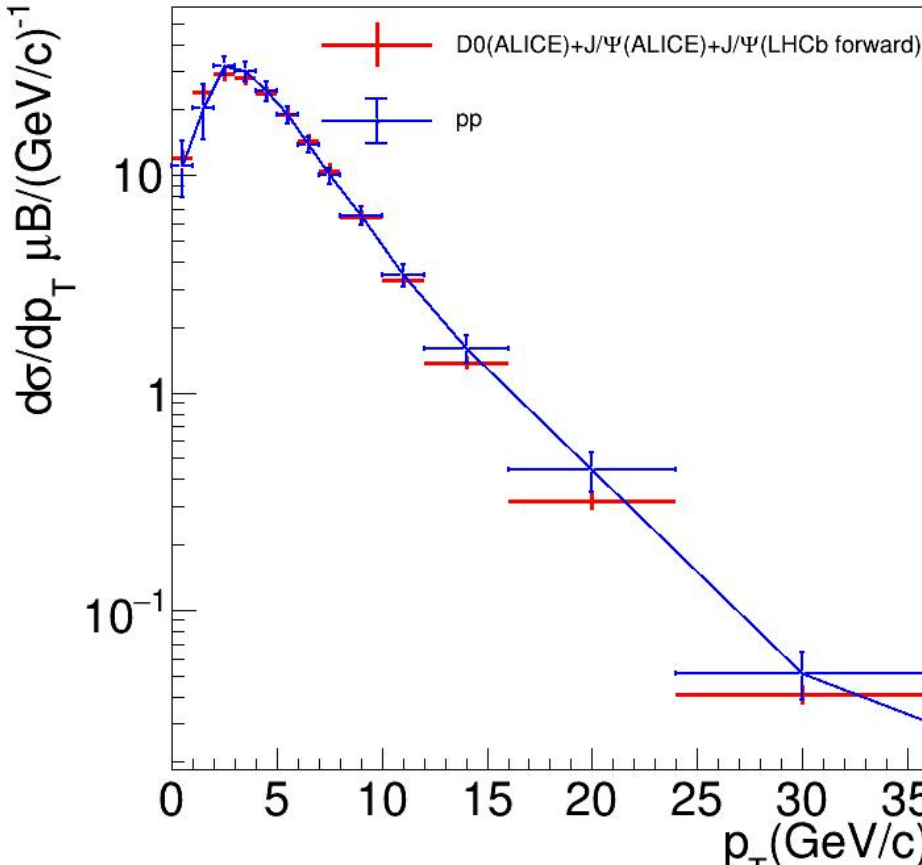
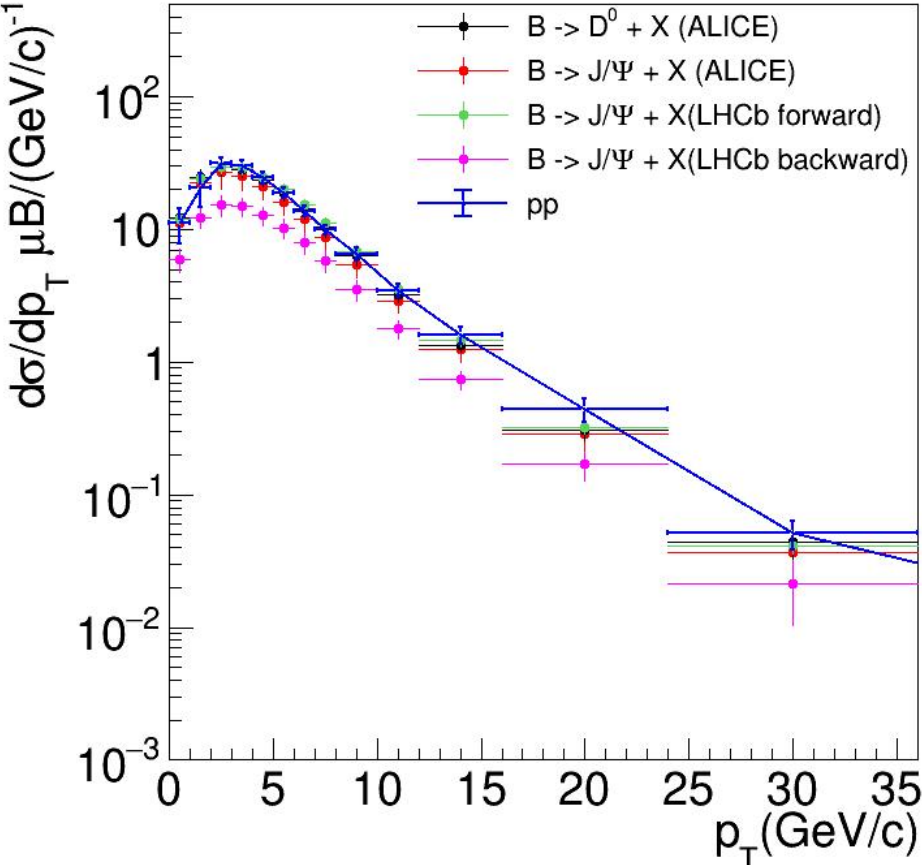


