6/30/2020

COMBINATION OF CHARM MEASUREMENTS AT THE LHC

HonexComb Meeting

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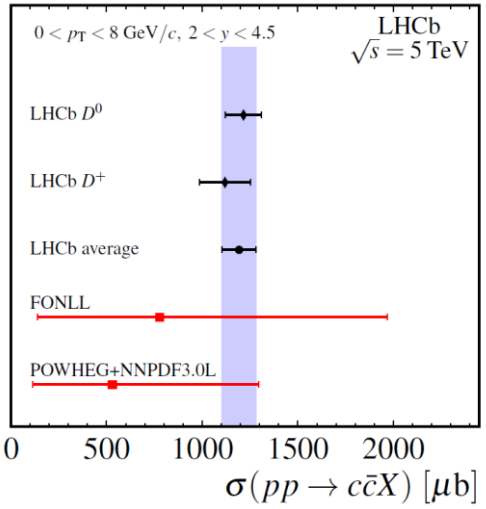
Total charm cross-section in *pp* collisions

- The measurement of the total charm cross section could be one of the most promising area for combining measurements from different experiments.
- Our first goal is to combine open charm results obtained by the four collaborations in *pp* collisions, to derive a total charm cross-section.

- Collect existing open charm measurements from the four collaborations
- Compare results, and study p_T and rapidity dependence.

Decay channel	**Fragmentation fraction** Phys. Lett. B667 (2008) 1.
$D^0 \to K^-\pi^+$	$f(c \to D^0) = 0.565 \pm 0.032$
$D^+ \to K^-\pi^+\pi^+$	$f(c \to D^+) = 0.246 \pm 0.020$
$D_s^+ \to (K^-K^+)_\phi\pi^+$	$f(c \to D_s^+) = 0.080 \pm 0.017$
$D^{*+} \to D^0(\to K^-\pi^+)\,\pi^+$	$f(c \to D^{*+}) = 0.224 \pm 0.028$



Summary of open charm meson results in *pp*

- Collected open charm meson (D^0, $D^{\pm}$, $D_s^{\pm}$, $D^{*\pm}$) results

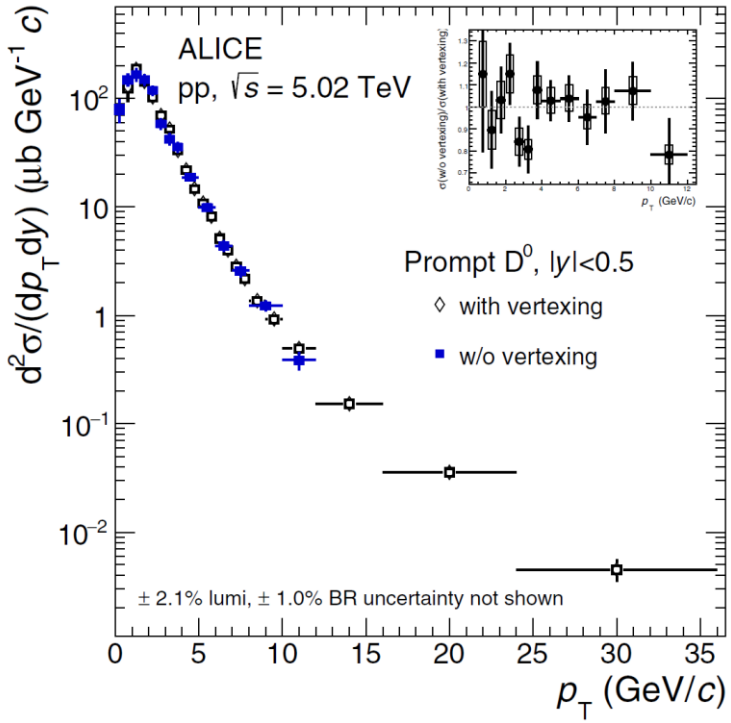
pp	**ALICE**	**LHCb**	**CMS**	**ATLAS**
5TeV	Eur. Phys. J. C79 (2019) 388 $\boldsymbol{D^0, D^{\pm}, D_s^{\pm}, D^{*\pm}}$	JHEP 06 (2017) 147 $\boldsymbol{D^0, D^{\pm}, D_s^{\pm}, D^{*\pm}}$	Phys. Lett. B 782 (2018) 474 $\boldsymbol{D^0}$	
7TeV	Eur. Phys. J. C77 (2017) 550 $\boldsymbol{D^0, D^{\pm}, D_s^{\pm}, D^{*\pm}}$	Nucl. Phys. B871 (2013) 1 $\boldsymbol{D^0, D^{\pm}, D_s^{\pm}, D^{*\pm}, \Lambda_c^+}$		Nucl. Phys. B 907 (2016) 717 $\boldsymbol{D^{\pm}, D_s^{\pm}, D^{*\pm}}$
13TeV		JHEP 05 (2017) 074, JHEP 09 (2016) 013 $\boldsymbol{D^0, D^{\pm}, D_s^{\pm}, D^{*\pm}}$		

- The 5TeV results seem to be a good starting point:

