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**My recent work on**  
 **$\mu$ ,  $J/\psi$  and  $\Upsilon$  off-line reconstruction efficiencies**

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25th, July. 2008

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# Outline

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- Motivation of this work;
- Data used;
- $J/\psi$  off-line reconstruction efficiency
  - Single Muon (from  $J/\psi$ ) reconstruction efficiency vs.  $p_T$  &  $\eta$
  - Mean value and resolution of  $J/\psi$  invariant mass
  - $J/\psi$  reconstruction efficiency
- $Y$  reconstruction efficiency
  - Single Muon (from  $Y$ ) reconstruction efficiency v.s.  $p_T$  &  $\eta$
  - Mean value and resolution of  $Y$  invariant mass
  - $Y$  reconstruction efficiency
- Summary

# Motivation

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- In the last month, I repeated some of Yang's work on  $J/\psi$  cross-section measurement.
  - To get familiar with cross-section measurement of heavy quarkonium;
  - To use the similar method on the Upsilon cross-section measurement.
- In my work,
  - If the picture of mine was the same as Yang's and Liu's, my work went on.
  - If my picture differs from Yang's and Liu's, I will try to find the reasons and to fix it.

# Data used

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- CSA07 Data

- Yang's data from CSA07 (750k Global  $J/\psi$  without HLT);

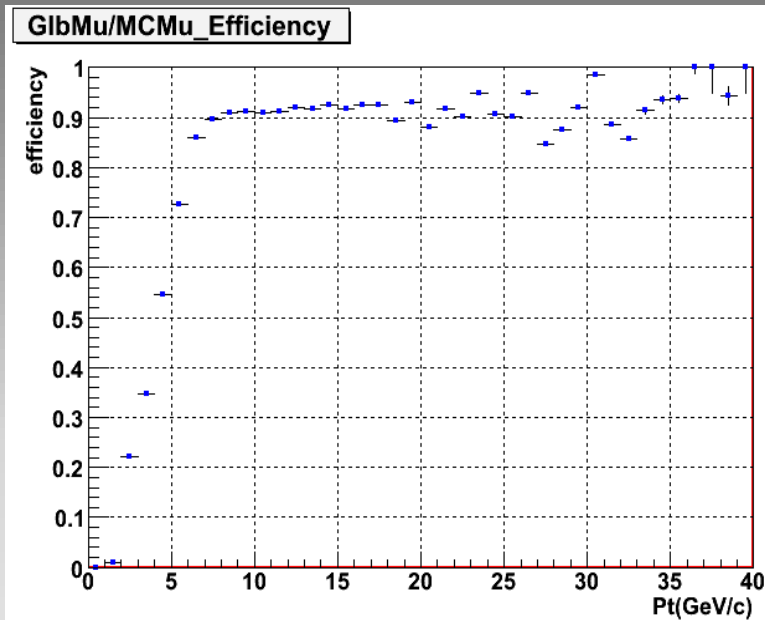
- Liu's data from CSA07

- 81k Global  $Y$  ( $p_T$  0~20 GeV/c)

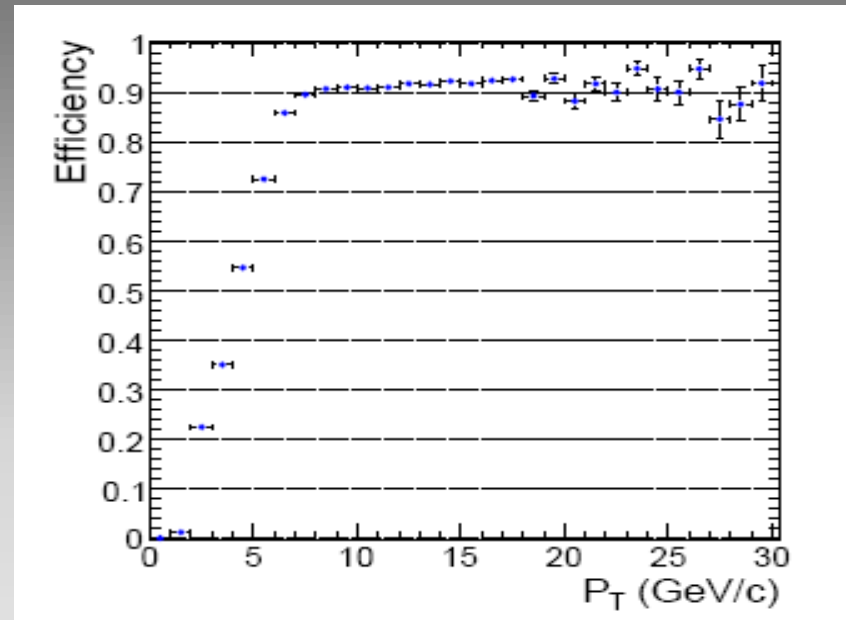
- 91k Global  $Y$  ( $p_T$  20~inf GeV/c)

