

η production in p-p collisions at $\sqrt{s} = 200\text{GeV}$

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for PHENIX collaboration



QM2004



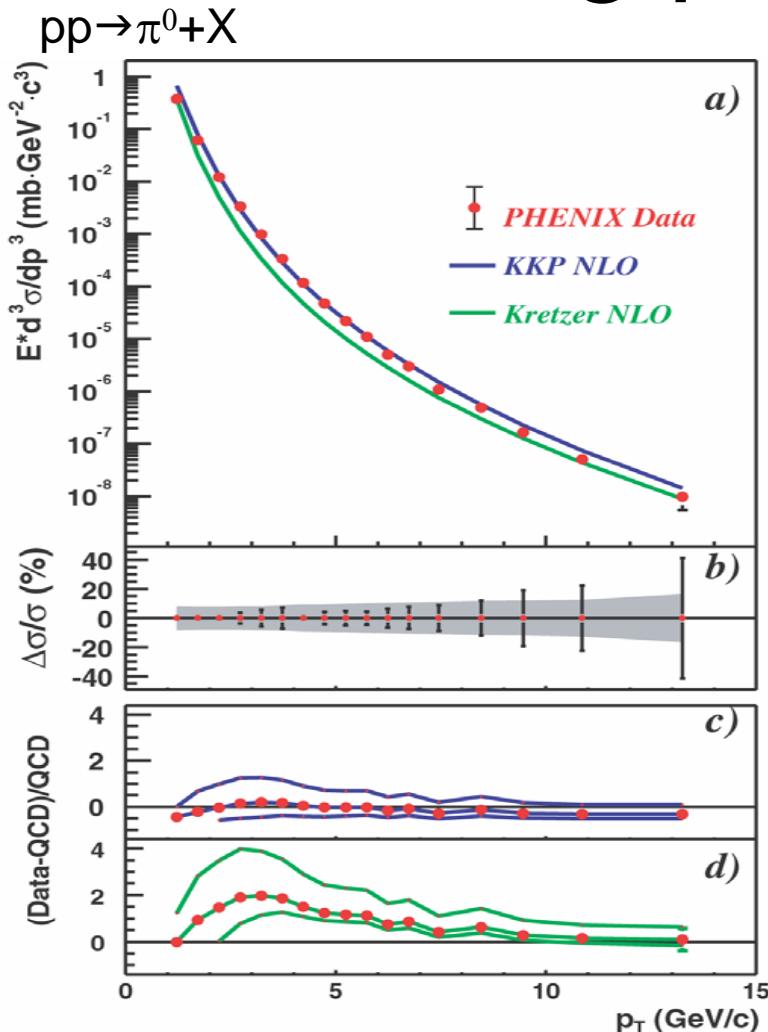
Introduction

- Interest in η production in p-p collisions
 - Test of perturbative QCD
 - Fragmentation difference from other hadrons
 - Input for other measurements (direct photon)
 - Baseline for heavy ion collisions (d-Au,Au-Au)

