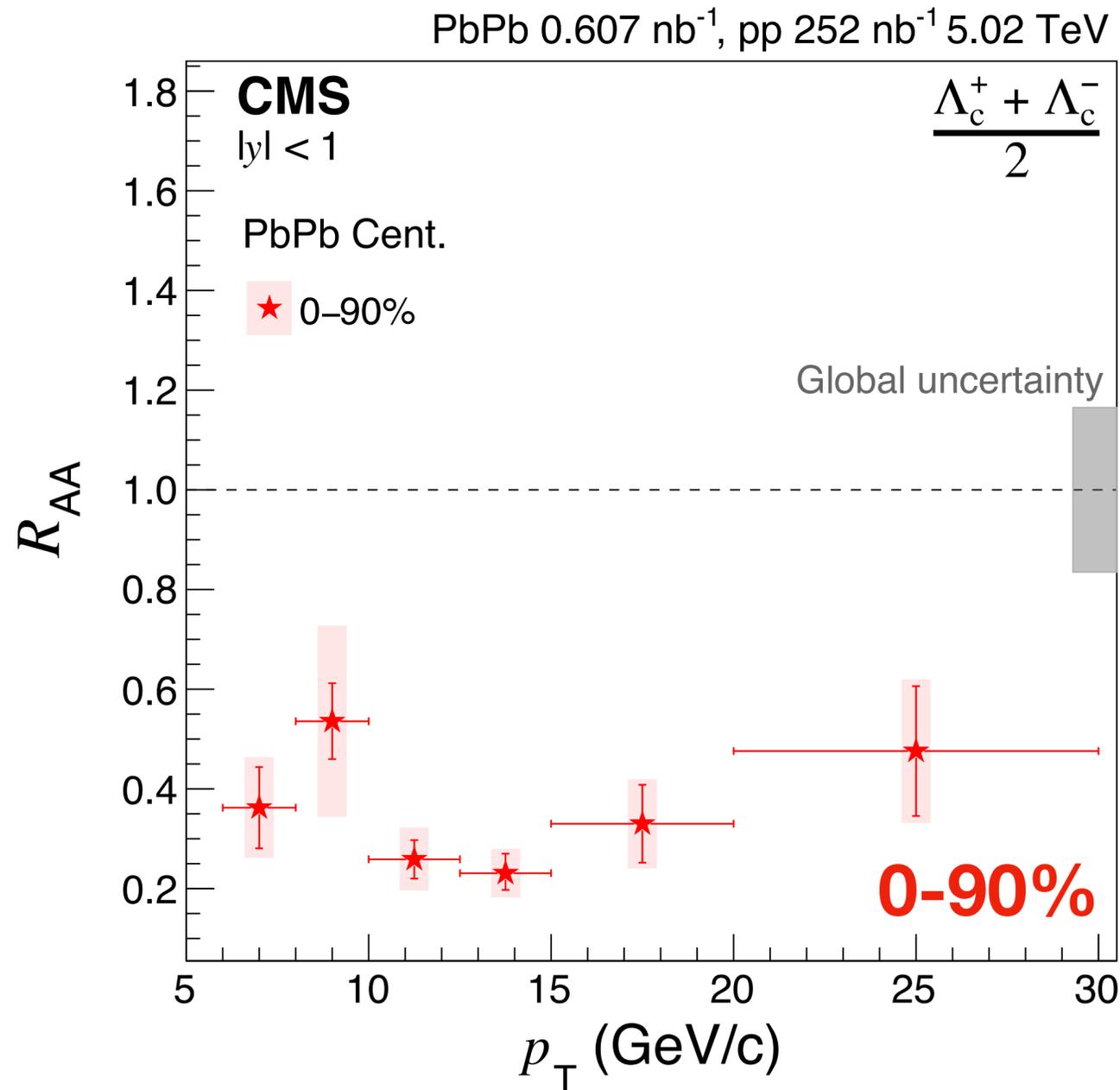
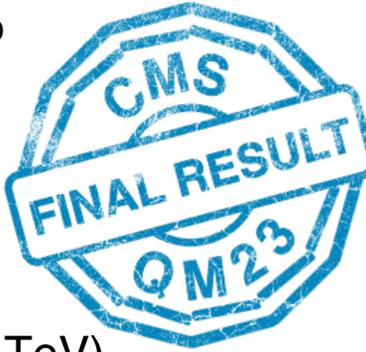


# $\Lambda_c^+$ vs. $D^0$ $R_{AA}$

- $\Lambda_c^+$  heavily suppressed
- High- $p_T$  trend similar to  $D^0$

HIN-21-004 Submitted to JHEP

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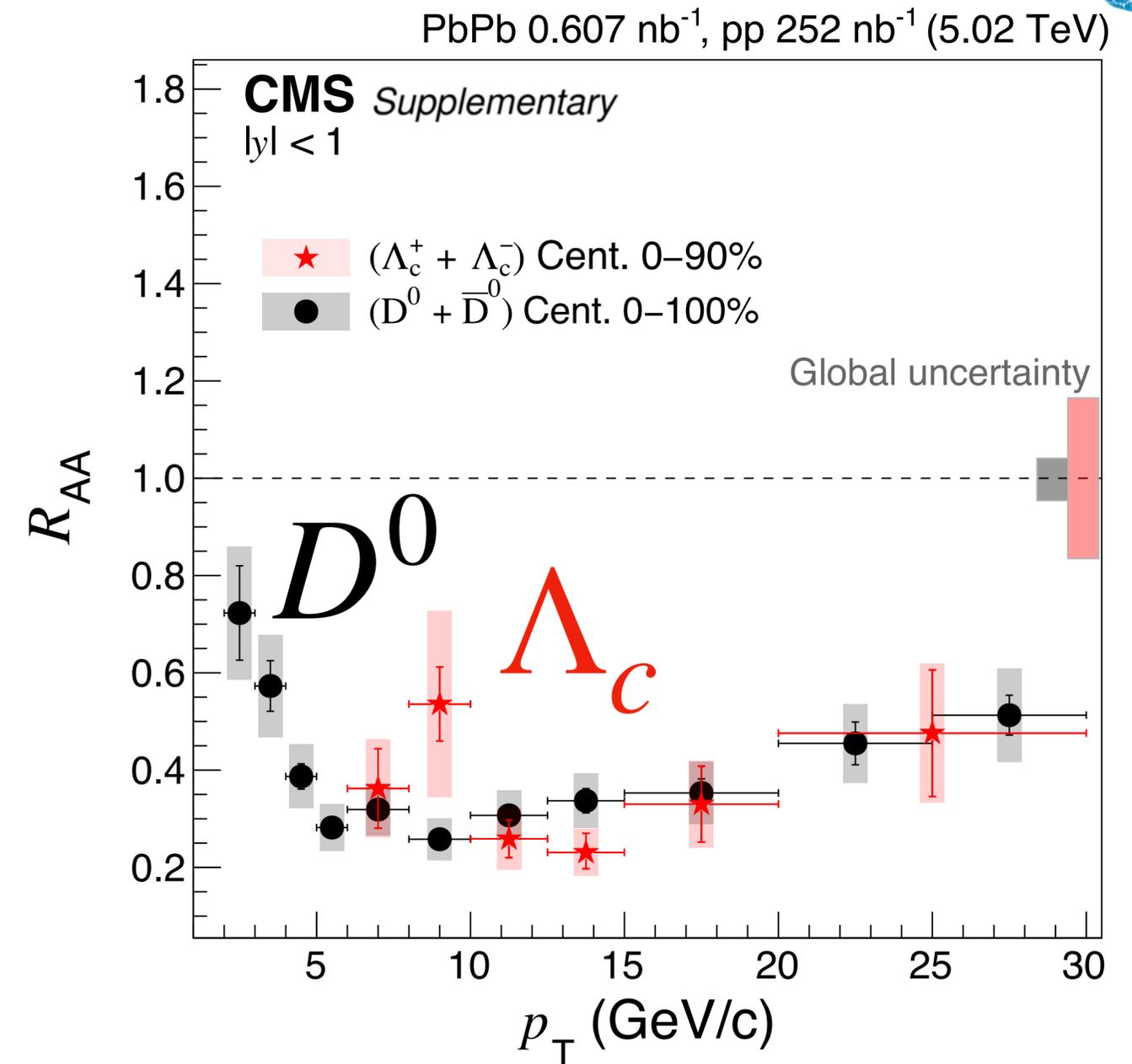
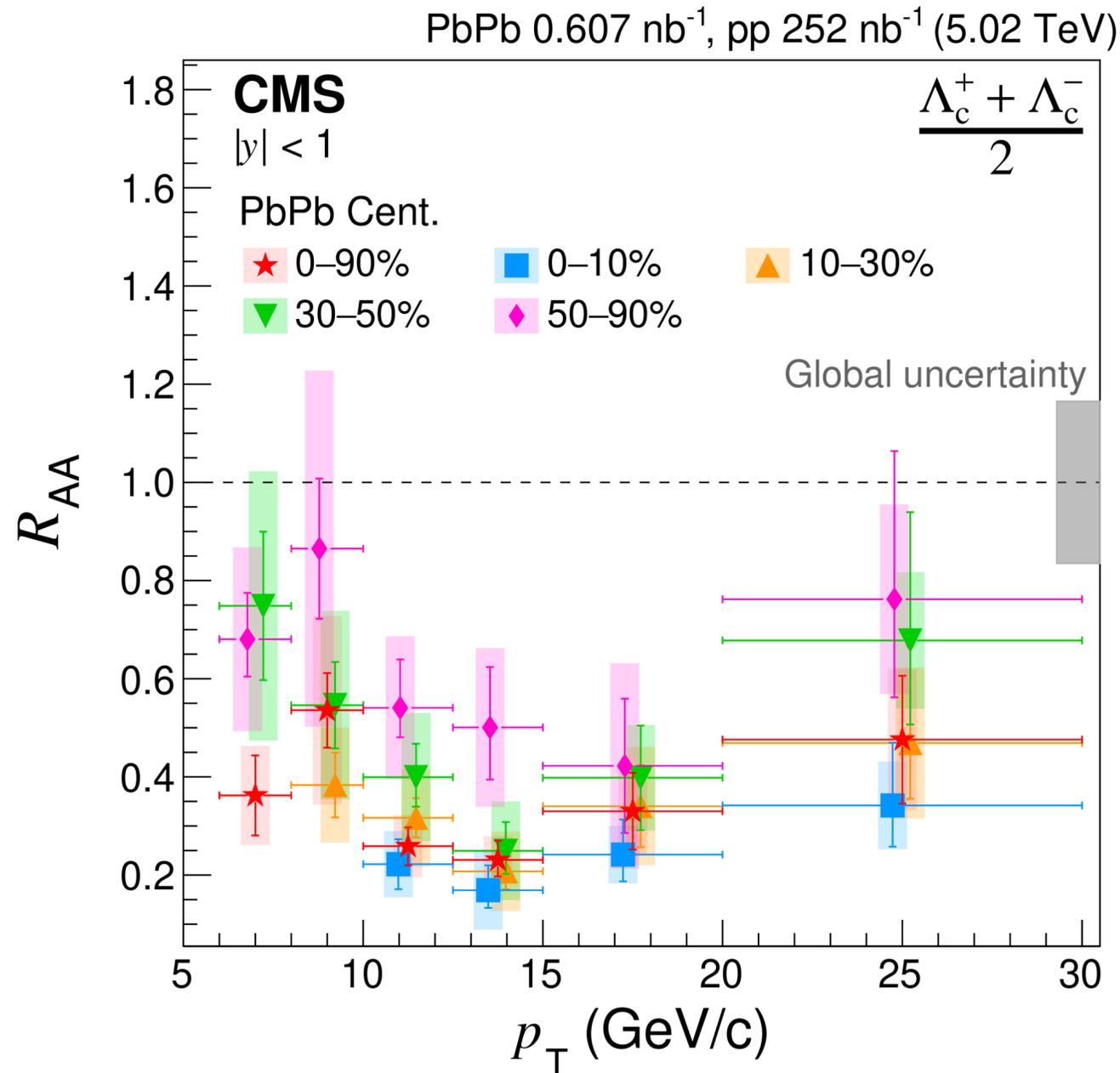
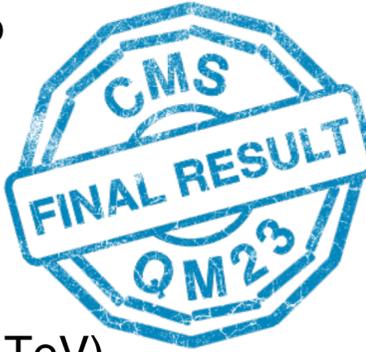


# $\Lambda_c^+$ $R_{AA}$ vs. centrality

- $\Lambda_c^+$  heavily suppressed in all centralities studied
- High- $p_T$  trend similar to  $D^0$

HIN-21-004 Submitted to JHEP

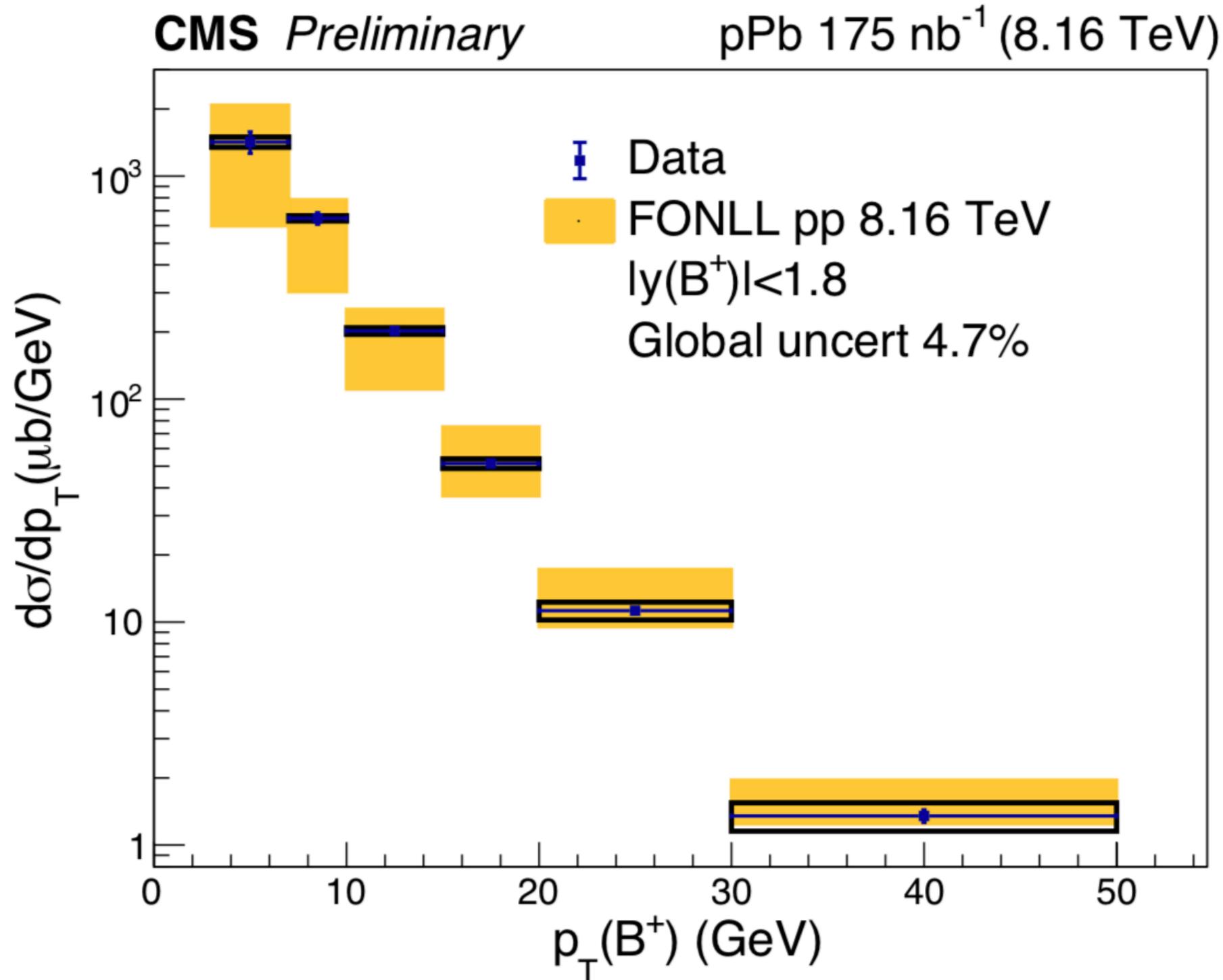
Soumik Chandra's talk  
Tues. 9:30, Ballroom D



# $B^+$ in 8.16 TeV pPb

CMS PAS HIN-22-001

**Tzu-An Sheng's talk**  
**Tues. 8:50, Ballroom D**

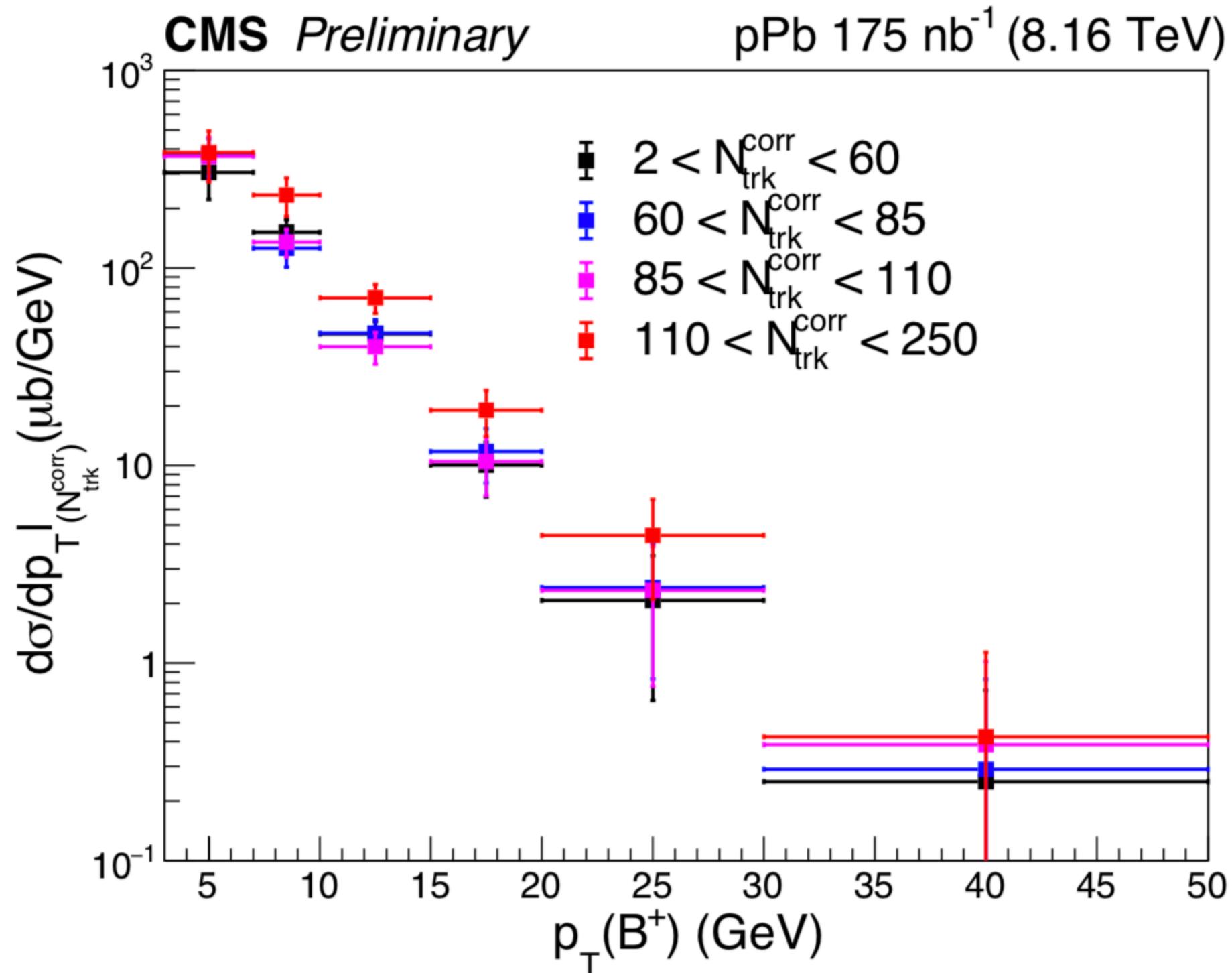


- **Cross section consistent with FONLL**

# Multiplicity dependence of $B^+$ in pPb

CMS PAS HIN-22-001

**Tzu-An Sheng's talk**  
**Tues. 8:50, Ballroom D**



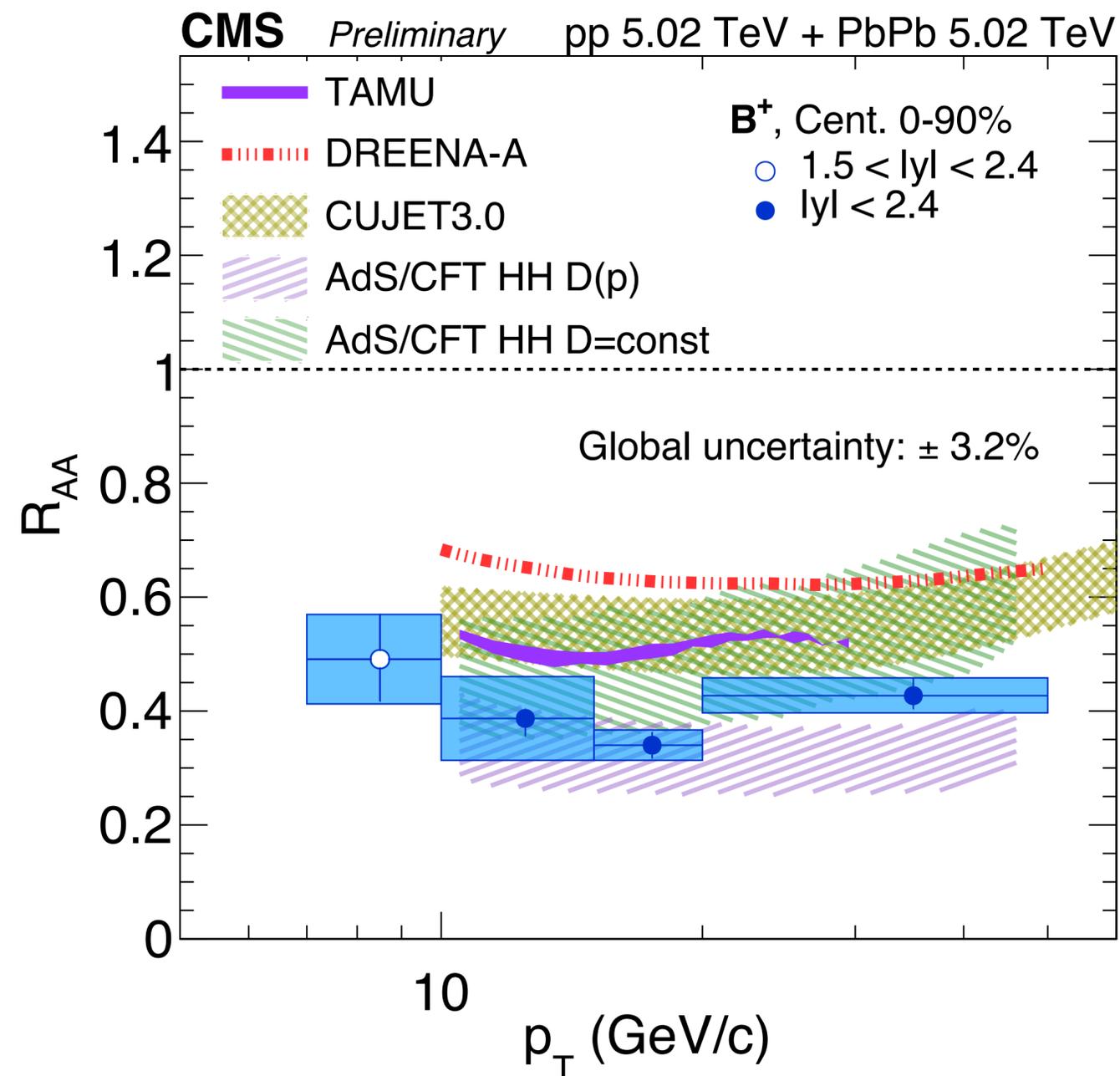
- **Cross section consistent with FONLL**
- **Studied as a function of event multiplicity**

# $B^+$ $R_{AA}$ compared to theory

- Updated  $R_{AA}$  using 2017 and 2018 data
- $B^+$  high- $p_T$  precision < many model uncertainties

