Inclusive b→J/ψ（J/ψ→μ μ）X analysis VIII

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Outline

- CSA07 Data Samples
- Muon efficiency: Tag&Probe vs. M.C. Truth
- Acceptance & J/Psi Efficiency
- uc-MLH fitting for b fraction
- Unfolding
- Ongoing and conclusion

CMS CSA07 M.C. data samples

b2J/psi

- /BtoJpsi/CMSSW_1_6_0-PreCSA07-HLT-A4/GEN-SIM-DIGI-RECO
  556324 events, 154 files, 18 block(s), 858.3GB
- /BtoJpsi/CMSSW_1_6_0-PreCSA07-A1/GEN-SIM-DIGI-RAW
  563463 events, 156 files, 16 block(s), 719.8GB
- /BbartoJpsi/CMSSW_1_6_0-PreCSA07-HLT-A4/GEN-SIM-DIGI-RECO
  509527 events, 141 files, 16 block(s), 786.6GB
- /BbartoJpsi/CMSSW_1_6_0-PreCSA07-A1/GEN-SIM-DIGI-RAW
  520373 events, 144 files, 14 block(s), 665.0GB

Incl b: 13.5 pb-1

CSA08 Incl b: 10 pb-1

p-J/psi

- /Charmonium_Pt_0_20/CMSSW_1_6_0-PreCSA07-HLT-A4/GEN-SIM-DIGI-RECO
  1021134 events, 160 files, 21 block(s), 1.0TB
- /Charmonium_Pt_0_20/CMSSW_1_6_0-PreCSA07-A1/GEN-SIM-DIGI-RAW
  1039884 events, 163 files, 19 block(s), 895.3GB
- /Charmonium_Pt_20_inf/CMSSW_1_6_0-PreCSA07-HLT-A4/GEN-SIM-DIGI-RECO
  1012650 events, 362 files, 37 block(s), 1.8TB
- /Charmonium_Pt_20_inf/CMSSW_1_6_0-PreCSA07-A1/GEN-SIM-DIGI-RAW
  1040964 events, 372 files, 32 block(s), 1.5TB

3.1pb-1

400pb-1

CSA08 p-J/Psi: ~10 pb-1

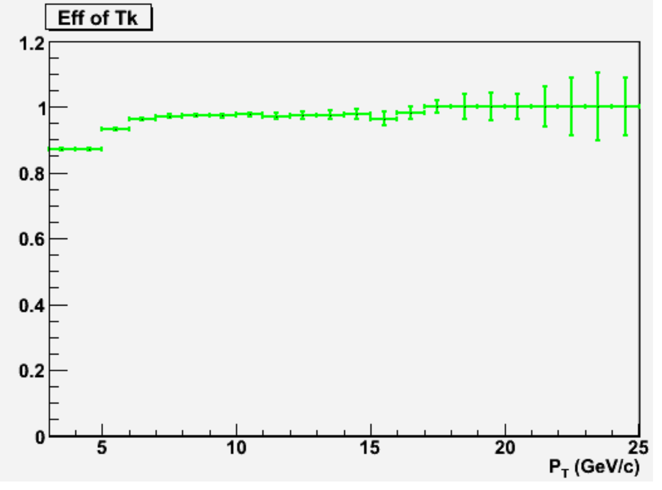
QCD

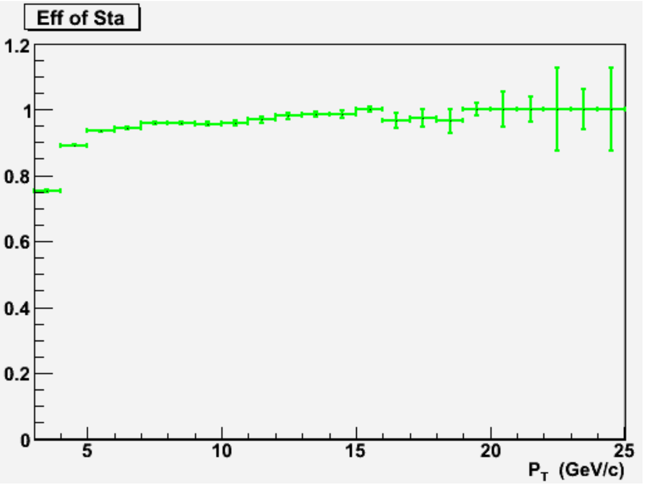
- /Muon_ppMuX/CMSSW_1_6_0-PreCSA07-HLT-B3/GEN-SIM-DIGI-RAW
  20697806 events, 5502 files, 29.3TB
- /Muon_ppMuX/CMSSW_1_6_0-PreCSA07-B2/GEN-SIM-DIGI-RAW
  21365589 events, 5679 files, 25.9TB
- /Muon_ppMuX/CMSSW_1_6_7-CSA07-1197906039/GEN-SIM-DIGI-RAW
  5555458 events, 5487 files, 9.6TB

