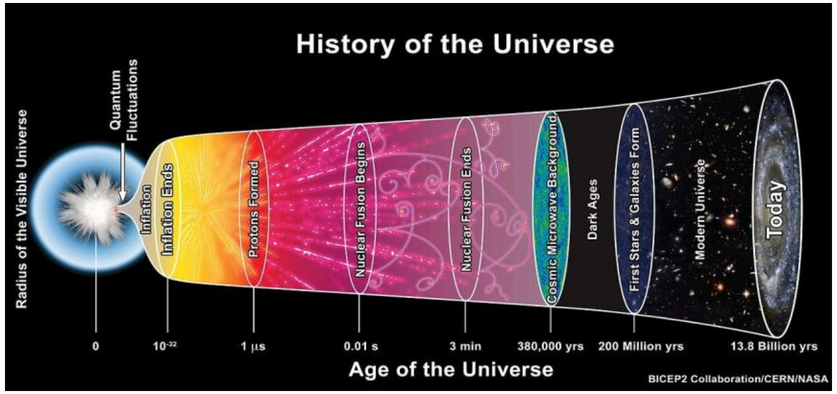
1.

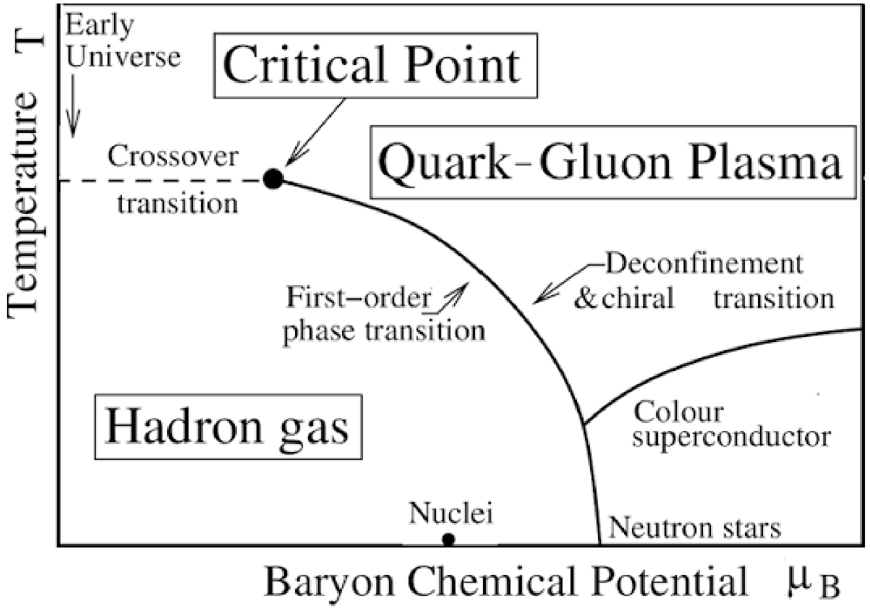
Towards Forward b-Hadrons as Probes of Azimuthal-Dependent Production in High-Energy Collisions

Farelanani Tshwaranang Makatu (Masters Student)
Prof. Zinhle Buthelezi, Dr. Siegfried Förtsch, Dr. Isobel Kolbe and Dr. Bharati Naik