CMS PAS HIN-21-014

**Tzu-An Sheng's talk**  
**Tues. 8:50, Ballroom D**

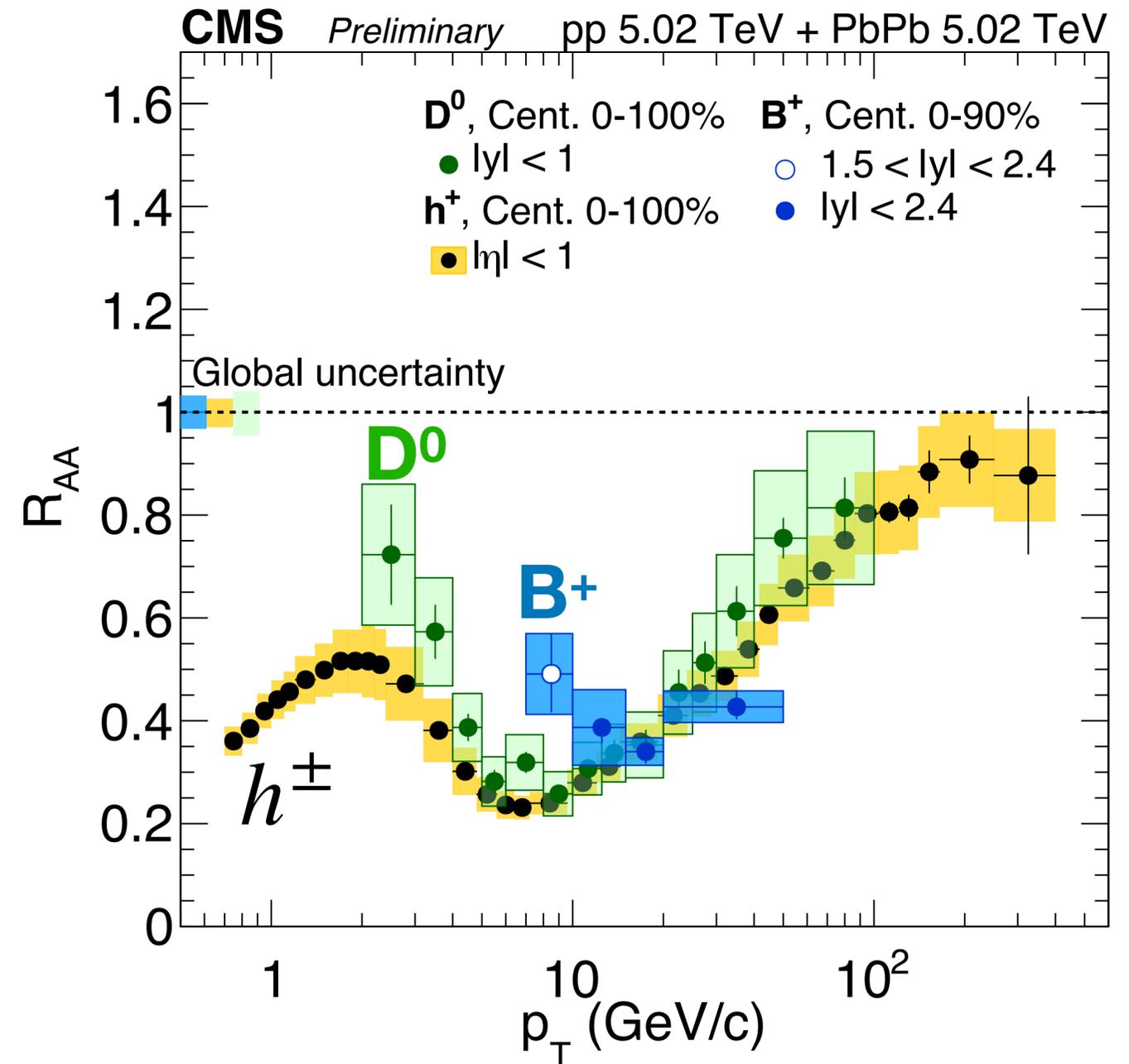
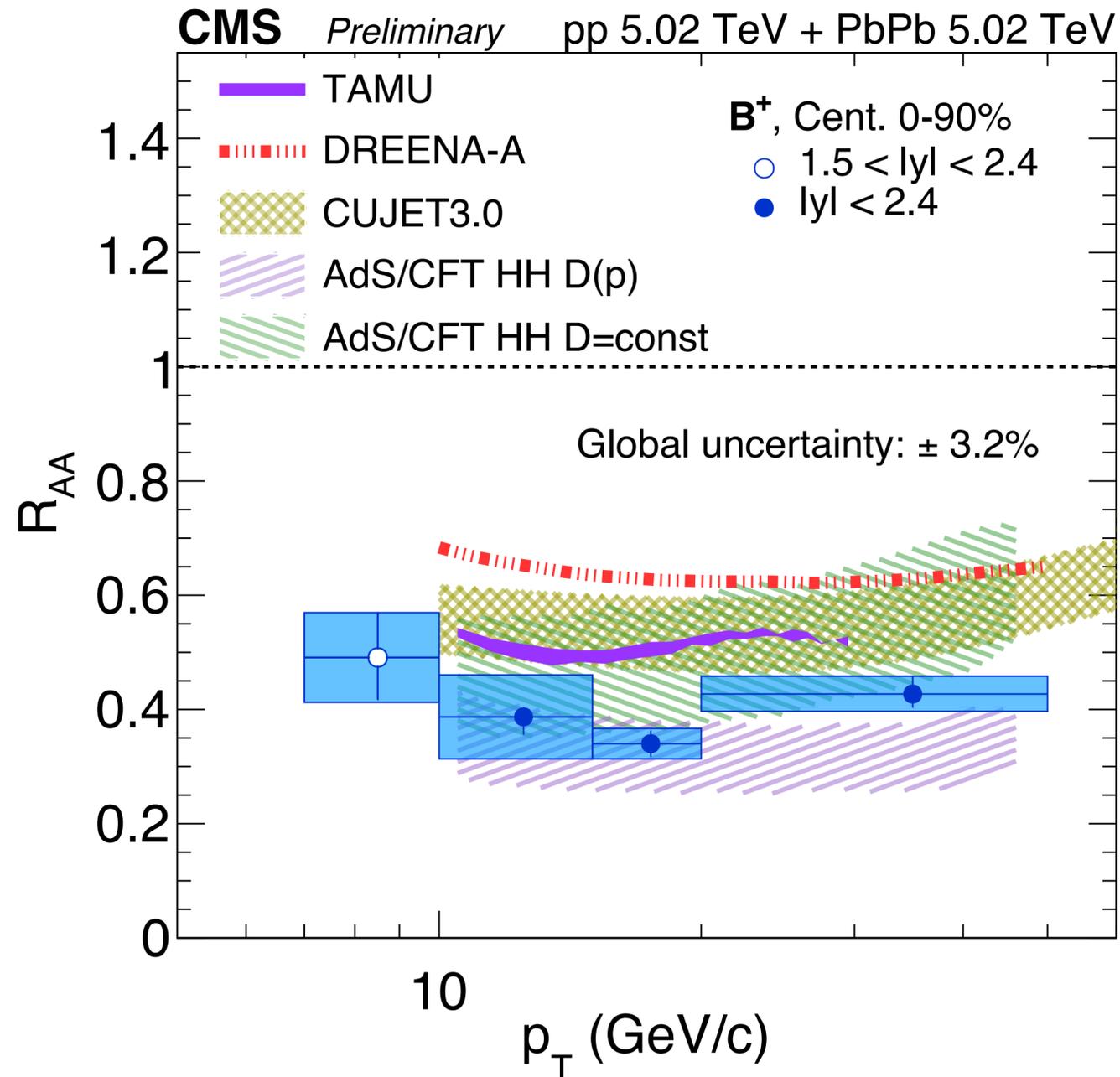


# $B^+$ vs. lighter flavors

- Updated  $R_{AA}$  using 2017 and 2018 data
- $B^+$  high- $p_T$  precision < many model uncertainties
- High- $p_T$  behavior similar to lighter hadrons

CMS PAS HIN-21-014

**Tzu-An Sheng's talk**  
**Tues. 8:50, Ballroom D**

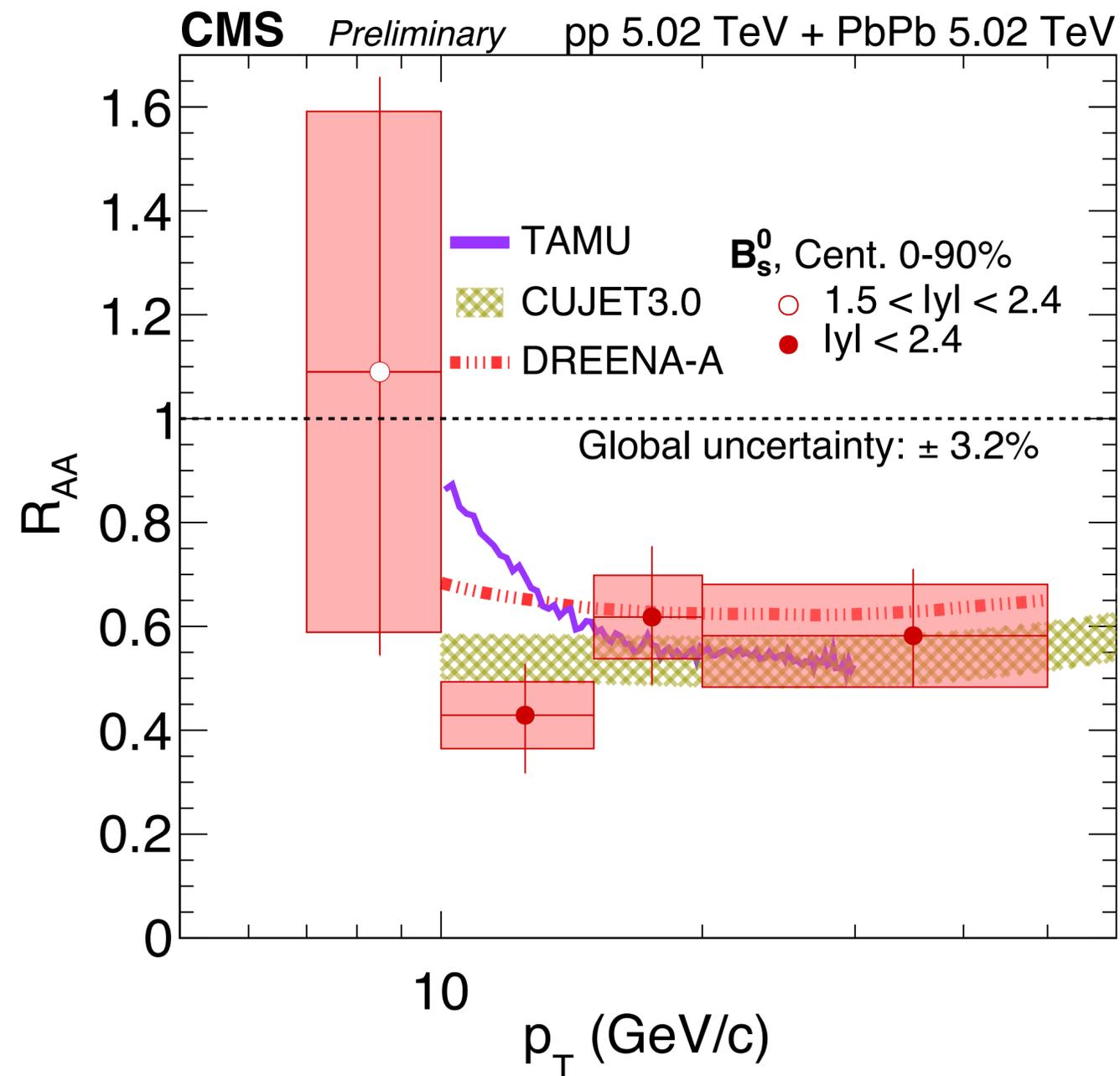


# What about $B_s^0$ ?

- Updated measurement of  $B_s^0$  consistent with models

CMS PAS HIN-21-014

**Tzu-An Sheng's talk**  
**Tues. 8:50, Ballroom D**

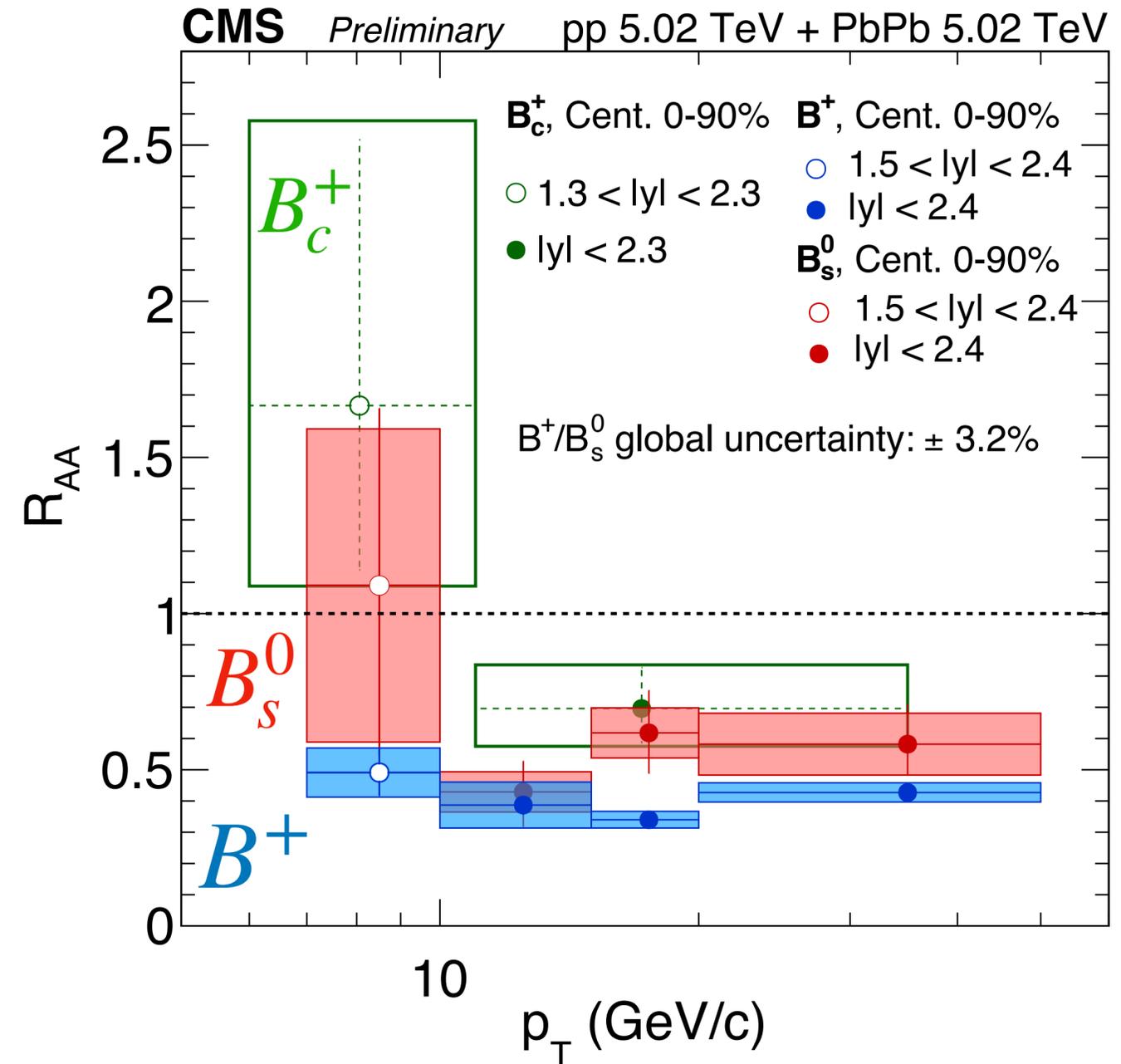
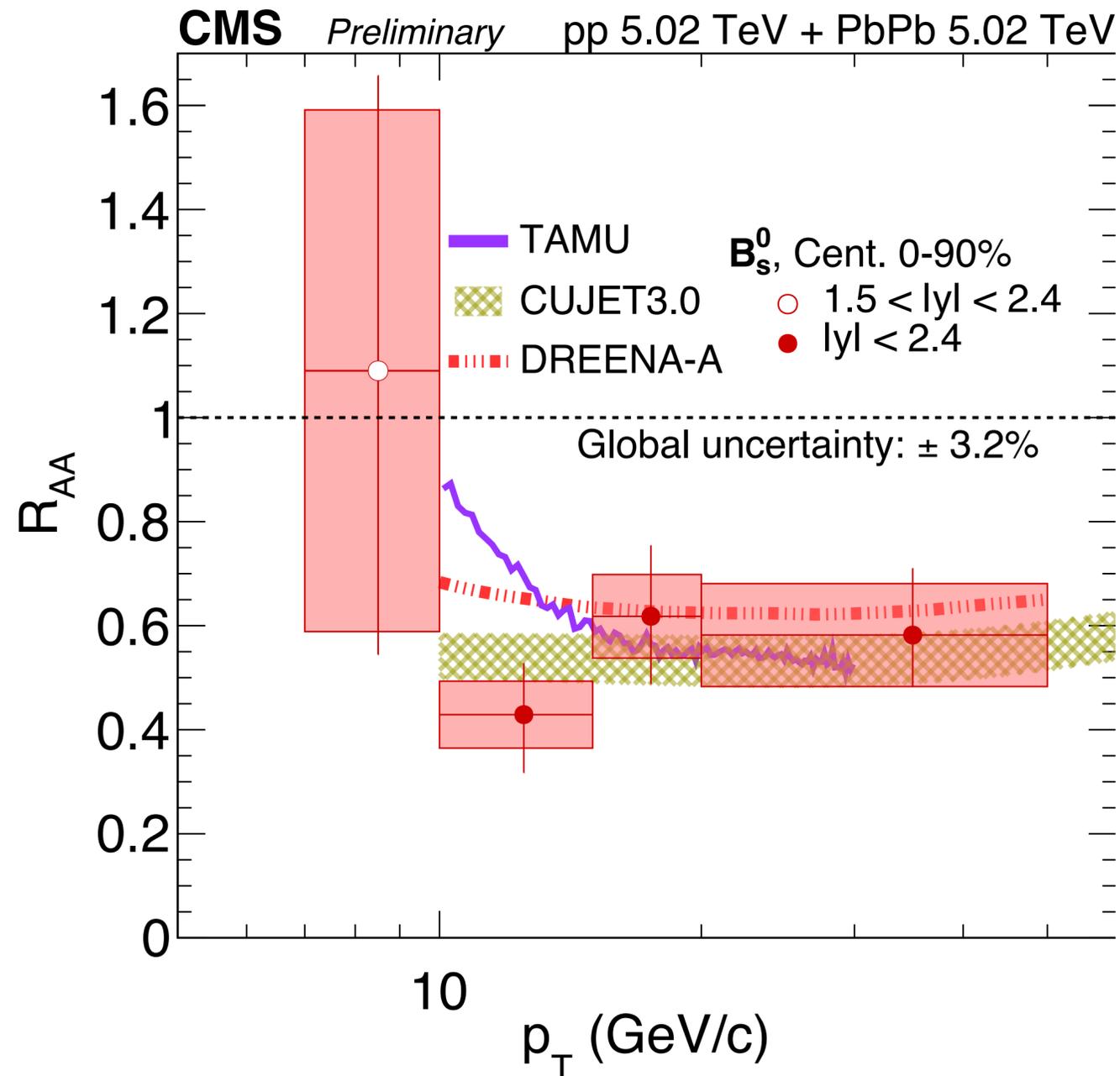


# B meson $R_{AA}$ ordering

- Updated measurement of  $B_s^0$  consistent with models
- $R_{AA}$  ordering of  $B_c^+ > B_s^0 > B^+$  - coalescence?

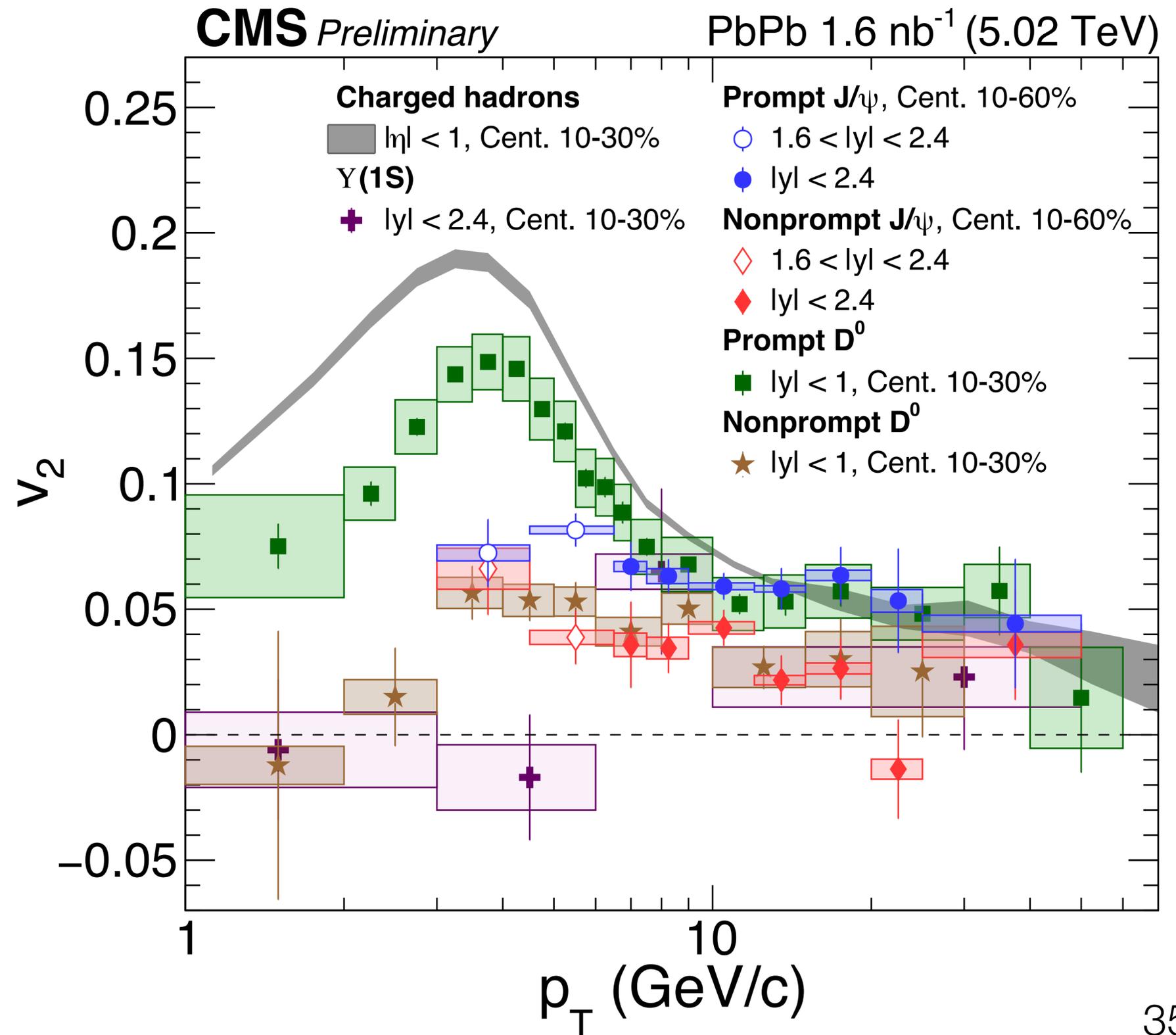
CMS PAS HIN-21-014  
PRL 128 (2022) 252301

**Tzu-An Sheng's talk**  
**Tues. 8:50, Ballroom D**



# $v_2$ of Heavy Flavor in PbPb

- **Nonprompt  $D^0 < \text{prompt } D^0$**

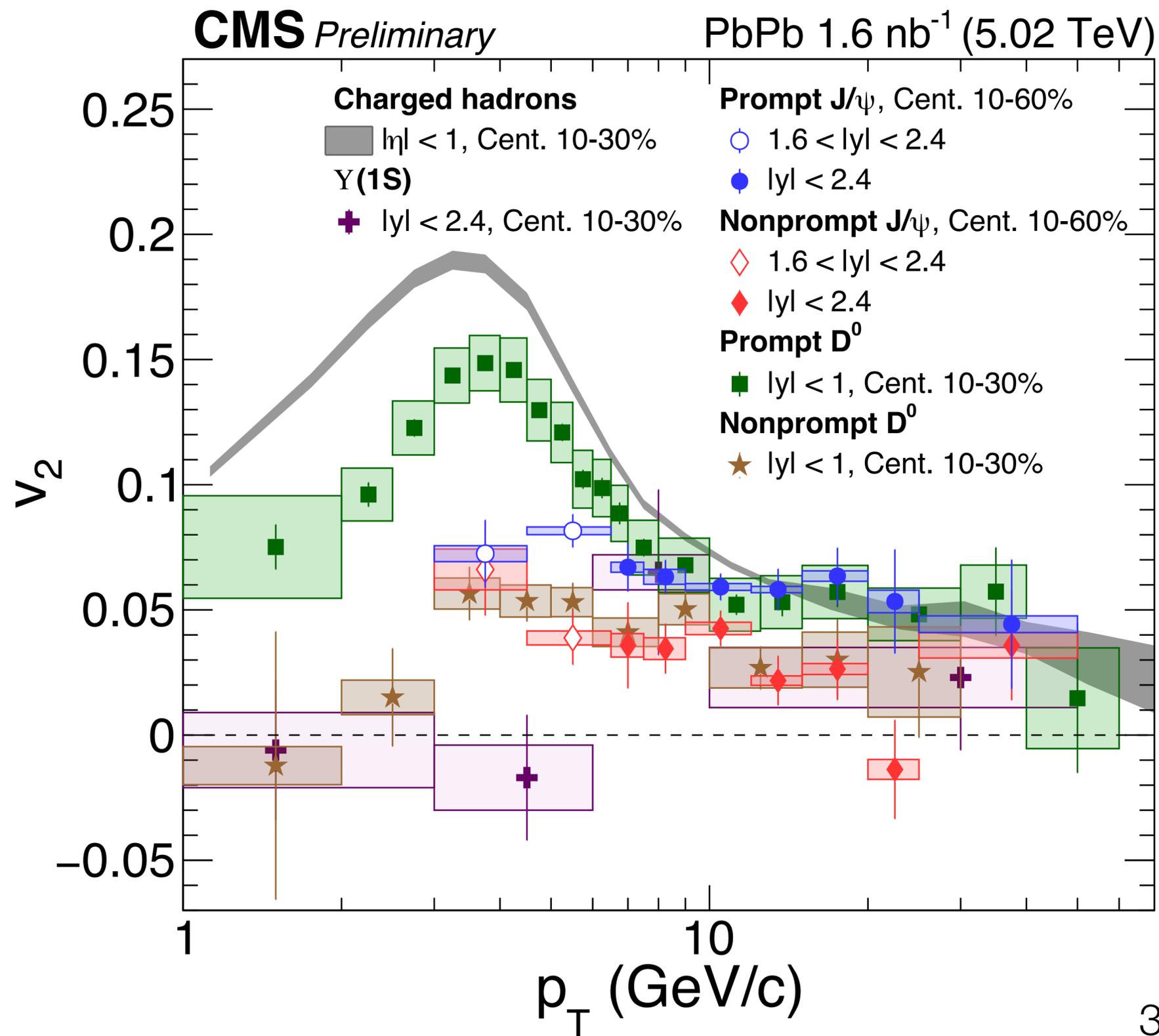


HIN-21-008 Submitted to JHEP

**Milan Stojanovic's talk**  
**Wed, 16:30, Ballroom D**

# $v_2$ of Heavy Flavor in PbPb

- **Nonprompt  $D^0$  < prompt  $D^0$**
- **Nonprompt  $J/\Psi$  < prompt  $J/\Psi$**

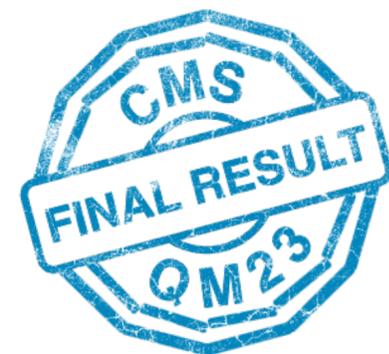
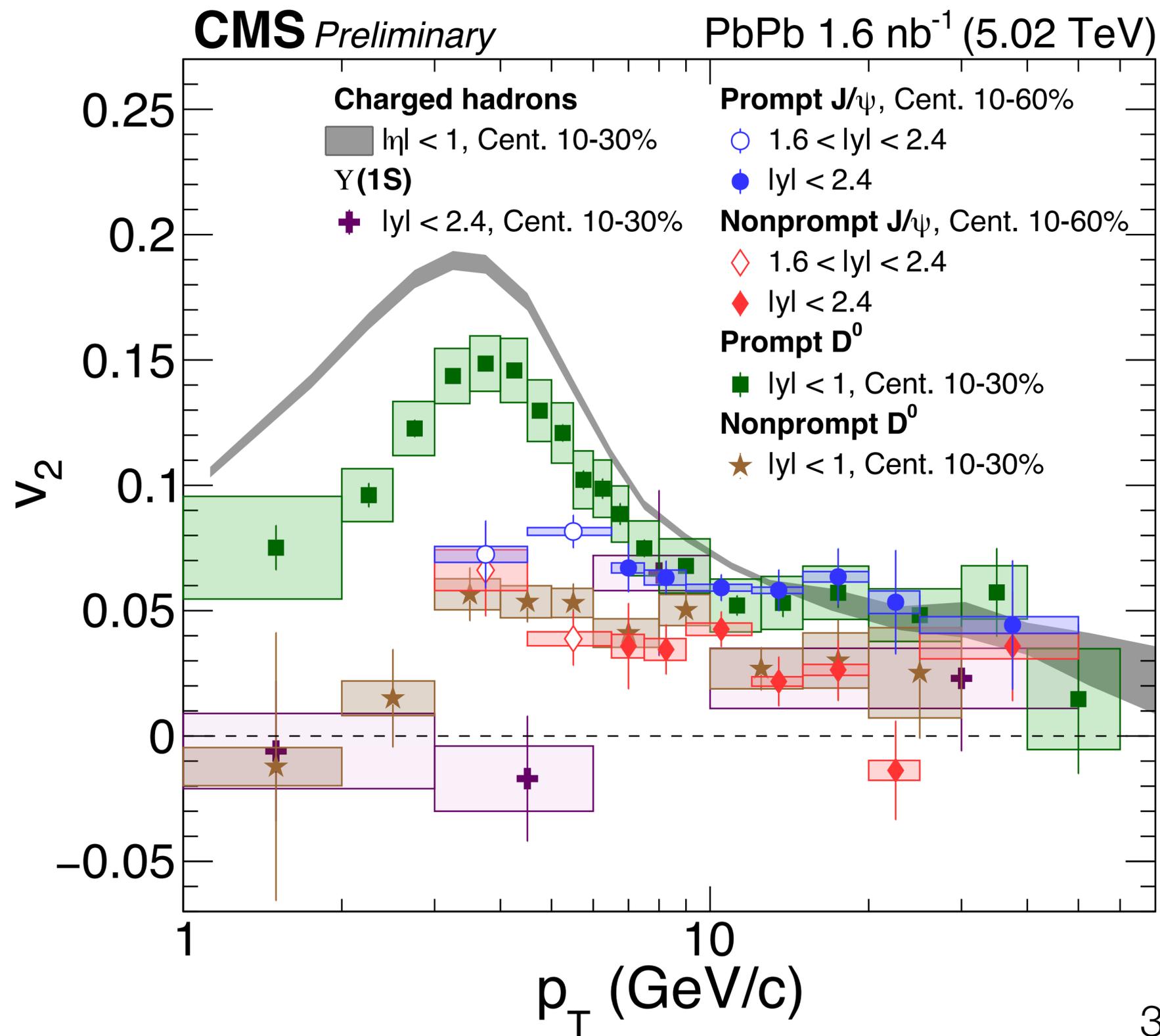


