[HIN-14-009]
Re-approval aftermath

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(Korea University)

lab meeting
5th August 2016

Re-approval homework

- 1) Discrepancy between p_T plot(S21) and rapidity plot(S22)
  - S21 : was correctly calculated
  - S22 : We correct for pile-up rejection (~4%) in case of pPb,
    but this was also applied to pp by a bug in the macro -> Now fixed

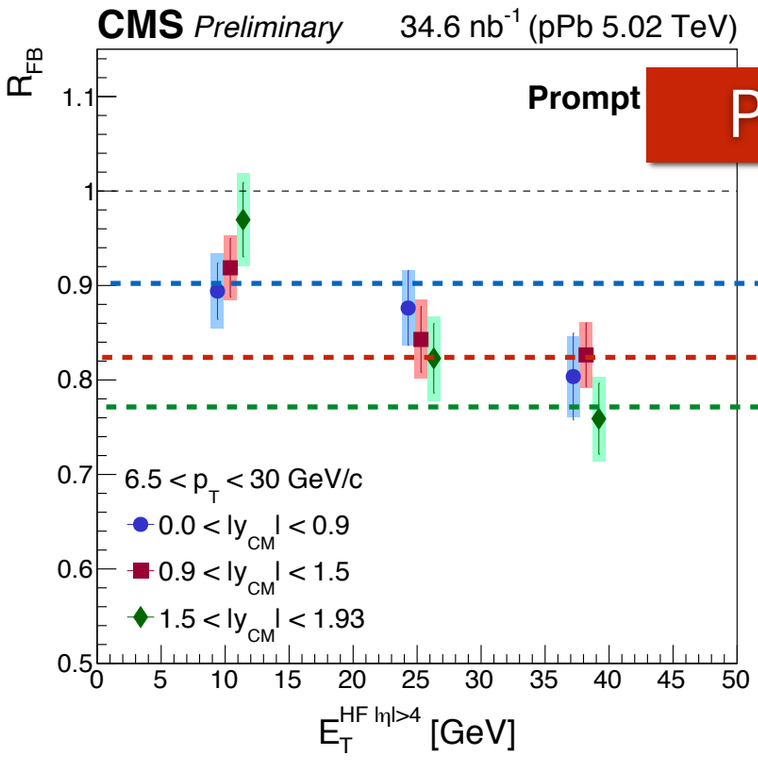
- 2) Propagation of uncertainties when combining bins -> fixed

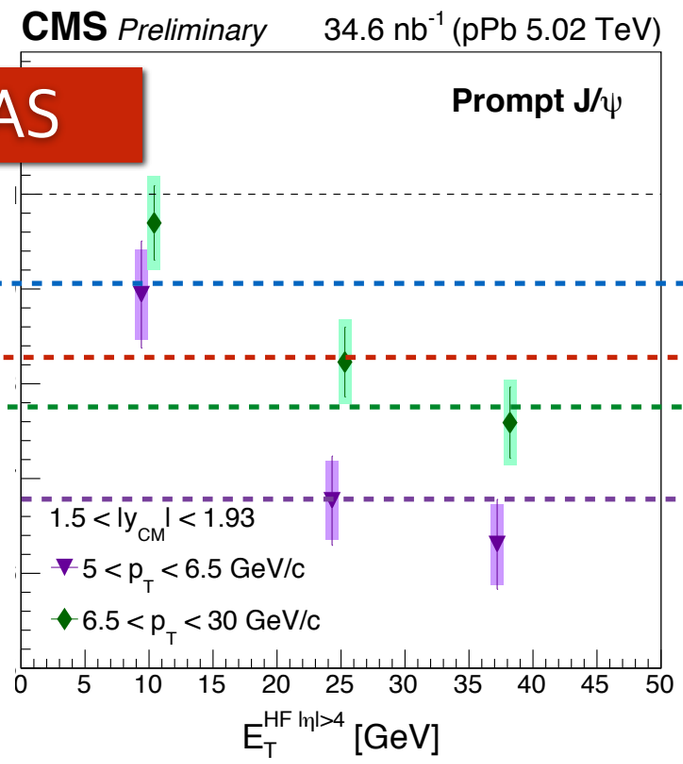
- 3) Plot style
  - Non-zero suppressed plots -> Done (all plots have common y-axes [0, 1.8])
  - Remove triangle points -> Done
  - Non-homework, but my preference : (extend x-axis and include bin width)

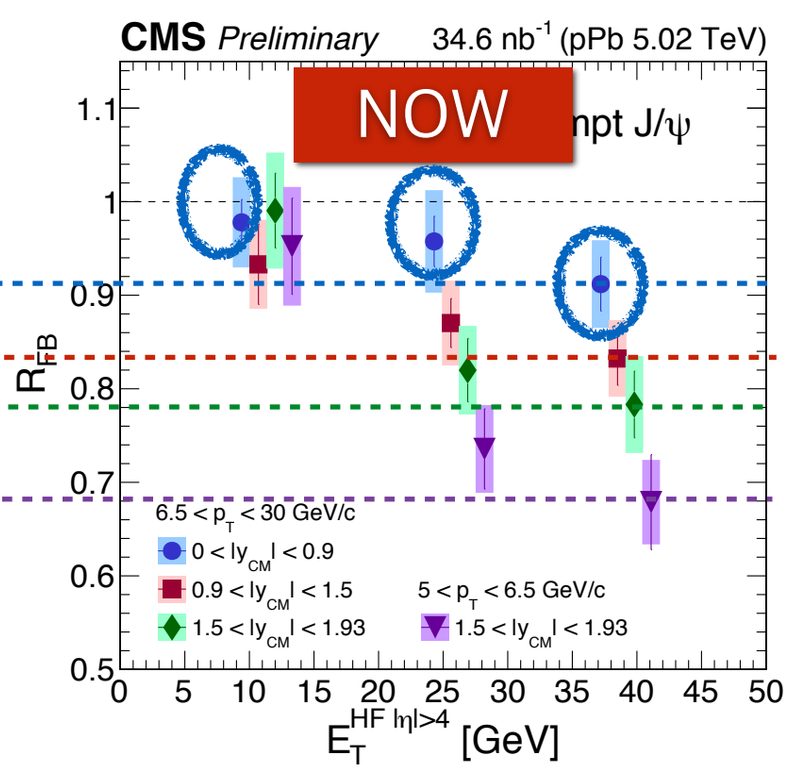
- 1) and 2) enter only in rapidity dependence
- Twiki : https://twiki.cern.ch/twiki/bin/view/CMS/HIN14009CommentsReapproval

Left two item (1)

- 1) Step-by-step comparison for R_{FB} vs E_T, as done for R_{FB} vs p_T
  - This will take more time due to the several iteration of whole analysis (acceptance, efficiency, fit, etc) : plan by this Friday
  - BUT, the difference is expected to be mainly coming from lifetime error cuts, because moved points on R_{FB} vs E_T are the same kinematic bins with the moved ones on R_{FB} vs P_T (blue shift up for the "whole" E_T bins)
  - Also, results are separated in two in case of PAS, which can cause misleading







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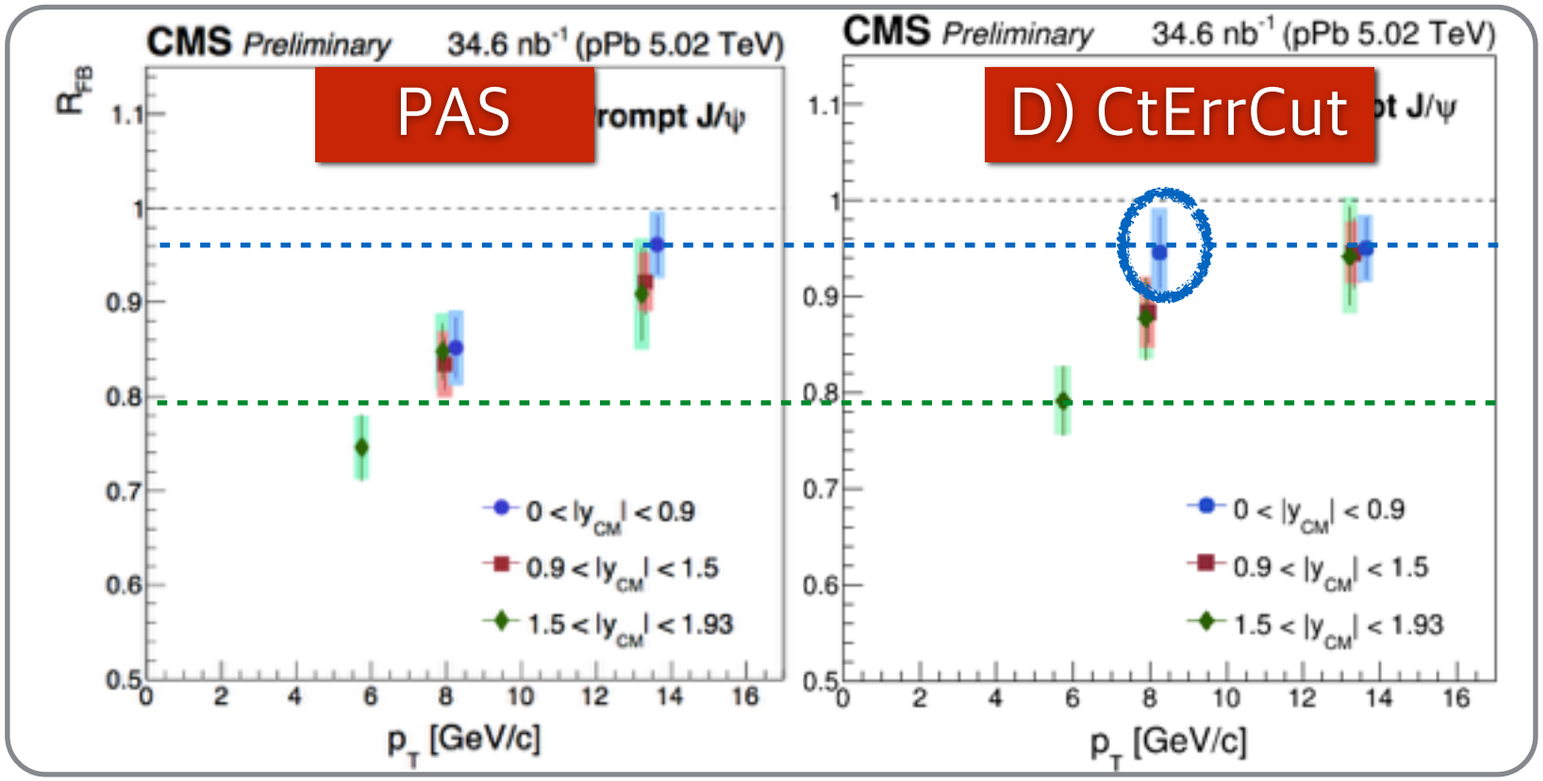
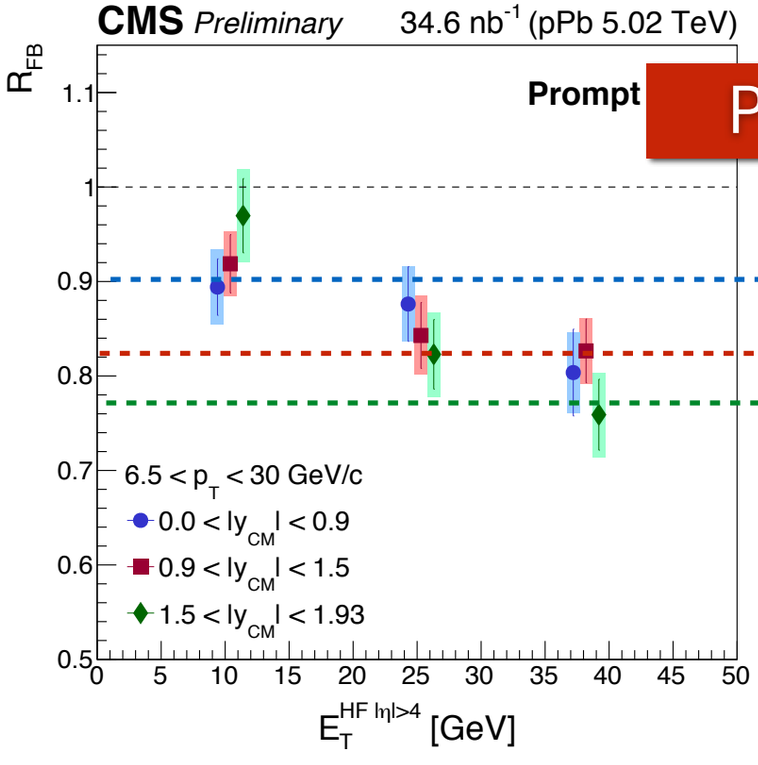
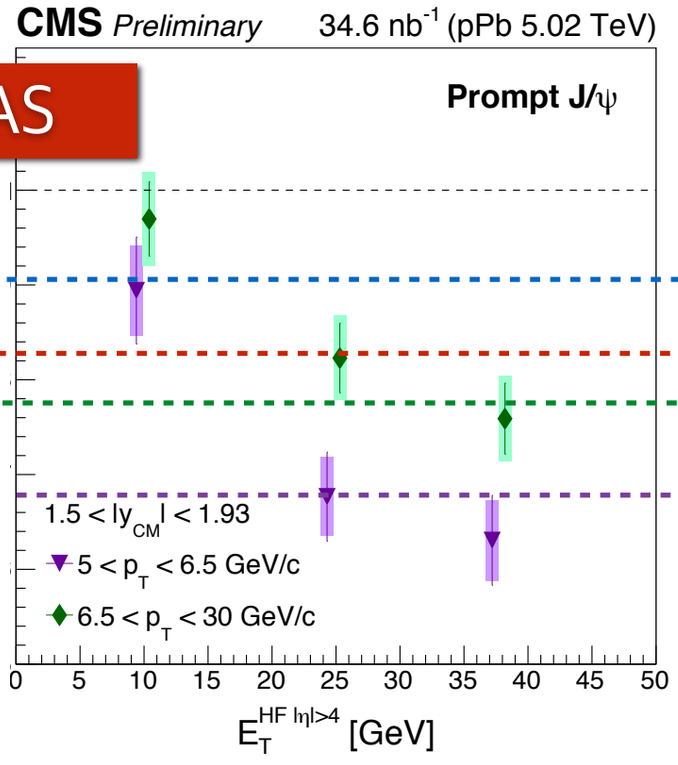
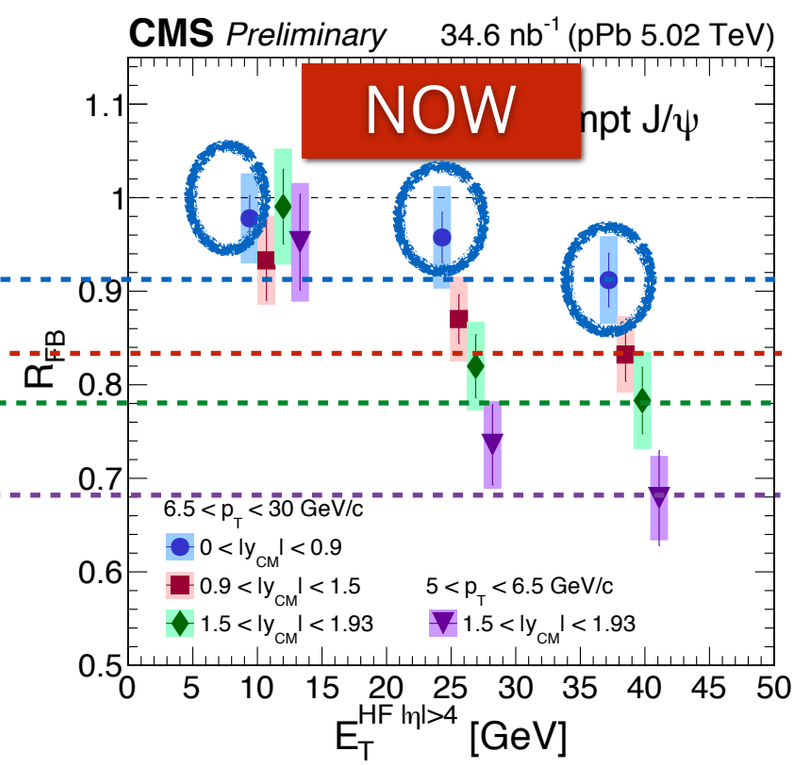






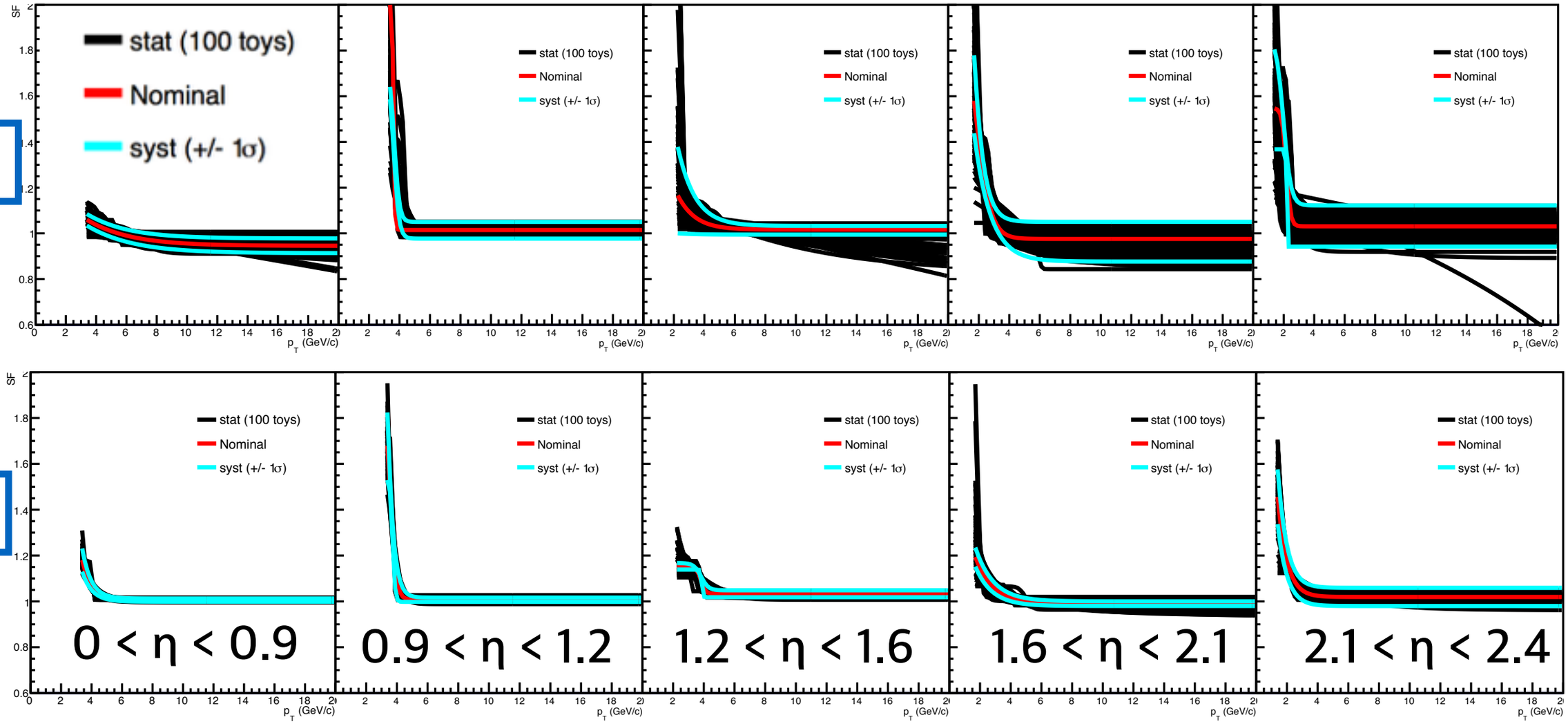


Left two item (2)

- 2) pp TNP should be finalized
  - Kisoo is on it + active communication with YS, KYO and Camelia

pp

pPb

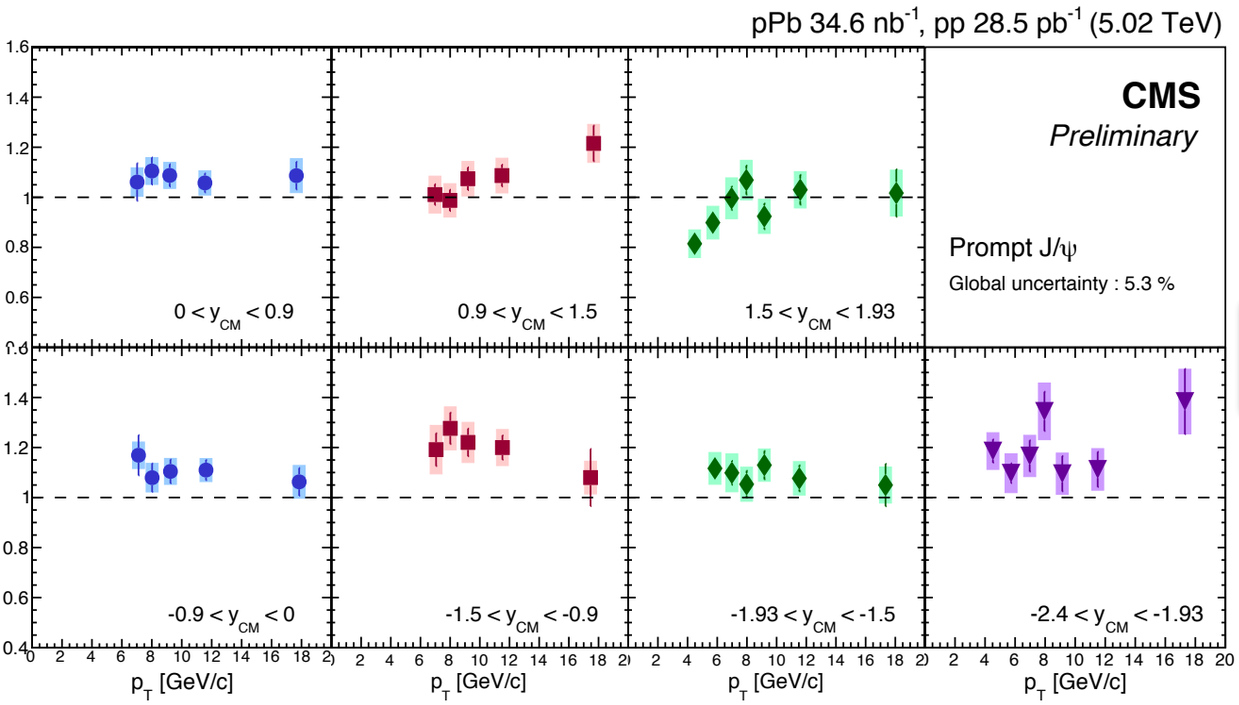


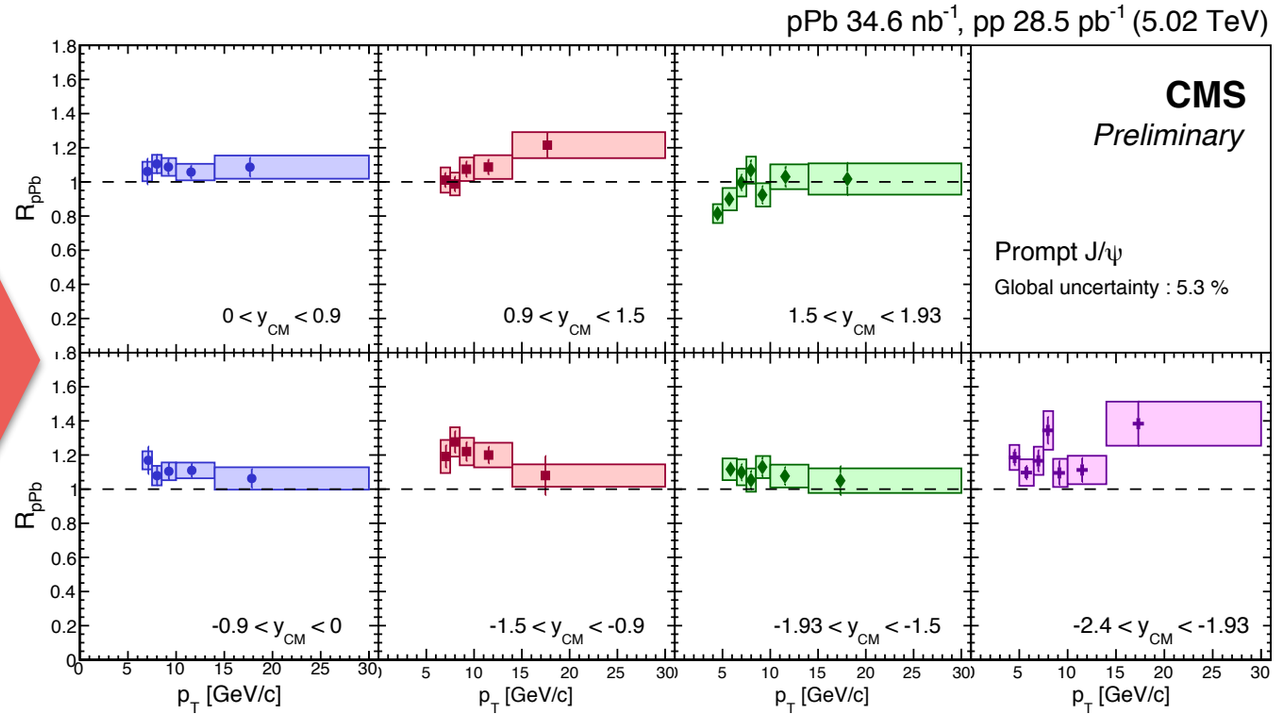
Results

prompt J/ψ

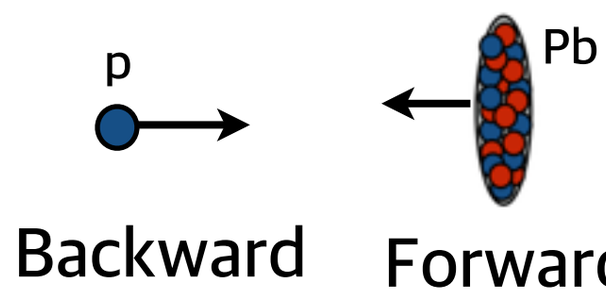
Prompt J/ψ : R_{pPb} vs p_T

- y-axis [0, 1.8]
- x-axis extends to 30 GeV/c, and bin width is presented
- Triangle points are replaced (comments from Yenjie)

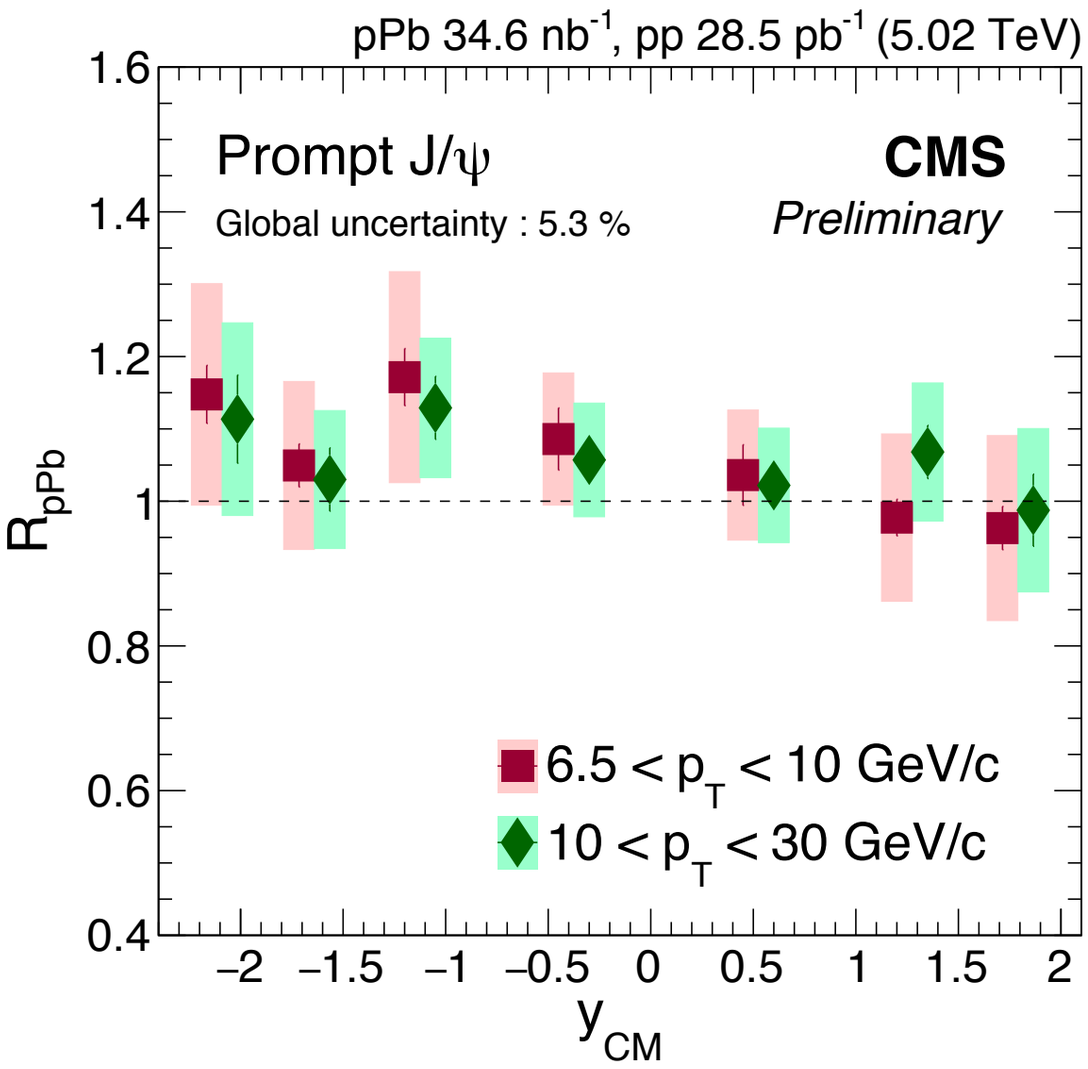


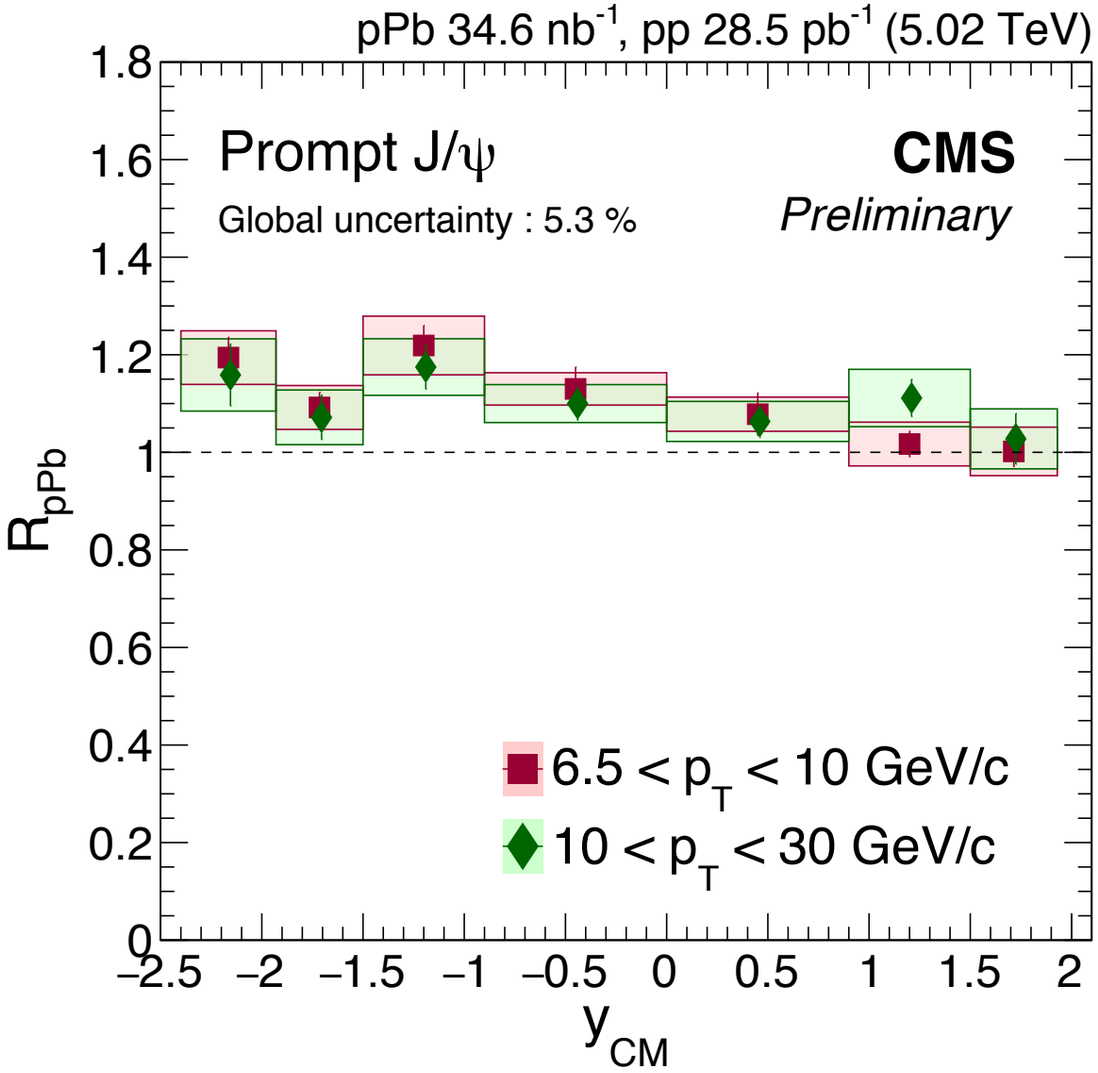


$$R_{\mathrm{pPb}}(p_{\mathrm{T}}, y) = \frac{\left(\frac{d\sigma}{dp_{\mathrm{T}}dy}\right)_{\mathrm{pPb}}}{A \times \left(\frac{d\sigma}{dp_{\mathrm{T}}dy}\right)_{\mathrm{pp}}}$$



Prompt J/ψ : R_{pPb} vs y





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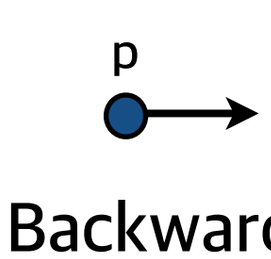
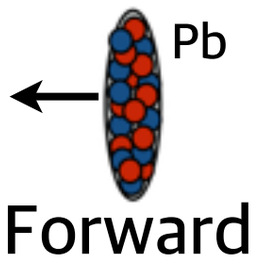
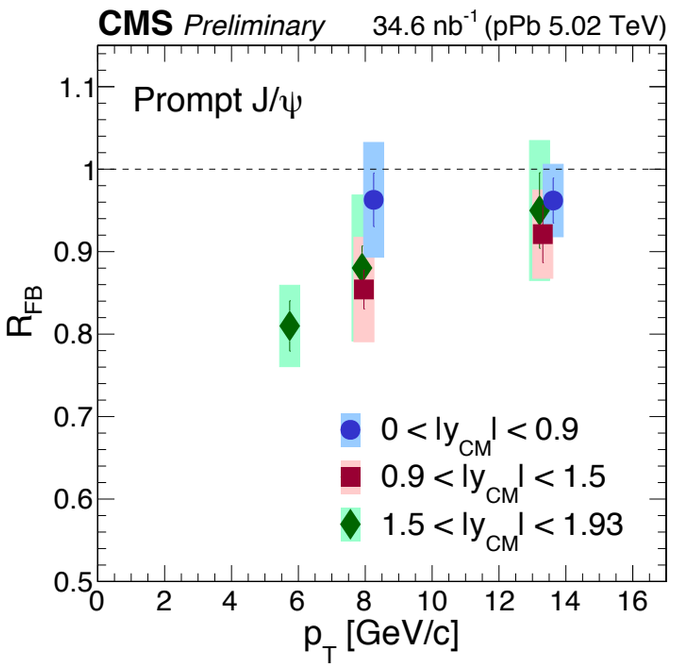
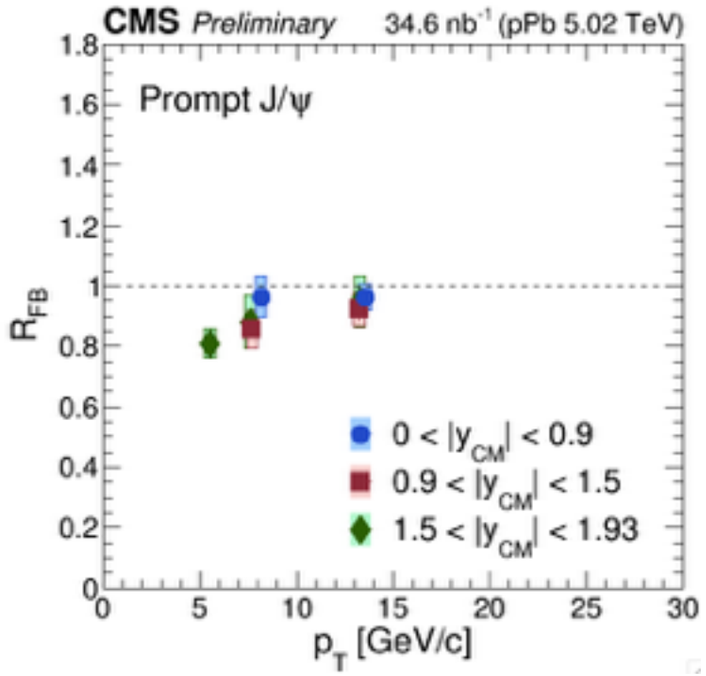