D^0 **in 5TeV *pp***	**ALICE**	**LHCb**	**CMS**
p_T [GeV/c]	0 -- 36	0 -- 10	2 -- 100
Rapidity	|y| < 0.5	2.0 < y < 4.5	|y| < 1.0

Prompt D^0 meson p_T spectrum

- **ALICE:**
- $0 < p_T < 36$ GeV/c
- $|y| < 0.5$
- Average of D^0 and $\overline{D}^0$
- Table from HEPDATA



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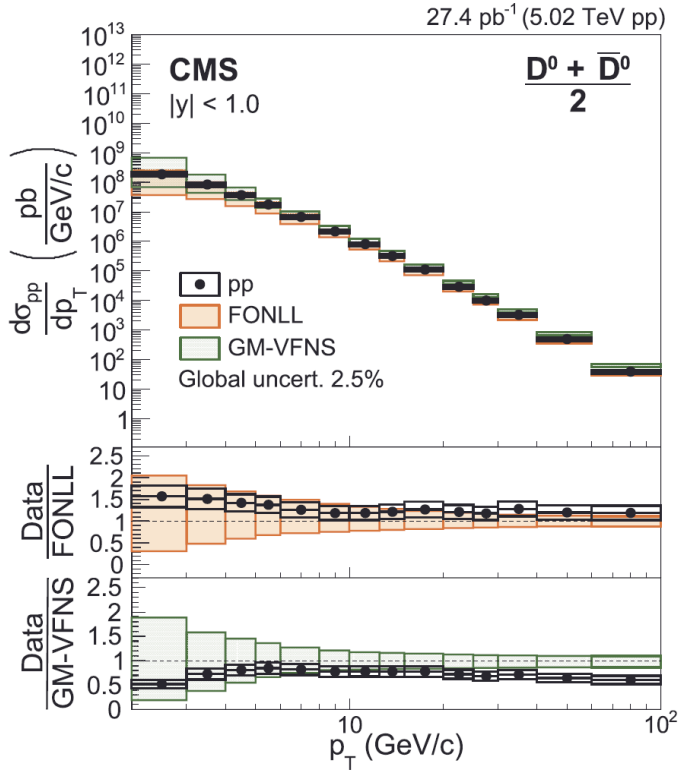
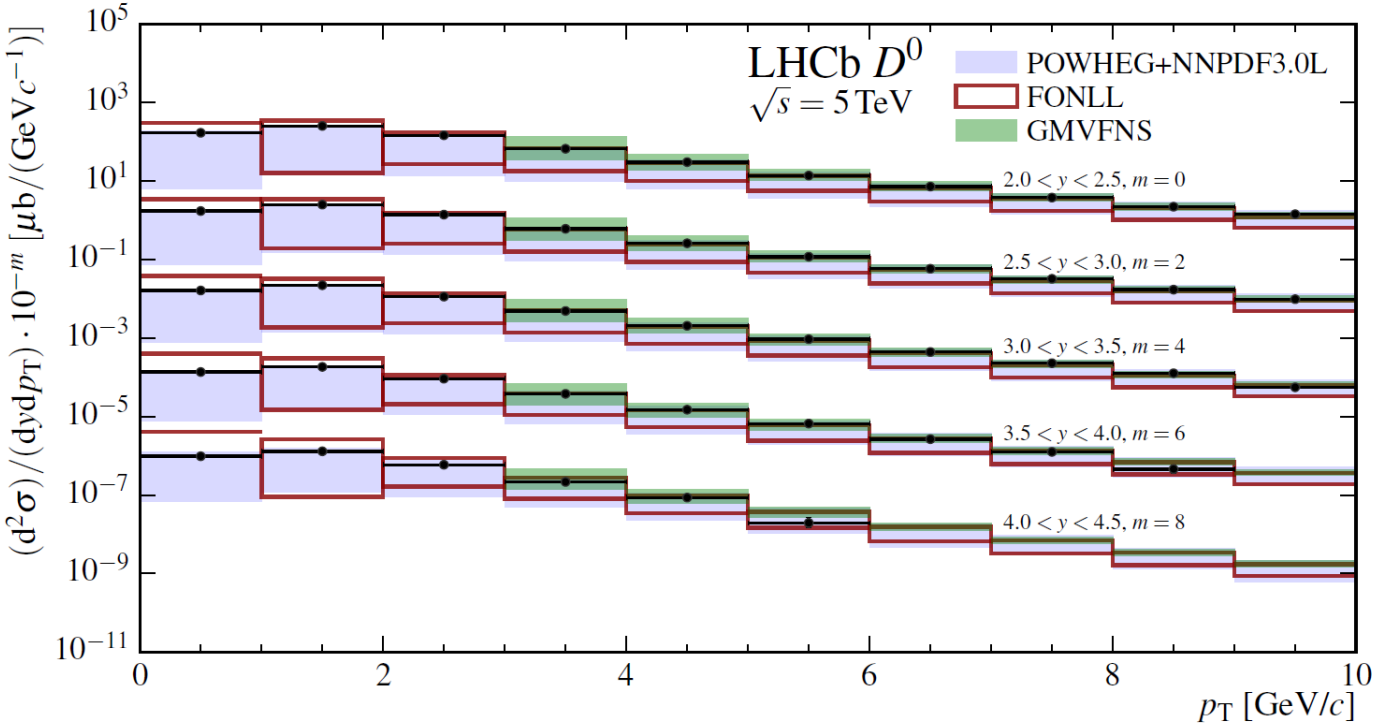
- **CMS**
- $2 < p_T < 100$ GeV/c
- $|y| < 1.0$
- Average of D^0 and $\overline{D}^0$
- Table from HEPDATA