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# $v_2$ of Heavy Flavor in PbPb

- **Nonprompt  $D^0$  < prompt  $D^0$**
- **Nonprompt  $J/\Psi$  < prompt  $J/\Psi$**
- $\Upsilon(1S) \approx 0$

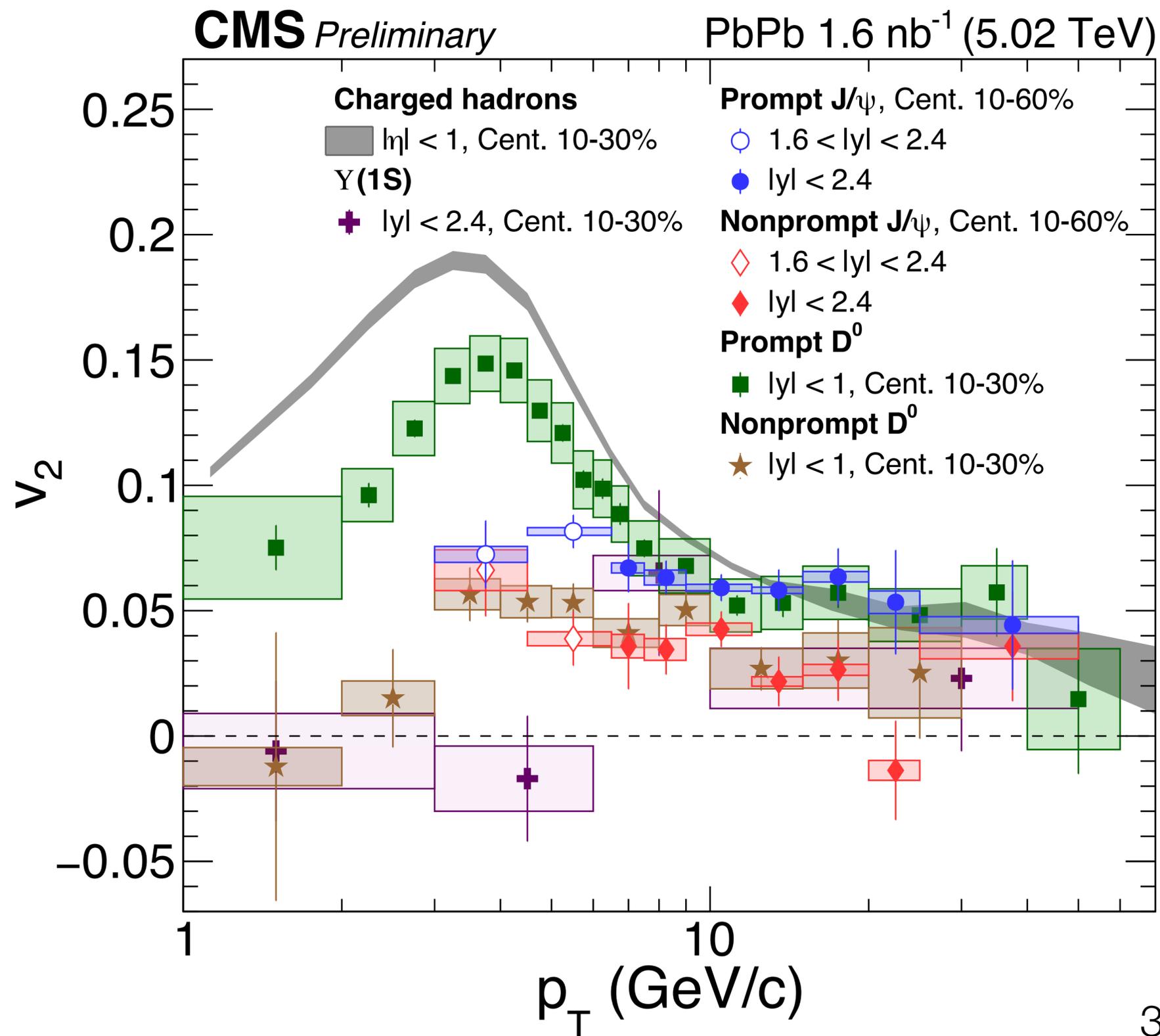


HIN-21-008 Submitted to JHEP

**Milan Stojanovic's talk**  
**Wed, 16:30, Ballroom D**

# $v_2$ of Heavy Flavor in PbPb

- **Nonprompt  $D^0$  < prompt  $D^0$**
- **Nonprompt  $J/\Psi$  < prompt  $J/\Psi$**
- $\Upsilon(1S) \approx 0$
- **Consistent picture of charm flow**
- **Less clear for beauty quarks**



HIN-21-008 Submitted to JHEP

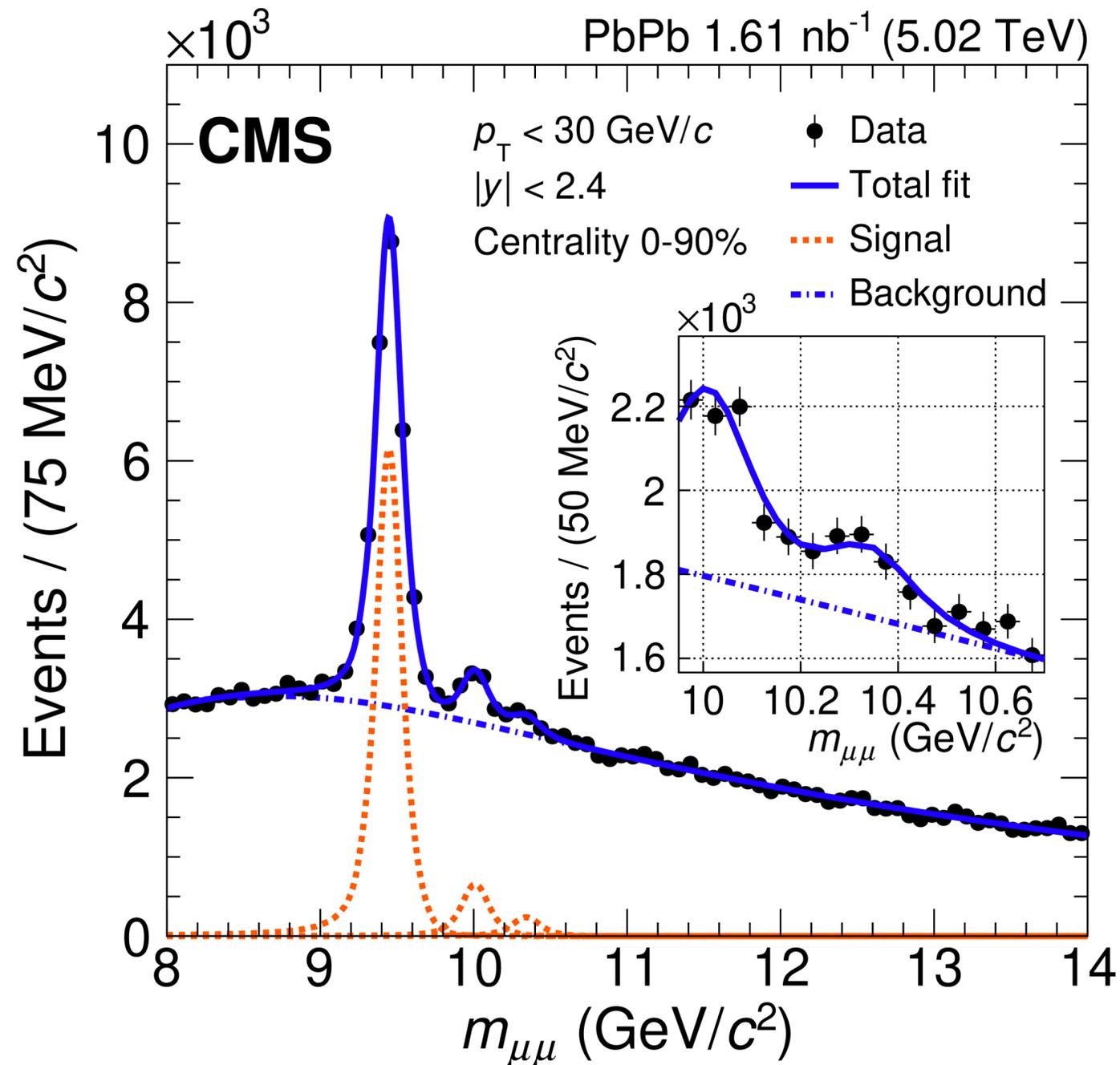
**Milan Stojanovic's talk**  
**Wed, 16:30, Ballroom D**

# Observation of $\Upsilon(3S)$

- First observation of  $\Upsilon(3S)$  in AA collisions

HIN-21-007 Submitted to PRL

**Ota Kukral's talk**  
**Wed, 17:10, Ballroom D**

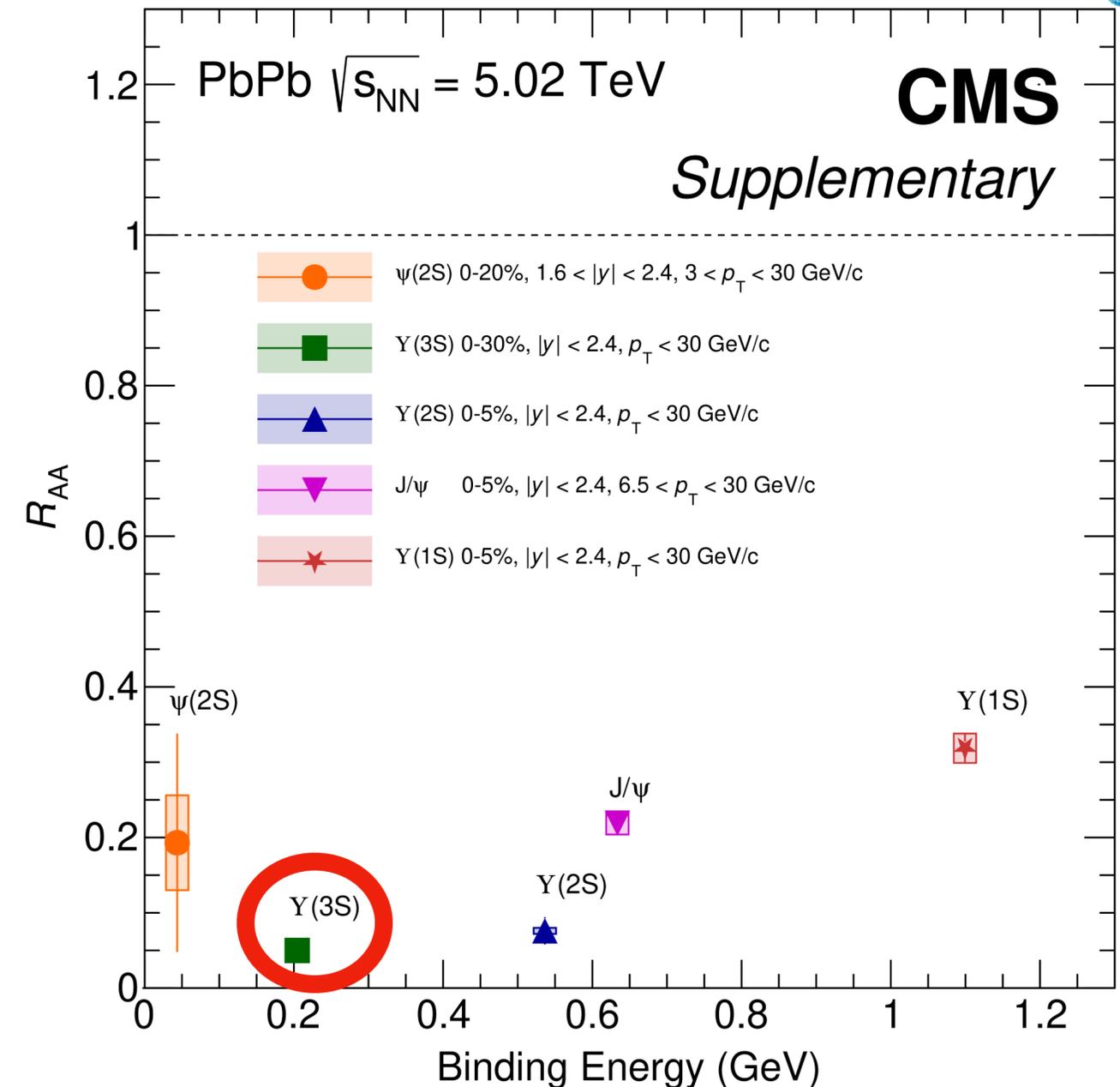
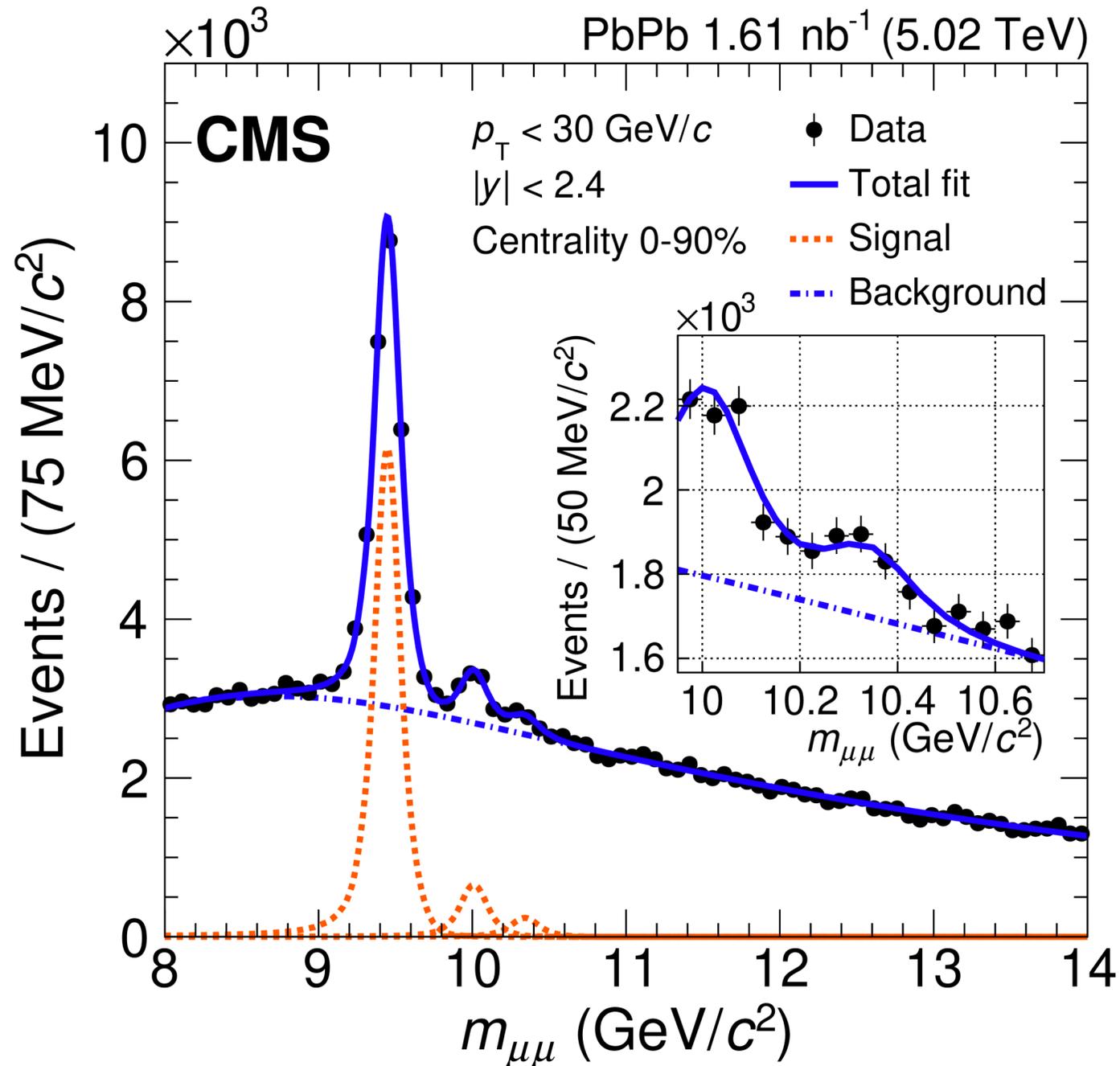
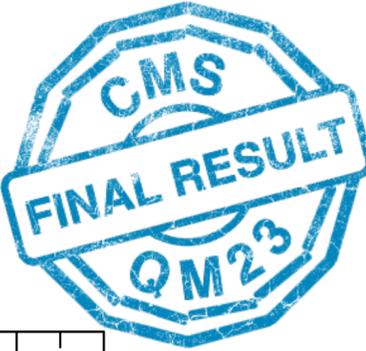


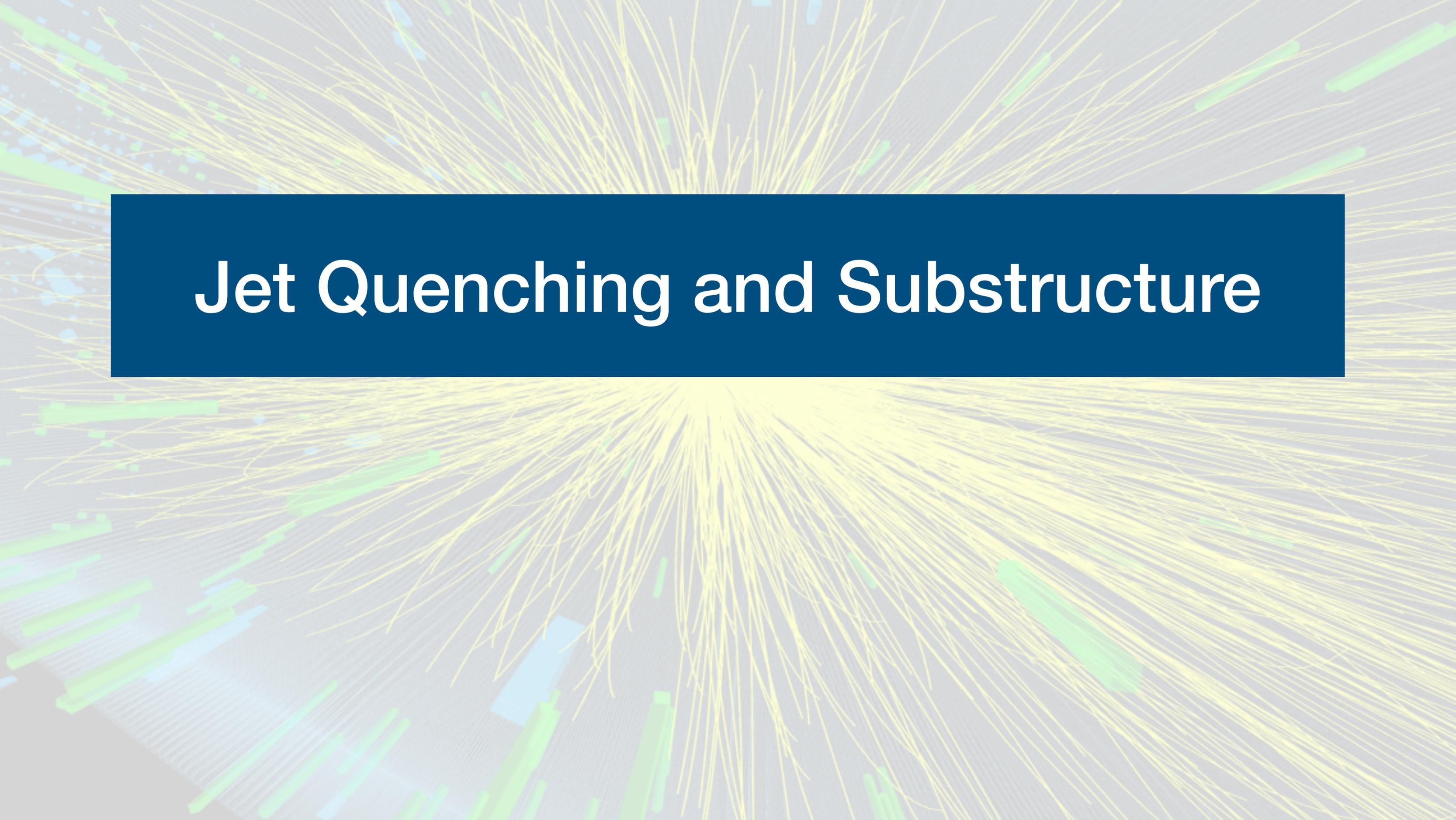
# 5 vector quarkonia states

- First observation of  $\Upsilon(3S)$  in AA collisions
- Stronger suppression at low binding energies

HIN-21-007 Submitted to PRL

**Ota Kukral's talk**  
**Wed, 17:10, Ballroom D**



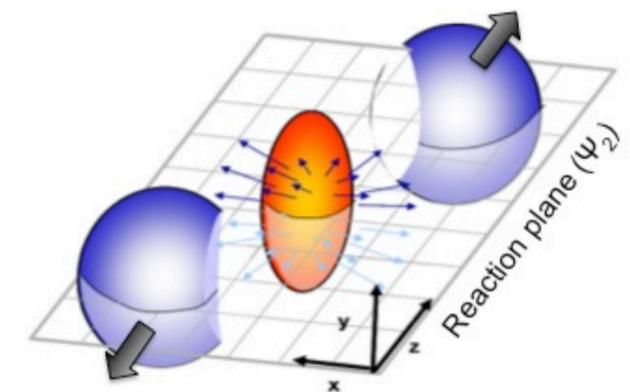
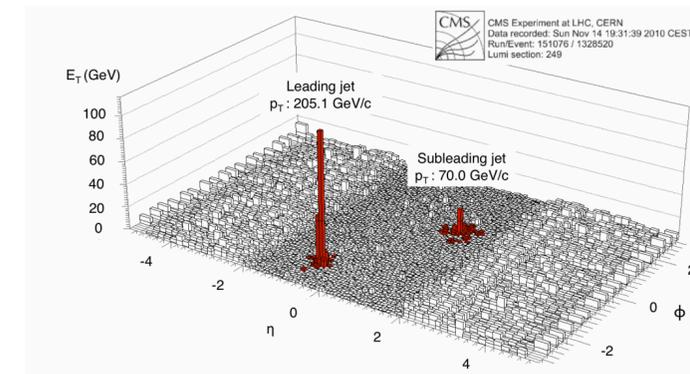
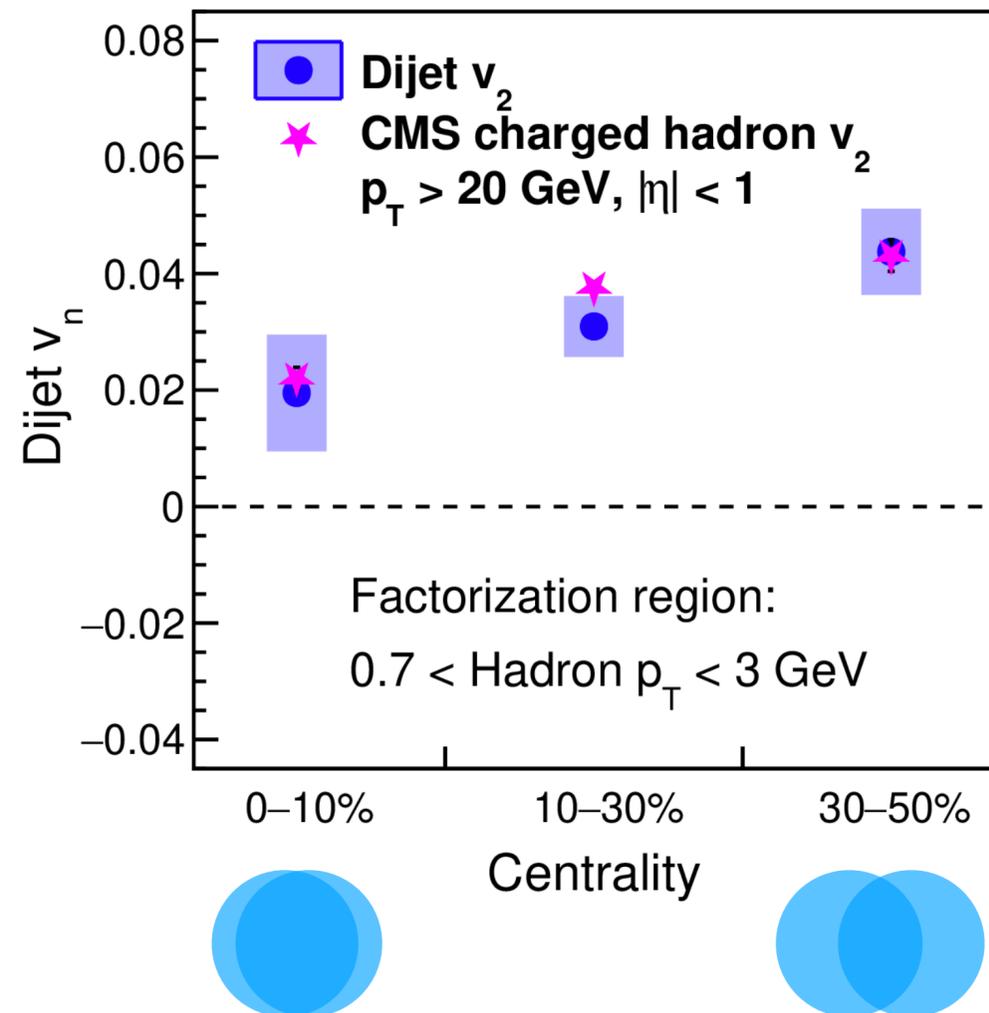
The background of the slide is a complex visualization of particle tracks, likely from a detector like ATLAS or CMS. It features a dense field of thin, light-yellow lines radiating from a central point, representing individual particles. Overlaid on this are several thicker, semi-transparent tracks in shades of green and blue, which represent reconstructed jets or other significant particle clusters. The overall effect is a dynamic and detailed representation of high-energy particle collisions.