Beauty hadron production in p-Pb collisions with Bayesian Unfolding

Liang Dong

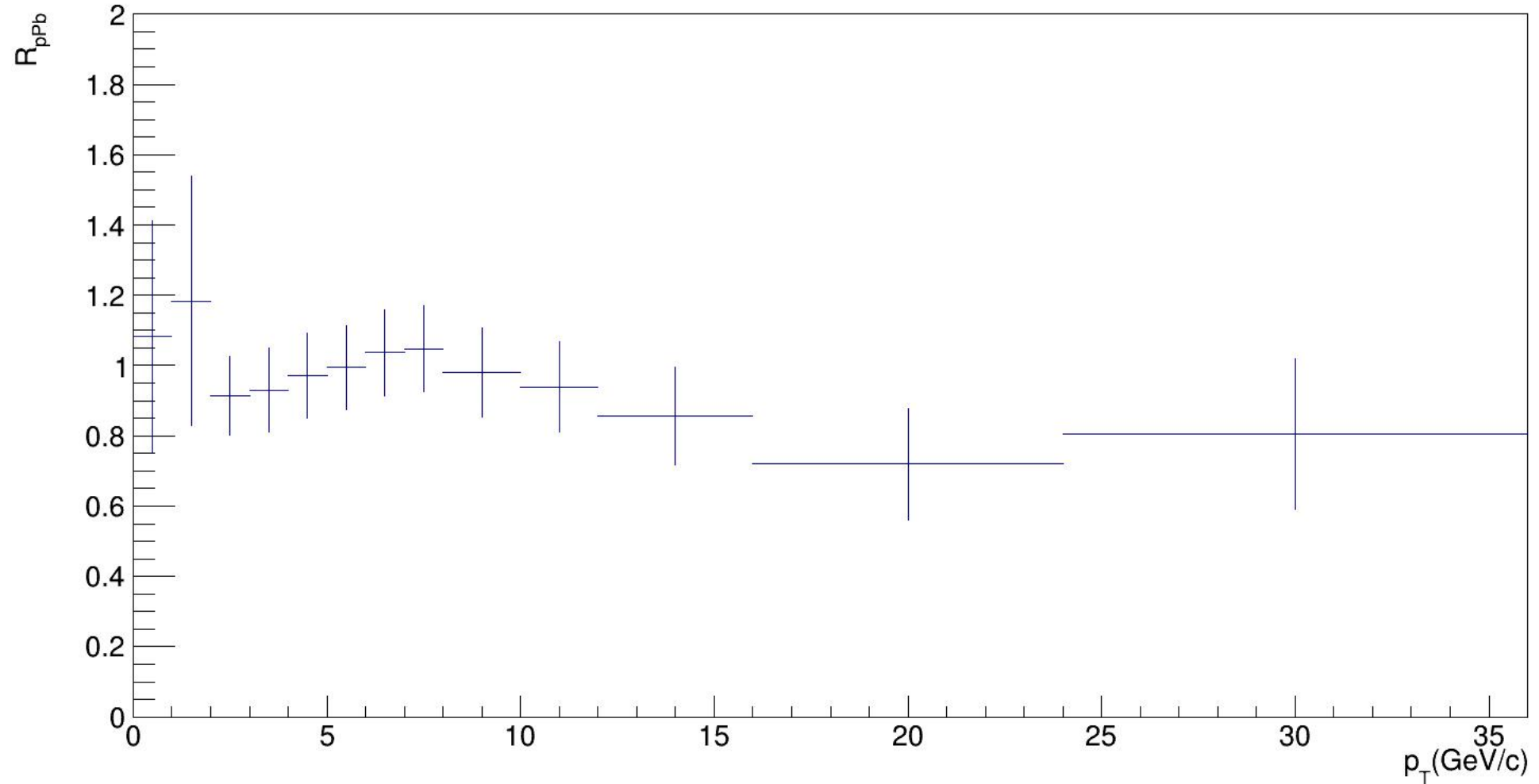
2024/12/03

The result of pPb



The result of Bayesian Unfolding based on experimental data of backward non-prompt J/ψ from LHCb is not consistent with the other three.