Phys. Lett. B 782 (2018) 474

Prompt D^0 meson p_T spectrum

- **LHCb**
- $0 < p_T < 10$ GeV/c
- $2 < y < 4.5$, in $\Delta y = 0.5$ bins
- Sum of D^0 and $\overline{D}^0$
- Tables from HEPDATA



JHEP 06 (2017) 147

Prompt D^0 cross-section vs. p_T

Average of D^0 and $\overline{D}^0$

LHCb results divided by 2

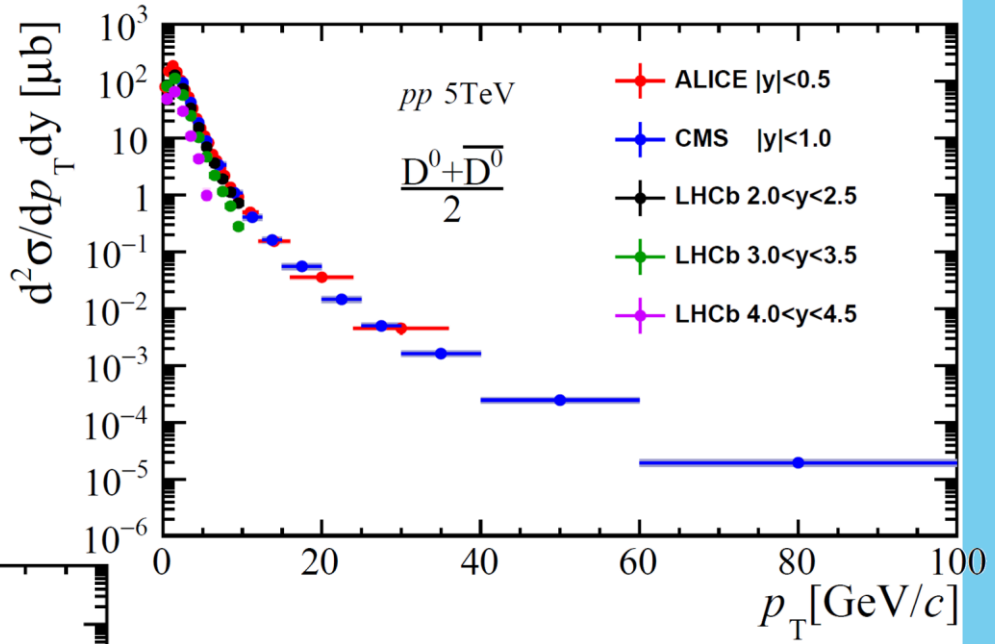
Divided by Δy

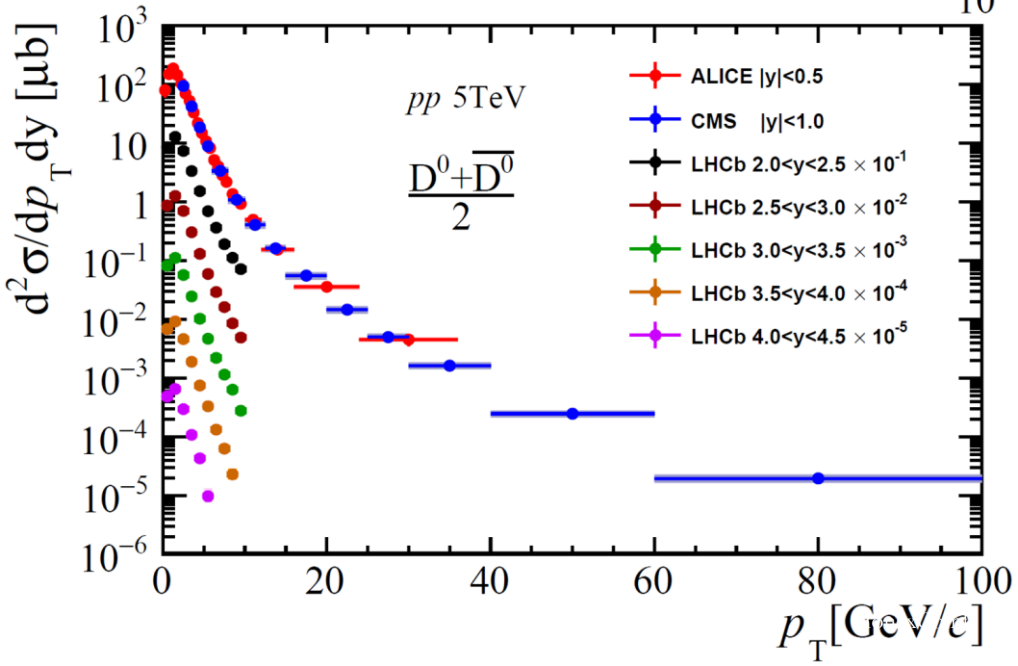
CMS Δy = 2.0

ALICE Δy = 1.0

LHCb Δy = 0.5

Comparison to FONLL in the future

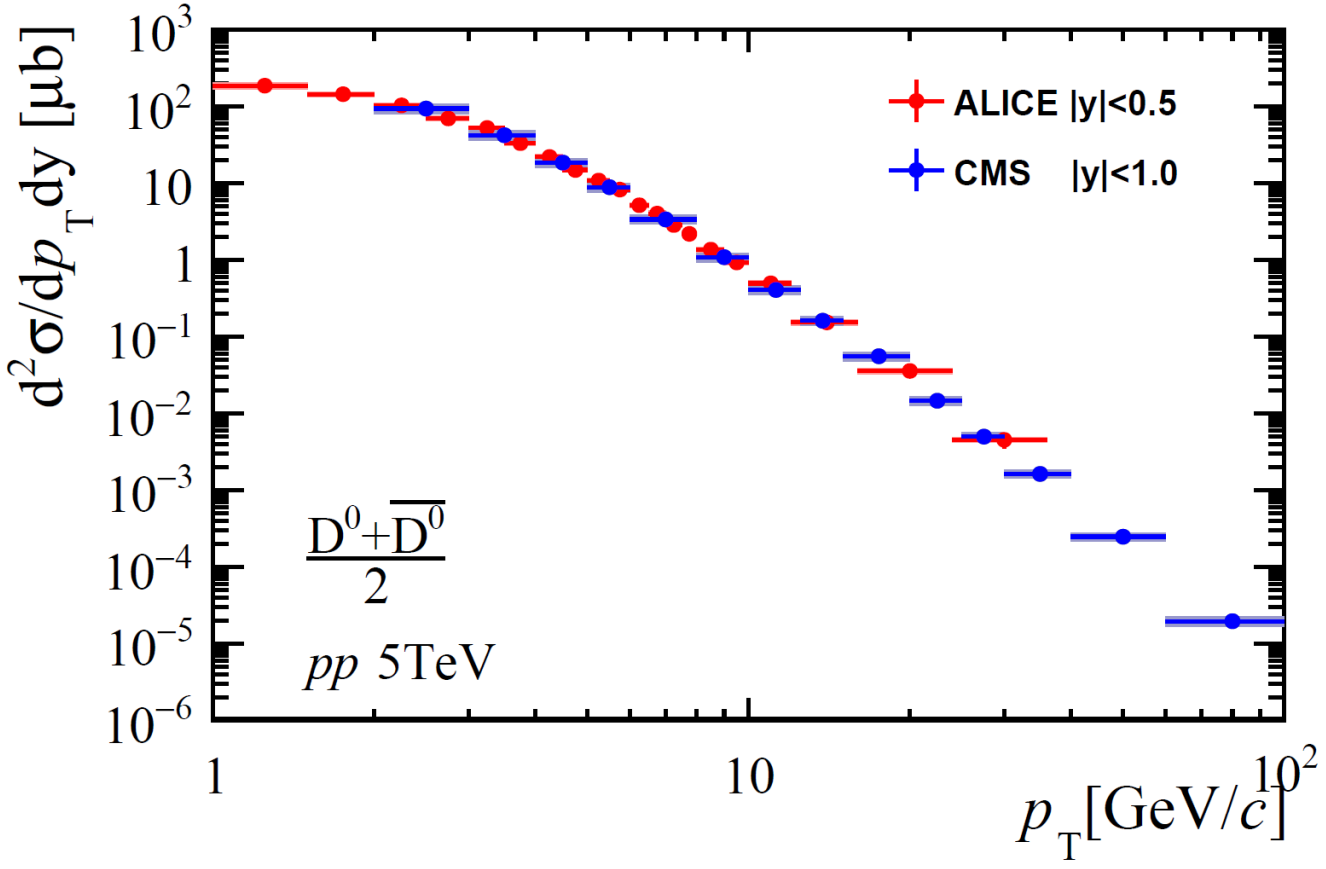




LHCb points scaled for better visibility