# Jet Quenching and Substructure

# Dijet $v_2$ in PbPb



- Positive **dijet  $v_2$**  - jet yields correlated with initial elliptic geometry



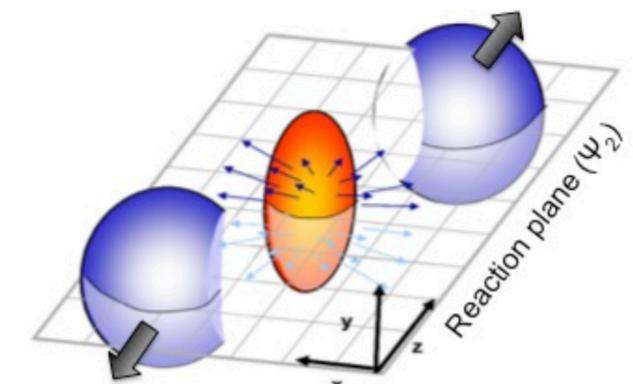
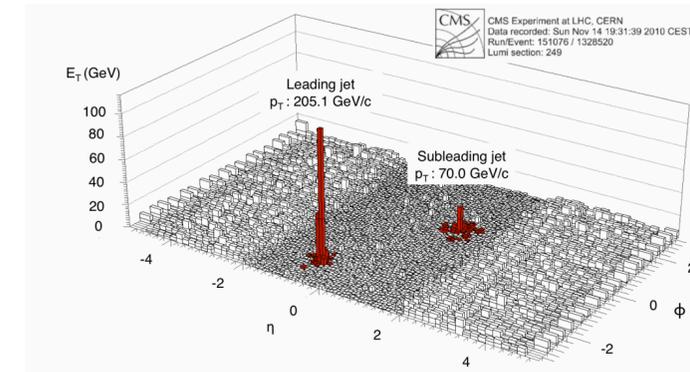
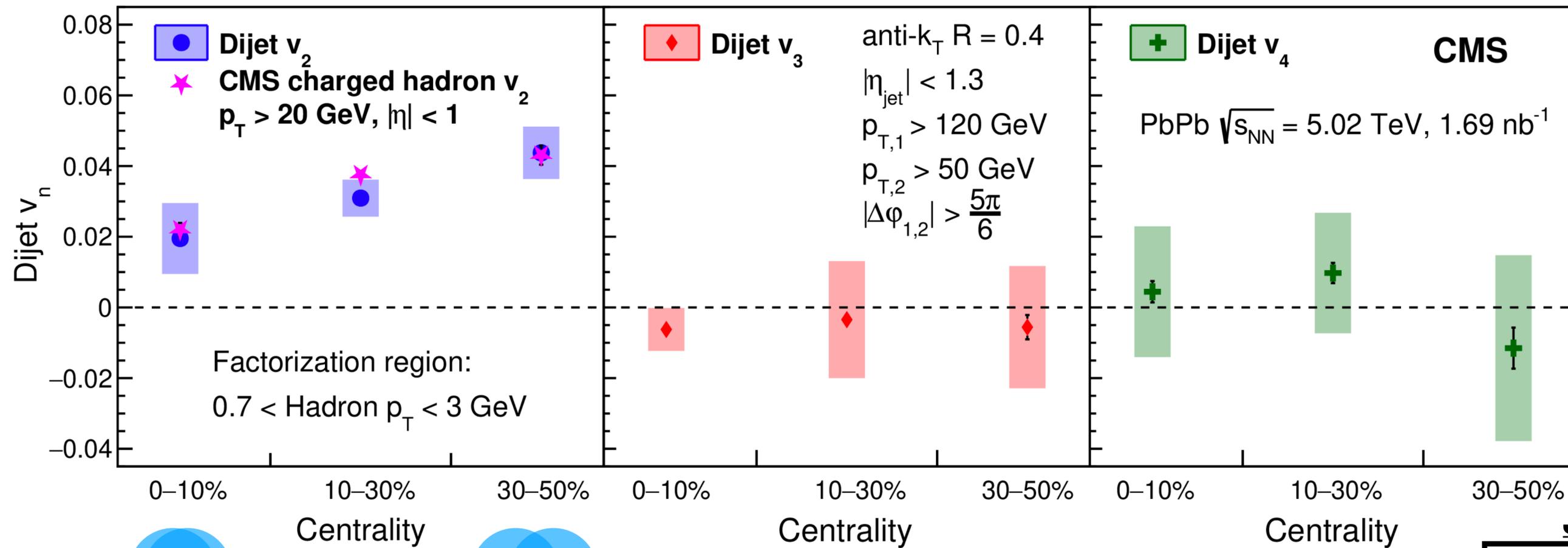
JHEP 07 (2023) 139

**Jussi Viinikainen's talk**  
**Wed, 11:20, Ballroom F**

# Dijet $v_{3,4}$ in PbPb



- Positive **dijet  $v_2$**  - jet yields correlated with initial elliptic geometry
- Zero  **$v_3, v_4$**  - initial-state fluctuations less important for dijets



JHEP 07 (2023) 139

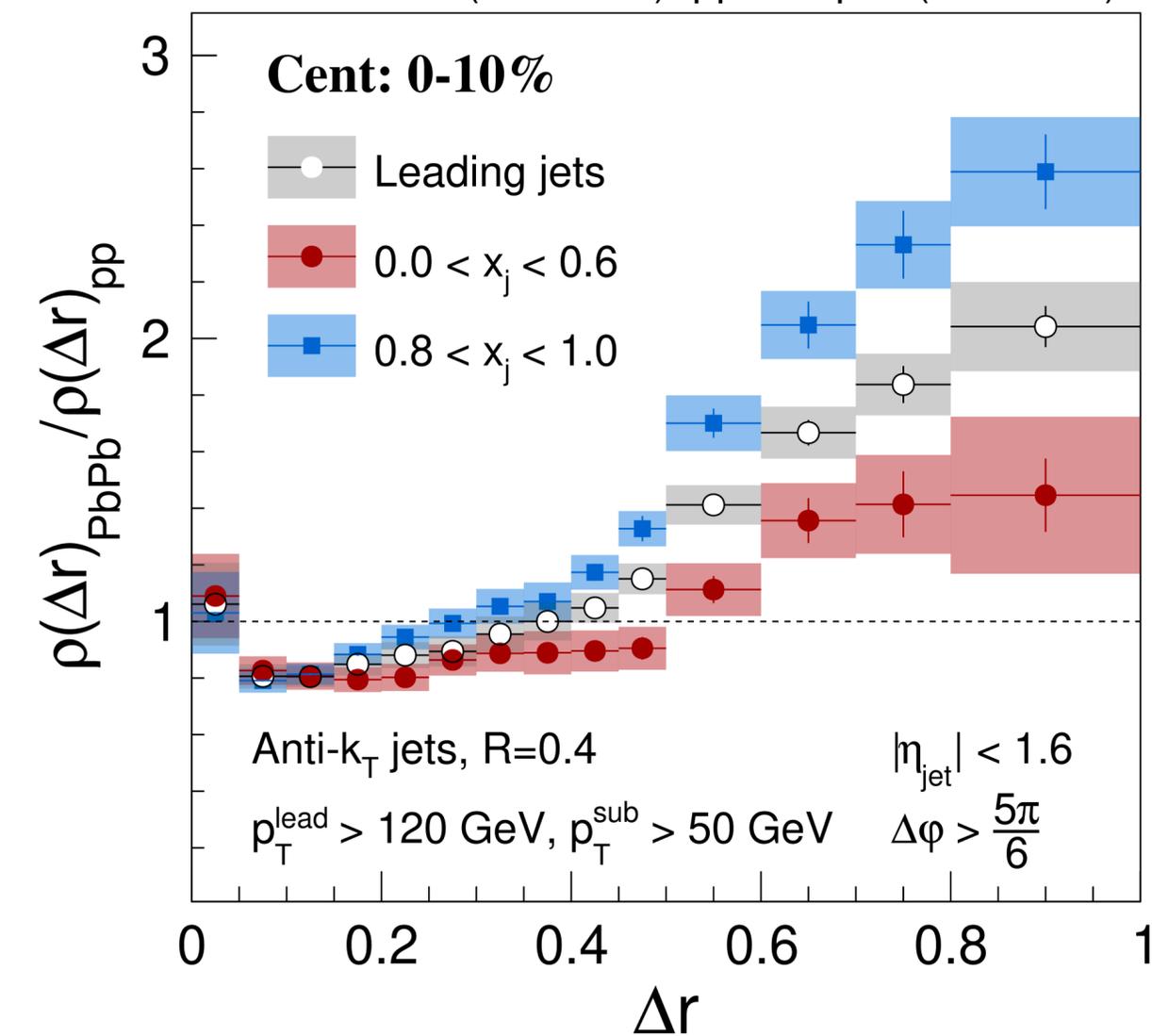
**Jussi Viinikainen's talk**  
**Wed, 11:20, Ballroom F**

# Leading jet shapes in PbPb

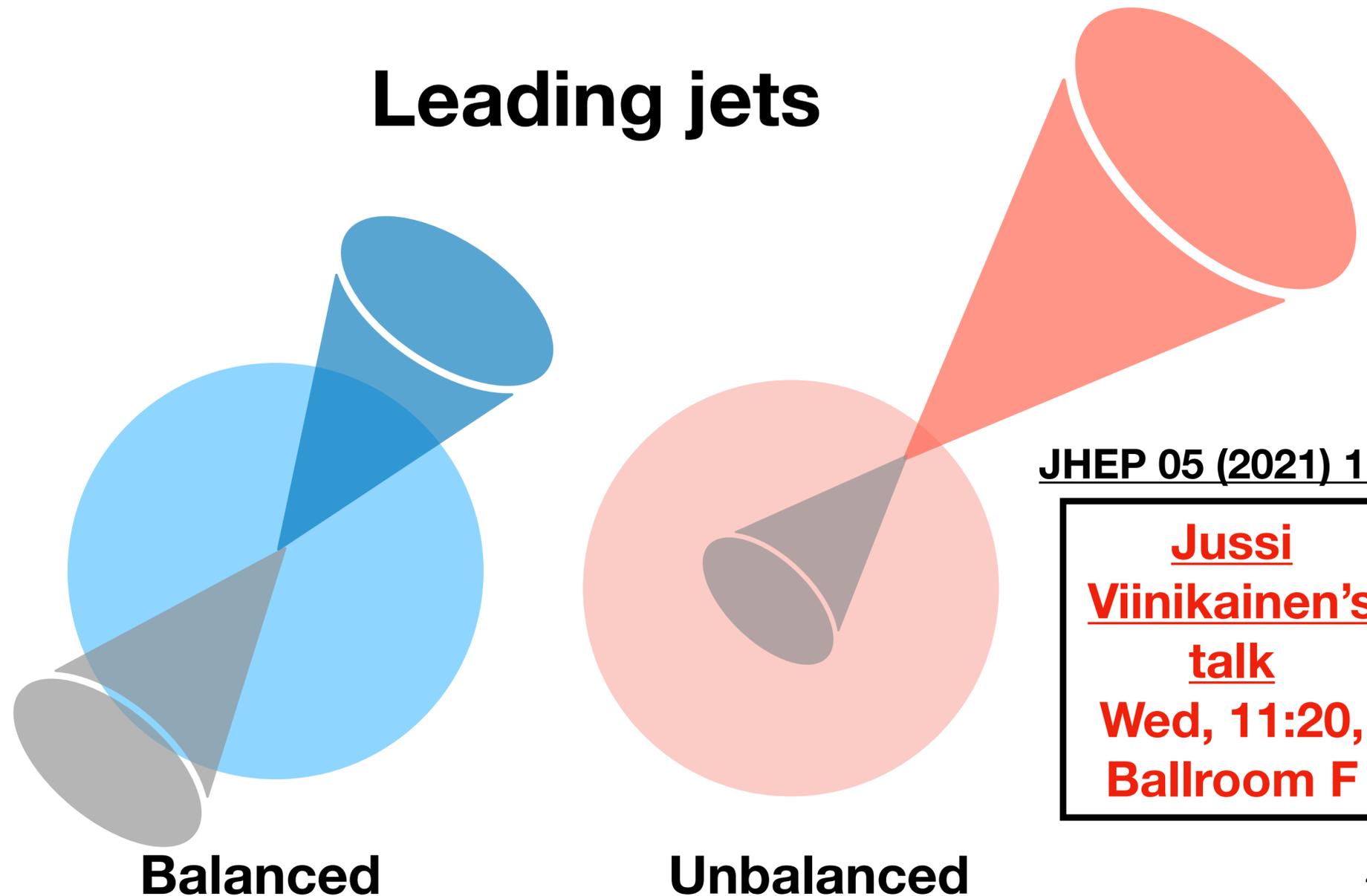
- Selecting **balanced** vs **unbalanced** dijets changes jet shape distributions

**CMS Supplementary** JHEP 05 (2021) 116

PbPb 1.7 nb<sup>-1</sup> (5.02 TeV) pp 320 pb<sup>-1</sup> (5.02 TeV)



## Leading jets



JHEP 05 (2021) 116

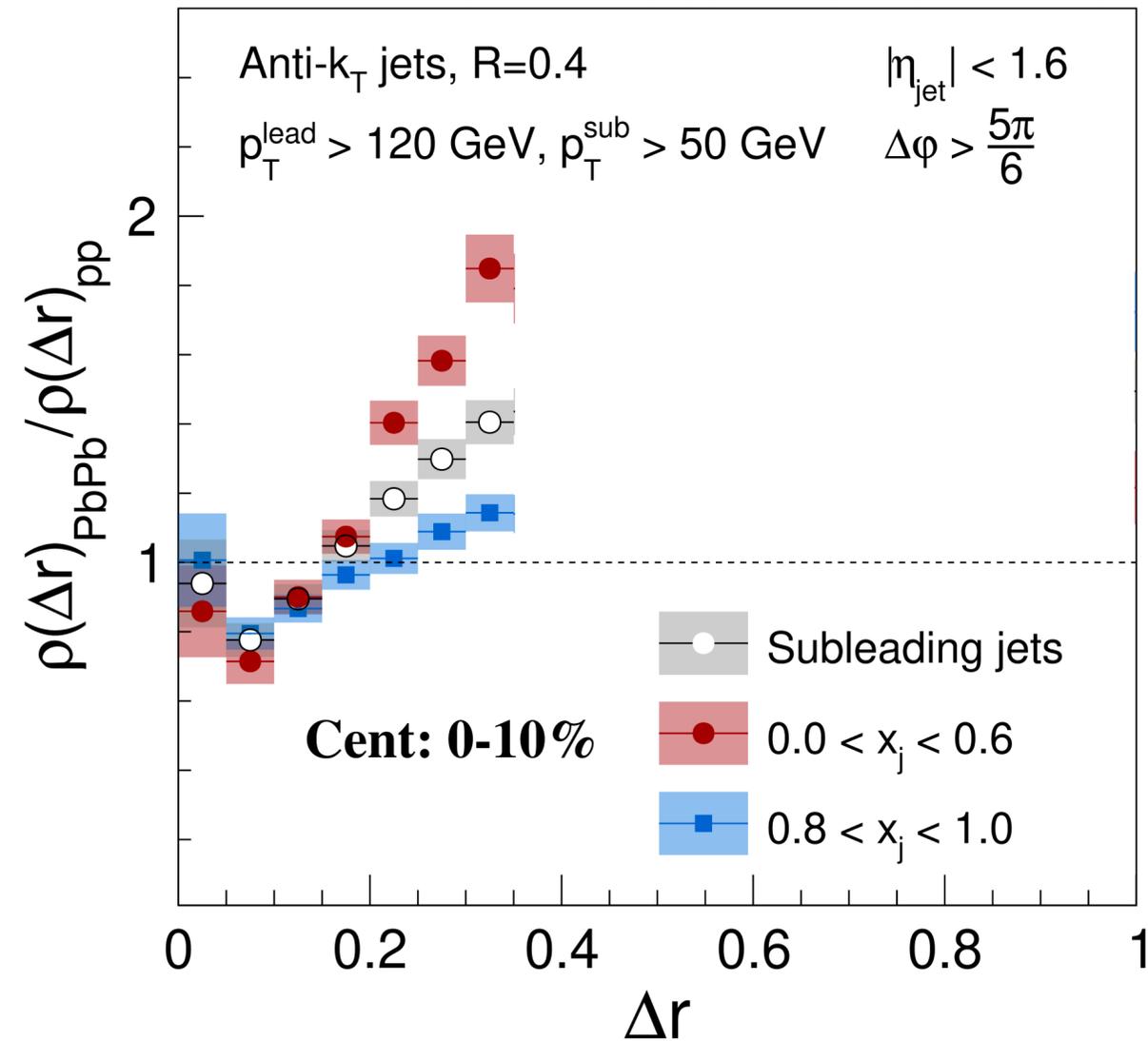
**Jussi Viinikainen's talk**  
**Wed, 11:20, Ballroom F**

# Subleading jet shapes in PbPb

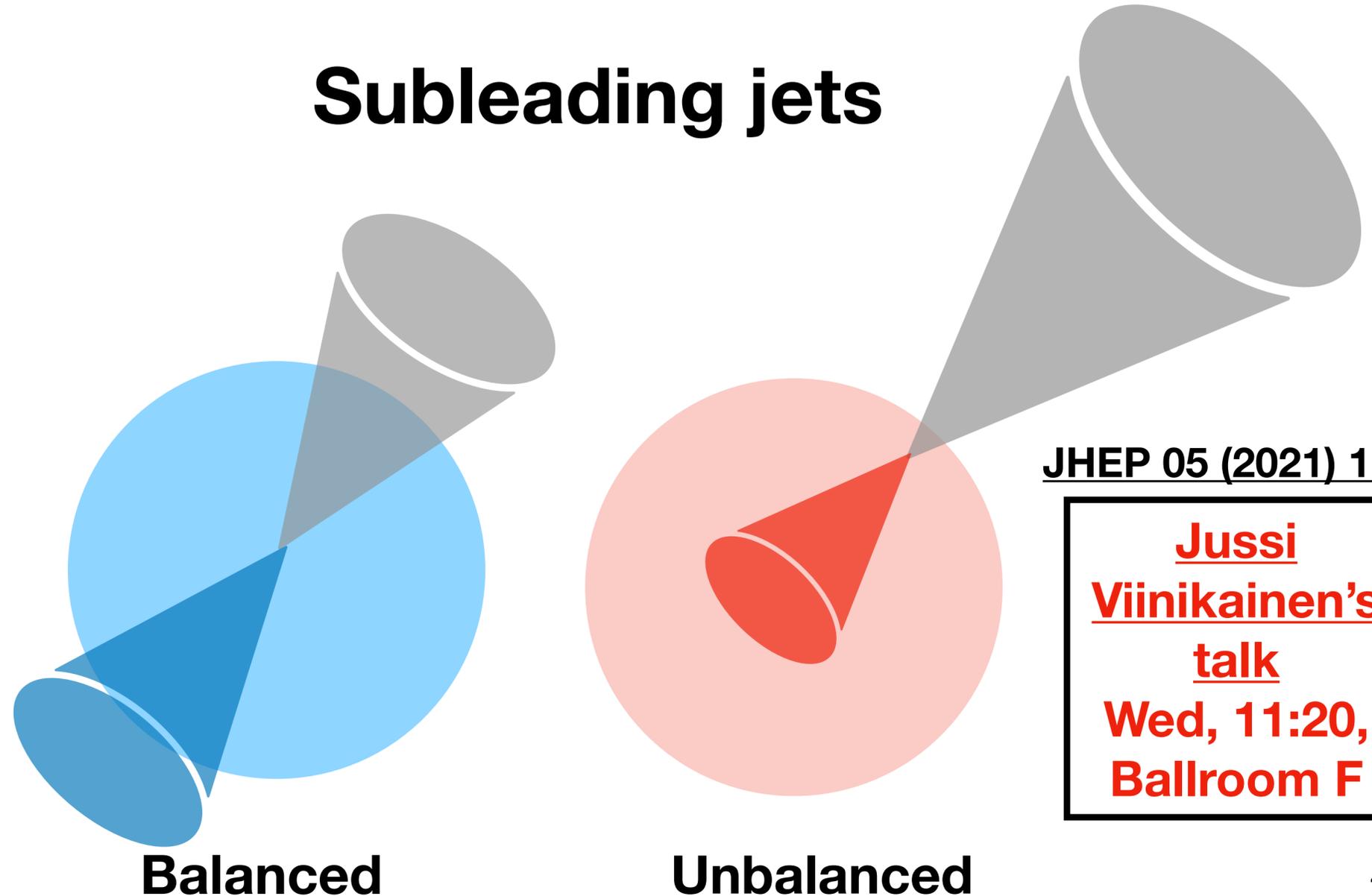
- Selecting **balanced** vs **unbalanced** dijets changes jet shape distributions
- Interplay of selection effects, fluctuations, quenching

**CMS Supplementary** JHEP 05 (2021) 116

PbPb 1.7 nb<sup>-1</sup> (5.02 TeV) pp 320 pb<sup>-1</sup> (5.02 TeV)



## Subleading jets



JHEP 05 (2021) 116

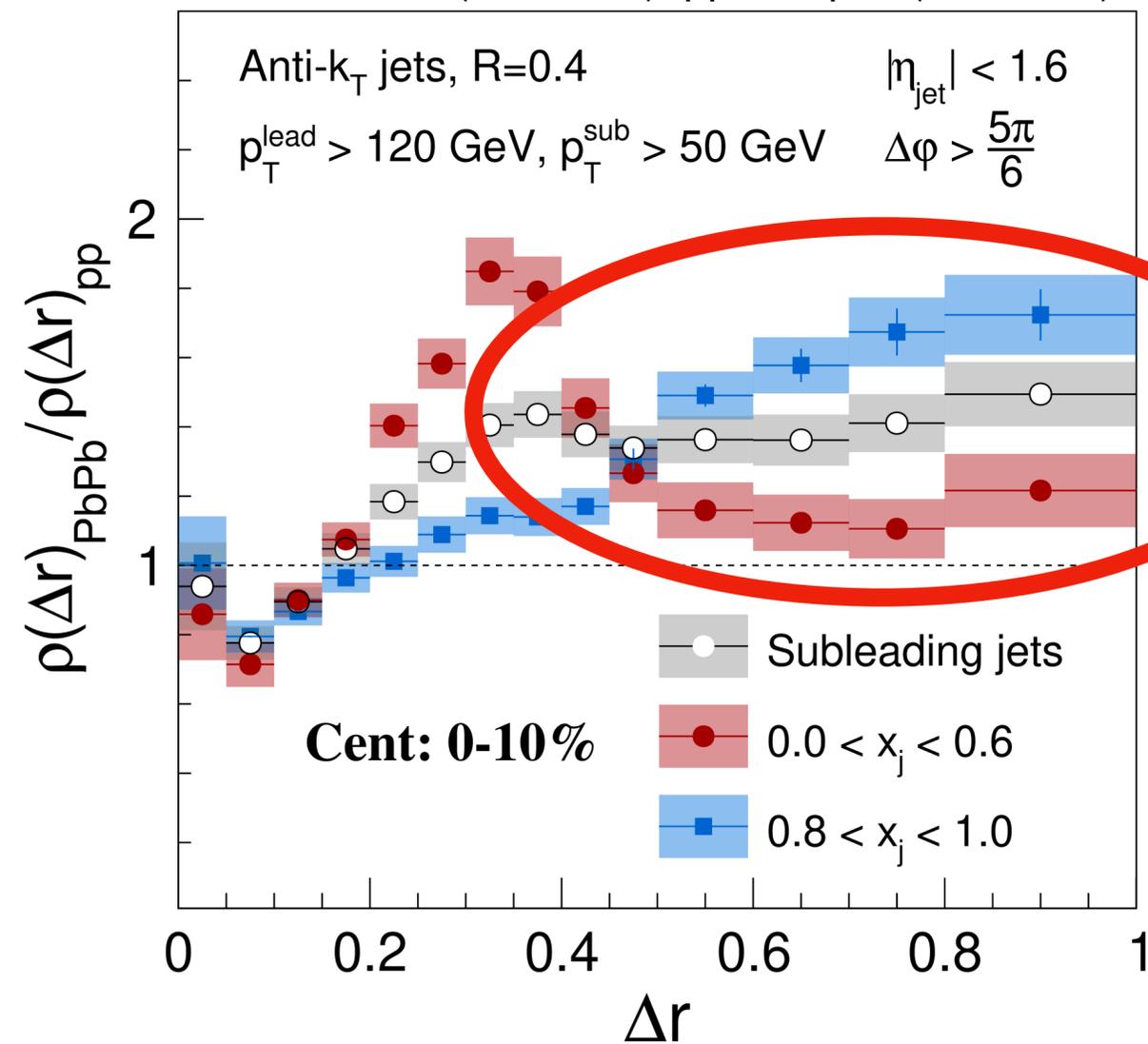
**Jussi Viinikainen's talk**  
**Wed, 11:20, Ballroom F**

# Subleading jet shapes in PbPb

- Selecting **balanced** vs **unbalanced** dijets changes jet shape distributions
- Interplay of selection effects, fluctuations, quenching

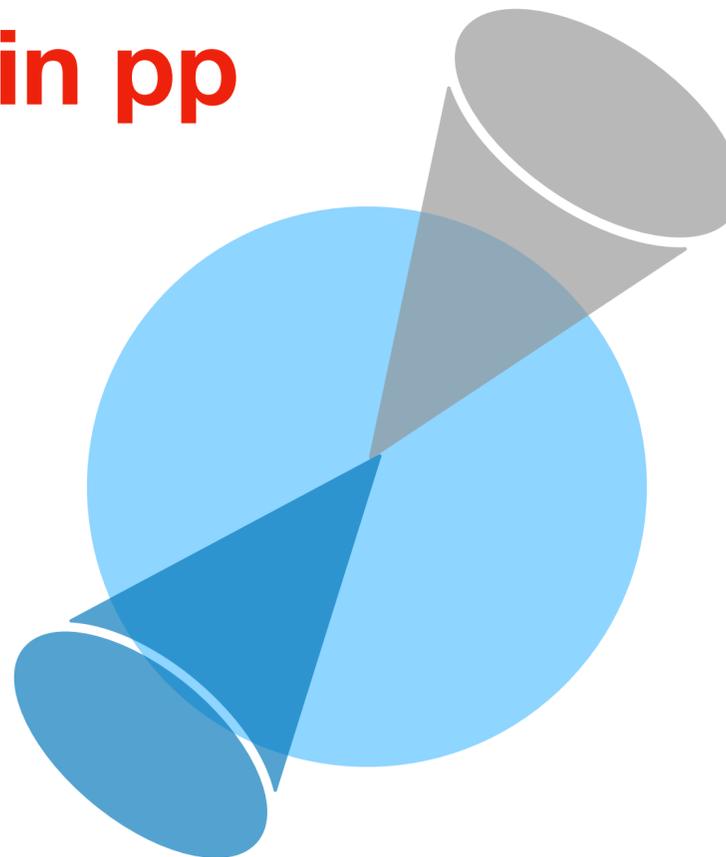
**CMS Supplementary** JHEP 05 (2021) 116

PbPb 1.7 nb<sup>-1</sup> (5.02 TeV) pp 320 pb<sup>-1</sup> (5.02 TeV)