$$\sigma_{ratio} = \sqrt{\frac{\sigma_{pPb}^2}{N_{pp}^2} + \frac{\sigma_{pp}^2 N_{pPb}^2}{N_{pp}^4}}$$



1. The error of low P_T range is large.
2. The central value of the data points for $P_T > 8$ GeV/c has dropped.

$d\sigma/dy(|y|<0.5)$ is 29.9172
error is 2.28823

$$\frac{d\sigma_{b\bar{b}}}{dy} \Big|_{|y_b|<0.5}^{\sqrt{s}=5.02\text{TeV}} = 29.6 \pm 2.4 \mu\text{b},$$

$$R_{pPb} = 1.01 \pm 0.11$$

The $b\bar{b}$ production cross section $d\sigma/dy$ at midrapidity almost the same between pp collision and pPb collision.

The total $b\bar{b}$ production cross section $\sigma_{b\bar{b}}$ in the full phase space in pp collisions at $\sqrt{s} = 5.02$ TeV and $\sqrt{s} = 13$ TeV are:

Total cross section combined is 188.605
Total cross section combined error is 22.2657

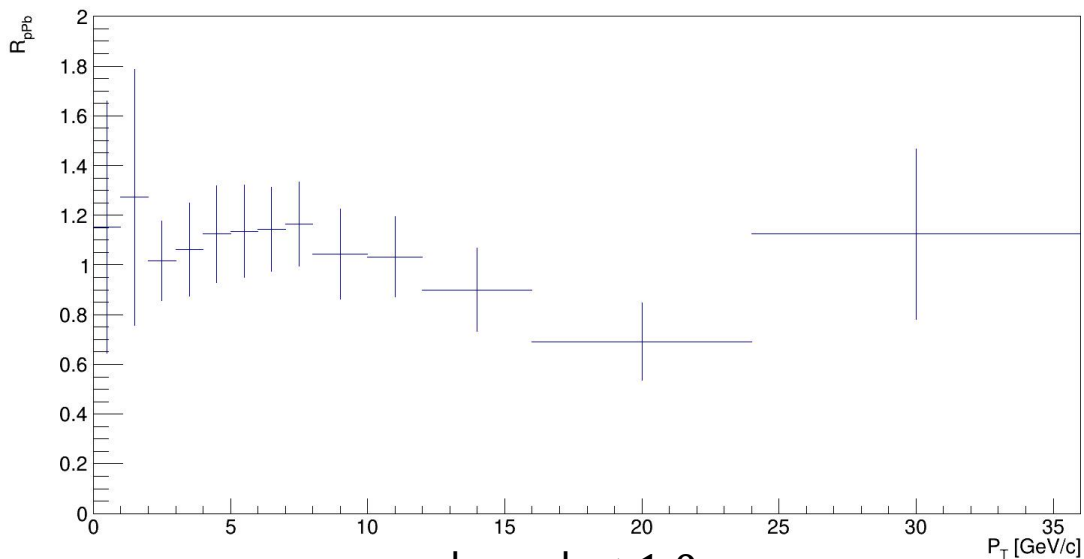
$$\sigma_{b\bar{b}}^{\sqrt{s}=5.02\text{TeV}} = 191.3 \pm 16.2 \mu\text{b},$$

$$\sigma_{b\bar{b}}^{\sqrt{s}=13\text{TeV}} = 499.8 \pm 39.6 \mu\text{b}$$

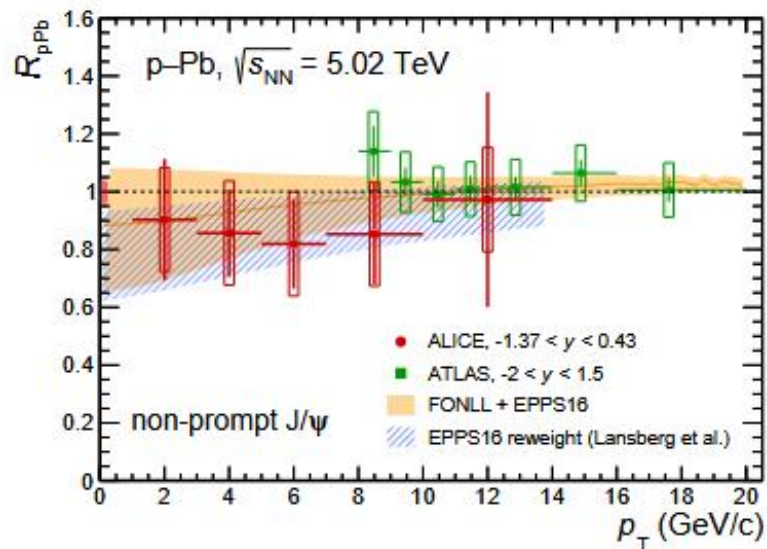
$$R_{pPb} = 0.99 \pm 0.14$$

Compared with pp collision, the total cross section is almost equal, but slightly lower.