Prompt D^0 cross-section vs. p_T
higher p_T

- Nice agreement between ALICE and CMS

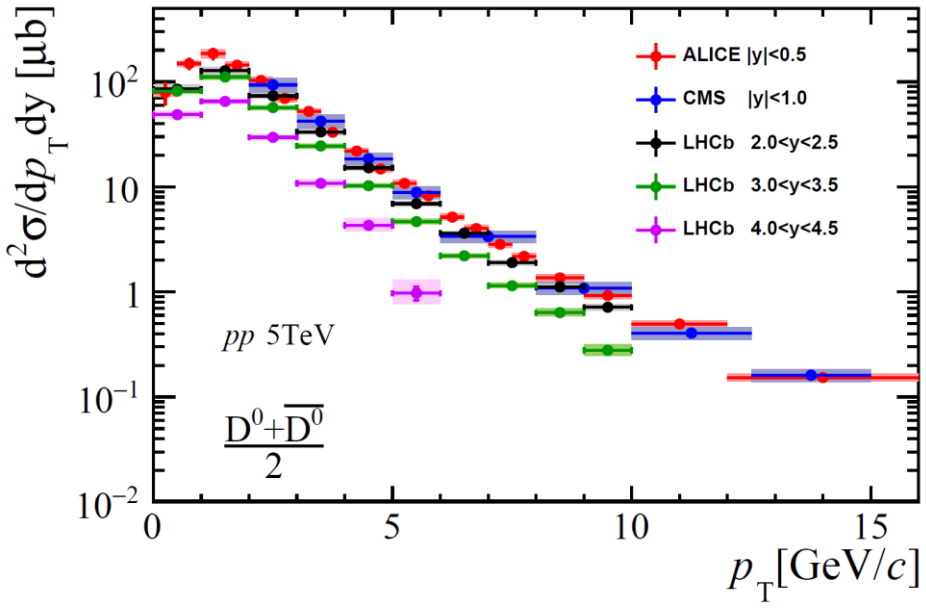


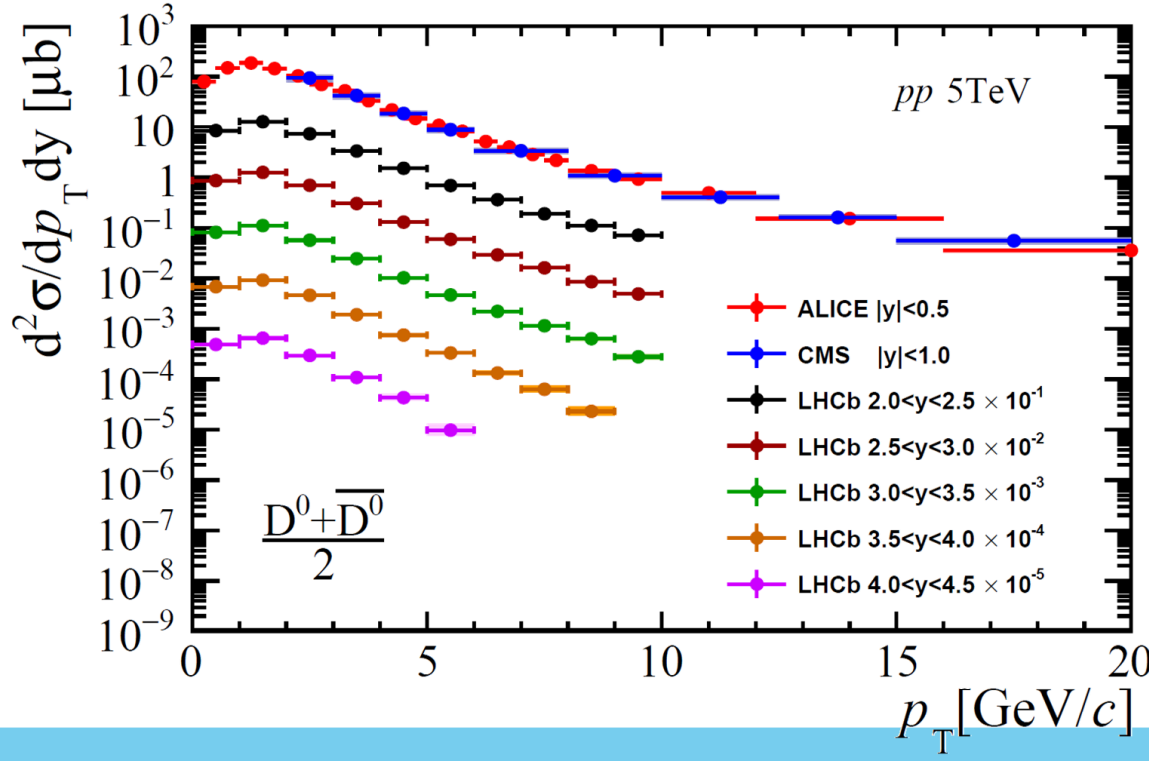
Prompt D^0 cross-section
lower p_T

LHCb and ALICE reach $p_T \sim 0$

Comparison of mid/forward rapidity: shape change in p_T?