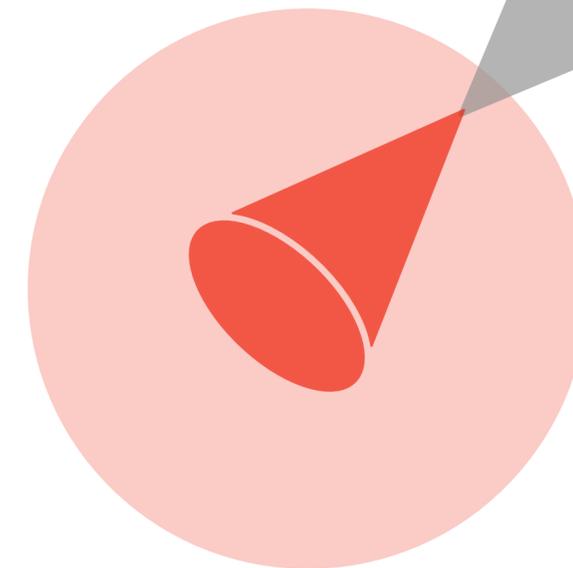


**3rd jet  
in pp**

**Subleading jets**



**Balanced**



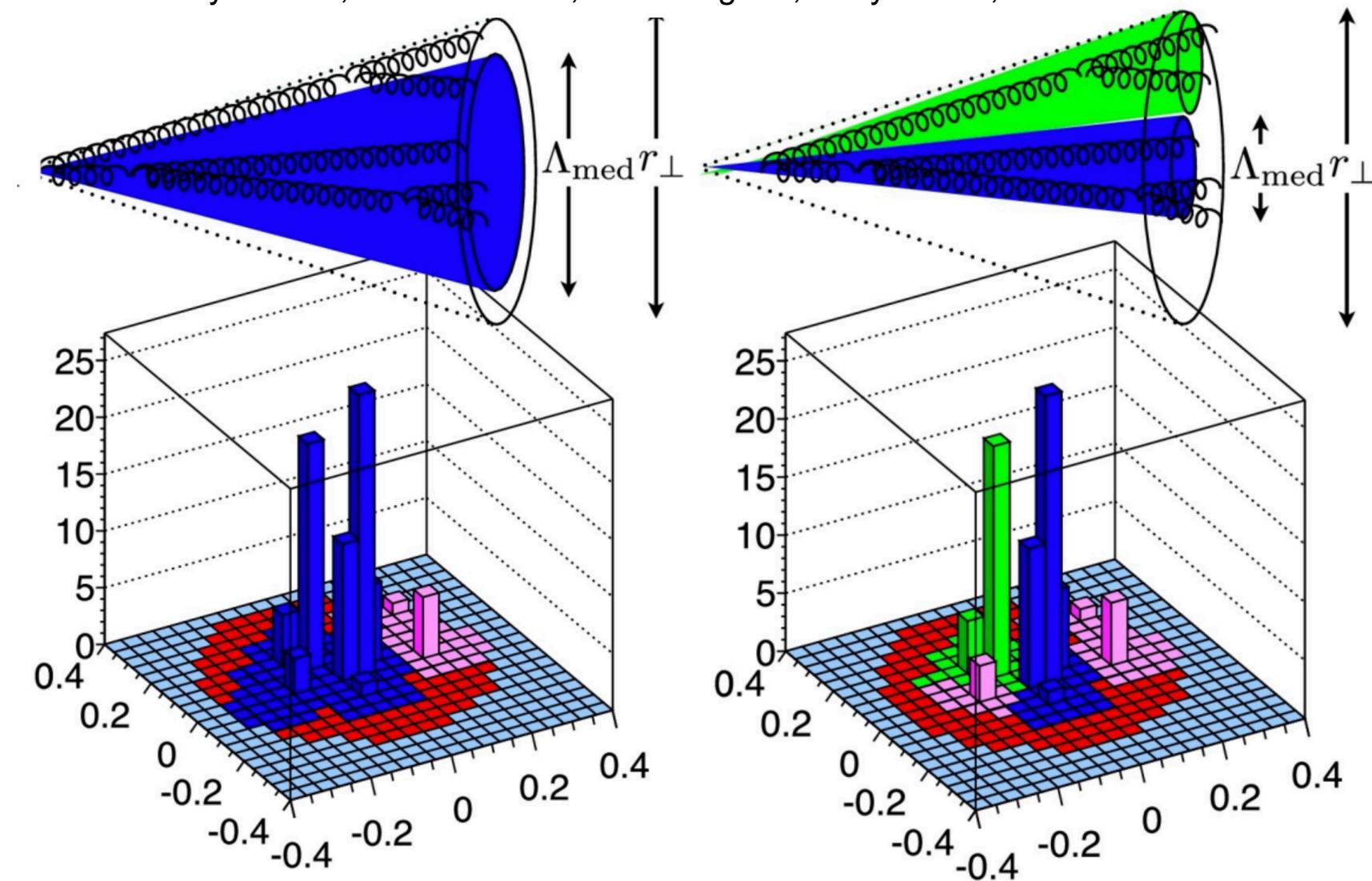
**Unbalanced**

JHEP 05 (2021) 116

**Jussi  
Viinikainen's  
talk  
Wed, 11:20,  
Ballroom F**

# Color coherence

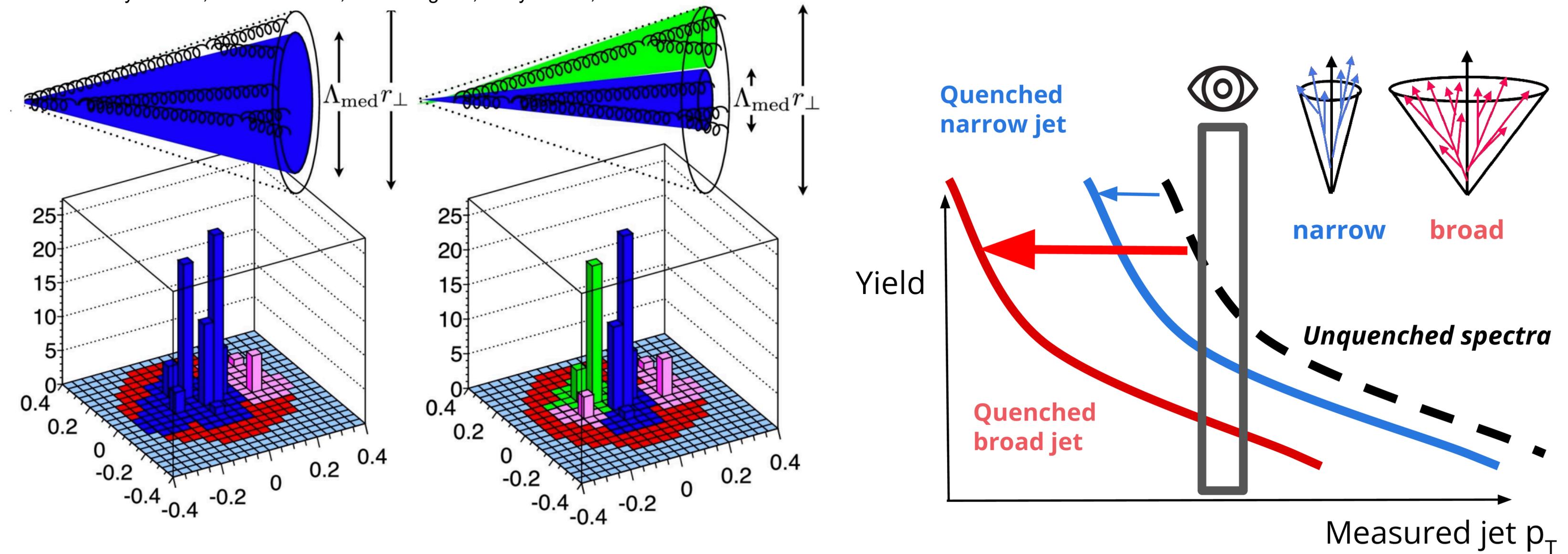
J. Casalderrey-Solana, Y. Mehtar-Tani, C. A. Salgado, K. Tywoniuk, arXiv:1210.7765



- **Narrowed jet core seen in inclusive jet samples - coherence effects?**

# Survival bias in inclusive samples

J. Casalderrey-Solana, Y. Mehtar-Tani, C. A. Salgado, K. Tywoniuk, arXiv:1210.7765

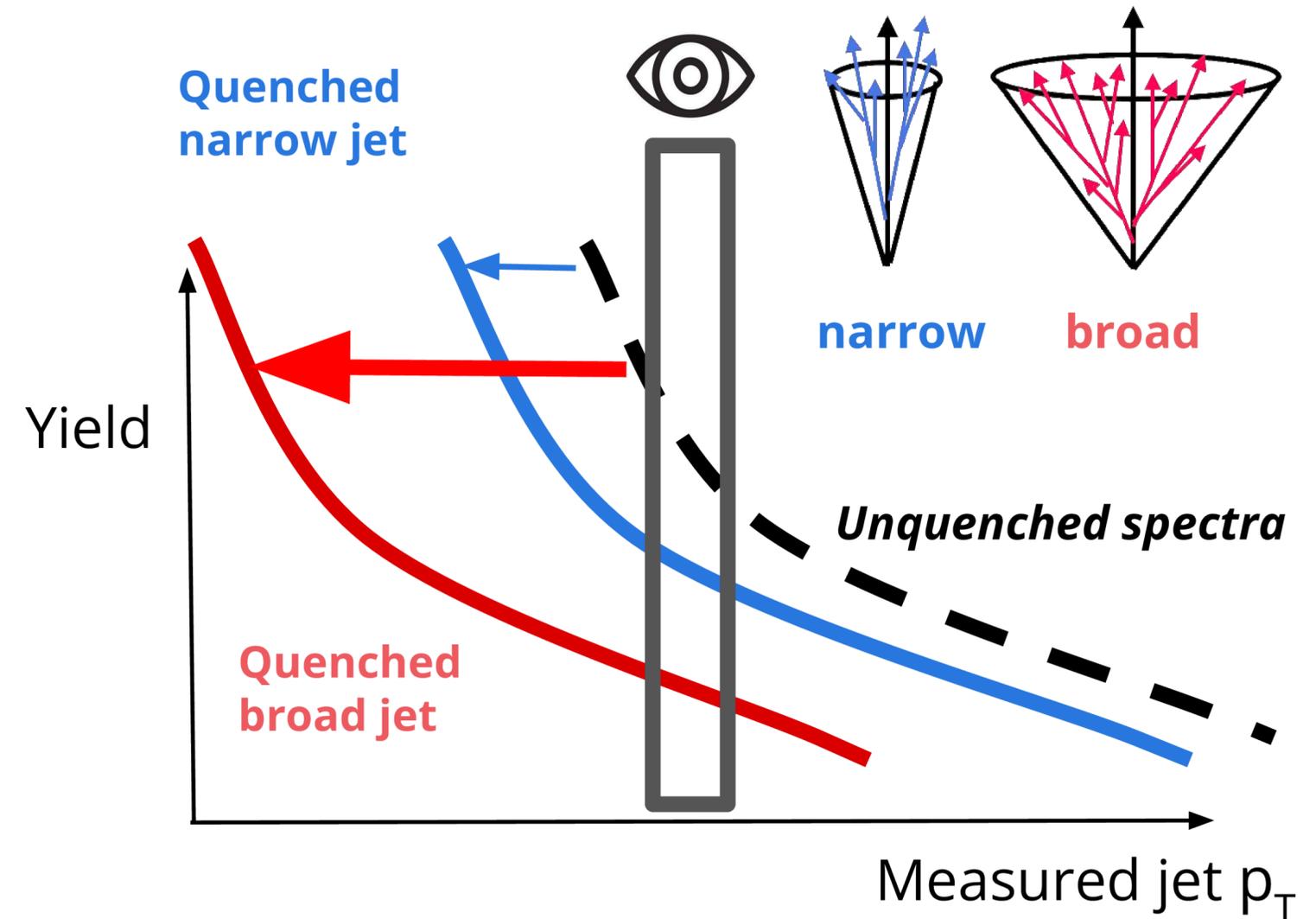
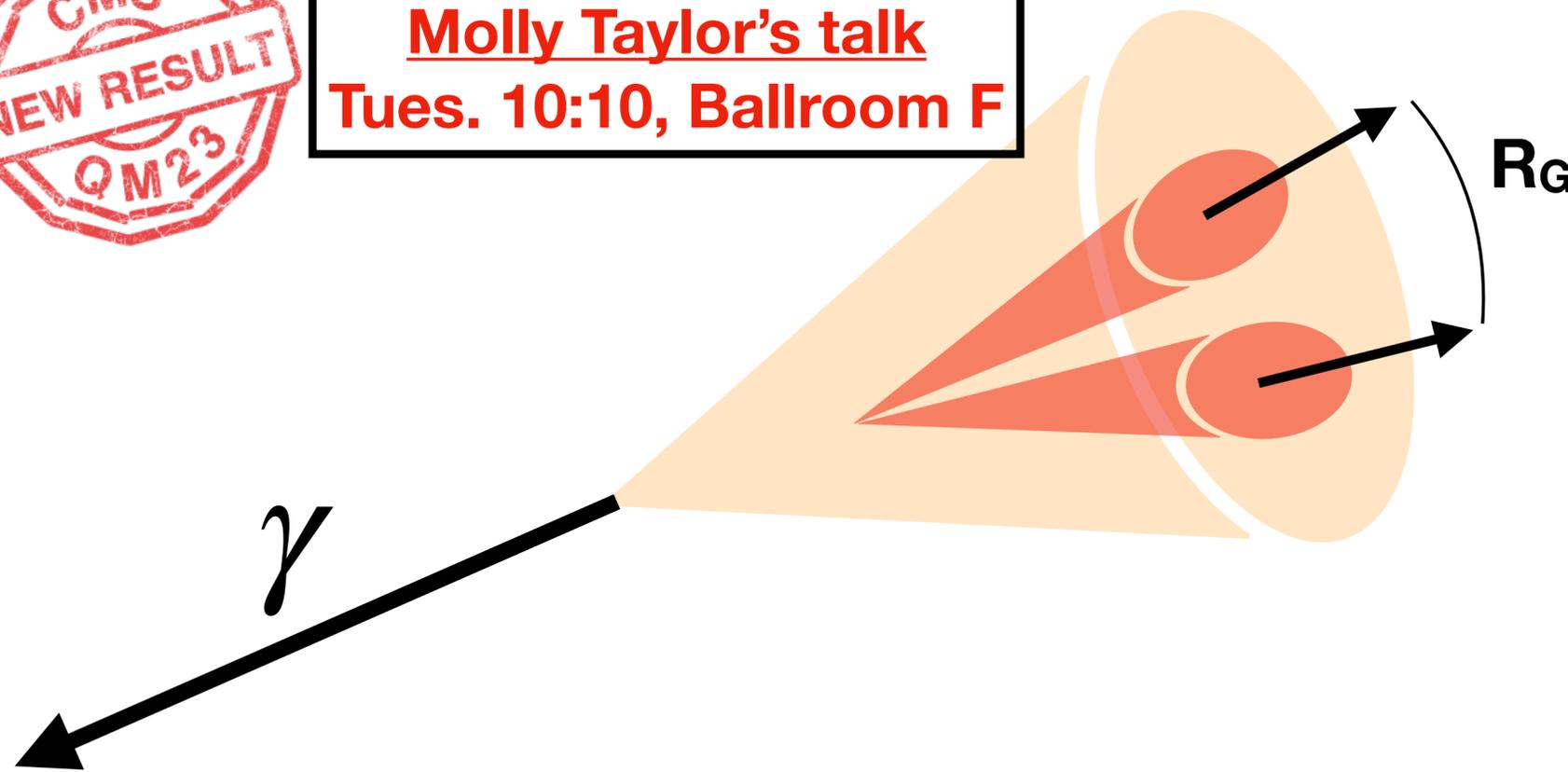


- **Narrowed jet core seen in inclusive jet samples - coherence?**
- **Different jet shower patterns  $\rightarrow$  survival bias of narrow jets at given  $p_T$**

# $\gamma$ -jet groomed jet radius

CMS PAS HIN-23-001

**Molly Taylor's talk**  
**Tues. 10:10, Ballroom F**



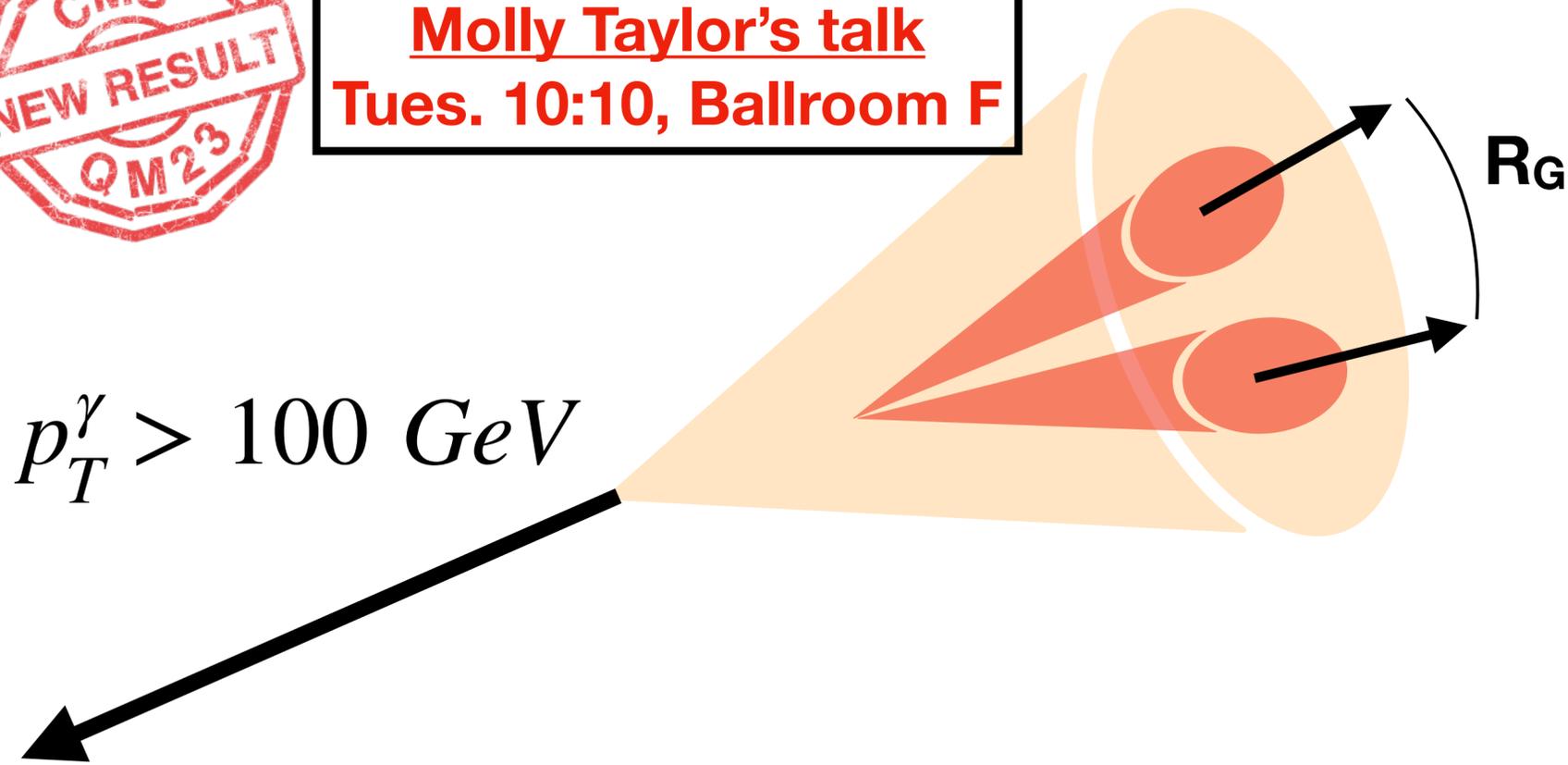
- **Narrowed jet core seen in inclusive jet samples - coherence?**
- **Different jet shower patterns  $\rightarrow$  survival bias of narrow jets at given  $p_T$**
- **Reduce bias with a photon tag!**

# Less biased $\gamma$ -jet $R_g$

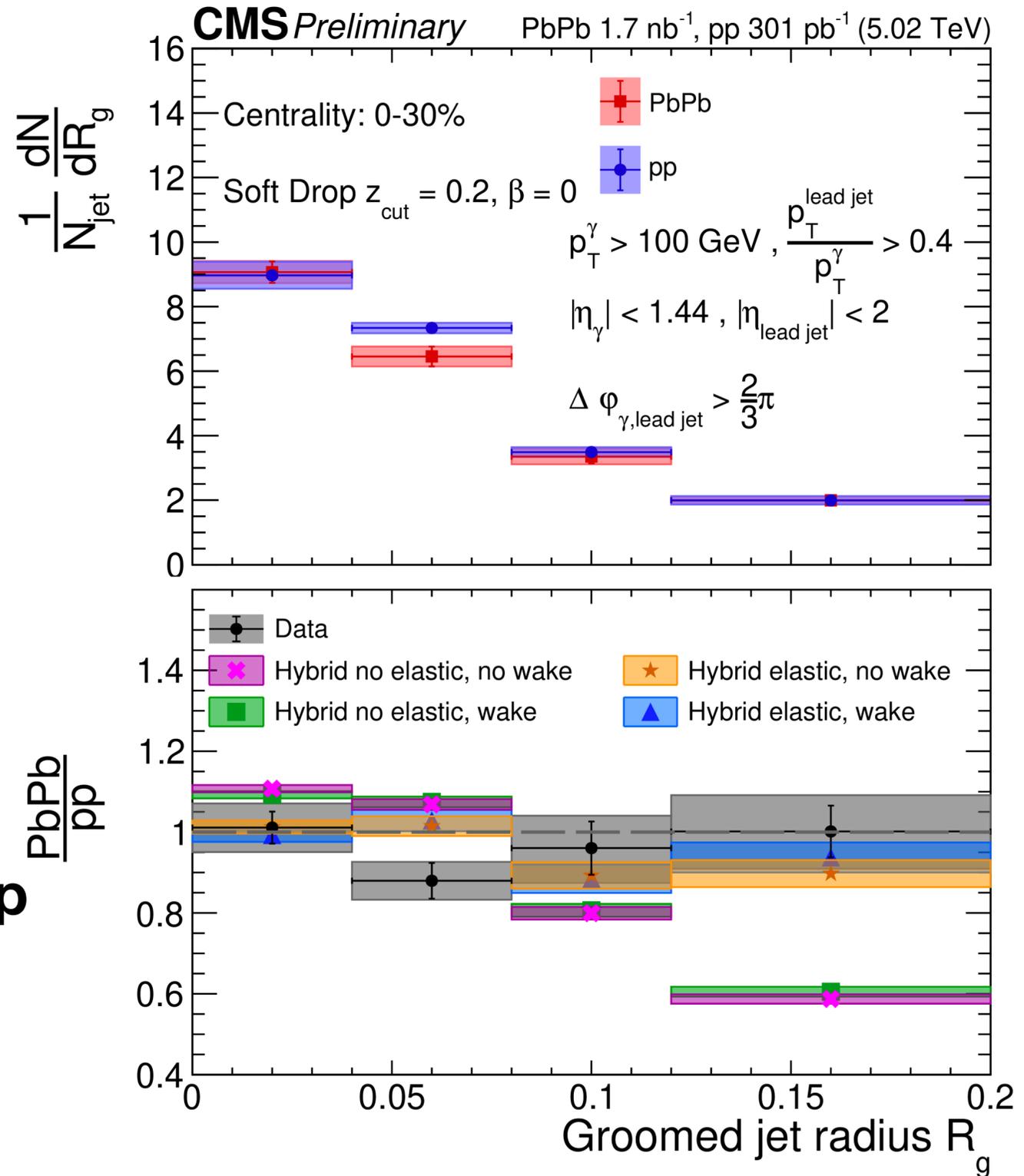


CMS PAS HIN-23-001

**Molly Taylor's talk**  
**Tues. 10:10, Ballroom F**



- $x_{J,\gamma} > 0.4$  (quenched+unquenched)
- Much less modification seen with respect to pp

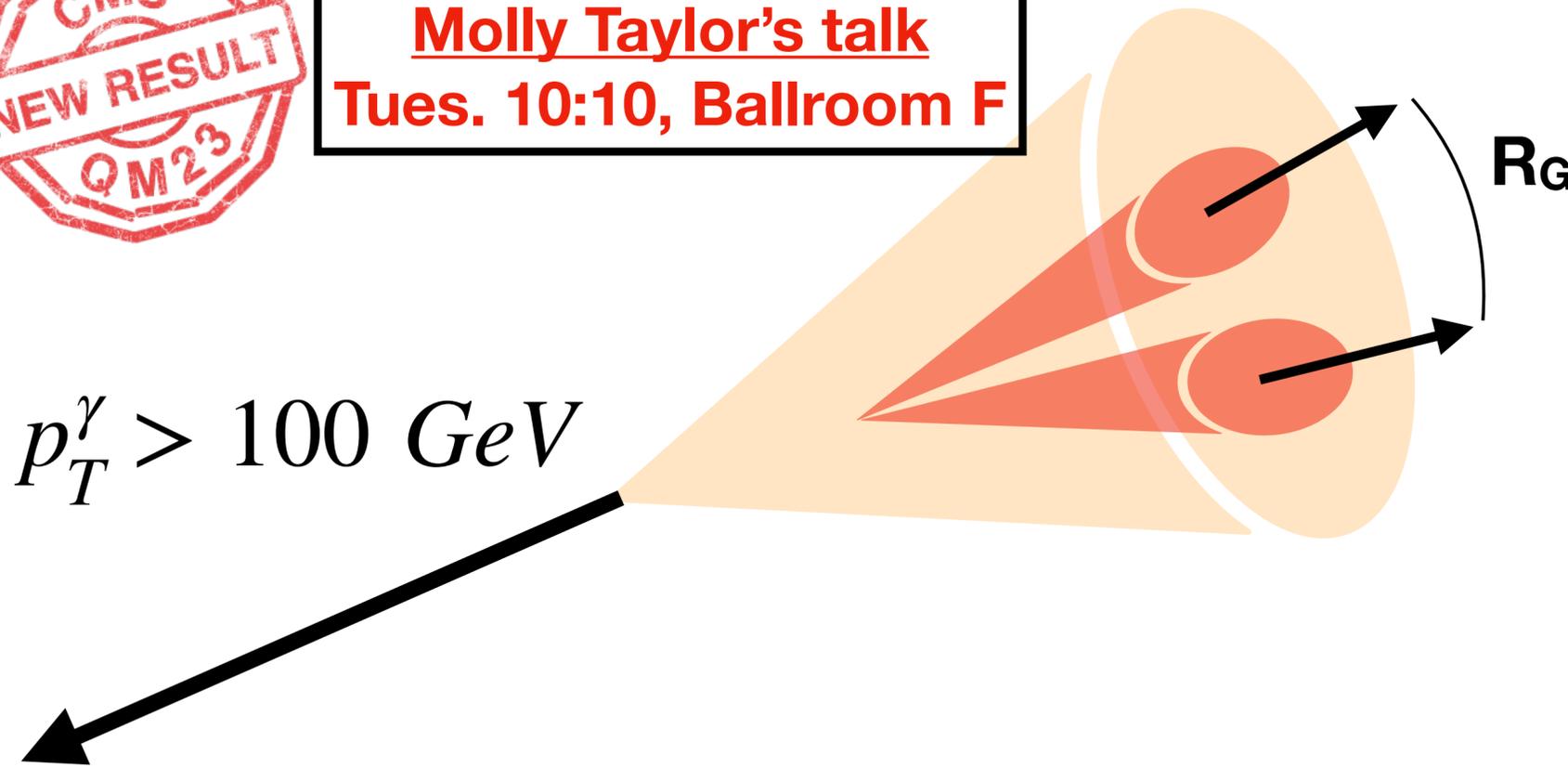


# More biased $\gamma$ -jet $R_g$

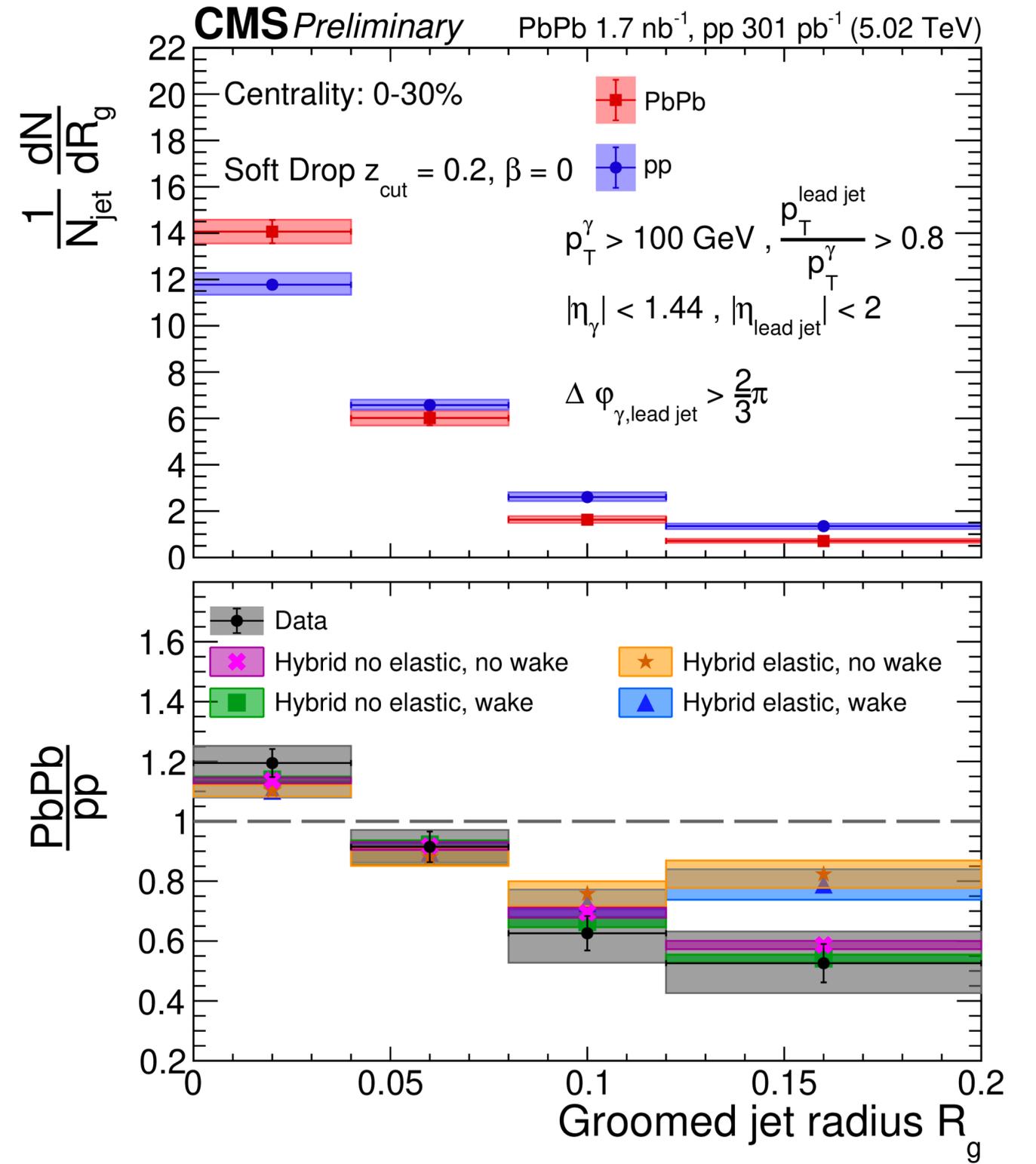


CMS PAS HIN-23-001

**Molly Taylor's talk**  
**Tues. 10:10, Ballroom F**



- $x_{J,\gamma} > 0.8$  (less quenched jets)
- **Narrowing effect seen**
- **Selection bias important for interpretation of inclusive jets samples and coherence!**



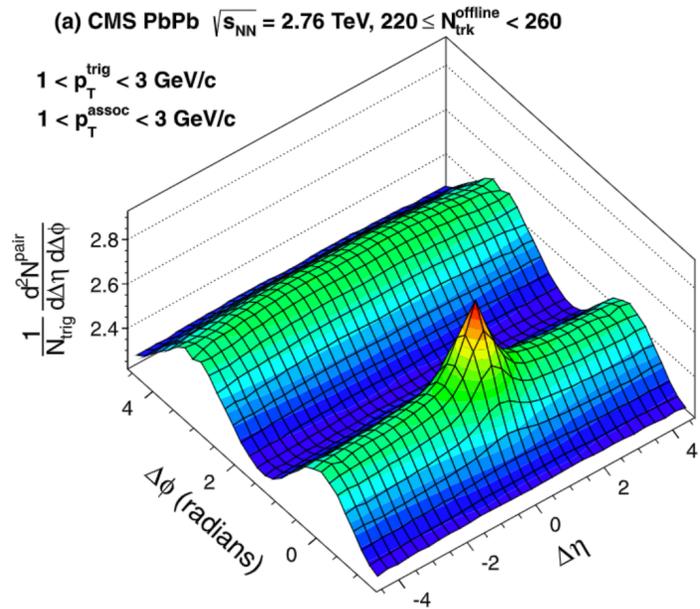
The background features a complex network of thin, yellow lines radiating from a central point, creating a starburst or sunburst effect. Interspersed among these lines are several thicker, green and light blue brushstroke-like elements, some of which are oriented horizontally and others diagonally. The overall aesthetic is dynamic and technical, suggesting a network or data visualization.

