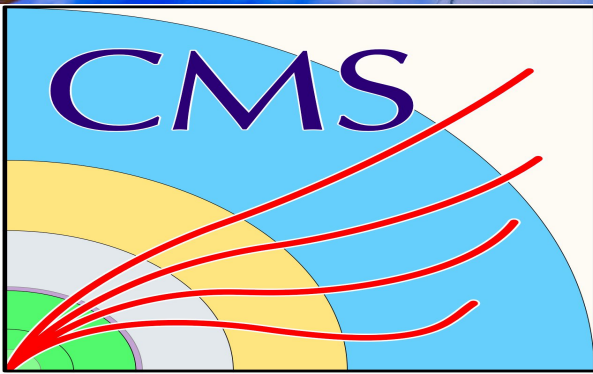


# Insights on b-mesons from CMS in pp, pPb, and PbPb Collisions

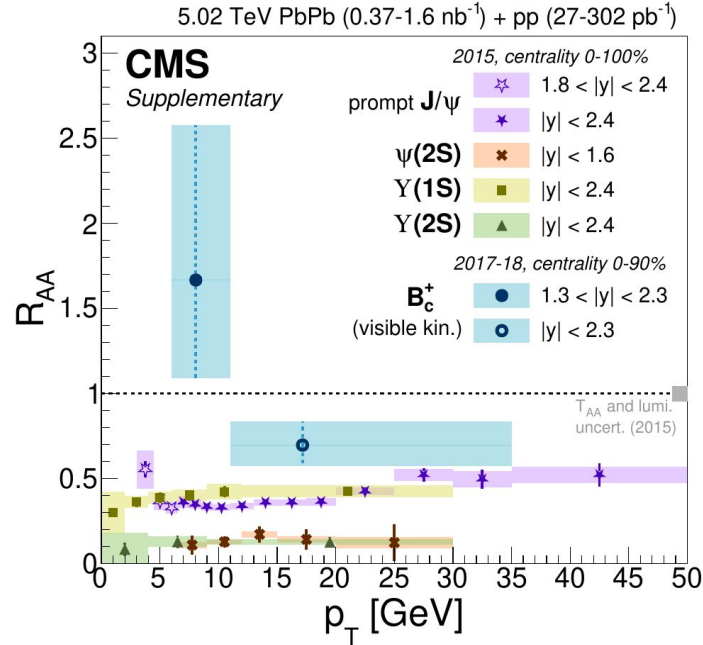
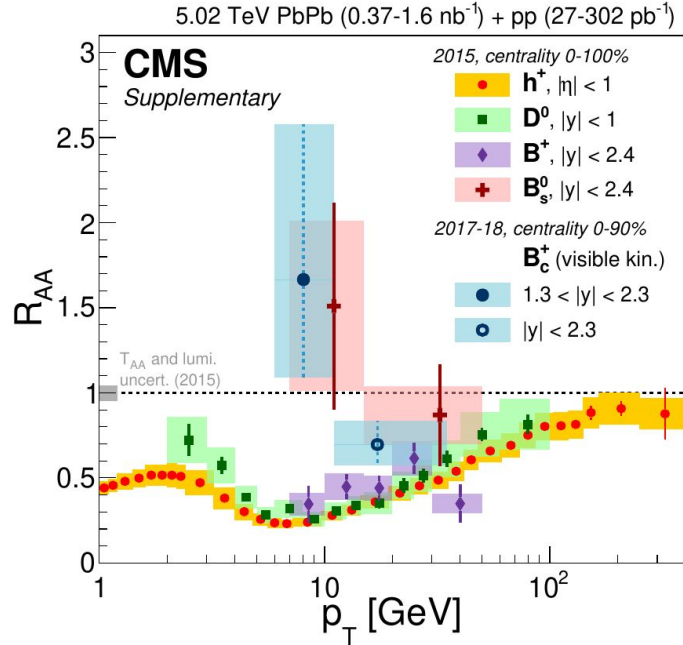


**Jhovanny Andres Mejia Guisao**

On behalf of the CMS collaboration

SQM 2024: The 21st International Conference on Strangeness in  
Quark Matter, 3-7 Jun 2024, Strasbourg (France).