SA-CERN Excellence

2. Quark-Gluon Plasma (QGP)

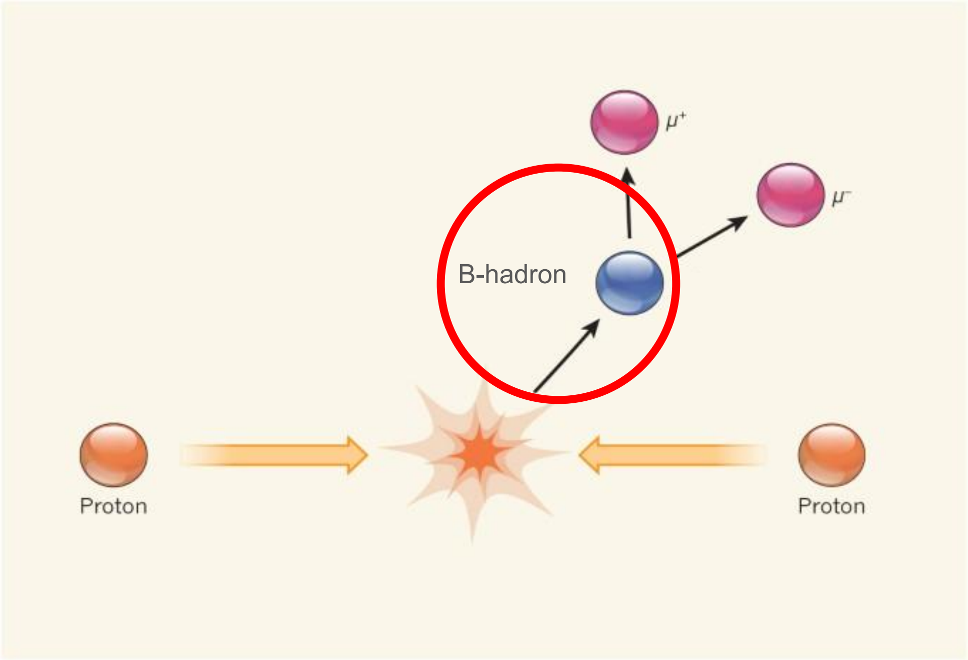




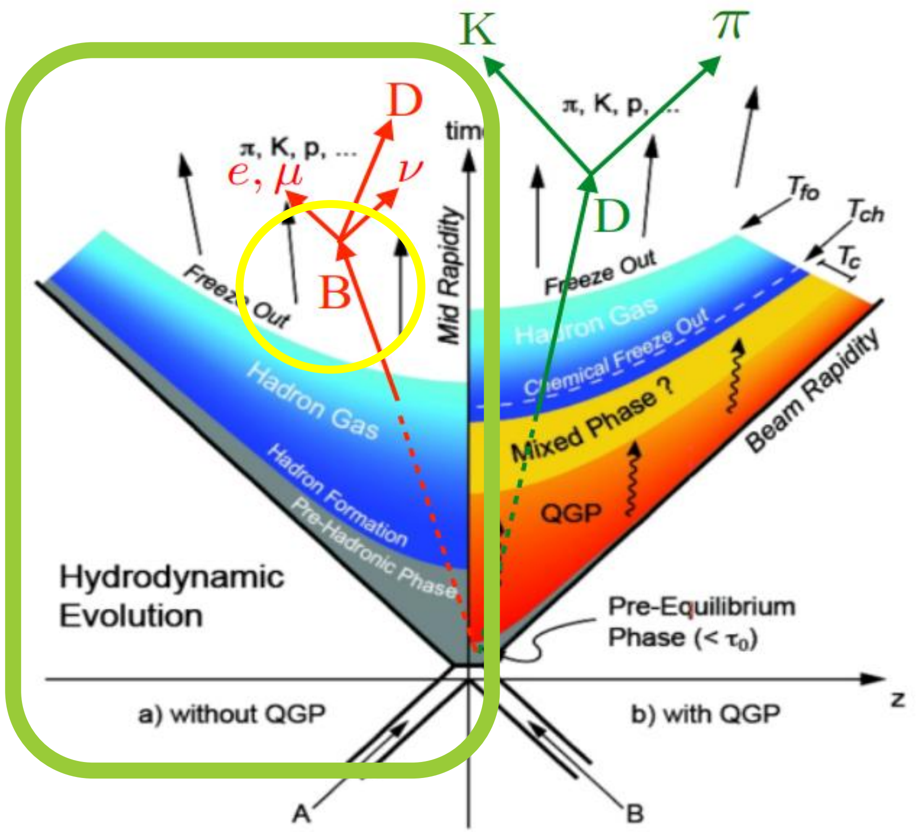
ALICE

3.

Proton-proton (pp) collision



(Zieminska, D, 2015)



(Betz, B, 2009)

$$\frac{d\sigma^{H_b}}{dp_T}(p_T;\ \mu_F, \mu_R) = \boxed{\mathrm{PDF}(x_1, \mu_F^2\ ) \otimes \mathrm{PDF}(x_2, \mu_F^2)} \otimes \boxed{\frac{d\sigma^b}{dp_T^b}(p_T;\ \mu_F, \mu_R)} \otimes \boxed{D_{b\to H_b}\left(z = \frac{p_{H_b}}{p_b}, \mu_F\right)}$$

Parton Distribution Functions (PDFs)

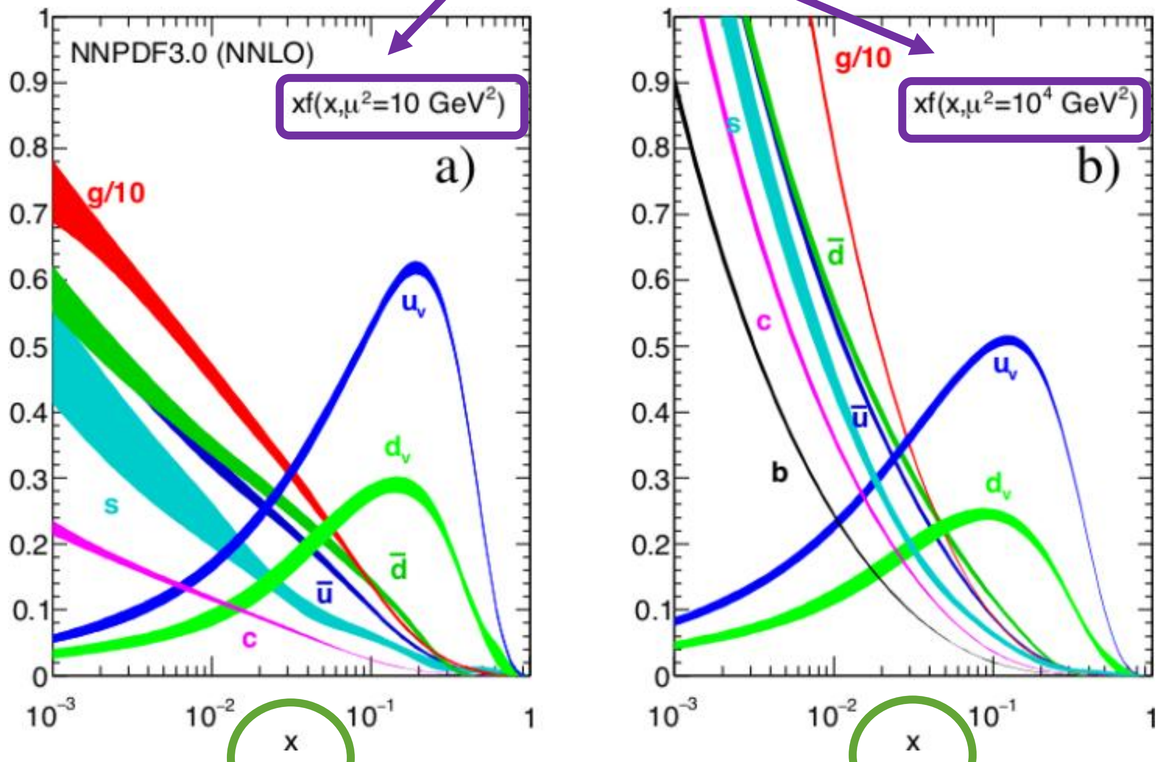
Hard-scattering cross section (pQCD)

Fragmentation functions (hadronization)

FONLL predictions

a) Low energy scale

$x \cdot f(x, \mu^2)$ → PDFs



Bjorken x (x)

b) High energy scale

(NNPDF Collaboration, 2018)

Lower transverse momentum (p_T)

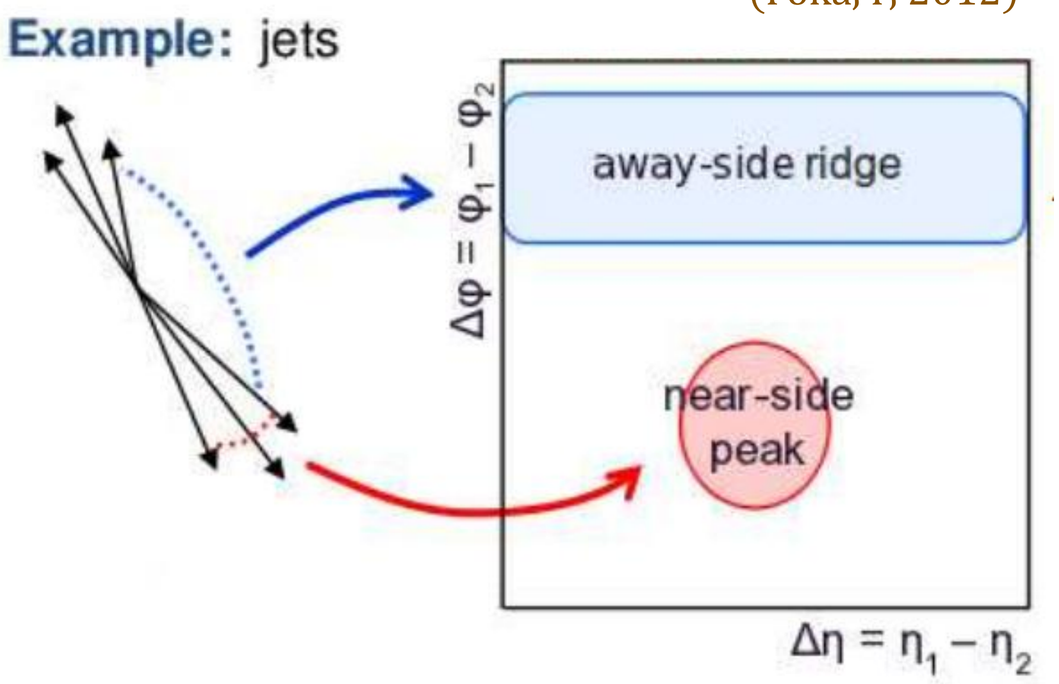
"FONLL" =
Fixed Order (FO) calculations
+
Next-to-Leading Logarithm (NLL)

Higher transverse momentum (p_T)

5.