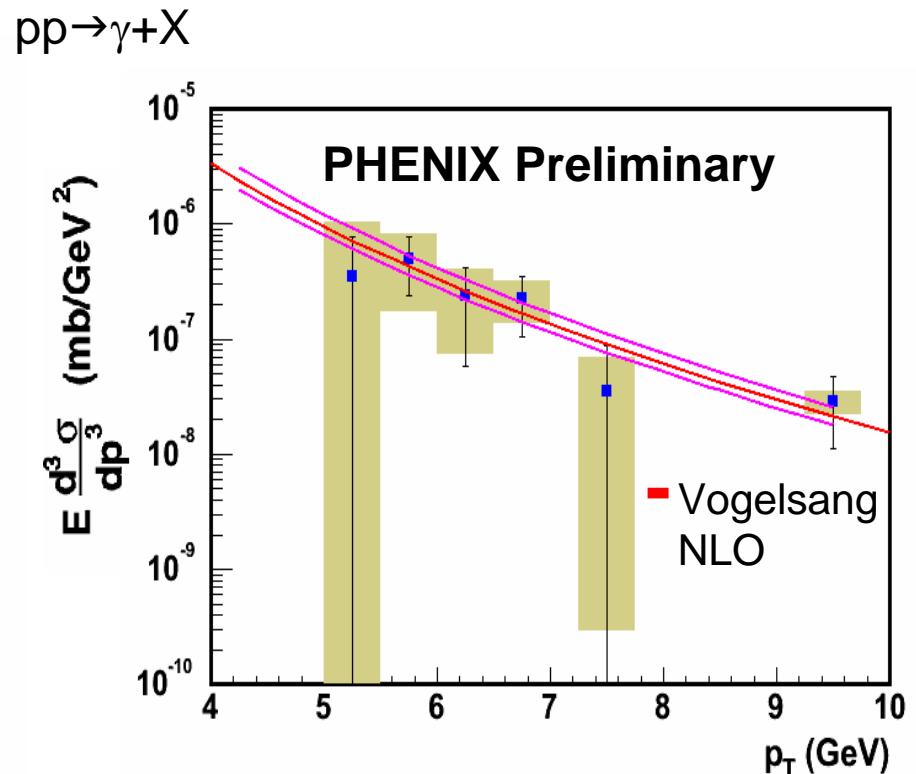
Testing pQCD

- Ingredients of pQCD
 - Structure function
 - Factorization theorem
 - Fragmentation
- Checking the applicability of pQCD is important in RHIC spin program
 - translate experimental measurements into spin structure functions
- p-p measurements are baseline of p-A, A-A
 - Need better understanding of p-p

Testing pQCD in PHENIX



Poster by S.Bathe, PRL91, 241803(2003)



Poster by K.Reygers

- Good agreement with pQCD calculation

The “mixing”:strangeness in η

$$|\eta_0\rangle = \frac{1}{\sqrt{3}} |u\bar{u} + d\bar{d} + s\bar{s}\rangle$$

$$|\eta_8\rangle = \frac{1}{\sqrt{6}} |u\bar{u} + d\bar{d} - 2s\bar{s}\rangle$$

$$|\eta\rangle = \cos\theta_P |\eta_8\rangle - \sin\theta_P |\eta_0\rangle$$

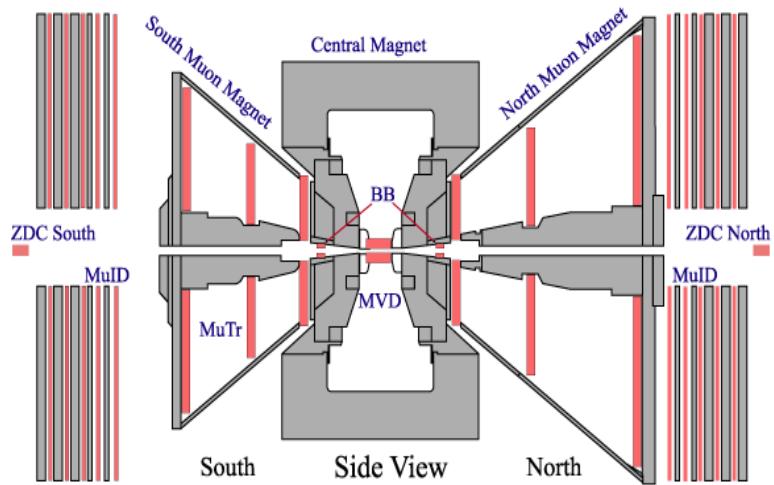
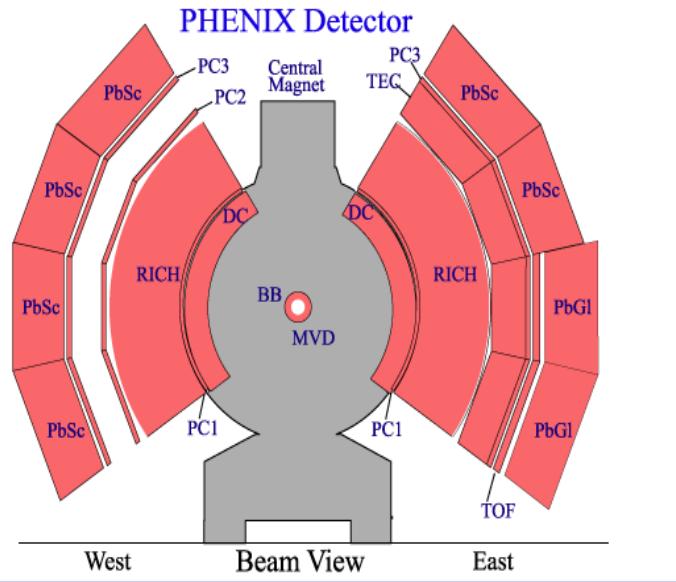
$$|\eta'\rangle = \sin\theta_P |\eta_8\rangle + \cos\theta_P |\eta_0\rangle$$