# Collectivity in small systems

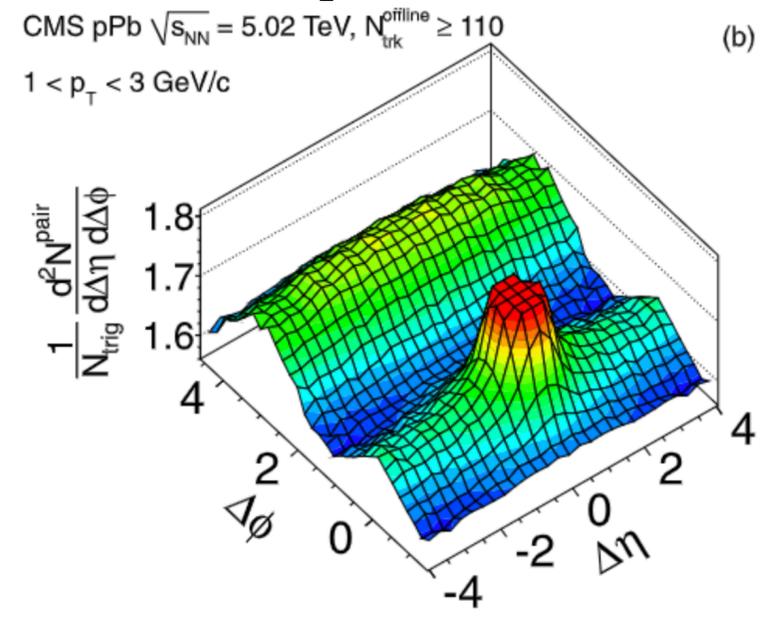
# Systems smaller than pp?

PLB 724 (2013) 213  
 PLB 718 (2013) 795  
 PLB 765 (2017) 193

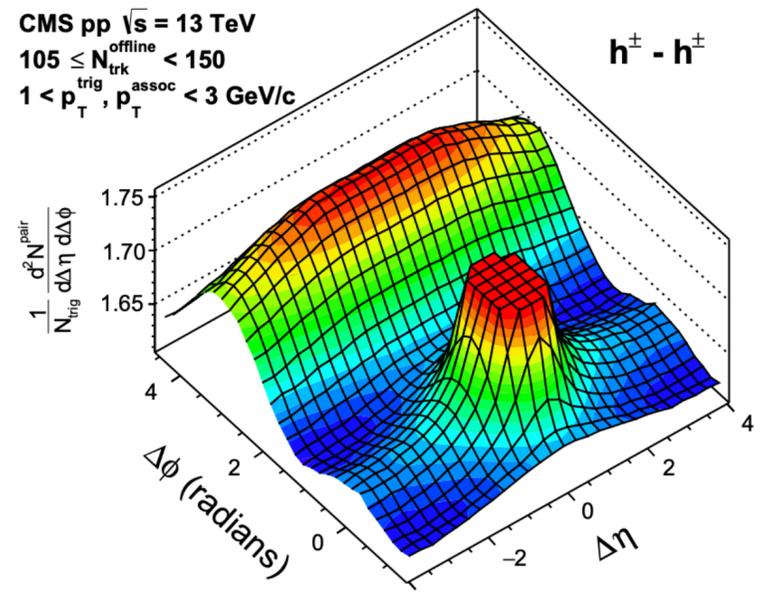
## PbPb



## pPb



## High-multiplicity pp

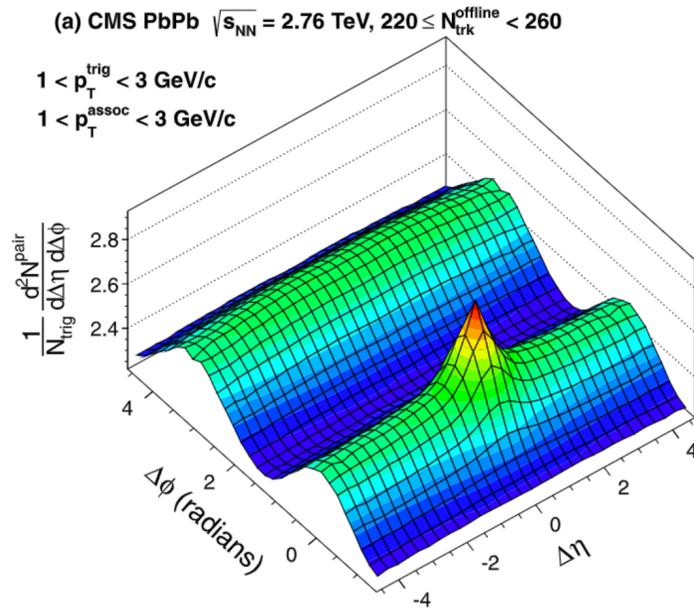


???

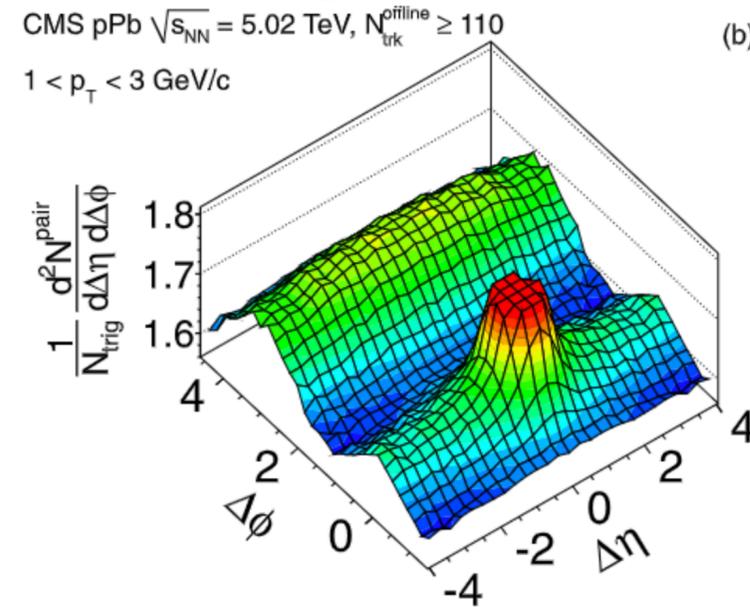
# Search for flow in individual jets

PLB 724 (2013) 213  
 PLB 718 (2013) 795  
 PLB 765 (2017) 193

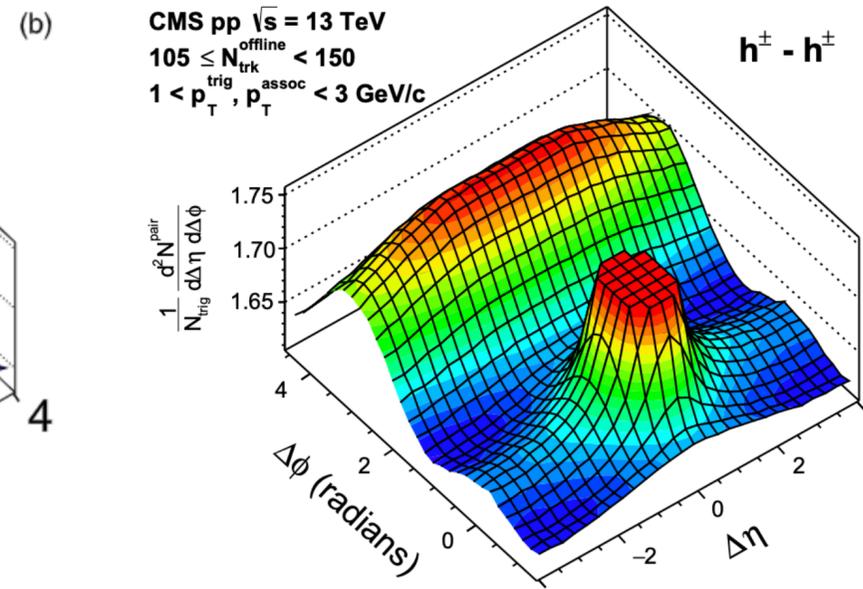
## PbPb



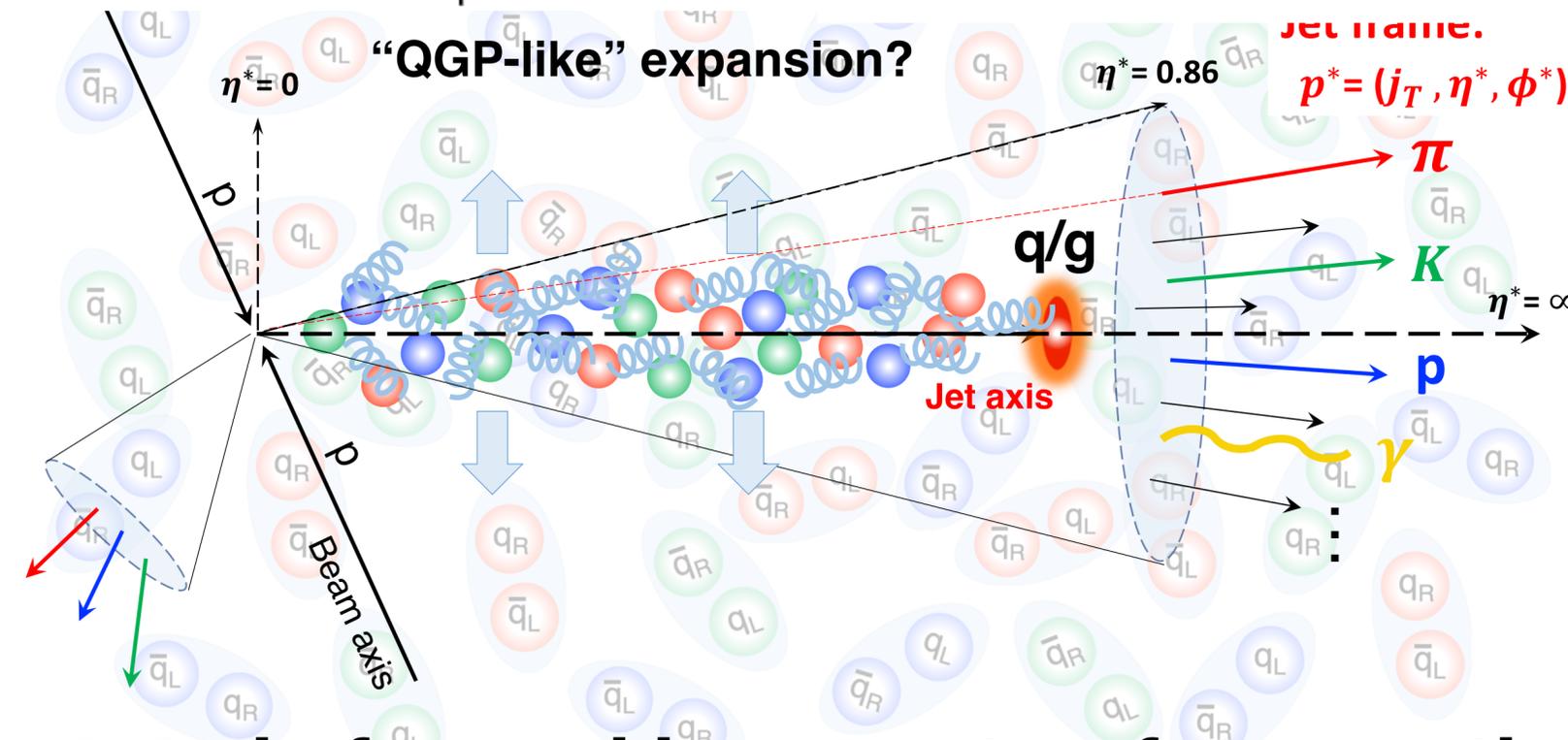
## pPb



## High-multiplicity pp



???

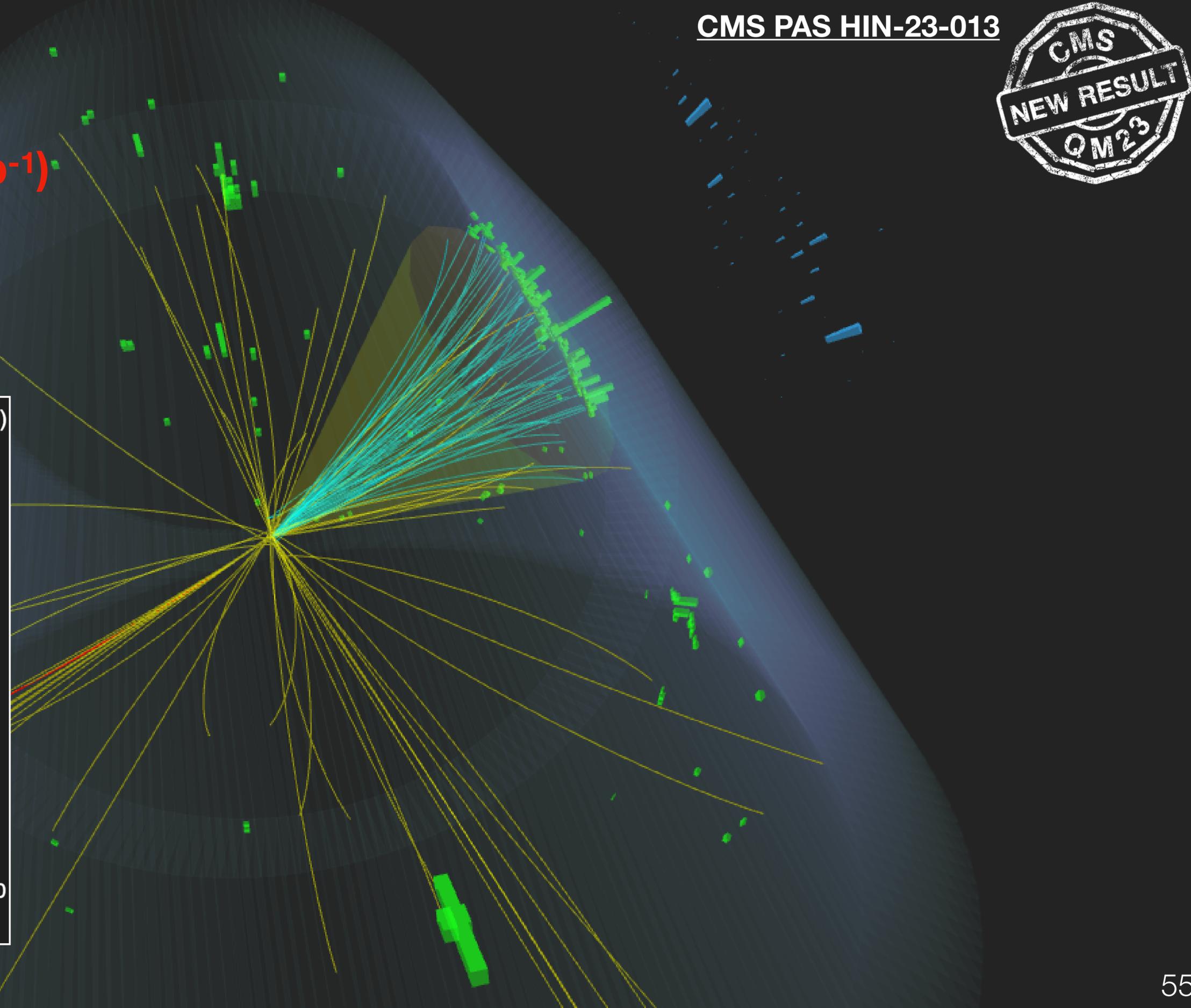
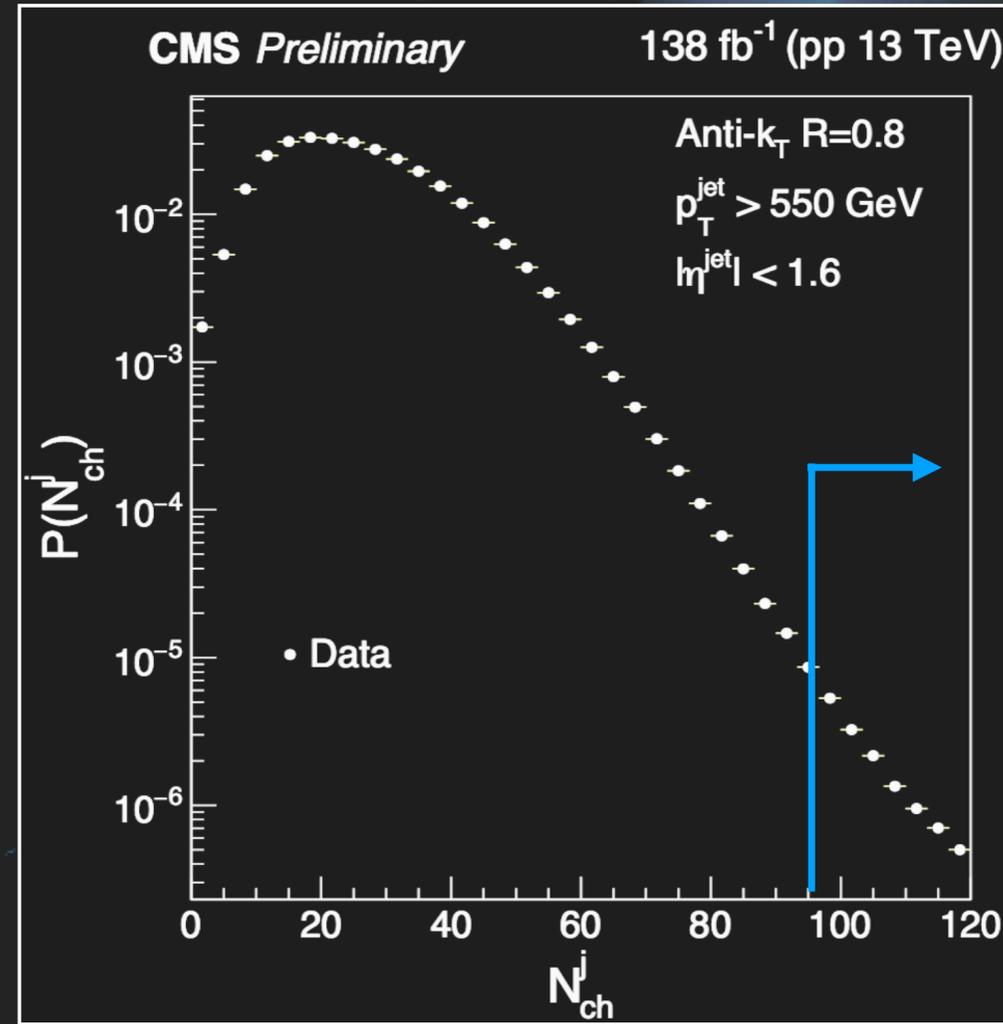


What if a QGP-like state is formed by a parton fragmenting to many particles?

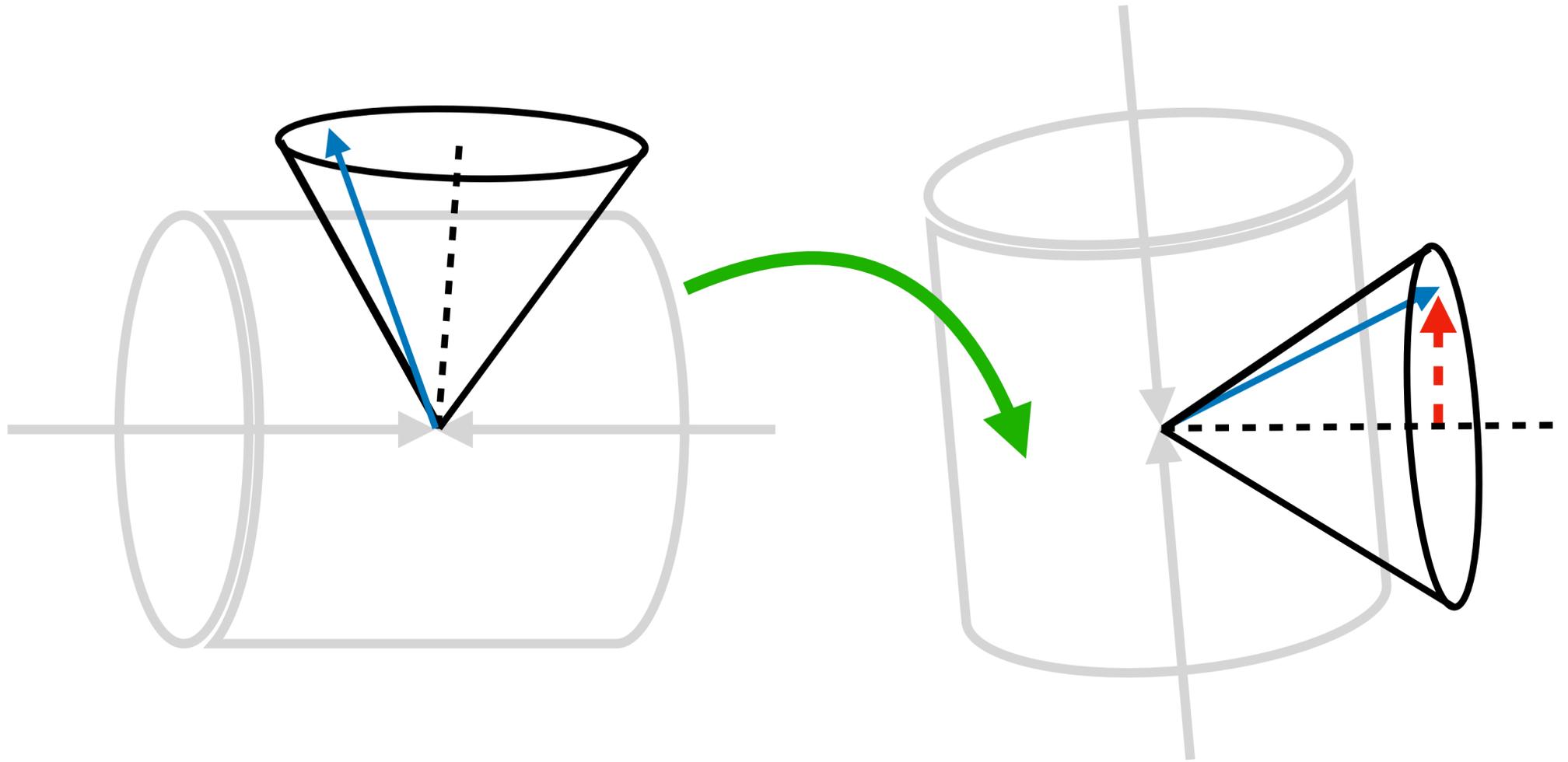


# high-pileup pp data (138 fb<sup>-1</sup>) PUPPI pileup mitigation

## Select high multiplicity jets



# Rotated reference frame



- ***In rotated reference frame,*** calculate two particle correlation using jet constituents

**CMS PAS HIN-23-013**

**Parker Gardner's talk**  
**Wed. 12:00, Ballroom C**



# Two particle correlation

CMS Preliminary

138 fb<sup>-1</sup> (pp 13 TeV)