# Nuclear modification of Bc Vs. open and hidden heavy flavor mesons

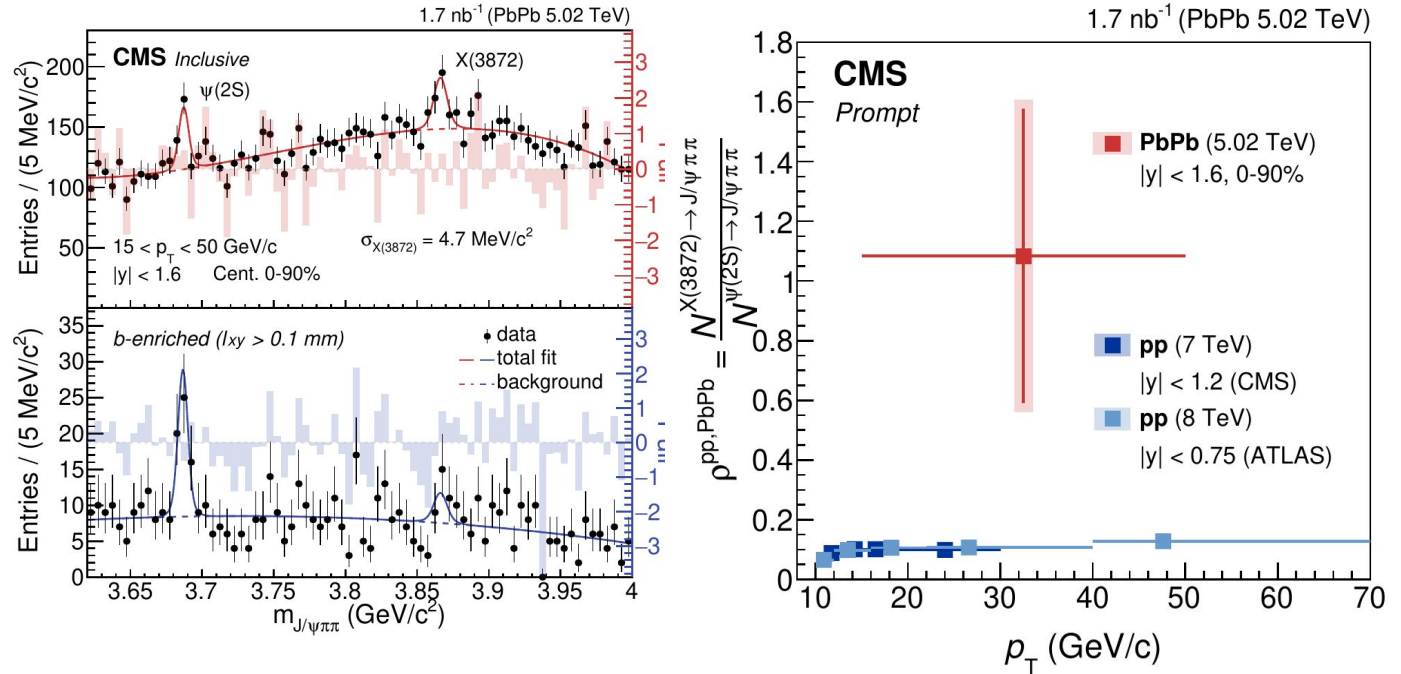


**CMS-HIN-20-004,**  
**Phys. Rev. Lett. 128 (2022) 252301**

- ★ **Bc meson charm quark and a bottom antiquark.**
- ★ **Intermediate in size and binding energy between the  $J/\psi$  and  $Y(1S)$  mesons.**
- ★ **Bc less suppressed than quarkonia and most of the open heavy-flavor mesons.**

# Evidence for X(3872) in PbPb collisions and studies of its prompt production at 5.02 TeV

**CMS-HIN-19-005,**  
**Phys. Rev. Lett. 128, (2022) 032001**



- Clearly, this is not a b-meson.
- However, heavy quarks, are invaluable tools for studying QGP.
- The formation of the QGP could enhance or suppress the production of the X(3872) particle.

**CMS-PAS-HIN-22-001**

# **Measurement of the $B^+$ differential cross section as a function of transverse momentum and multiplicity in pPb collisions at 8.16 TeV**

Recent observations of QGP-like phenomena in small collision systems, such as pp and pPb collisions, challenge our understanding of high-energy heavy ion physics.

