

# PYTHIA Simulations of Charmonia

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# Simulations requirements

PYTHIA 8.185

p+p at 115 GeV

LHCb-like requirements for  $\mu$ :

$$2 < \eta_{\mu} < 5$$

$$p_{\text{T}}^{\mu} > 0.7 \text{ GeV}/c$$

Momentum resolution:  $\Delta p/p = 0.5\%$

Energy resolution:  $\Delta E/\sqrt{E} = 10\%$

$\mu$  identification efficiency: 98%

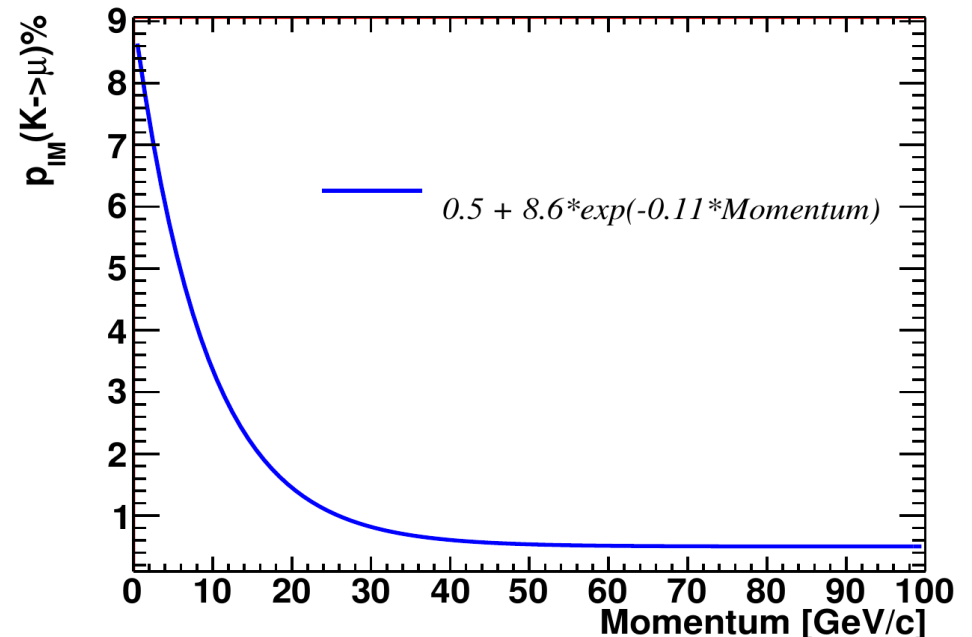
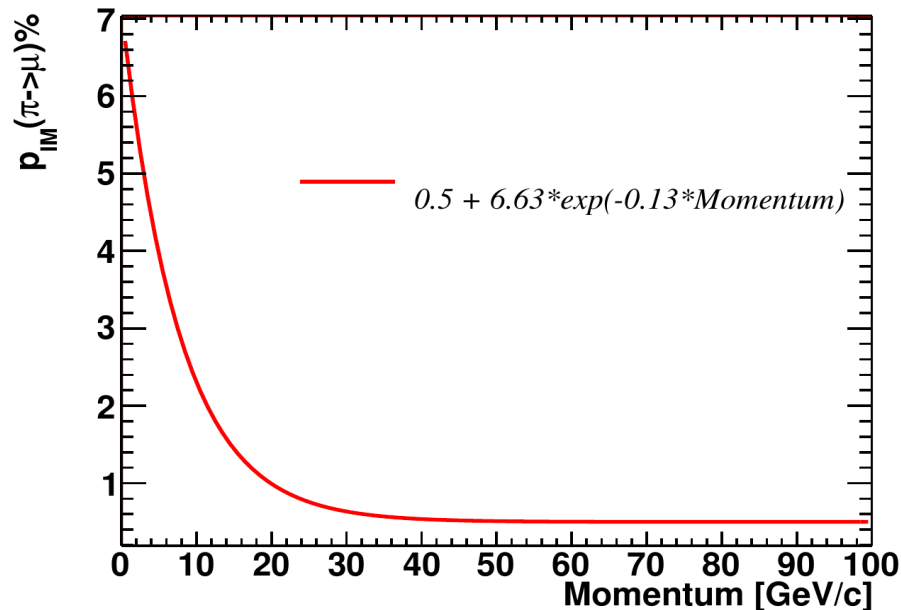
# J/Ψ simulation

$$J/\Psi \rightarrow \mu^+ \mu^-$$

μ from π and K decays rejected by applying LHCb-like conditions:

If π, K decays below 12 m in detector in “z” – μ from the decay is rejected

If π, K decays after 12 m there is probability of π → μ misidentification – distributions taken from LHCb paper



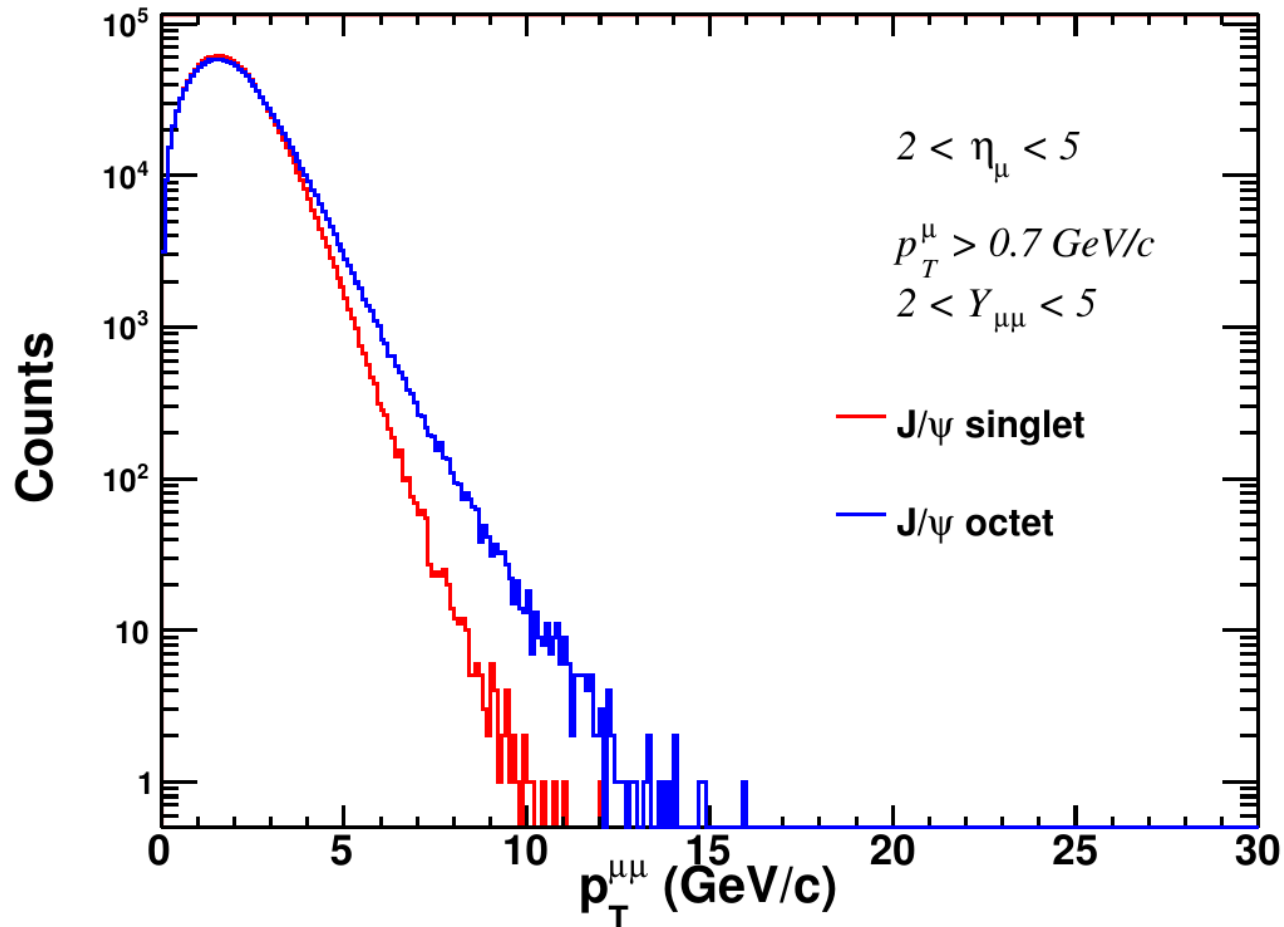
# J/ $\psi$ simulation – singlet vs octet