R_{pPb} as a function of P_T within a certain rapidity range.



$pp: |y_{cms}| < 1.0$
 $pPb: |y_{lab}| < 1.0$



Non-prompt D^0 and D^+ average p_T -differential R_{pPb} in $p\text{-Pb}$ collisions at $\sqrt{s_{NN}} = 5.02 \text{ TeV}$ in the rapidity interval $-0.96 < y_{cms} < -0.04$.

cmenergies

5020.0

observables

RPA

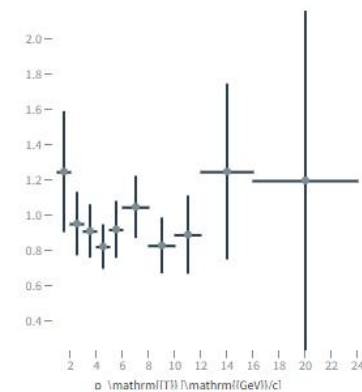
reactions

P PB --> hb --> D0 X

P PB --> hb --> D X

REACTION	P PB --> hb --> D0 X
REACTION	P PB --> hb --> D X
SQRT(S)/NUCLEON	5020.0 GEV
YRAP	-0.96 TO 0.04
p_T [GeV/c]	Average non-prompt D^0 and D^+ R_{pPb} , nuclear modification factor
1.0 - 2.0	1.2461 ± 0.27541 stat ± 0.19834 sys $\pm 4.25\%$ sys, uncertainty on luminosity
2.0 - 3.0	0.95143 ± 0.14589 stat ± 0.098157 sys $\pm 4.25\%$ sys, uncertainty on luminosity
3.0 - 4.0	0.90961 ± 0.1215 stat ± 0.08156 sys $\pm 4.25\%$ sys, uncertainty on luminosity
4.0 - 5.0	0.82146 ± 0.098998 stat ± 0.070224 sys $\pm 4.25\%$ sys, uncertainty on luminosity
5.0 - 6.0	0.91833 ± 0.13733 stat ± 0.076138 sys $\pm 4.25\%$ sys, uncertainty on luminosity
6.0 - 8.0	1.046 ± 0.13839 stat ± 0.10072 sys $\pm 4.25\%$ sys, uncertainty on luminosity
8.0 - 10.0	0.82771 ± 0.13391 stat ± 0.077285 sys $\pm 4.25\%$ sys, uncertainty on luminosity
10.0 - 12.0	0.88889 ± 0.19955 stat ± 0.089924 sys $\pm 4.25\%$ sys, uncertainty on luminosity
12.0 - 16.0	1.2469 ± 0.47319 stat ± 0.14992 sys $\pm 4.25\%$ sys, uncertainty on luminosity
16.0 - 24.0	1.1959 ± 0.93726 stat ± 0.21471 sys $\pm 4.25\%$ sys, uncertainty on luminosity