# Fraction of the full event sample for each multiplicity class

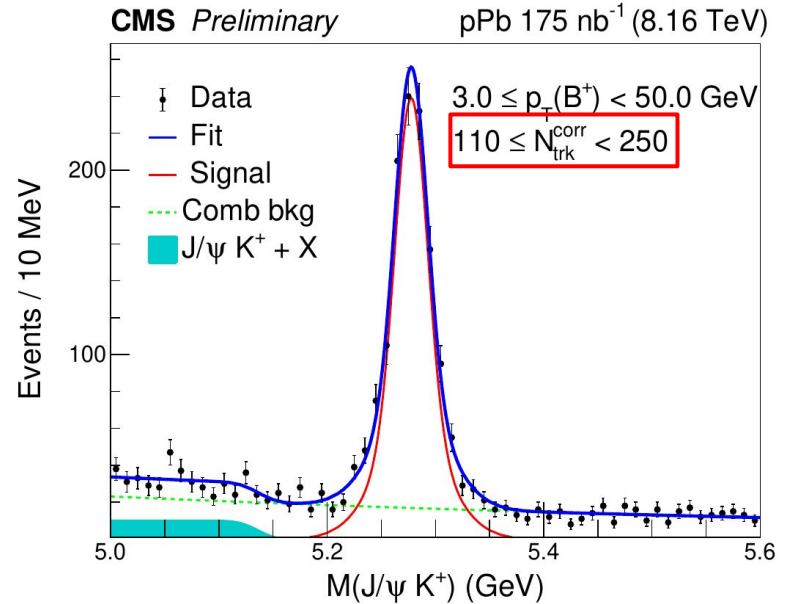
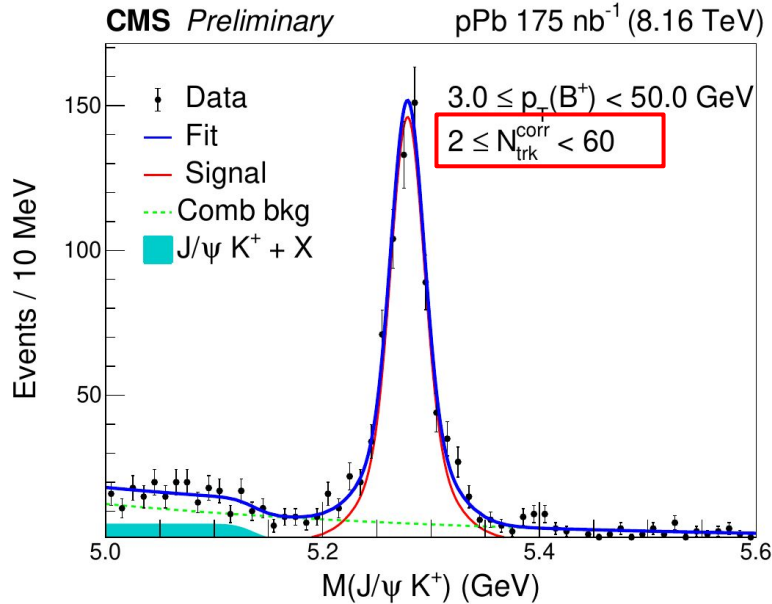
Multiplicity class	Fraction (%)	$\langle N_{\text{trk}} \rangle$	$\langle N_{\text{trk}}^{\text{corrected}} \rangle$
$2 \leq N_{\text{trk}} < 250$	100.0	88	$102 \pm 2$
$2 \leq N_{\text{trk}} < 60$	27.5	42	$49 \pm 1$
$60 \leq N_{\text{trk}} < 85$	24.1	72	$84 \pm 2$
$85 \leq N_{\text{trk}} < 110$	20.6	96	$112 \pm 3$
$110 \leq N_{\text{trk}} < 250$	27.7	140	$163 \pm 4$

charged particles with  $|\mathbf{y}| < 2.4$  and  $p_{\text{T}} > 0.4$  GeV.

First  $B^+$  meson studies at different charged particle multiplicities in pPb collisions.

CMS-PAS-HIN-22-001

# Invariant mass distribution



- ❑ **B<sup>+</sup> yields are obtained by unbinned maximum likelihood.**
- ❑ **Results are obtained for 6 pT bins and 4 multiplicity classes.**

**CMS-PAS-HIN-22-001**

# The differential cross sections

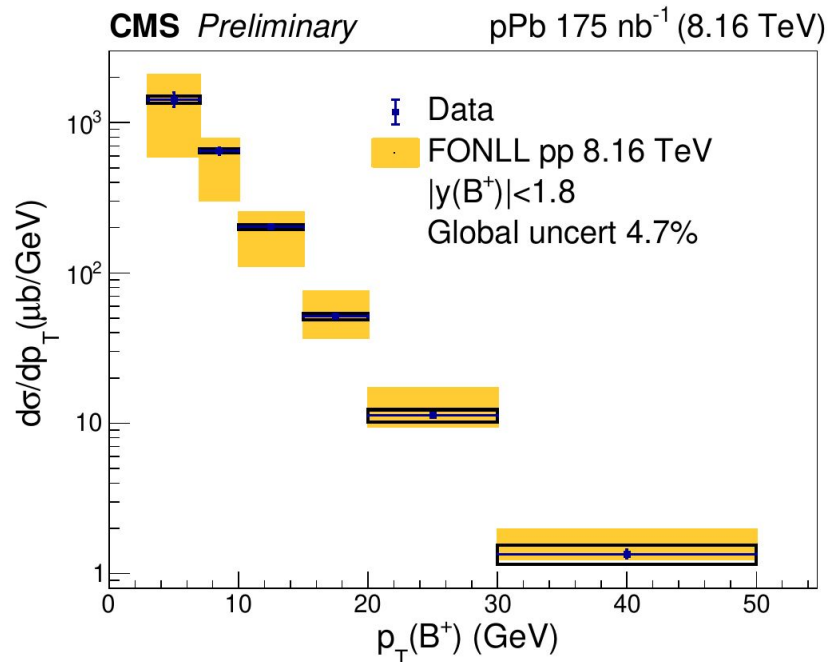
$$\frac{d\sigma}{dp_T} = \frac{1}{2} \frac{1}{\Delta p_T} \frac{N(p_T)}{\epsilon \mathcal{BL}}$$