Prompt J/ψ : R_{FB} vs P_T





- Each rapidity range is not very distinguishable with the extension of x & y axes
- We already have finer bins in R_{pPb}, so keep consistency (Comments from Yenjie)

$$R_{\mathrm{FB}}(p_{\mathrm{T}}, y) = \frac{d^2\sigma(p_{\mathrm{T}}, y > 0)/dp_{\mathrm{T}}dy}{d^2\sigma(p_{\mathrm{T}}, y < 0)/dp_{\mathrm{T}}dy}$$

- Observable free from pp reference
- Luminosity uncertainty cancels
- Useful to study the (quasi-)centrality dependence without N_{coll} information

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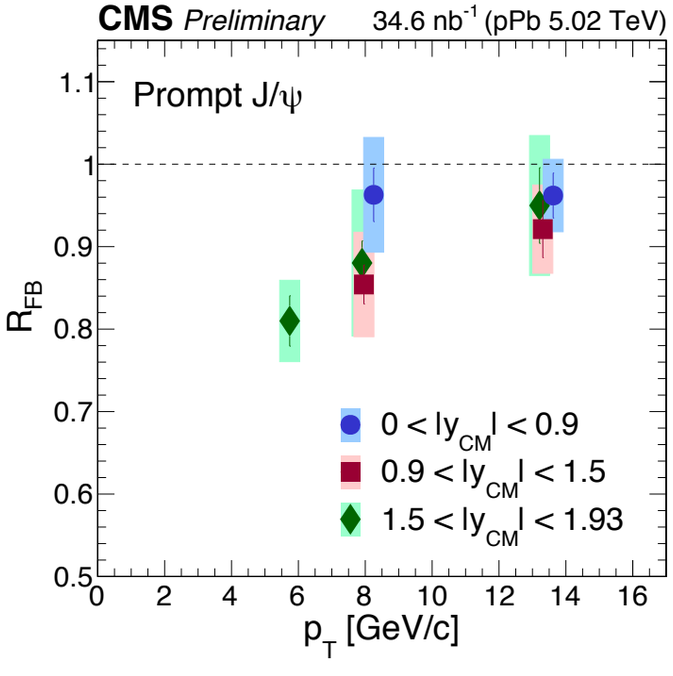

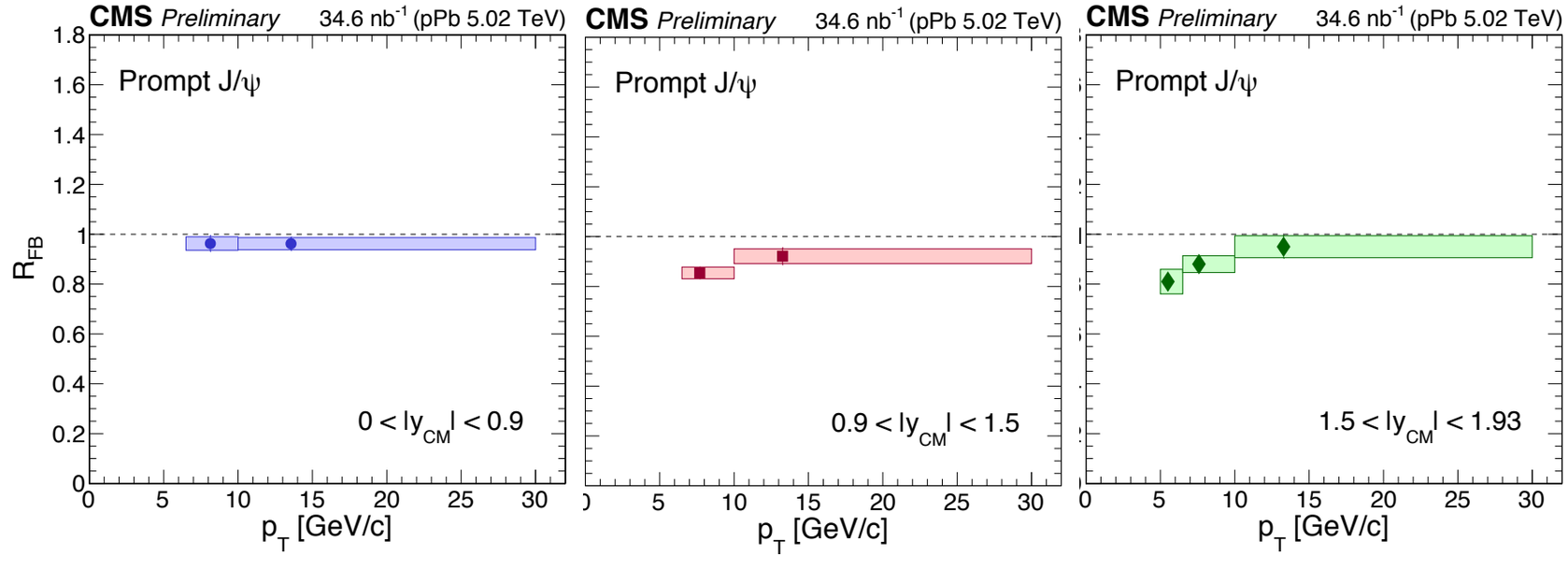

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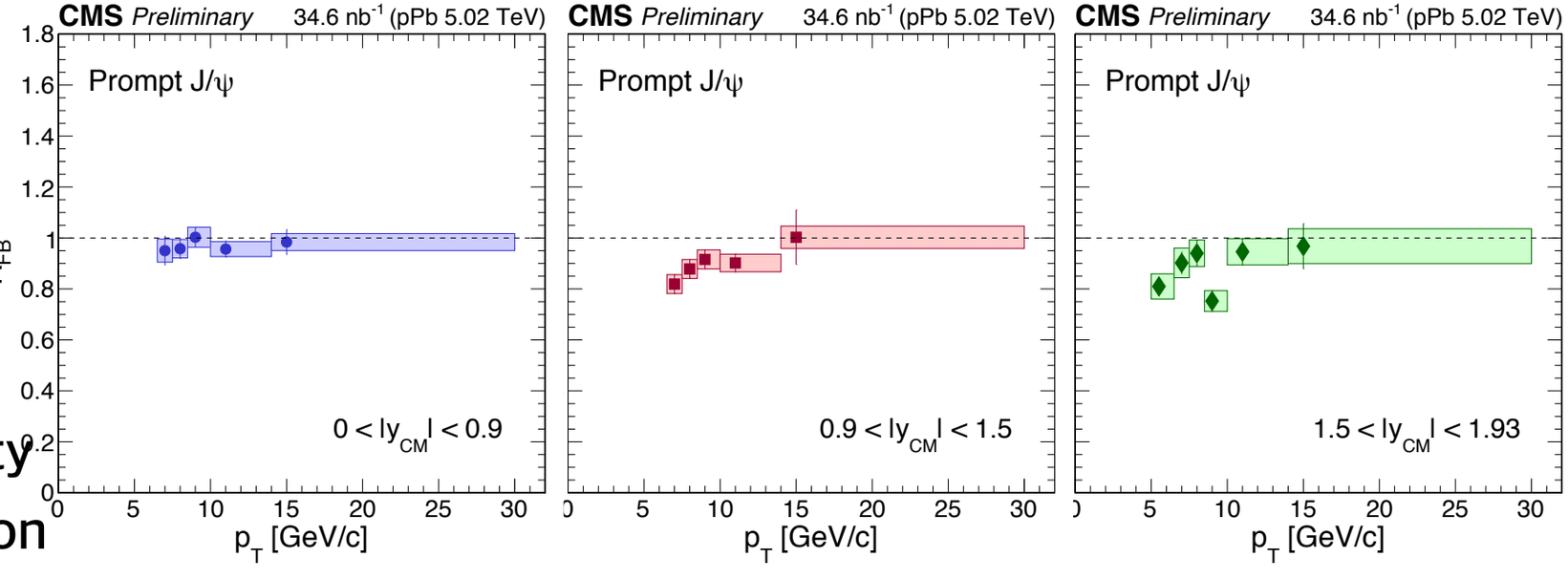
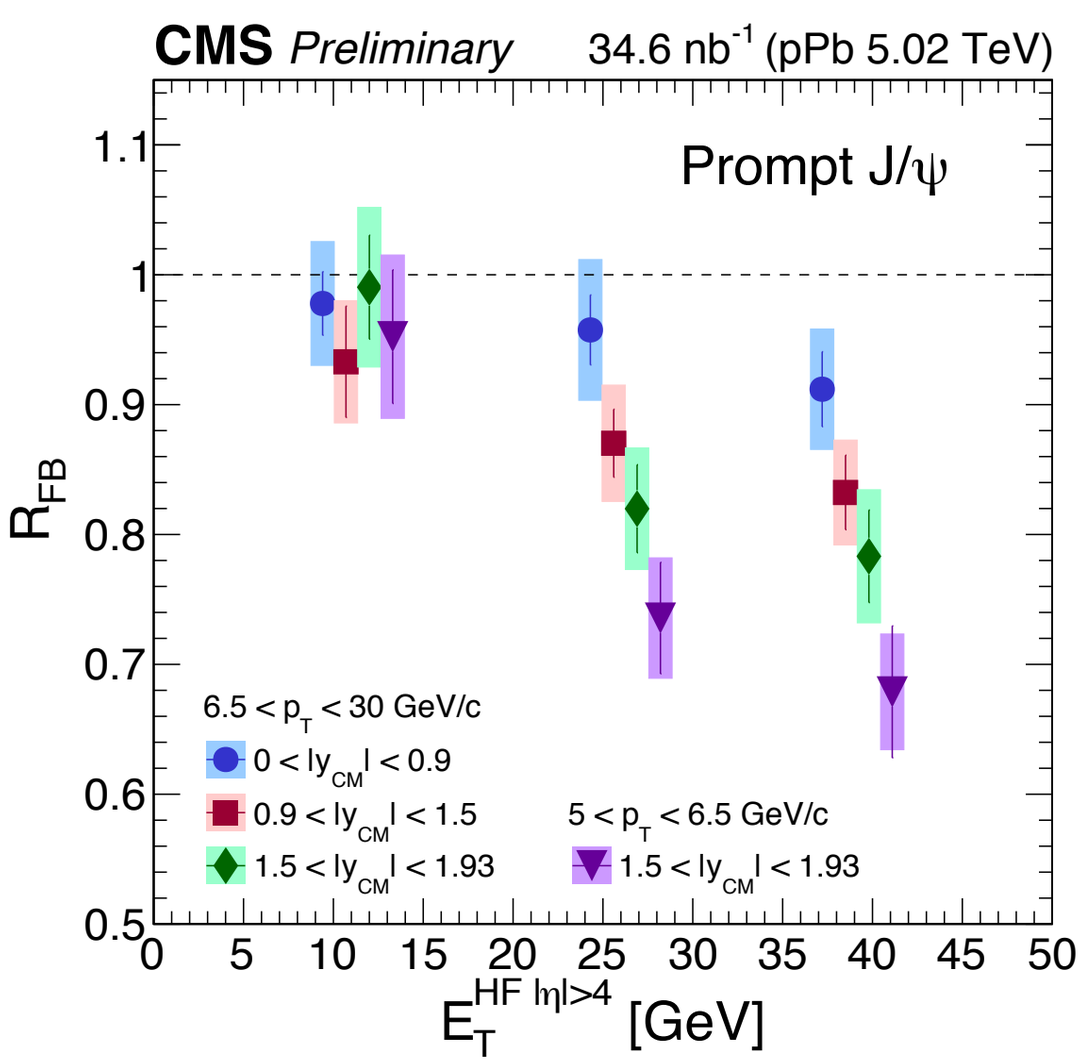
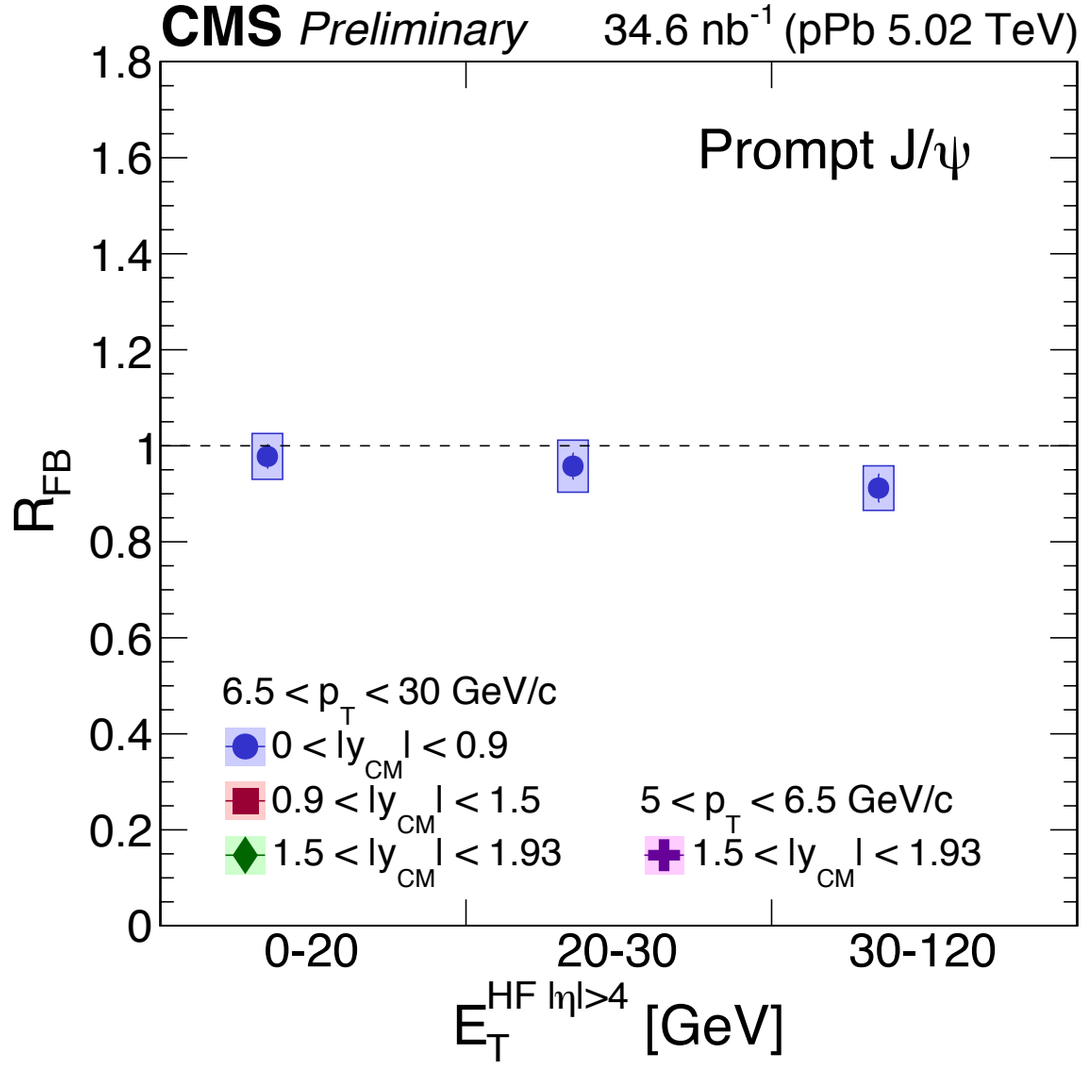


Prompt J/ψ : R_{FB} vs E_T





- y-axis [0, 1.8]
- Triangle points are replaced (comments from Yenjie)
- x-label os changed because x-point shift can be misleading
  e.g.) different mean E_T.. (Comments from George)

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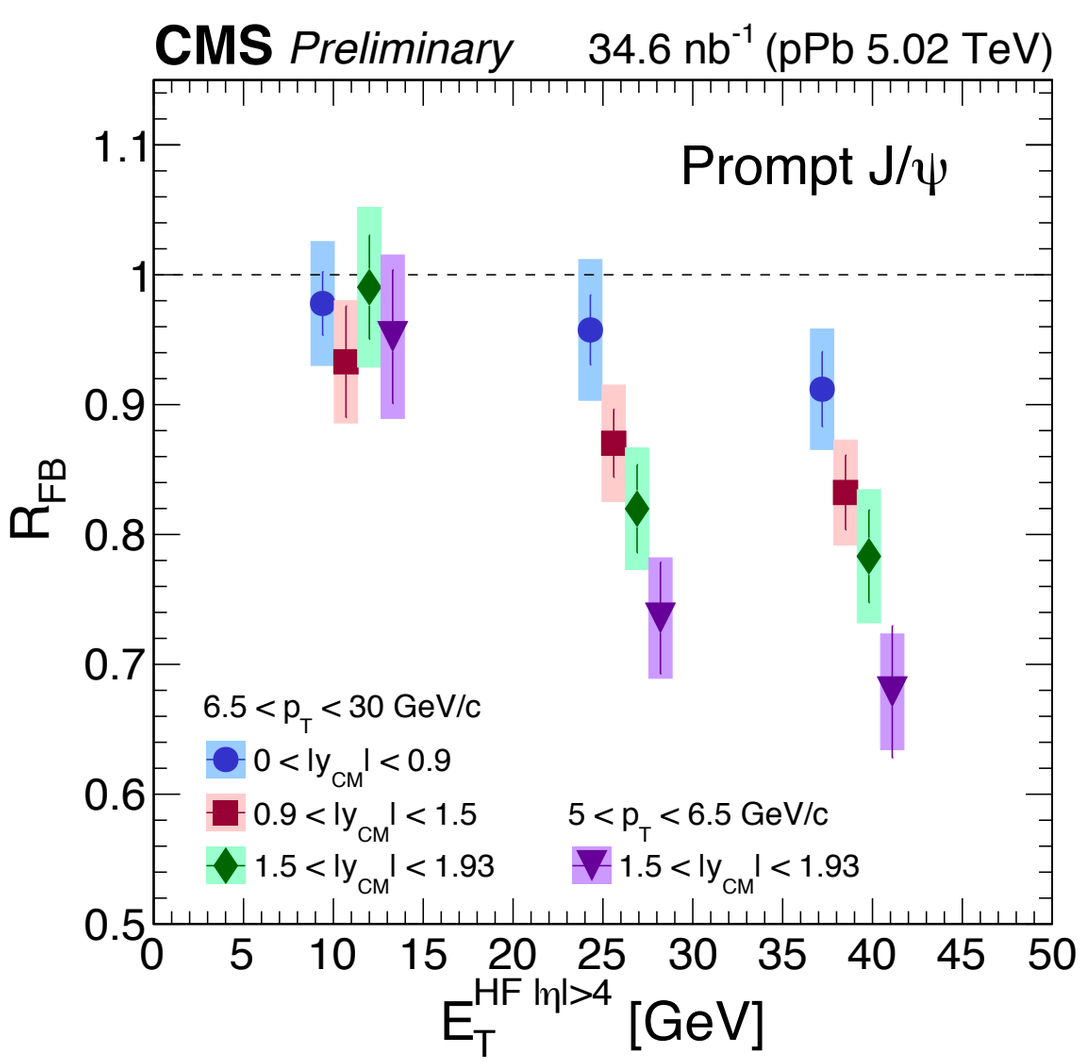

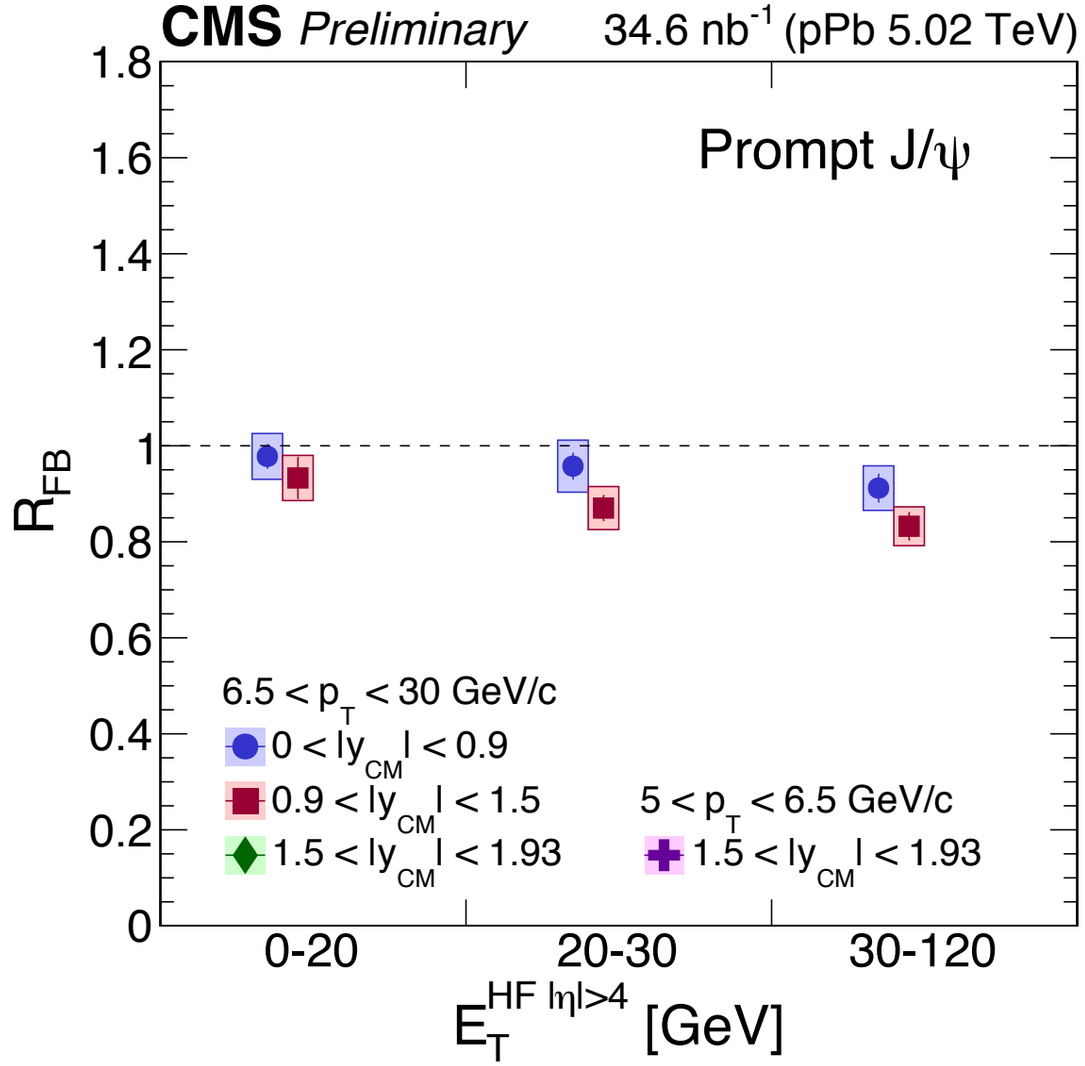

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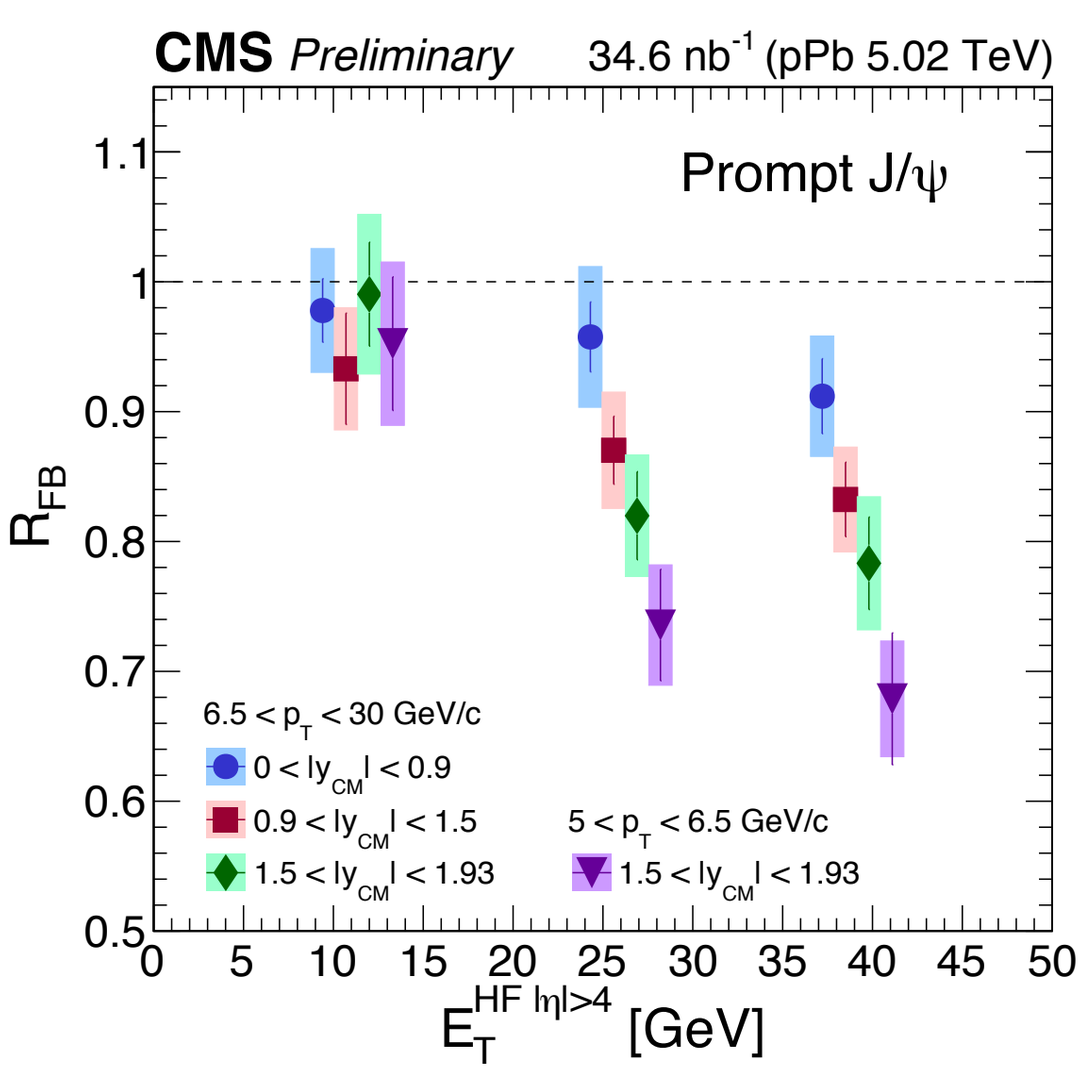

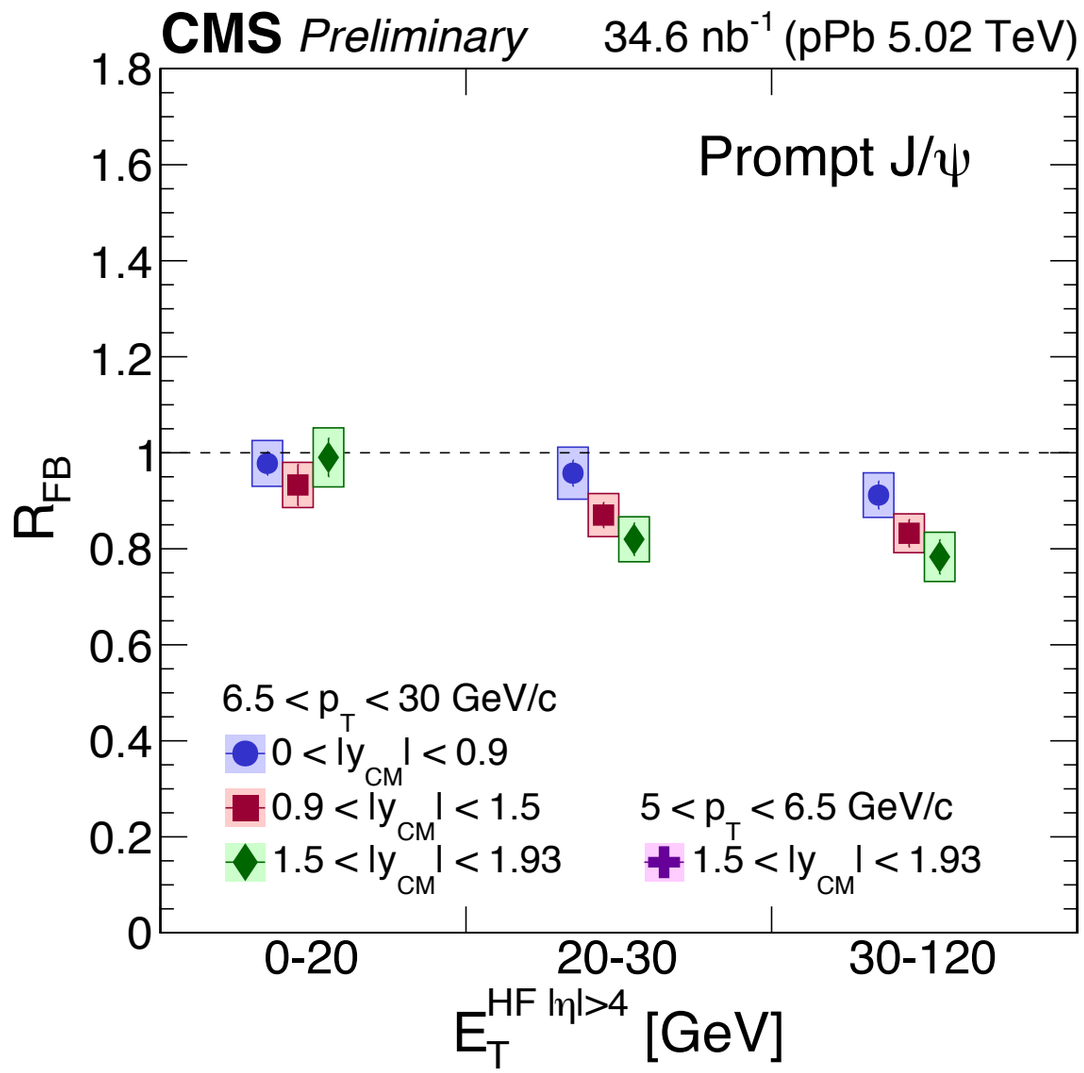

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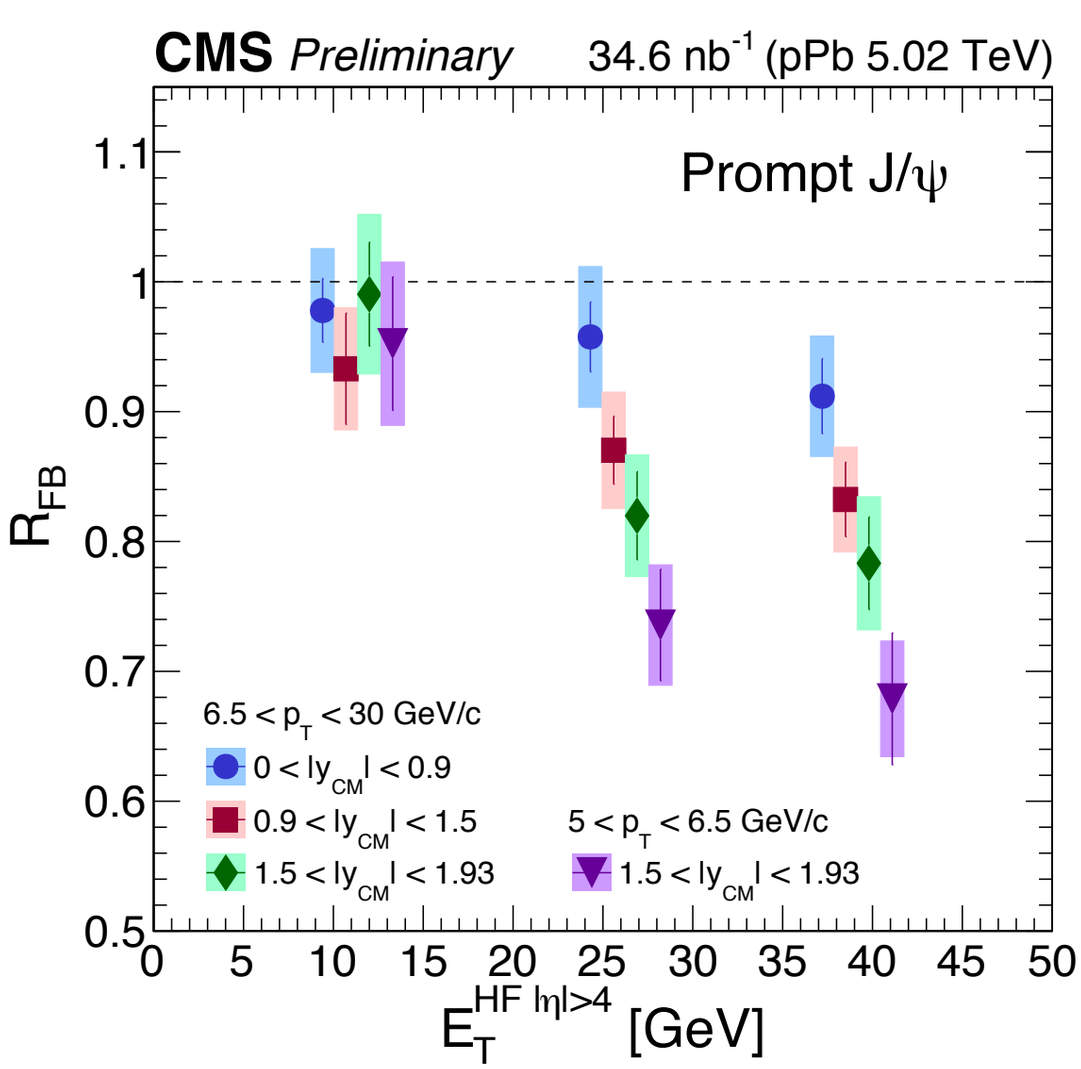