# Single Muon reconstruction efficiency vs. $p_T$

- Single muon (from  $J/\psi$ ) with  $|\eta| < 2.5$

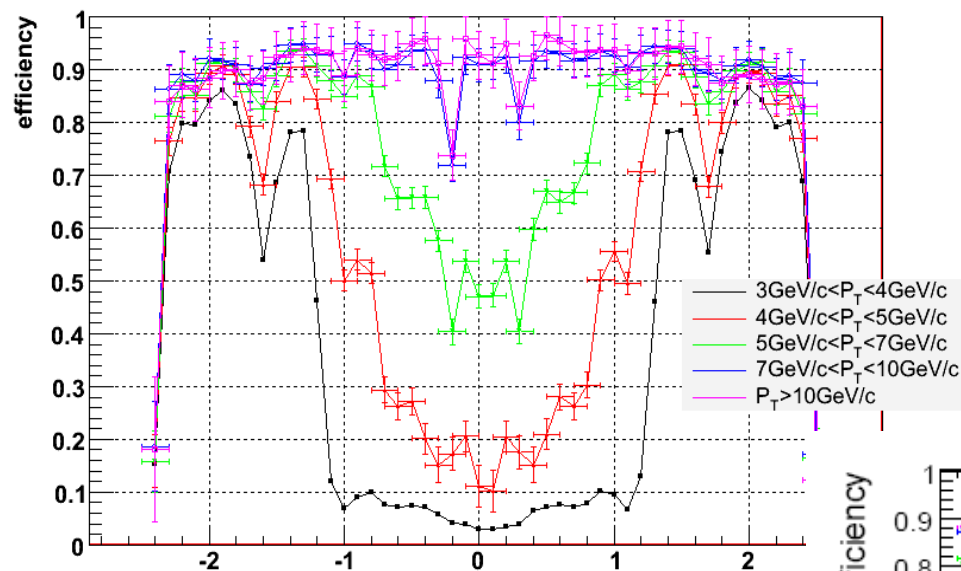


Full Simulation done by me

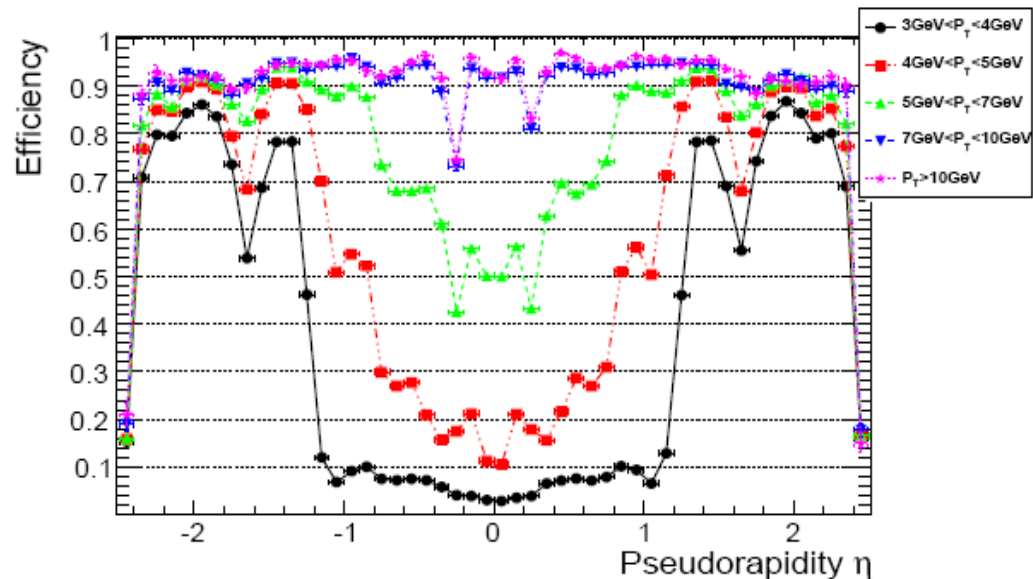


Full Simulation done by Yang

# Single Muon reconstruction efficiency vs. eta

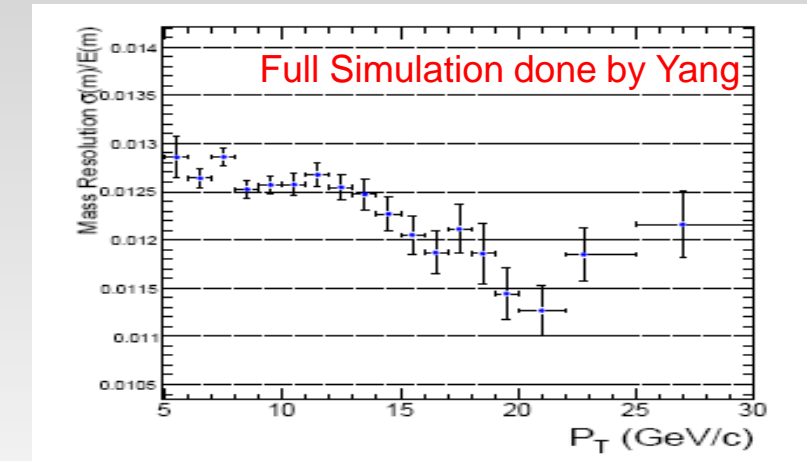
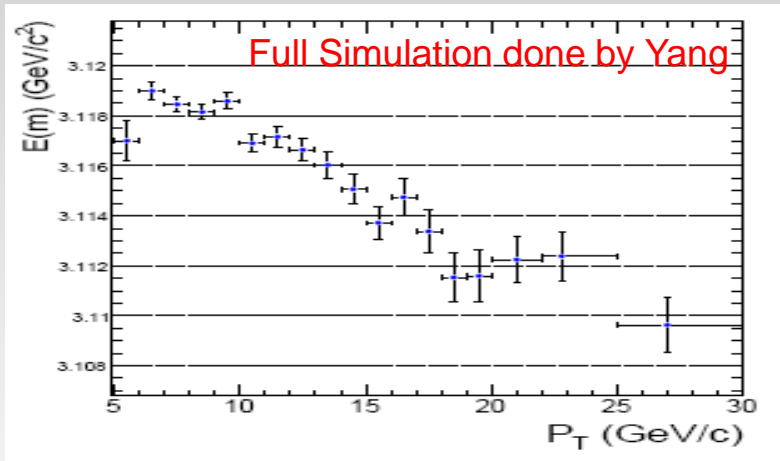
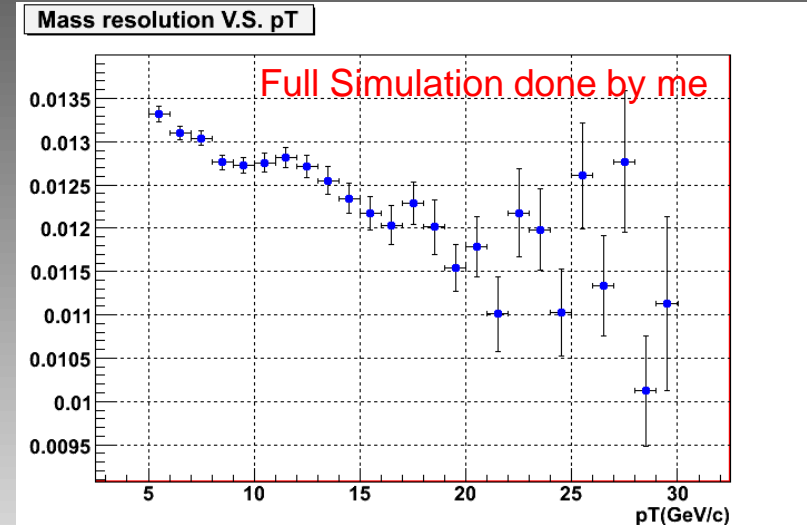
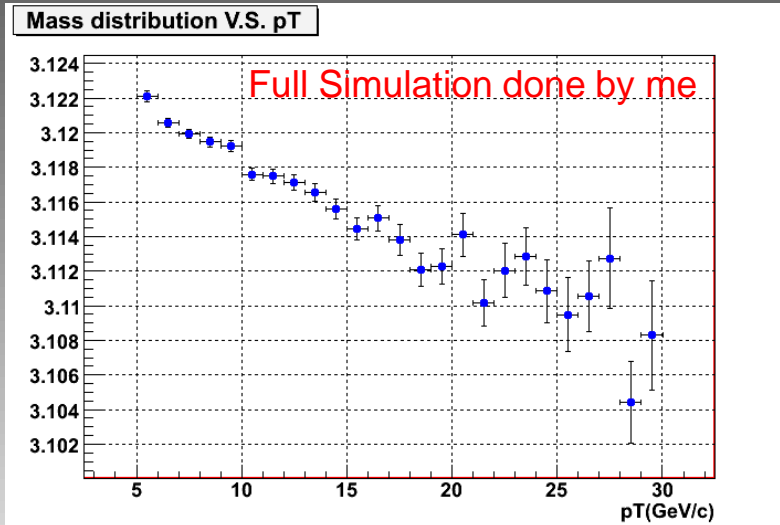