$$\theta_p \sim -12.4 +/- 3.5$$

hep-ex/0105185

- In SU(3) model
 - Expressed with mixing angle
- The number of strangeness quarks
 - η : 0.91 +/- 0.12
 - (ϕ : 1.94 +/- 0.09)
 - hep-ex/0105185
- There is some theoretical uncertainty
 - Eur.Phys.J.C7,217 (1999)
 - Phys.Rev.D58, 114006 (1998)
- Fragmentation with the assumption of SU(3) symmetry is under study
 - Phys.Rev.D58,094014(1998)

PHENIX experiment

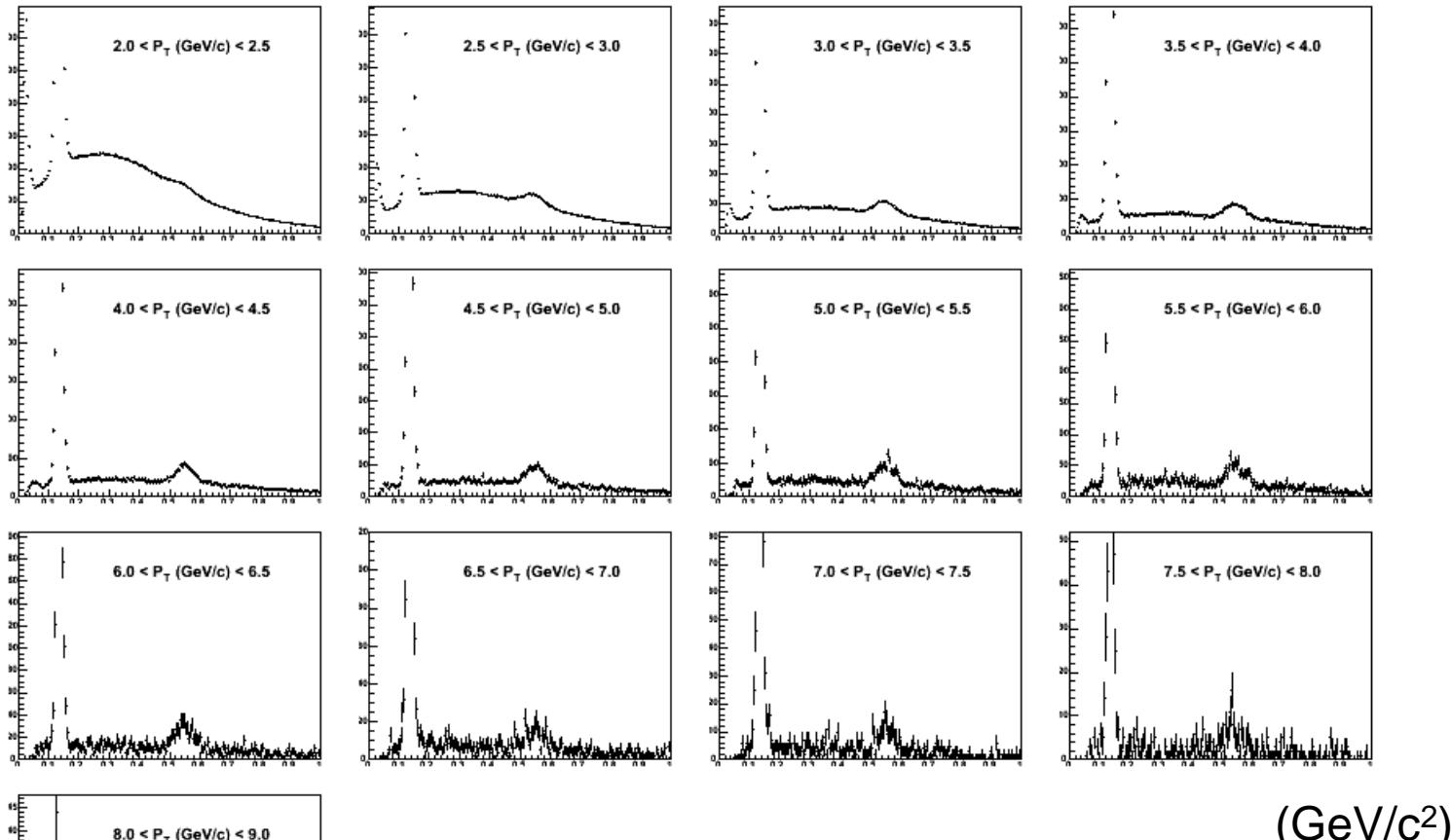


- Complete configuration in Run-3
- Used in this analysis
 - Beam-Beam counter
 - Vertex determination