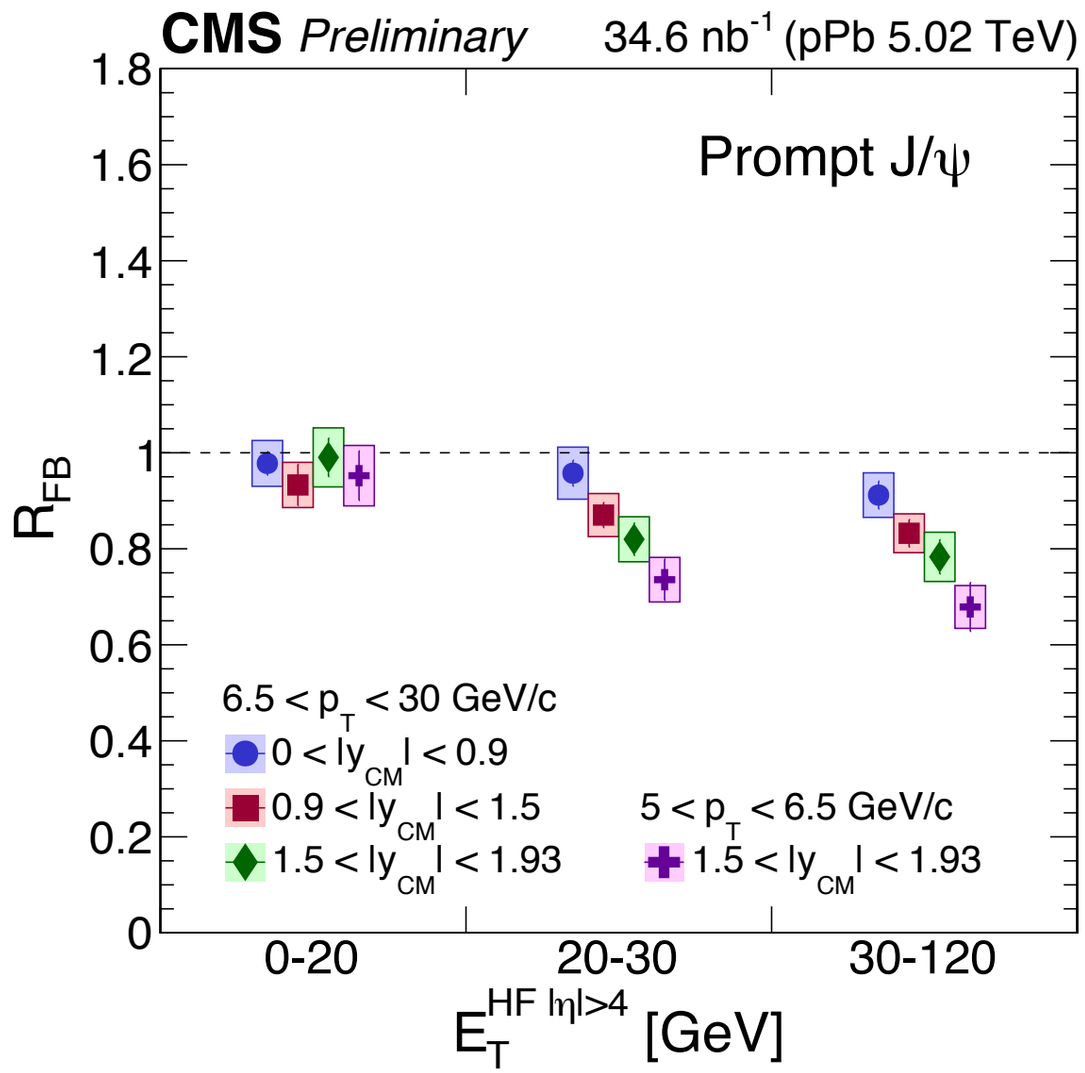

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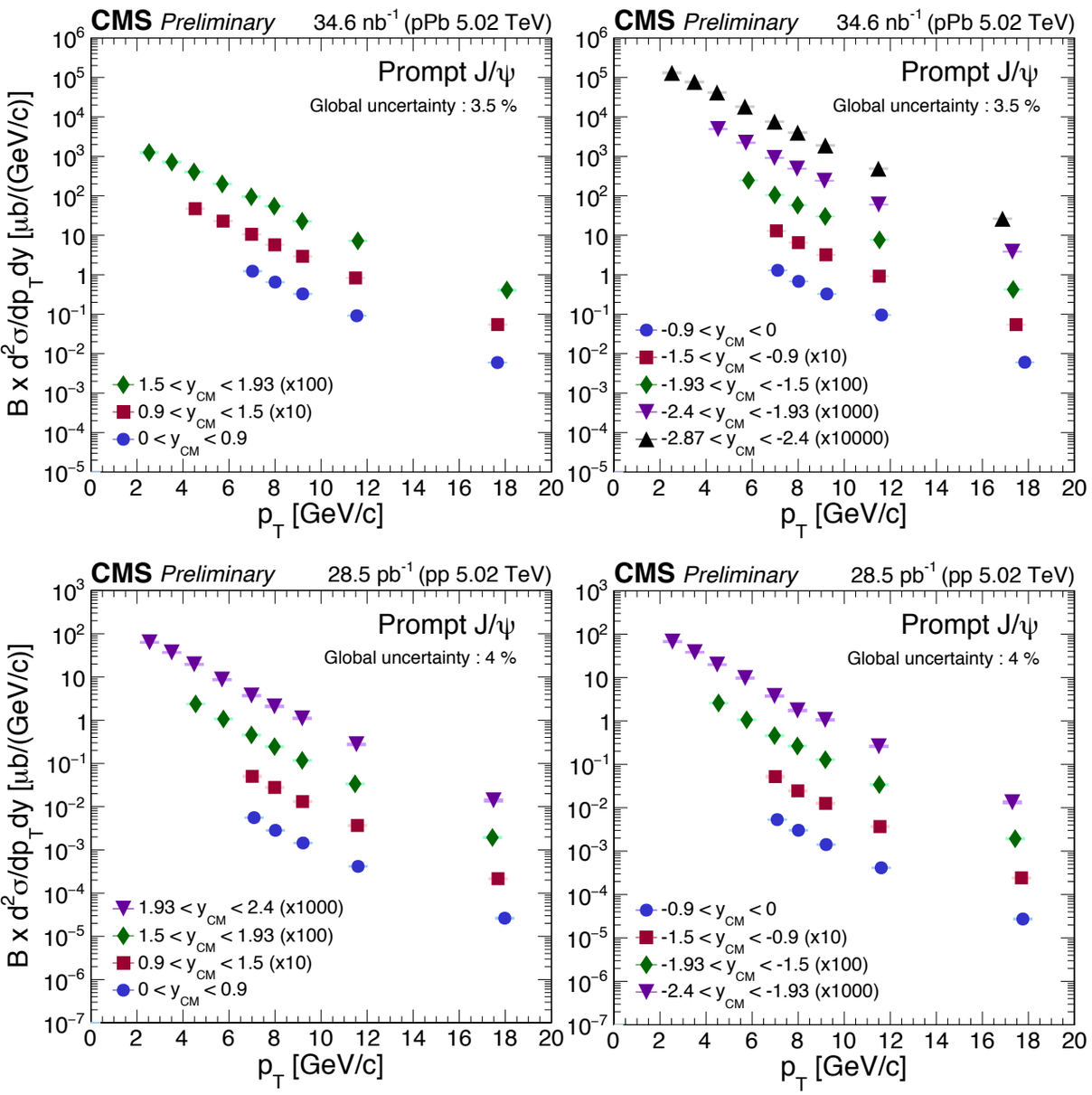
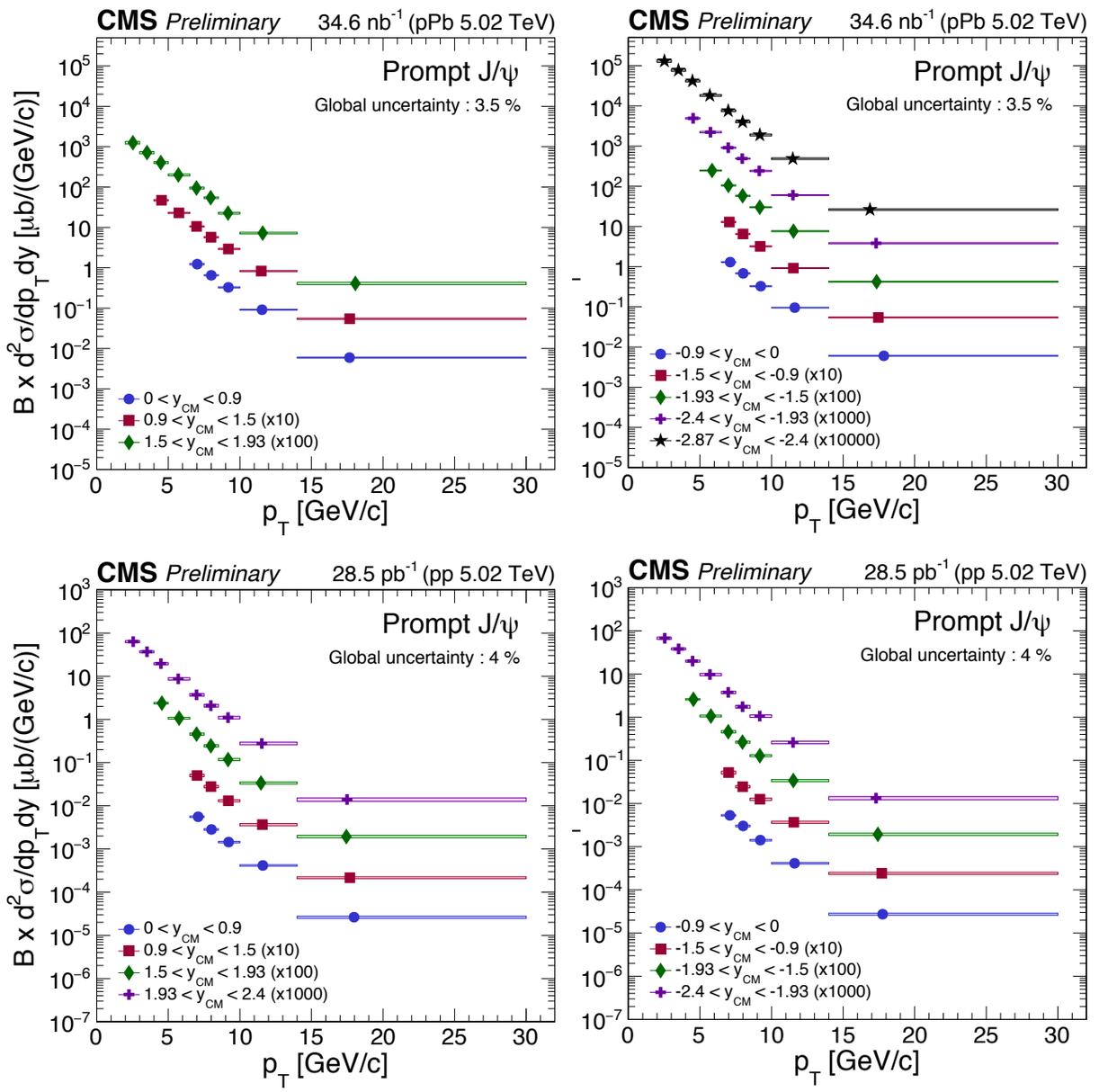
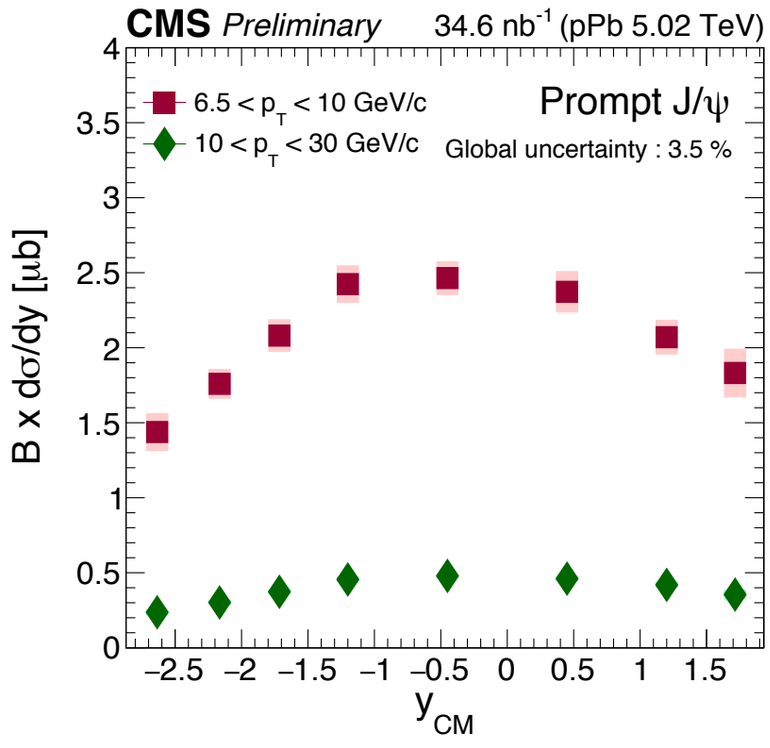
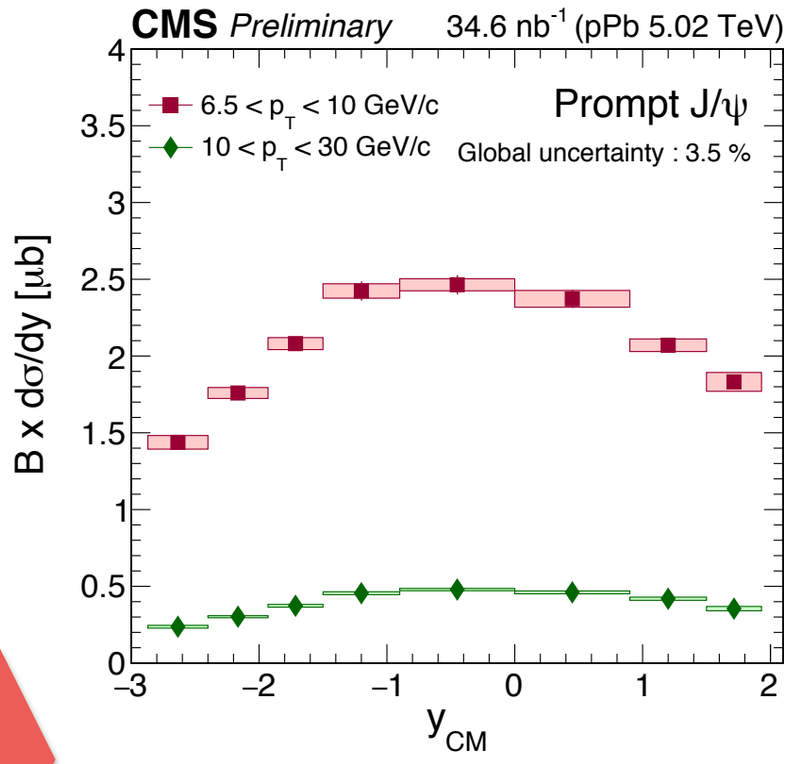
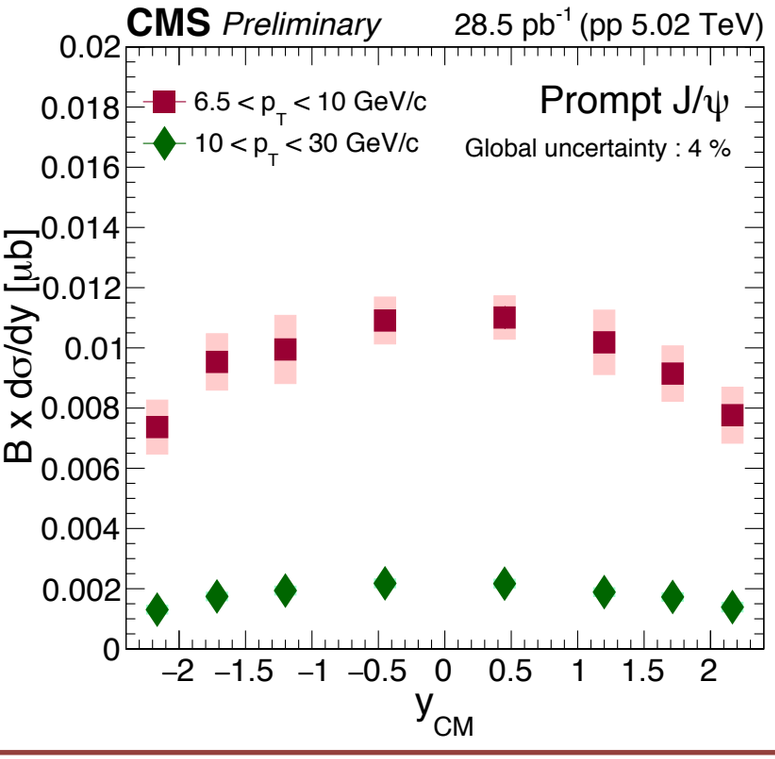


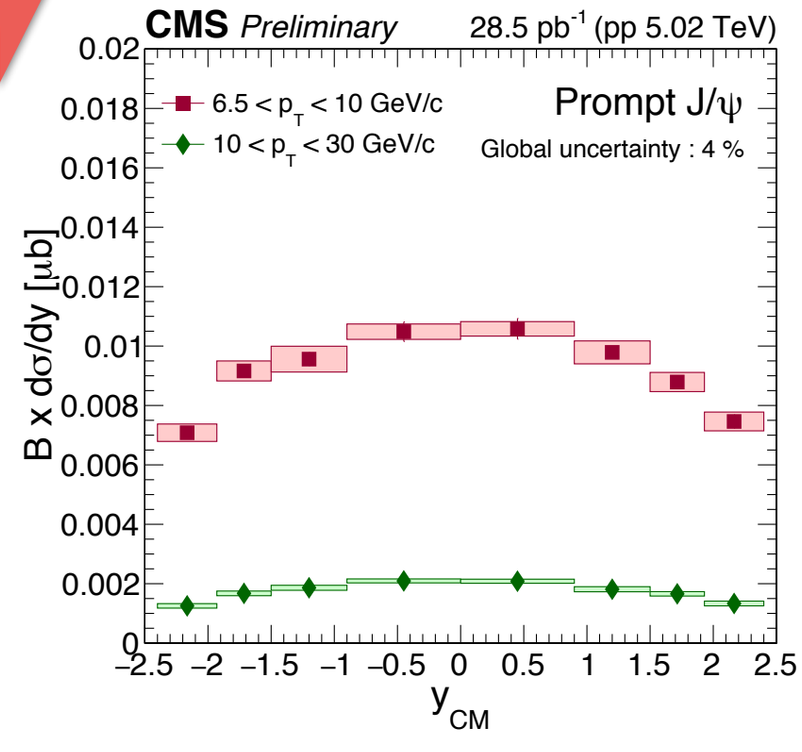


Prompt J/ψ : cross sections vs y









- wrong normalization corrected (pile-up)
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Results

non-prompt J/ψ

Non-prompt J/ψ : R_{pPb} vs p_T

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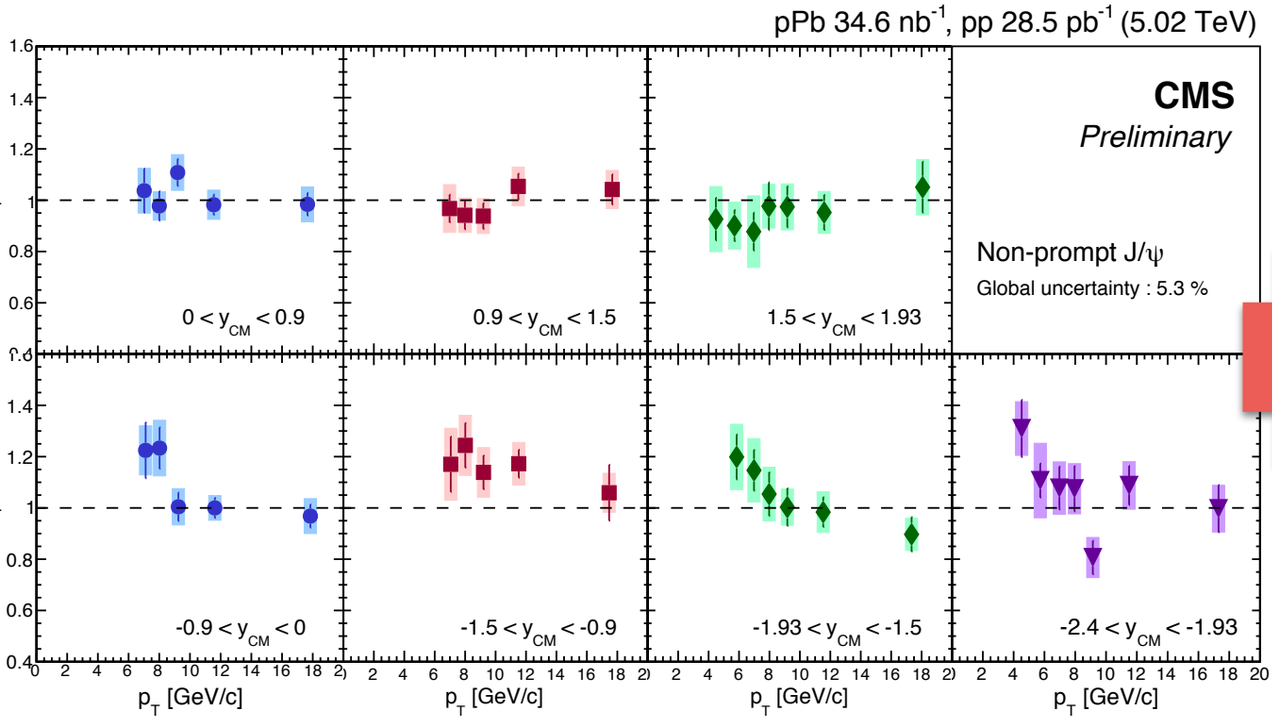
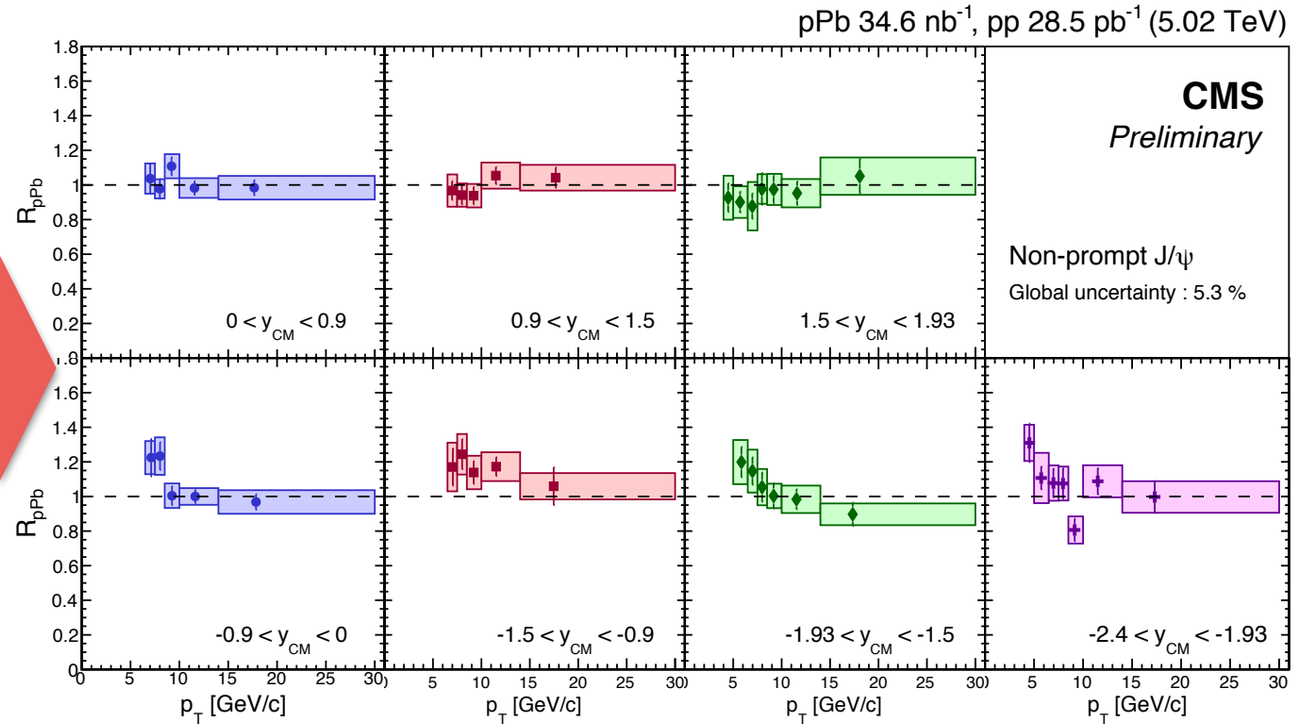
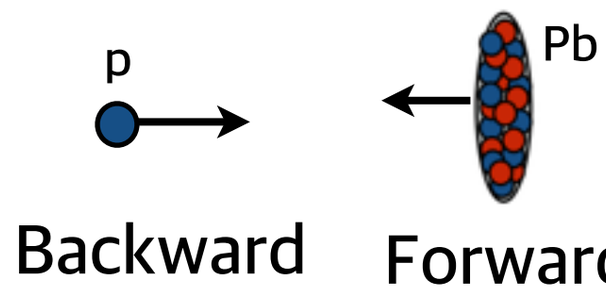




$$R_{\mathrm{pPb}}(p_{\mathrm{T}}, y) = \frac{\left(\frac{d\sigma}{dp_{\mathrm{T}}dy}\right)_{\mathrm{pPb}}}{A \times \left(\frac{d\sigma}{dp_{\mathrm{T}}dy}\right)_{\mathrm{pp}}}$$



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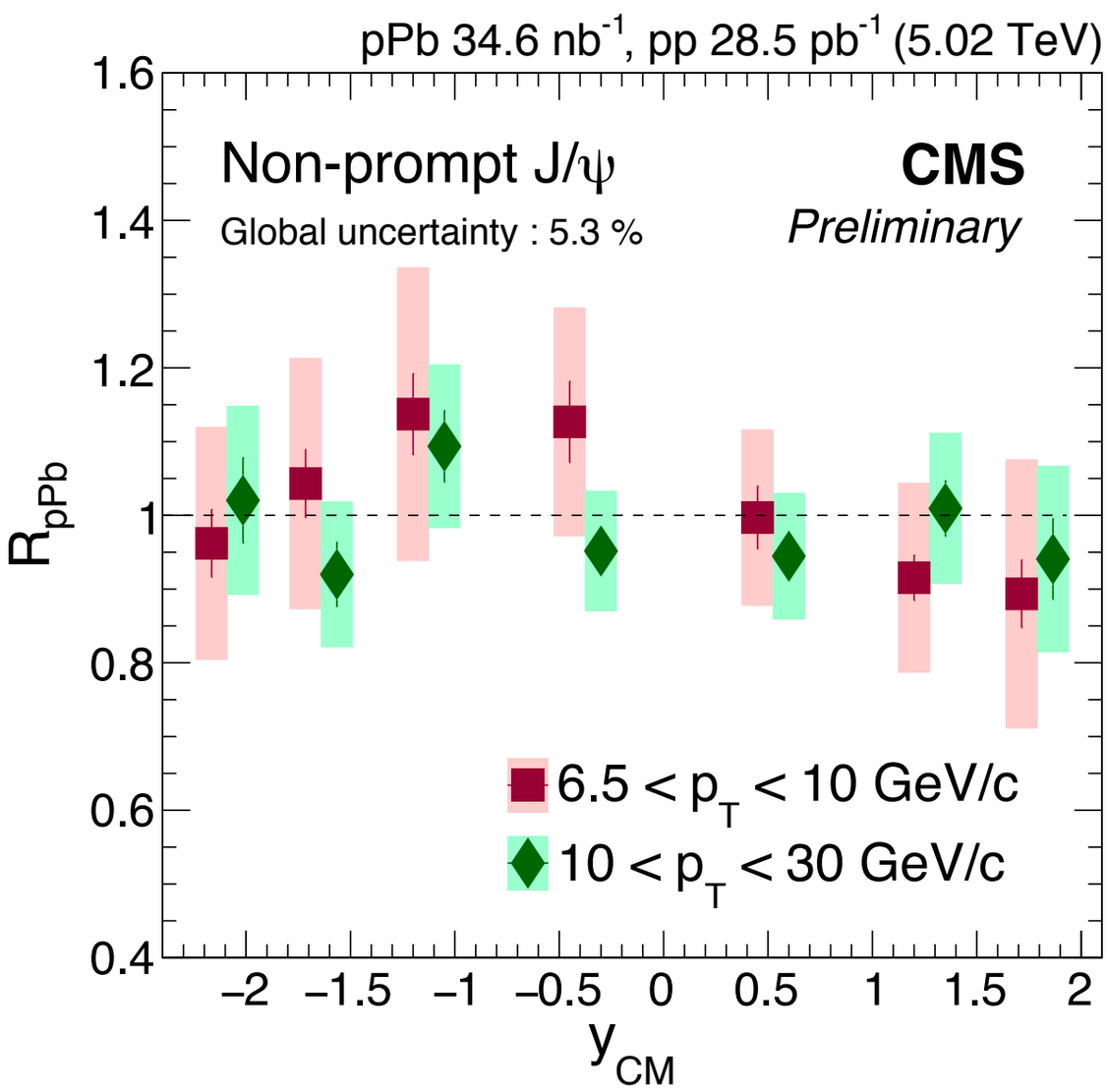

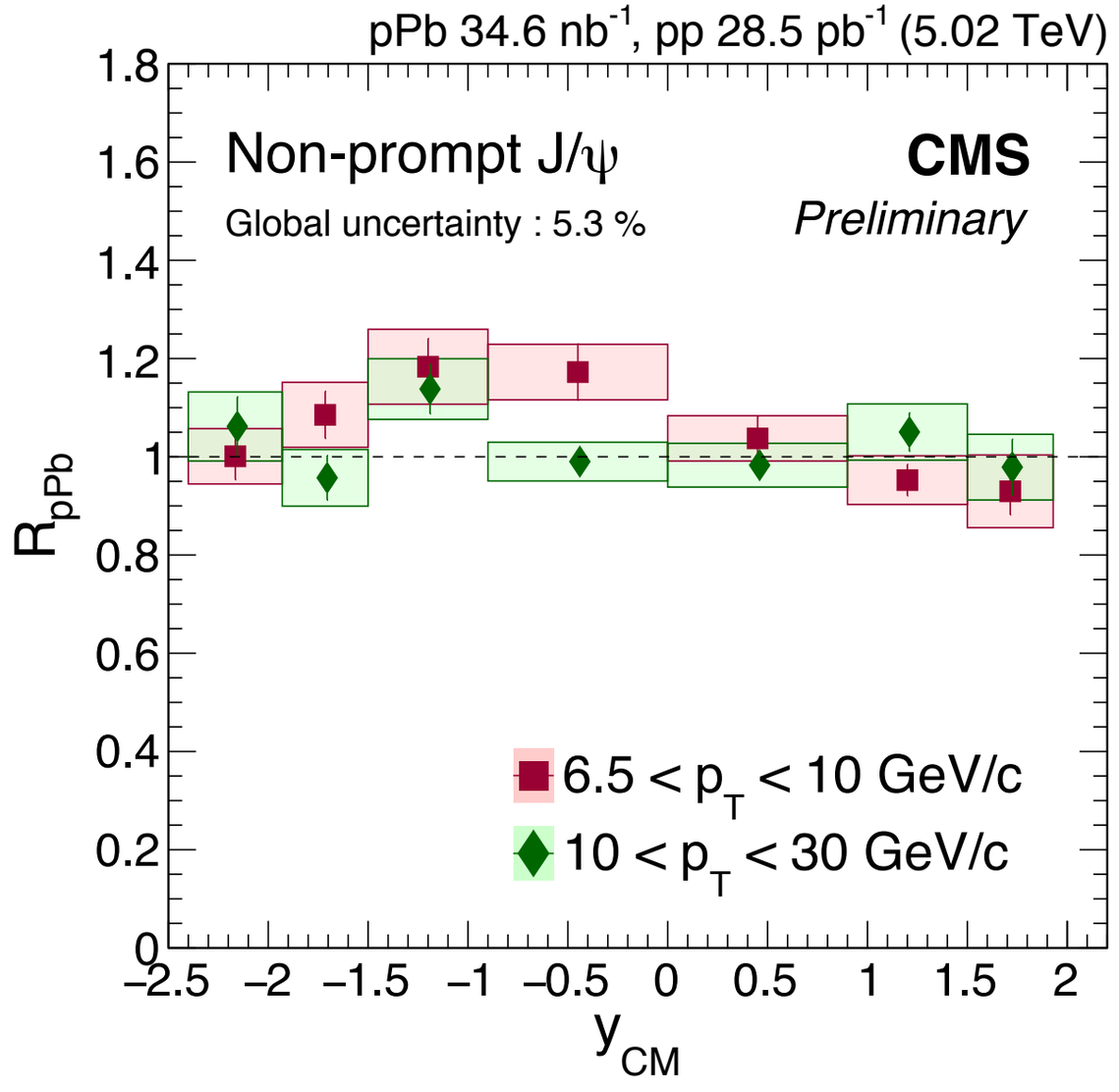

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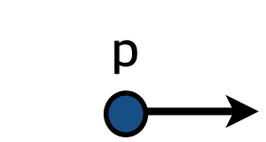

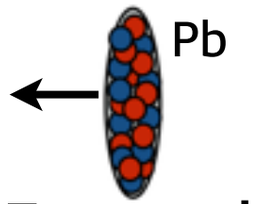

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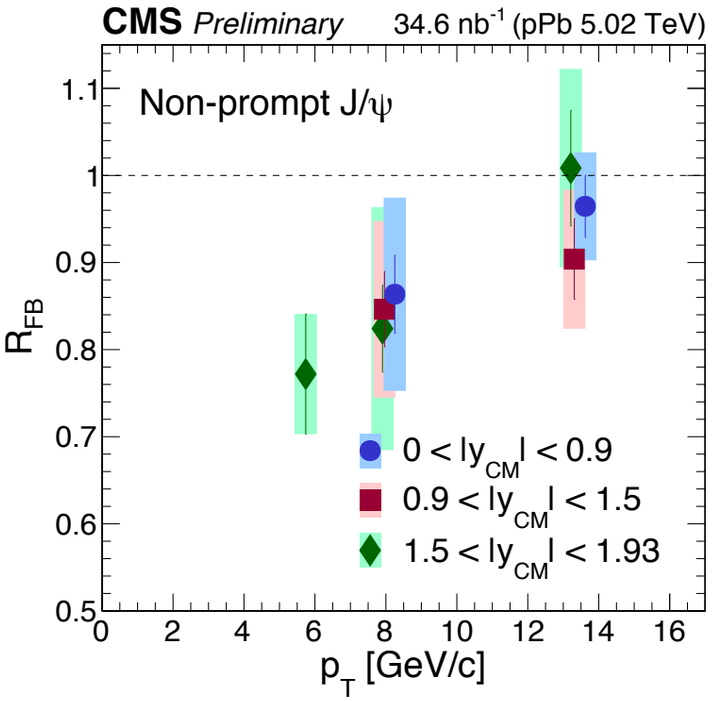

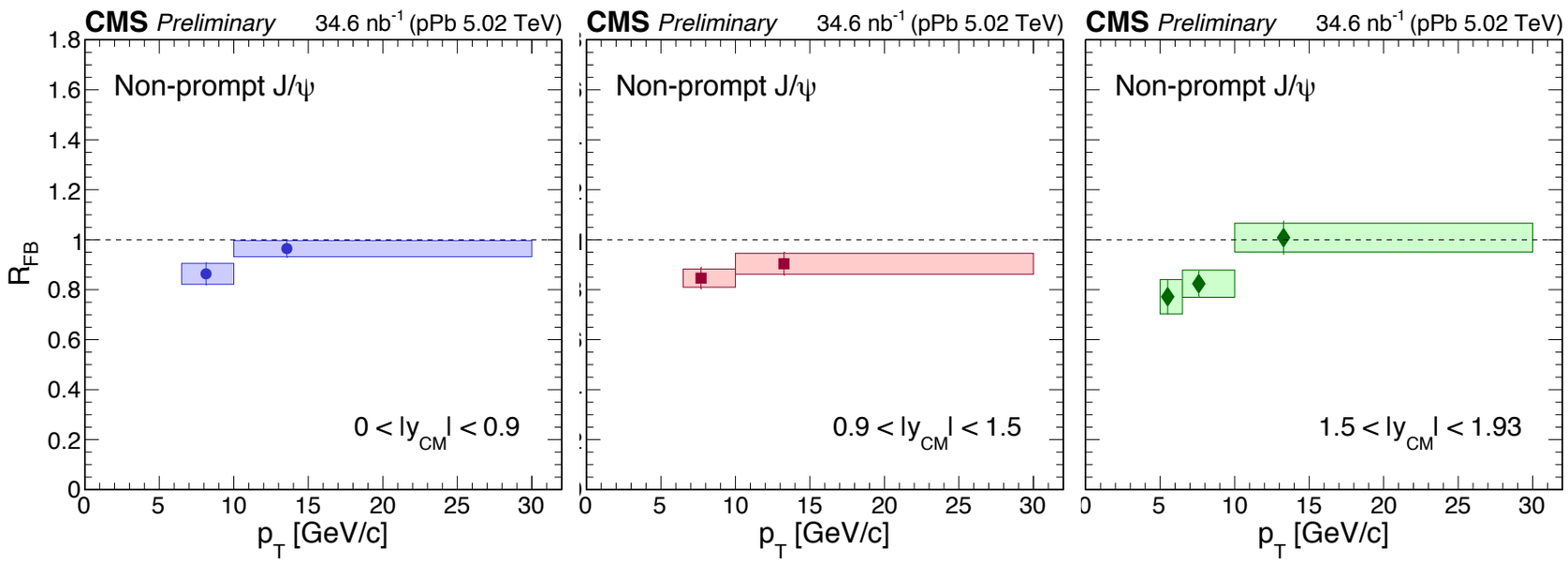

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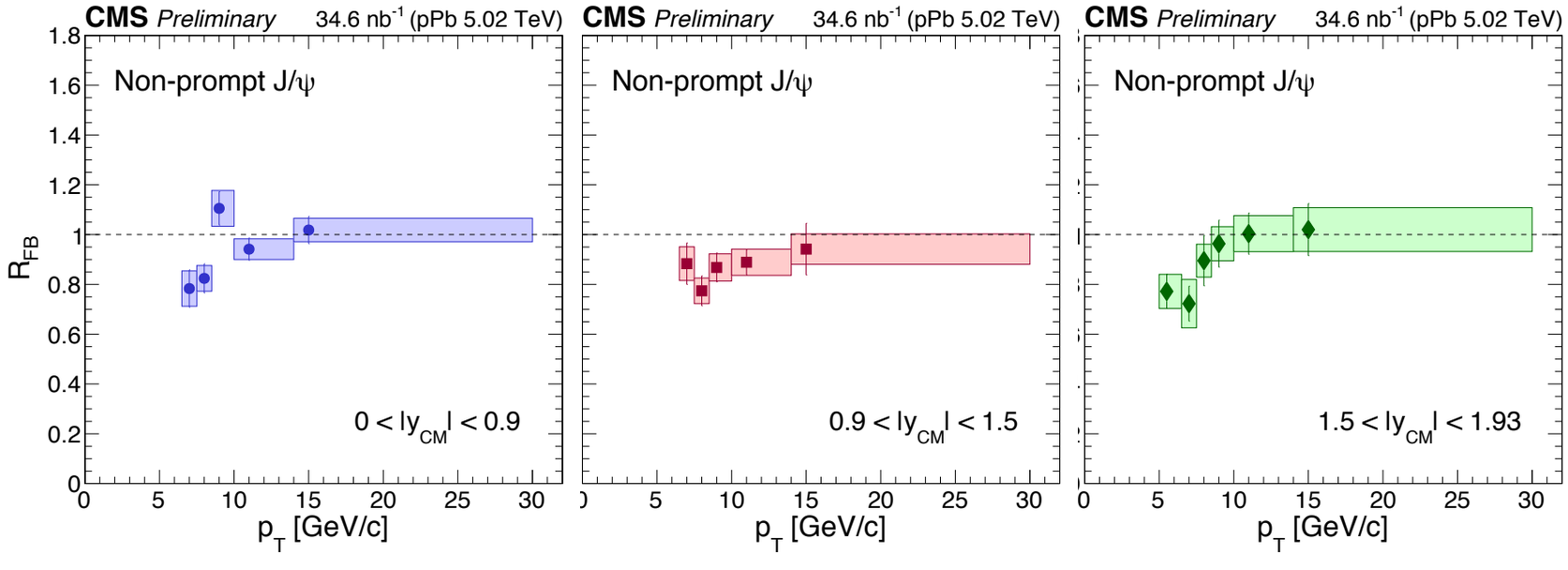