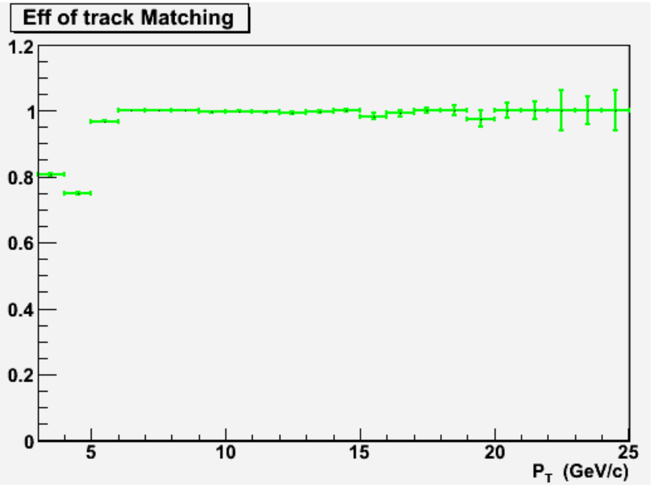
QCD: 0.45 pb-1

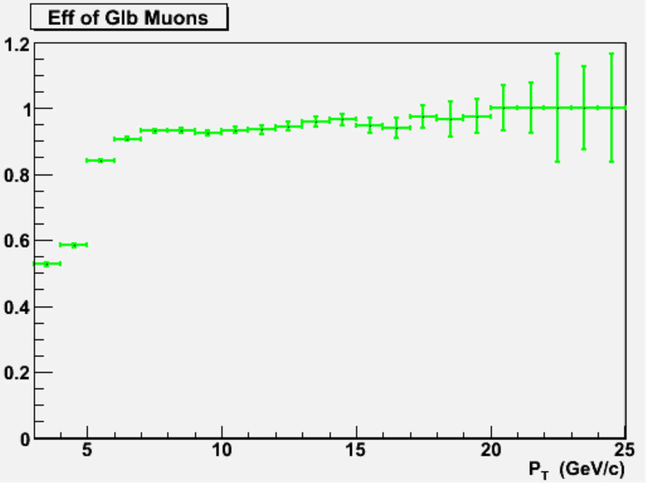
CSA08 QCD: 0.45 pb-1

Efficiencies from data: Tag&Probe

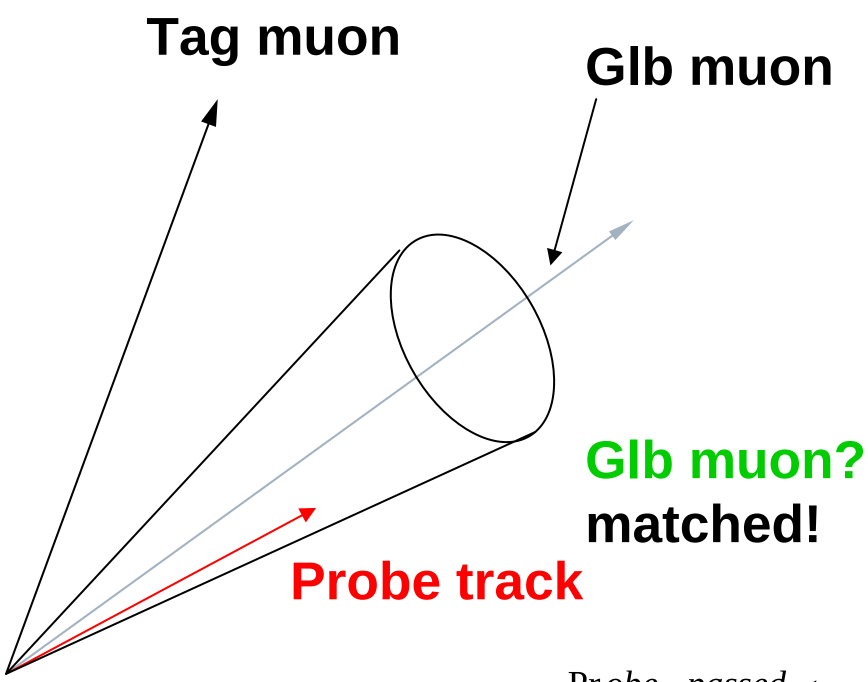


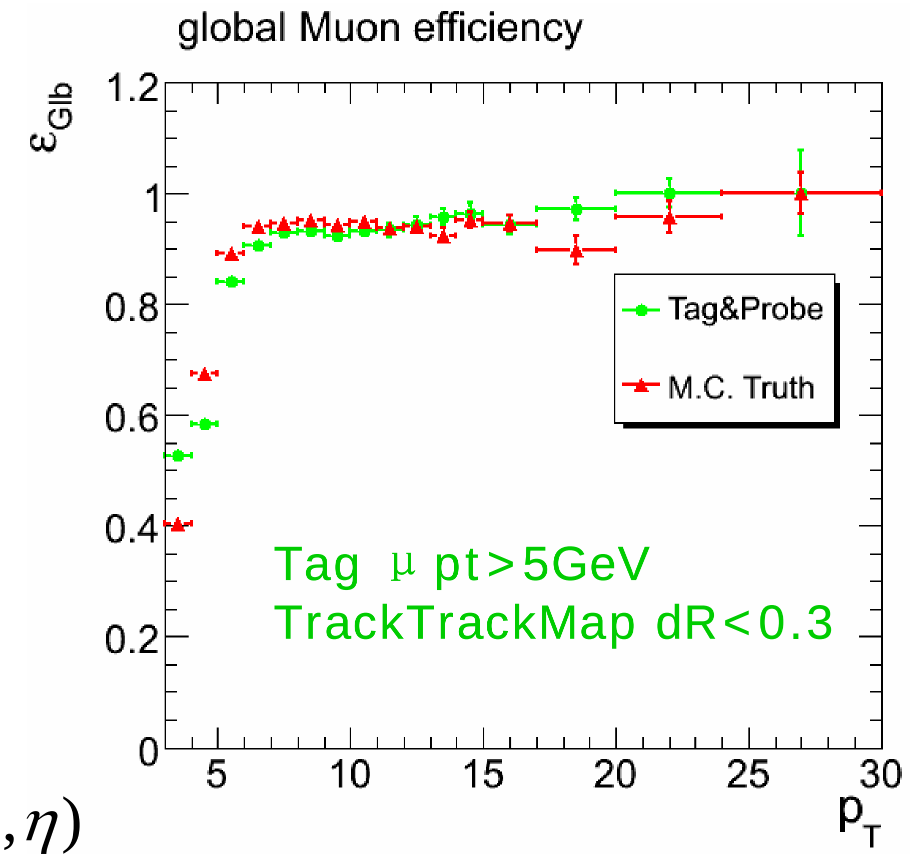






Glb Muon efficiency





$$\varepsilon^{T.P.} = \frac{N^{\mathrm{Probe-passed}}(p_T,\eta)}{N^{\mathrm{Probe-by-Tag}}(p_T,\eta)}$$

Measurement of Cross-secton

- The inclusive b-> J/ψ cross-section is calculated by

$$\frac{d\sigma}{dp_T}\cdot \mathrm{Br}(J/\psi \to \mu^+\mu^-) = f_b(p_T)\cdot \frac{N_{Reco}(p_T)\cdot(1-A')}{\int Ldt\cdot A\cdot \varepsilon_{Trig}\cdot \varepsilon_{Offline}\cdot \Delta p_T}$$