Two-particle Correlation Method

(Foka, P, 2012)



Correlation Function:

$$C(\Delta\eta, \Delta\varphi) = \frac{N_{pairs}^{mixed}}{N_{pairs}^{signal}} \frac{S(\Delta\eta, \Delta\varphi)}{B(\Delta\eta, \Delta\varphi)}$$

Near-side peak: $(\Delta\eta, \Delta\varphi) = (0, 0)$

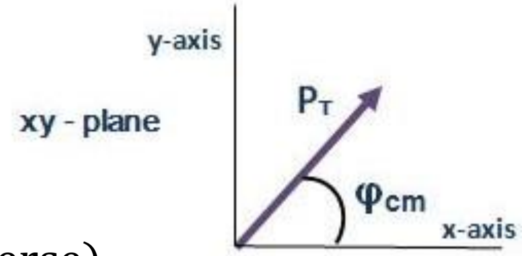
trigger particle as b-hadron decay muon at forward rapidity

Away-side: $\Delta\varphi \approx \pi$

associate particle as charged particles at mid-rapidity

6.

ALICE Detector



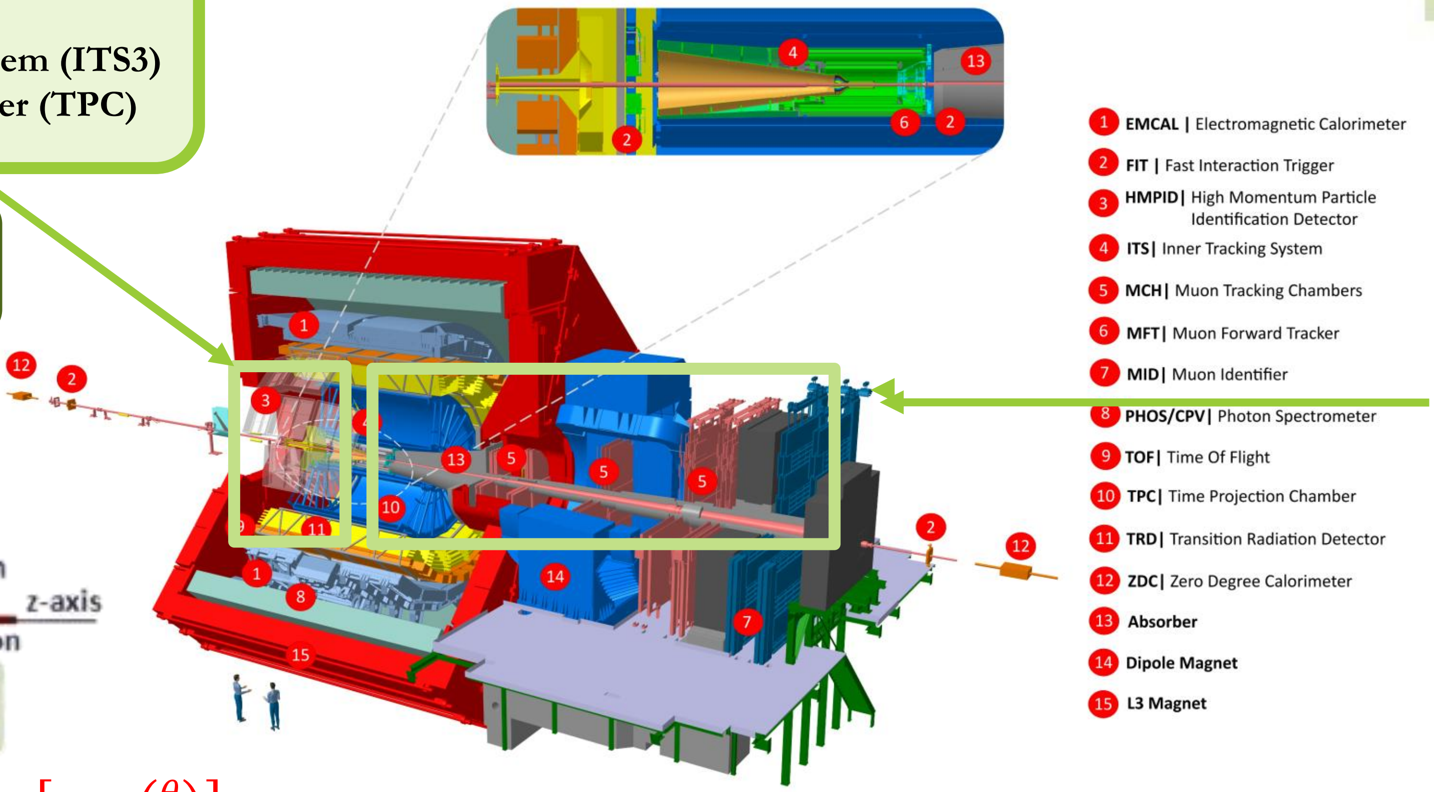
$P_T = P \cdot \sin \varphi_{cm}$

Azimuthal angle (φ/ϕ): x-y plane (transverse)

Central Barrel ($|\eta| < 0.9$):

contains **Inner Tracking System (ITS3) + Time Projection Chamber (TPC)**

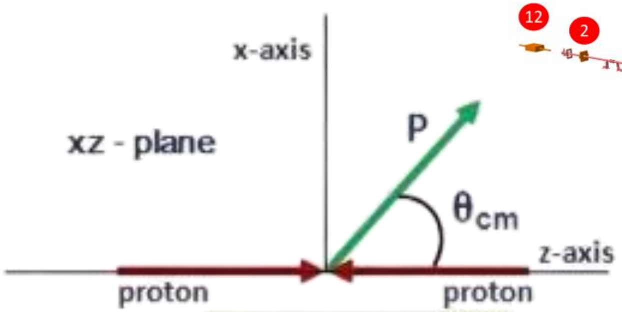
Mid-rapidity



Muon Spectrometer ($-4 < \eta < -2.5$):

contains the **Muon Forward Tracker (MFT)** at $-3.6 < \eta < -2.5$.