$N(p_T)$  is the measured yield

$\beta$  product world-average branching fractions

$\epsilon$  is the total efficiency

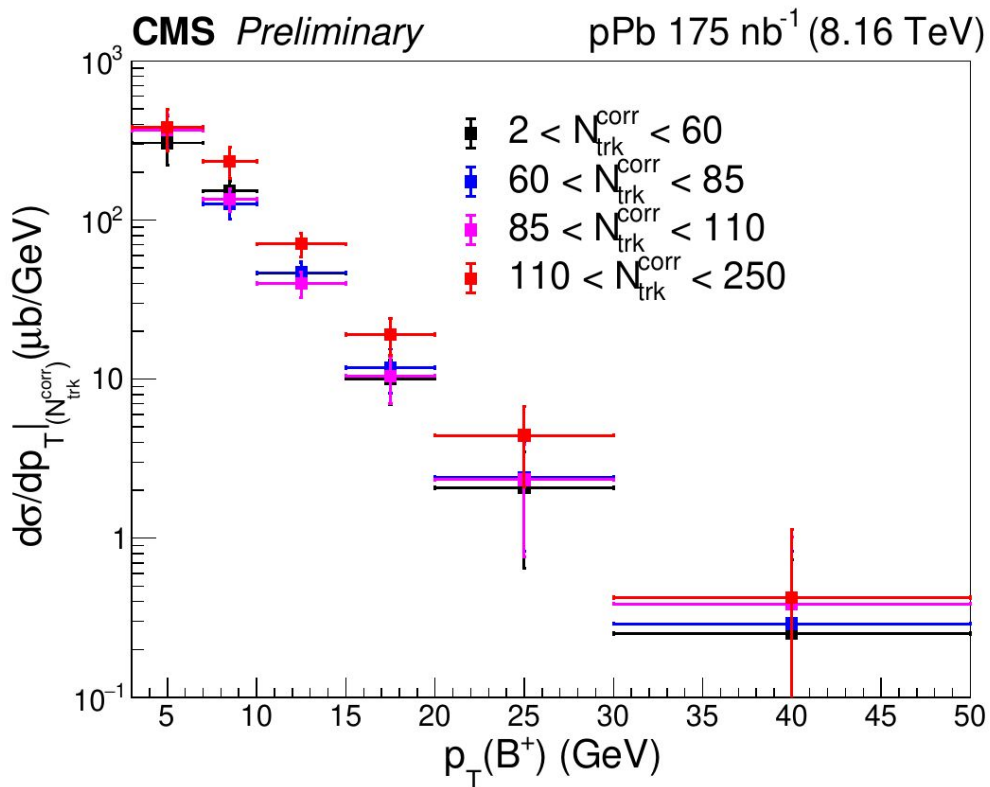
$\mathcal{L}$  is the integrated luminosity



The theoretical predictions of FONLL are in good agreement with the measurements

CMS-PAS-HIN-22-001

# B+ cross section Vs. multiplicity



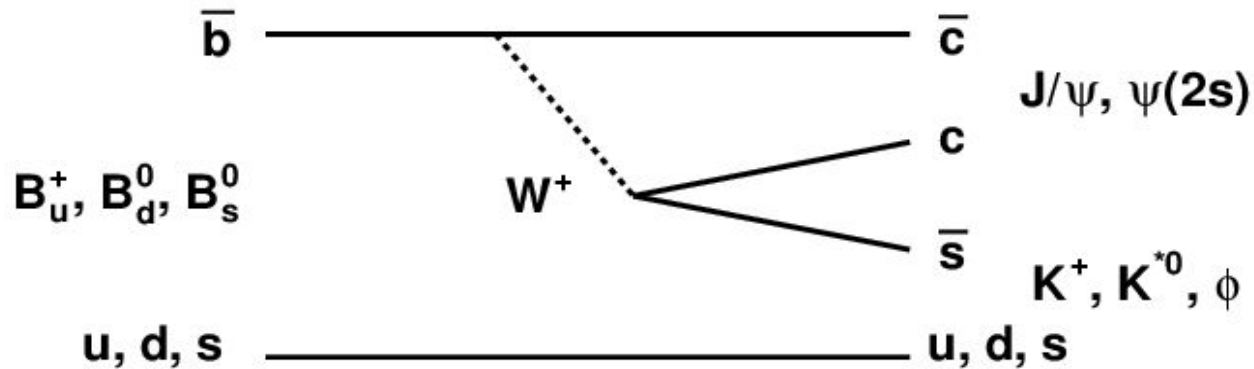
- cross section Vs. multiplicity.
- for the first time in pPb collisions.
- Total uncertainties.