Visualize

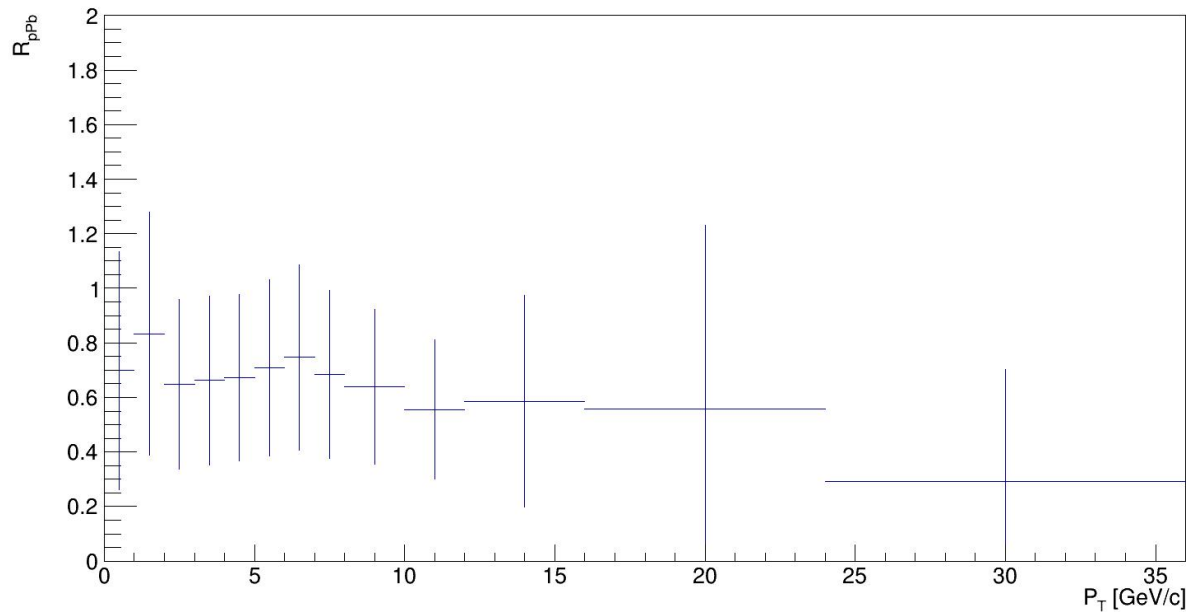


Sum errors Log Scale (X) Log Scale (Y)

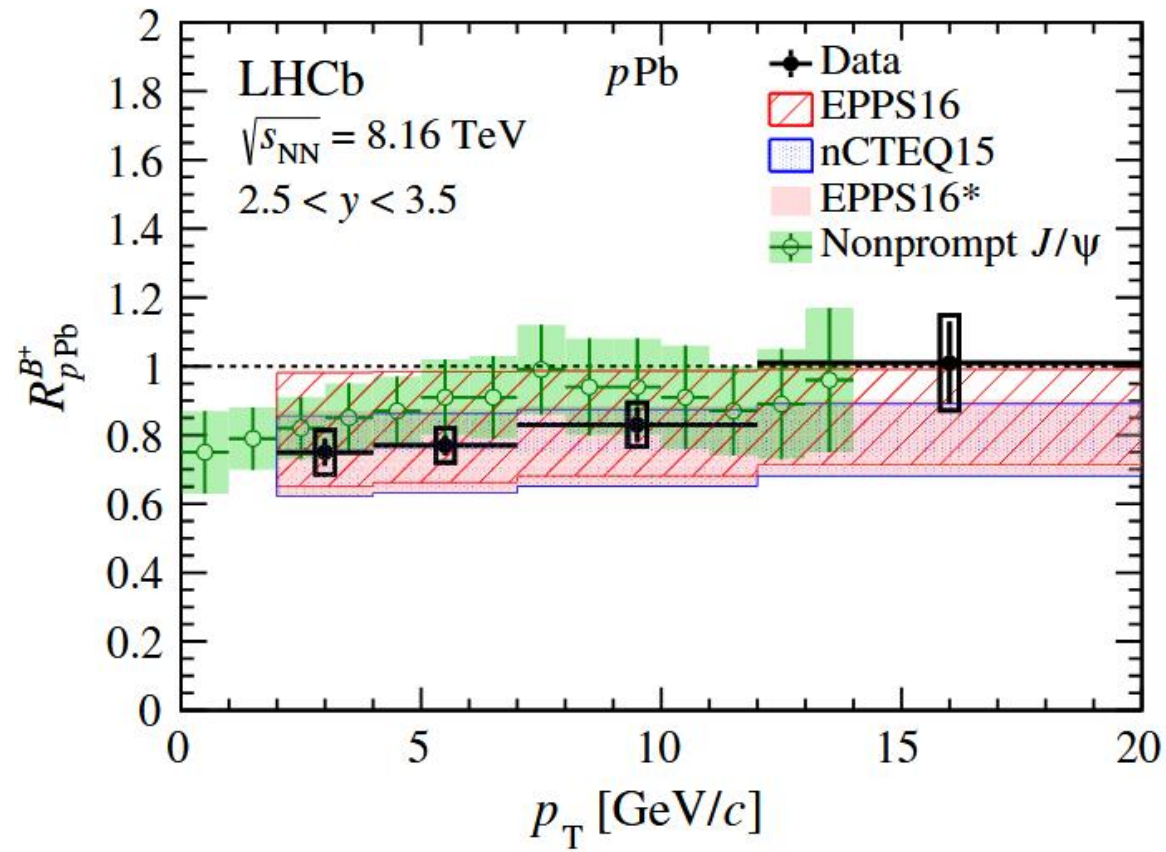
Deselect variables or hide different error bars by clicking on them.