Full Simulation done by me



Full Simulation done by Yang

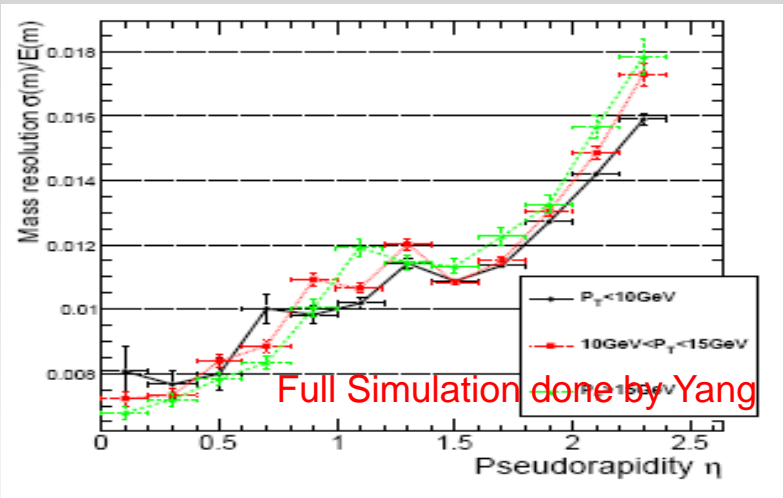
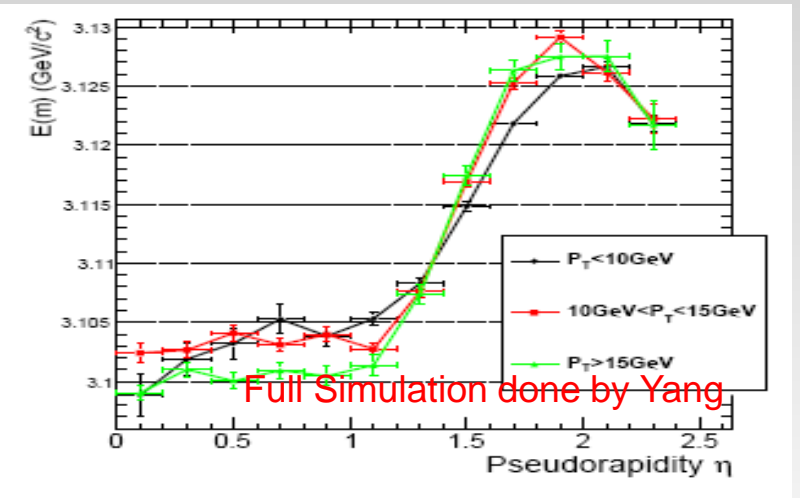
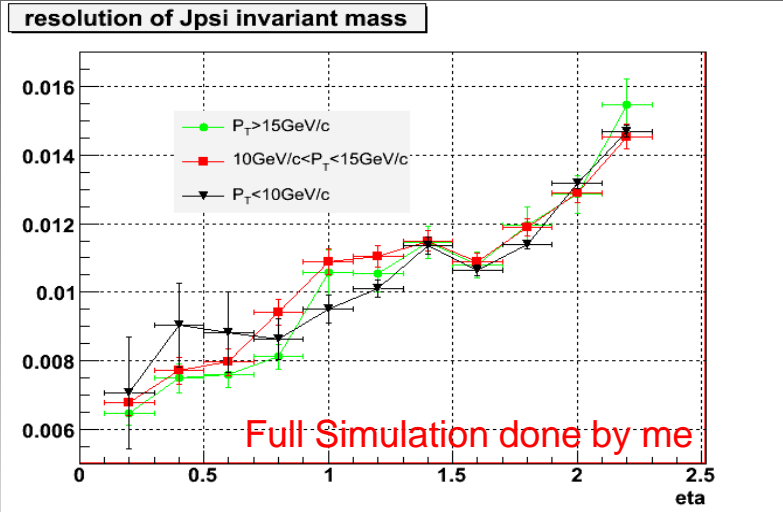
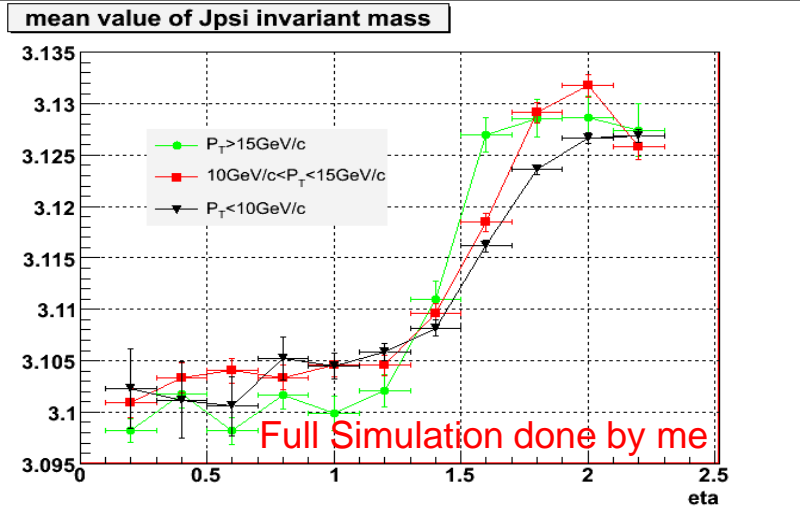
# Mean value and mass resolution vs. pT