*Singlet:*

Charmonium:gg2ccbar(3S1)[3S1(1)]g = on,off

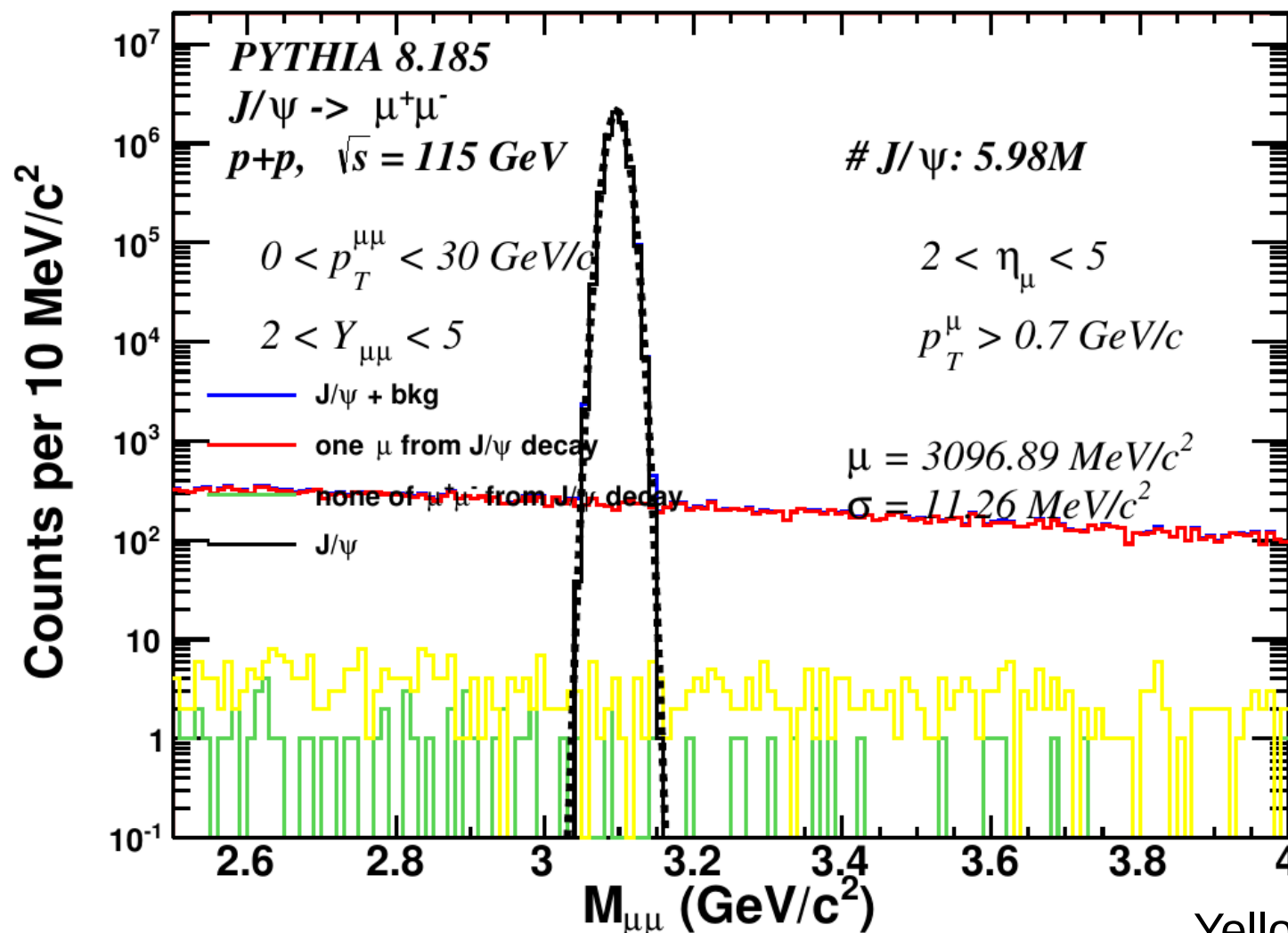
*Octet:*

Charmonium:gg2ccbar(3S1)[3S1(8)]g = on,off



# J/ $\Psi$ simulation – different bkg sources

octet

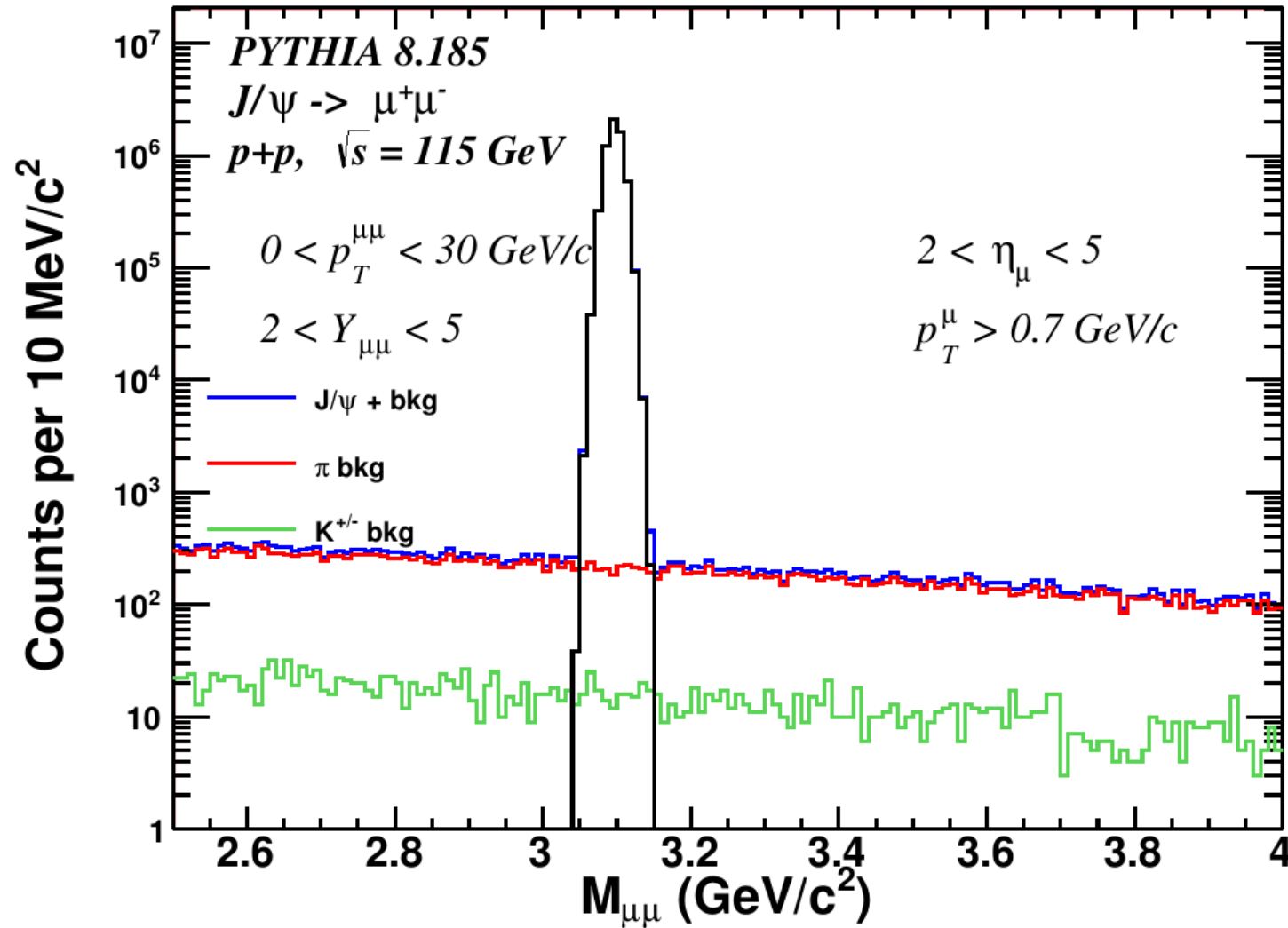


1/6 fb<sup>-1</sup>  
generated

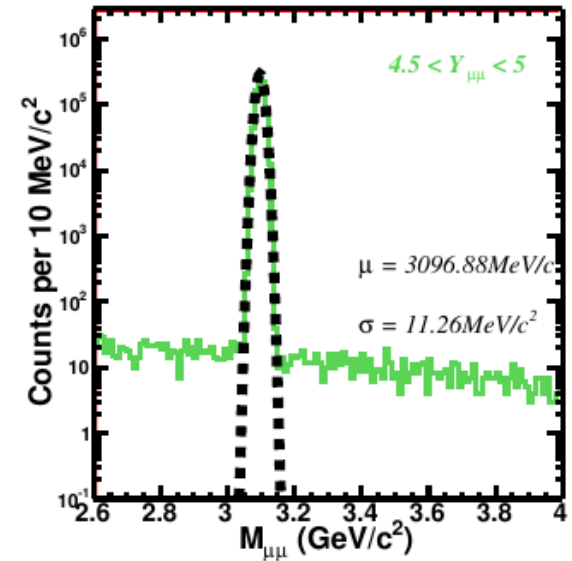
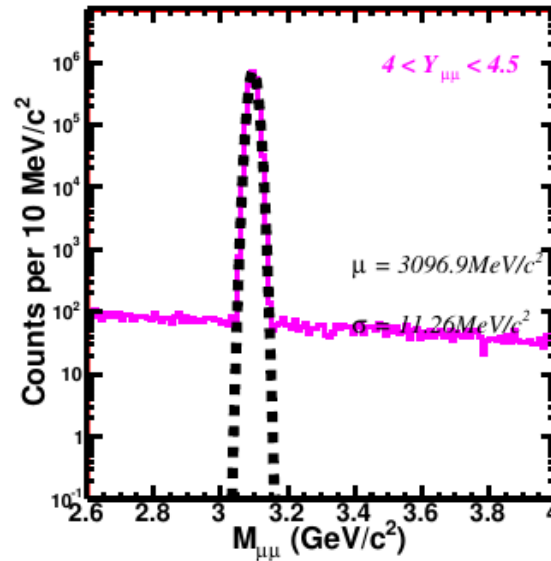
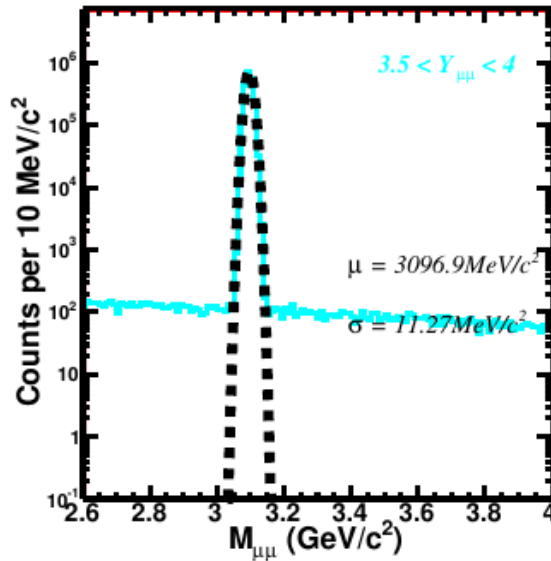
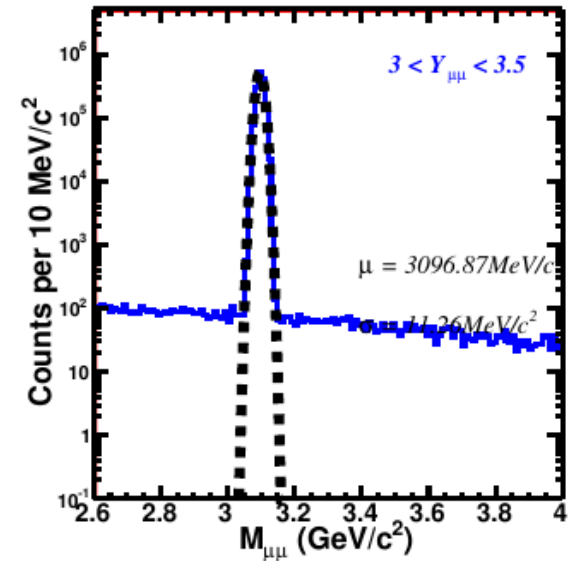
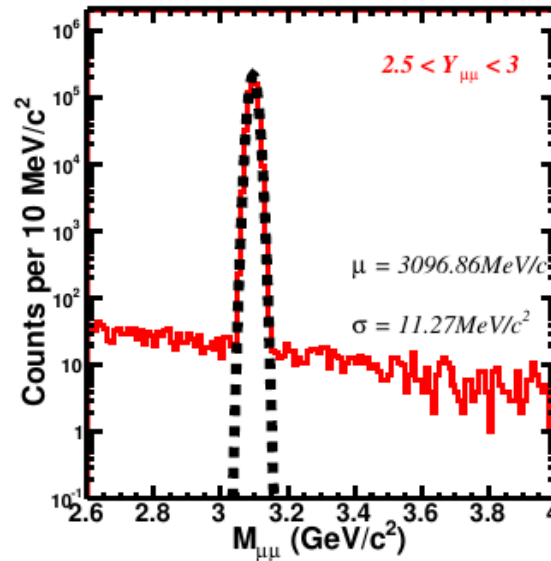
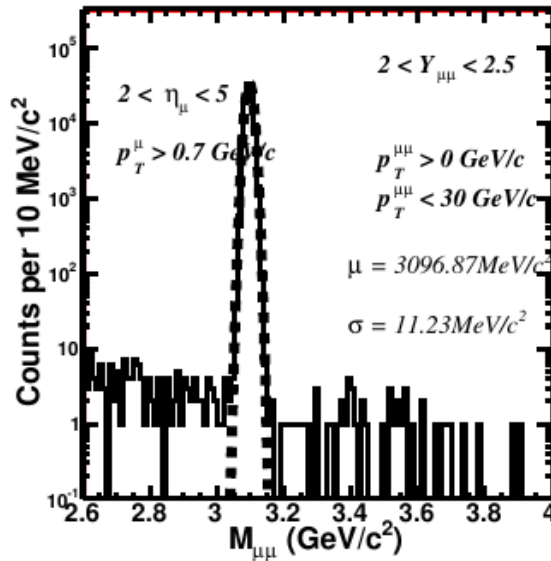
Yellow -  $\mu$  from  
different J/ $\Psi$