 - EMCal (PbSc)
 - Photon detection
 - High energy Photon trigger

Data analysis

- Run-3 45M events with high energy photon trigger
- BBC vertex $|z| < 30$ cm
- Photon Asymmetry $|E_1 - E_2| / |E_1 + E_2| < 0.8$
- Corrections
 - Acceptance and reconstruction
 - Photon trigger efficiency & minbias trig. efficiency
 - Photon conversion loss

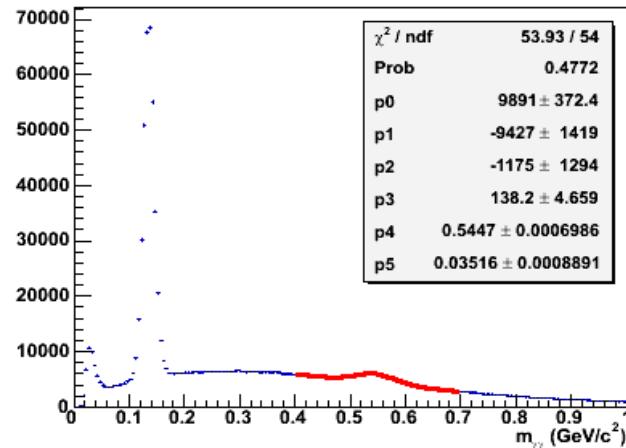
Invariant mass spectra



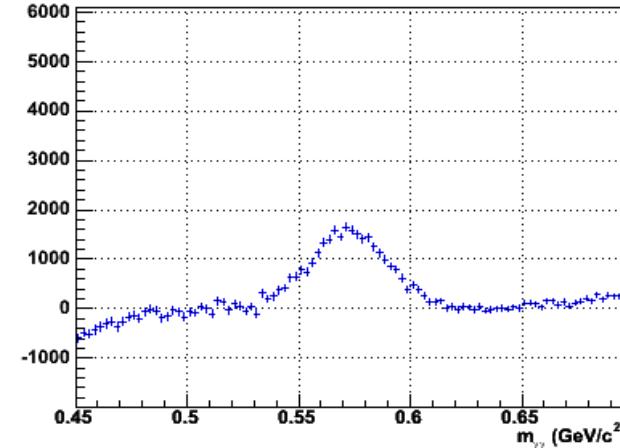
η peaks are clearly seen at $\sim 0.55 \text{ (GeV}/c^2)$
 η width $\sim 30 \text{ MeV}/c^2$