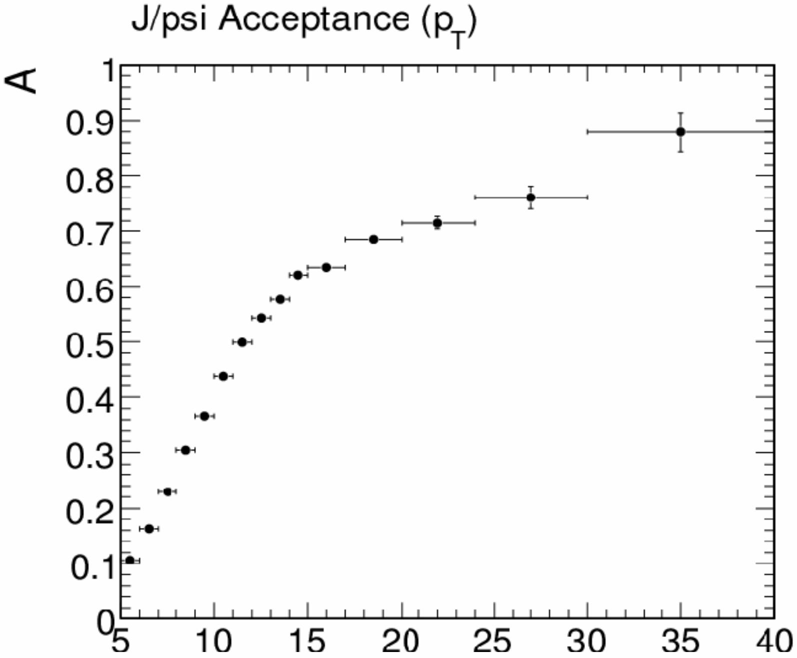
1. $\int L\,dt$: the integral luminosity
2. f_b : **fraction for J/Ψ from b**
3. ΔP_T : the size of the P_T bin.
4. N_{Reco}: the number of reconstructed J/ψ signals
5. A, A' : the acceptance and relative acceptance
6. ε_{Trig} : trigger efficiency
7. $\varepsilon_{Offline}$: off-line reconstruction efficiency

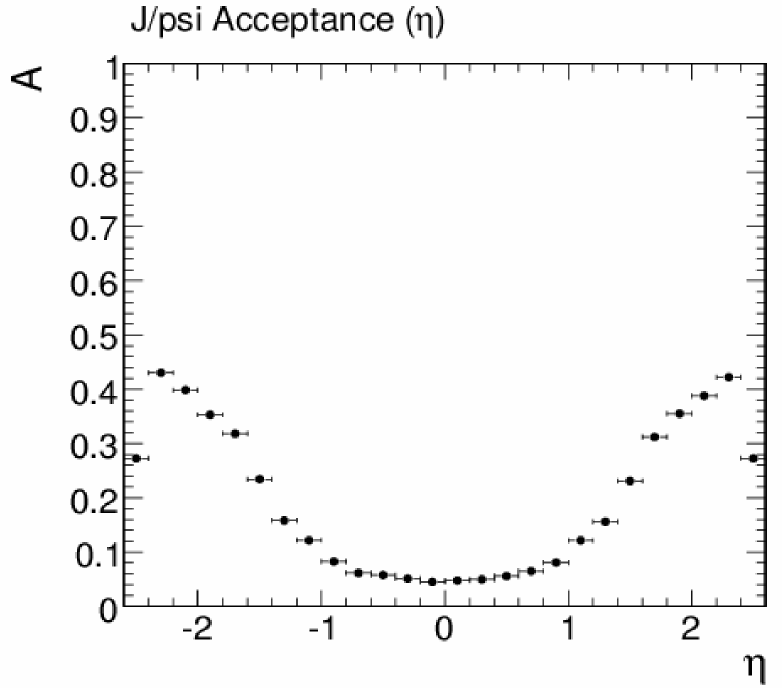
Acceptances I

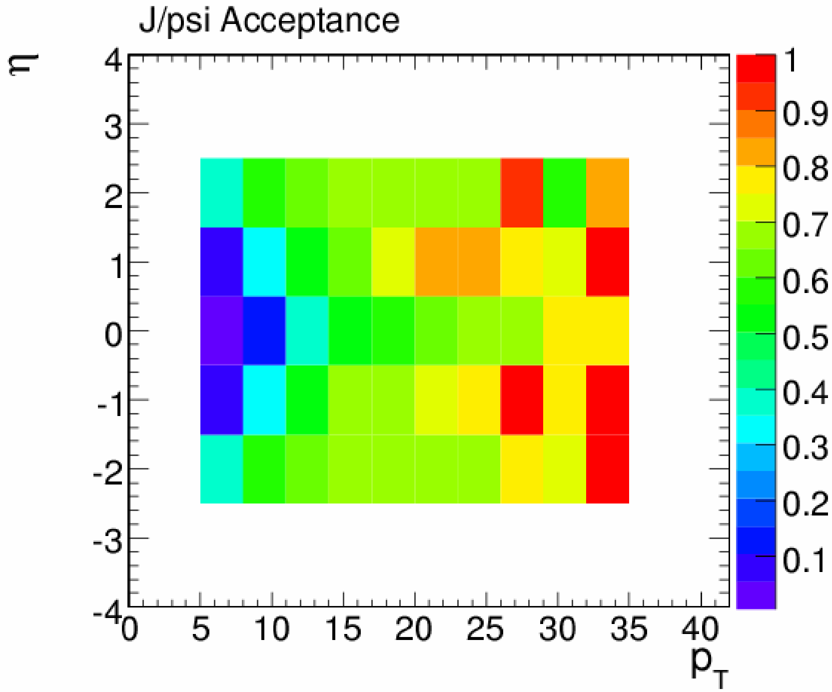
- Acceptances include the detector geometric and kinematic acceptances, Can be obtained by Monte Carlo simulation. is treated and defined as:

$$A(p_T^{J/\psi},\eta^{J/\psi}) = \frac{N^{Rec}(p_T^{J/\psi},|\eta^{J/\psi}|<2.4)}{N^{Gen}(p_T^{J/\psi},|\eta^{J/\psi}|<2.4)}$$