Mean value of J/ψ invariant mass

Resolution of J/ψ invariant mass

# Mean value and mass resolution vs. eta

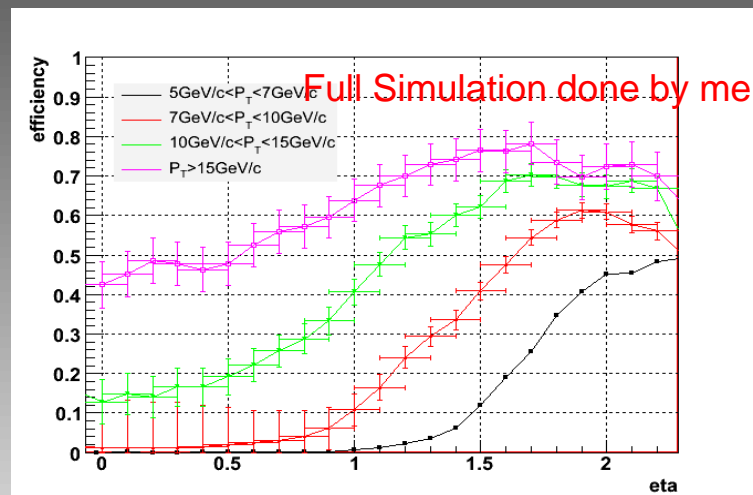
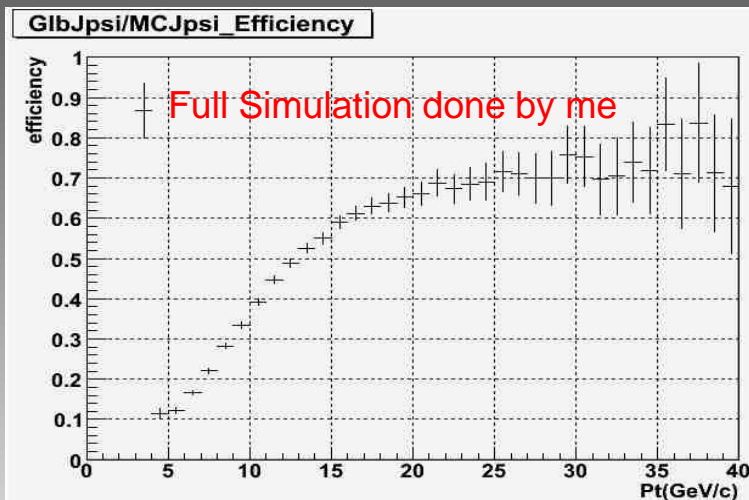


Mean value of J/ψ invariant mass

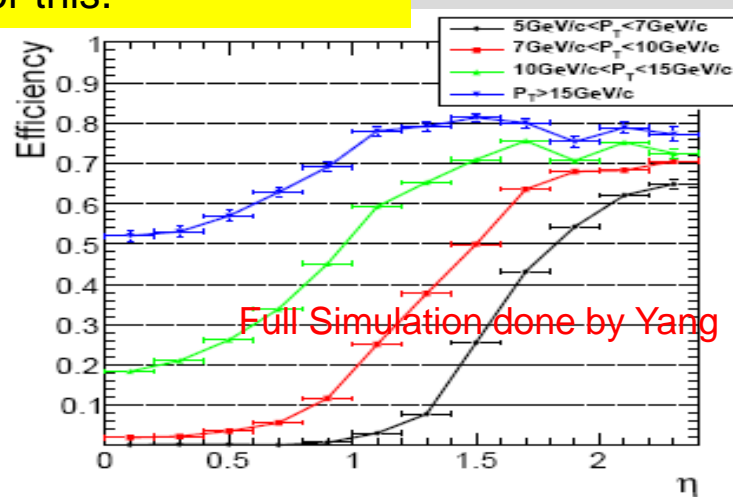
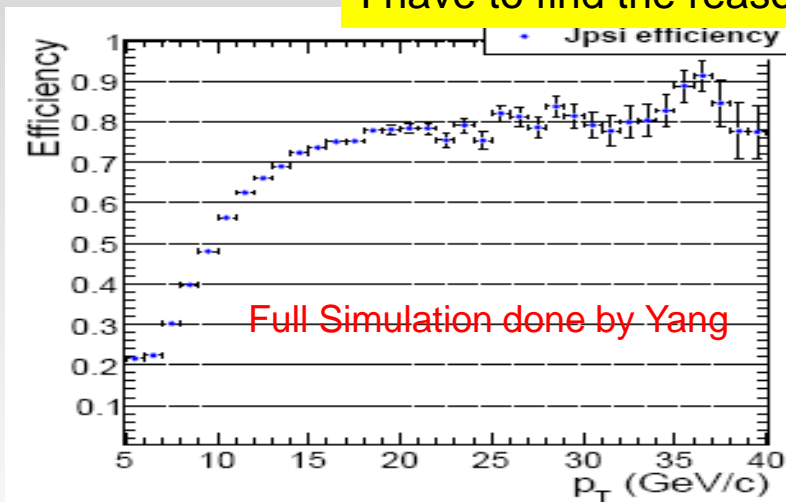
Resolution of J/ψ invariant mass