Yield extraction(examples)

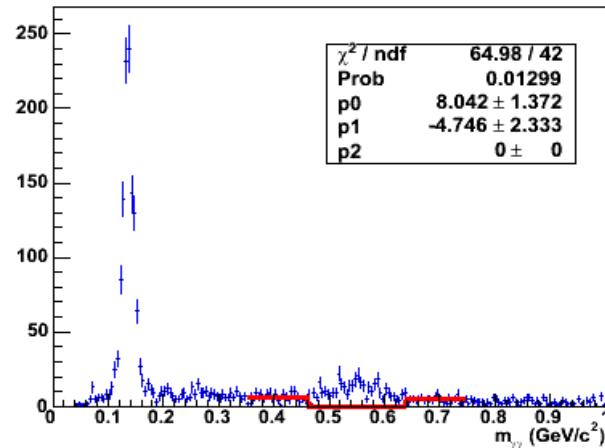
2.5-3.0 GeV/c



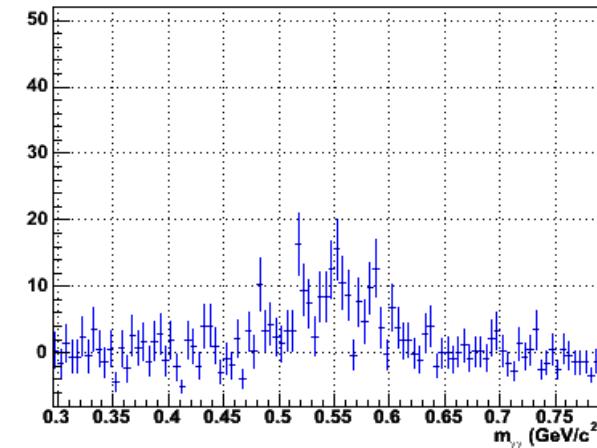
After BG subtraction : 2.5-3.0GeV/c



6.5-7.0 GeV/c



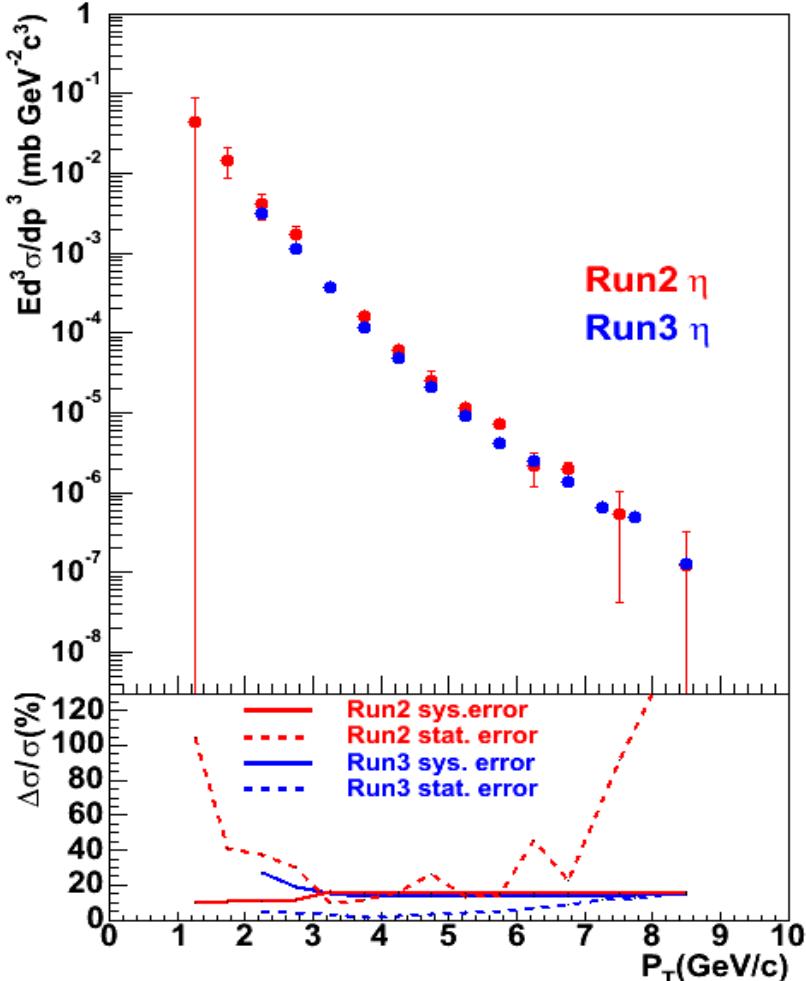
After BG subtraction : 6.5-7.0 GeV/c



Background is subtracted by fitting

Cross Section