Acceptance II

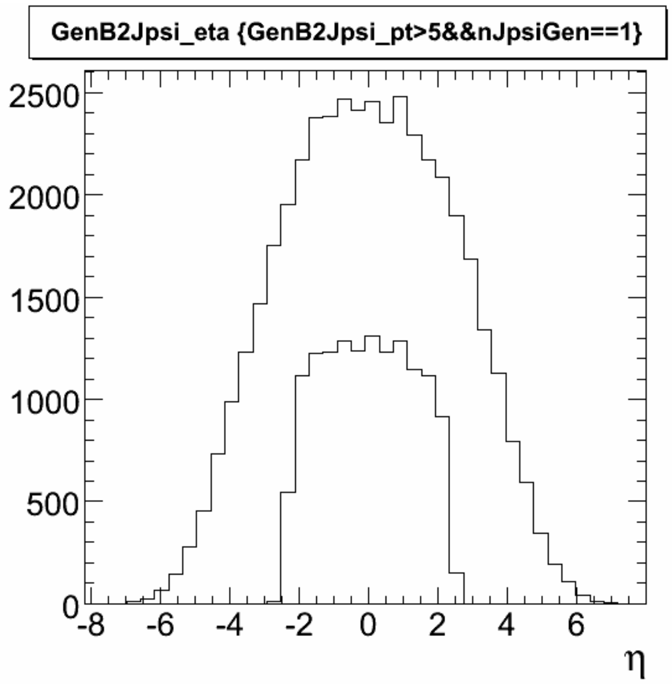


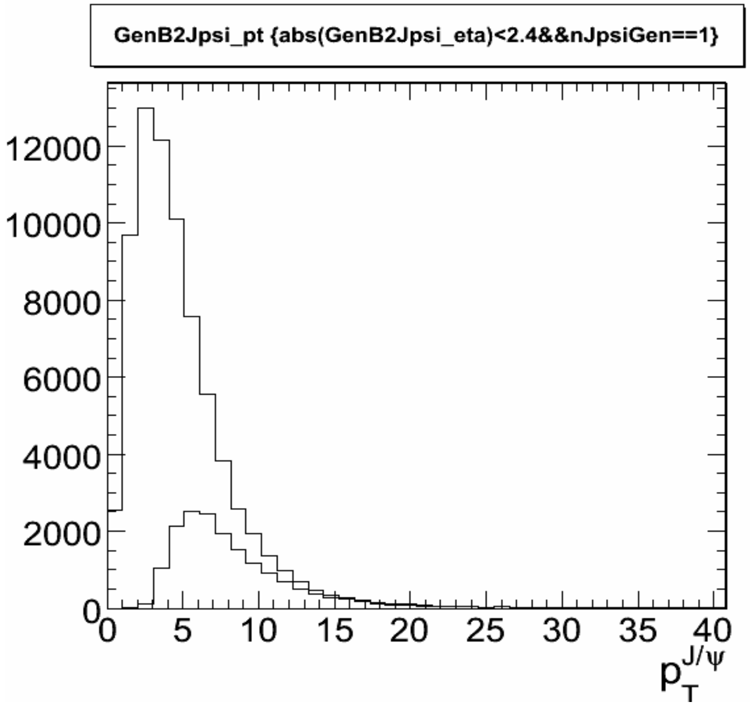




$$A^0(p_T^{J/\psi},\eta^{J/\psi}) = \frac{N^{Rec}(p_T^{J/\psi},|\eta^{J/\psi}|<2.4)}{N^{Gen+filter}(p_T^{J/\psi},|\eta^{J/\psi}|<2.4)}$$

AcceptanceIII:
correction from Gen+filter to Gen I





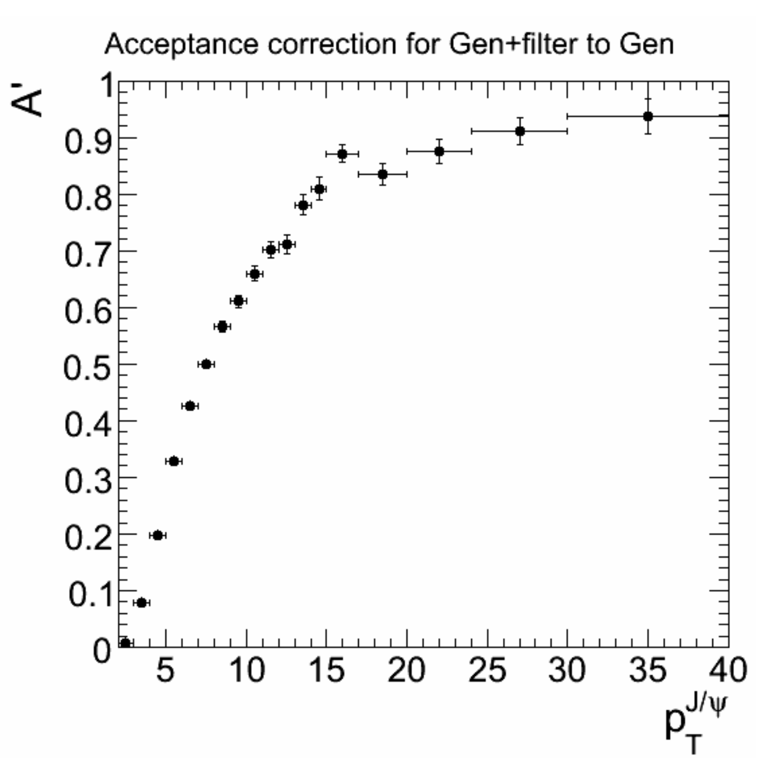
CSA07Bphys_BtoJpsi_GEN.cfg only with Gen tier

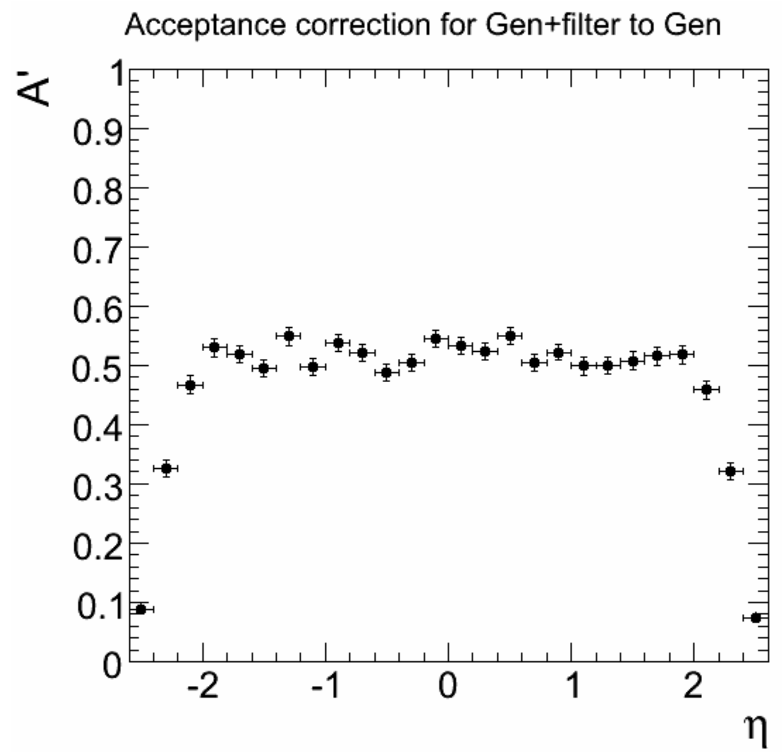
```
module mumufilter = MCParticlePairFilter {
  ......
  untracked vdouble MinPt = {2.0,2.0}
  untracked vdouble MinEta = {-2.5,-2.5}
  untracked vdouble MaxEta = {2.5,2.5}
  ...... }
```