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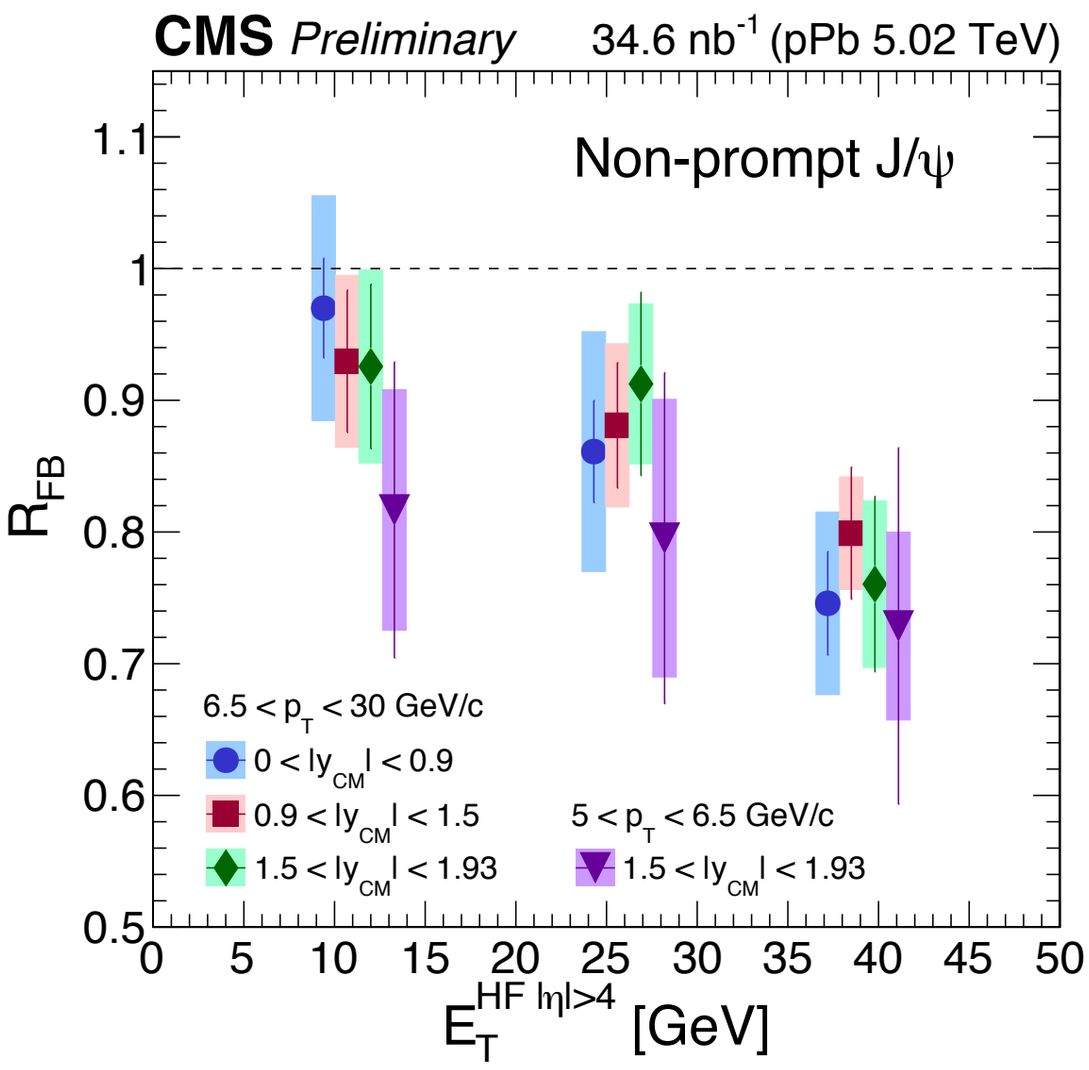

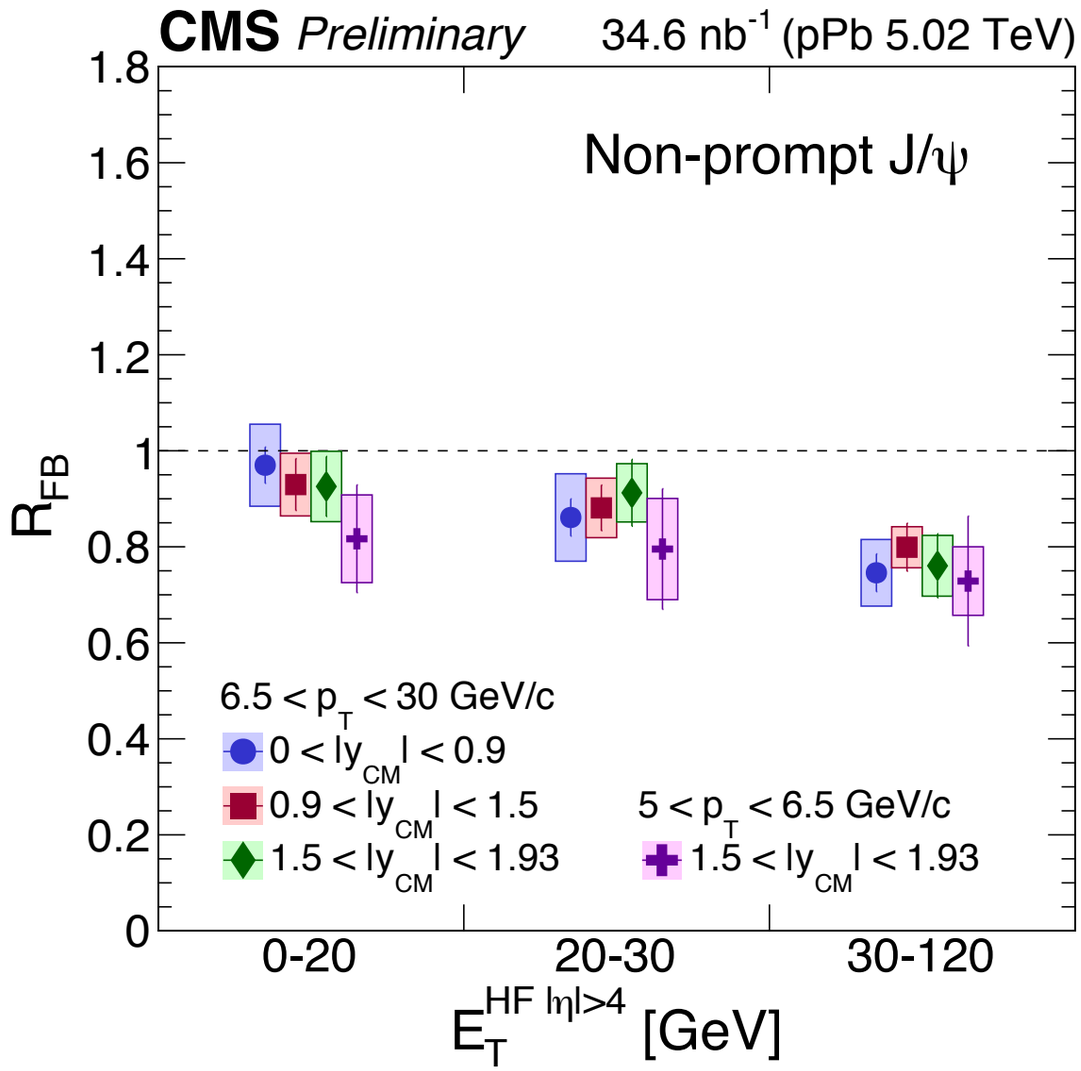

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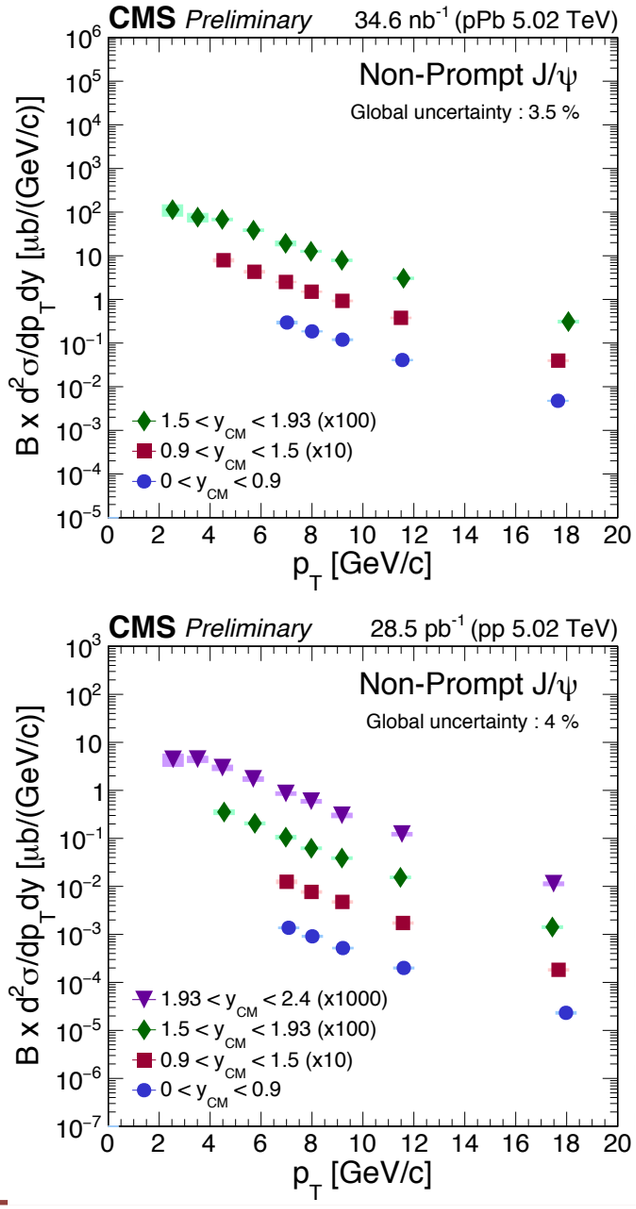
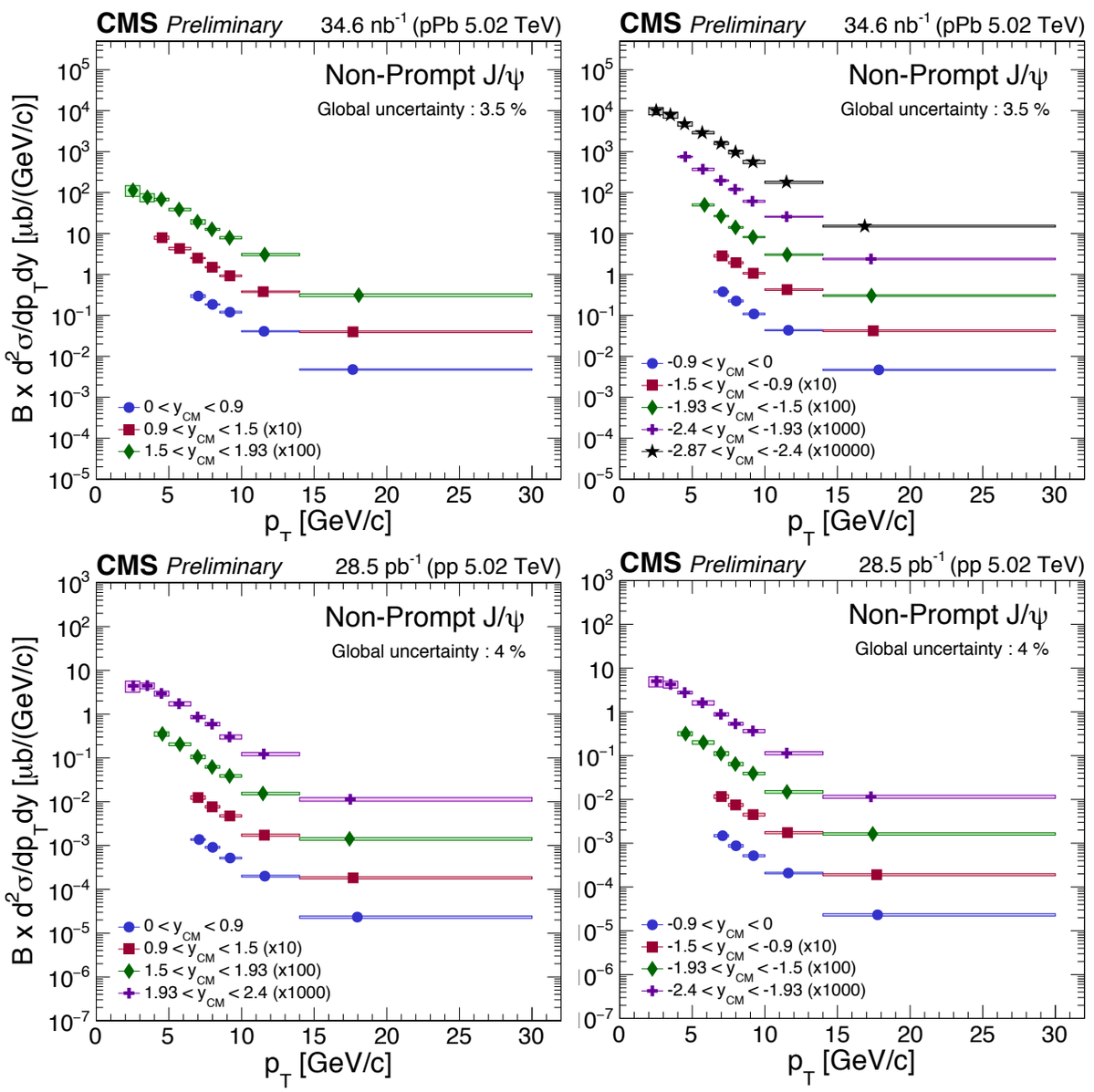
  e.g.) different mean E_T.. (Comments from George)

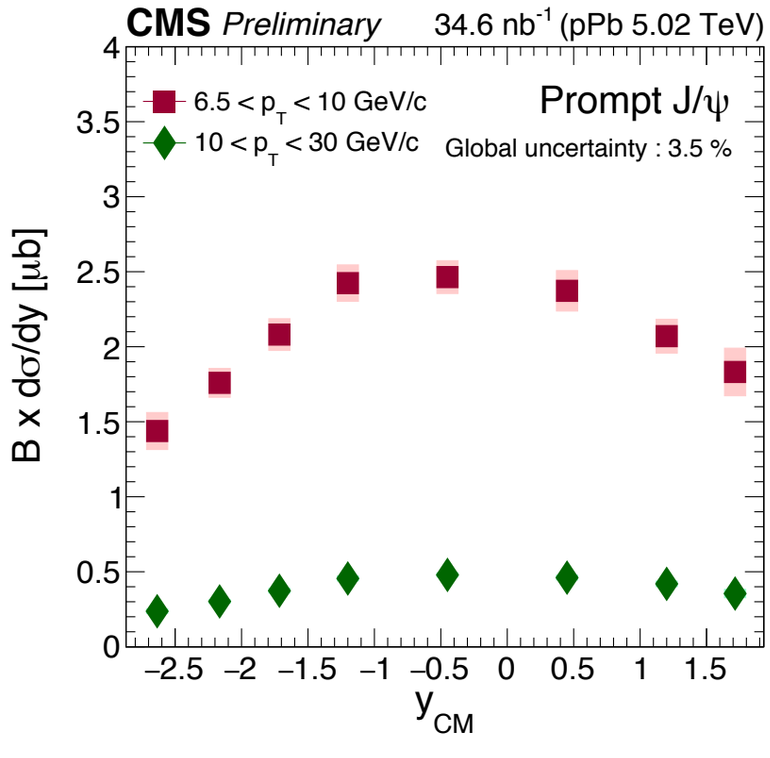
Non-prompt J/ψ : cross sections vs p_T

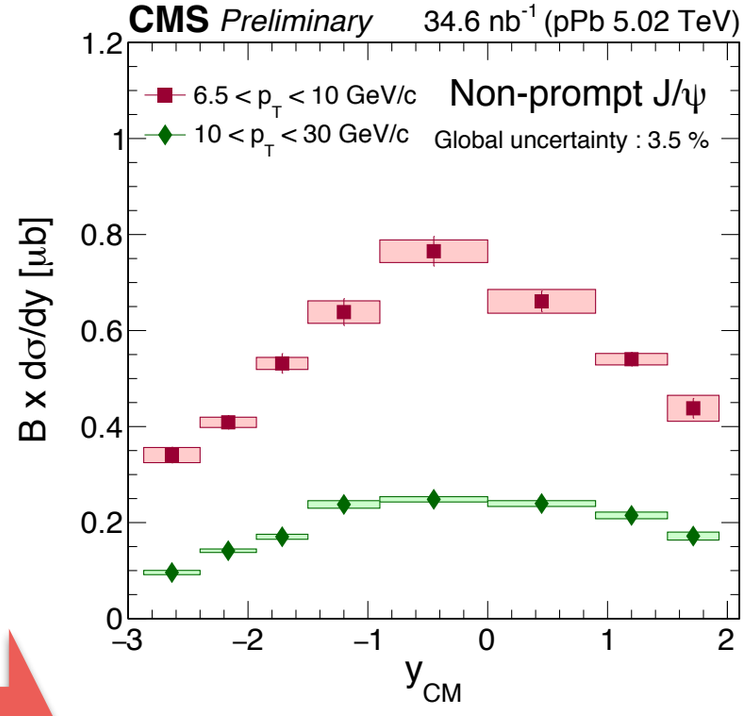
- x-axis extends to 30 GeV/c, and bin width is presented
- Triangle points are replaced (comments from Yenjie)

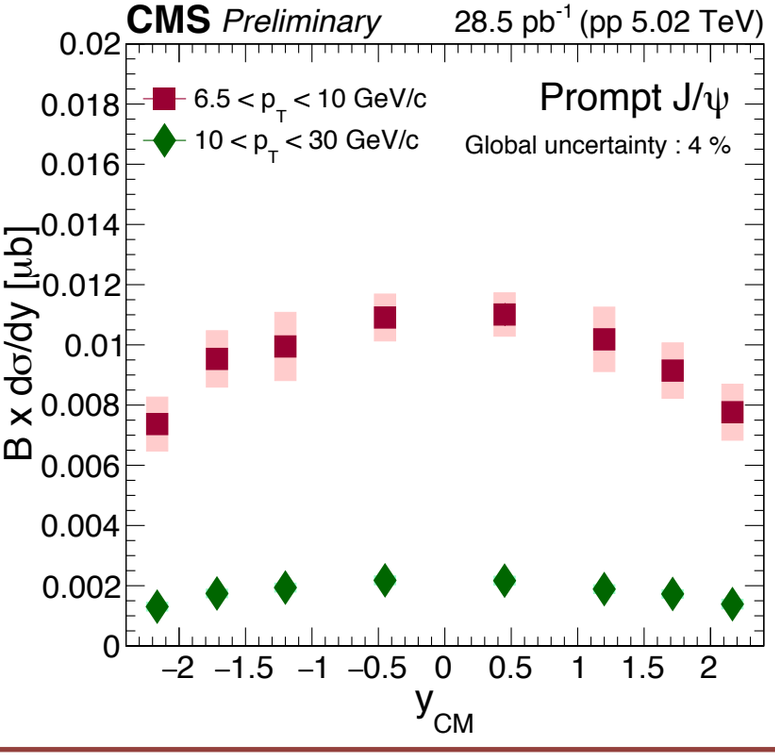


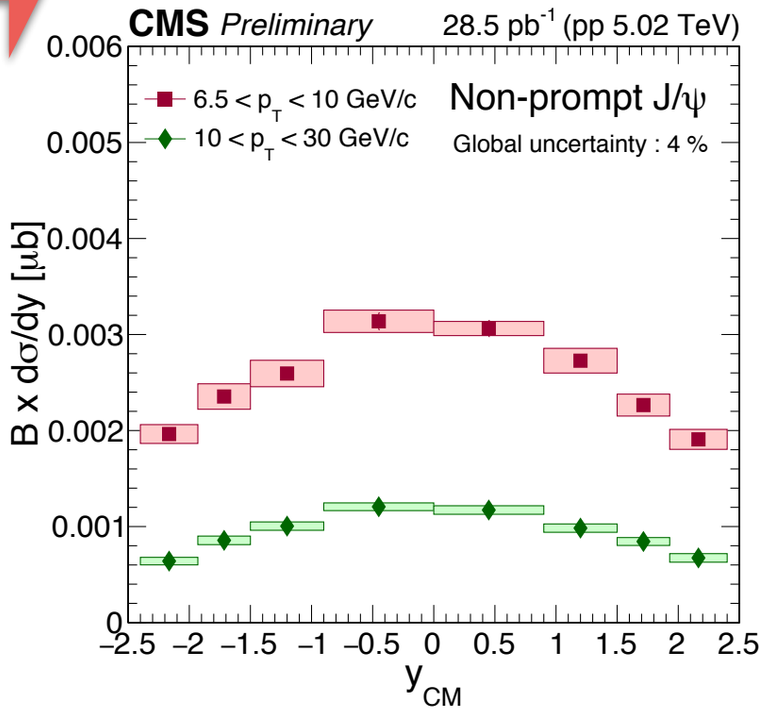


Non-prompt J/ψ : cross sections vs y







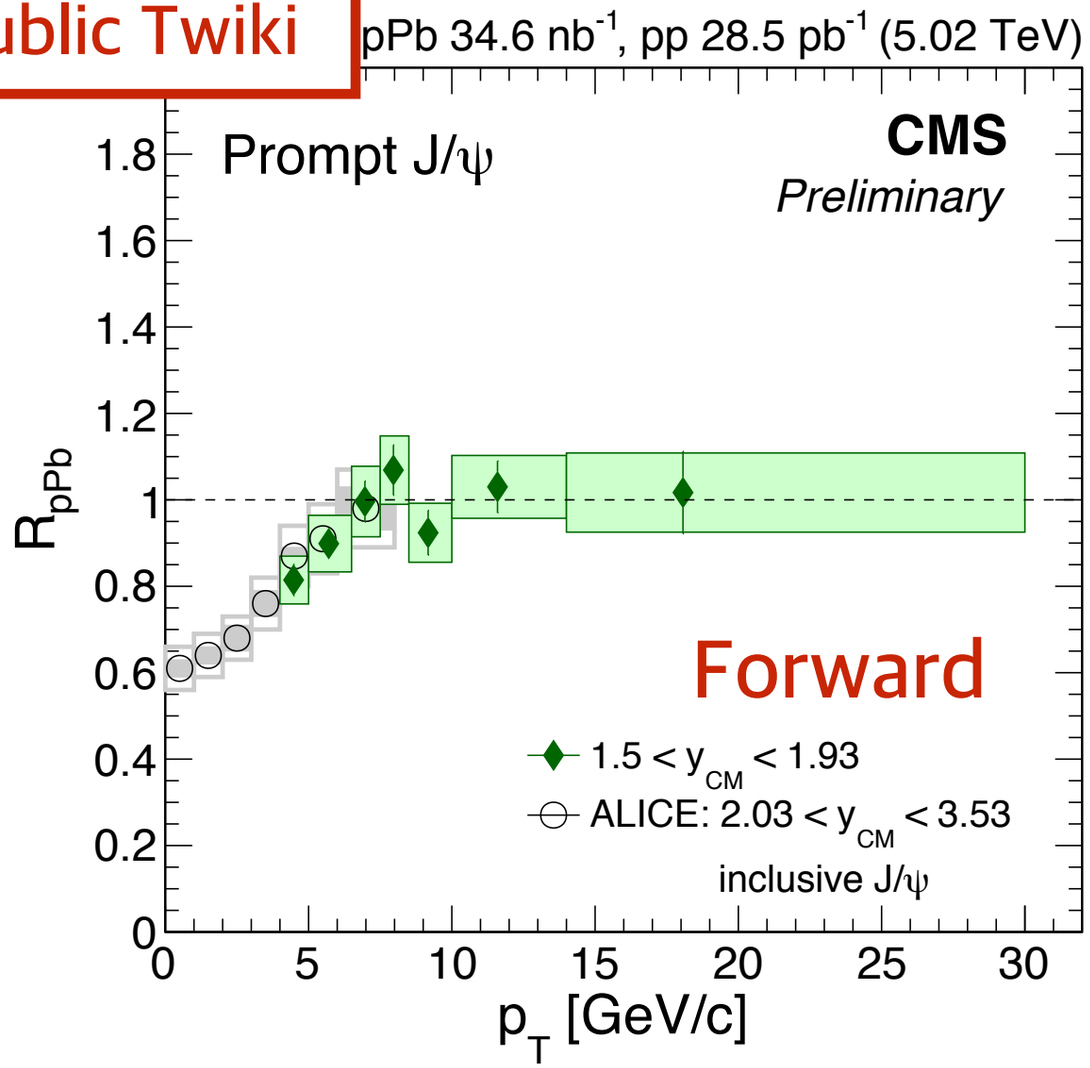


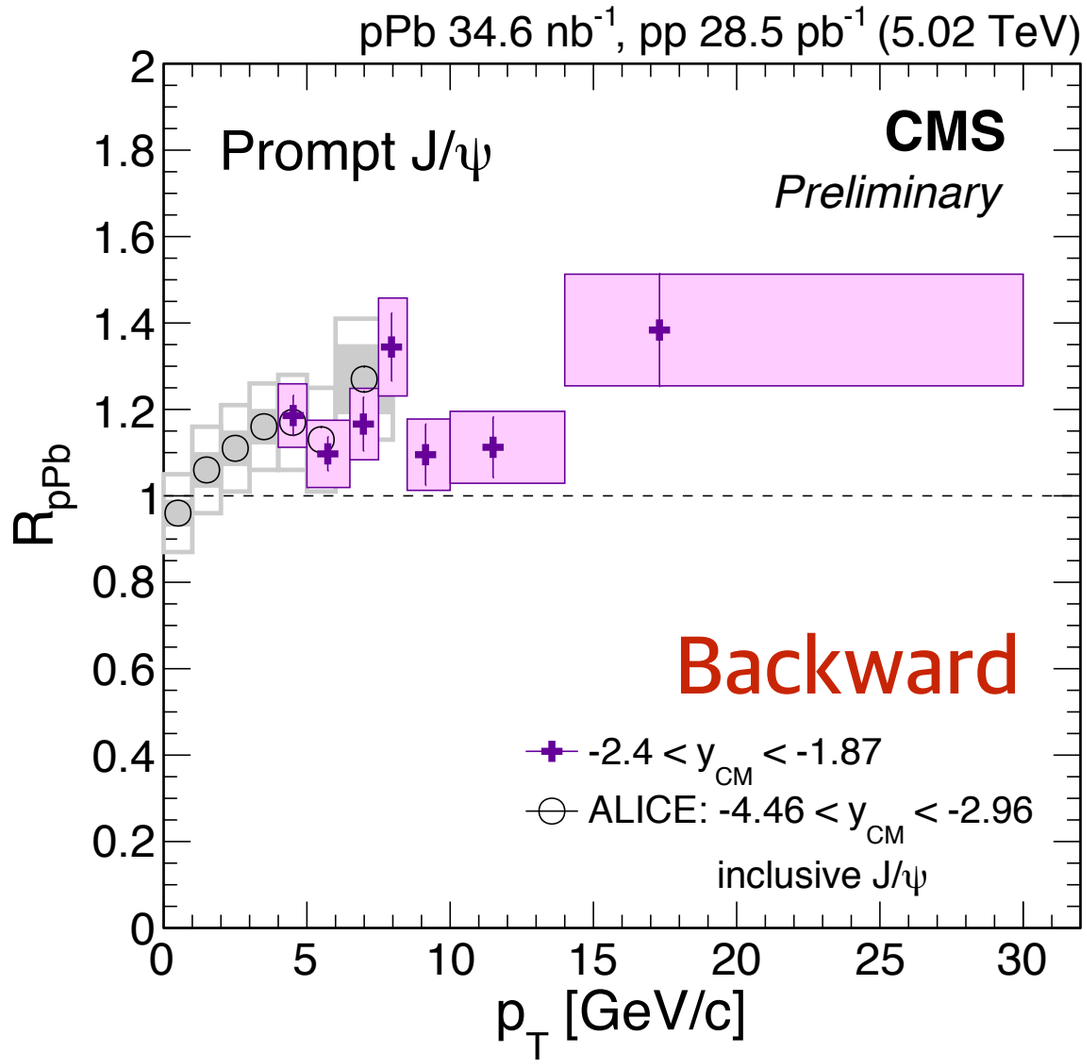
- wrong normalization corrected (pile-up)
- error propagation for bin merging fixed
- bin width is presented

Comparison with other experiments

ALICE : R_{pPb} vs p_T

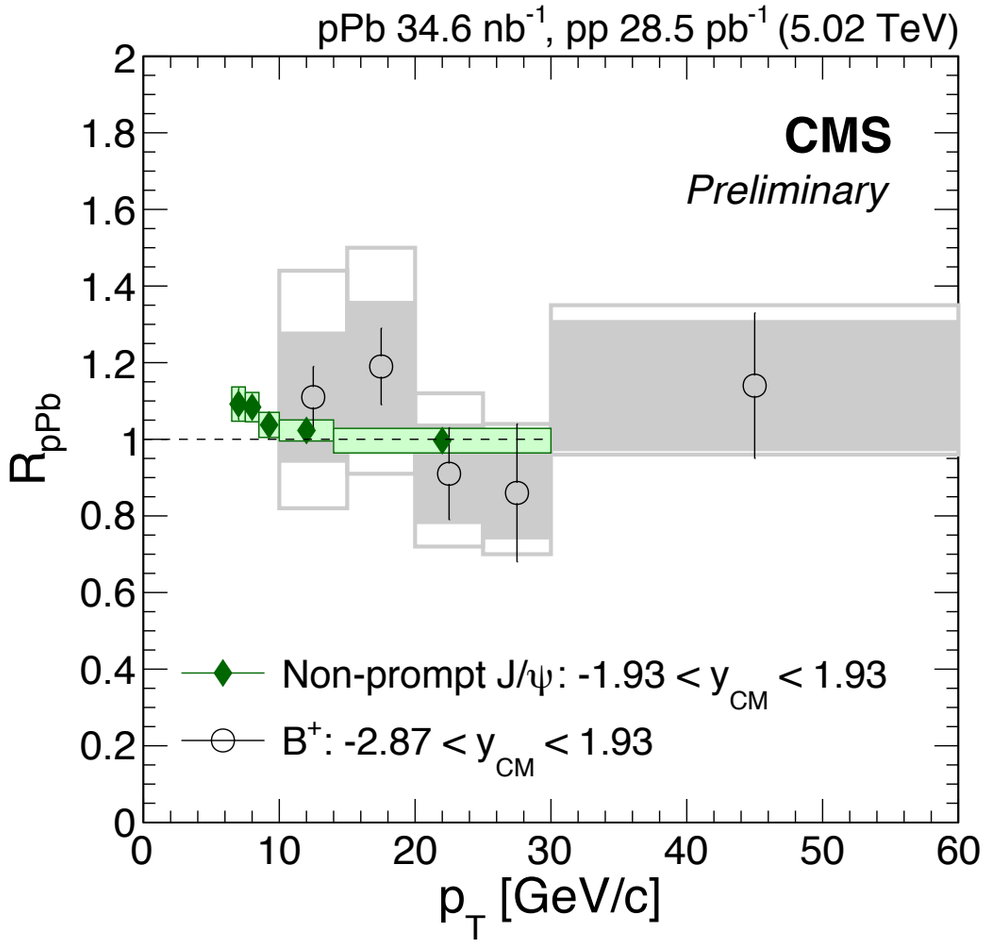
Approval for Public Twiki

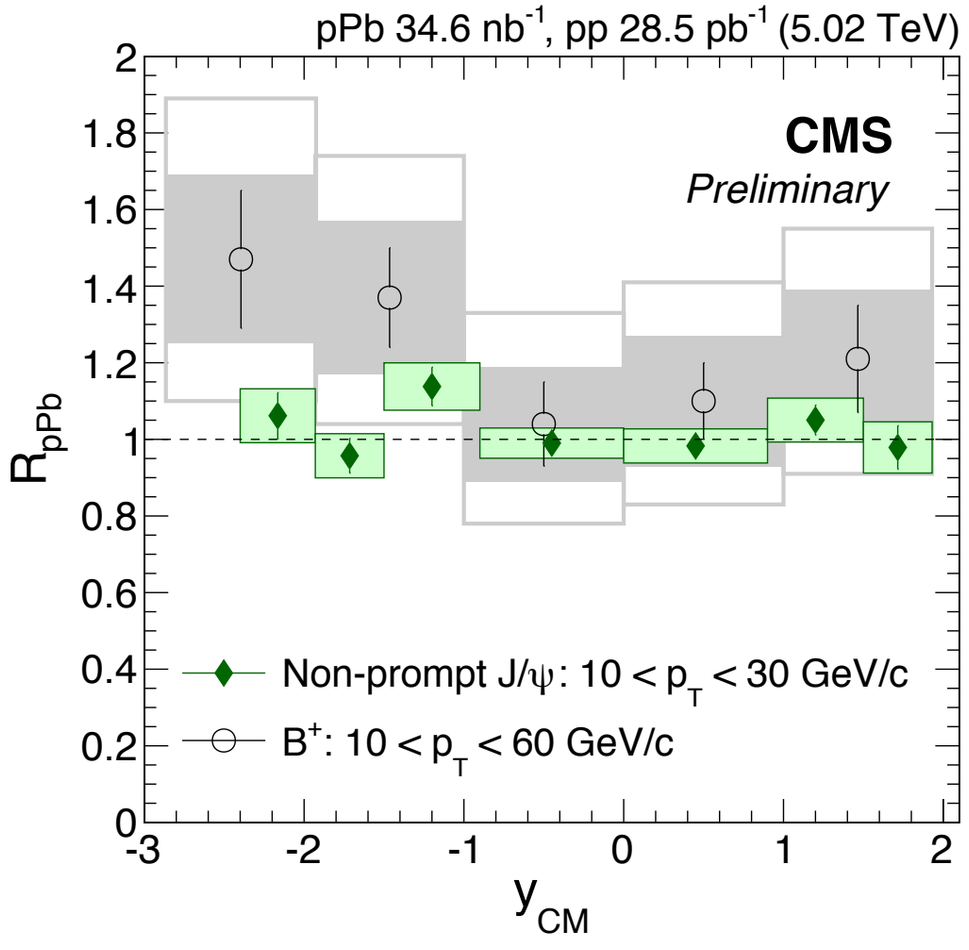




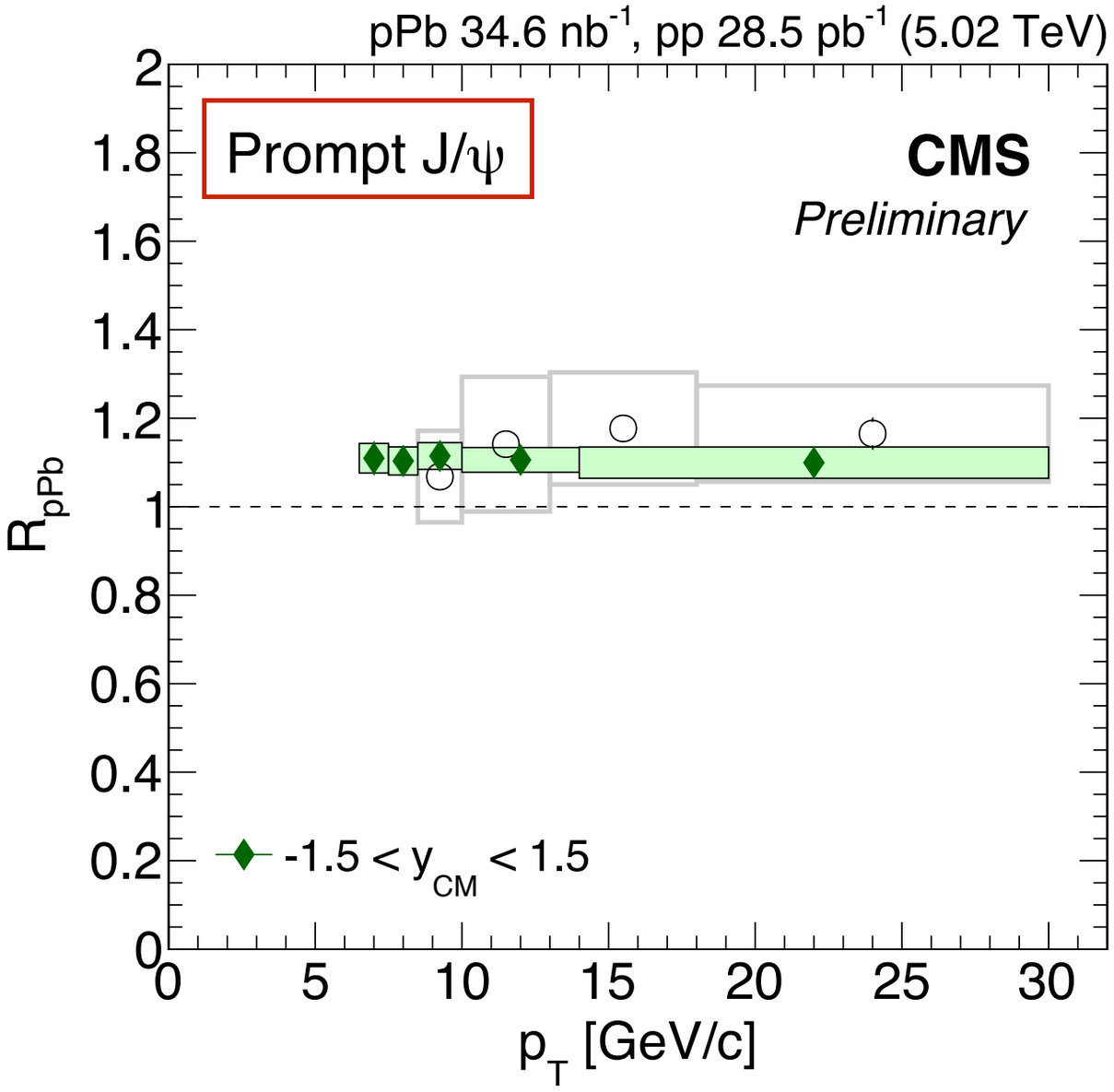
- N.B. 1) y_{CM} interval not overlap, 2) inclusive vs prompt, 3) ALICE : extrapolated pp
- Despite, general trends in agreement
  - At forward, R_{pPb} decreases with decreasing p_T
  - At backward, $R_{pPb} \gtrsim 1$