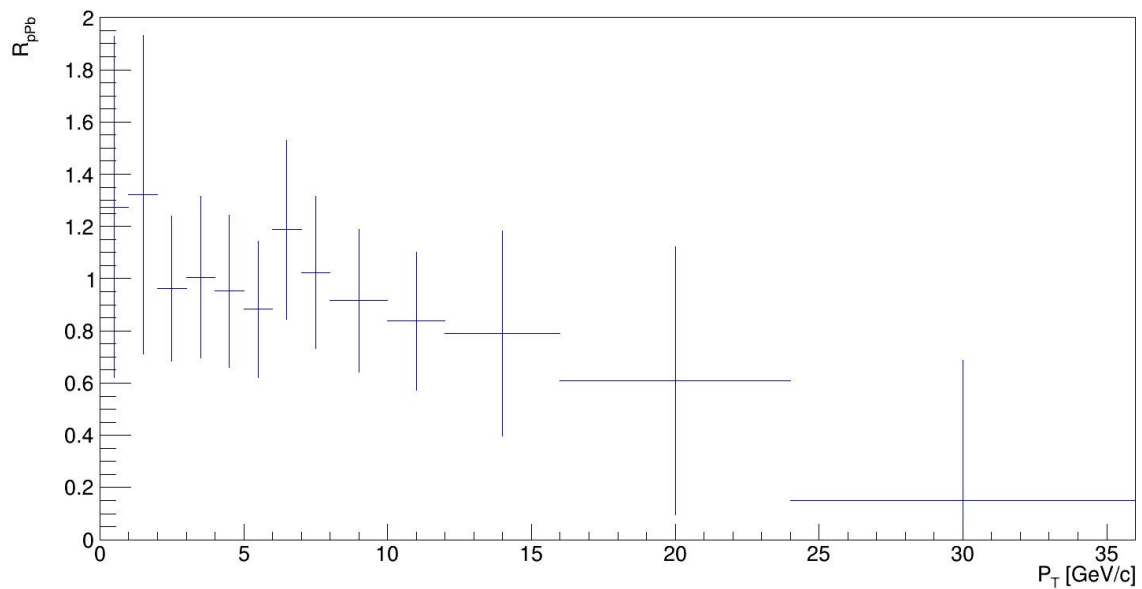
Variables

Average non-prompt D^0 and D^+ R_{pPb} , nuclear modification factor
 YRAP: -0.96 TO 0.04
 Summed error