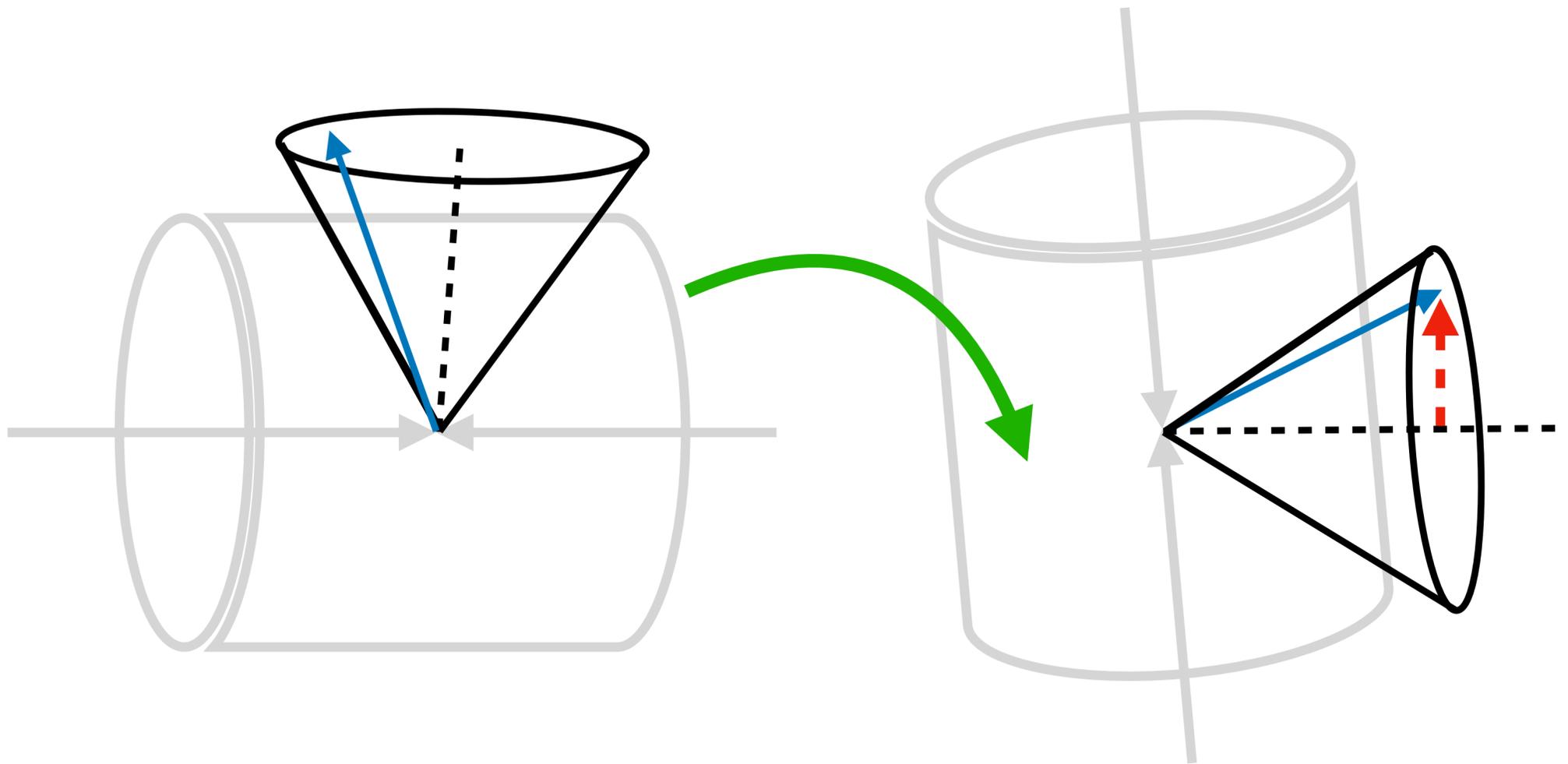
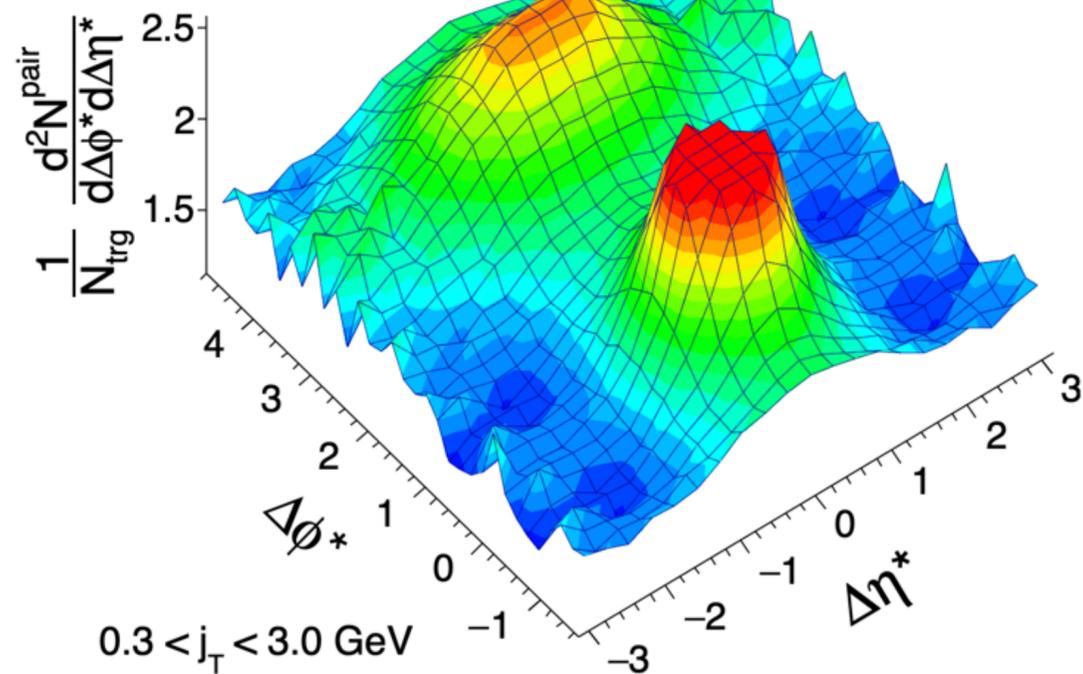
$\langle N_{ch}^j \rangle = 101$

Top 0.0023% highest- $N_{ch}^j$  jets

Anti  $k_T$ -R=0.8

$p_T^{\text{jet}} > 550$

$|\eta^{\text{jet}}| < 1.6$



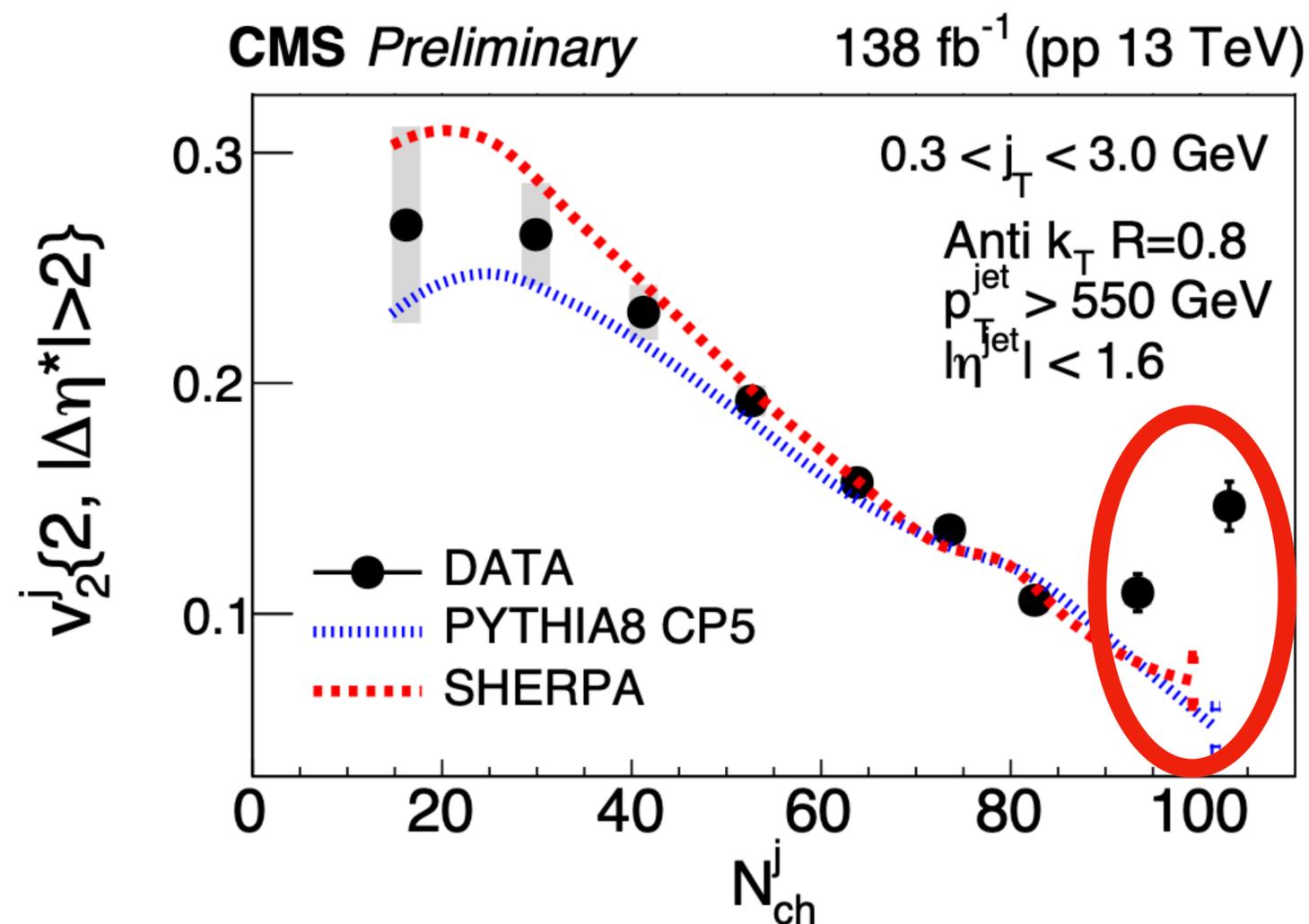
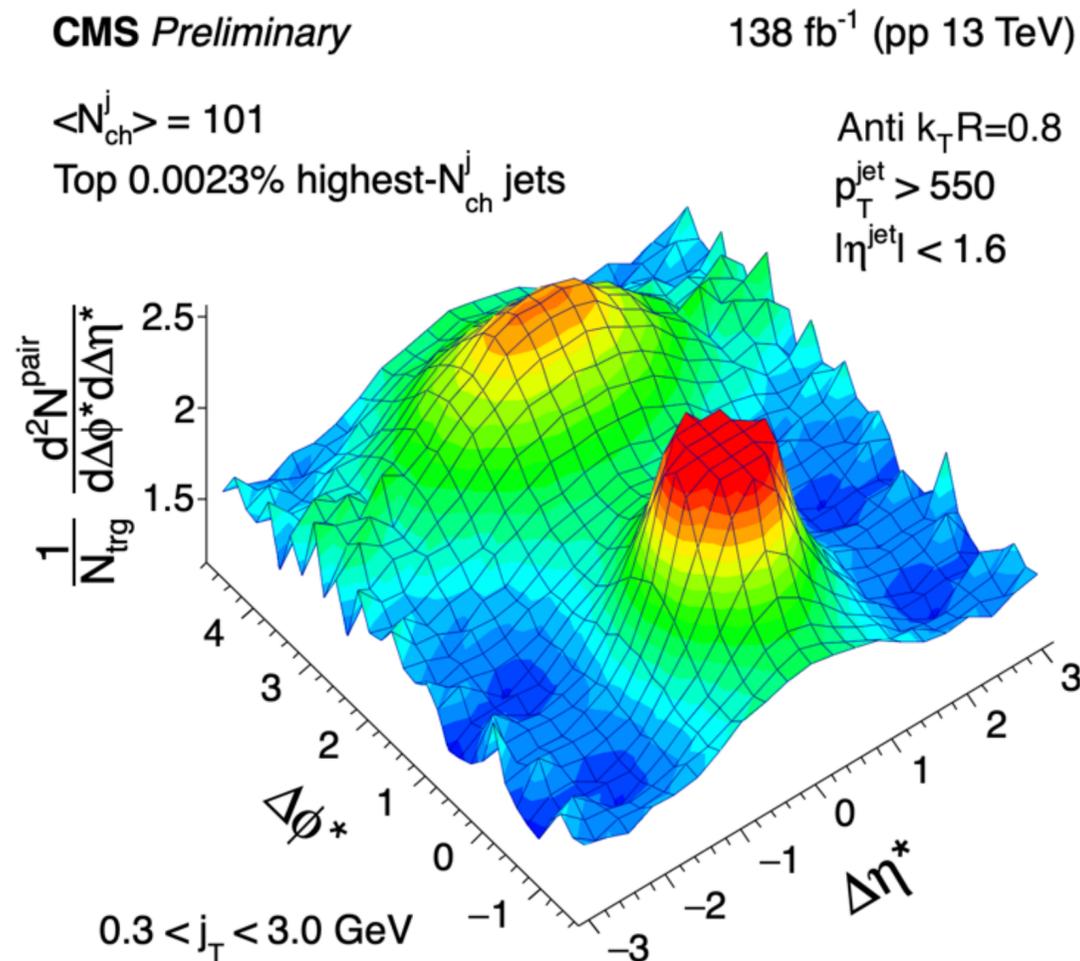
- ***In rotated reference frame***, calculate two particle correlation using jet constituents

CMS PAS HIN-23-013

**Parker Gardner's talk**  
**Wed. 12:00, Ballroom C**



# In-jet $v_2$ with respect to the jet axis

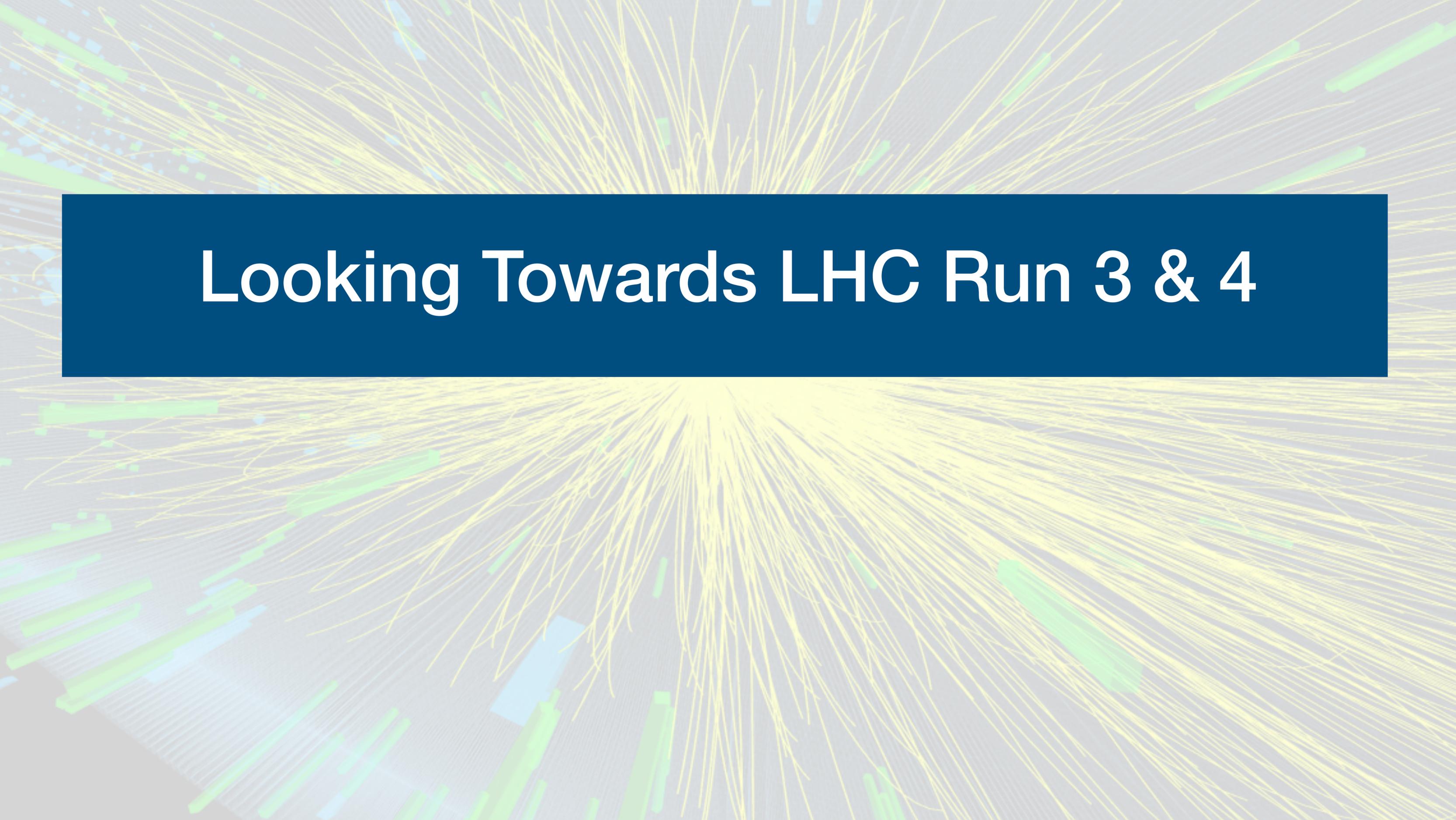


- **In rotated reference frame**, calculate two particle correlation using jet constituents
- $v_2$  well described by MC for  $N_{ch}^{\text{jet}} < 80$
- Upward trend seen for  $N_{ch}^{\text{jet}} > 80$
- Potential sign of collectivity in jets?

CMS PAS HIN-23-013

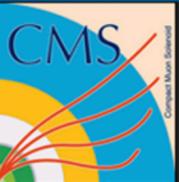
**Parker Gardner's talk**  
**Wed. 12:00, Ballroom C**



The background features a complex, abstract pattern of thin, radiating lines in shades of yellow and light green, creating a starburst or sunburst effect. These lines are set against a light grey background. Interspersed among the lines are several thicker, semi-transparent rectangular bars in various shades of green and blue, some of which are oriented diagonally. The overall composition is dynamic and futuristic.

# Looking Towards LHC Run 3 & 4

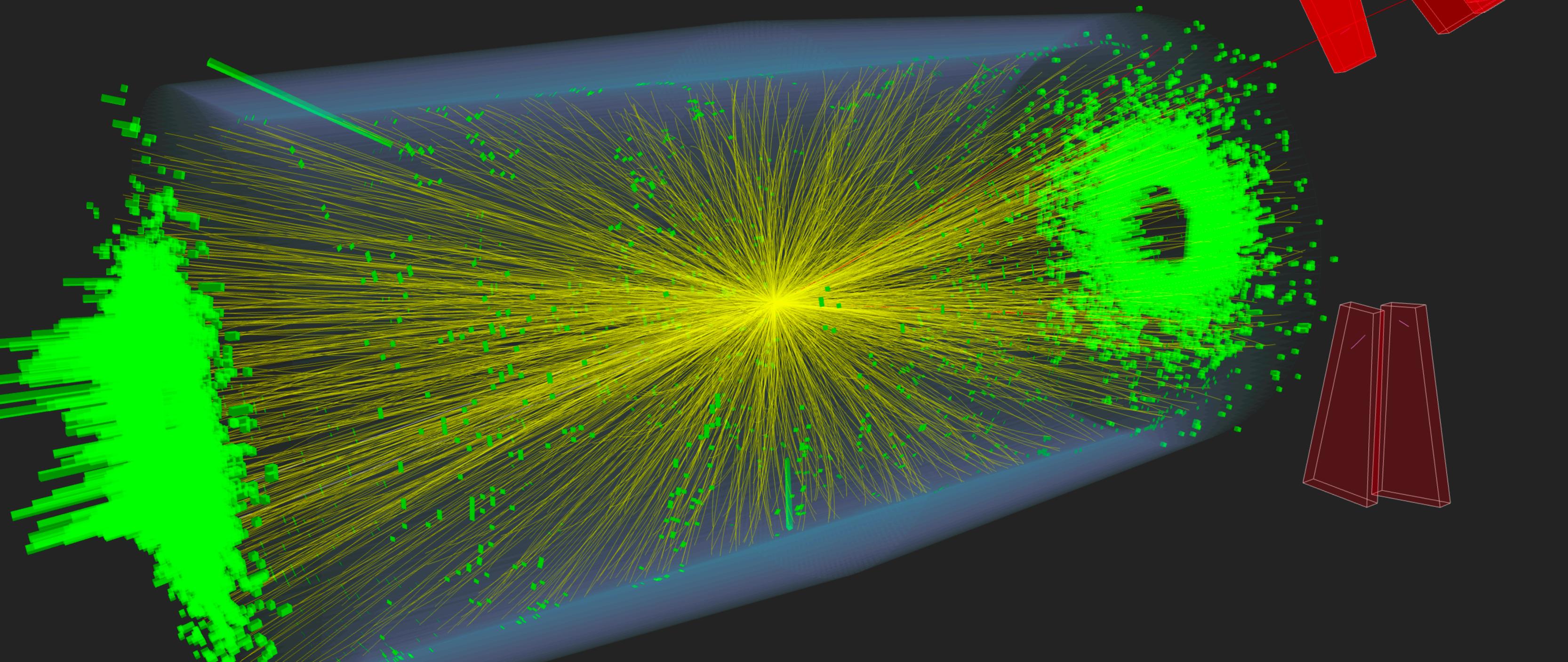
# 5.36 TeV PbPb Collisions!



CMS Experiment at the LHC, CERN

Data recorded: 2022-Nov-18 16:09:13.771584 GMT

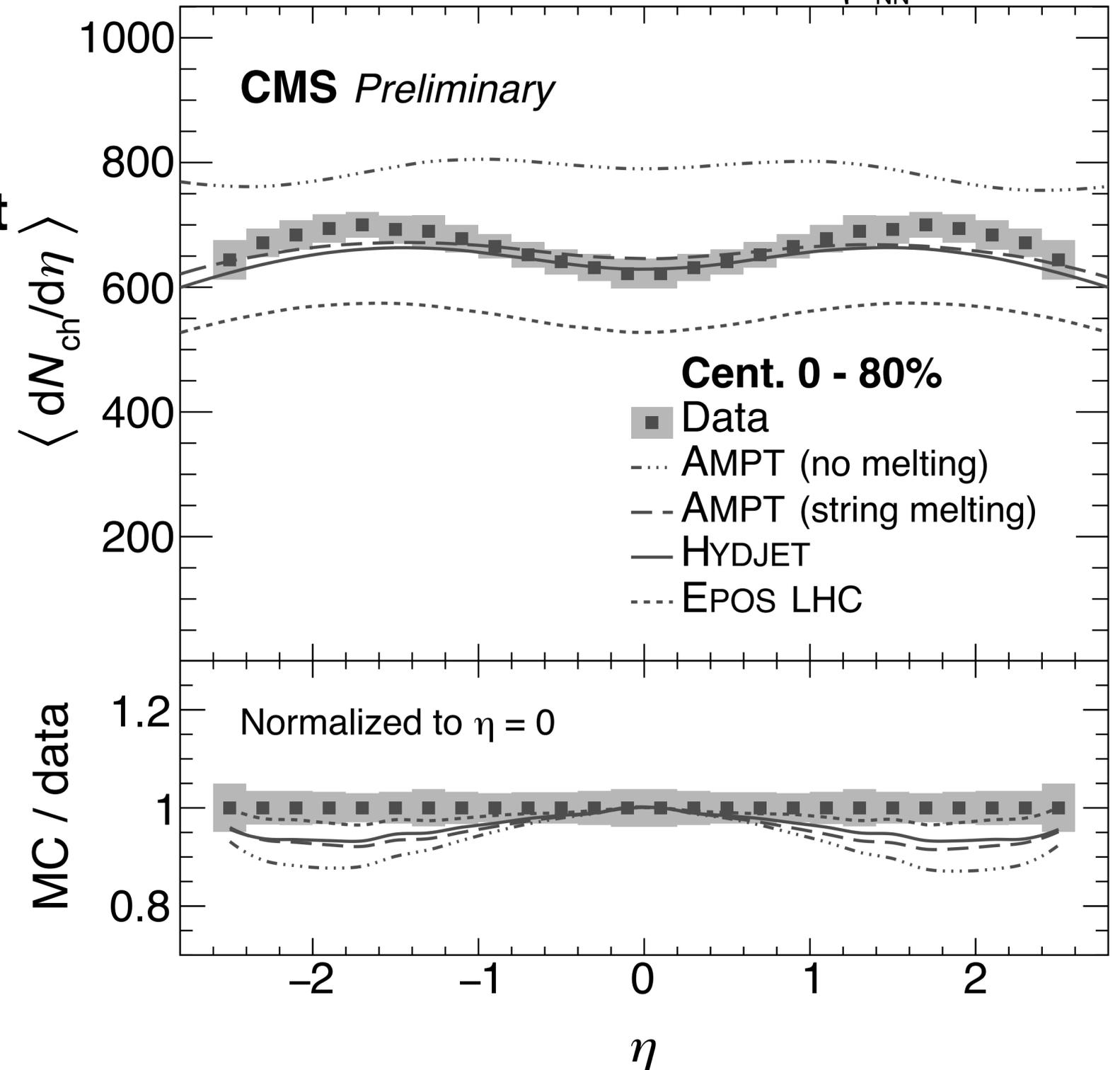
Run / Event / LS: 362294 / 4769619 / 16



# First CMS HI Run 3 result - $dN_{ch}/d\eta$

PbPb  $\sqrt{s_{NN}} = 5.36$  TeV

- 5.36 TeV data from 2022 test run
- Challenging for MC generators to predict both magnitude and shape of  $dN_{ch}/d\eta$

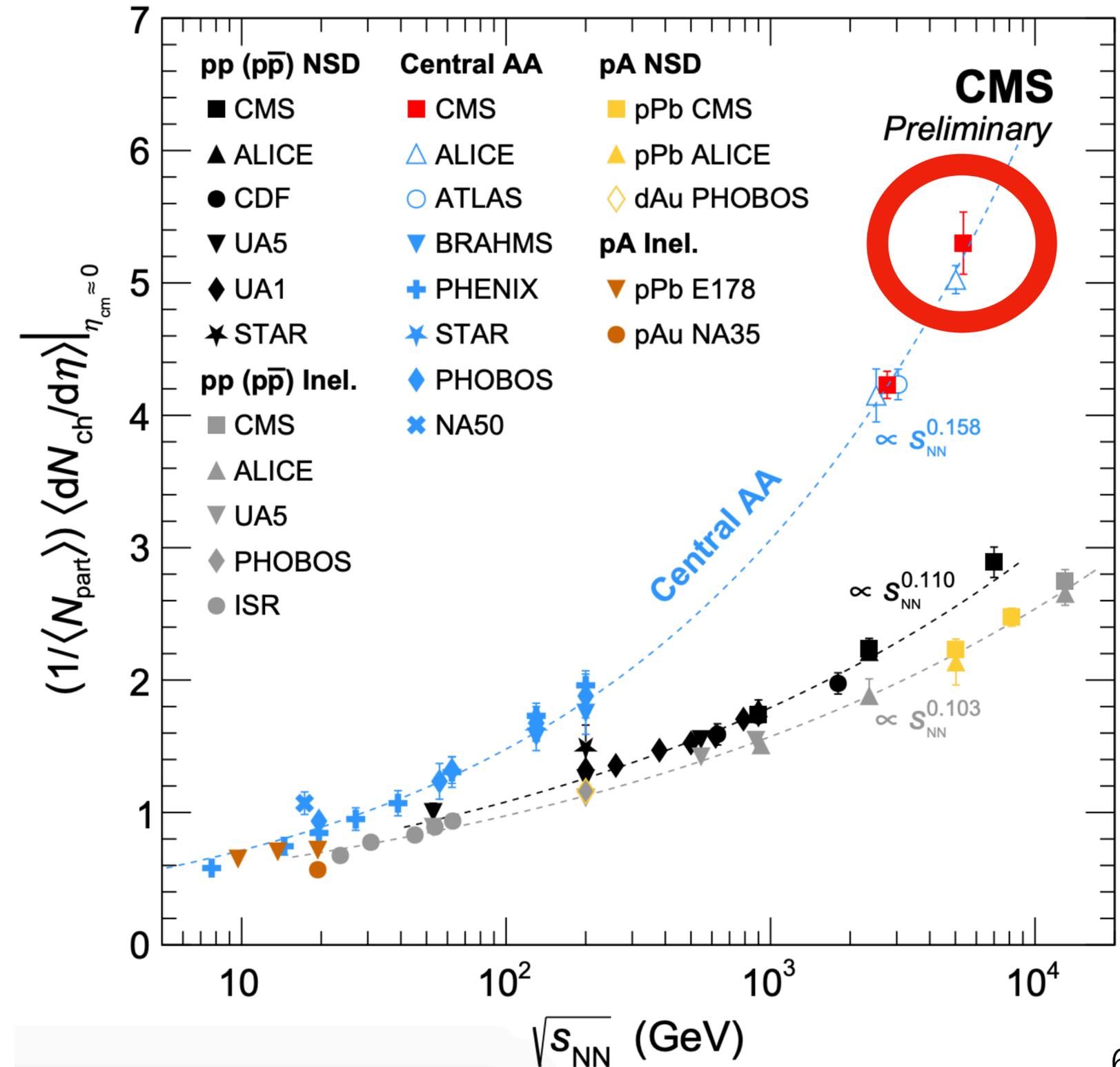


CMS PAS HIN-23-007

**Jing Wang's talk**  
**Tues. 11:20, Ballroom C**

# First CMS Run 3 result - $dN_{ch}/d\eta$

- 5.36 TeV data from 2022 test run
- Challenging for MC generators to predict both magnitude and shape of  $dN_{ch}/d\eta$
- $\sqrt{s_{NN}}$  dependence consistent with power law calculated using lower energies