**CMS-PAS-HIN-22-001**



CMS-PAS-HIN-21-014

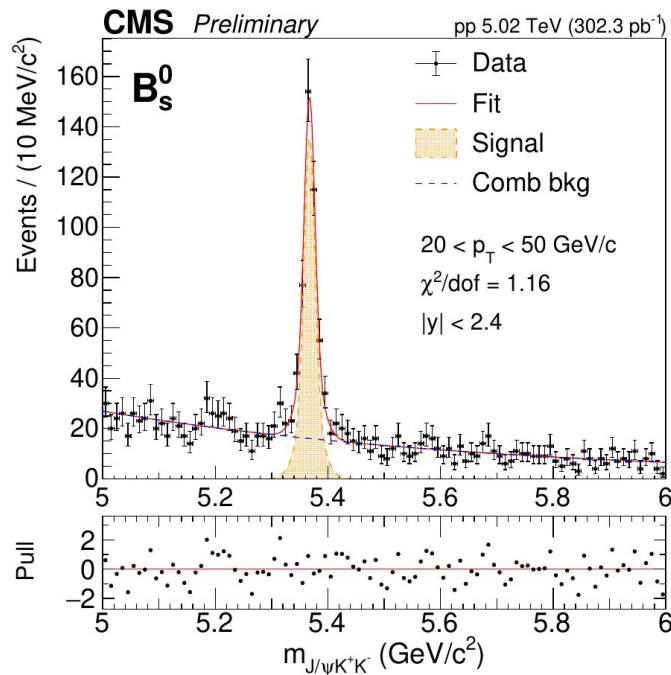
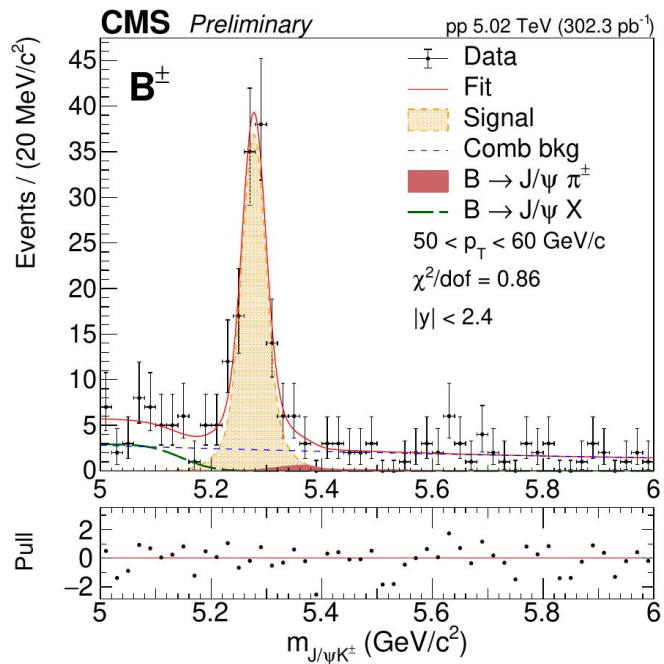
# Constraining bottom quark energy loss and hadronization with $B^+$ and $B_0^s$ nuclear modification factors in pp and PbPb collisions at 5.02 TeV with CMS