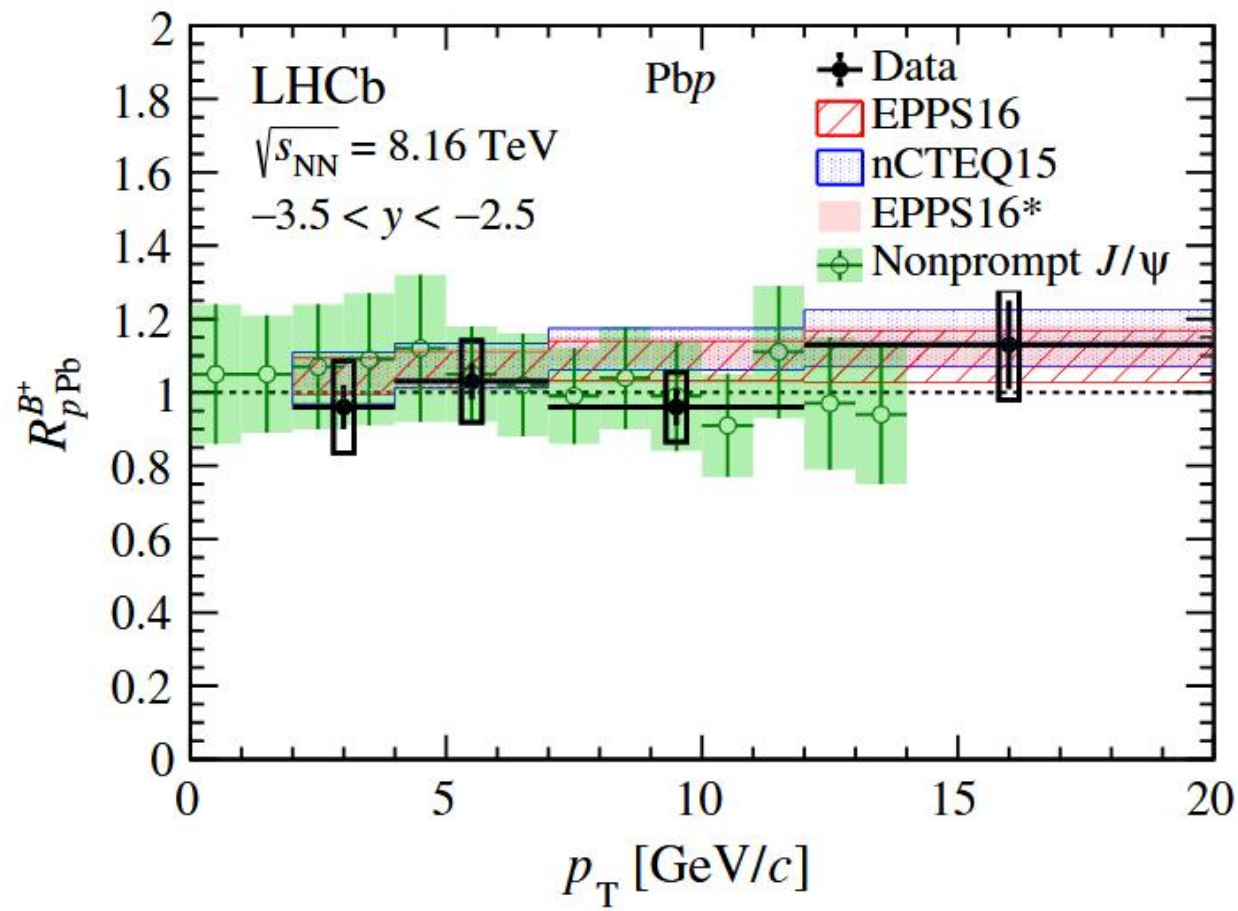


$pp: 2.5 < y_{cms} < 3.5$
 $pPb: 2.5 < y_{lab} < 3.5$

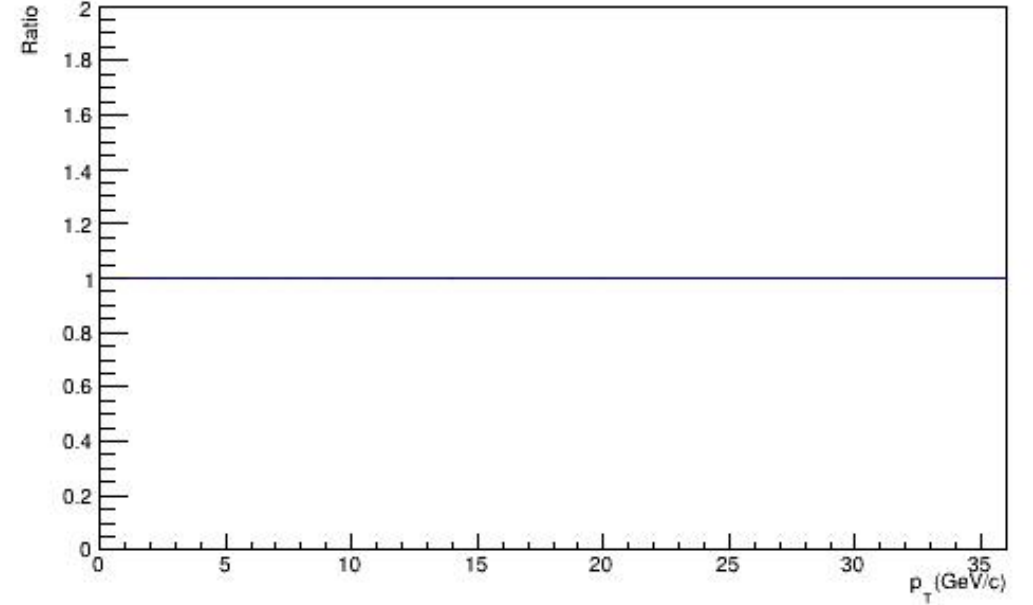
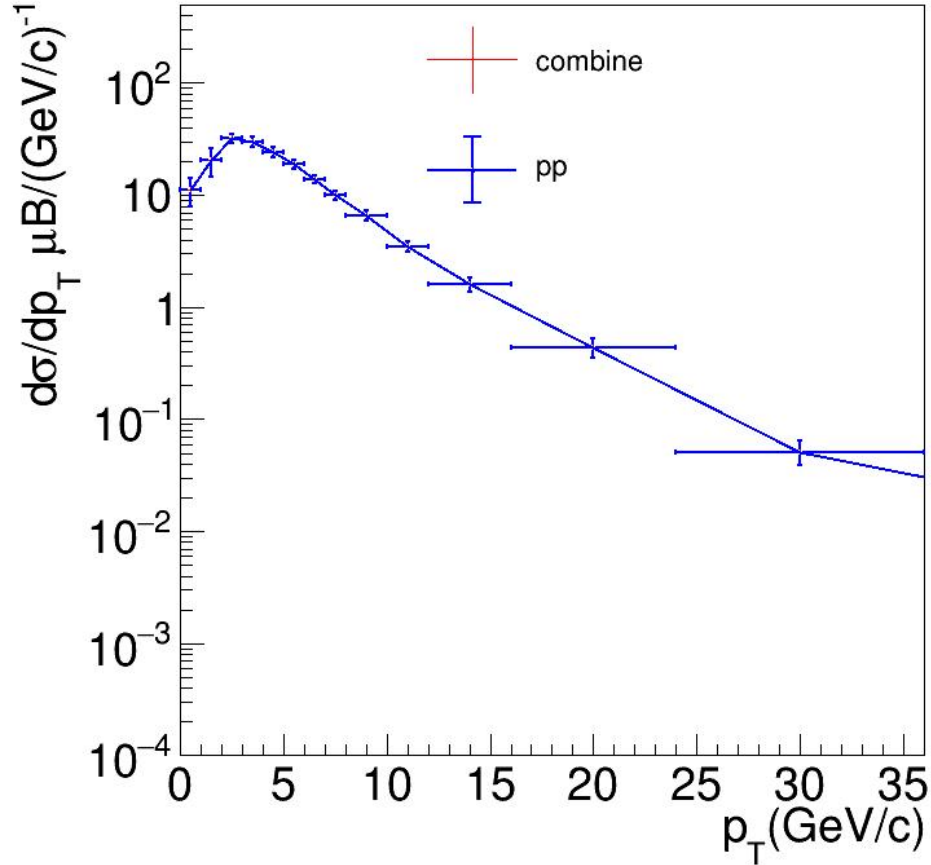