⇒

```
module mumufilter = MCParticlePairFilter {
  ......
  untracked vdouble MinPt = {0,0}
  untracked vdouble MinEta = {-20.,-20.}
  untracked vdouble MaxEta = {20.,20.}
  ...... }
```

Acceptance III: correction from Gen+filter to Gen II



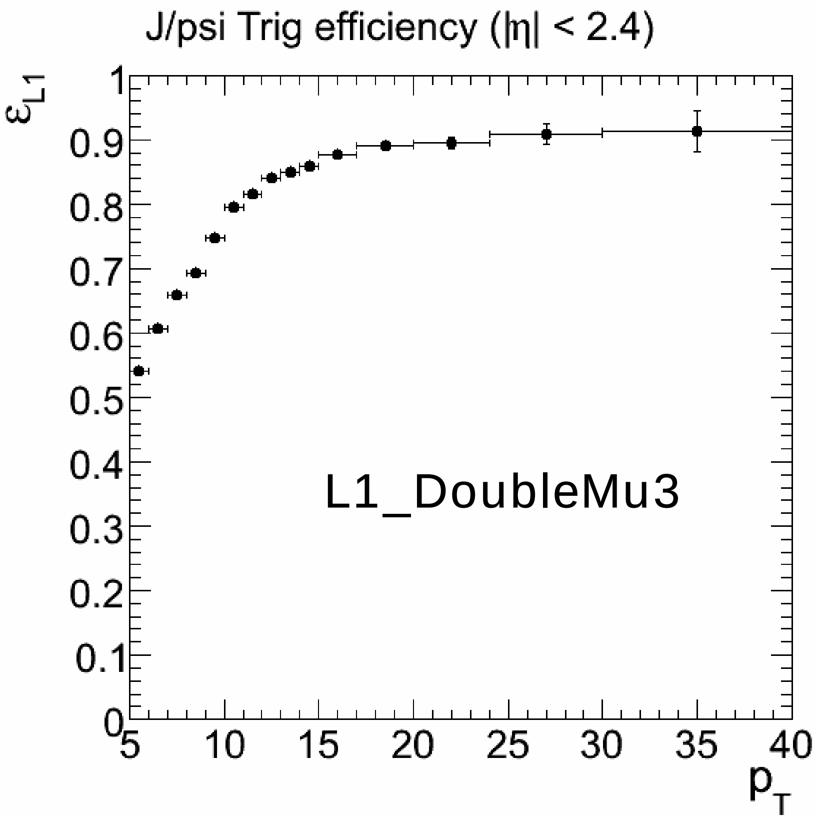


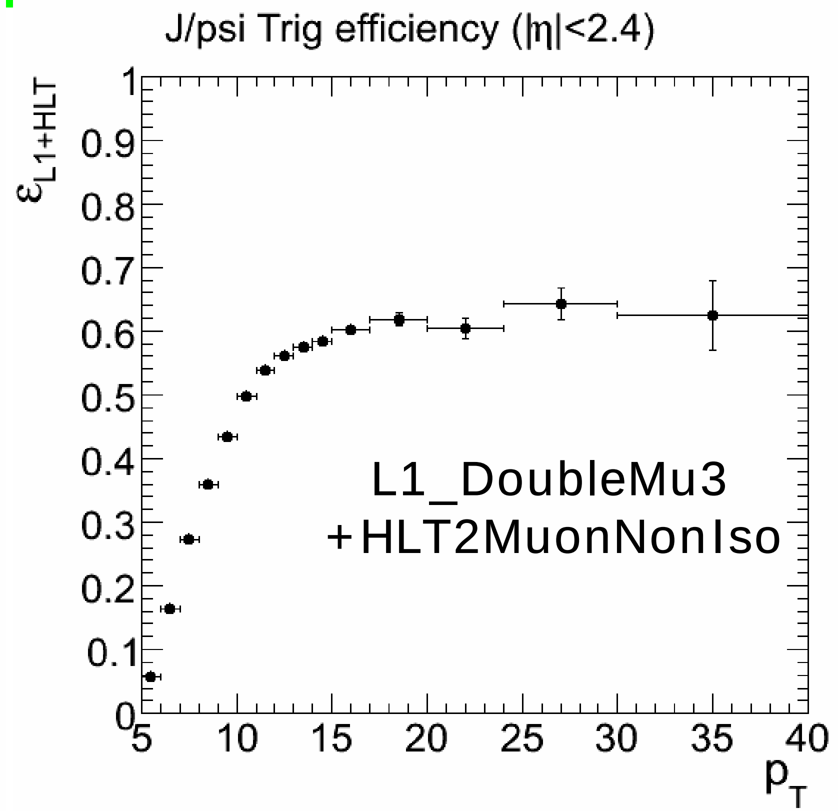
$$A'(p_T^{J/\psi}, \eta^{J/\psi}) = \frac{N^{Gen+filter}(p_T^{J/\psi}, |\eta^{J/\psi}| < 2.4)}{N^{Gen}(p_T^{J/\psi}, |\eta^{J/\psi}| < 2.4)}$$