Forward rapidity



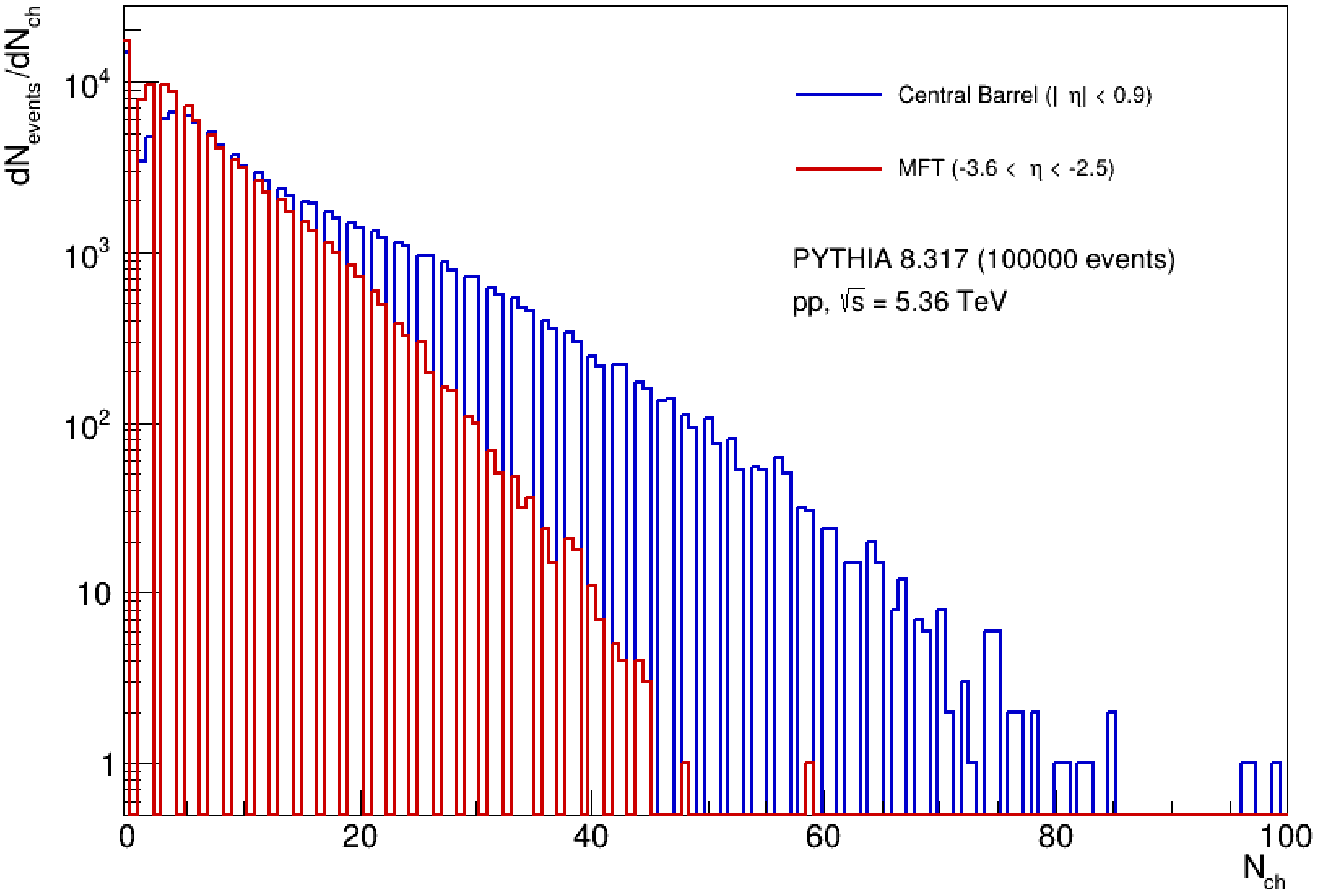
$\eta = -\ln[(\tan(\theta/2))]$

Pseudo-rapidity: $\eta = -ln\left[tan\left(\frac{\theta}{2}\right)\right]$

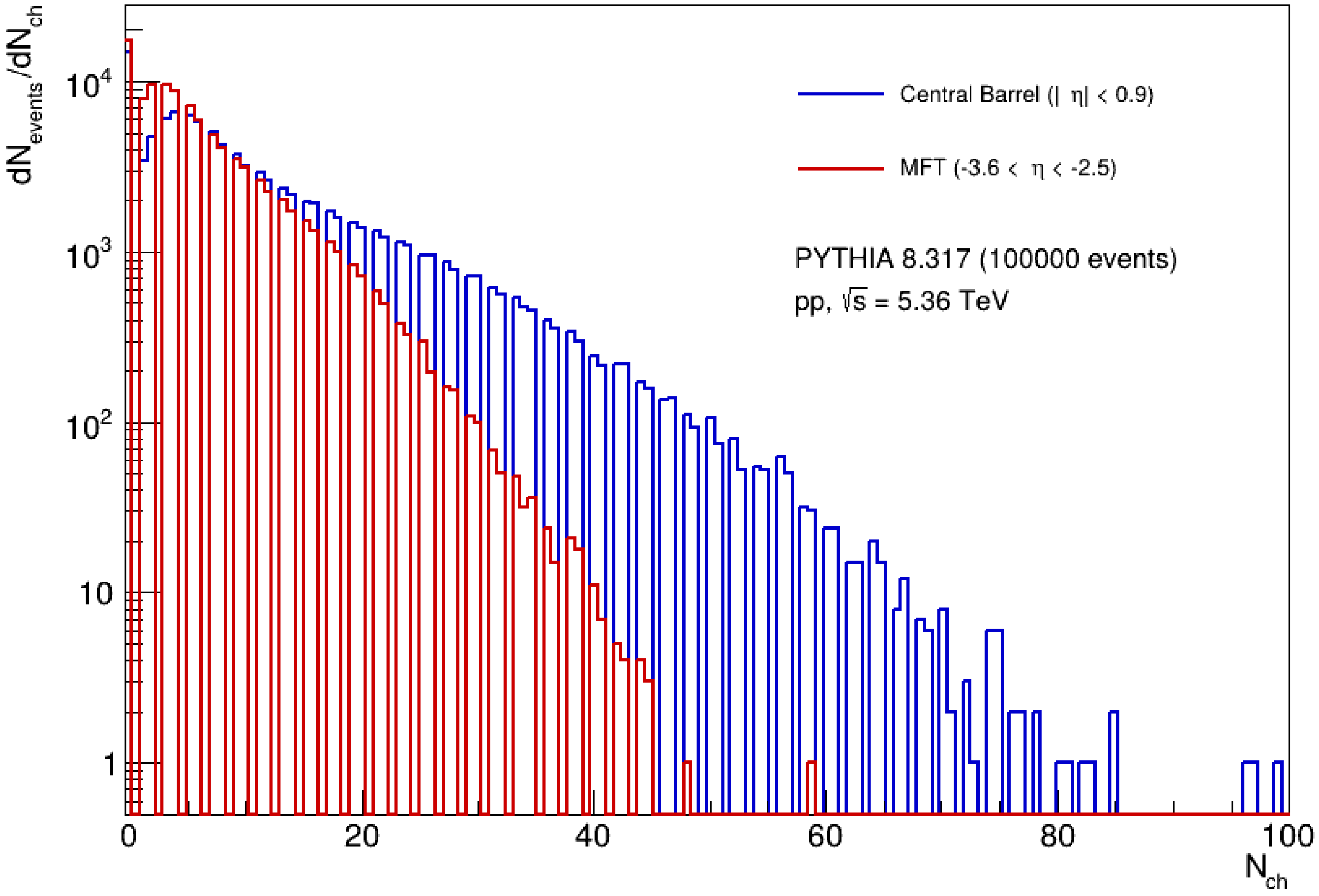
7. Central barrel vs. MFT (N_{ch}) - Multiplicity