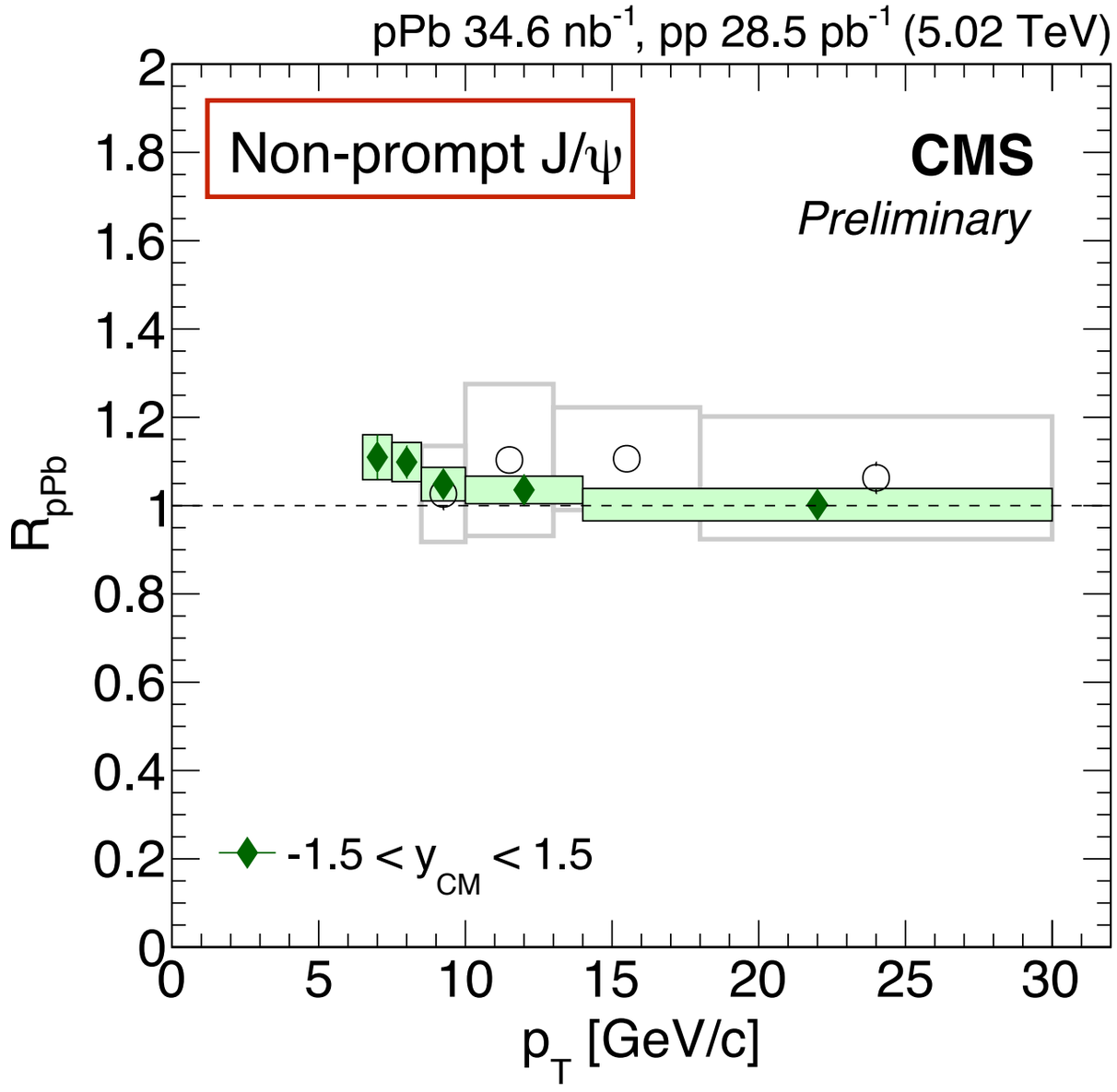
CMS B meson R_{pPb}





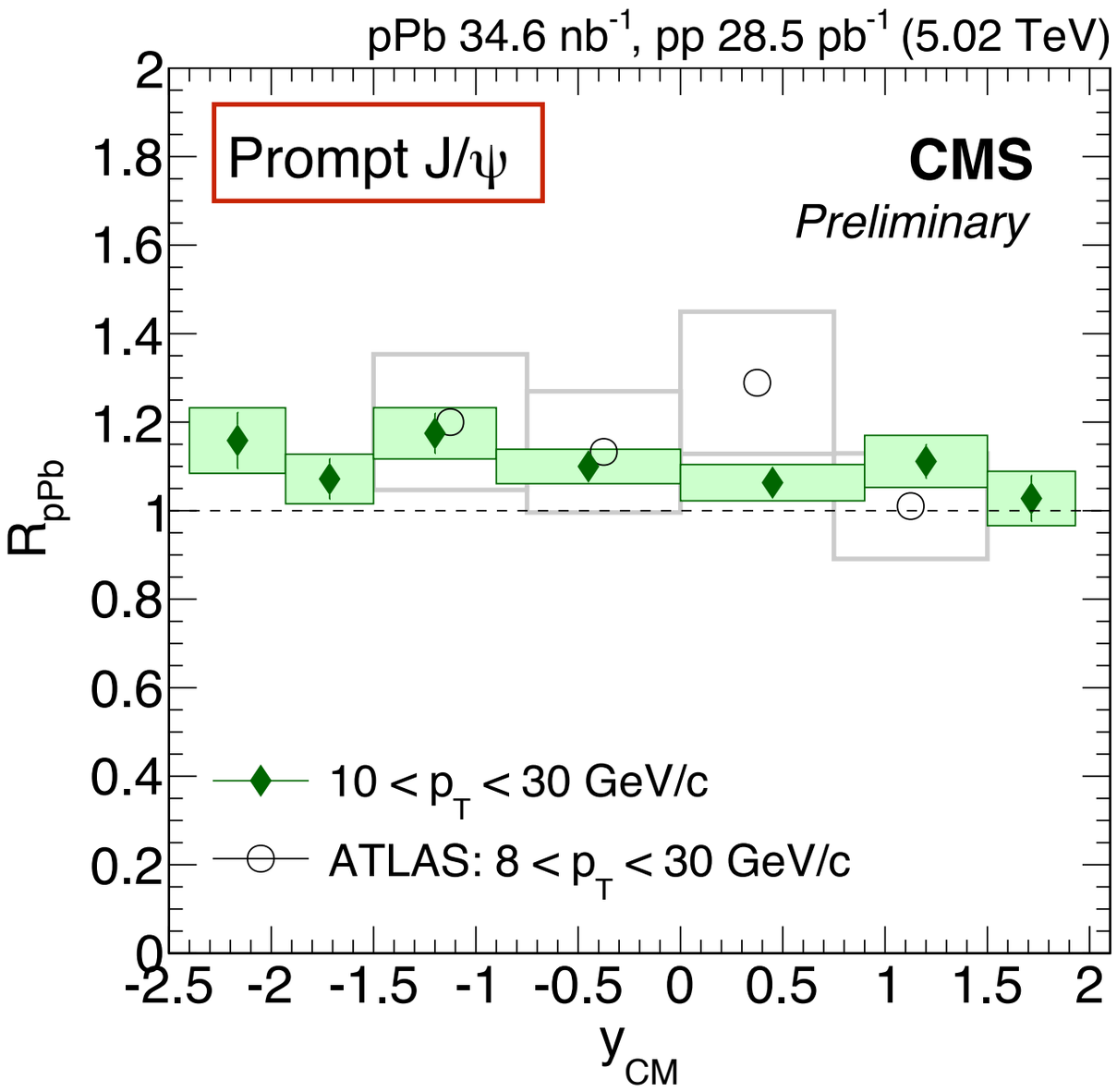
ATLAS : R_{pPb} vs p_T

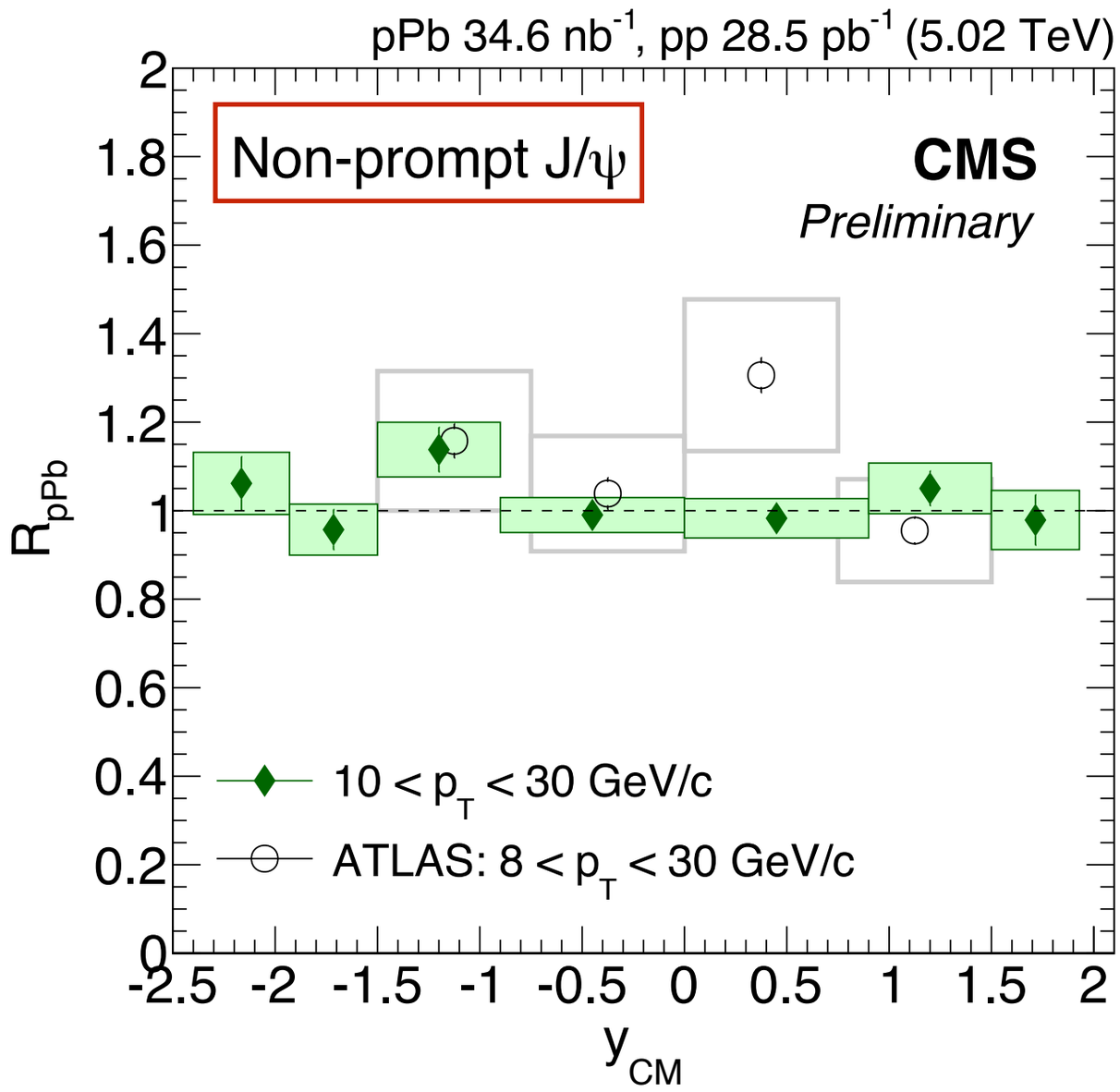




- Agreement in overlapping region ($R_{pPb} \gtrsim 1$)

ATLAS : R_{pPb} vs y

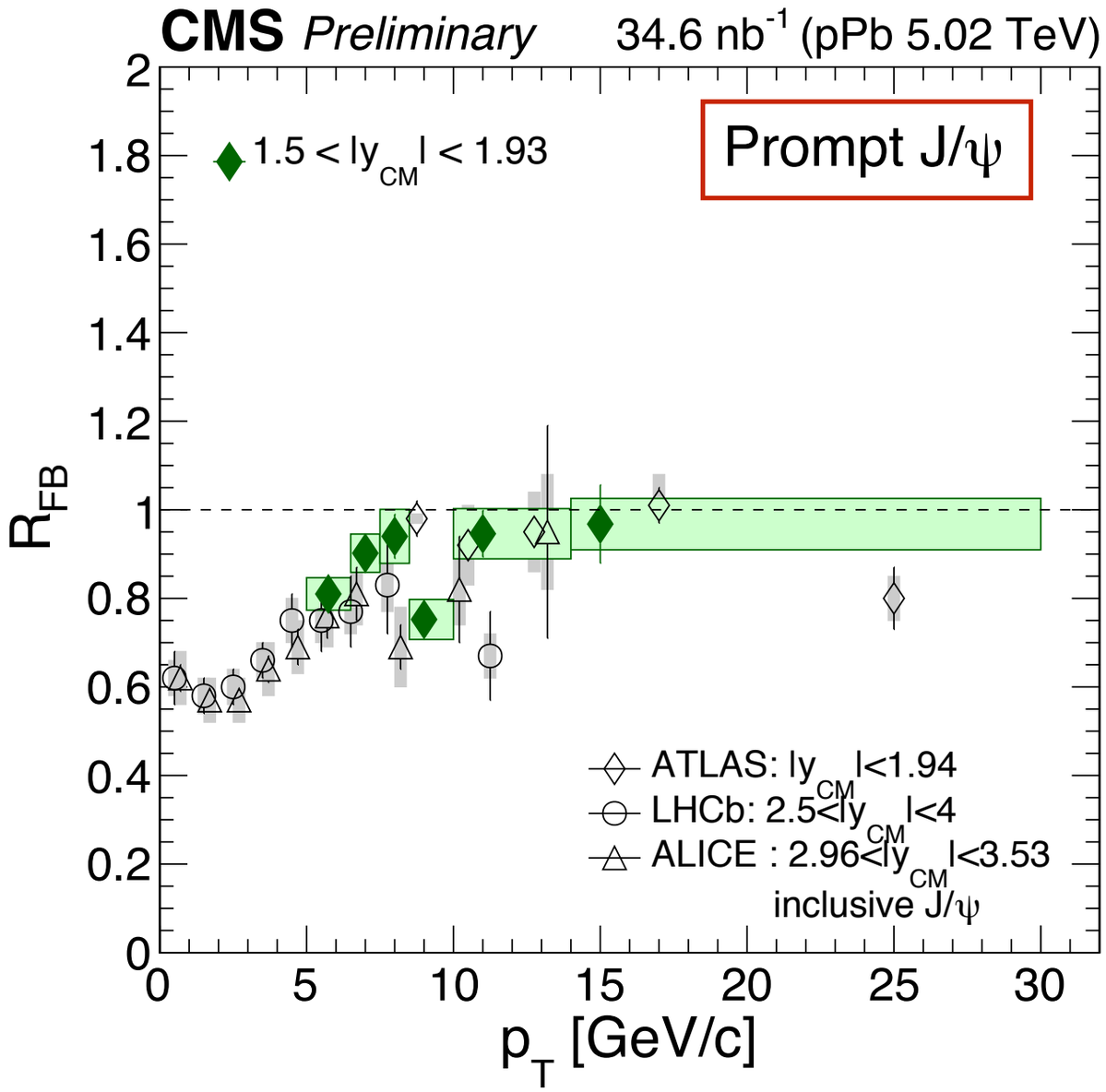


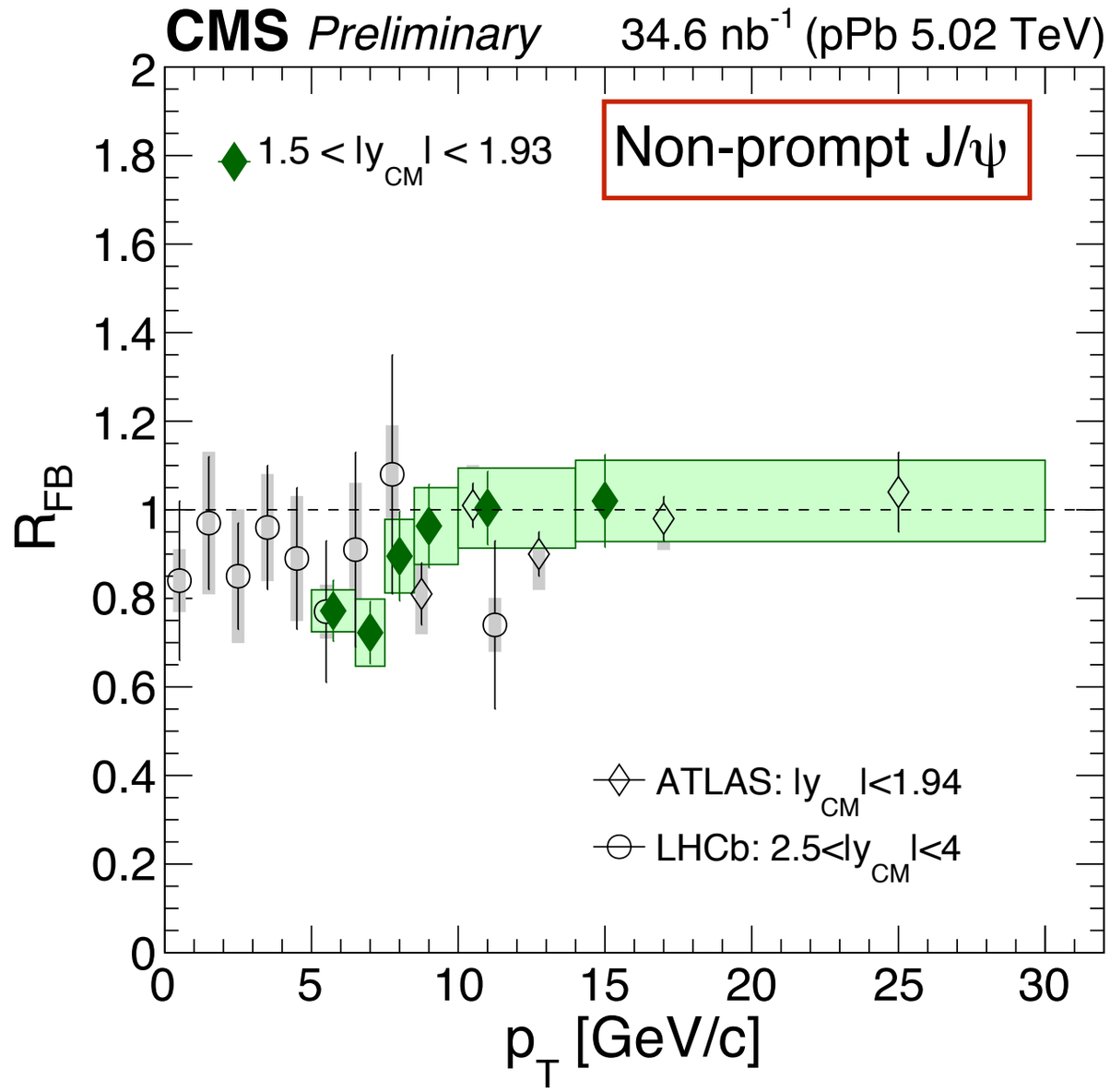


- Agreement in overlapping region ($R_{pPb} \gtrsim 1$)