# J/ $\Psi$ simulation – different bkg sources

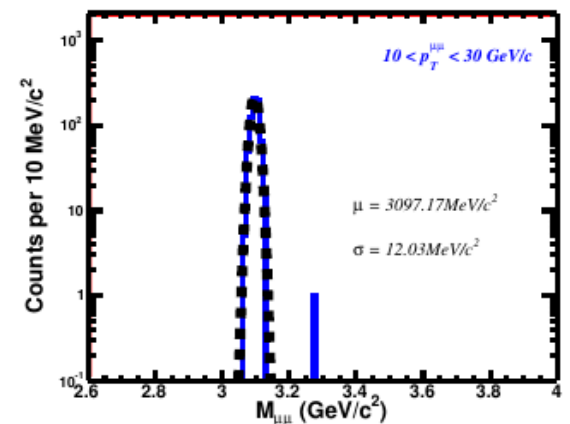
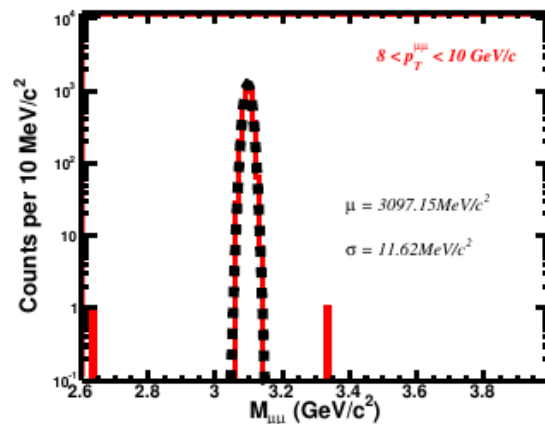
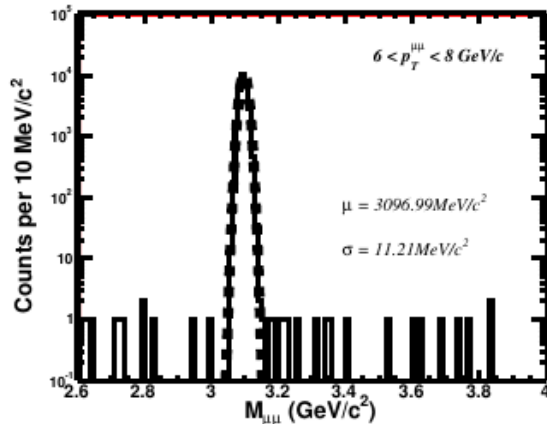
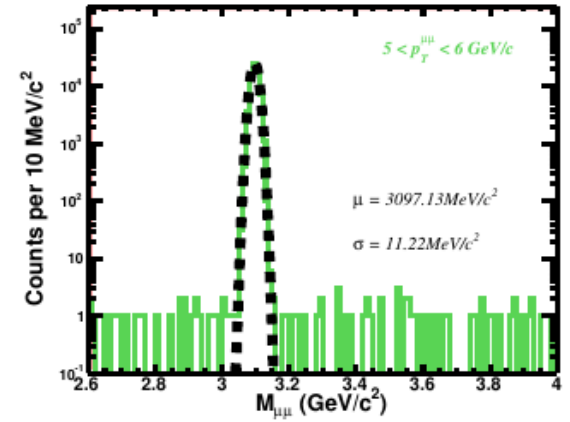
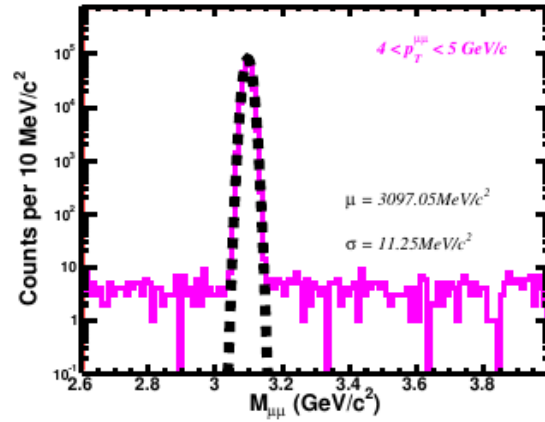
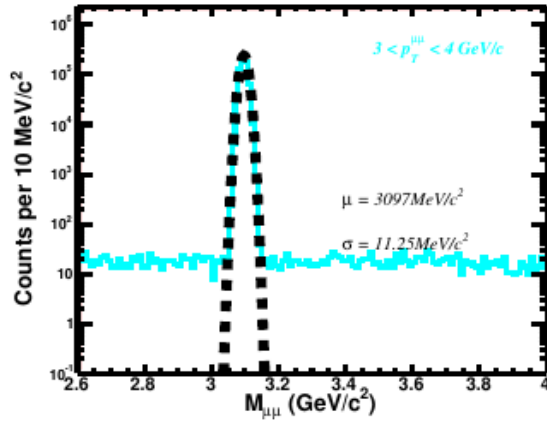
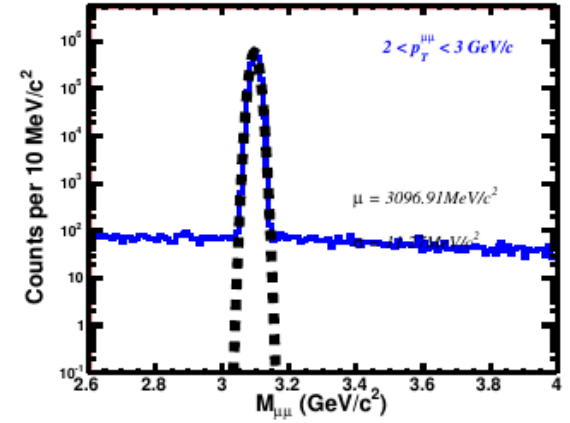
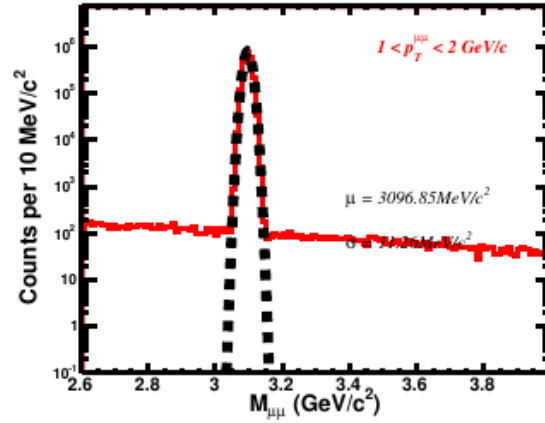
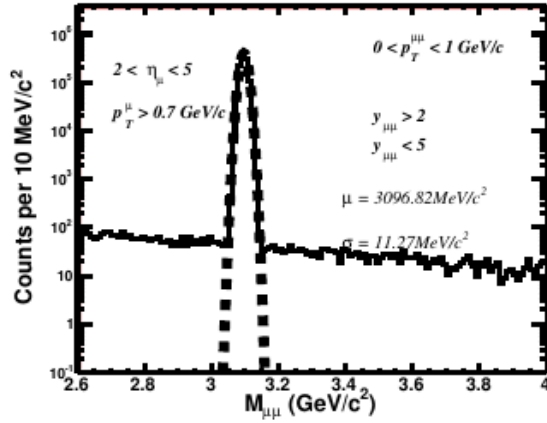
octet



# J/ $\Psi$ simulation – $y$ bins octet



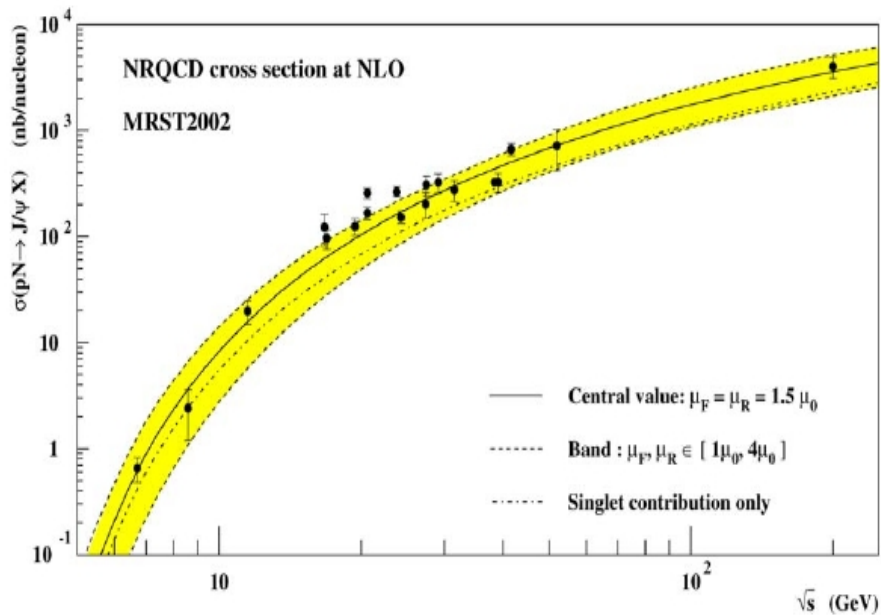
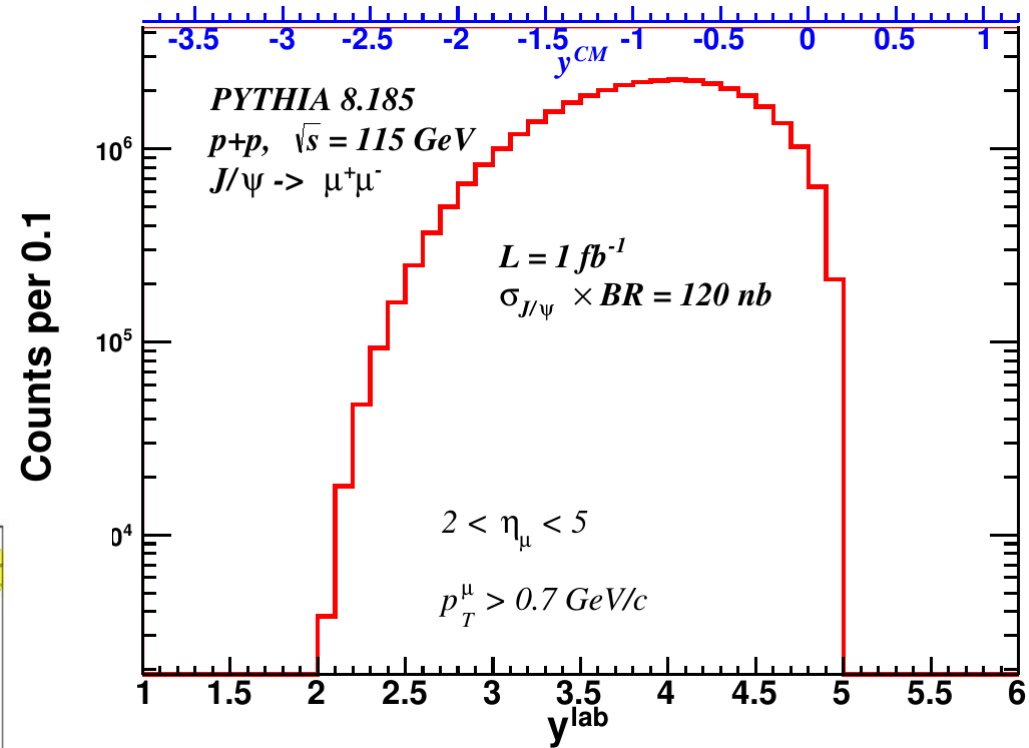
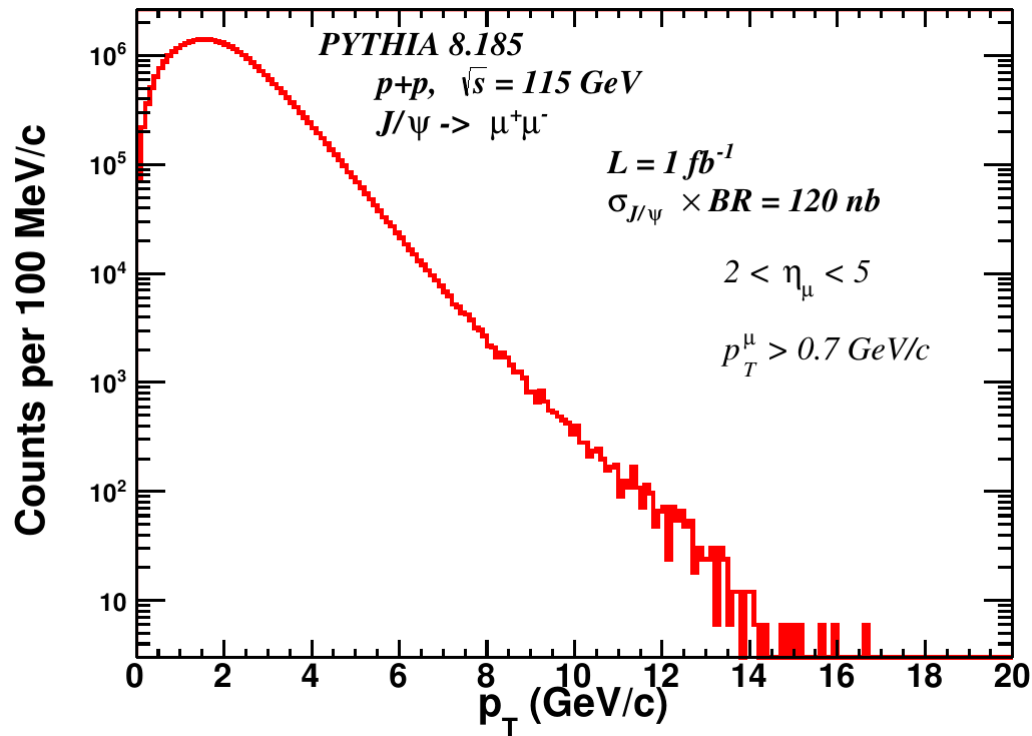
# J/ $\Psi$ simulation – $p_T$ bins *octet*