Forward rapidity / MFT
N_{ch} = 588 426

Mid-rapidity / Central barrel
N_{ch} = 1 055 485

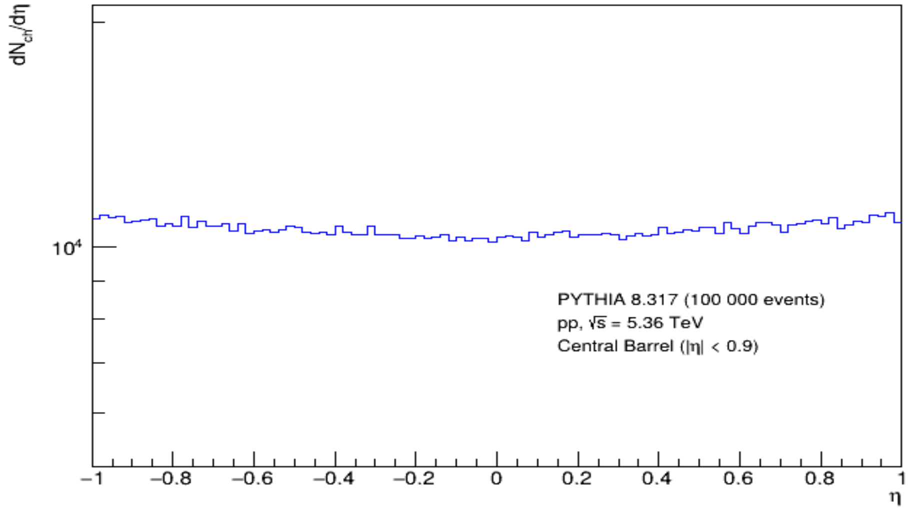


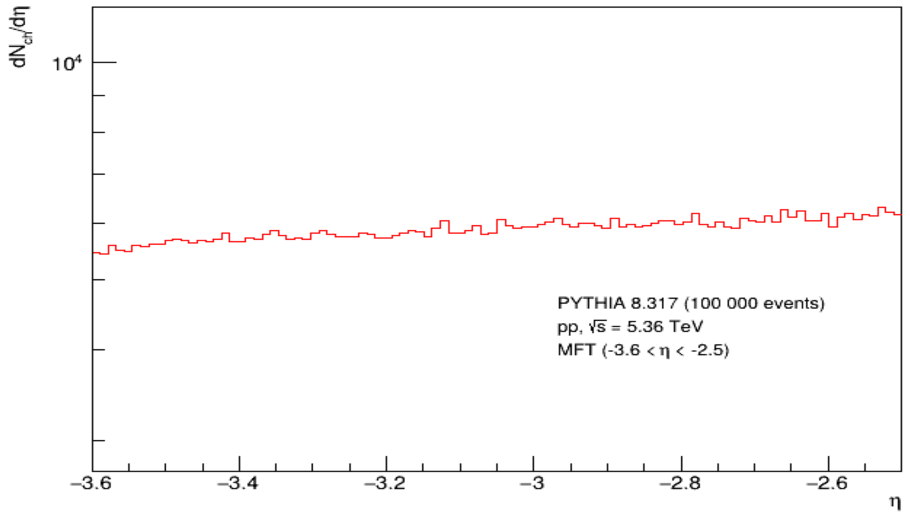
8. Central barrel vs. MFT (N_{ch}) - Multiplicity



Both distributions show the expected fall-off in N_{ch} per event but **show sufficient statistics for associate particles**.