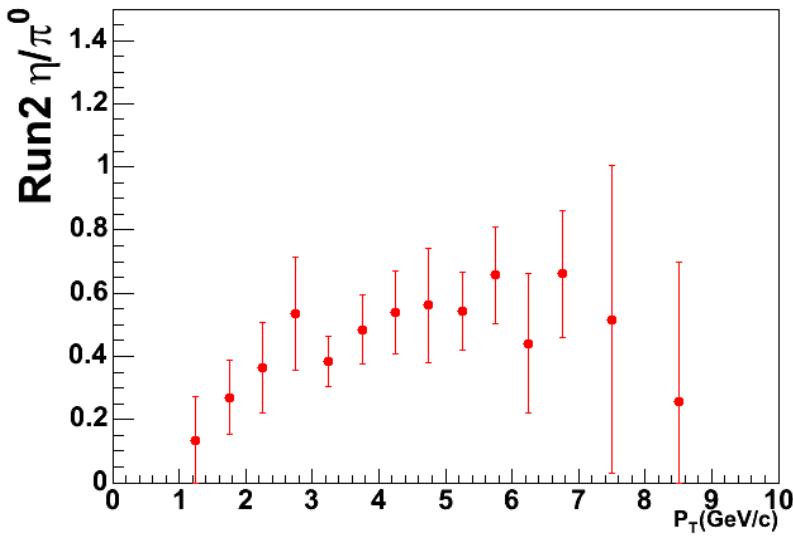
PHENIX Preliminary



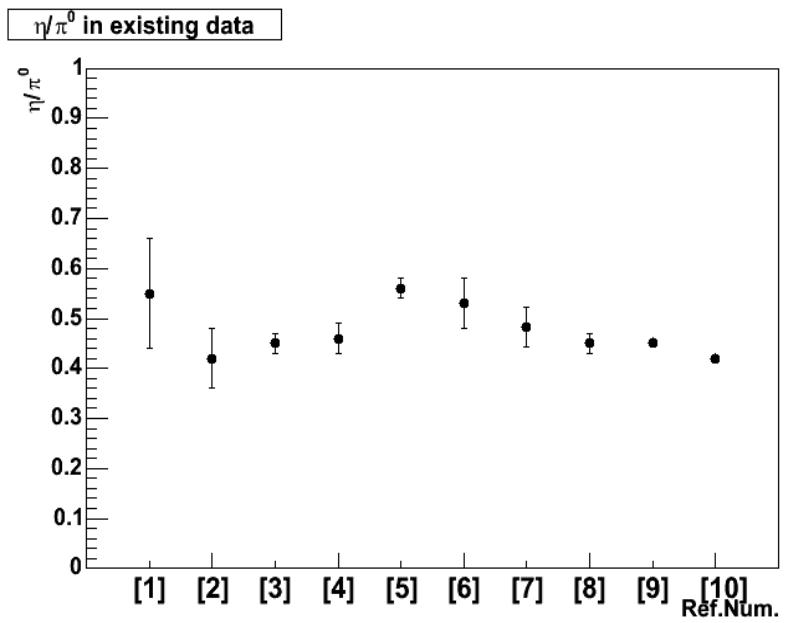
- 2 independent analysis (Run-2 and Run-3)
- Uncertainty in overall normalization $\sim 10\%$ (not shown)
- Agrees within the systematical error
- Run-3 data have more statistics and go to higher p_T
 - Trigger eff. Is under study