# J/ψ off-line reconstruction efficiency



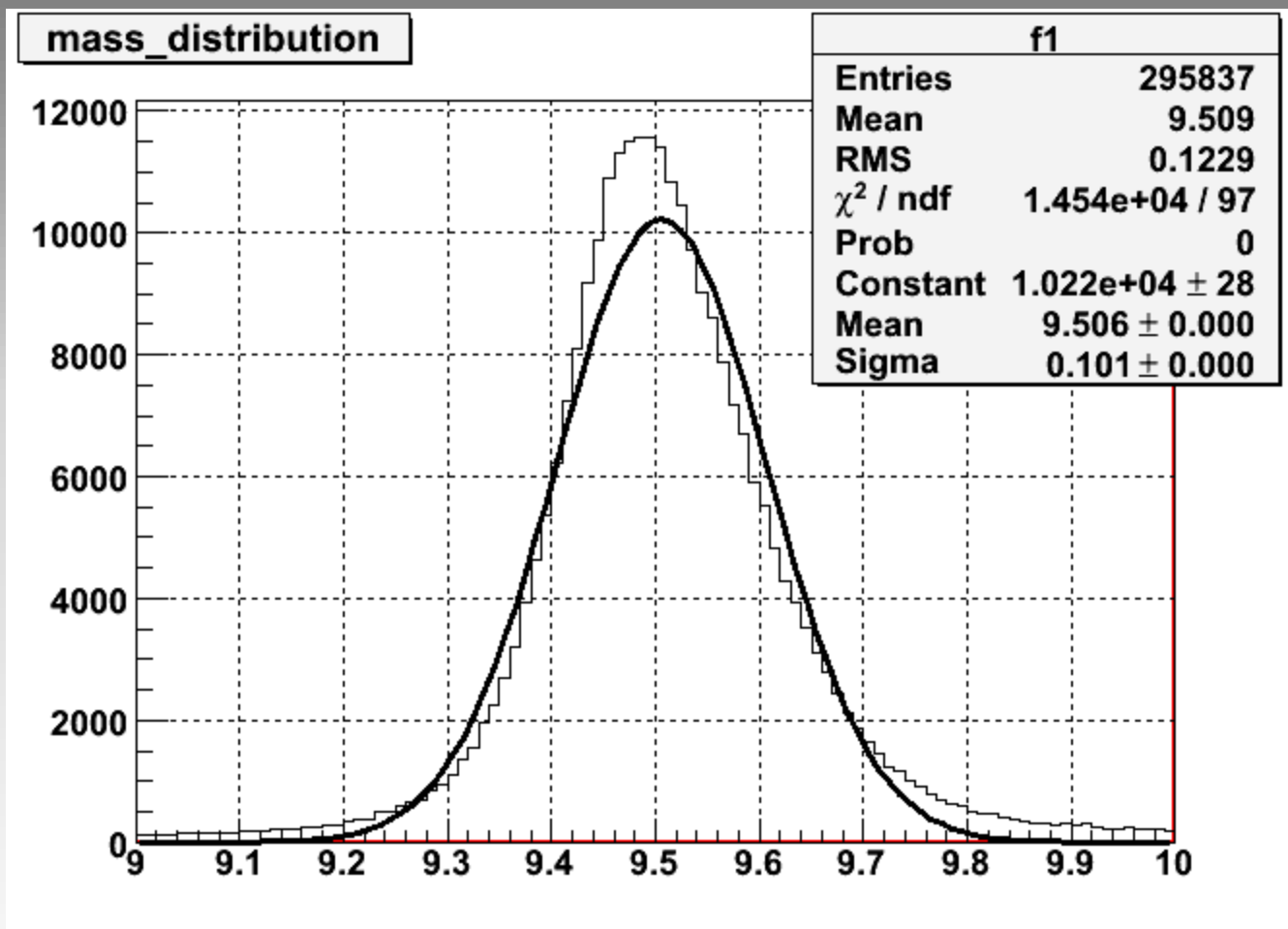
My result is lower than Yang's.  
I have to find the reason for this.



# The $\Upsilon$ Analysis

- Data used (normalized to 25 pb<sup>-1</sup>)

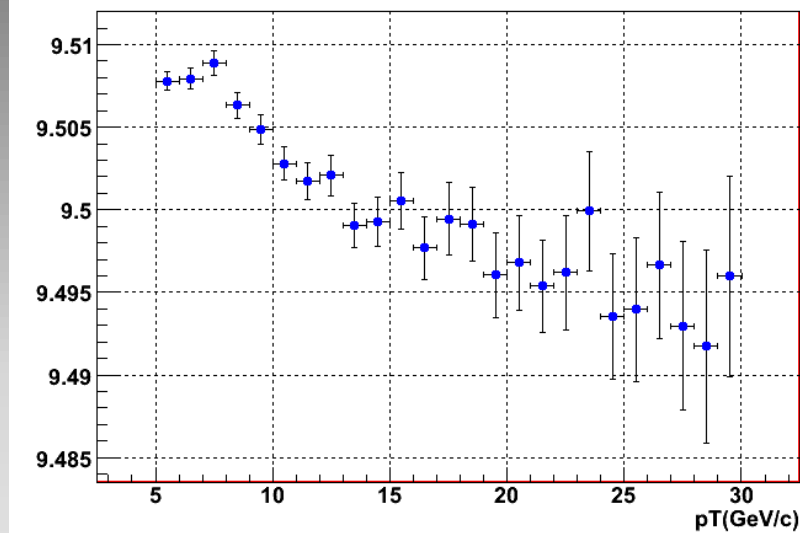
Data set name (CSA07)	Events used
Bottomonium_Pt_0_20_HLT CMSSW_1_6_0	813864 (25 pb <sup>-1</sup> )
Bottomonium_Pt_20_inf_HLT CMSSW_1_6_0	91322 (2164pb-1)