# J/ψ simulation – p<sub>T</sub> and y

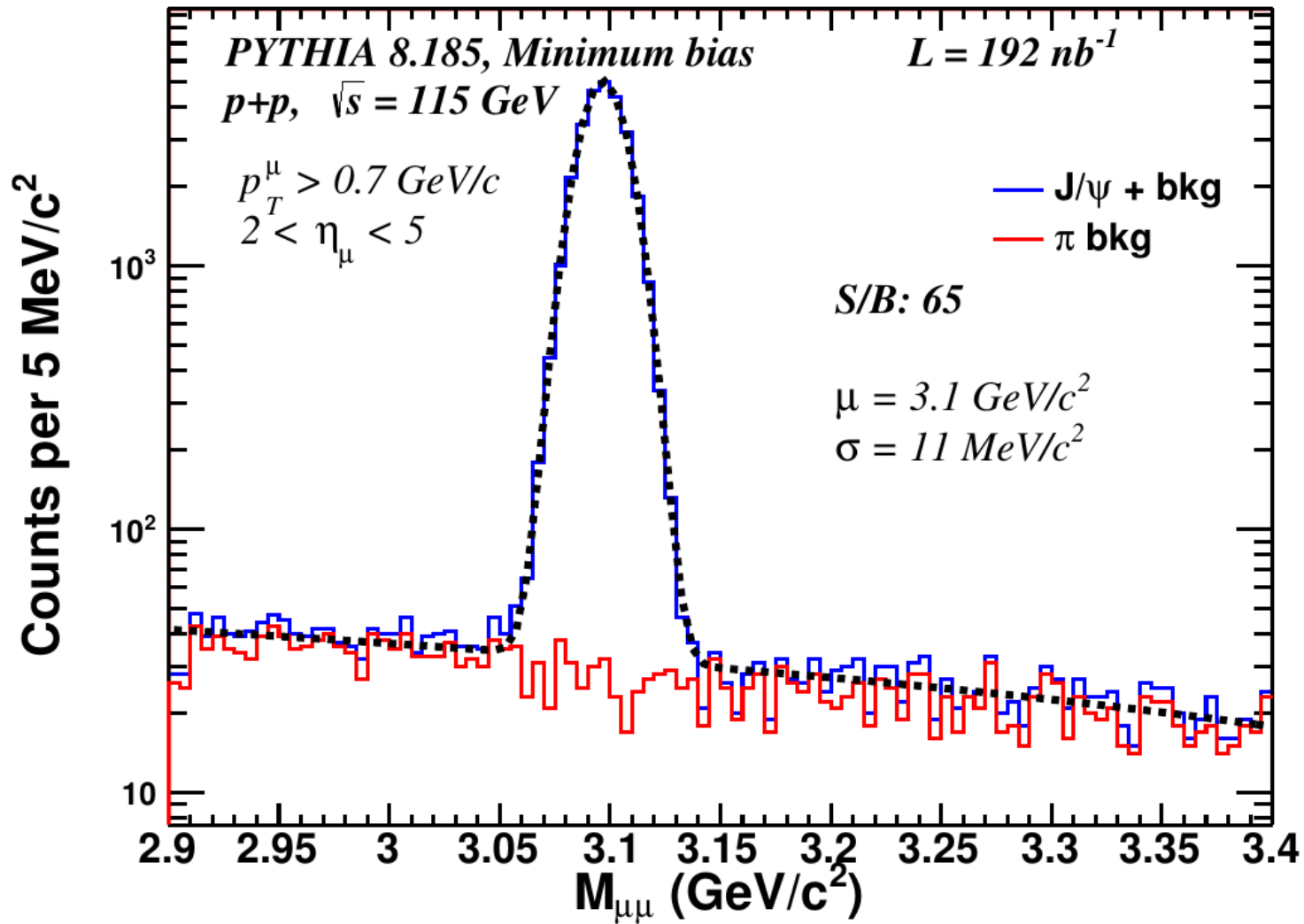
octet



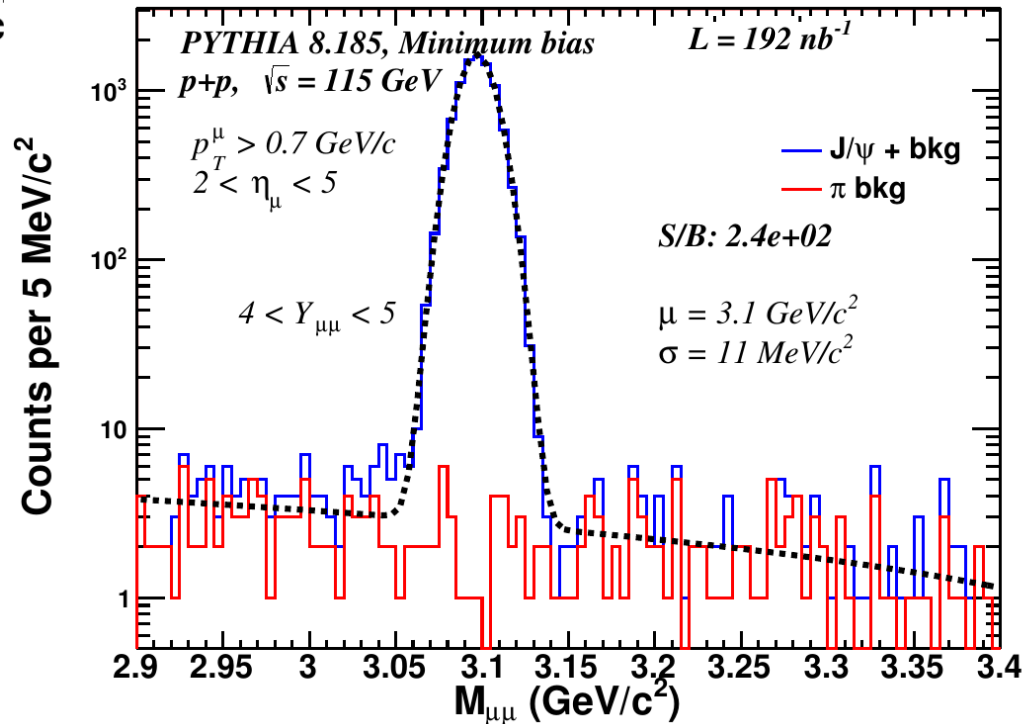
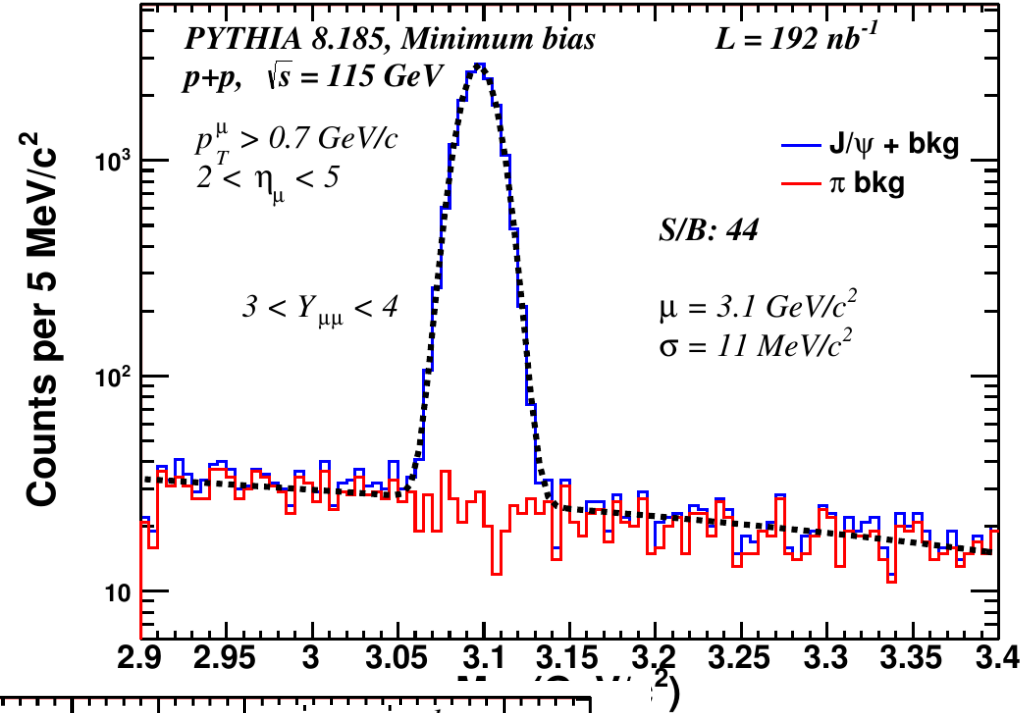
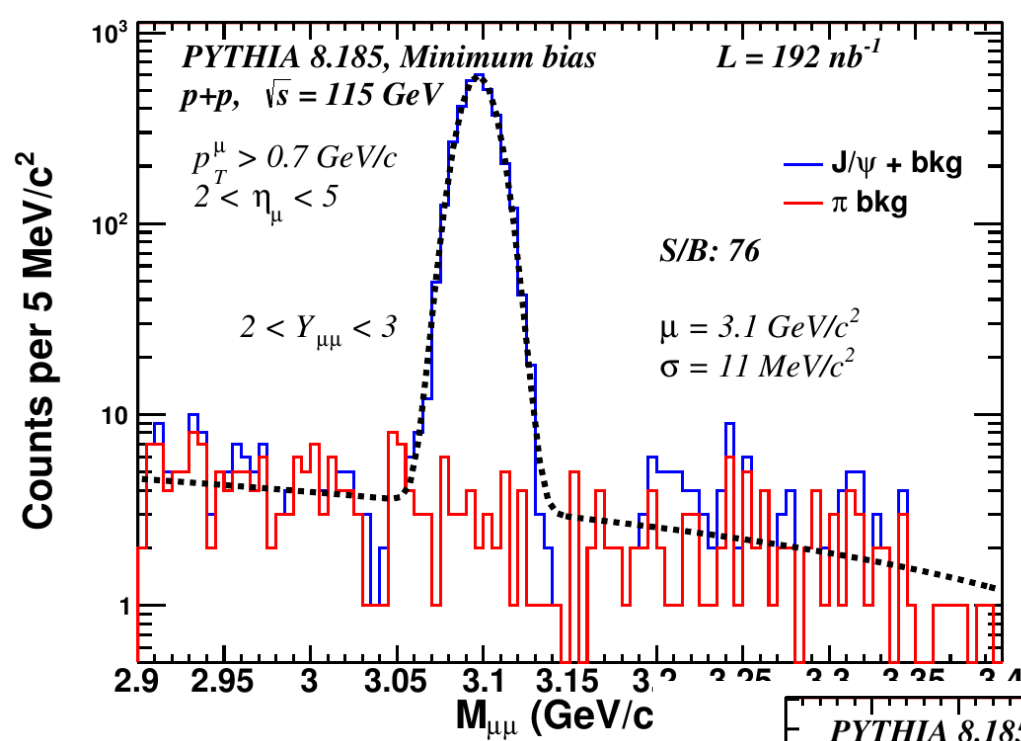
# Minimum bias

$$J/\psi \rightarrow \mu^+ \mu^-$$

+ pi, K decays

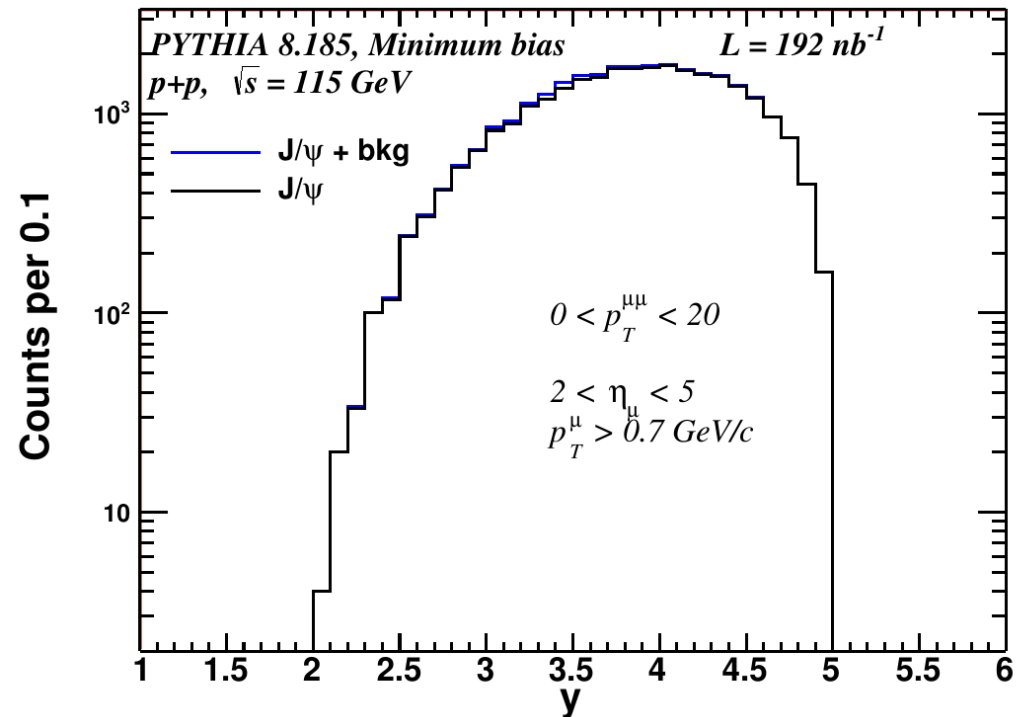
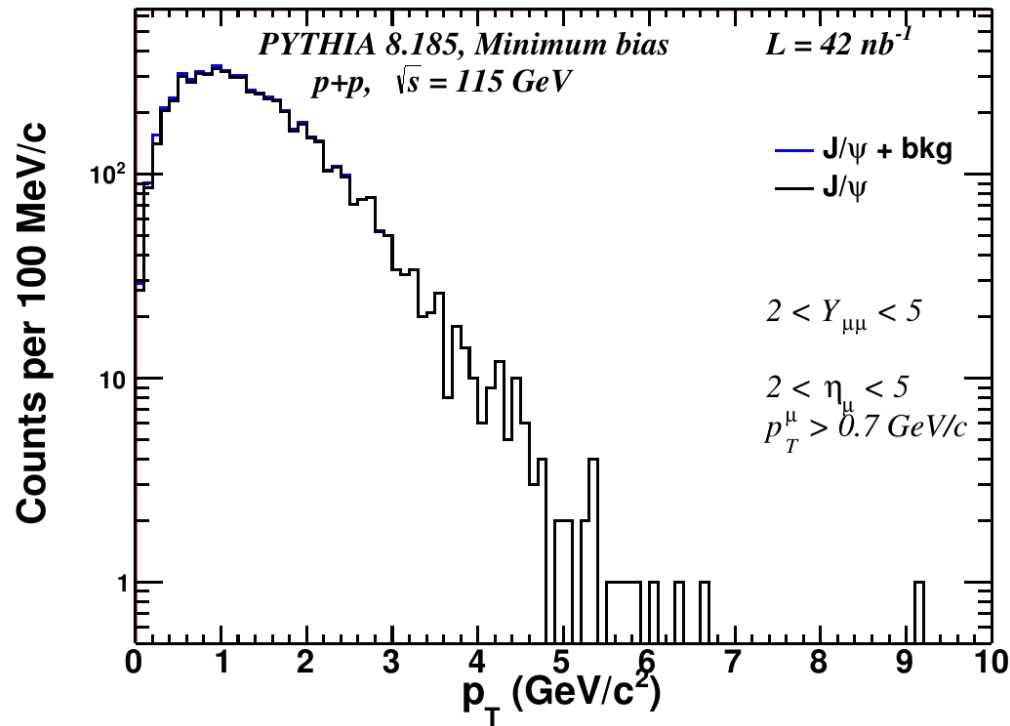