η/π^0 ratio

PHENIX Preliminary



π^0 from PRL91(2003) 241803



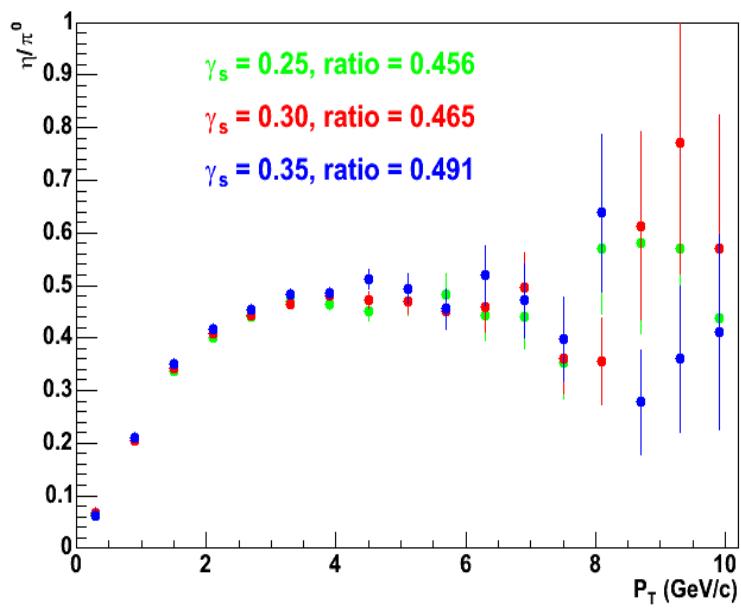
See p.12 for Ref.Num.

- The ratio is 0.54 ± 0.05 (p_T range: 3.5-9 GeV/c)
- The value agrees with existing data (right plot, p.12)
- The normalization of Run3 data is under study.

existing data (η/π^0 ratio)

Ref.	beam (GeV)	system	pt (GeV/c)	η/π^0	expt	Ref.Num
Phys.Lett.55B,232(1975)	sqrt(s)=52.7	p-p	3~5.6	0.55+/-0.11		[1]
Phys.Rev.Lett.40,683(1978)	p_lab =100	p-p	>2.0	0.42+/-0.06		[2]
	p_lab =200	p-p	>2.0	0.45+/-0.02		[3]
	p_lab=300	p-p	>1.6	0.46+/-0.03		[4]
Phys.Lett.158B,282(1985)	sqrt(s)=53	p-p	2.8	0.56+/-0.02	AFS	[5]
		p-p	4	0.53+/-0.05		[6]
Phys.Lett.194B,568(1987)	sqrt(s)=24.3	p-p	2.5-3.7	0.482+/-0.040	UA6	[7]
Z.Phys.C 42,527(1989)	p_lab=280	p-p	4~7	0.45+/-0.02+/-0.04	WA70	[8]
Phys.Rev.D68,052001(2003)	p_lab=500	p-Be	3~8	0.45+/-0.01	E706	[9]
	p_lab=800	p-Be	3~8	0.42+/-0.01		[10]

Pythia simulation



- Strangeness “suppression”
 - due to heavier mass of strangeness quark
- Suppression factor γ_s
$$\bar{u}\bar{u} : \bar{d}\bar{d} : \bar{s}\bar{s} = 1:1:\gamma_s$$
$$\gamma_s = 0.3$$
- To determine the factor precisely by the ratio might be difficult

Summary and outlook

- η invariant cross section is measured
- η/π^0 ratio agrees with existing data
- Will compare with pQCD calculation (under study)
- Measure high p_T hadrons
 - constraint fragmentation functions for different flavors, meson and hadrons