# Mean value and resolution of Y mass

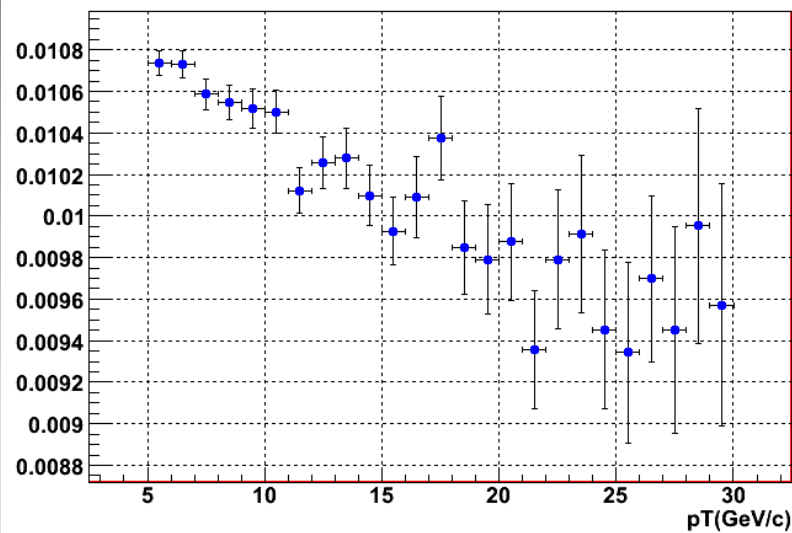
- Mean value and mass resolution of invariant mass as a function of pT

Mass mean value distribution VS. pT



Mean value of Y invariant mass

Mass resolution VS. pT

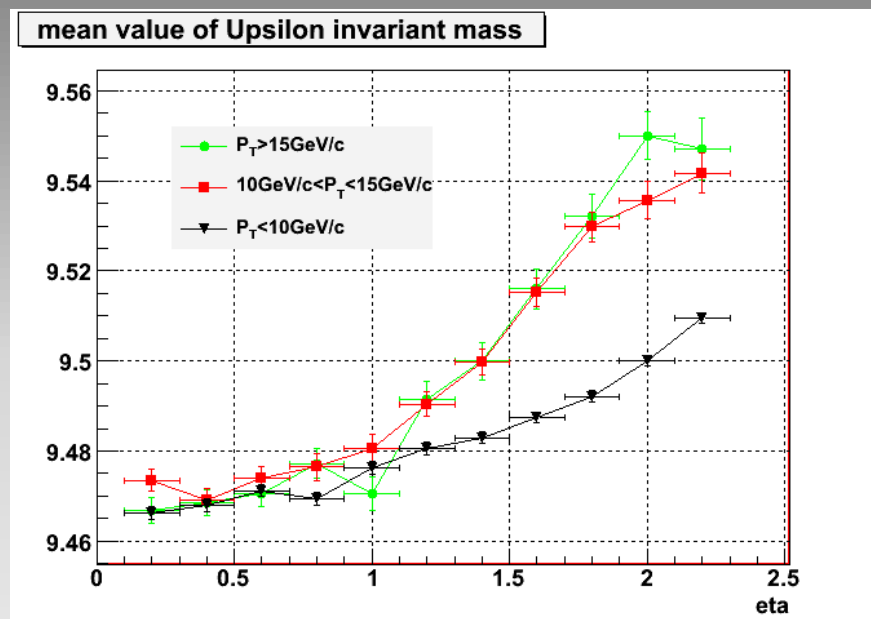


Resolution of Y invariant mass

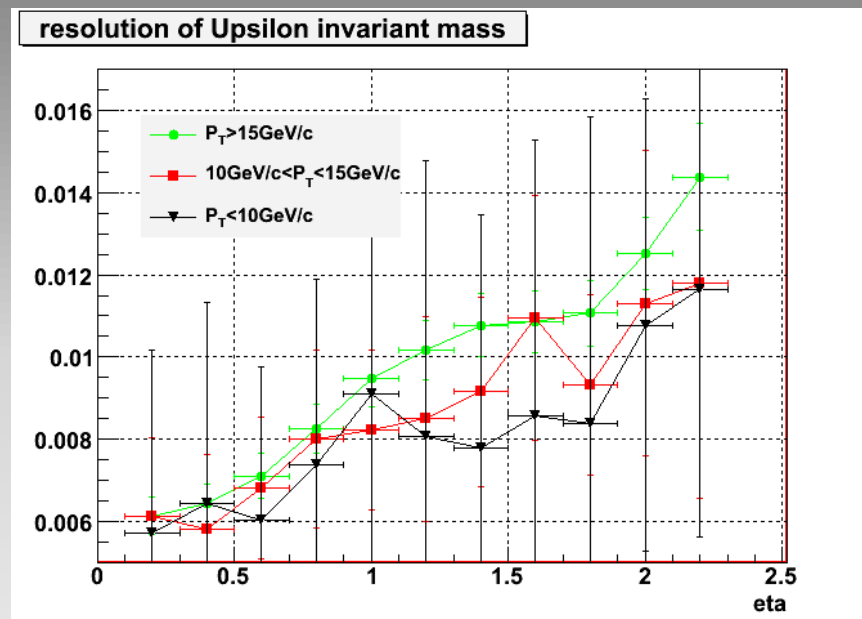
- The wor Y mass =  $9460.30 \pm 0.26$  MeV/c

# Mass value and resolution of $\Upsilon$

- Mean value and mass resolution of invariant mass as a function of Eta



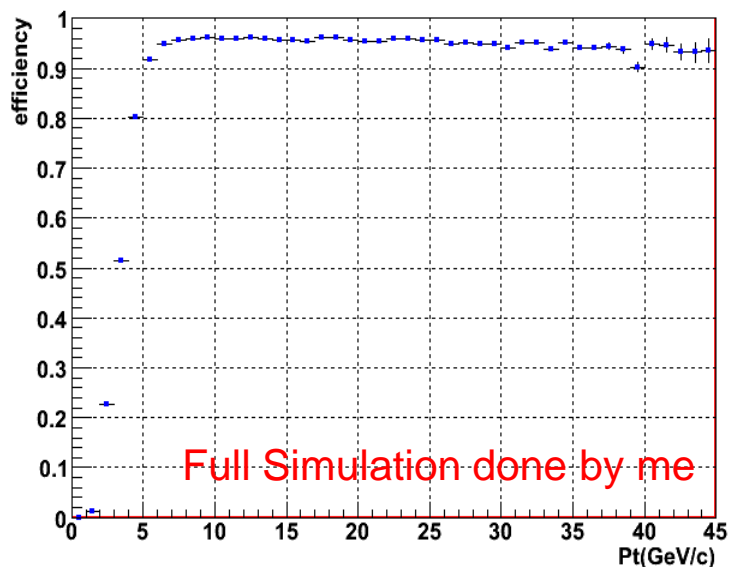
Mean value of  $\Upsilon$  invariant mass