$N_{Gen\_Try:}$ 20,000,000

updated to ->120,000,000

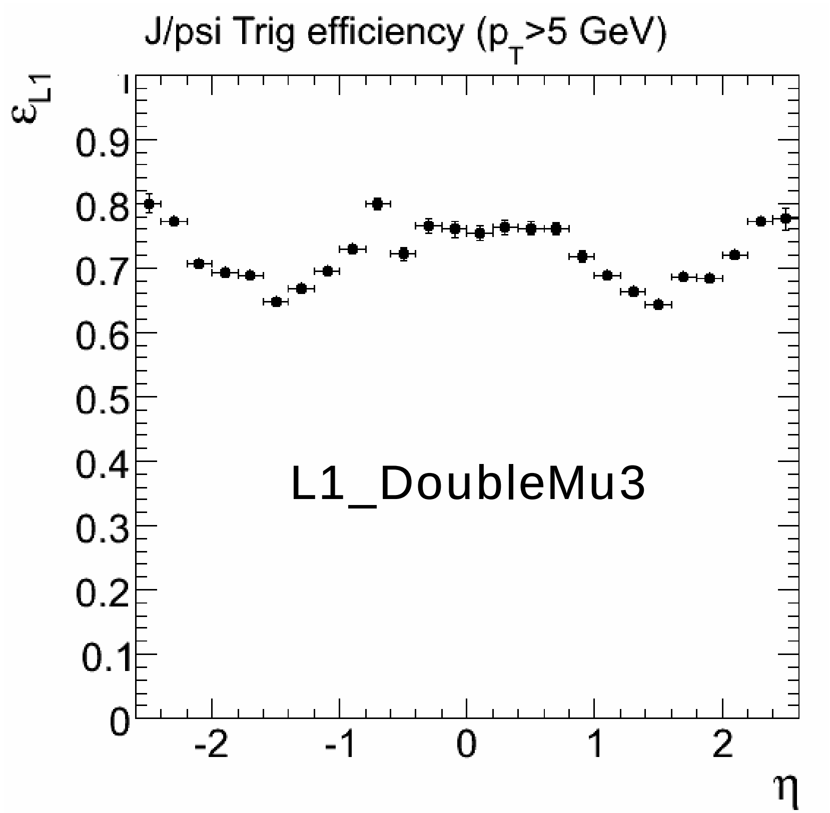
Trig efficiency: J/psi's w.r.t. Offline glb Reco. I

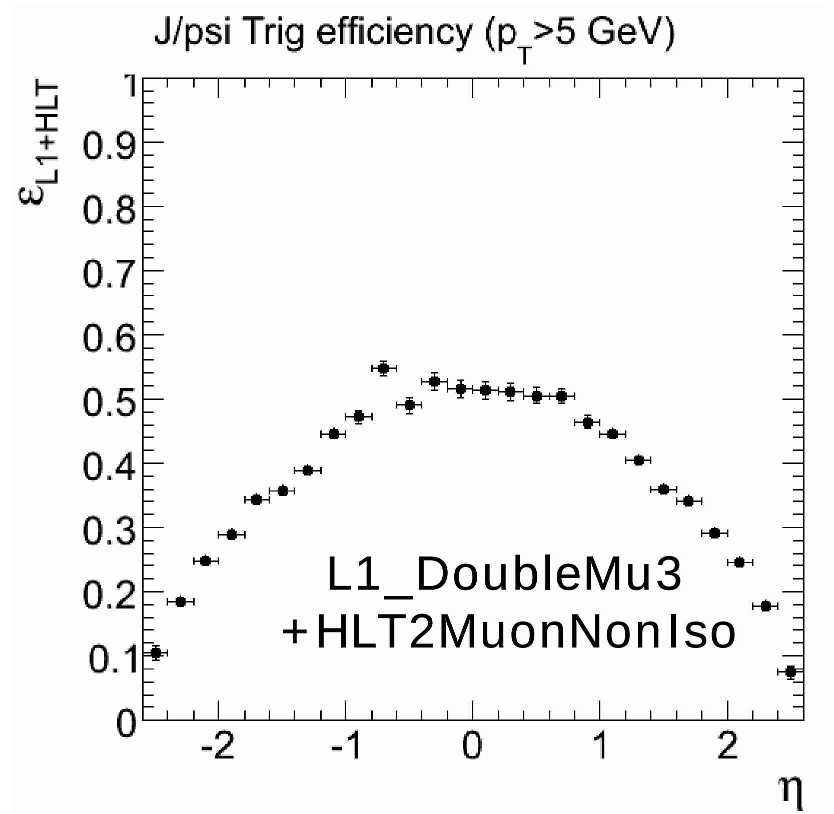




$$\varepsilon_{L1,L1+HLT}^{w.r.t.Offline} = \frac{N_{L1,L1+HLT}^{Offline+Glb}\ (p_T^{J/\psi}, |\eta^{J/\psi}| < 2.4)}{N^{Offline+Glb}(p_T^{J/\psi}, |\eta^{J/\psi}| < 2.4)}$$

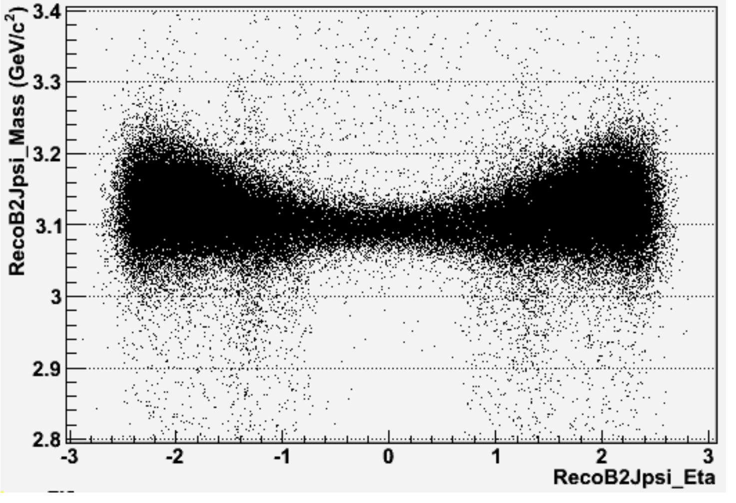
Trig efficiency: J/psi refered to Offline glb Reco. II