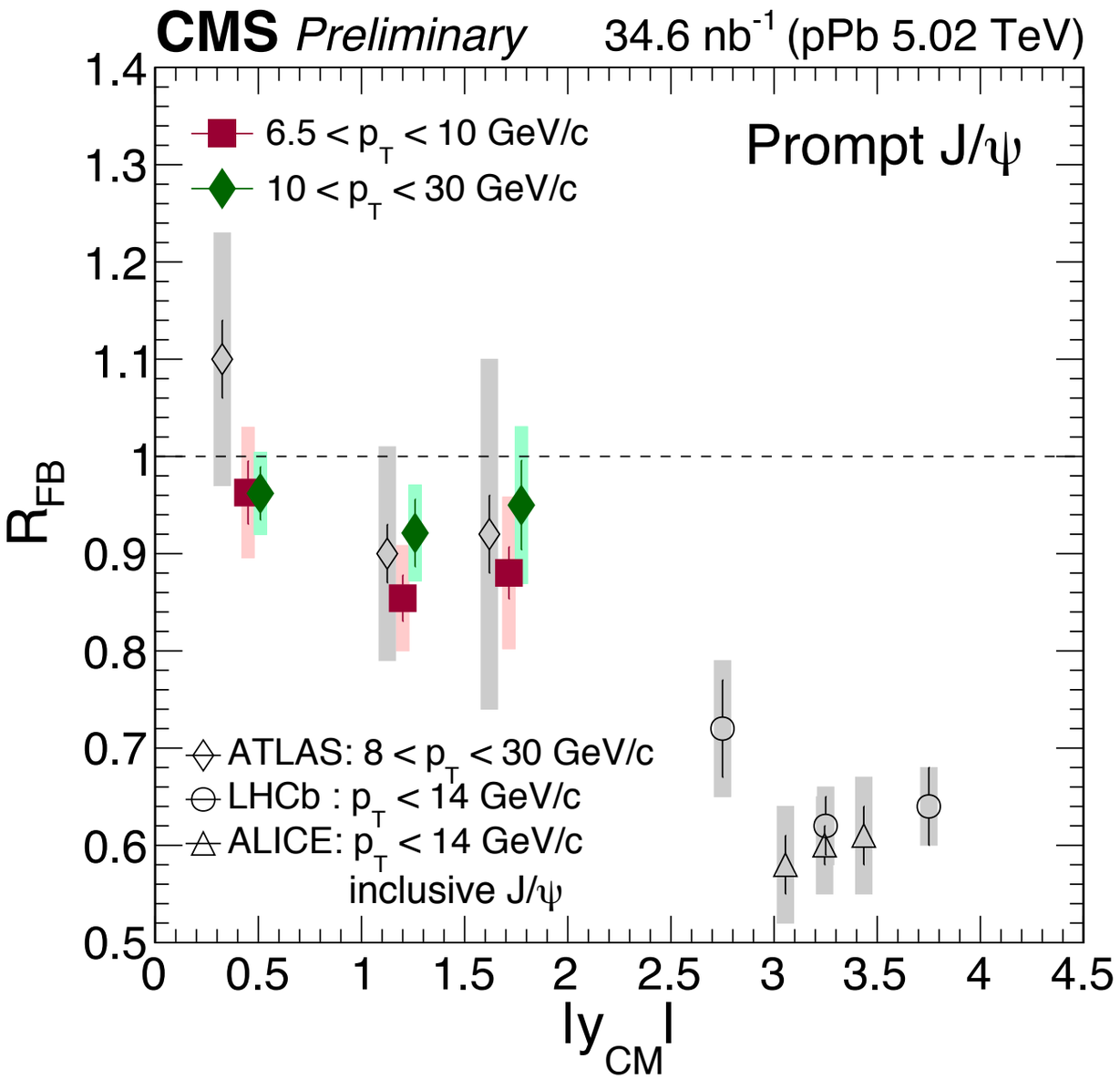
ATLAS, ALICE, LHCb : R_{FB} vs p_T

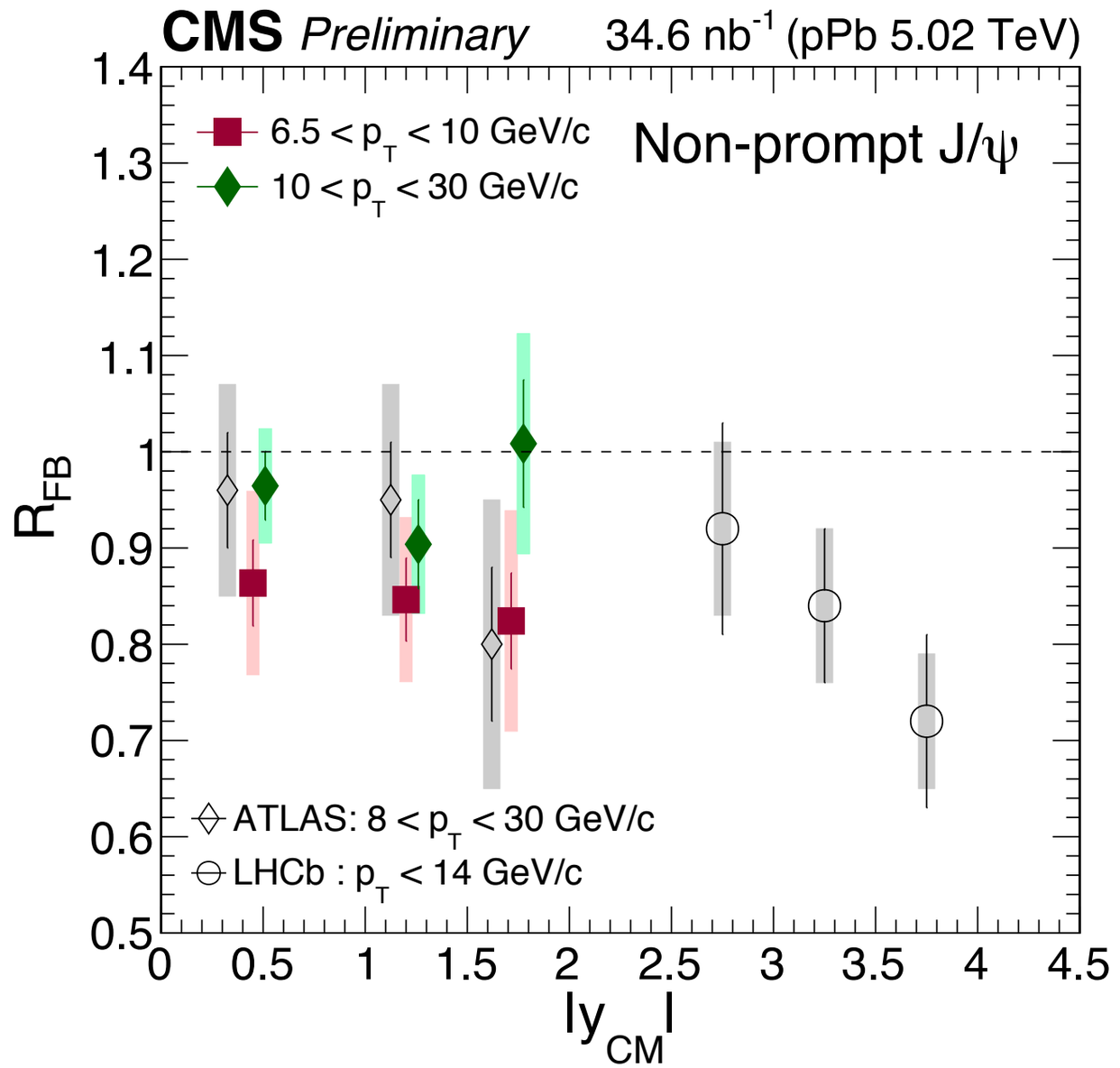
- Update of already approved plots





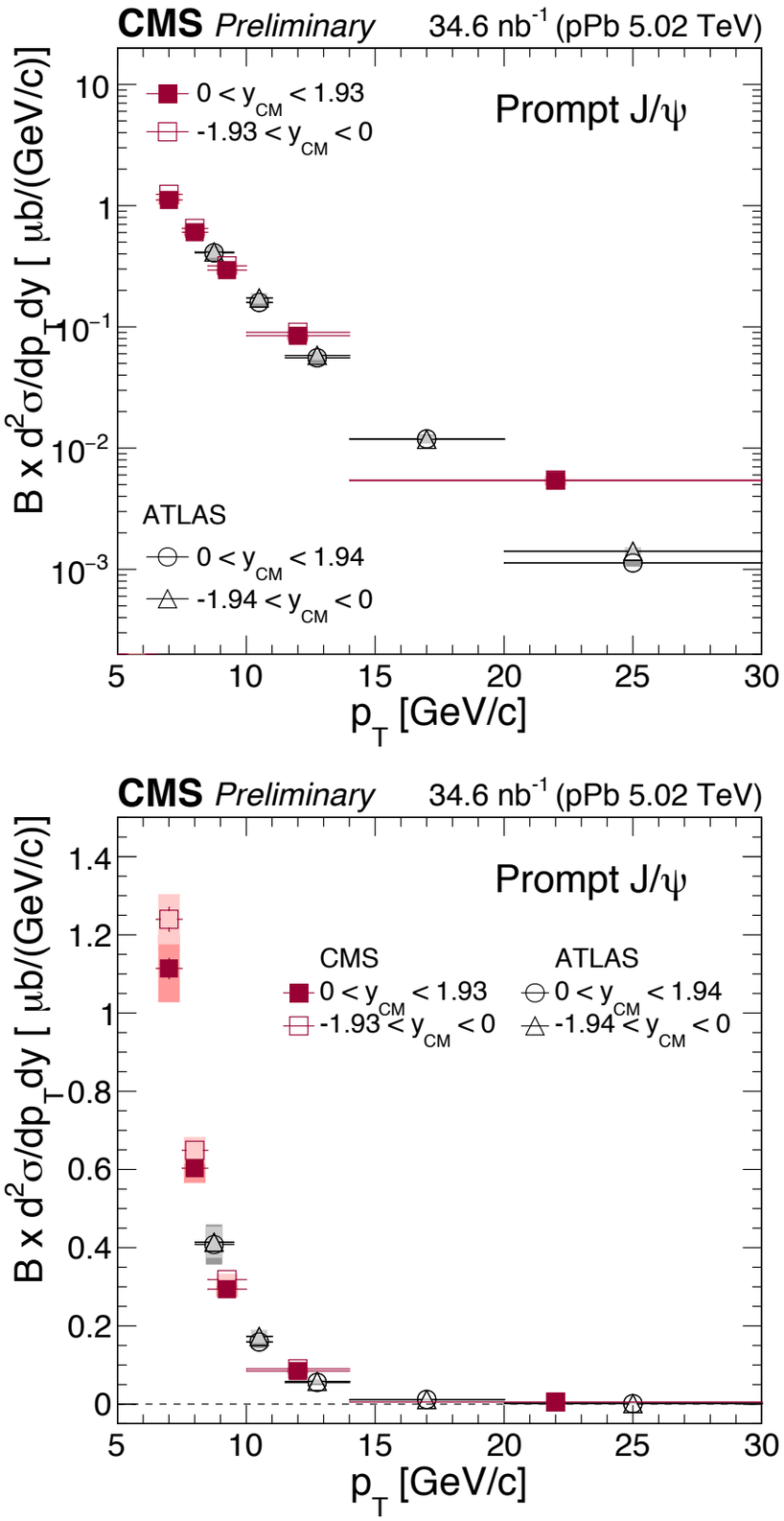
ATLAS, ALICE, LHCb : R_{FB} vs y

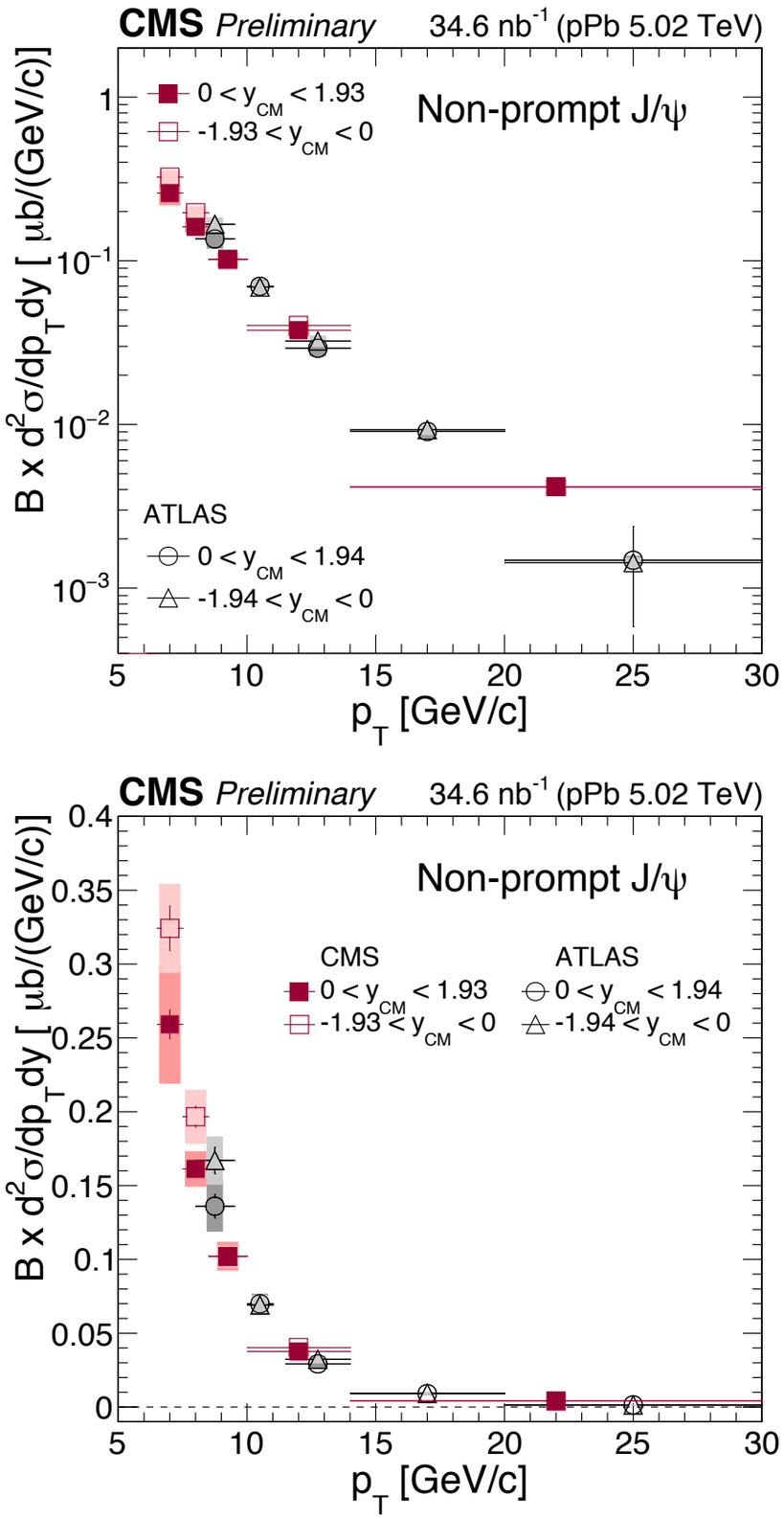




ATLAS : cross sections

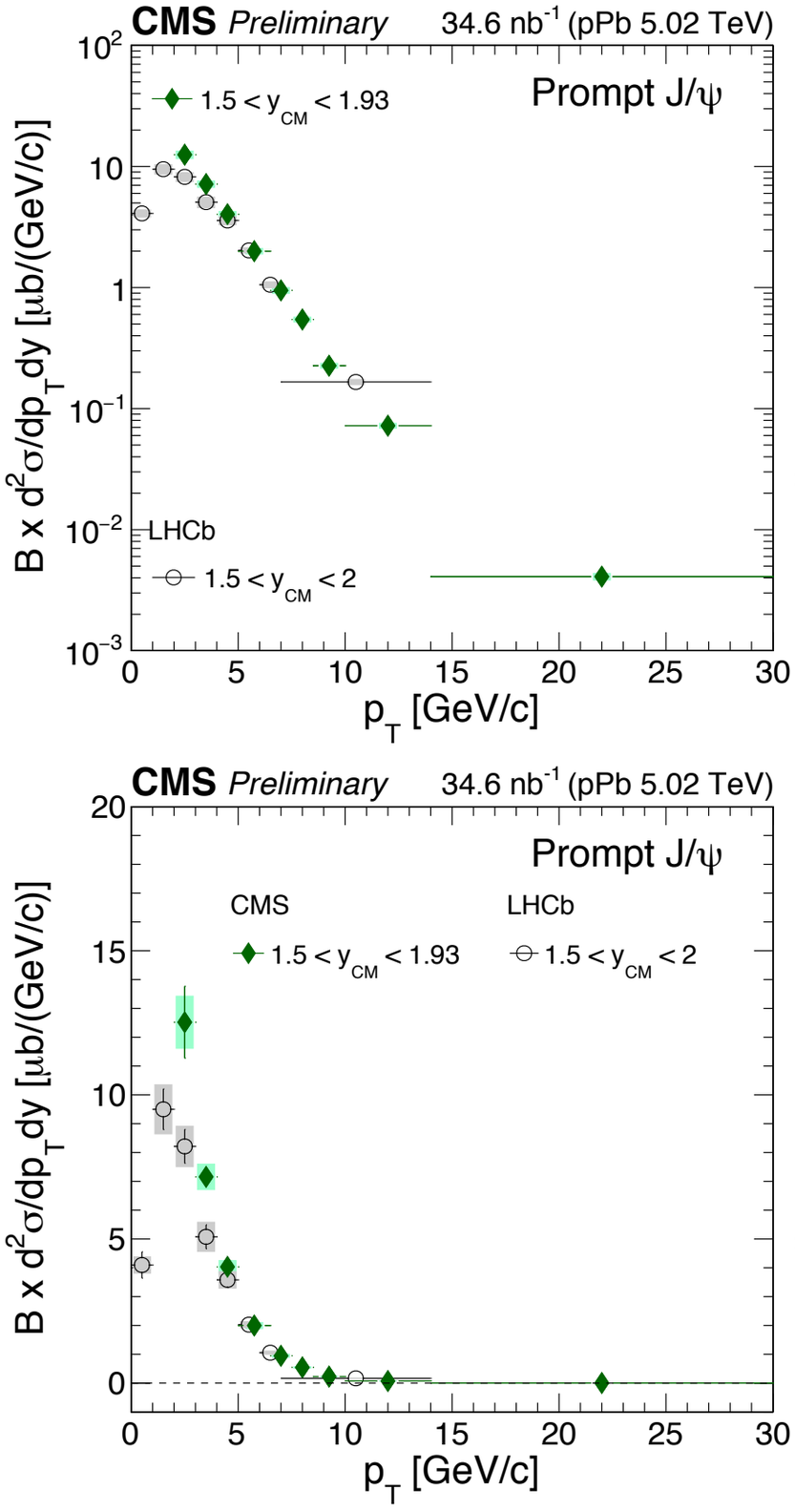
- Update of already approved plots

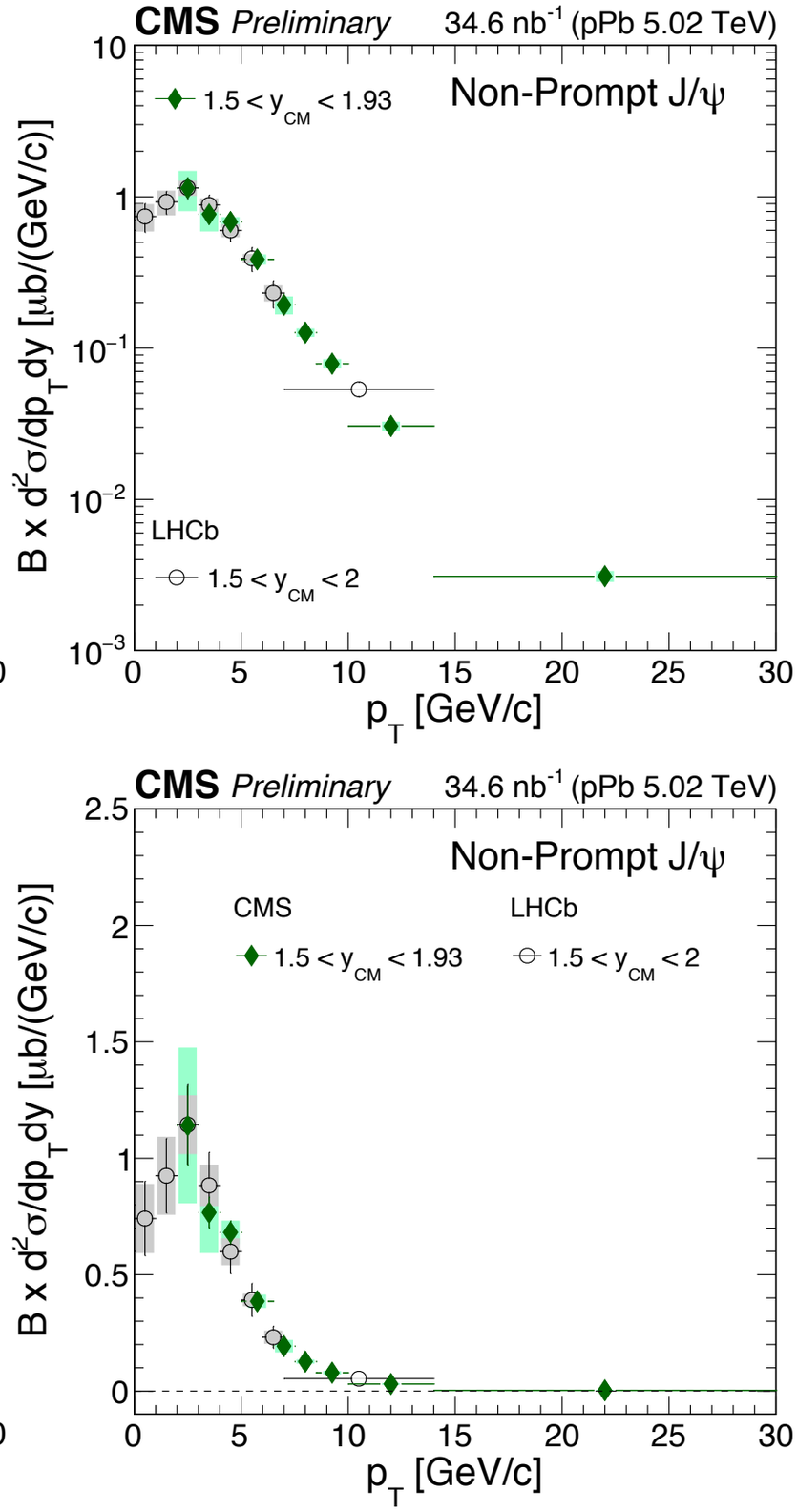




LHCb : cross sections

- Update of already approved plots





Backup

Re-approval homework

- 1) Discrepancy between p_T plot(S21) and rapidity plot(S22)
  - S21 : was correctly calculated
  - S22 : We correct for pile-up rejection (~4%) in case of pPb,
    but this was also applied to pp by a bug in the macro -> Now fixed

- 2) Propagation of uncertainties when combining bins -> fixed

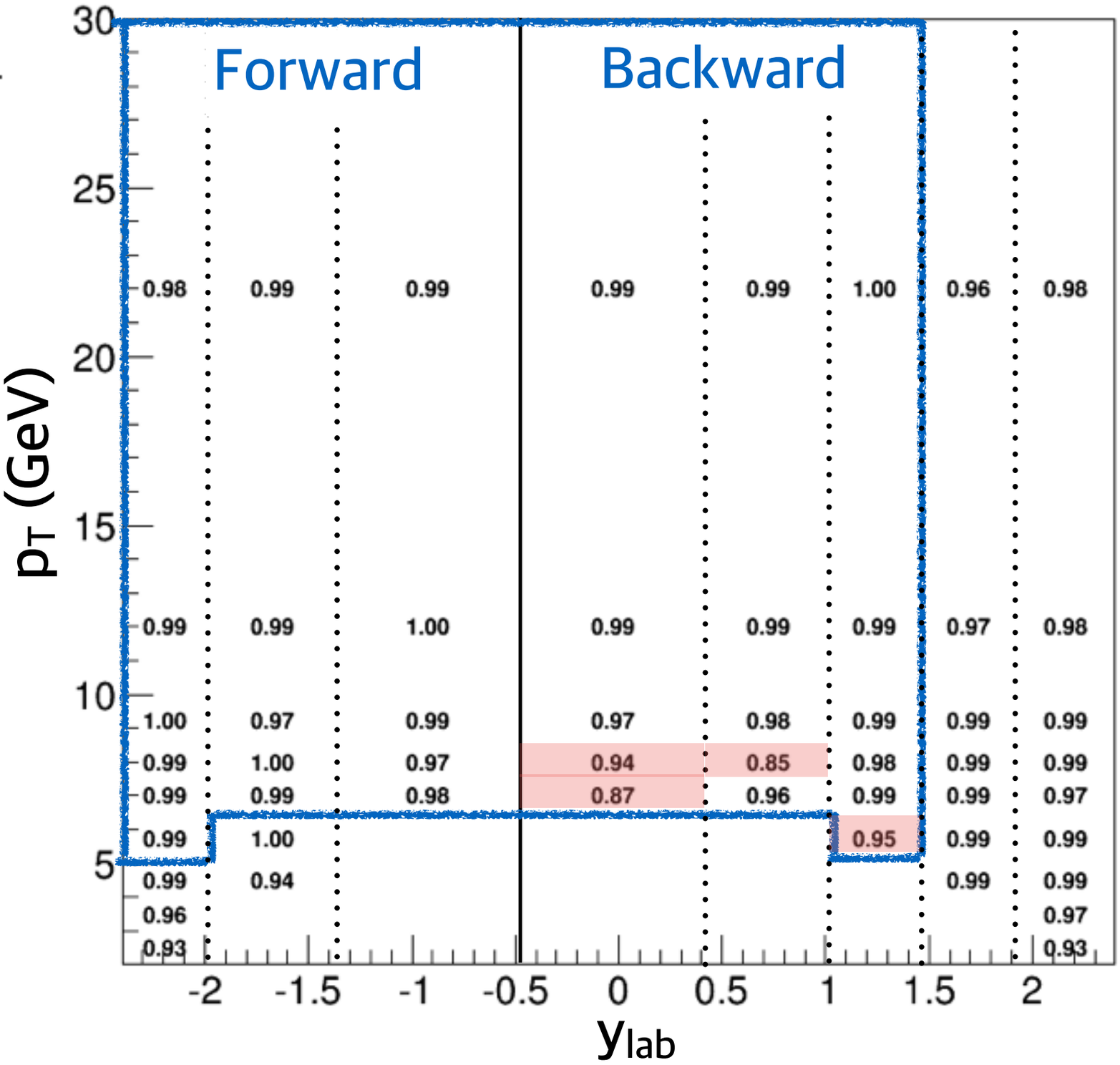
- 3) Plot style
  - Non-zero suppressed plots -> Done (all plots have common y-axes [0, 1.8])
  - Remove triangle points -> Done
  - Non-homework, but my preference : (extend x-axis and include bin width)

- 1) and 2) enter only in rapidity dependence
- Twiki : https://twiki.cern.ch/twiki/bin/view/CMS/HIN14009CommentsReapproval

Lifetime error cut

- Whole table for S10 (comments from Wei)

$$\text{Ratio} = \frac{\text{Efficiency with lifetime error cut}}{\text{Efficiency without lifetime error cut}}$$



- Blue line indicates the kinematic coverage for R_{FB} measurement
- 1-3 % in most bin

error propagation

- Combining bins : $(F \pm \sigma_F) = (A \pm \sigma_A) + (B \pm \sigma_B)$

- Reapproval : quadratic sum of relative errors
  - This should be applied only for multiplication and division

$$(\frac{\sigma_F}{F}) = \sqrt{(\frac{\sigma_A}{A})^2 + (\frac{\sigma_B}{B})^2}$$

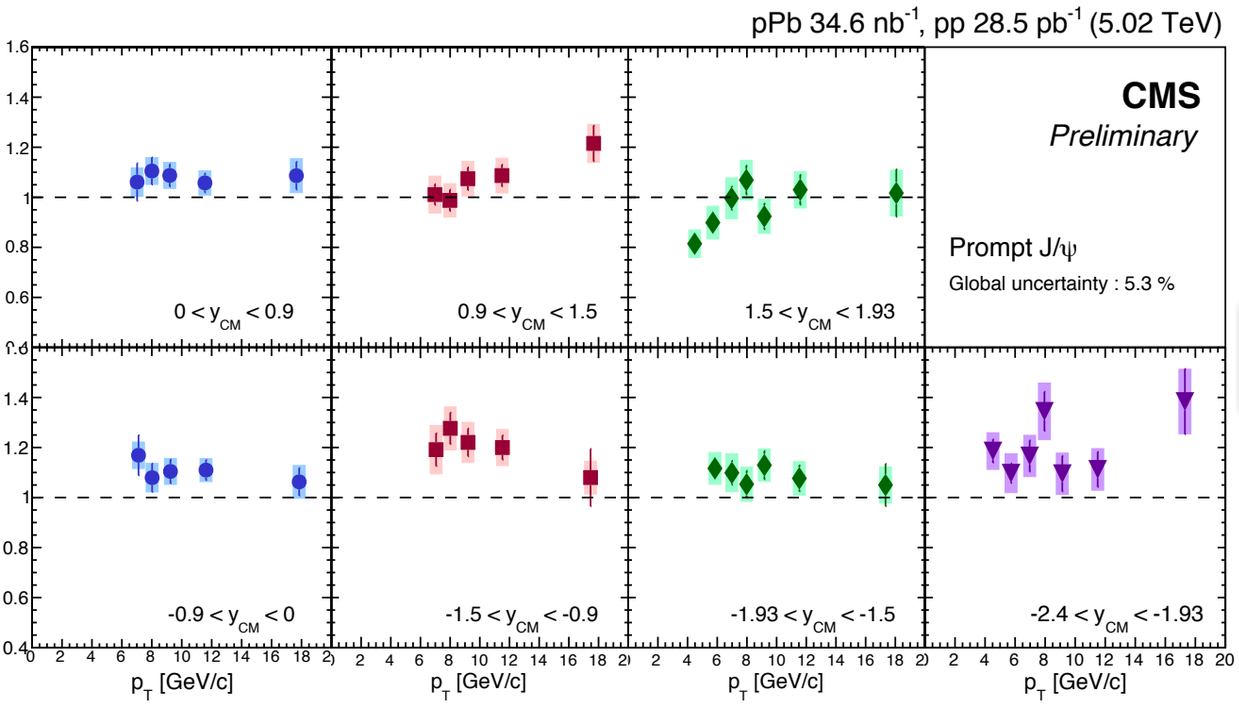
- Now : quadratic sum of absolute errors
  - properly take into account statistics (A,B) in each bin

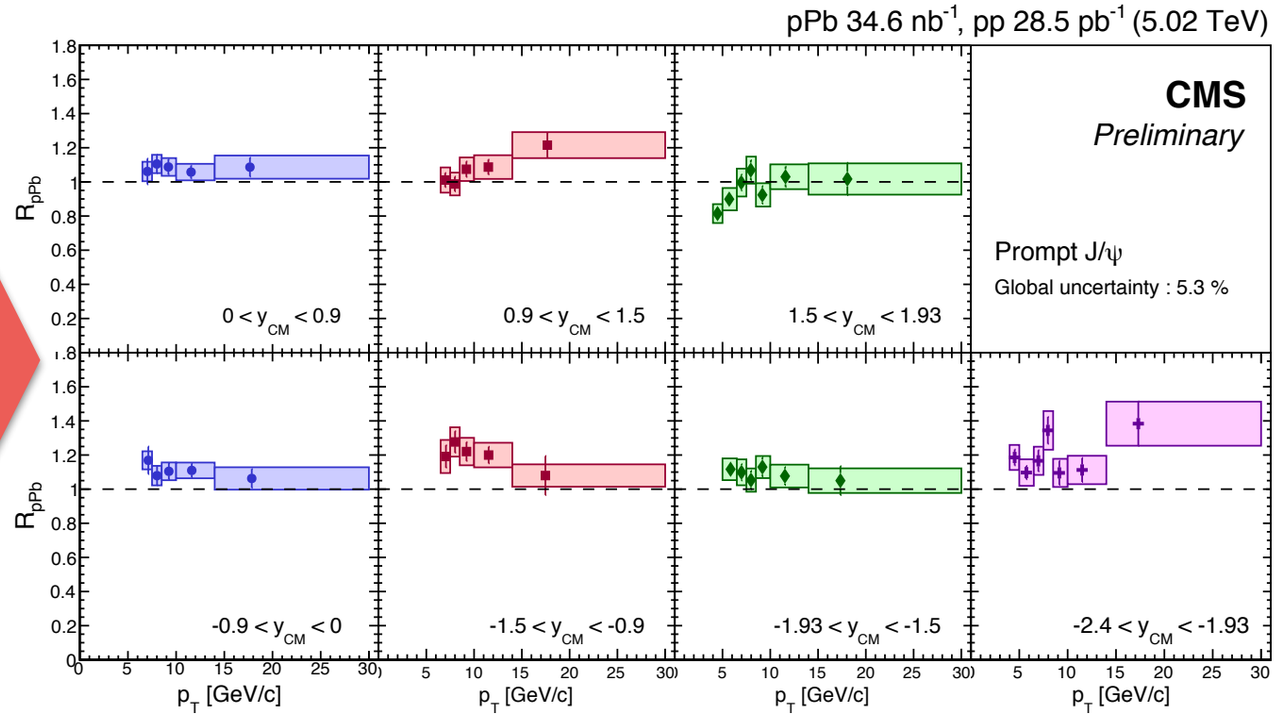
$$(\frac{\sigma_F}{F}) = \frac{\sqrt{\sigma_A^2 + \sigma_B^2}}{F}$$

Results

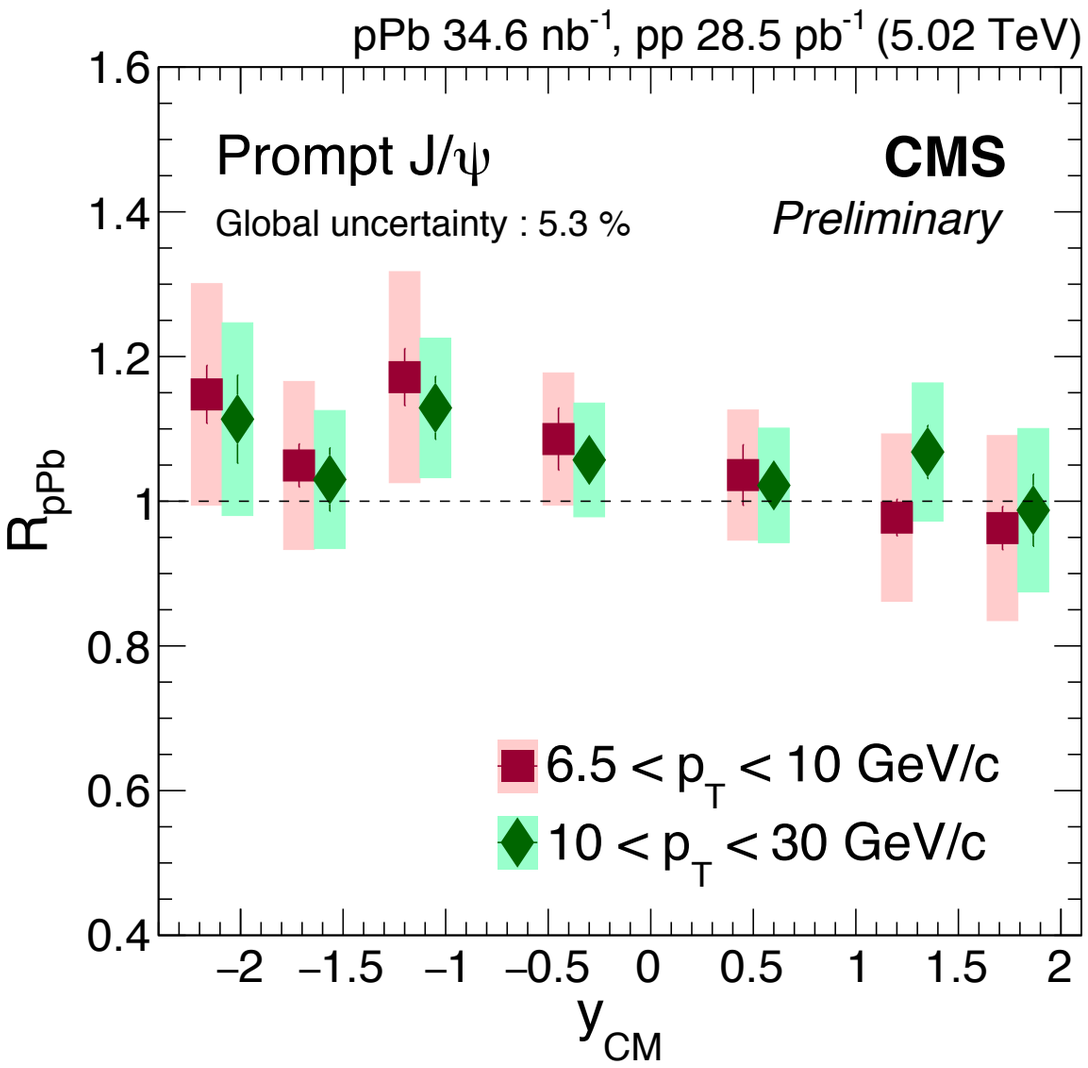
Prompt J/ψ : R_{pPb} vs p_T

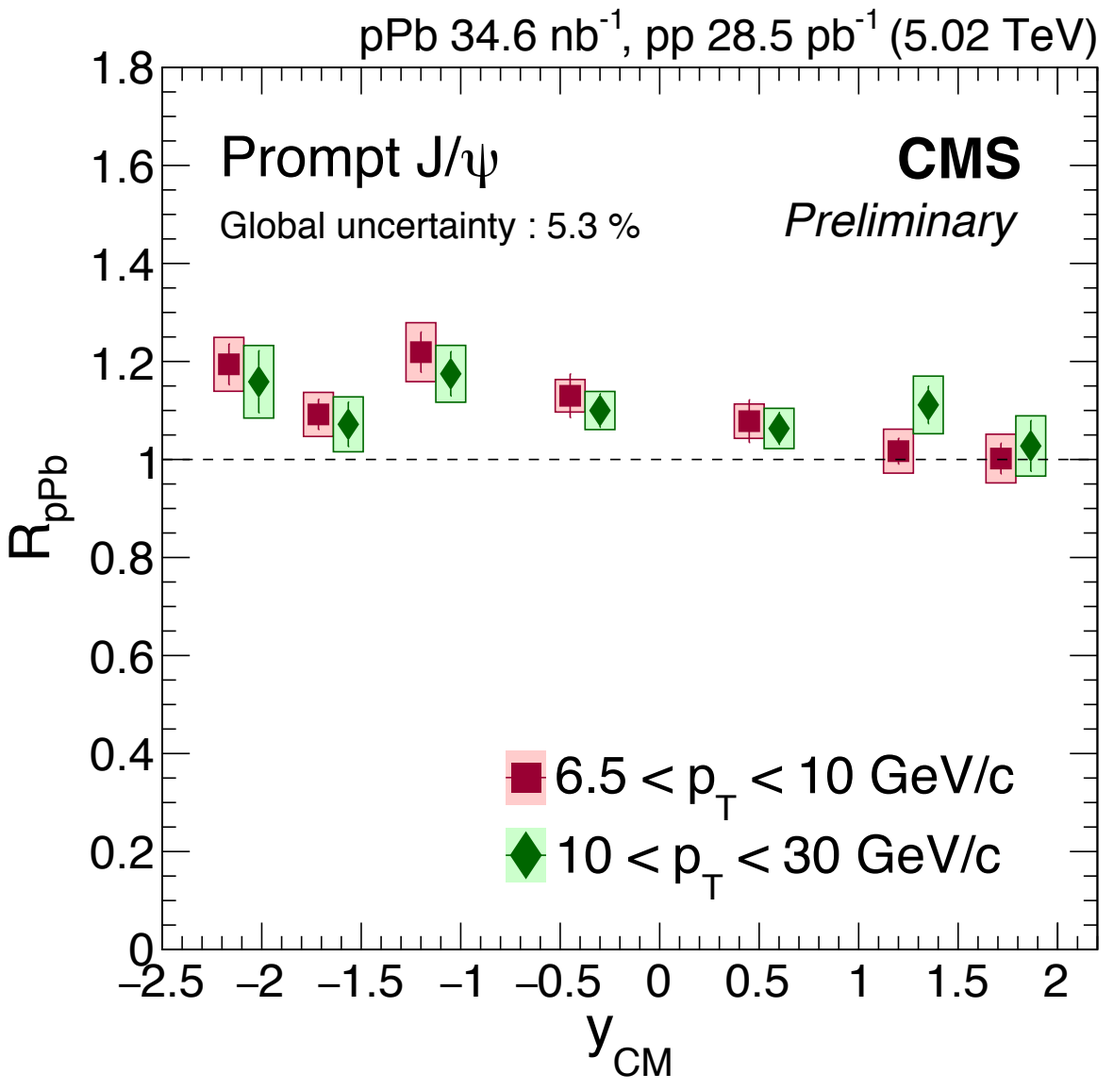
- y-axis [0, 1.8]
- x-axis extends to 30 GeV/c, and bin width is presented
- Triangle points are replaced (comments from Yenjie)





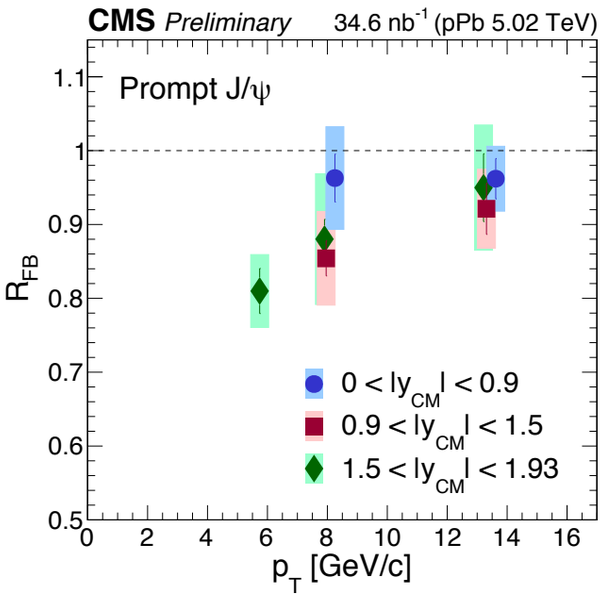
Prompt J/ψ : R_{pPb} vs y

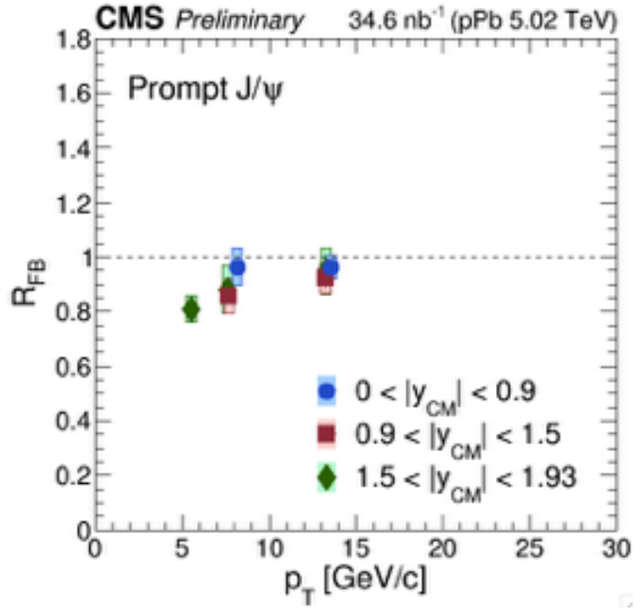




- y-axis [0, 1.8]
- Wrong normalization corrected (pile-up)
- Error propagation for bin-merging fixed
- Bin width is not presented : Any suggestions?
  (1) This is the only plot without bin-width (2) confusion from x-point shift

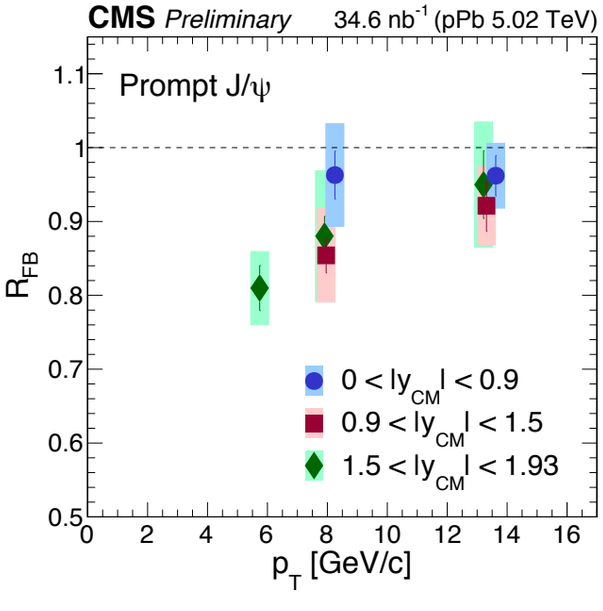
Prompt J/ψ : R_{FB} vs P_T

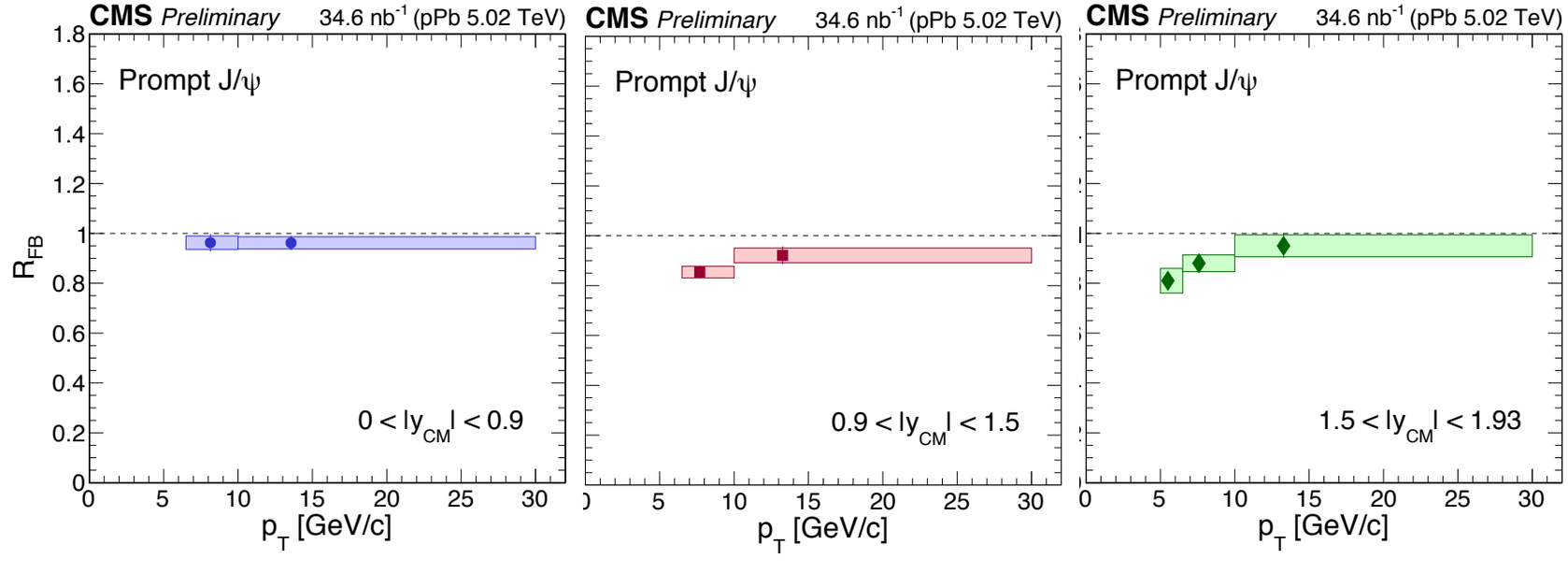




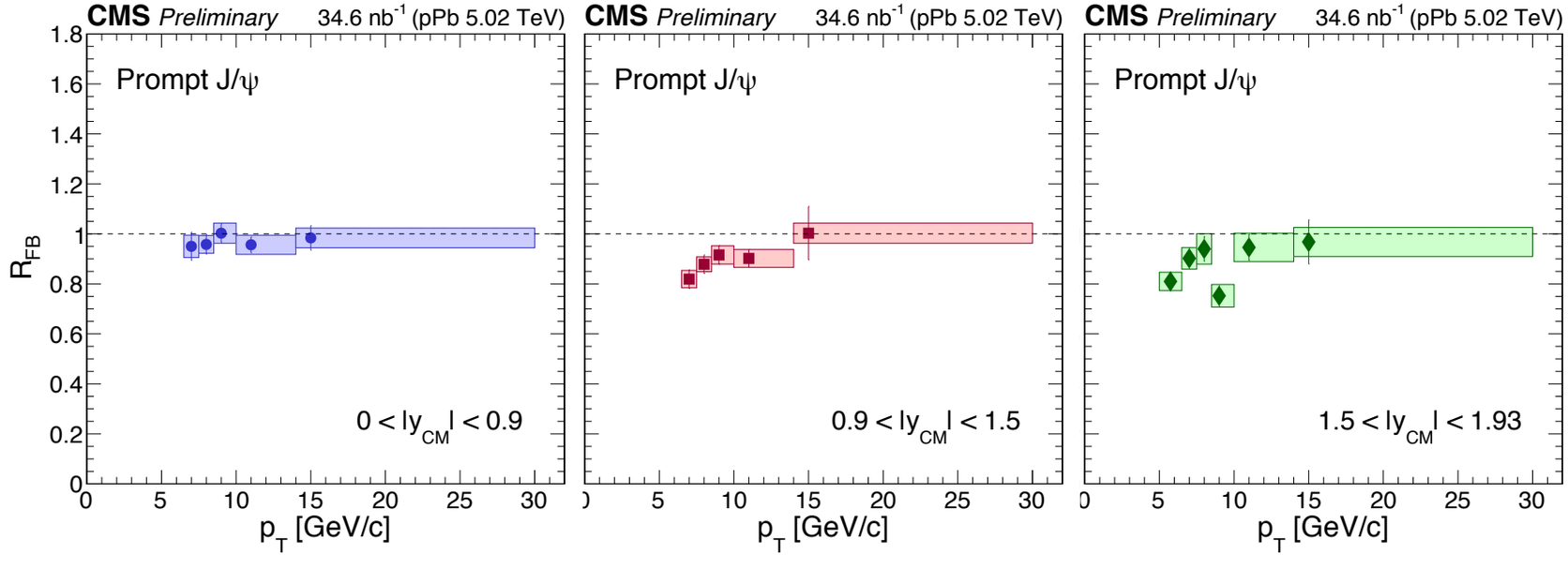
- Each rapidity range is not very distinguishable with the extension of x & y axes
- We already have finer bins in R_{pPb}, so keep consistency (Comments from Yenjie)