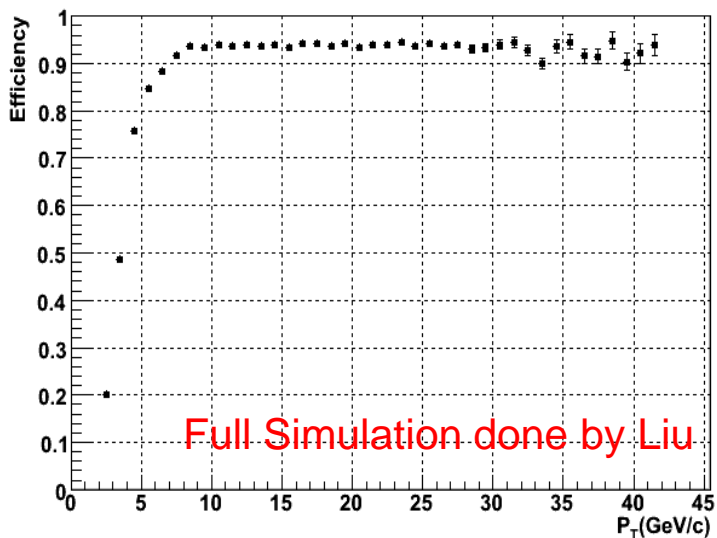
Resolution of  $\Upsilon$  invariant mass