# Minimum bias, y bins



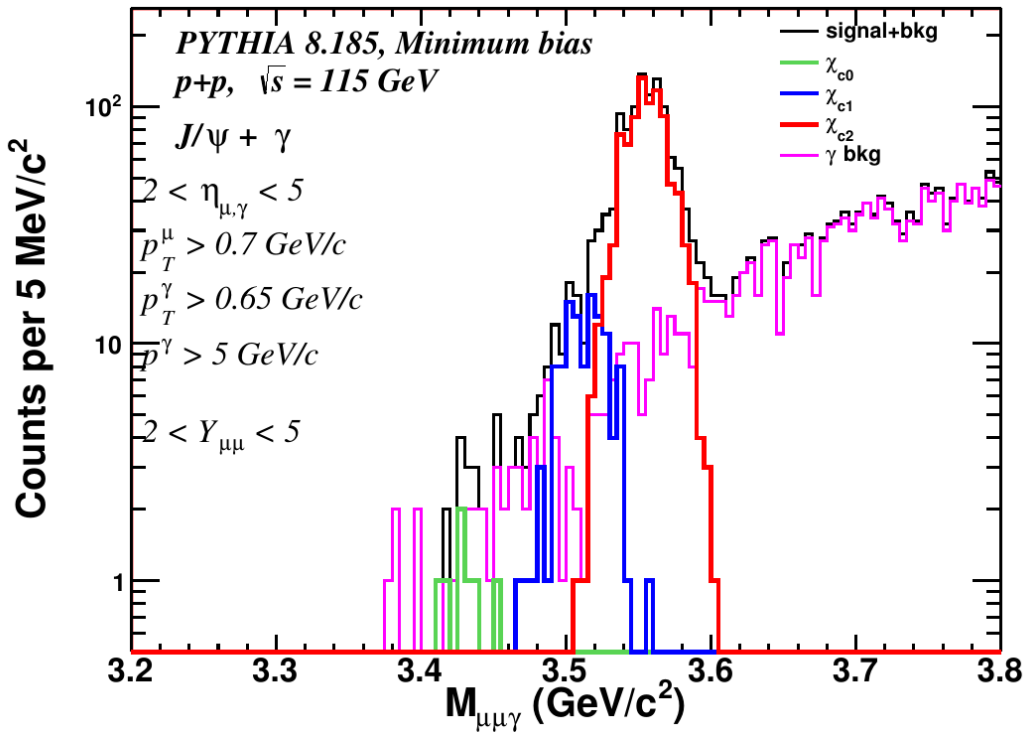
# Minimum bias – $p_T$ and $y$

$$J/\psi \rightarrow \mu^+ \mu^-$$

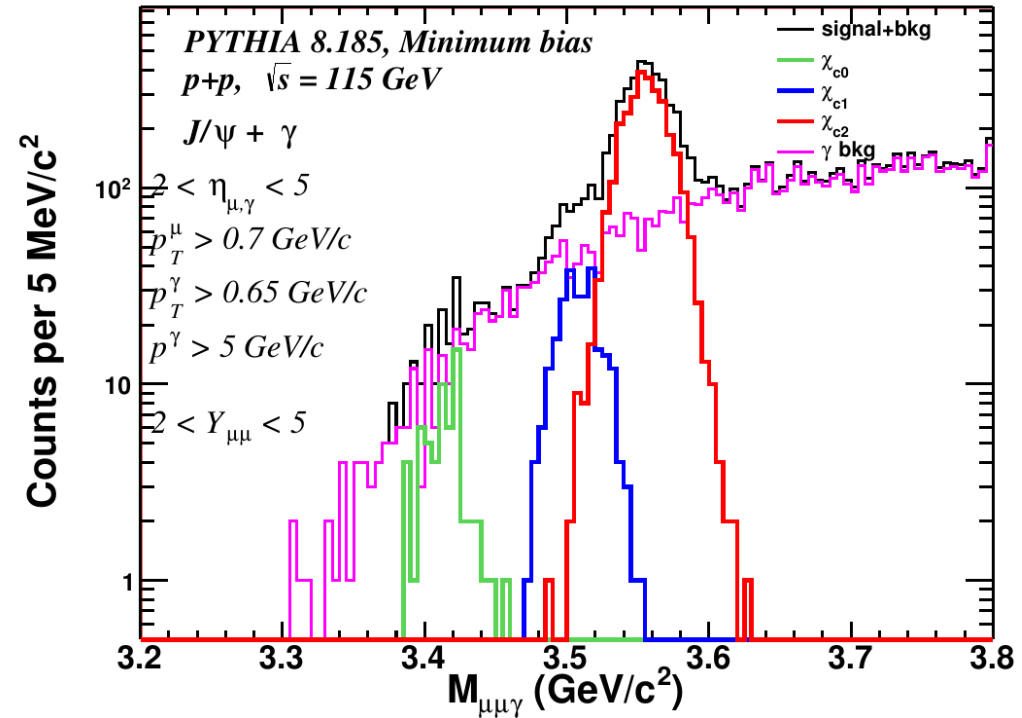


# Minimum bias

$$\chi_{c0} \rightarrow J/\Psi \gamma \rightarrow \mu^+ \mu^- \gamma$$



$p_T$  gamma > 0.65 GeV/c  
 $p$  gamma > 5 GeV/c

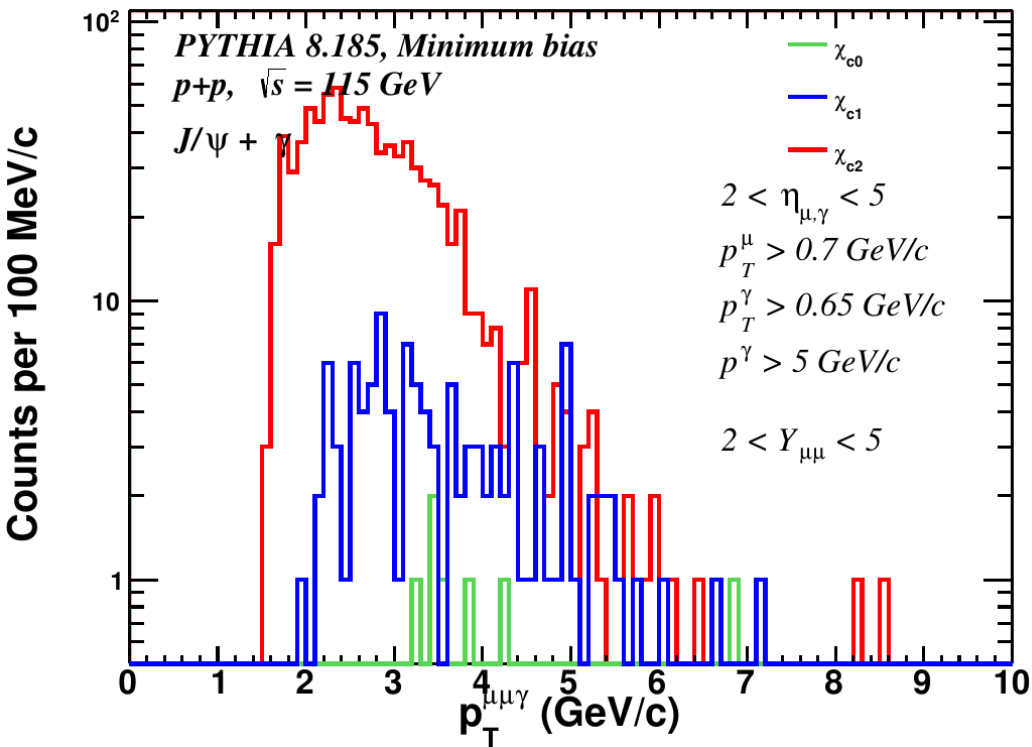


$p_T$  gamma > 0.5 GeV/c  
 $p$  gamma > 4 GeV/c

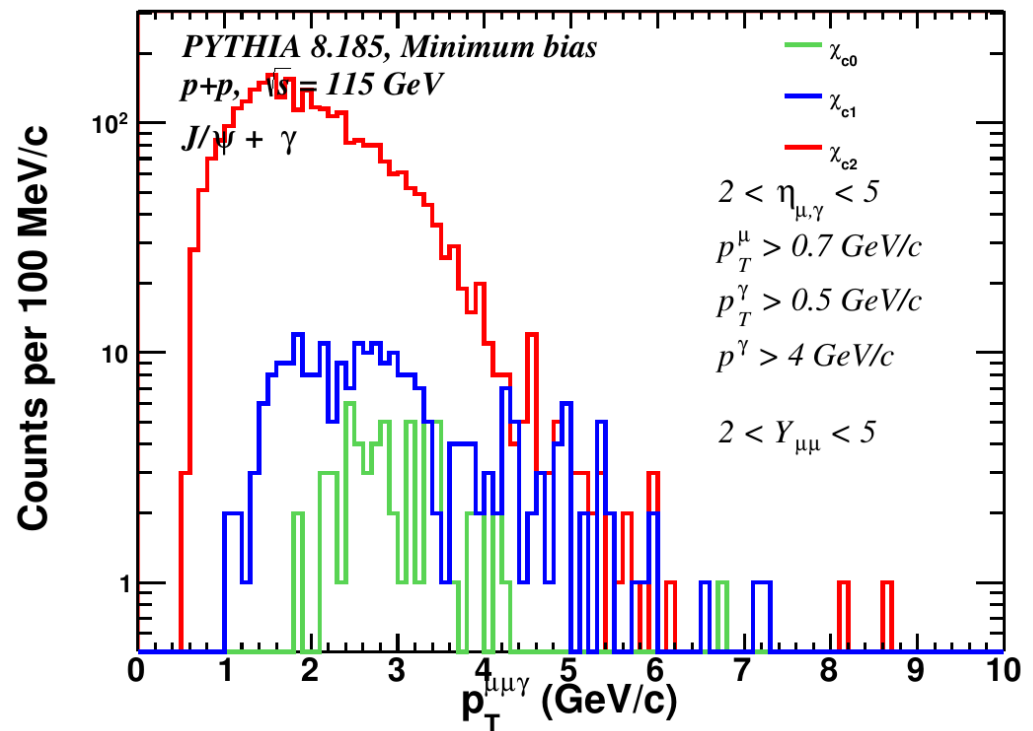
gamma background -  $\mu^+ \mu^-$  from J/ψ  
 decay, gamma not from  $\chi_C$  decay