Prompt J/ψ : R_{FB} vs P_T

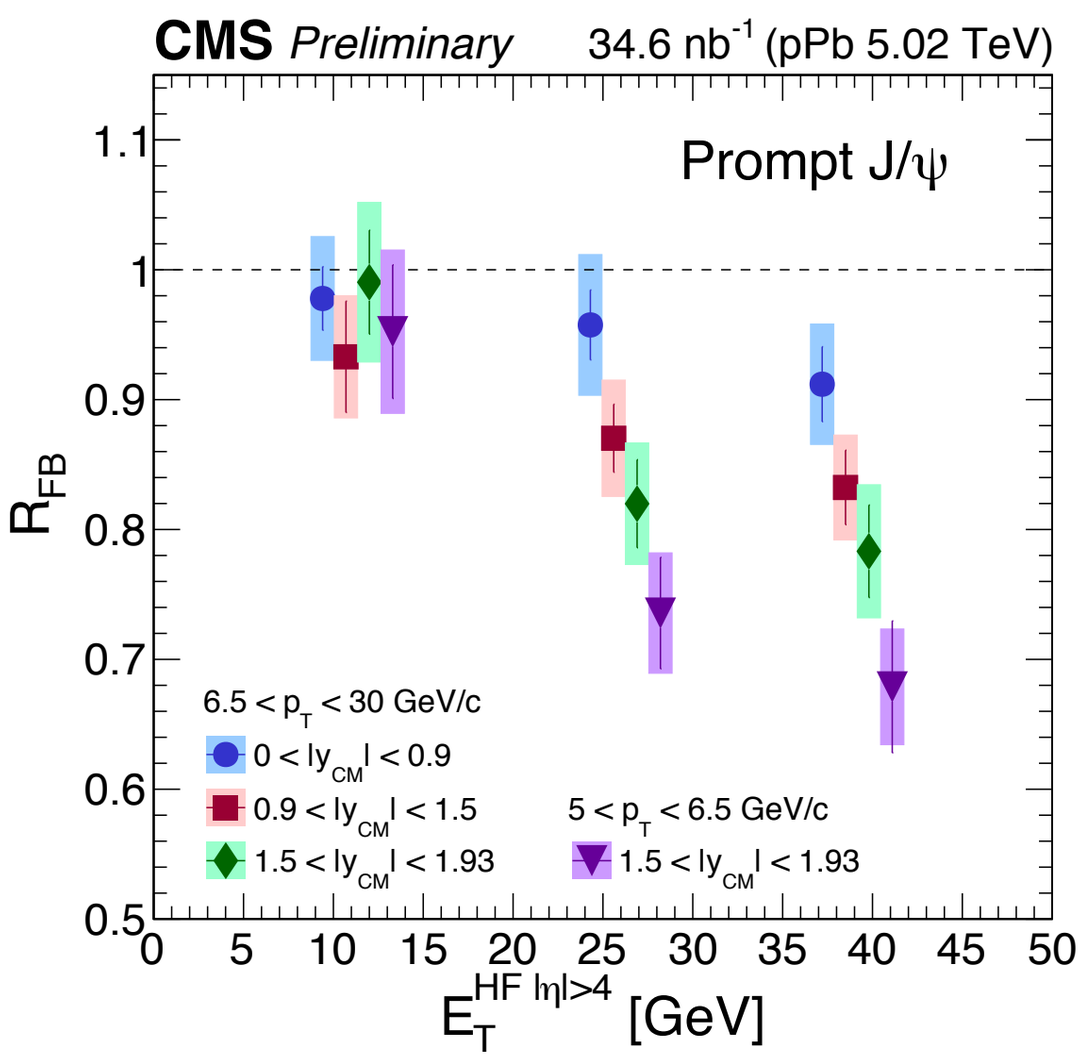


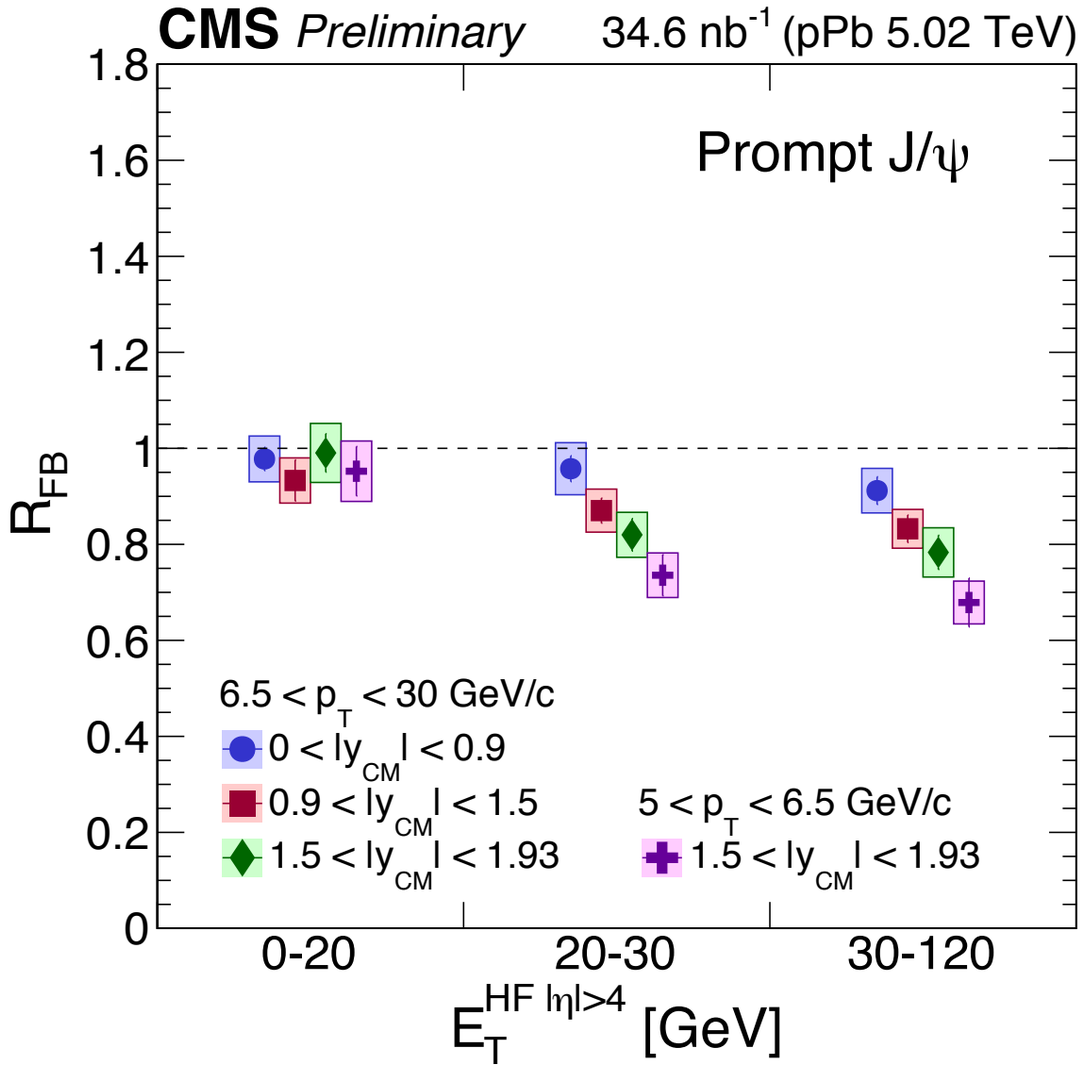


- Same binning with R_{pPb}



Prompt J/ψ : R_{FB} vs E_T

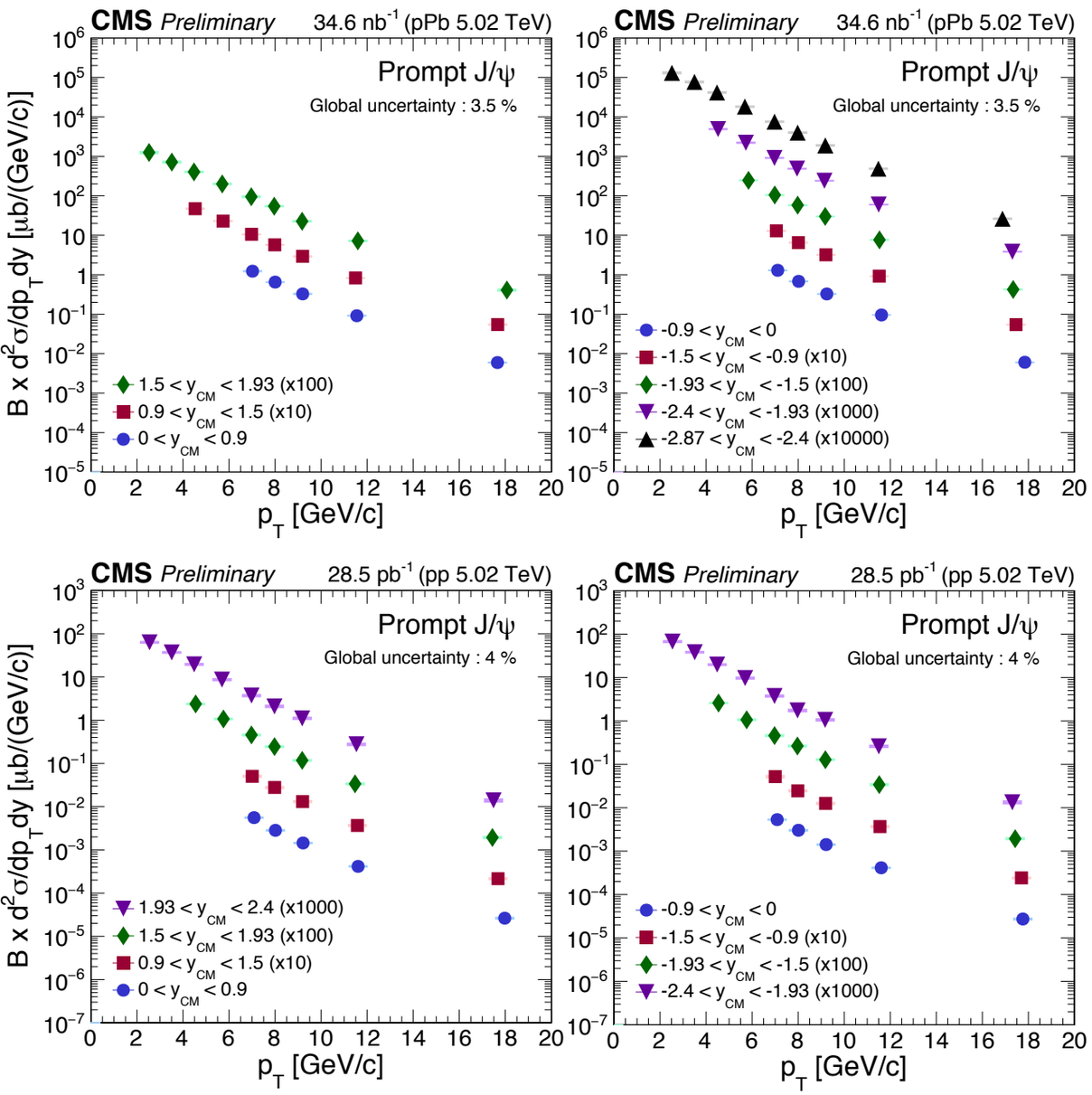


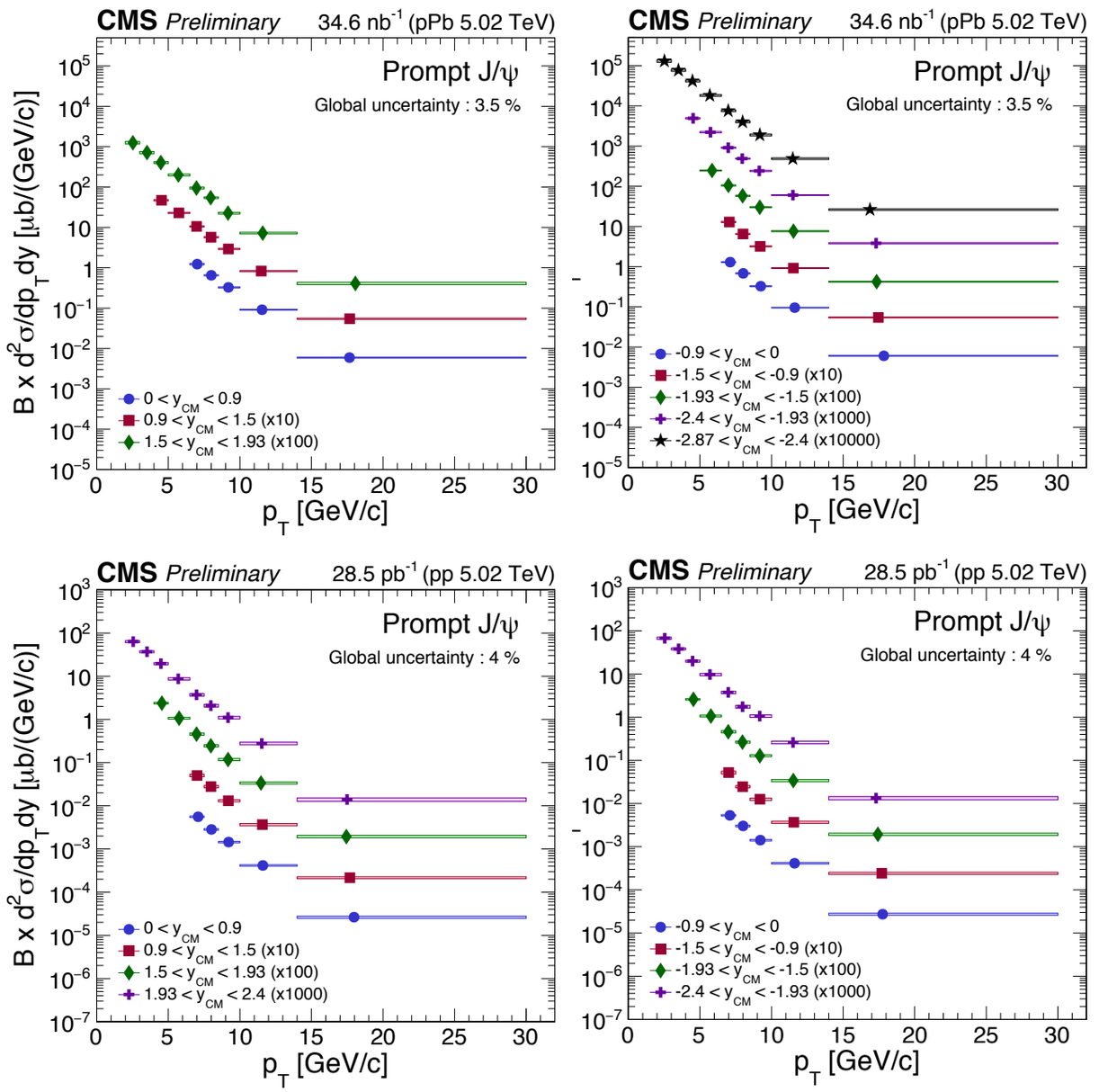


- y-axis [0, 1.8]
- Triangle points are replaced (comments from Yenjie)
- x-label os changed because x-point shift can be misleading
  e.g.) different mean E_T.. (Comments from George)

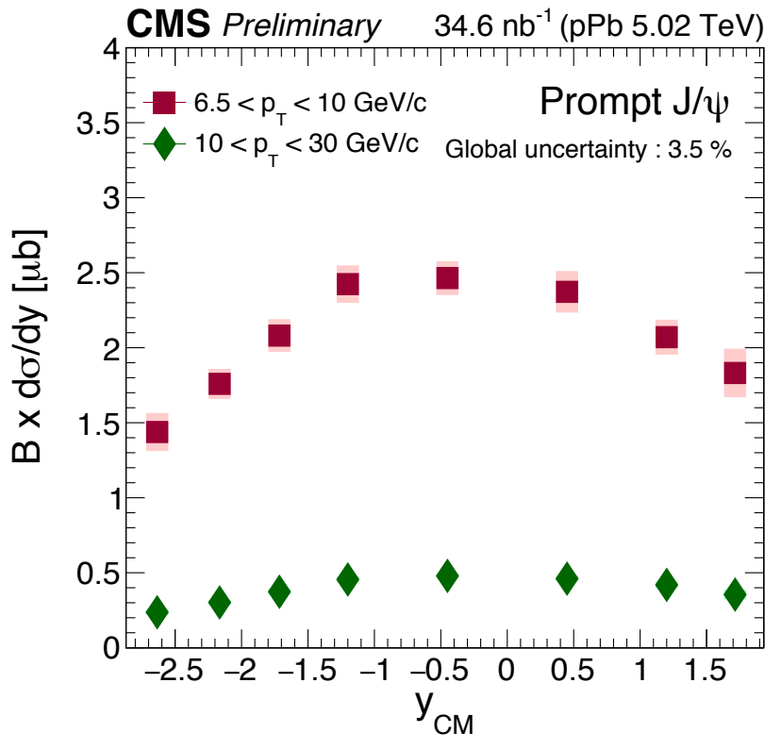
Prompt J/ψ : cross sections vs p_T

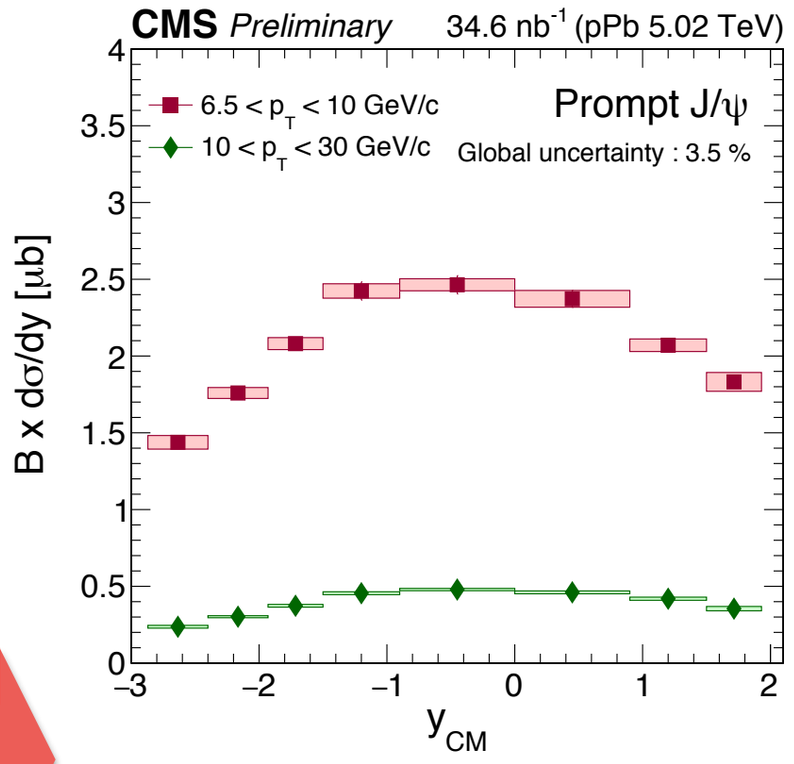
- x-axis extends to 30 GeV/c, and bin width is presented
- Triangle points are replaced (comments from Yenjie)

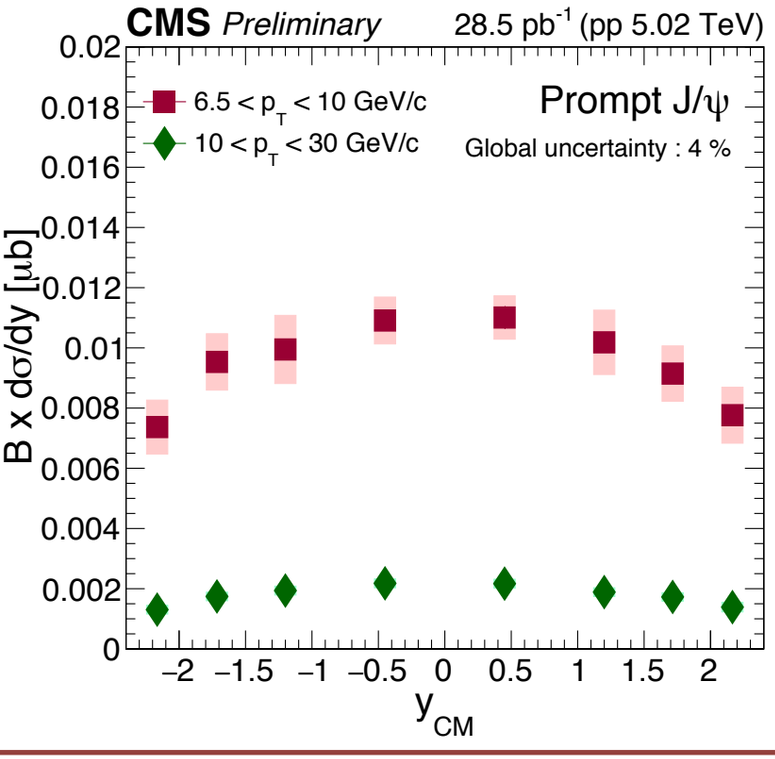


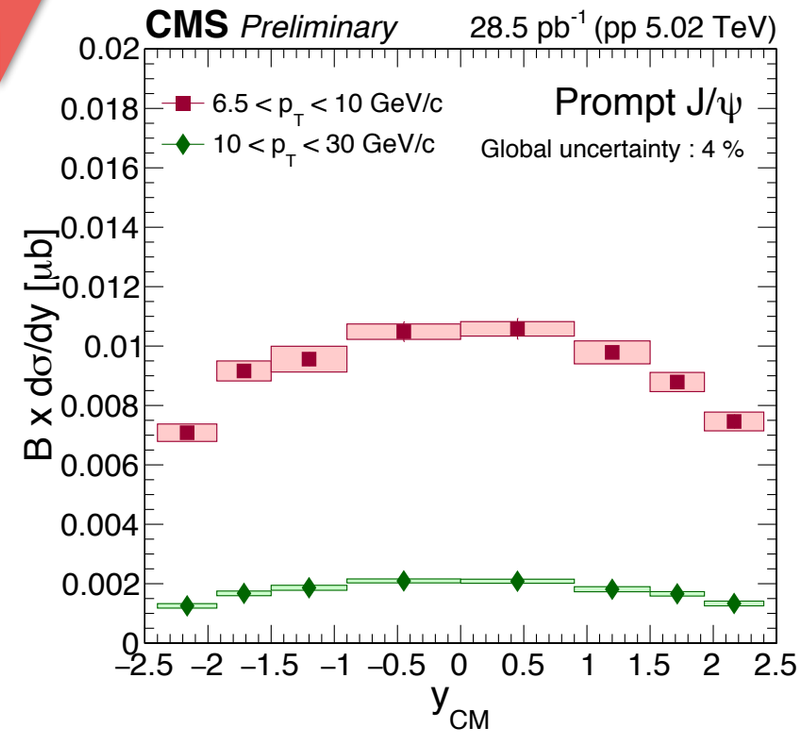


Prompt J/ψ : cross sections vs y



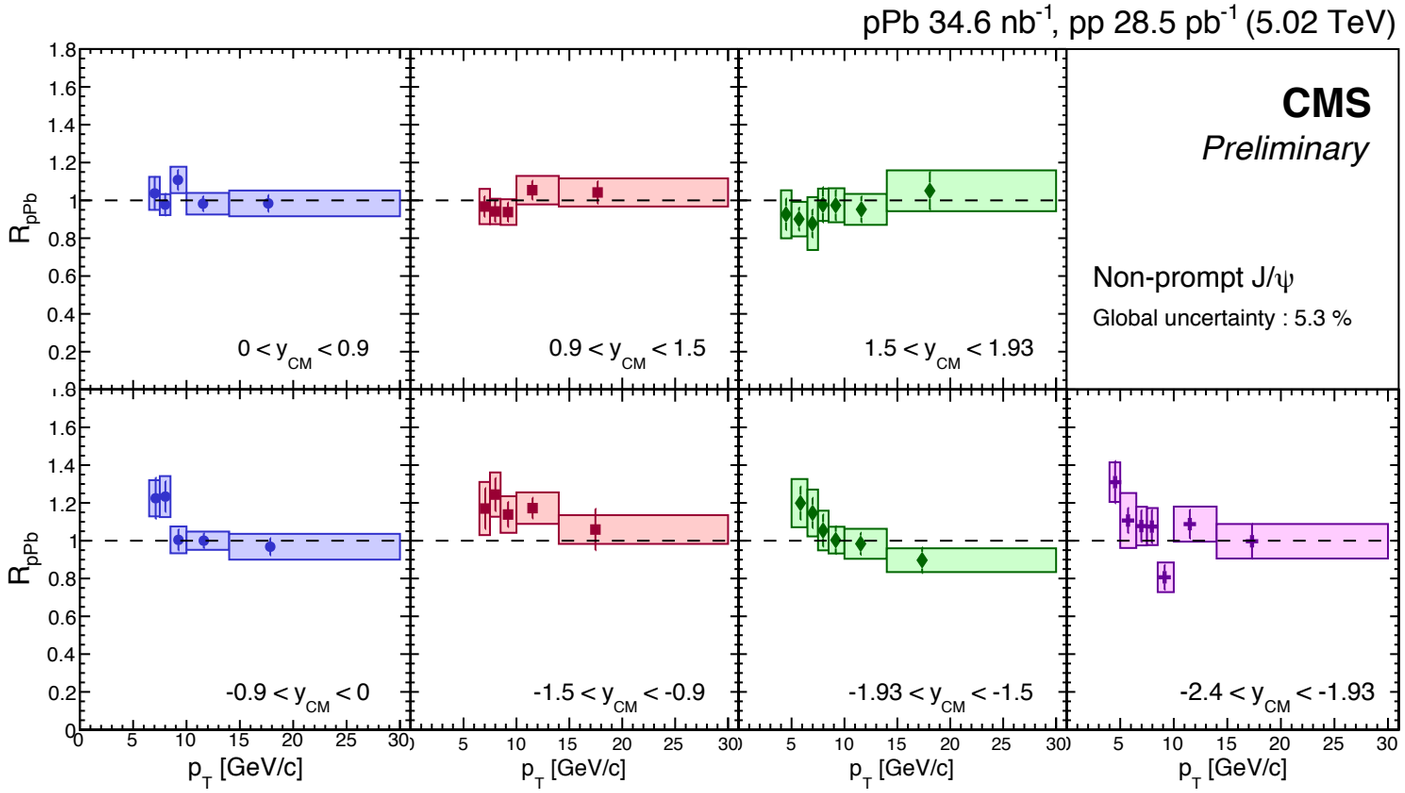


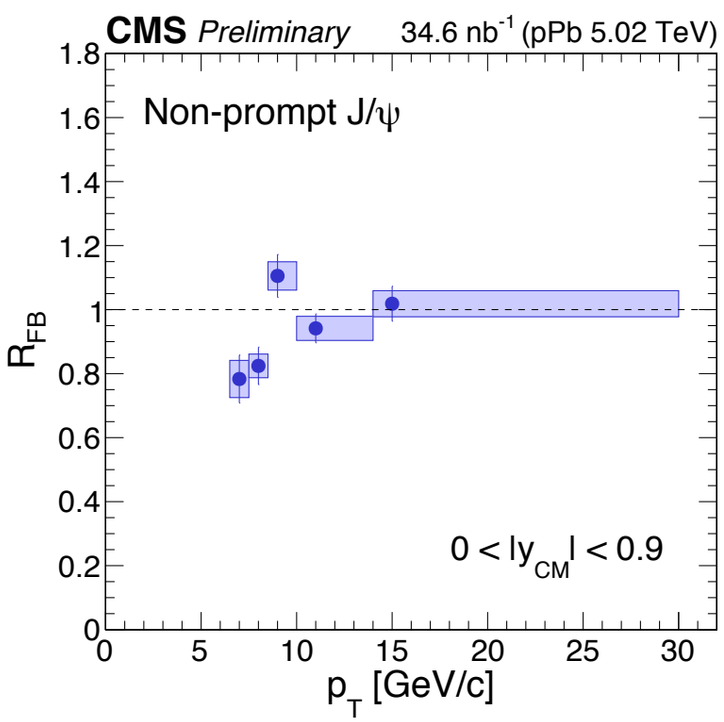


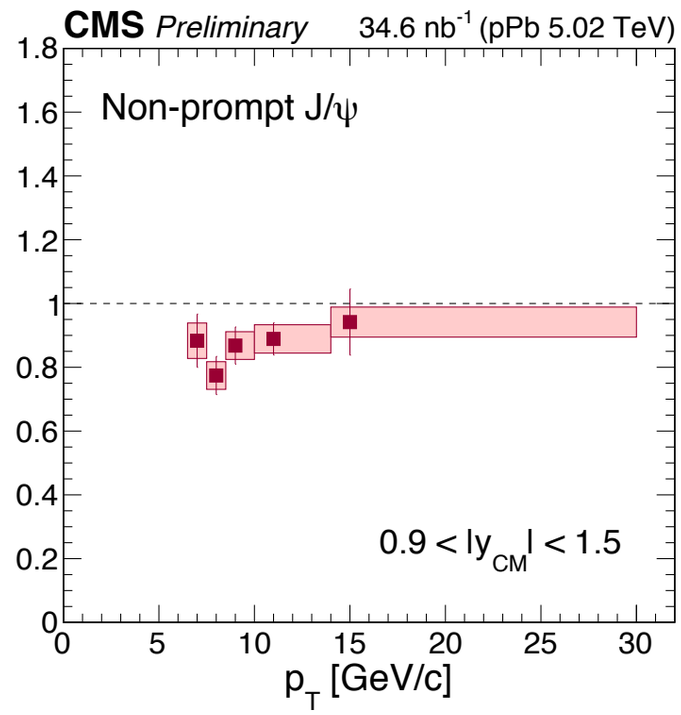


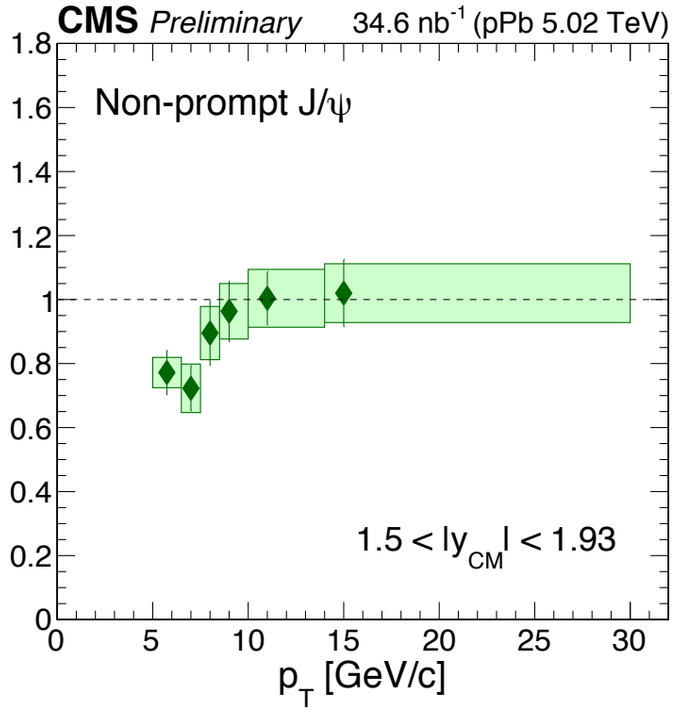
- wrong normalization corrected (pile-up)
- error propagation for bin merging fixed
- bin width is presented