# $B^+$ and $B_0^s$ Invariant mass distribution

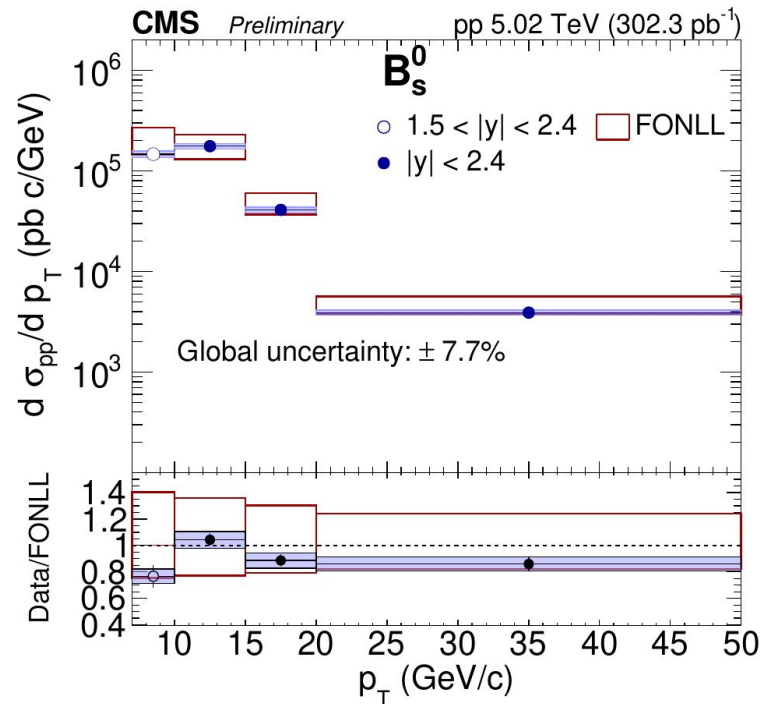
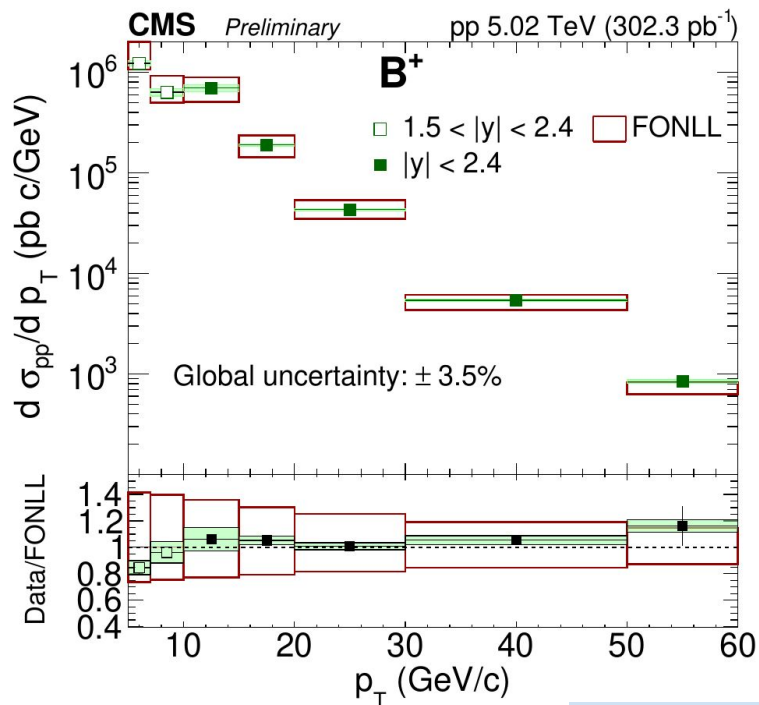
- pp invariant mass Vs Pt
- Rapidity interval  $|y| < 2.4$ .

- $B^+$  and  $B_0^s$  signal extraction.
- Figure, highest pT bins.



**CMS-PAS-HIN-21-014**

# The differential cross section for B meson production in pp collisions

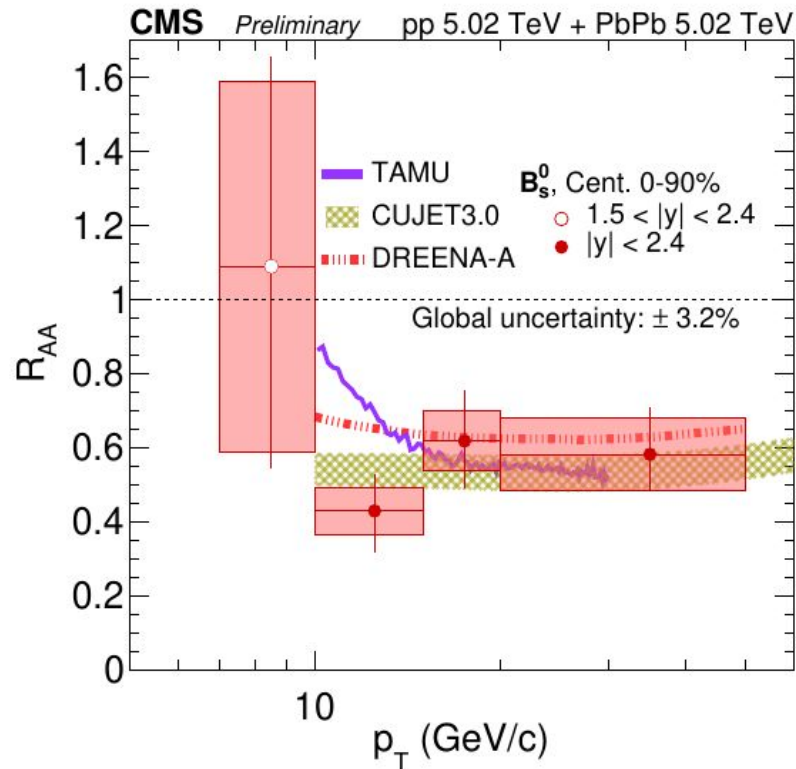
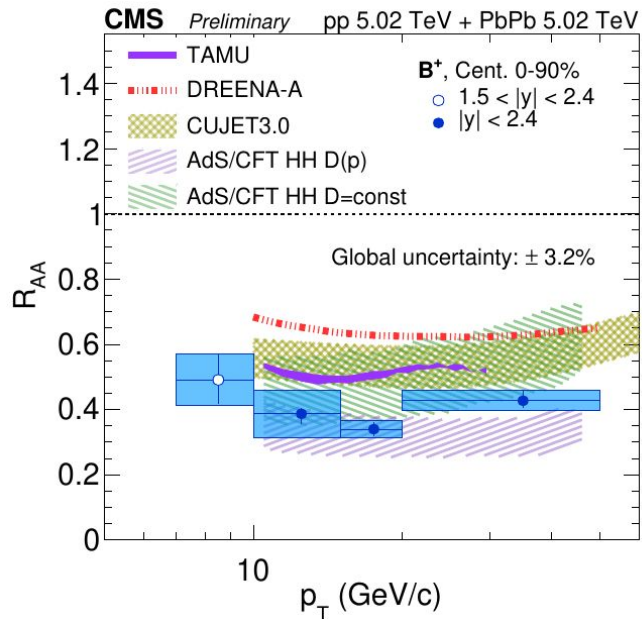