# Minimum bias, $\chi_c$ $p_T$

$$\chi_c \rightarrow J/\Psi \quad \gamma \rightarrow \mu^+ \mu^- \gamma$$

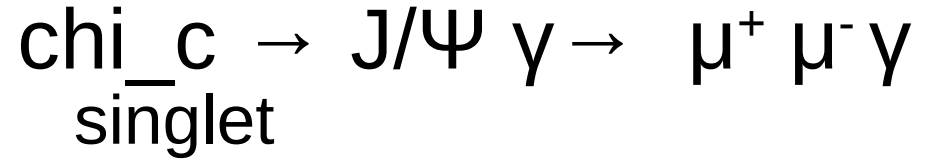


$p_T$  gamma  $> 0.65$  GeV/c  
 $p$  gamma  $> 5$  GeV/c

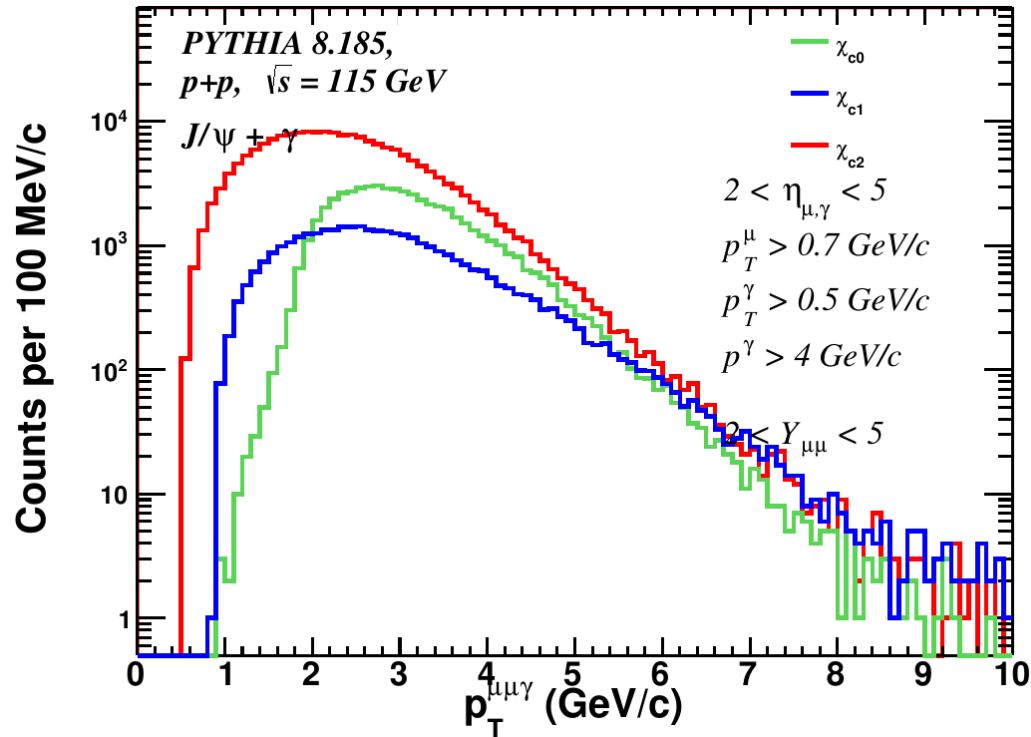


$p_T$  gamma  $> 0.5$  GeV/c  
 $p$  gamma  $> 4$  GeV/c

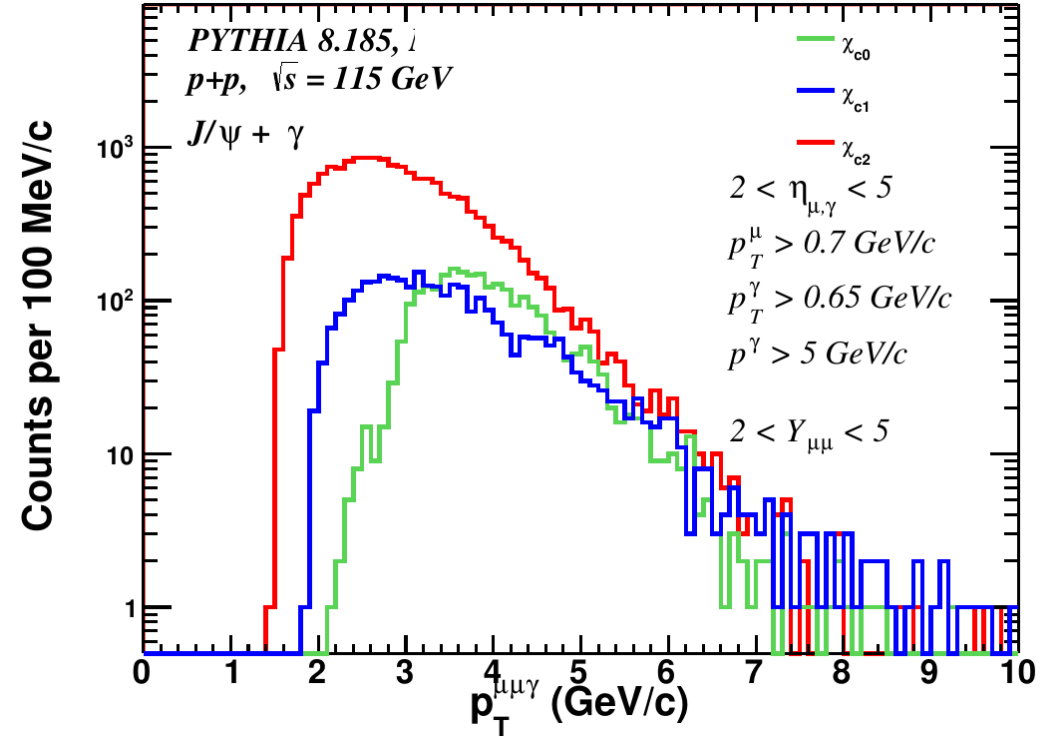
# Simulation of $\chi_c$ signal



Acceptance vs gamma cuts



$p_T$  gamma  $> 0.5$  GeV/c  
 $p$  gamma  $> 4$  GeV/c

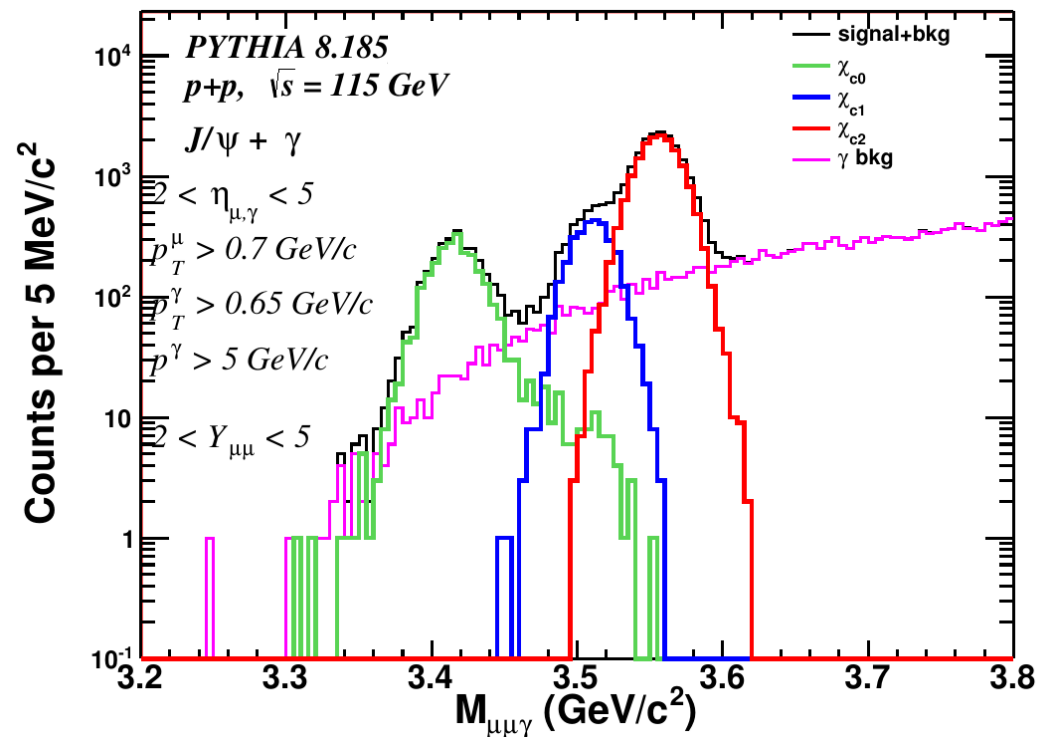
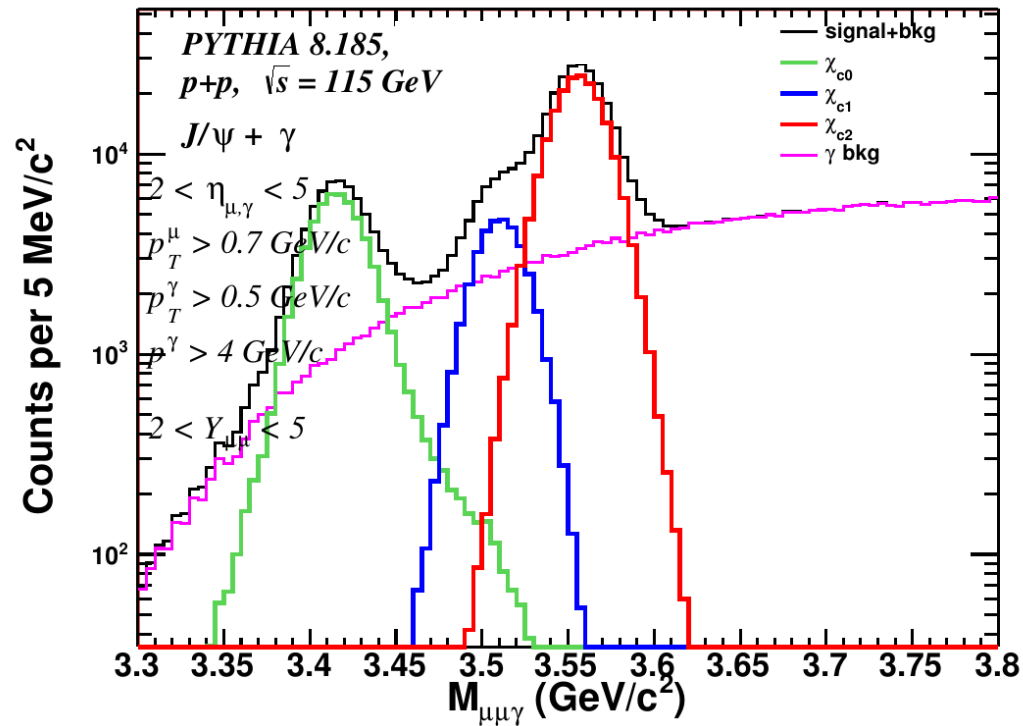