Non-prompt J/ψ



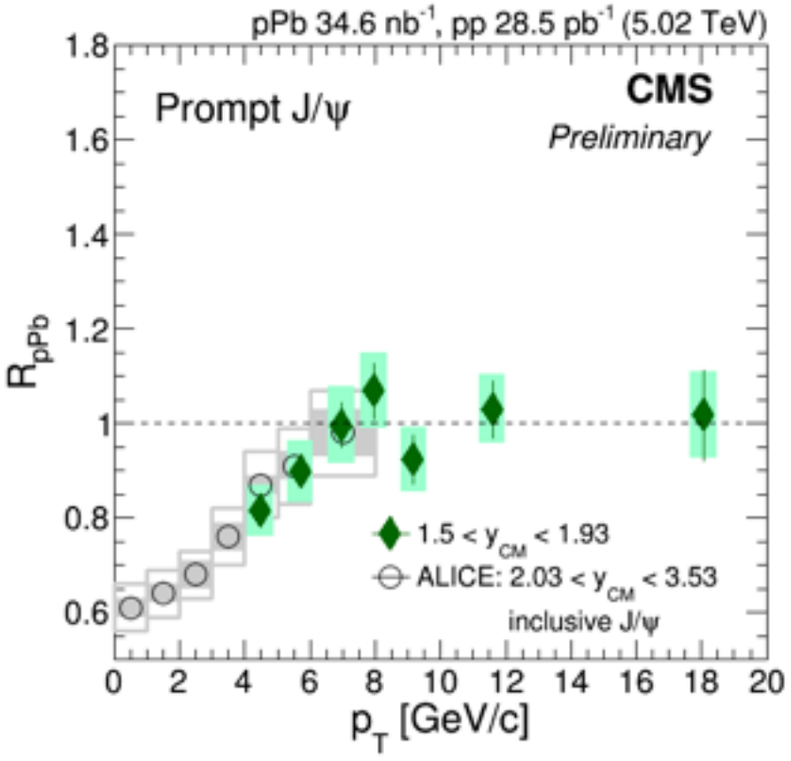


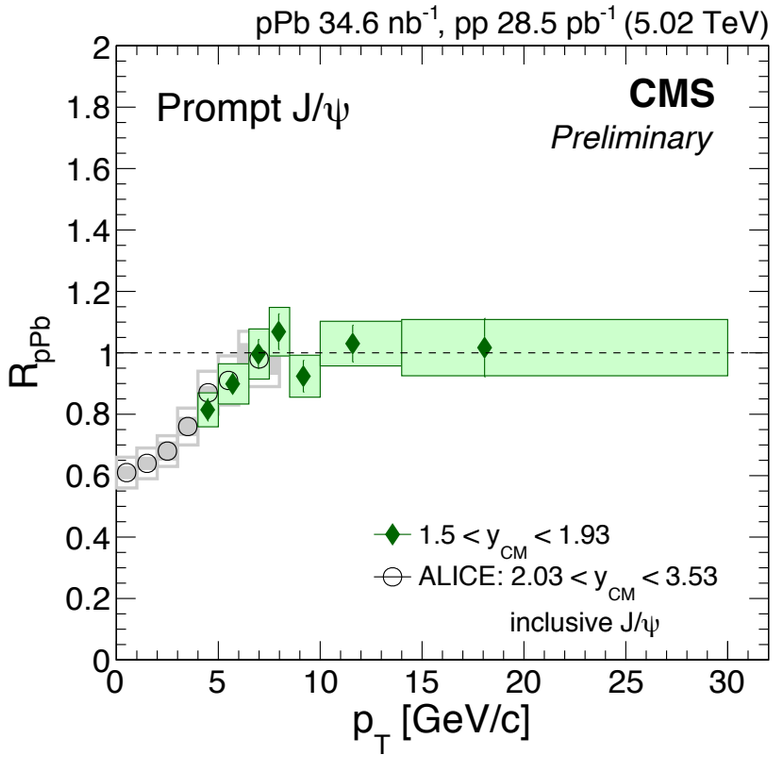


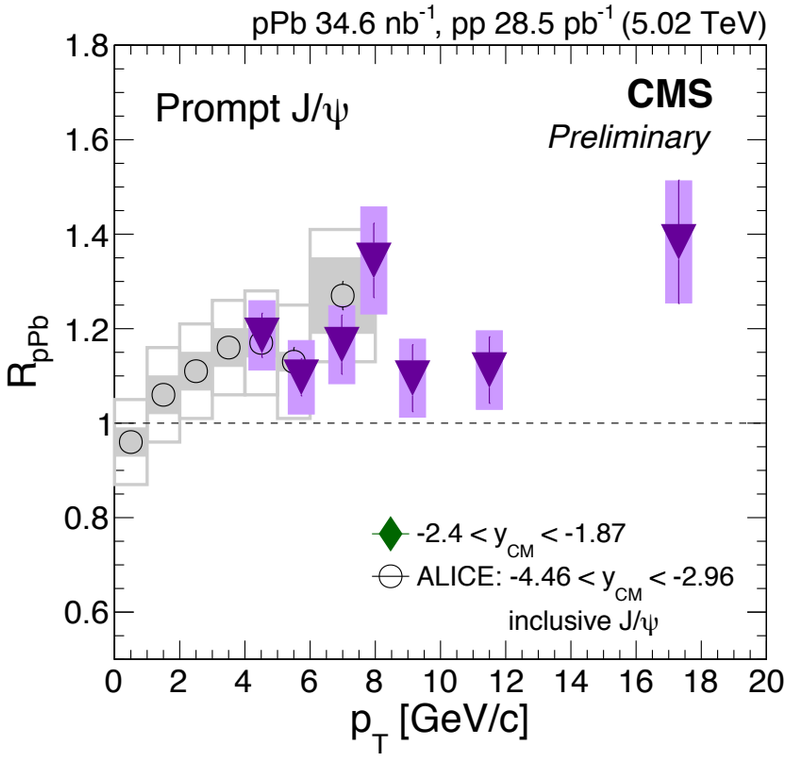


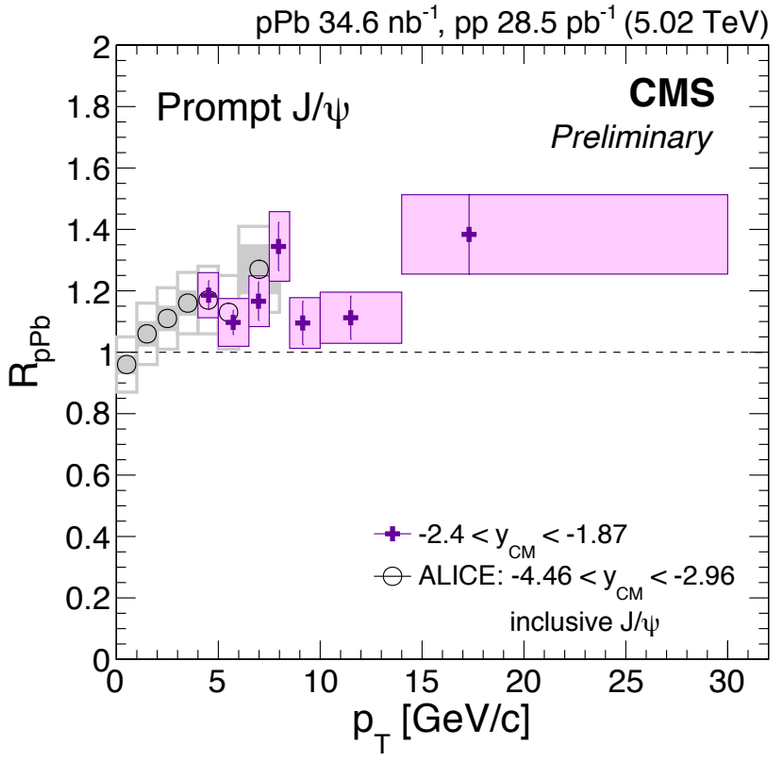
Comparison with other experiments

ALICE : R_{pPb} vs p_T

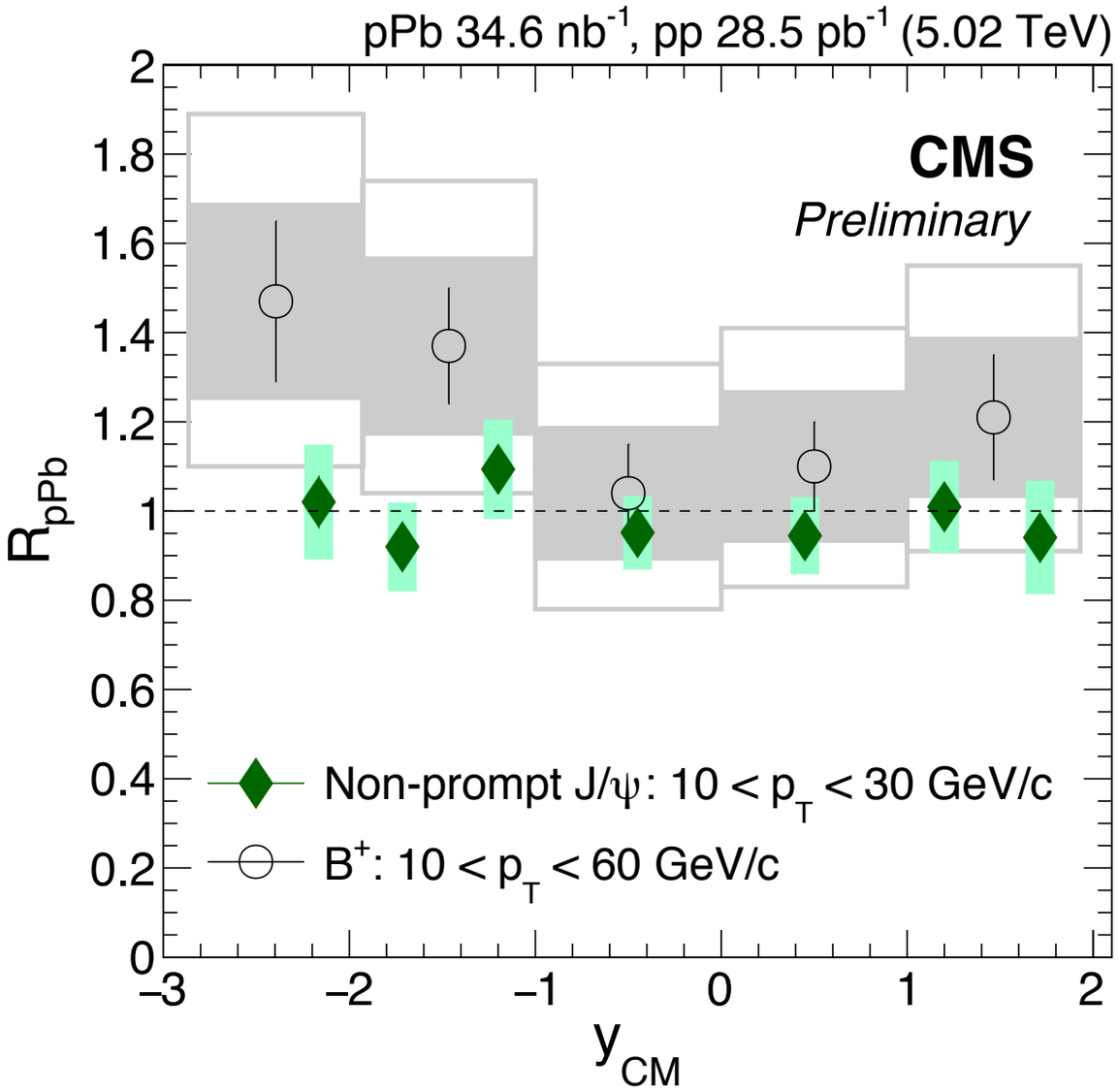


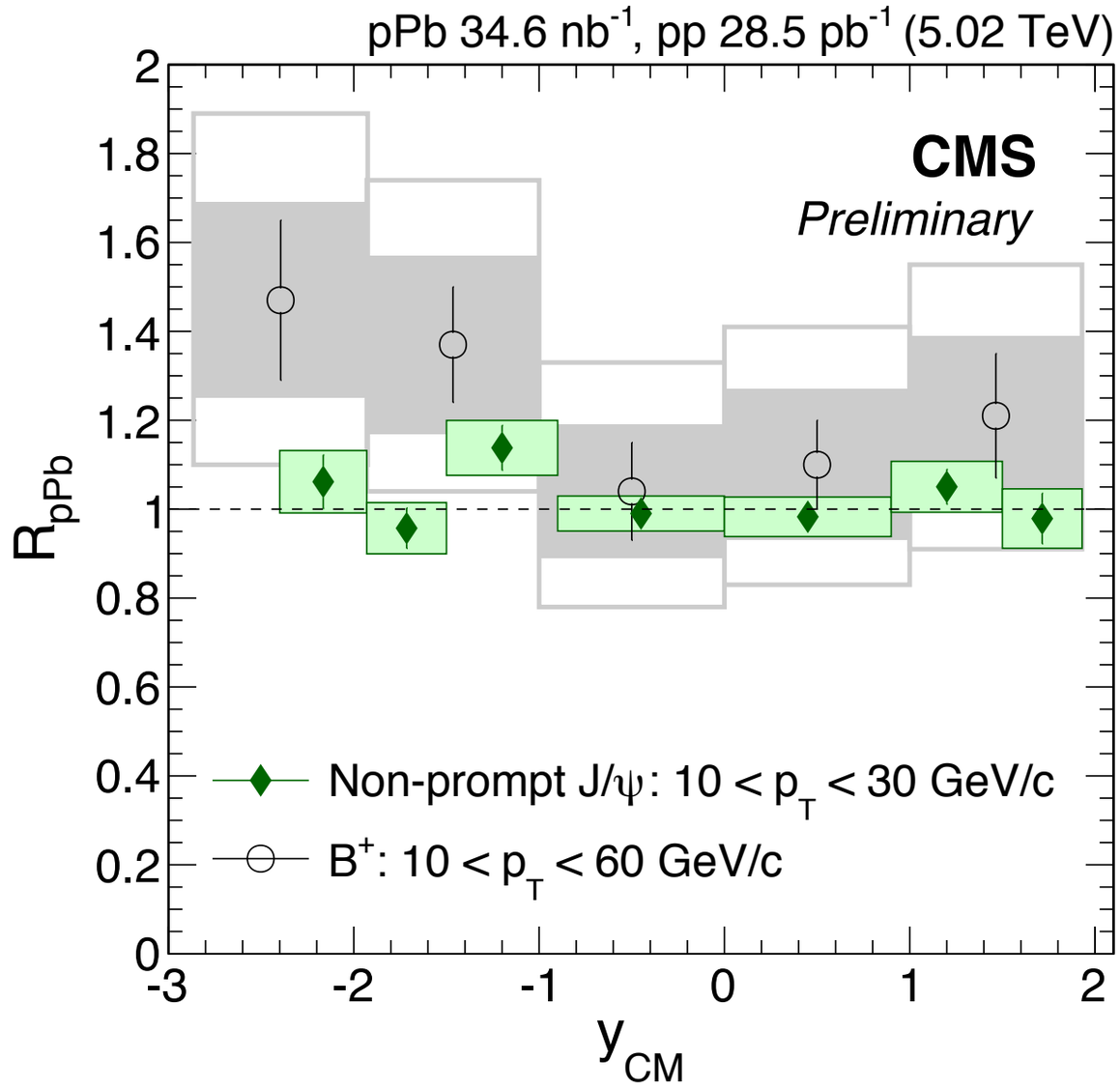




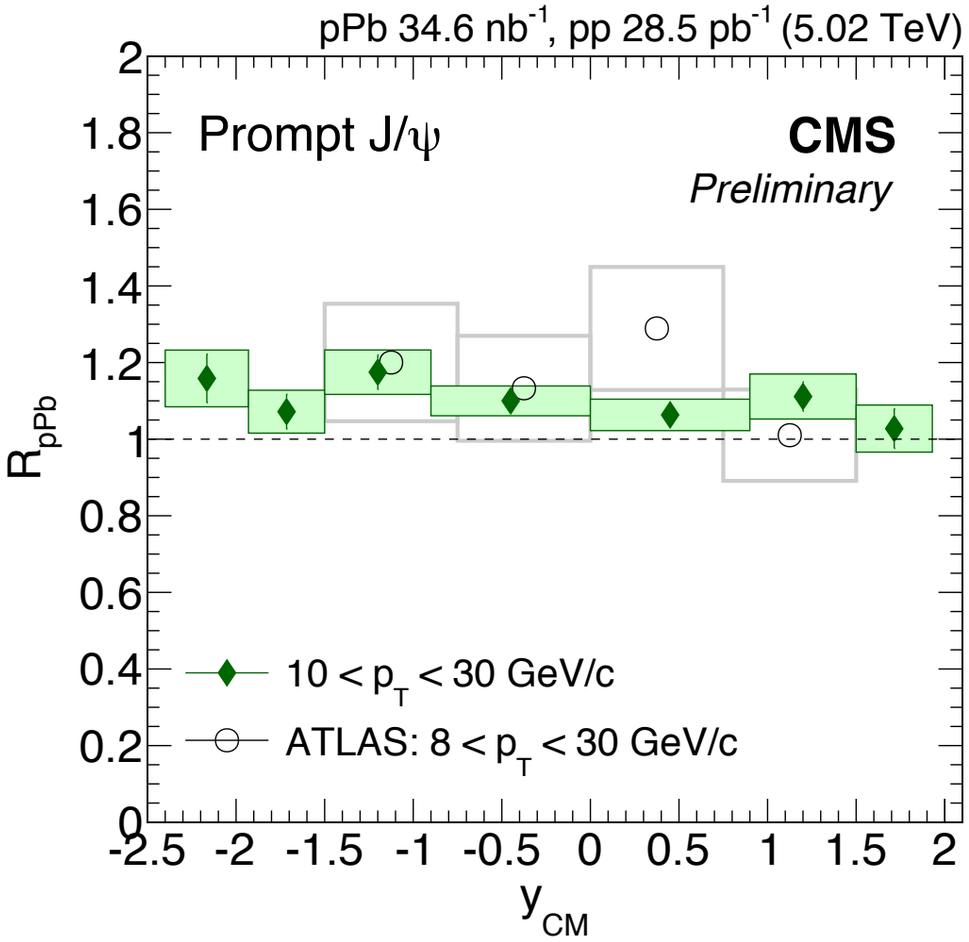


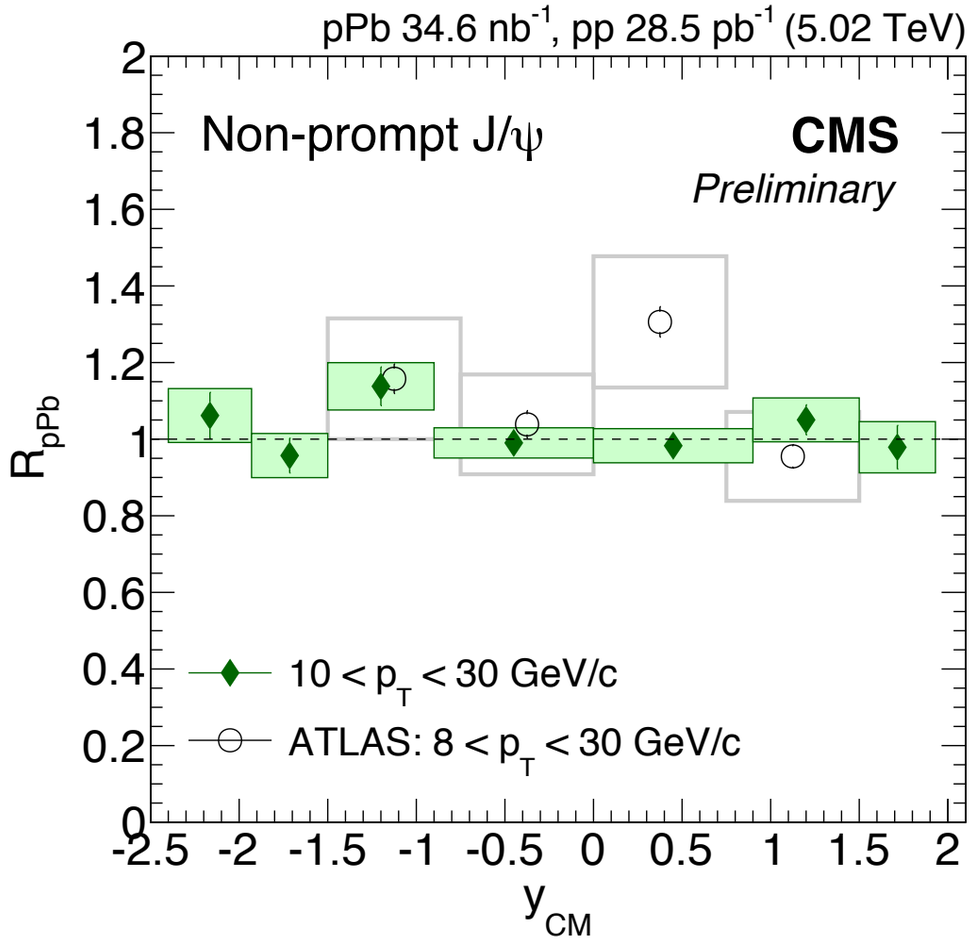
CMS B meson R_{pPb}





ATLAS : R_{pPb} vs y





- NEW : ATLAS points provided by Qipeng

Plan

- Implement comments from dilepton today, and circulate the 1st set of slides to get more comments on plot style and uncertainty propagation from outside
- Then, implement additional comments and send the final slides when two left items[S3] are also ready

- Or, wait until two left items are finalized?

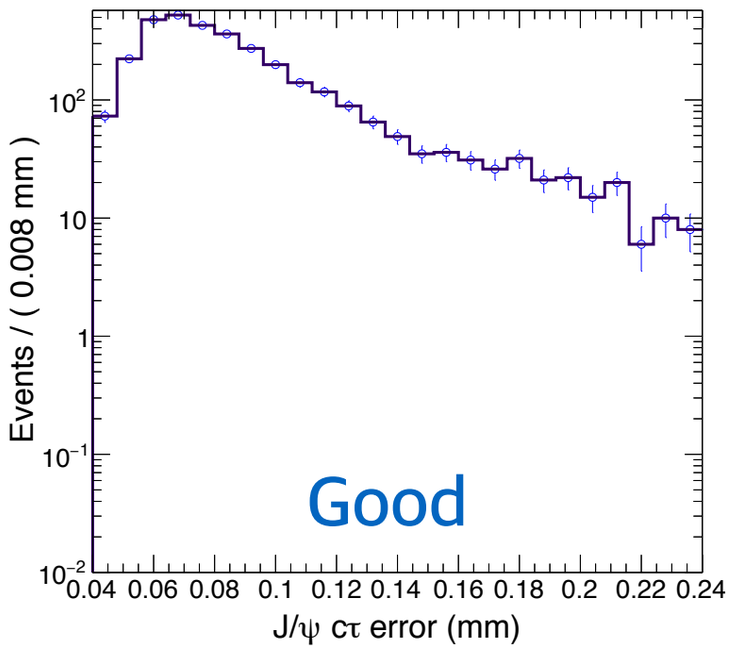
Backup

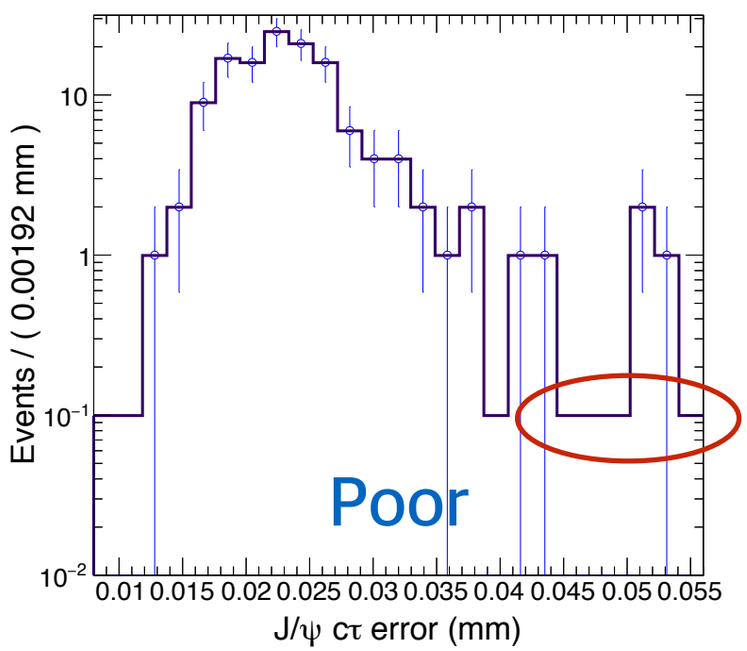
Lifetime error cut

- Total PDF for signal extraction

$$F(\ell_{J/\psi}, m_{\mu\mu}) = \int [f_{Sig} \cdot D_{Sig}(\sigma_\ell) F_{Sig}(\ell_{J/\psi}, \sigma_\ell) \cdot M_{Sig}(m_{\mu\mu}) + (1 - f_{Sig}) \cdot D_{Bkg}(\sigma_\ell) F_{Bkg}(\ell_{J/\psi}, \sigma_\ell) \cdot M_{Bkg}(m_{\mu\mu})] d\sigma_\ell,$$

- Lifetime error range cut applied for 2D fits to prevent empty bins in PDF shape
- In the previously approved results, we applied the same cut to MC and Data
- Possible bias due to the different distributions between MC and Data



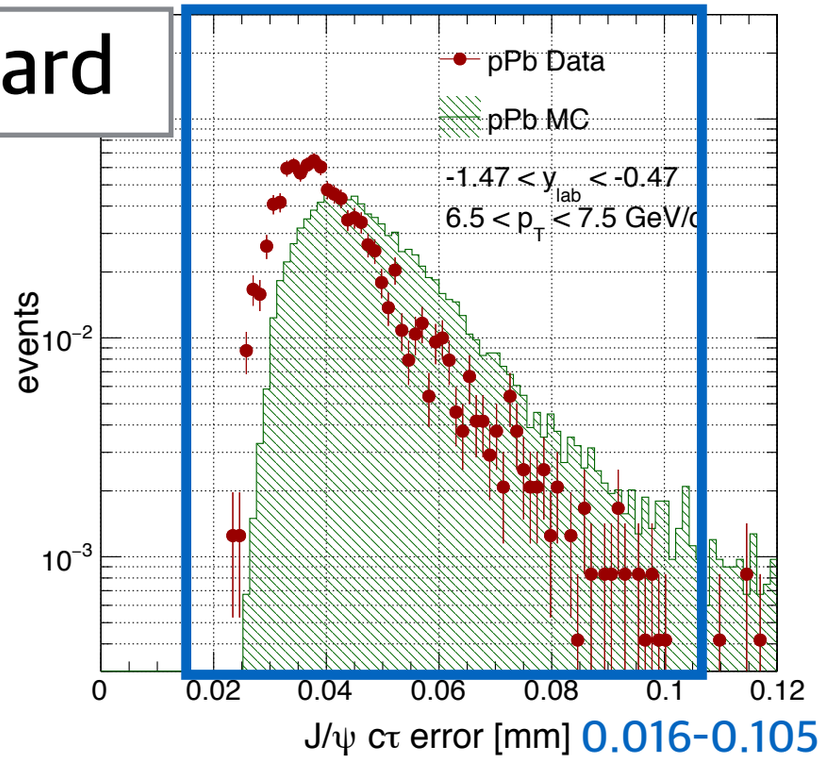


Lifetime error cut

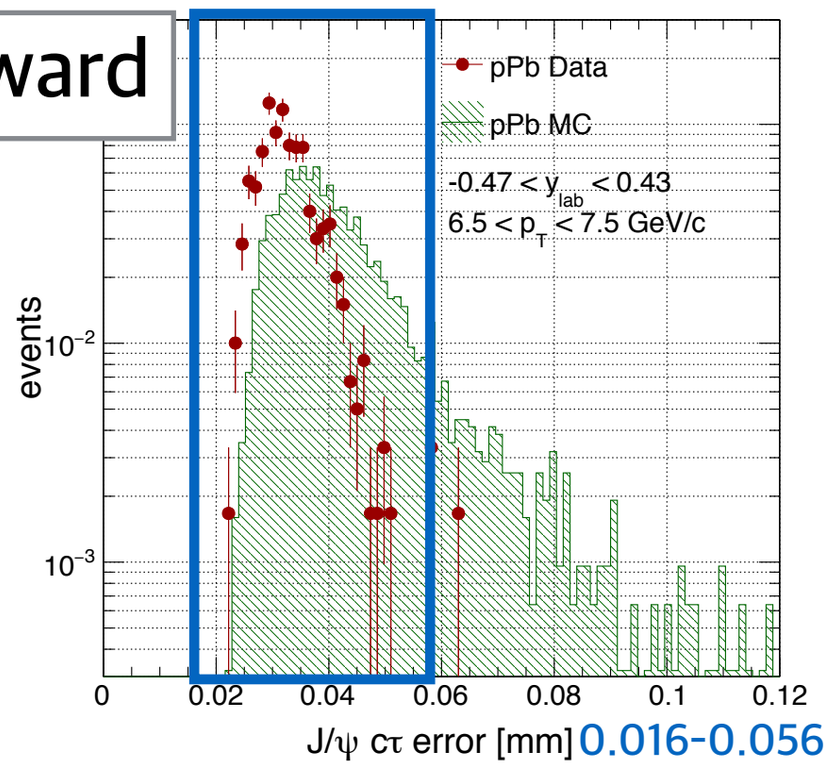
$$\text{Ratio} = \frac{\text{Efficiency with lifetime error cut}}{\text{Efficiency without lifetime error cut}}$$

p_T (GeV)	Forward (y_{CM} :0-0.9)	Backward (y_{CM} :-0.9-0)
6.5-7.5	0.98	0.87
7.5-8.5	0.97	0.95
8.5-10	0.99	0.97
10-14	0.99	0.99
14-30	0.99	0.99

forward



backward



- In Data, this cut makes NO differences (~0.6%)
- In MC : up to 13 % differences for certain bins
- Conclusion : Lifetime error cut is removed from MC
  (MC/Data difference doesn't affect other part of analysis)

B-fraction released

- Previously approved result :

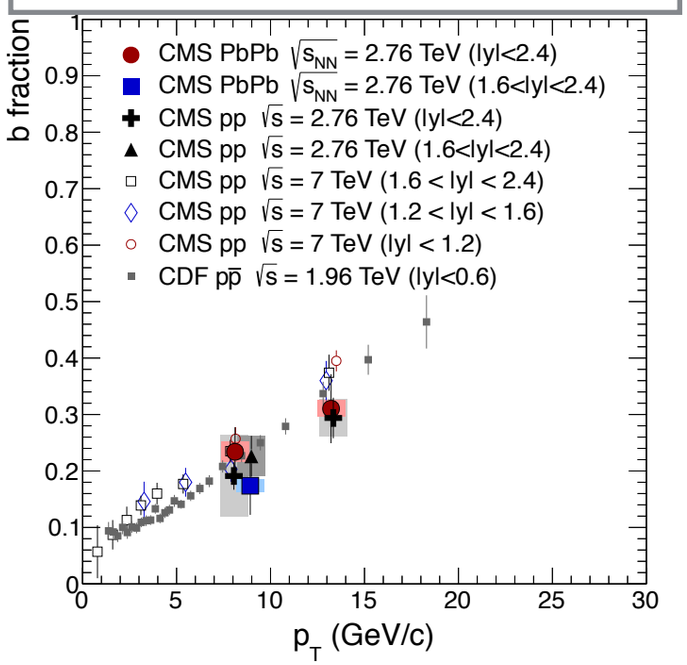
  B-fraction was fixed for some bins (19/110 bins)

  to the previous measurement in order to get stable fits

  following the recommendation from ARCs

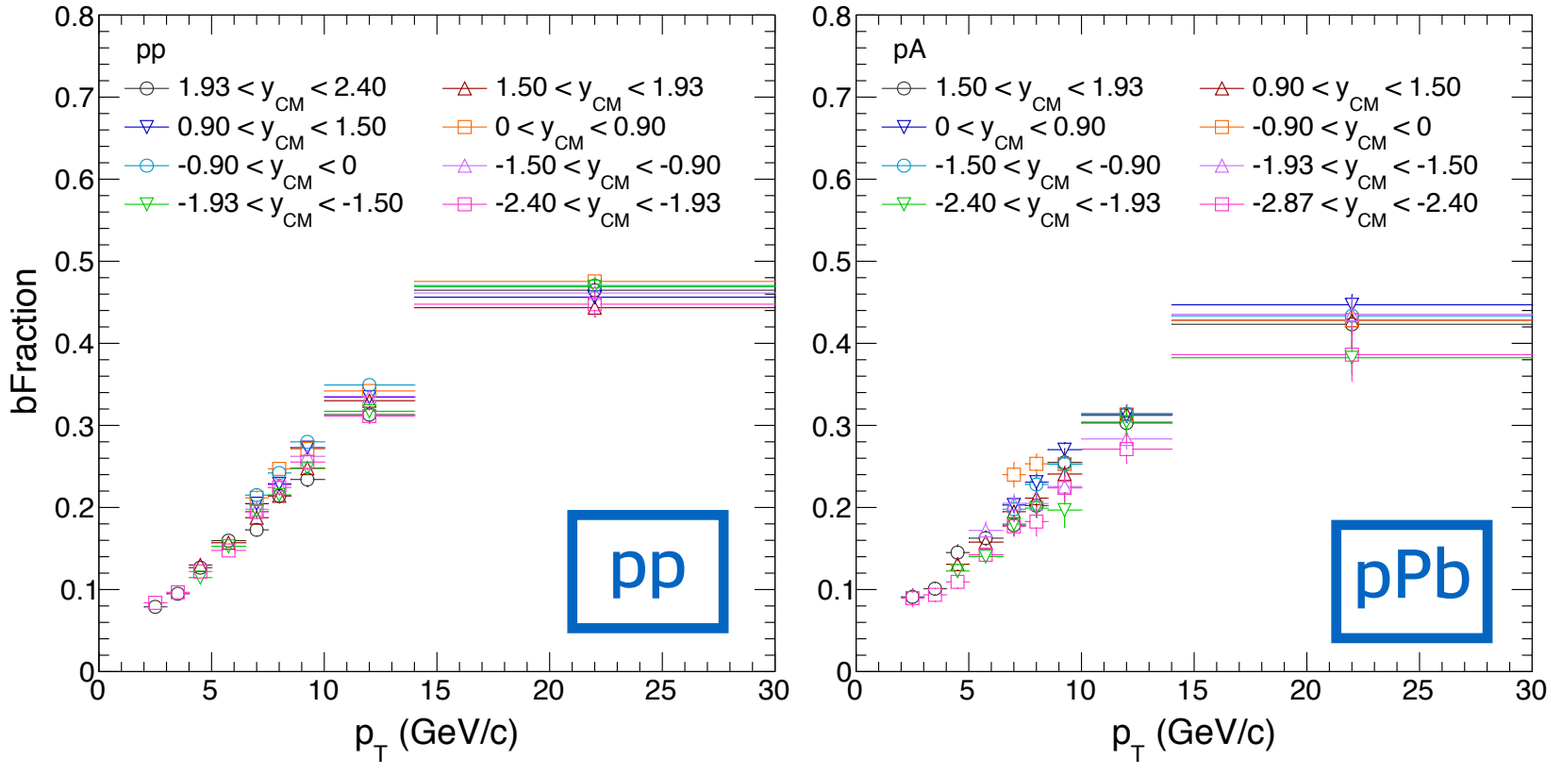
  - Mainly low p_T bins
  - and 2nd run periods with low statistics

other CMS measurements



- Now :

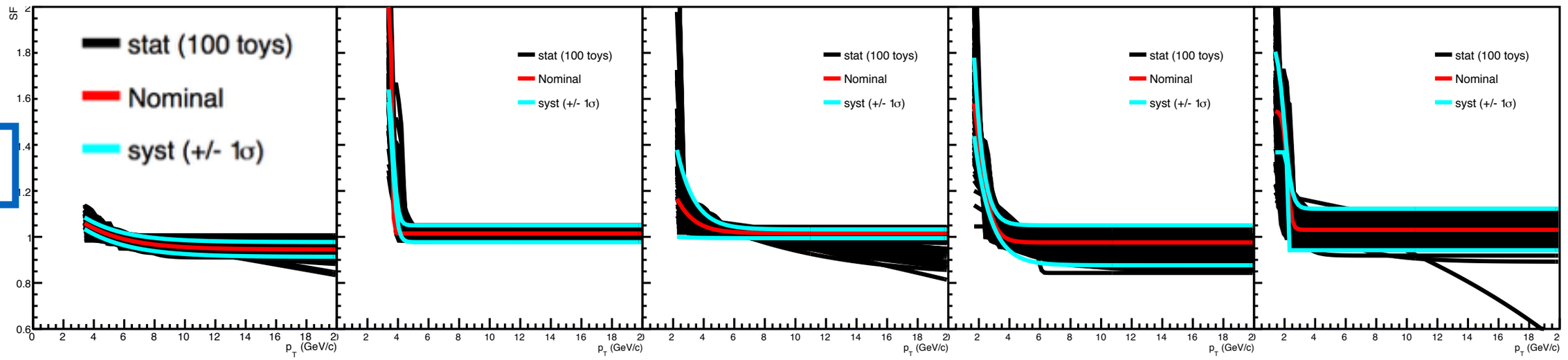
  B-fraction is released



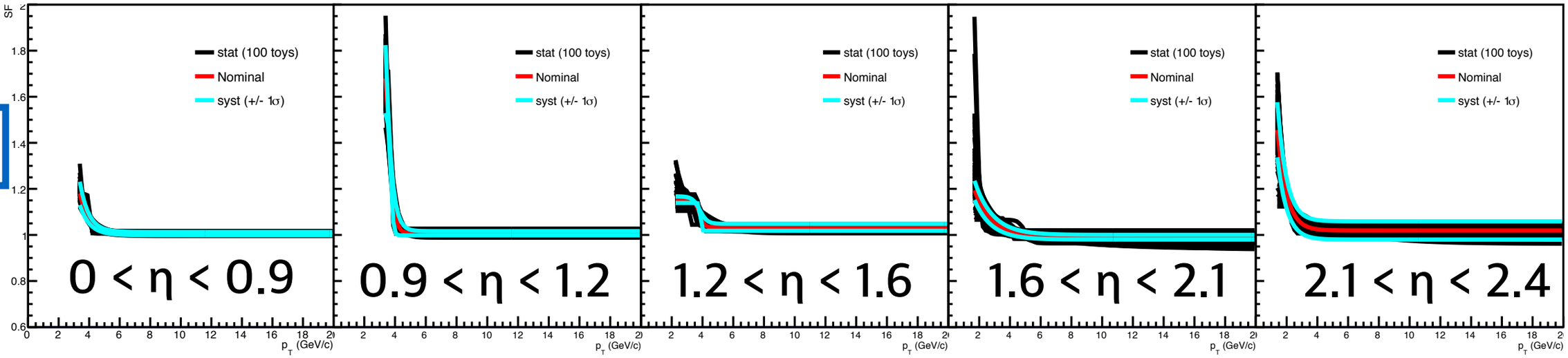
Uncertainties from TNP

- Scale factors (single muon efficiency ratio Data/MC) vs p_T

pp



pPb

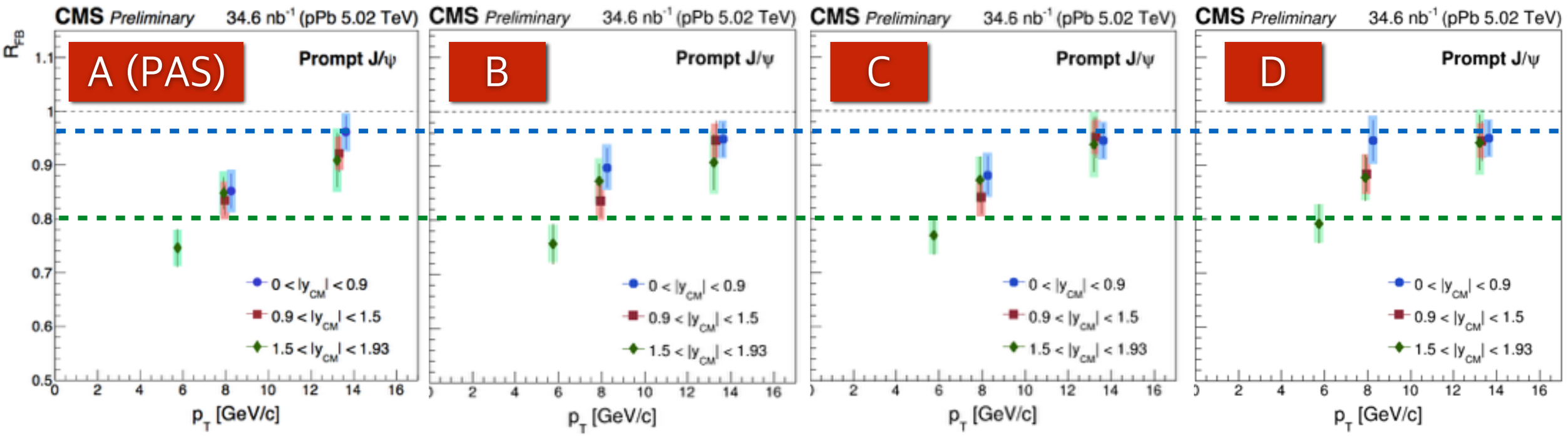


- Statistical uncertainty(black): 100 toy MC randomly moved up or down by $1\sigma^{stat}$
- Systematic uncertainty(blue): all points shifted up or down by $1\sigma^{syst}$
- Total uncertainties from TNP : $\sigma_{TnP} = \sqrt{(\sigma_{TnP}^{stat})^2 + (\sigma_{TnP}^{syst})^2}$

Summary of Update (1)

- Example of the evolution of result plots (prompt J/psi R_{FB})

$$R_{\mathrm{FB}}(p_{\mathrm{T}}, y) = \frac{d^2\sigma(p_{\mathrm{T}}, y > 0)/dp_{\mathrm{T}}dy}{d^2\sigma(p_{\mathrm{T}}, y < 0)/dp_{\mathrm{T}}dy}$$

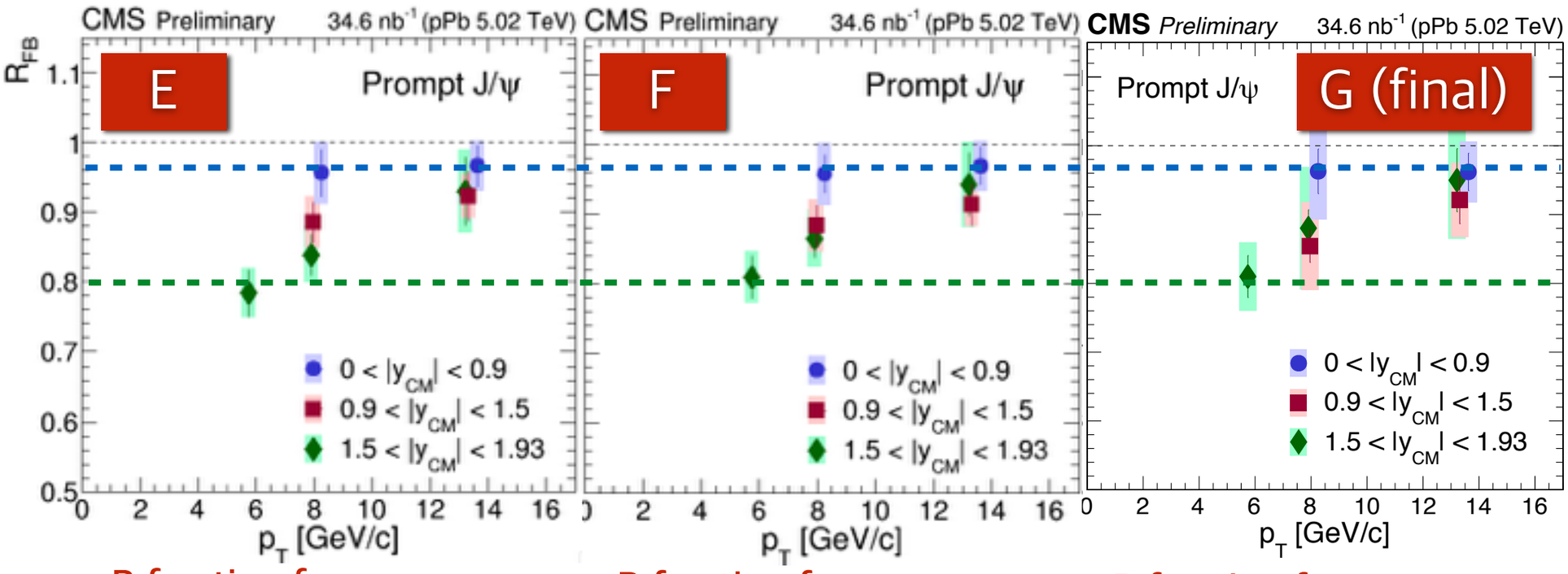


A (PAS)	B	C	D
- B fraction fixed	- B fraction free	- B fraction free	- B fraction free
- z vertex cut	- z vertex cut	- no z vertex cut	- no z vertex cut
- lifetime error cut	- lifetime error cut	- no lifetime error cut	- no lifetime error cut
- separate fit (1st & 2nd run)	- separate fit (1st & 2nd run)	- separate fit (1st & 2nd run)	- separate fit (1st & 2nd run)
- MC with lower stat.	- MC with lower stat.	- MC with lower stat.	- MC with lower stat.
- old single muon cut	- old single muon cut	- old single muon cut	- old single muon cut

- Difference mostly coming from D (lifetime error cut), and partially from B (B fraction)

Summary of Update (2)

- Example of the evolution of result plots (prompt J/psi R_{FB})



- B fraction free
- no z vertex cut
- no lifetime error cut
- merged fit (1st & 2nd run)
- MC with lower stat.
- old single muon cut

- B fraction free
- no z vertex cut
- no lifetime error cut
- merged fit (1st & 2nd run)
- MC with higher stat.
- old single muon cut

- B fraction free
- no z vertex cut
- no lifetime error cut
- merged fit (1st & 2nd run)
- MC with higher stat.
- new single muon cut

- Agreement within uncertainties