9. Central barrel vs. MFT (N_{ch}) – Angular distributions





Forward rapidity / MFT
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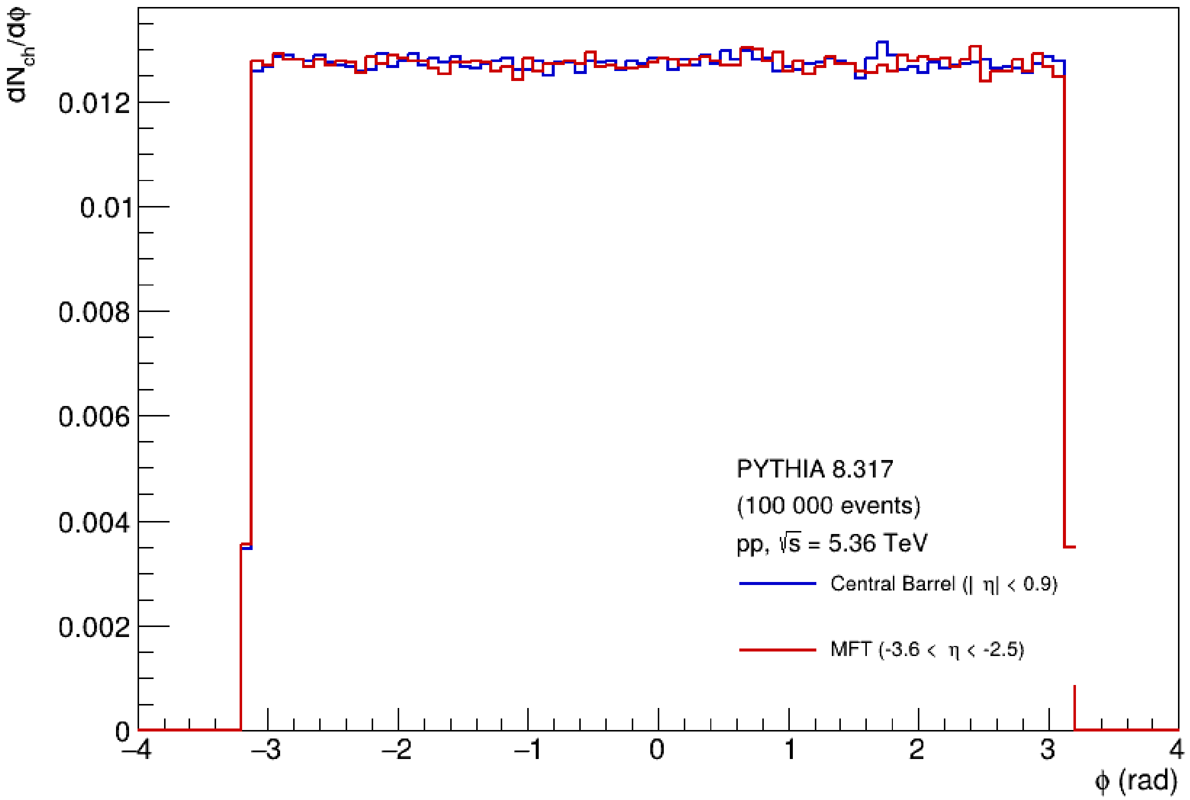
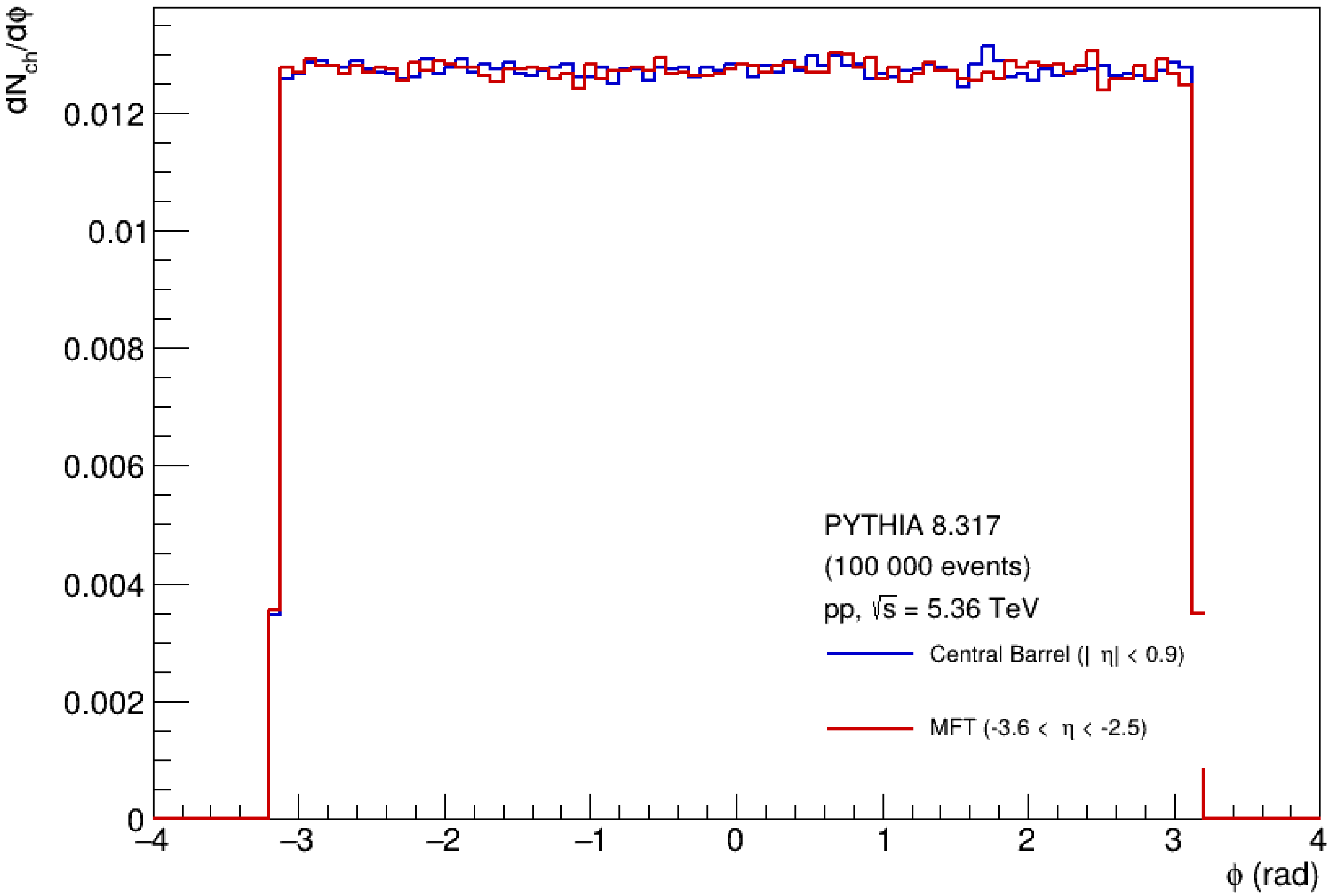


10.

Central barrel vs. MFT (N_{ch}) – Angular distributions



Constant production in both η region = good characteristic for associate particles