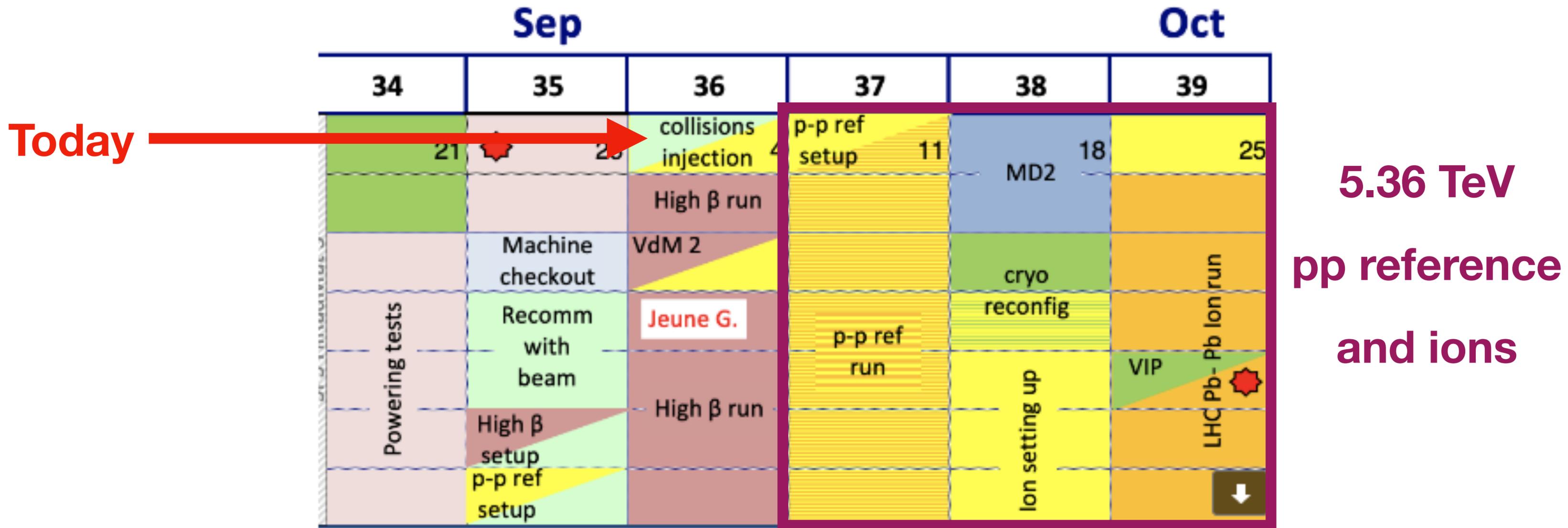


CMS PAS HIN-23-007

**Jing Wang's talk**  
**Tues. 11:20, Ballroom C**

# Looking Forward: Run 3

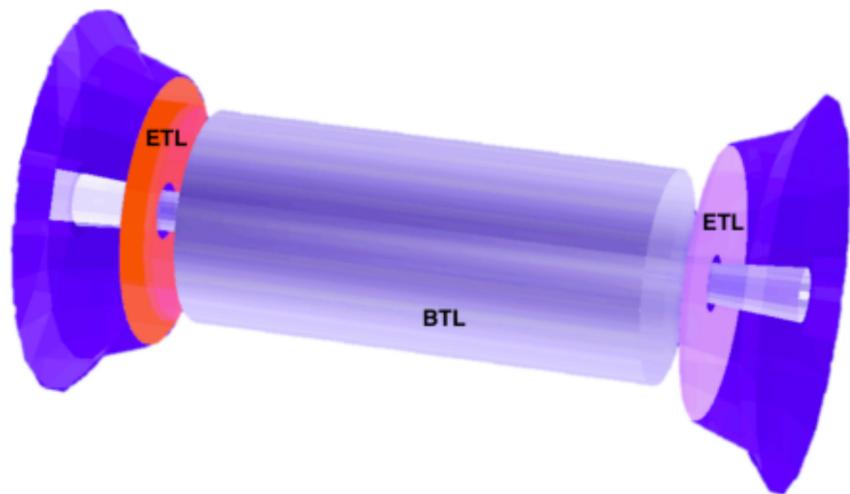
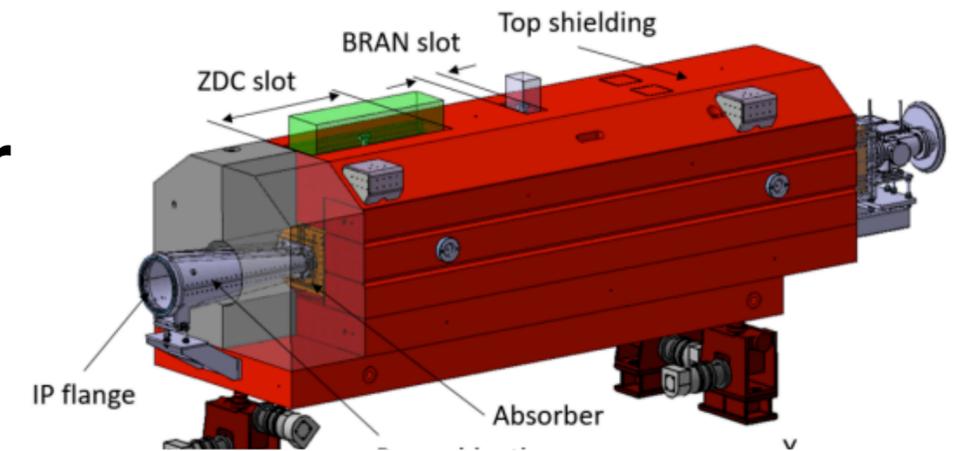
Ready for large 5.36 TeV data sets!



LHC schedule

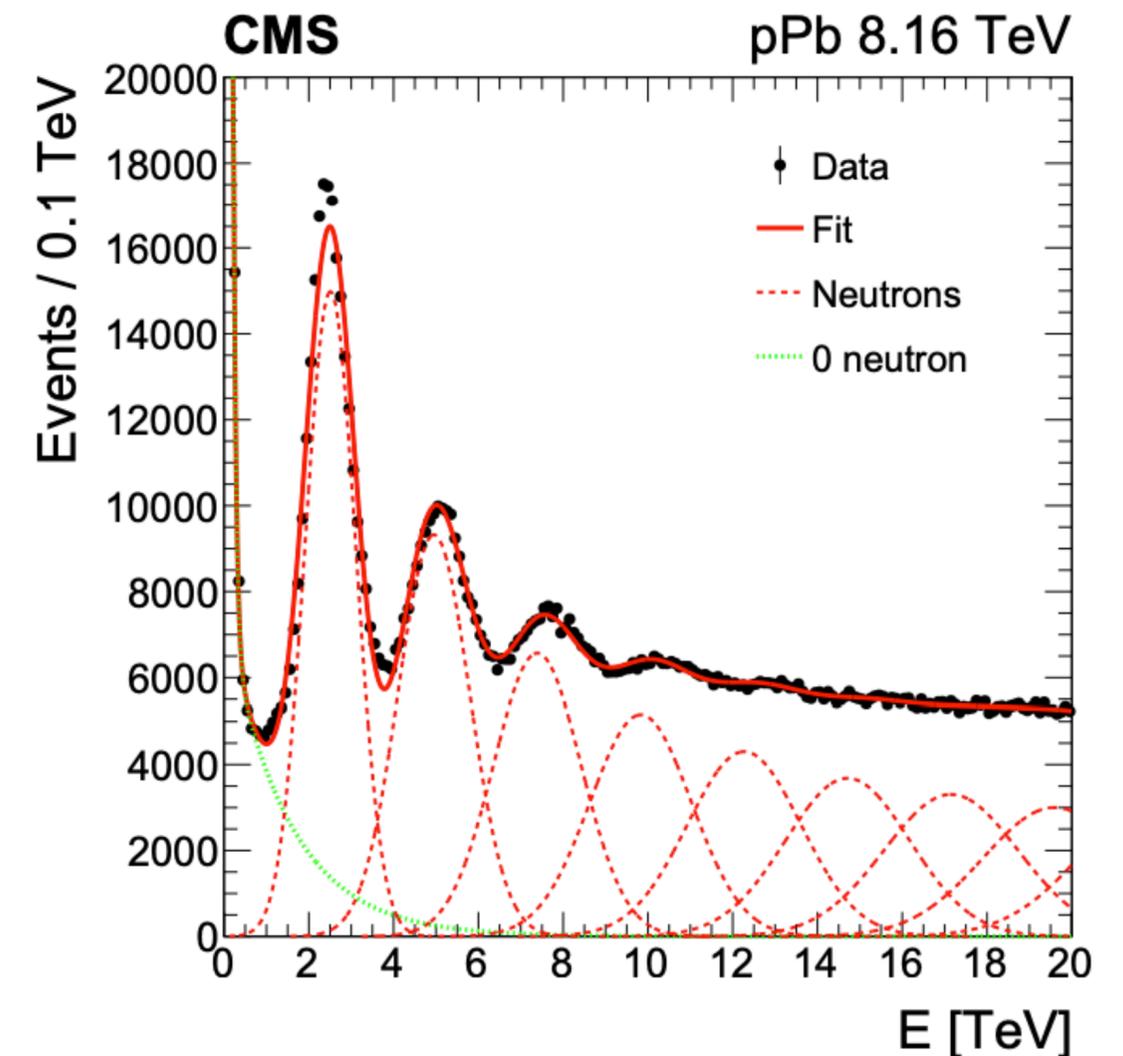
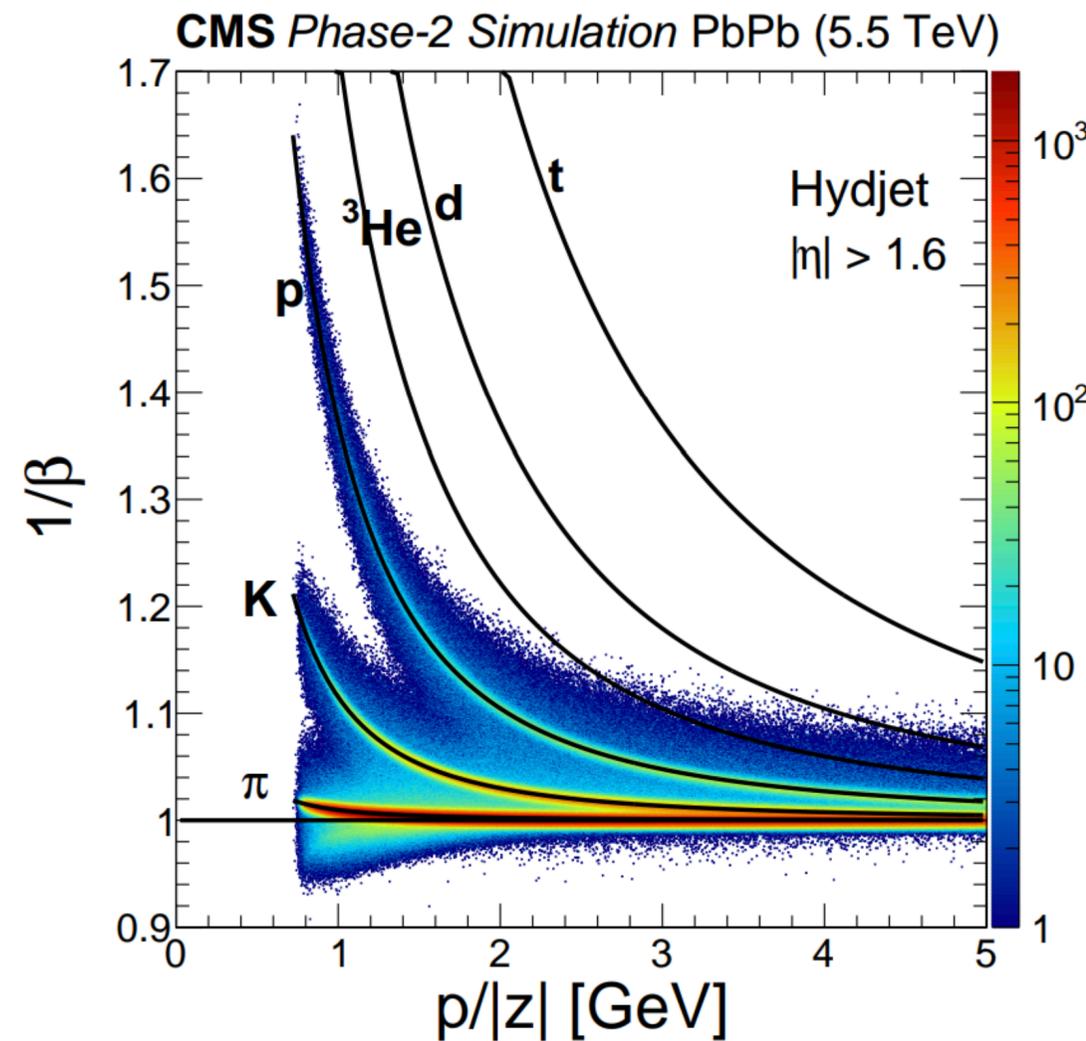
# Run 4 upgrades

- Adding PID and pileup rejection with MIP Timing Detector
- Research on rad-hard ZDCs for HL-LHC



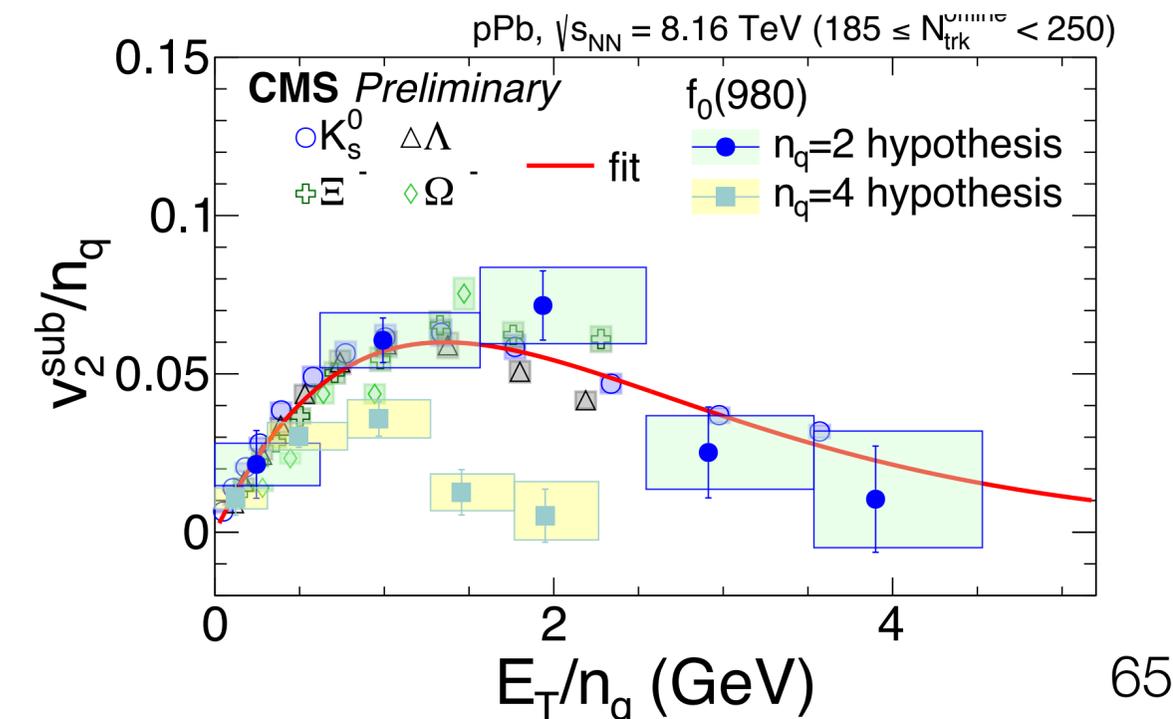
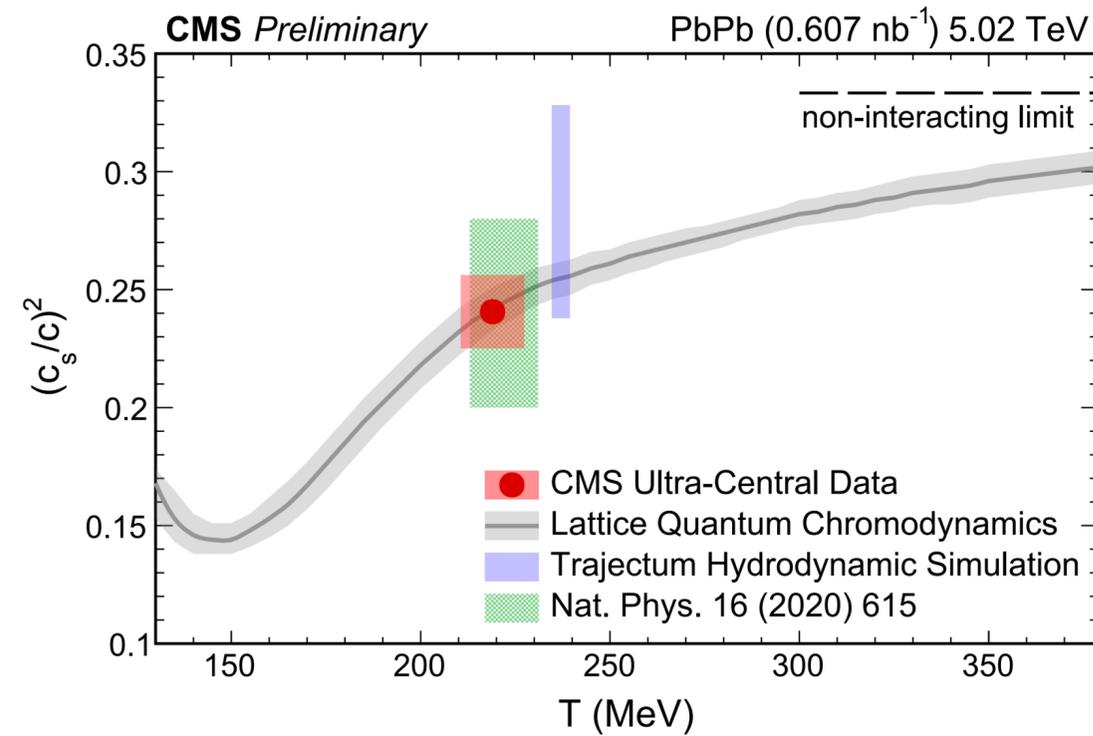
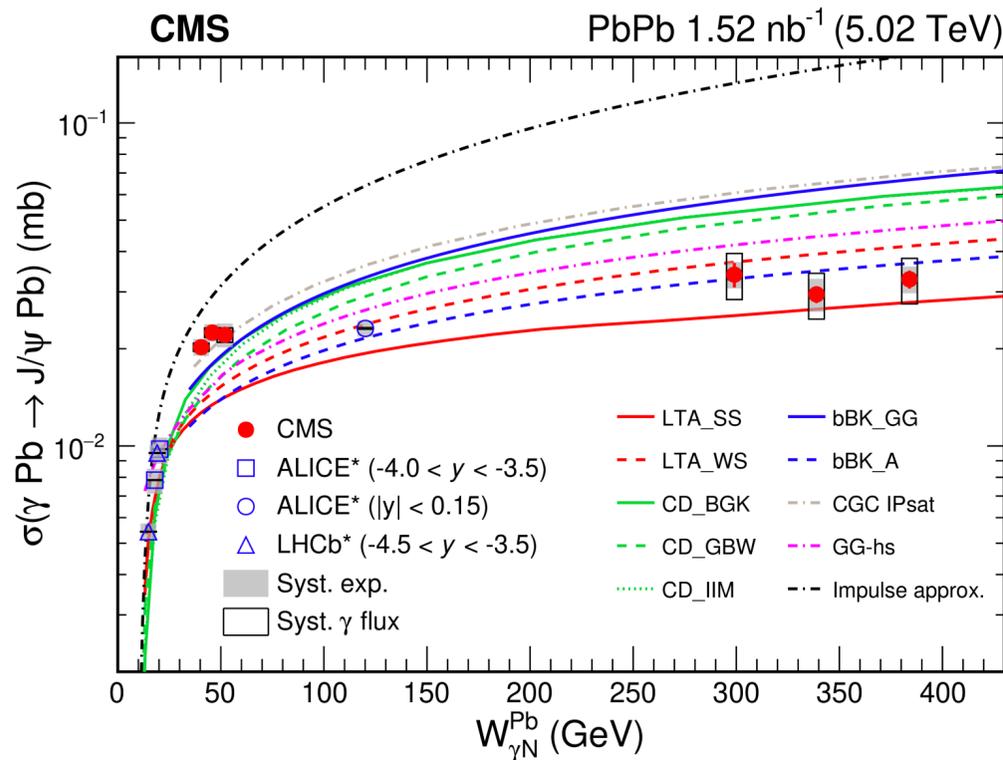
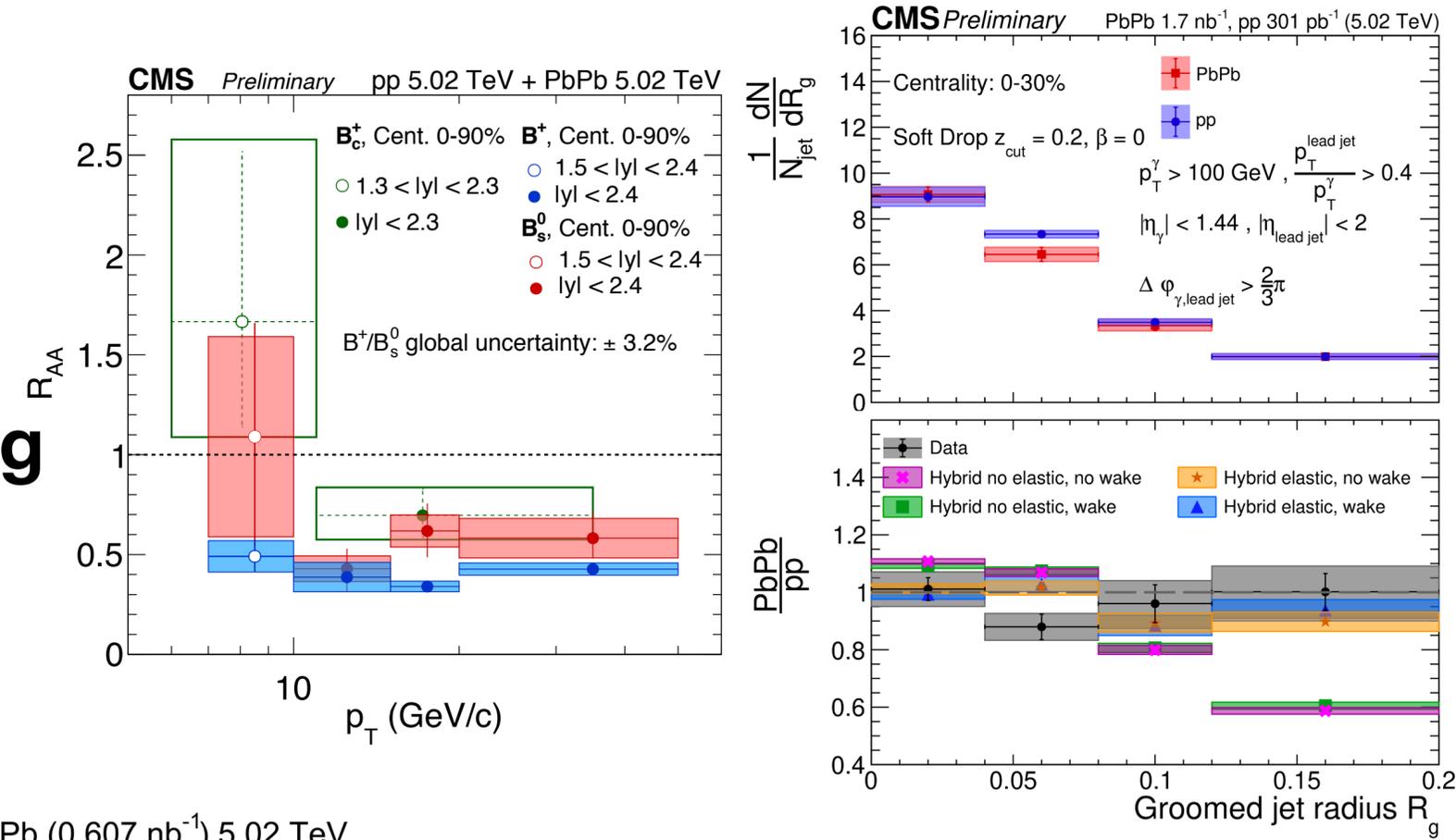
CERN-LHCC-2021-018  
MTD - DP-2021/037

**Zhenyu Ye's talk**  
**Wed. 11:00, Ballroom D**



# Summary

- Studies of initial state using UPCs
- Examination of QGP degrees of freedom
- Studies on hadronization and heavy flavor
- Interplay of selection effects and quenching
- Hint of collectivity in individual jets
- CMS's first Run 3 HI result



# Talks and Posters

Talk	Speaker	Time	Room
<u>Studies of heavy quark dynamics using B mesons with the CMS experiment</u>	Tzu-An Sheng	Tuesday, 8:50	<b>D</b>
<u>Measurements of charm quark production and hadronization at CMS</u>	Soumik Chandra	Tuesday, 9:30	<b>D</b>
<u>Elliptic anisotropy measurement of the <math>f_0(980)</math> in pPb collisions and determination of its quark content by CMS</u>	An Gu	Tuesday, 9:30	<b>B</b>
<u>Revealing the medium-recoil effect with high-pT Z boson tagged underlying event distribution in PbPb collisions at CMS</u>	Pin-Chun Chou	Tuesday, 9:50	<b>F</b>
<u>Measurements of the jet axis decorrelation and the groomed jet radius with photon-jet events in PbPb and pp collisions</u>	Molly Taylor	Tuesday, 10:10	<b>F</b>
<u>Particle production and collective flow measurements with CMS Run 3 PbPb data</u>	Jing Wang	Tuesday, 11:20	<b>C</b>
<u>Net-charge fluctuations and balance functions with the CMS experiment</u>	Shengquan Tuo	Tuesday, 11:40	<b>B</b>
<u>Small-system properties as measured with jets and high-pT azimuthal anisotropy by the CMS experiment</u>	Dener De Souza Lemos	Tuesday, 14:50	<b>C</b>
<u>Probing small-x nuclear gluonic structure via coherent charmonium photoproduction in UPCs at CMS</u>	Jiazhao Lin	Wednesday, 8:30	<b>A</b>
<u>New opportunities for understanding high-density QCD matter with CMS Phase II detector at the High-Luminosity LHC era</u>	Zhenyu Ye	Wednesday, 11:00	<b>D</b>
<u>Resolving medium properties using high-pT jets with jet and in-jet correlations in PbPb collisions at 5.02 TeV with CMS</u>	Jussi Viinikainen	Wednesday, 11:20	<b>F</b>
<u>Search for long-range QCD collective phenomena inside high-multiplicity jets in pp collisions with the CMS experiment</u>	Parker Gardner	Wednesday, 12:00	<b>C</b>
<u>Extracting the speed of sound in the strongly-interacting matter created in relativistic nuclear collisions with CMS</u>	Cesar Bernardes	Wednesday, 15:40	<b>C</b>
<u>Measurements of prompt and nonprompt D0 mesons production and collective flow with CMS at 5.02 TeV</u>	Milan Stojanovic	Wednesday, 16:30	<b>D</b>
<u>Studies of the relative suppression of excited quarkonium states with CMS</u>	Ota Kukral	Wednesday, 17:10	<b>D</b>
Poster	Speaker		
<u>Observation of the gamma gamma to tau tau production in PbPb collisions with the CMS experiment</u>	Matthew Nickel	66	