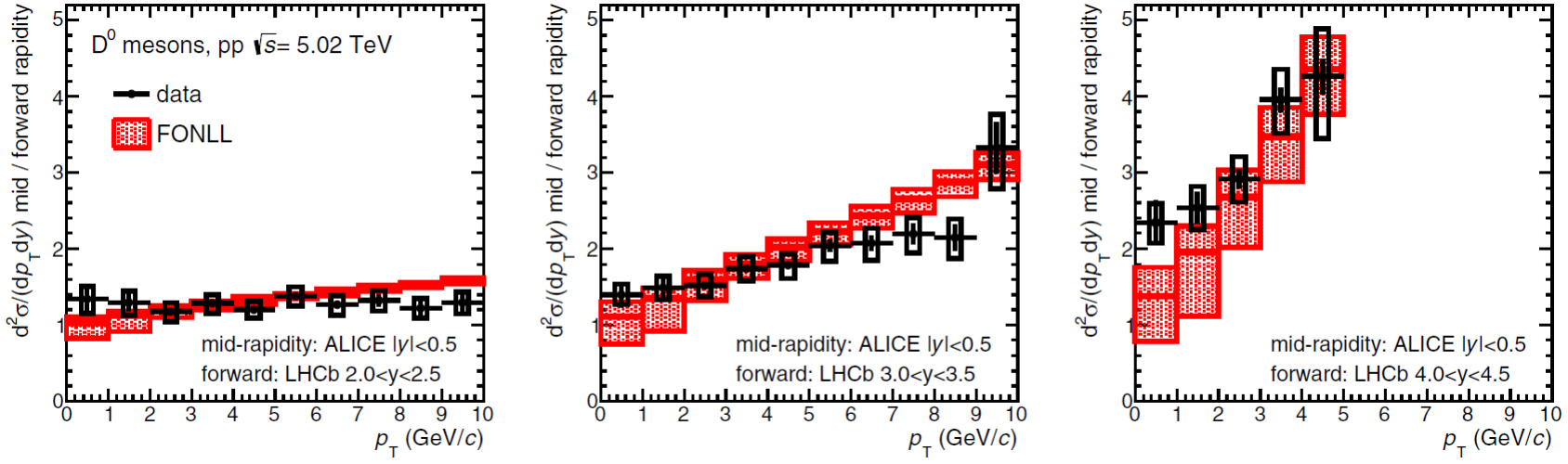
Comparison to FONLL





Prompt D^0 cross-section vs. p_T
ALICE/LHCb ratio vs. p_T

- ALICE/LHCb ratio already published in the ALICE paper.
- Mid/forward rapidity ratio vs. p_T
  - LHCb 2.0 < y < 2.5 bin: flat distribution vs. p_T
  - Larger rapidity bins: ratio increases with increasing p_T
  - Slope increases with increasing y
- Consistent with FONLL calculations



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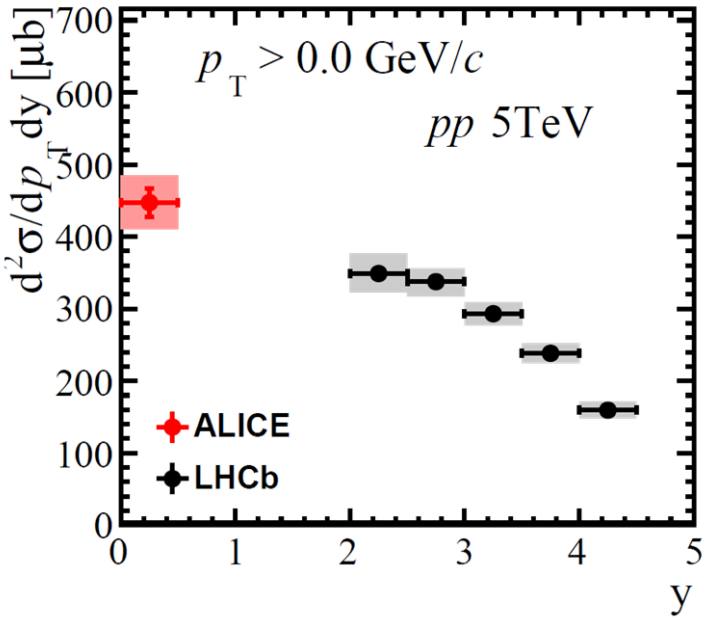
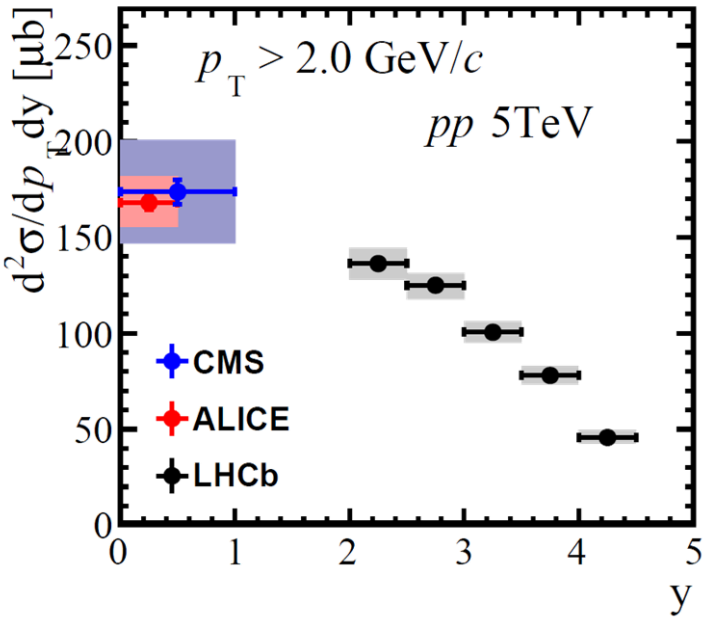
Prompt D^0 cross-section vs. y