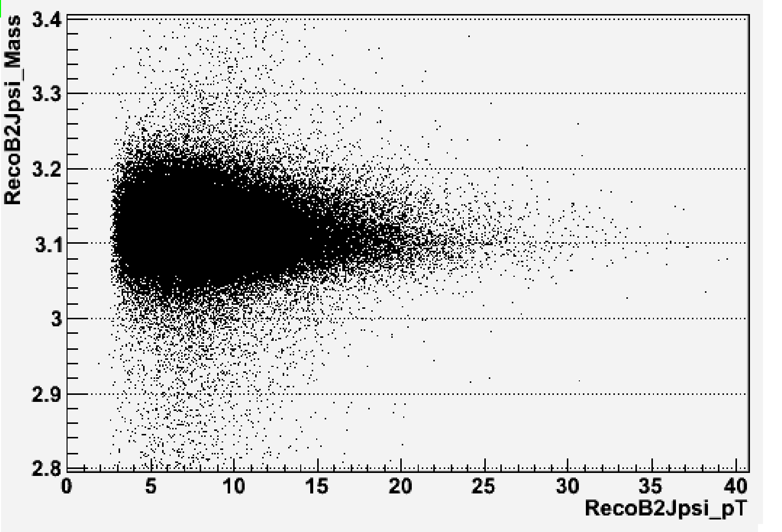


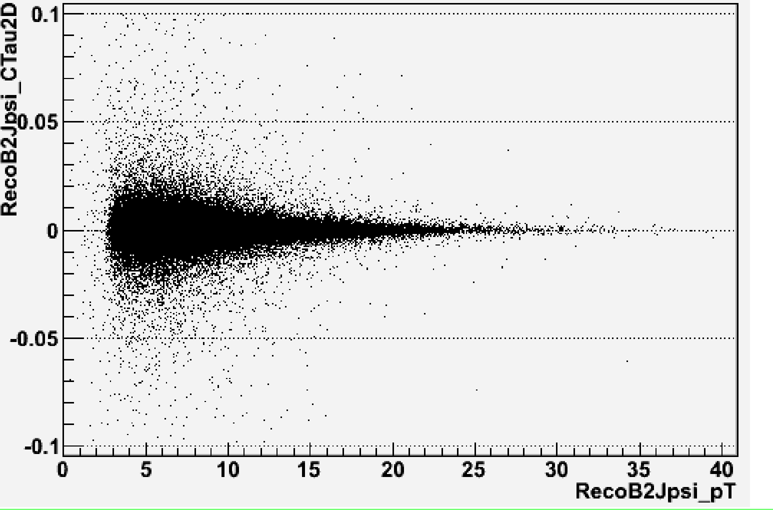


$$\varepsilon_{L1,L1+HLT}^{w.r.t.Offline} = \frac{N_{L1,L1+HLT}^{Offline+Glb}(p_T^{J/\psi}, |\eta^{J/\psi}| < 2.4)}{N^{Offline+Glb}(p_T^{J/\psi}, |\eta^{J/\psi}| < 2.4)}$$