$p_T$  gamma  $> 0.65$  GeV/c  
 $p$  gamma  $> 5$  GeV/c

# Simulation of $\chi_c$ signal

$$\chi_c \rightarrow J/\psi \gamma \rightarrow \mu^+ \mu^- \gamma$$

singlet



$p_T$  gamma  $> 0.5$  GeV/c  
 $p$  gamma  $> 4$  GeV/c

$p_T$  gamma  $> 0.65$  GeV/c  
 $p$  gamma  $> 5$  GeV/c

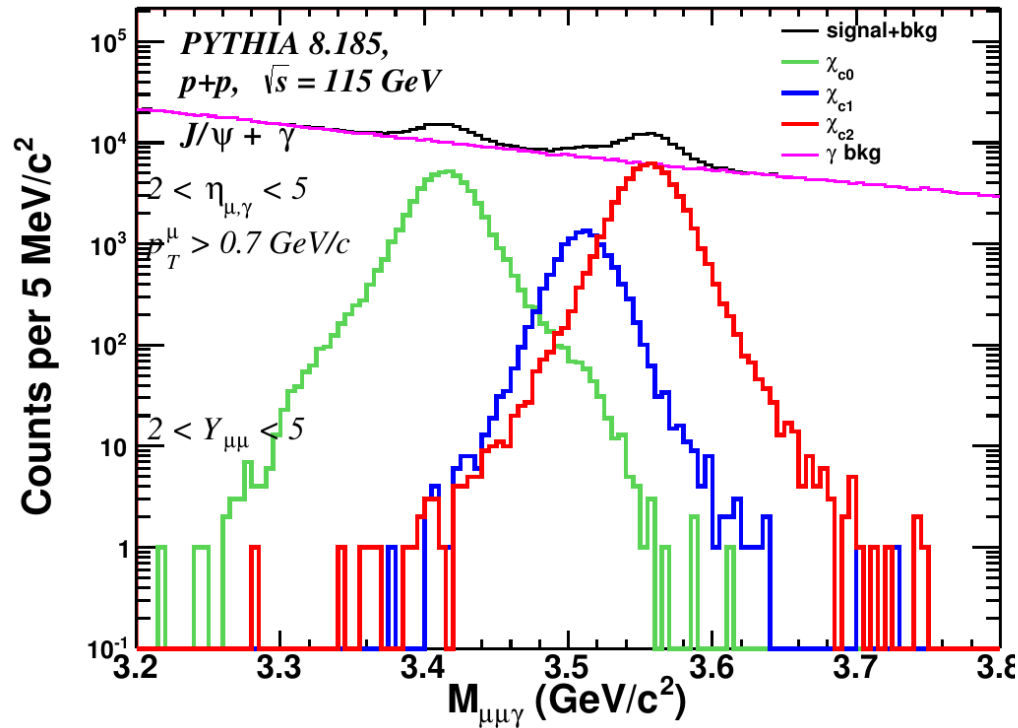


# Simulation of chi\_c signal

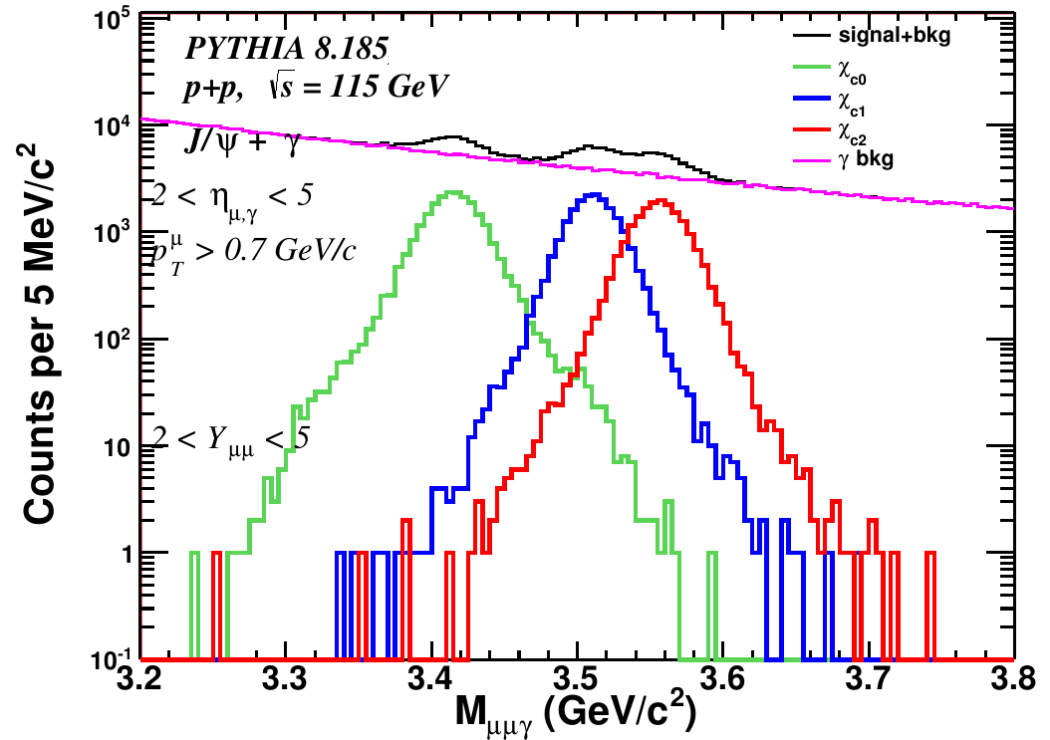
$$\chi_{c0} \rightarrow J/\psi \gamma \rightarrow \mu^+ \mu^- \gamma$$

no gamma cuts

singlet



octet

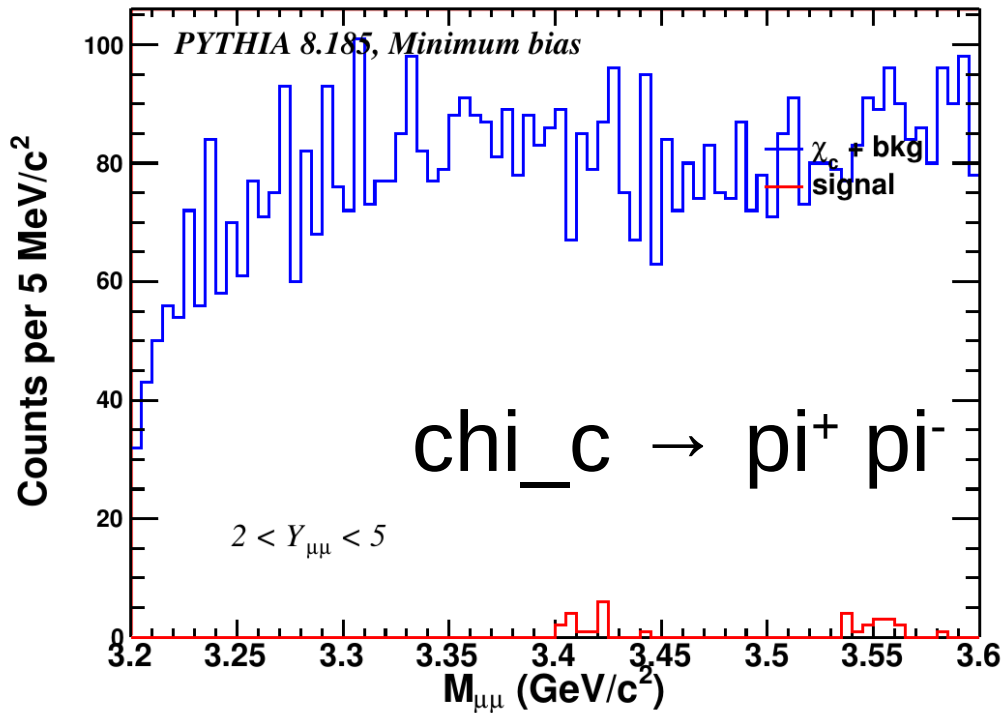


Ratios ?

Charmonium:O(3PJ)[3P0(1)] (default = 0.05,0.05,0.05;  
minimum = 0.0)

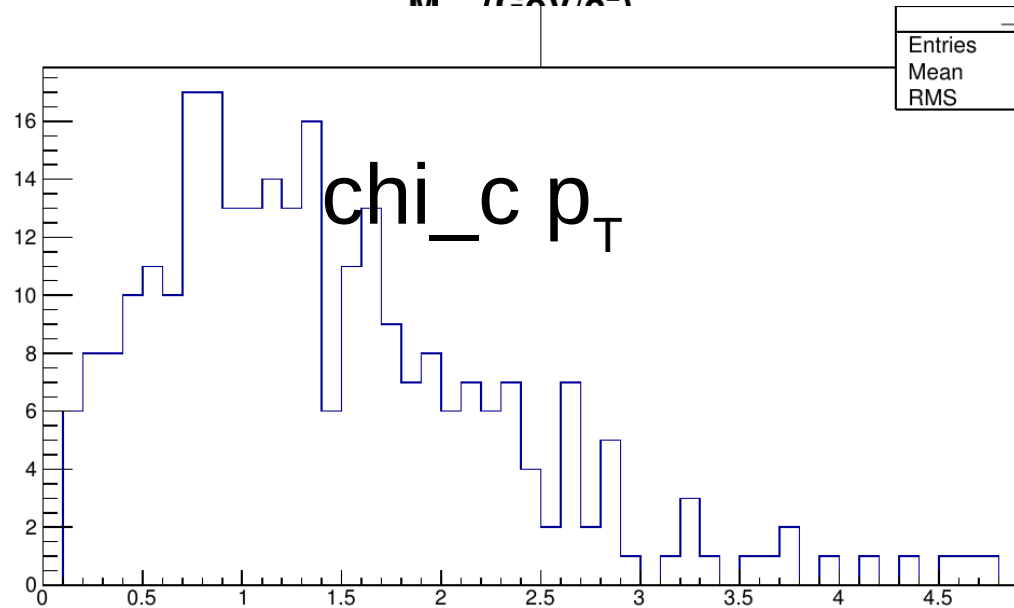
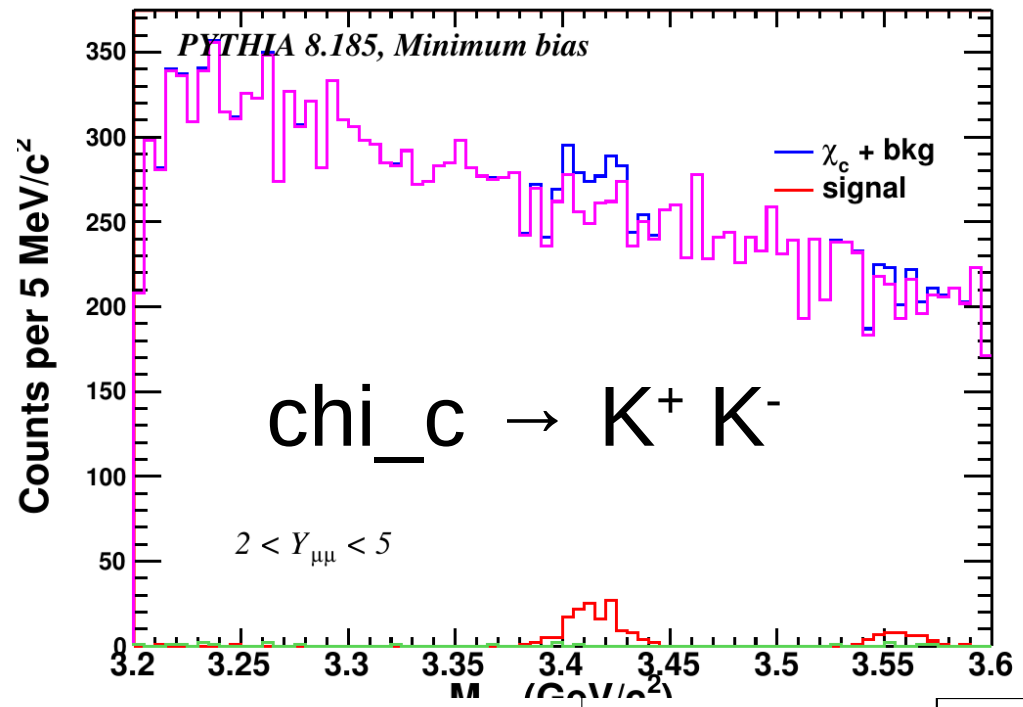
Charmonium:O(3PJ)[3S1(8)] (default = 0.0031,0.0031,0.0031;  
minimum = 0.0)