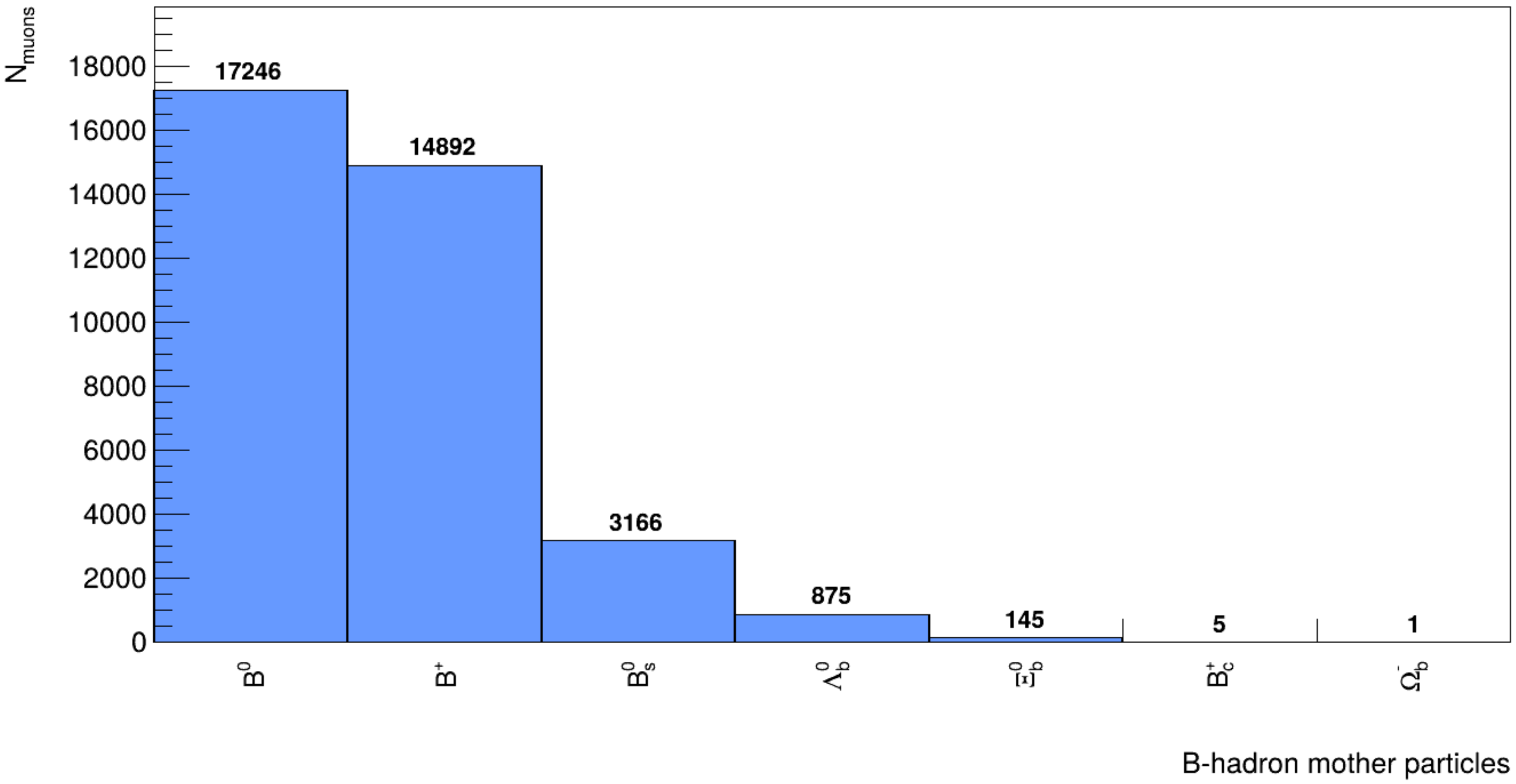
b-Hadron decayed muons at forward rapidity

Mesons

Baryons

PDG code	Mother particle	Quark content
511	B^0	d$\bar{b}$
521	B^+	u$\bar{b}$
531	B_s^0	s$\bar{b}$
5122	Λ_b^0	udb
5232	Ξ_b^0	usb
541	B_c^+	c$\bar{b}$
5332	Ω_b^-	ssb