# Single Muon (from $\gamma$ ) reconstruction efficiency

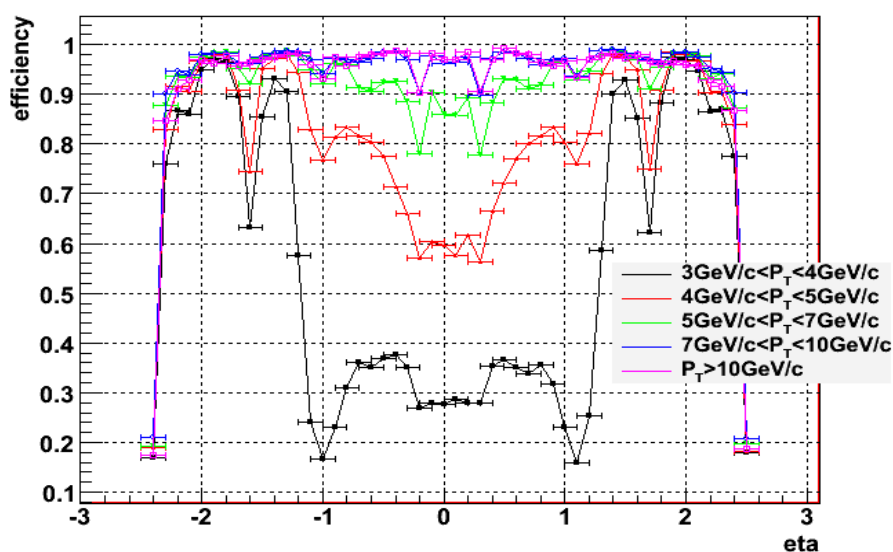
GlbMu/MCMu\_Efficiency



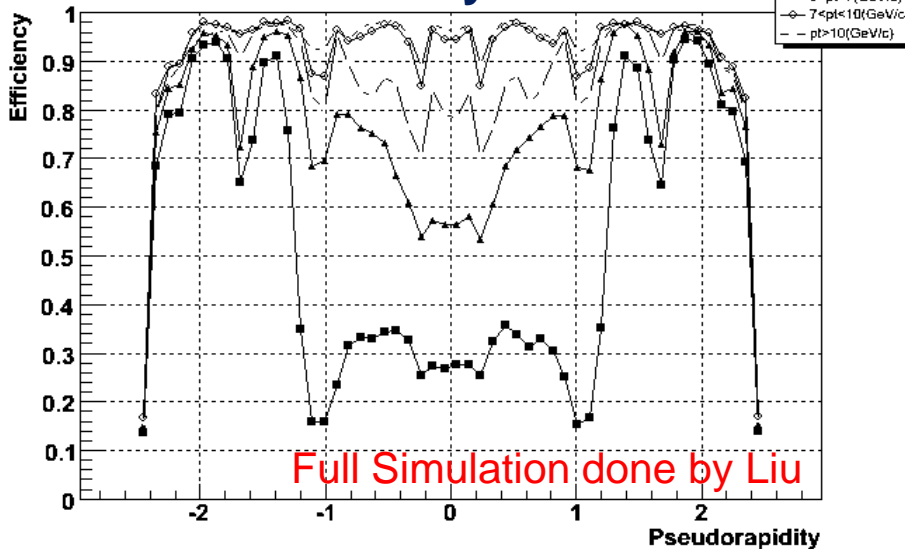
Efficiency vs. pT



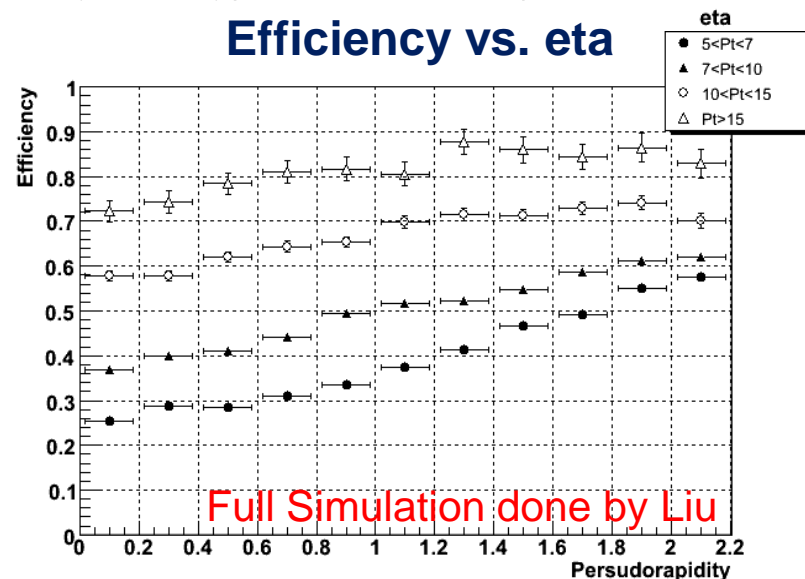
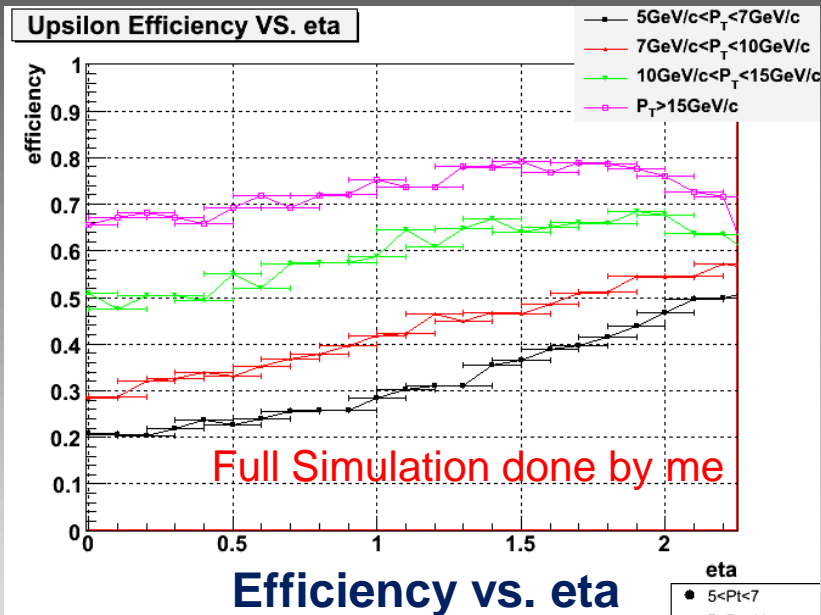
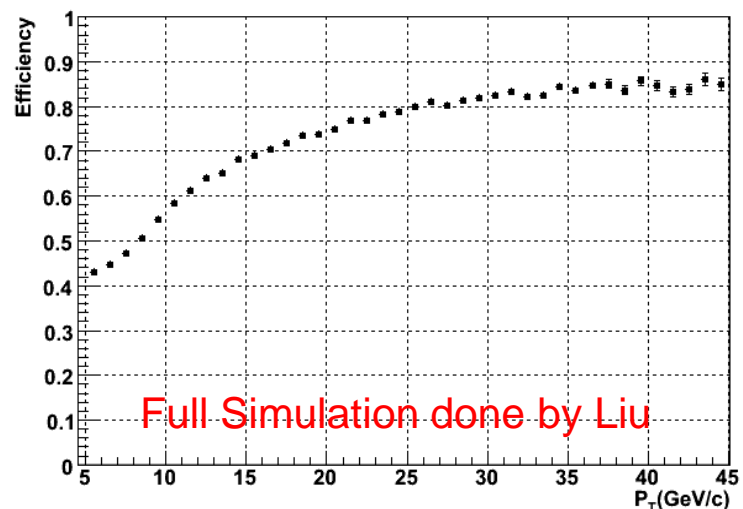
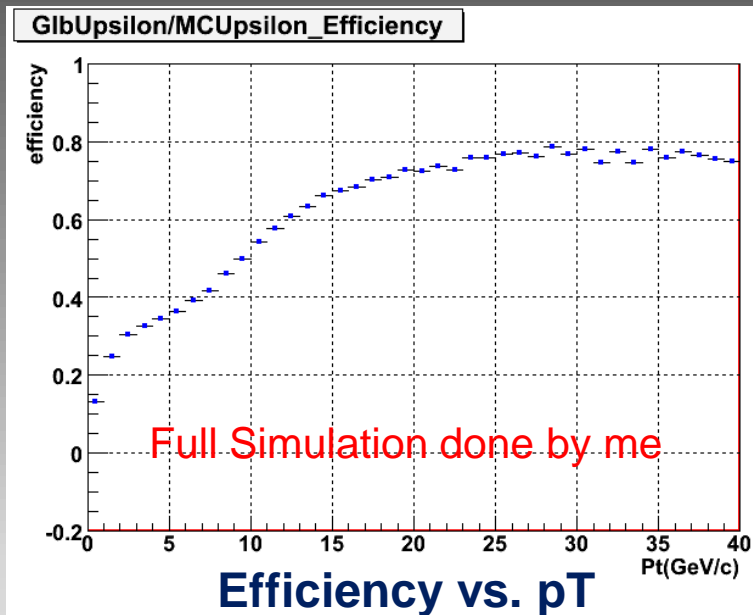
Muon Efficiency VS. eta



Efficiency vs. eta



# Y reconstruction efficiency



# Summary

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- The  $\mu$ ,  $J/\psi$  and  $Y$  off-line reconstruction efficiencies were studied. This is the one of the steps to figure out the total efficiency in the heavy-quarkonia cross-section measurement.
- However, the result seems not too good. I should continue to improve it. I will try to use other muon reconstruction algorithm, e.g. the tag\_and\_probe method.

# Next to do

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- Fix up the  $J/\psi$  and  $Y$  reconstruction efficiency.
  - More exact cuts (e.g. mass window,  $\Delta R$ , etc)
  - The tag\_and\_probe technology  
(with or without the influence of background)
- The ppMuX background
- The HLT information
- Systematic uncertainties



# Reference

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- [1] Z.C.Yang et al, Feasibility study of  $J/\psi$  X-section measurement in CMS, CMS AN 2007/023, June 2008.
- [2] Liu Lie, 在CMS上研究 $\Upsilon$ 的产生和极化, June 2008.
- [3] Jean-Philippe Lansberg,  $J/\psi$ ,  $\psi'$ , and  $\Upsilon$  production at hardon collicers, International Journal of Modern Physics A, 2006
- [4] <https://twiki.cern.ch/twiki/bin/view/CMS/WorkBook>