**FONLL consistent with data**

**CMS-PAS-HIN-21-014**

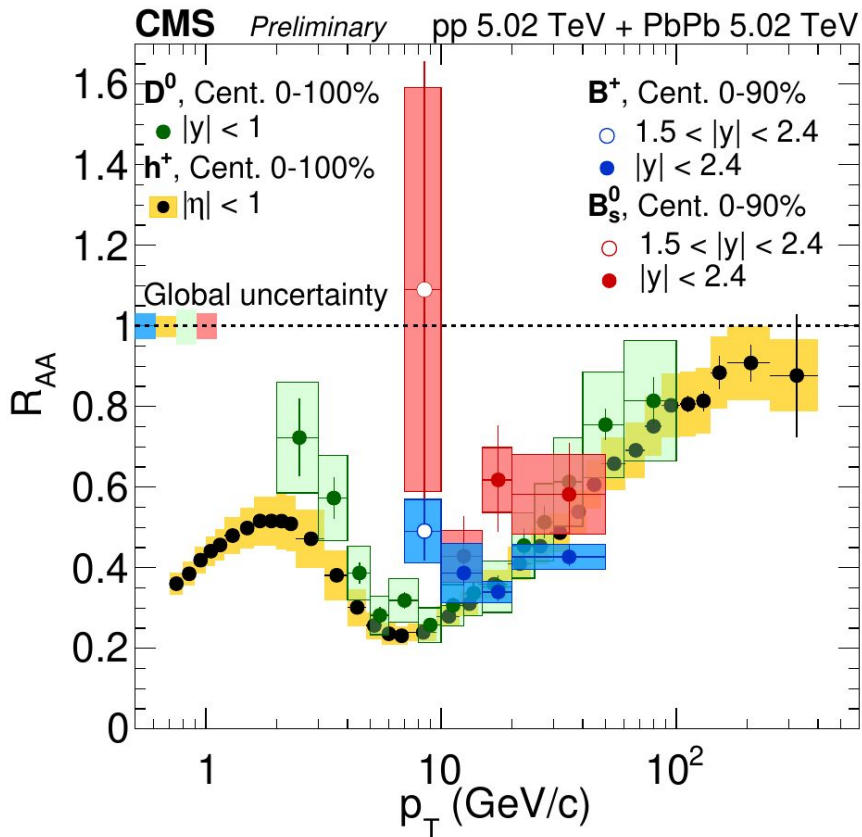
# The nuclear modification factors of $B^+$ and $B_s^0$

$$R_{AA}(p_T) = \frac{1}{T_{AA}} \frac{dN_{PbPb}^{B^\pm, B_s^0}}{dp_T} / \frac{d\sigma_{pp}^{B^\pm, B_s^0}}{dp_T}$$