$N_{muons} = 36330$

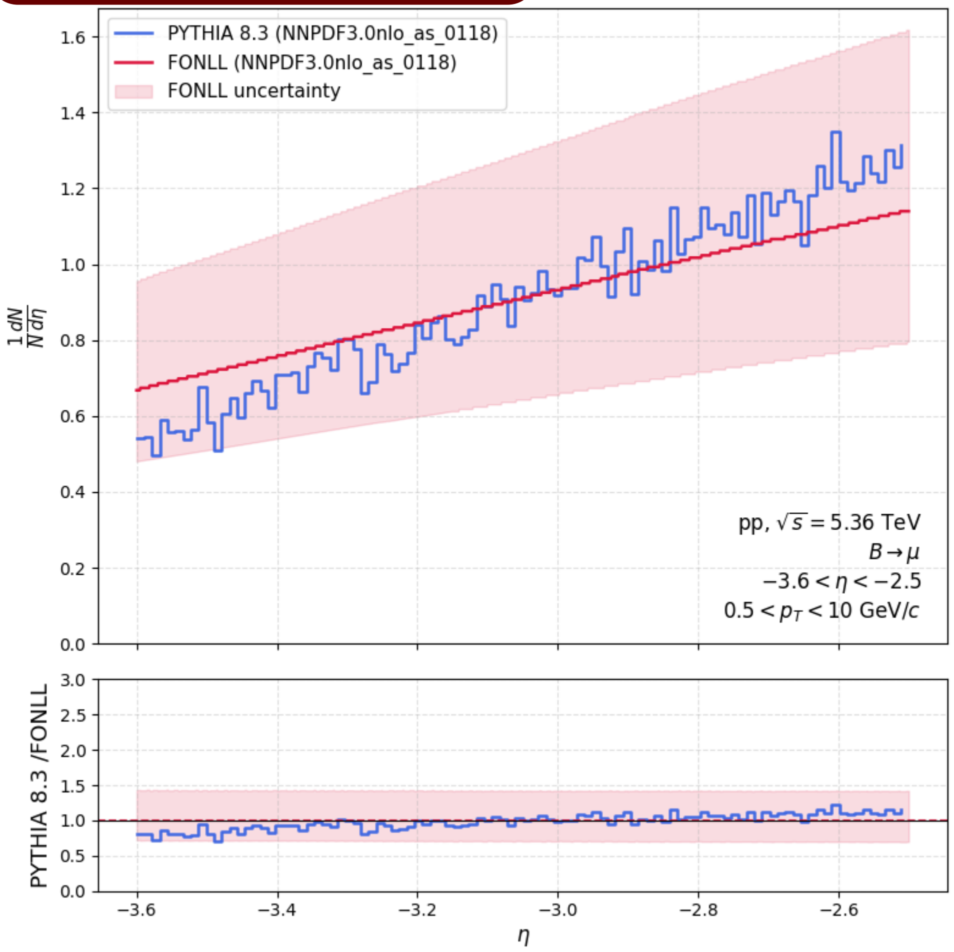


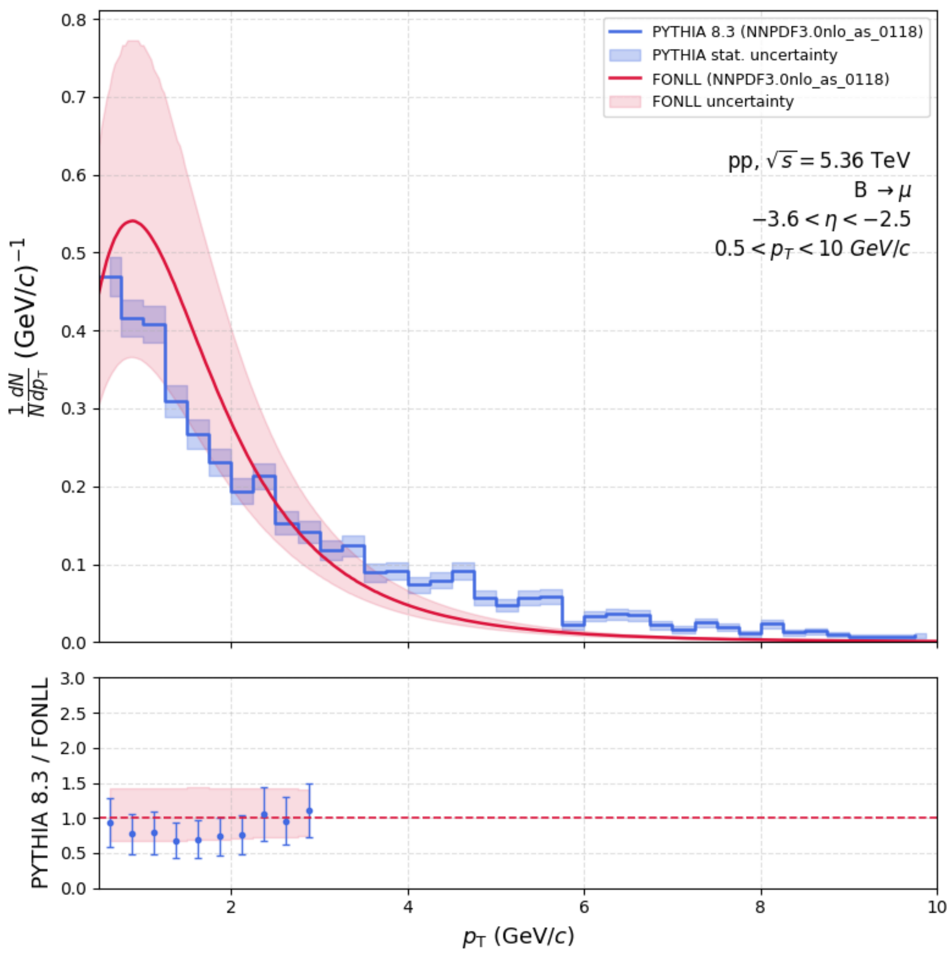
12. FONLL vs. PYTHIA 8.317 (b-Hadrons)

$N_{points} = N_{muons} = 1000$

FONLL values from: [LPTHE FONLL Heavy Quark Production (M. Cacciari)]

$N_{events} = 100\ 000$
$N_{muons} = 3644$





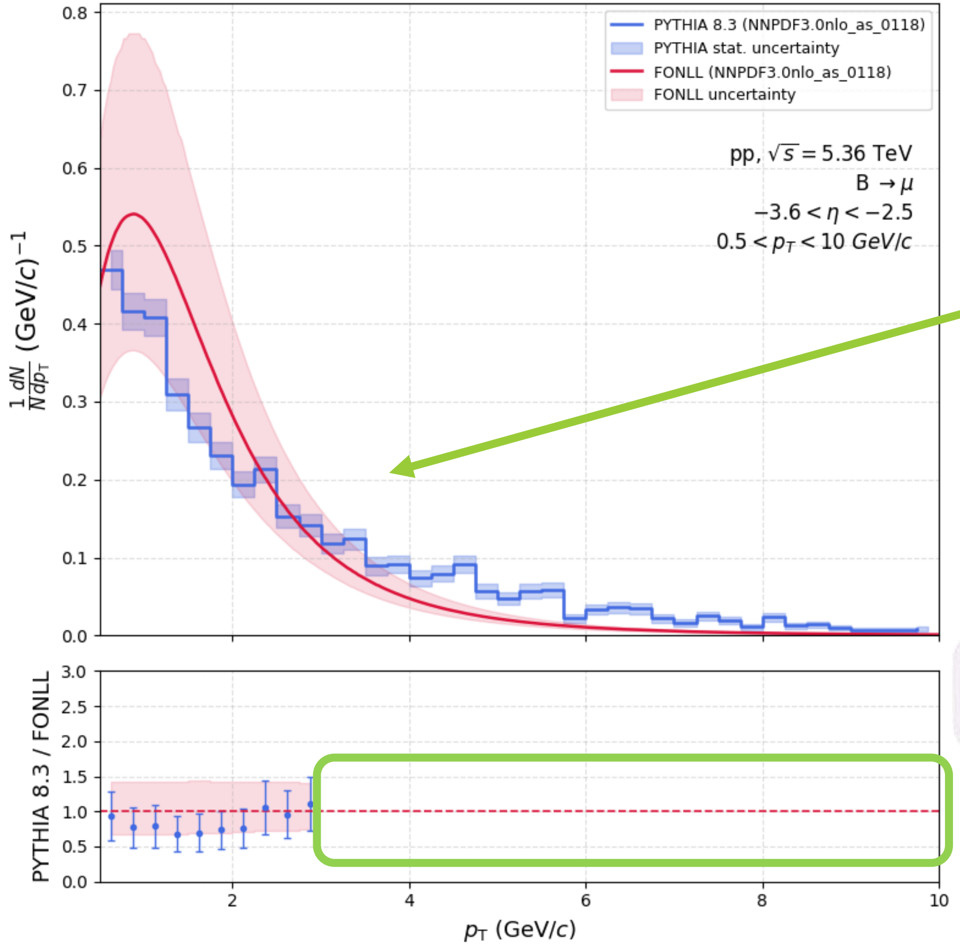
Similar shapes and trends observed in both η and p_T = PYTHIA agrees with FONLL in shape

But the ratio bars?

13. FONLL vs. PYTHIA 8.317 (b-Hadrons)

$N_{events} = 100\ 000$
$N_{muons} = 3644$

FONLL values from: LPTHE FONLL Heavy Quark Production (M. Cacciari)



Both FONLL and PYTHIA agree in general shape = exponential decay after peak near 0.5 GeV/c

Too few raw PYTHIA counts per bin = lack of statistics in the higher p_T region.

To-do list

- PYTHIA prediction of the correlation function – increasing statistics
- Monte Carlo (MC) data at $\sqrt{s} = 5.36\ TeV$ - basis for Pb-Pb collision
- Accurate detector cuts to the datafile – ITS, TPC and MFT

- Two-particle correlation method on MC data
- RIVET analysis

Summary

- Validated the theoretical and simulation framework
- Observed the distributions of our particles of interests – confirmed agreement with theoretical predictions
- Understand the pp collision baseline → "setting the stage"

Thank you!

Questions?

Charged particles

PDG code	Charged particle detected	Mean lifetime τ (s)	Mass (MeV/c^2)
211	π^+	2.60×10^{-8}	139.57
-211	π^-	2.60×10^{-8}	139.57
-321	K^-	1.24×10^{-8}	493.68
321	K^+	1.24×10^{-8}	493.68
2212	p	$> 2.84 \times 10^{37}$	938.27
-2212	$\bar{p}$	$> 2.84 \times 10^{37}$	938.27
-11	e^+	2.19×10^{-6}	5.11×10^{-1}
11	e^-	2.19×10^{-6}	5.11×10^{-1}
13	μ^-	$> 2.08 \times 10^{36}$	105.66
-13	μ^+	$> 2.08 \times 10^{36}$	105.66