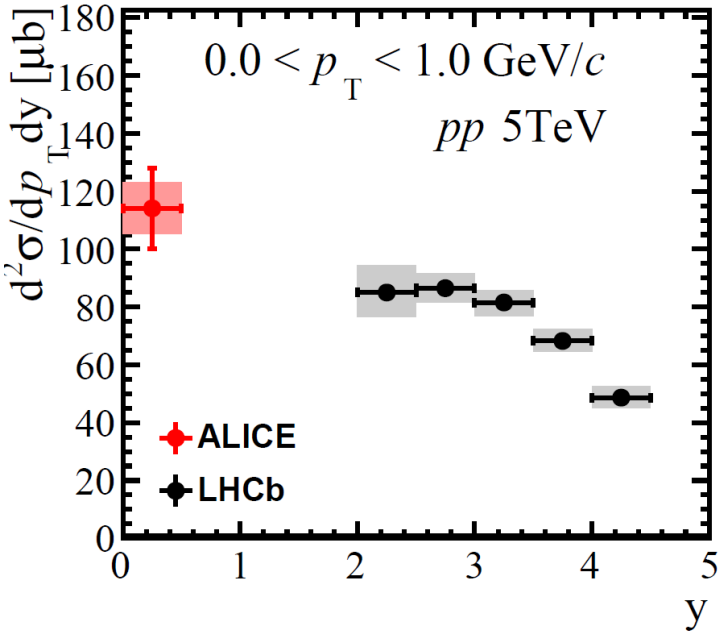
- Summing all p_T bins:
  - ALICE: $0 < p_T < 36$ GeV/c
  - CMS: $2 < p_T < 100$ GeV/c
  - LHCb: $0 < p_T < 10$ GeV/c
- Conservative systematic uncertainties:
  - Assuming totally correlated systematic across bins for now
- Comparison to FONLL in the future

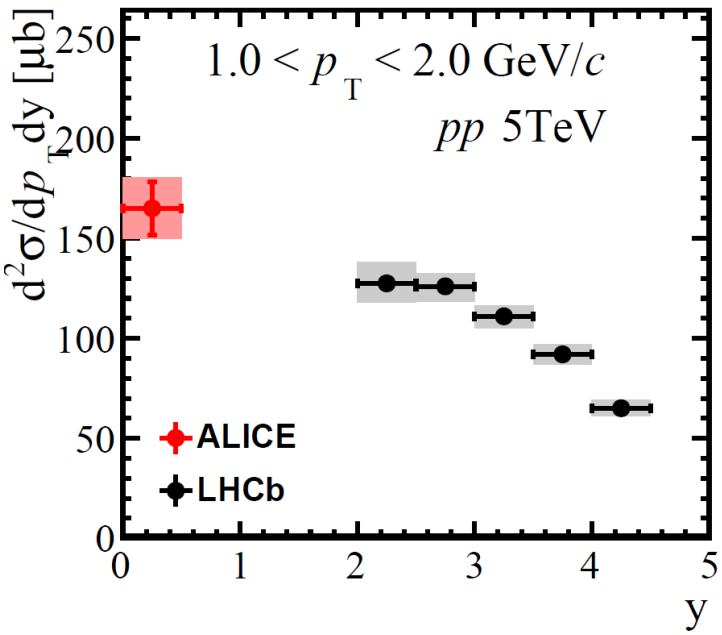




Prompt D^0 cross-section vs. y
in common p_T bins

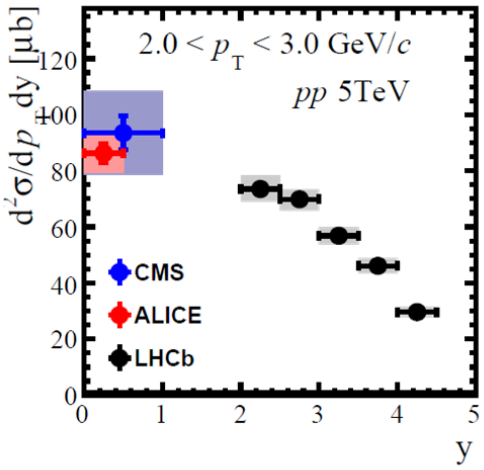
- No CMS measurement below $p_T = 2\text{GeV}/c$
- Conservative systematic uncertainties:
  - Assuming totally correlated systematic across bins for now