$pp: -3.5 < y_{cms} < -2.5$
 $pPb: -3.5 < y_{lab} < -2.5$



Reproduction of pp results



$$Ratio = \frac{error_{combine}}{error_{pp}}$$

$$error = \frac{|error_{combine} - error_{pp}|}{error_{pp}}$$

$$d\sigma/dp_T(\text{ave.}) = \sum_{i=(D^0, J/\psi)} w(i) d\sigma/dp_T(i)$$

$$w(i) = \frac{1/\sigma_i^2}{\sum_{i=(D^0, J/\psi)} 1/\sigma_i^2}$$

The central value and error of P_T spectrum are exactly the same


```

Measured non-prompt data stat. is: D0: 0.0914069 Jpsi: 0.00433353
Measured non-prompt data syst. is: D0: 0.105395 Jpsi: 0.0436938
Response matrix stat. is: D0: 0.000396427 Jpsi: 0.00747292
Branching ratio of h_{B} decay is: D0: 0.057947 Jpsi: 0.0862069
Bayes iterations is: D0: 0.00291001 Jpsi: 0.0137509
W/o pT extrapolation is: D0: 0.00143486 Jpsi: 0
Beauty hadron pT shape is: D0: 0.0104423 Jpsi: 0.00723097

```

Uncertainty sources	$\sqrt{s} = 5.02 \text{ TeV}$		
	D ⁰	J/ ψ	average
Measured non-prompt data stat.	9.1	0.4	2.6
Measured non-prompt data syst.	10.5	4.4	4.3
Response matrix stat.	< 0.1	0.7	0.5
Branching ratio of h _B decay	5.8	8.6	6.4
Bayes iterations	0.3	1.4	1.0
W/o p _T extrapolation	0.1	N/A	< 0.1
Beauty hadron p _T shape	1.0	0.8	0.6

The proportion of each uncertainty is basically the same.

$d\sigma/dy(|y|<0.5)$ is 29.6337
error is 2.44776

$$\frac{d\sigma_{b\bar{b}}}{dy} \Big|_{|y_b|<0.5}^{\sqrt{s}=5.02\text{TeV}} = 29.6 \pm 2.4 \mu\text{b},$$

The $b\bar{b}$ production cross section $d\sigma/dy$ at midrapidity is almost the same.

The total $b\bar{b}$ production cross section $\sigma_{b\bar{b}}$ in the full phase space in pp collisions at $\sqrt{s} = 5.02$ TeV and $\sqrt{s} = 13$ TeV are:

Total cross section combined is 191.344
Total cross section combined error is 16.1997

$$\sigma_{b\bar{b}}^{\sqrt{s}=5.02\text{TeV}} = 191.3 \pm 16.2 \mu\text{b},$$
$$\sigma_{b\bar{b}}^{\sqrt{s}=13\text{TeV}} = 499.8 \pm 39.6 \mu\text{b}$$

The total section is almost the same.