**CMS-PAS-HIN-21-014**

# The $B^+$ and $B_0^s$ RAA Vs. RAA of charged particles and D0 mesons

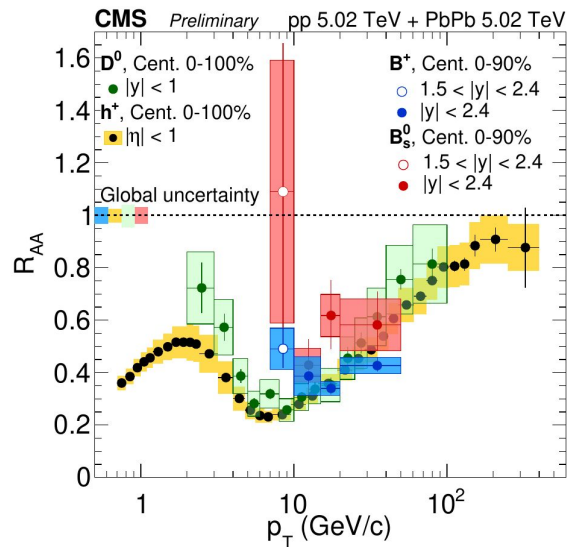
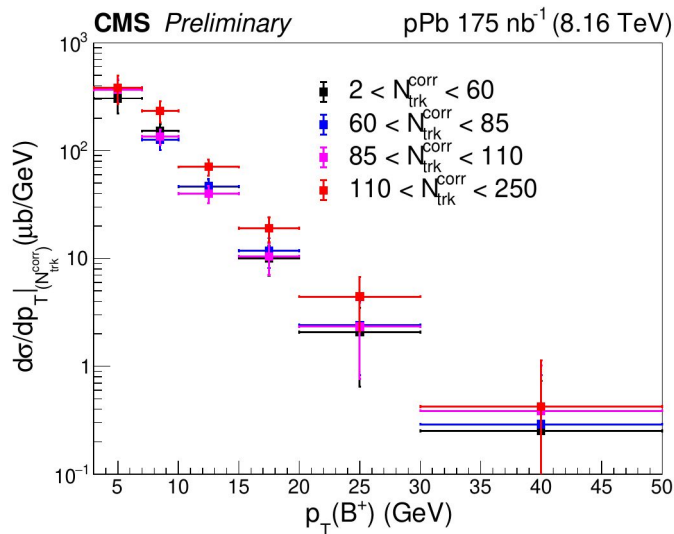


- $B^+$  meson
  - values consistent with charged particles and D0 mesons for  $p_T > 10$  GeV
  - Lower  $p_T$  reduced level of suppression
- $B_0^s$  meson
  - Hints at a larger RAA than that of  $B^+$



**CMS-PAS-HIN-21-014**

# Summary



- Inclusive B<sup>+</sup> meson differential cross section in pPb at 8.16 TeV.
- Measurement agreement with FONLL predictions.
- Cross section on multiplicity classes measured for the first time in pPb collisions.

- Cross sections of B<sup>+</sup> and B<sub>s</sub> mesons in pp at 5.02 TeV.
- Well-described by FONLL calculations.
- RAA of B<sup>+</sup> are significantly lower than unity at p<sub>T</sub>>10 GeV, while at low p<sub>T</sub>, the B<sub>s</sub><sup>0</sup> hints at a larger RAA than that of B<sup>+</sup>.

THANKS for listening!



# Backup slides



## Summary of systematic uncertainties for the $B^+$ cross section as a function of $p_T$ (pPb)

$p_T$ (GeV)	$d\sigma/dp_T$ ( $\mu b \text{ GeV}^{-1}$ )	stat. error ( $\mu b \text{ GeV}^{-1}$ )	sys. error ( $\mu b \text{ GeV}^{-1}$ )
3 – 7	1422.79	157.19	75.82
7 – 10	647.10	38.61	17.67
10 – 15	202.10	7.24	7.04
15 – 20	51.41	2.02	2.54
20 – 30	11.25	0.47	1.03
30 – 50	1.35	0.09	0.20

## Summary of systematic uncertainties for the $B_s^0$ cross section as a function of $p_T$ (pp)

Source	$p_T$ (GeV/c)			
	7–10	10–15	15–20	20–50
Hadron tracking efficiency	4.8	4.8	4.8	4.8
Track selection	0.65	0.2	2.7	0.78
Data-MC discrepancy	3.7	1.9	1.7	1.5
$p_T$ shape	0.045	0.015	0.0037	0.0024
PDF variation	3.6	2	2.9	3.2
Muon efficiency	0.46	0.38	0.35	0.45
Bkg contamination of efficiency	1.1	2.3	0.28	0.38
Sum	7.2	6	6.5	6
Luminosity $\mathcal{L}$				1.9
Branching fractions				7.5
Sum (global systematics)				7.7

## Summary of systematic uncertainties for the $B^+$ cross section as a function of $p_T$ (pp)

Source	$p_T$ (GeV/c)							
	5–7	7–10	10–15	15–20	20–30	30–50	50–60	20–50
Hadron tracking efficiency	2.4	2.4	2.4	2.4	2.4	2.4	2.4	2.4
Track selection	1.8	0.31	0.43	0.37	0.27	0.052	1.6	0.24
Data-MC discrepancy	4.7	7.2	7.2	0.98	0.87	0.92	0.83	0.84
$p_T$ shape	0.02	0.0054	0.013	0.0095	0.0047	0.0032	0.018	0.0031
PDF variation	2.1	1.4	3.2	1.1	0.69	1.8	2.4	0.57
Muon efficiency	0.47	0.45	0.37	0.36	0.43	0.64	0.64	0.47
Bkg contamination of efficiency	1.5	2.8	0.84	0.41	0.46	0.18	1.1	0.41
Sum	6.2	8.3	8.3	2.9	2.7	3.2	4.1	2.7
Luminosity $\mathcal{L}$				1.9				
Branching fractions				2.9				
Sum (global systematics)				3.5				