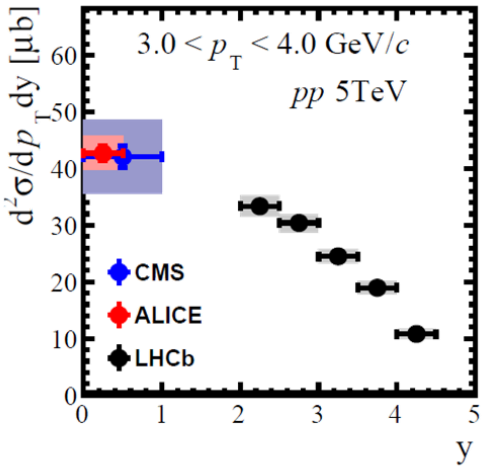


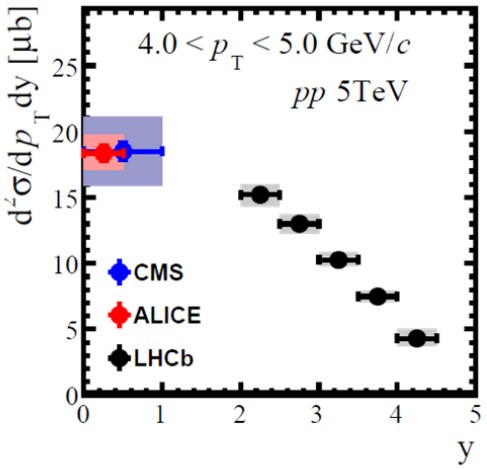


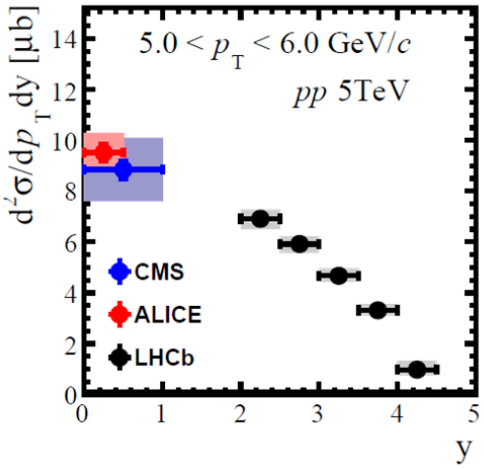
Prompt D^0 cross-section vs. y
in common p_T bins

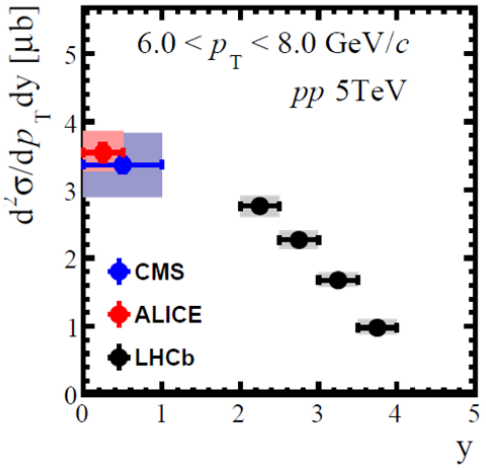
- Gap at $1 < y < 2$

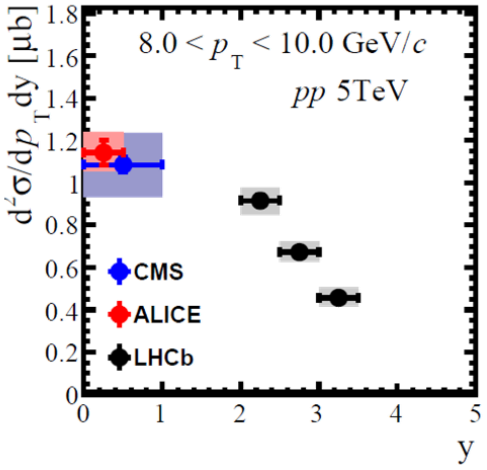












For the next step…

- Comparisons of $D_s^{\pm}$ meson (ALICE LHCb CMS)

pp	ALICE	LHCb	CMS	ATLAS
5TeV	Eur. Phys. J. C79 (2019) 388 $D^0, D^{\pm}, D_s^{\pm}, D^{*\pm}$	JHEP 06 (2017) 147 $D^0, D^{\pm}, D_s^{\pm}, D^{*\pm}$	Phys. Lett. B 782 (2018) 474 D^0 $D_s^{\pm}$ *(preliminary)*	
7TeV	Eur. Phys. J. C77 (2017) 550 $D^0, D^{\pm}, D_s^{\pm}, D^{*\pm}$	Nucl. Phys. B871 (2013) 1 $D^0, D^{\pm}, D_s^{\pm}, D^{*\pm}, \Lambda_c^+$		Nucl. Phys. B 907 (2016) 717 $D^{\pm}, D_s^{\pm}, D^{*\pm}$
13TeV		JHEP 05 (2017) 074, JHEP 09 (2016) 013 $D^0, D^{\pm}, D_s^{\pm}, D^{*\pm}$		

- Comparisons of Λ_c^+ baryon (ALICE LHCb CMS)
- Comparison to FONLL calculations whenever possible
- A twiki page for collecting results:
  - https://twiki.cern.ch/twiki/bin/view/Honexcomb/HonexcombCharmSection
- After collecting all the results, we will have a clear picture of what is worth combining with a real statistical procedure.