# Minimum bias, chi\_c



Large background

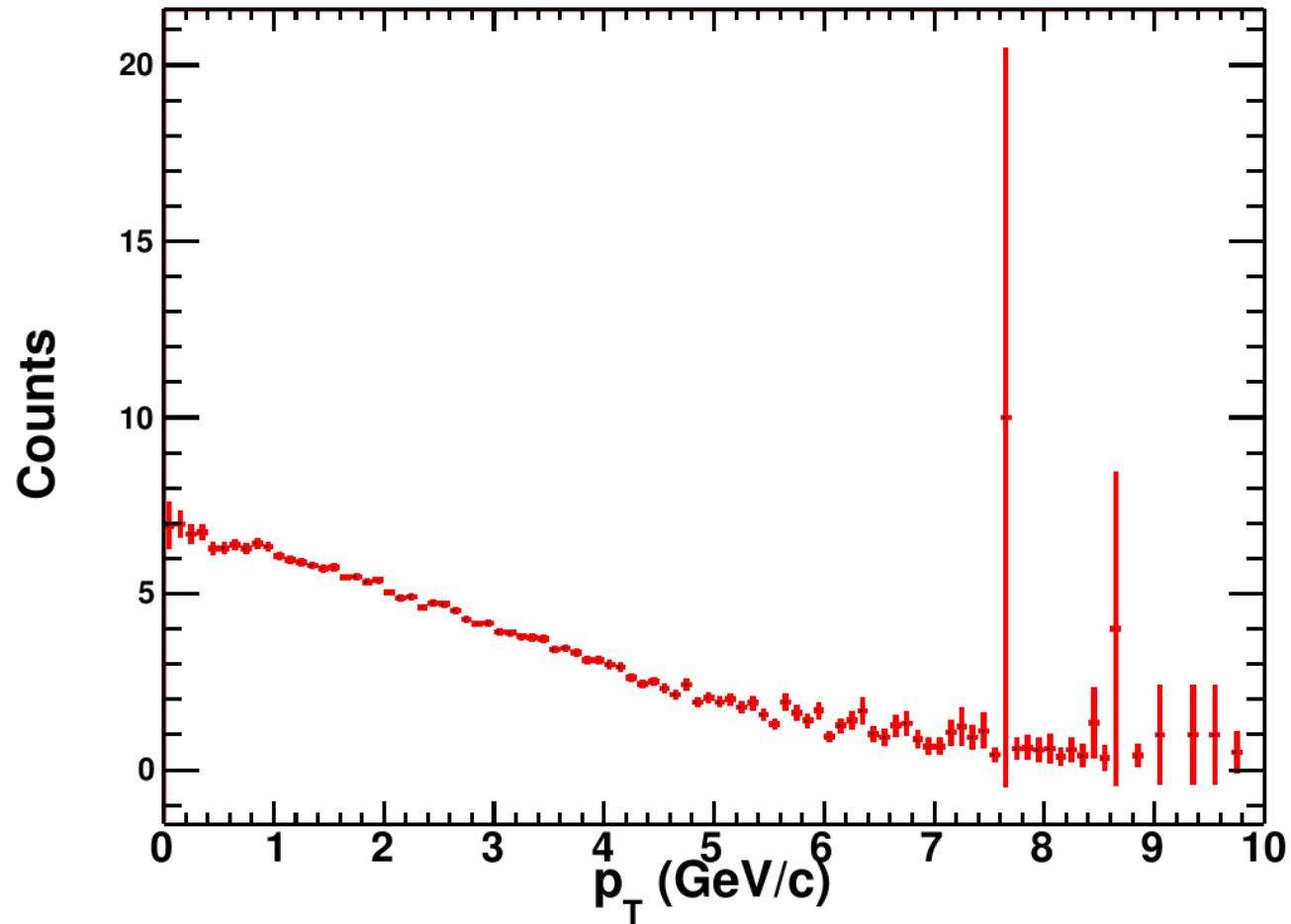
in this channels  
 $\chi_{c0}$  and  $\chi_{c2}$   
only



# Backup

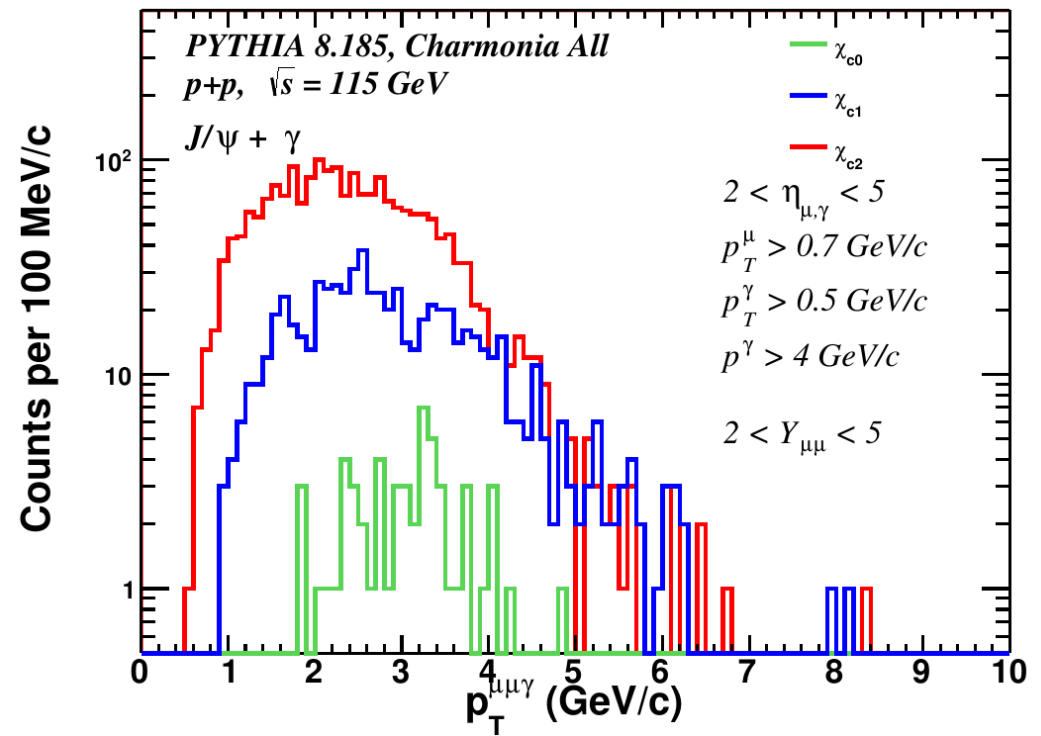
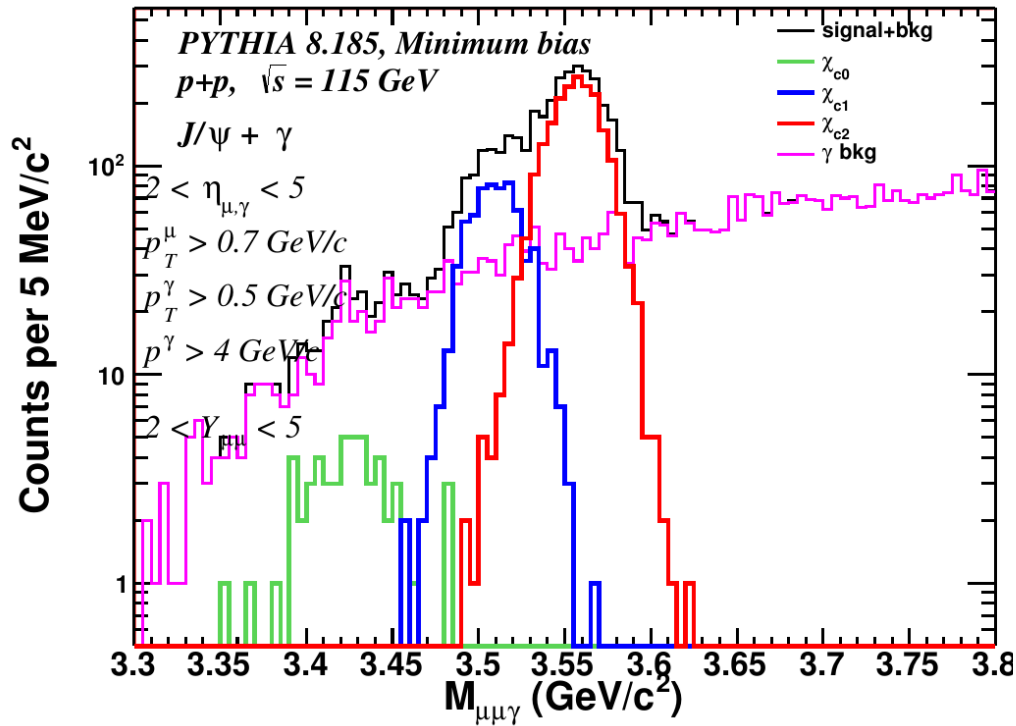
# Charmonia All

chi\_C2/chi\_C1 ratio



# Charmonia All, chi\_c

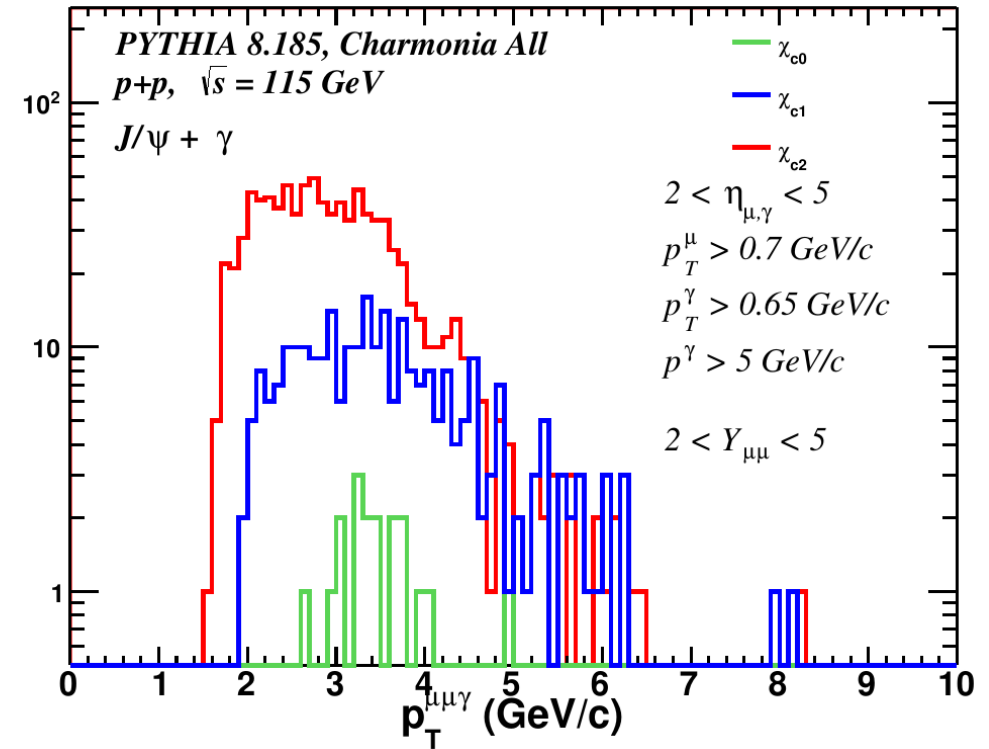
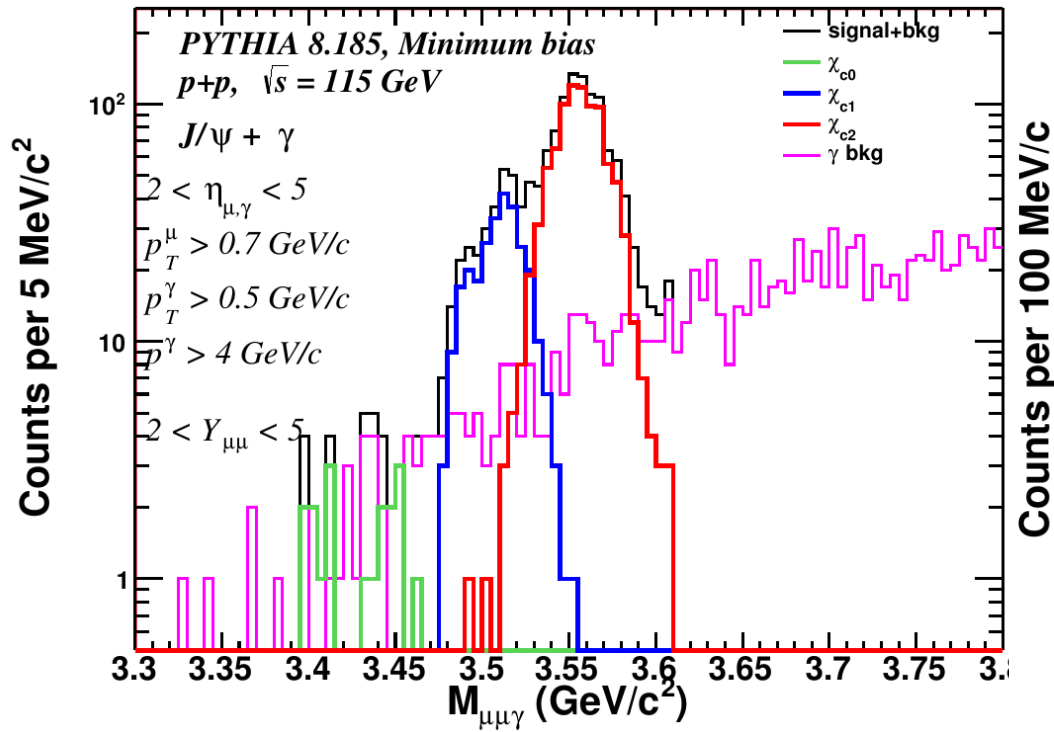
chi\_c → μ<sup>+</sup> μ<sup>-</sup>



$p_T$  gamma > 0.5 GeV/c  
 $p$  gamma > 4 GeV/c

# Charmonia All, $\chi_c$

$\chi_c \rightarrow \mu^+ \mu^-$



$p_T^\gamma > 0.65 \text{ GeV}/c$

$p^\gamma > 5 \text{ GeV}/c$

# Minimum bias, $\chi_c$ , $y$ bins

$\chi_c \rightarrow K^+ K^-$