Resolution Model: mass & pdl p-J/Ψ





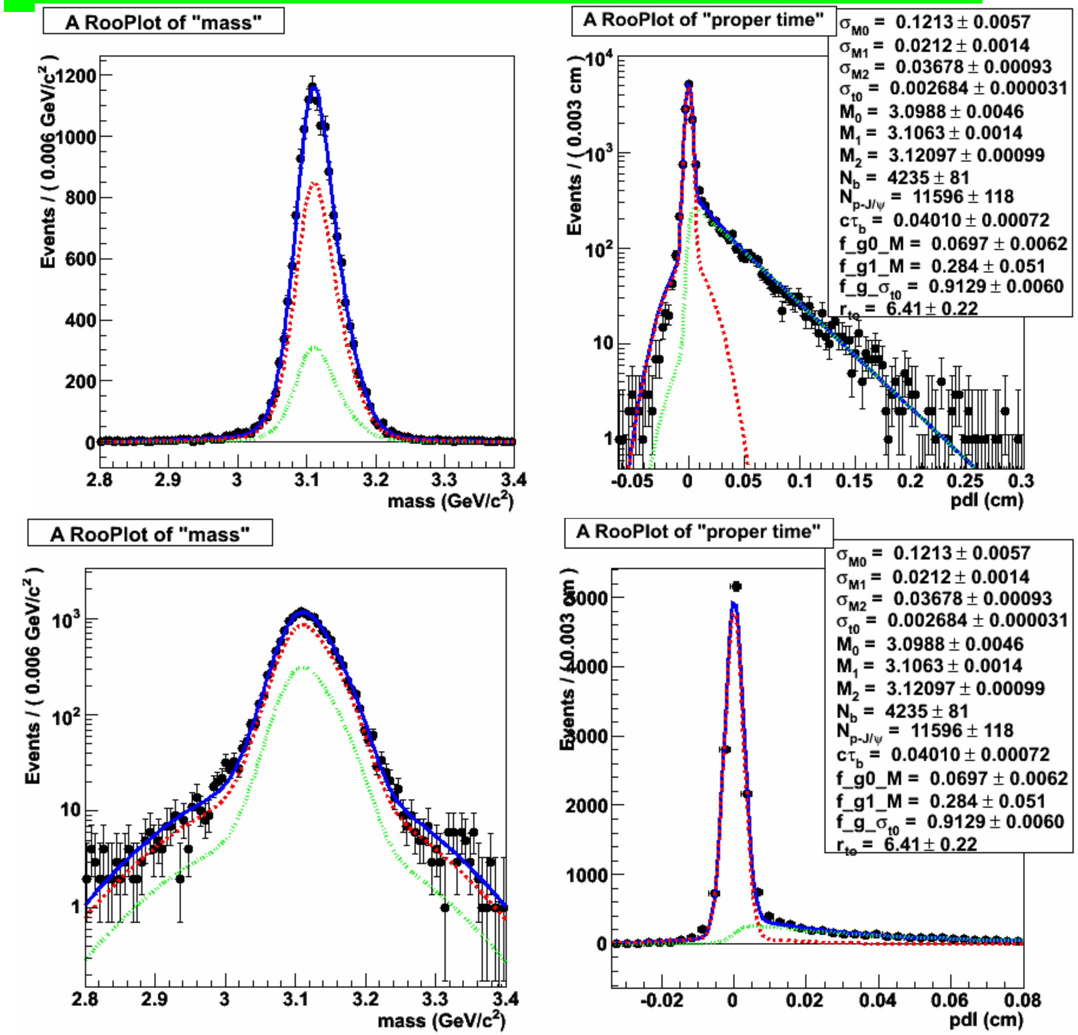


Mass: 3Gaussion

Pdl: 2 Gaussion

pT: 9-10GeV

Offline p-jpsi: 11545
b: 4288



1. a finite experimental resolution on each measurement

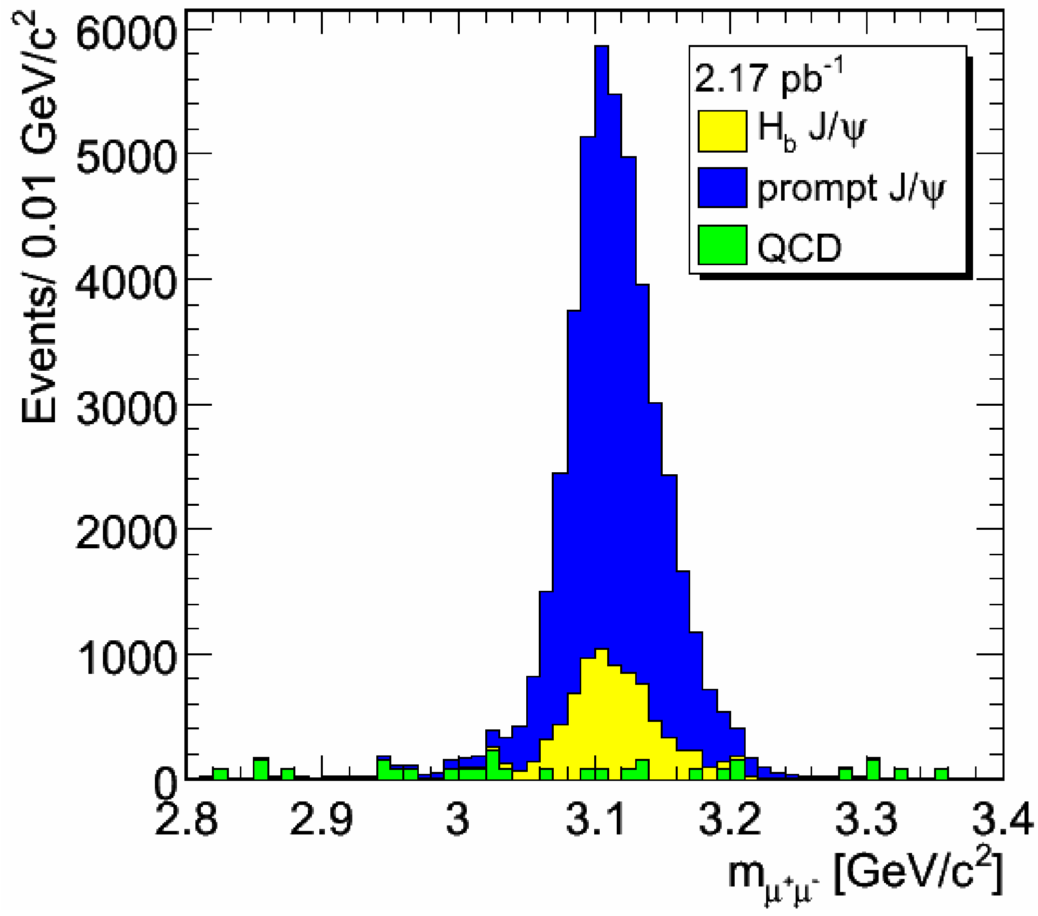
$$F_I(t) = \exp(-t/\tau)$$

$$F_R(t) = \exp(-t/\tau) \otimes G(t, \mu, \sigma)$$
$$\equiv \int dt' \exp(-t'/\tau)\, G(t-t', \mu, \sigma)$$

$$F_E(t,dt) = \exp(-t/\tau) \otimes G(t, \mu, \mathbf{dt})$$

$$F_E(t,dt) = \exp(-t/\tau) \otimes G(t, \mu, \mathbf{s \cdot dt})$$

Invariant mass distribution: 2.17 pb^{-1}



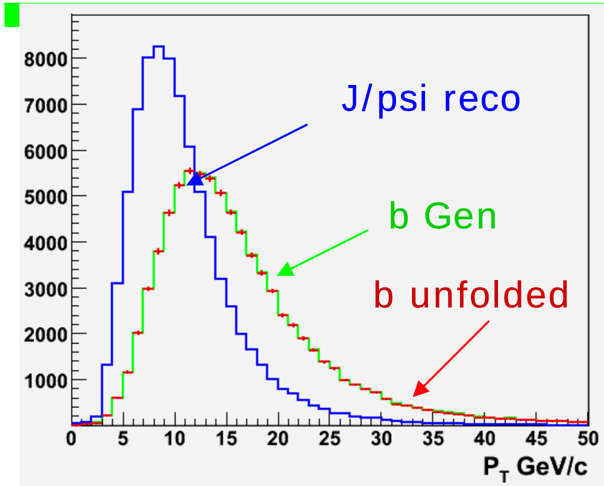
1. **L1+HLT filter**
2. **Each muon $p_T > 3 GeV/c$, $|\eta| < 2.4$.**
3. **Opposite change**
4. **From a common vertex**
5. **Mass window: [2.8 ,3.4]GeV/c^2.**

Unfolding

- **The differential *b*-hadron cross section vs. pT(H_b) is extracted from the measured differential ones of H_b ->J/ΨX**

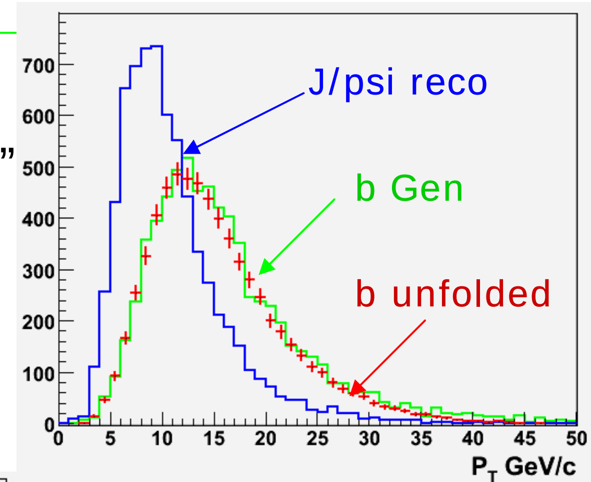
- **Distortions between *b*-hadron pT distribution and J/Ψ pT's from b-hadrons**

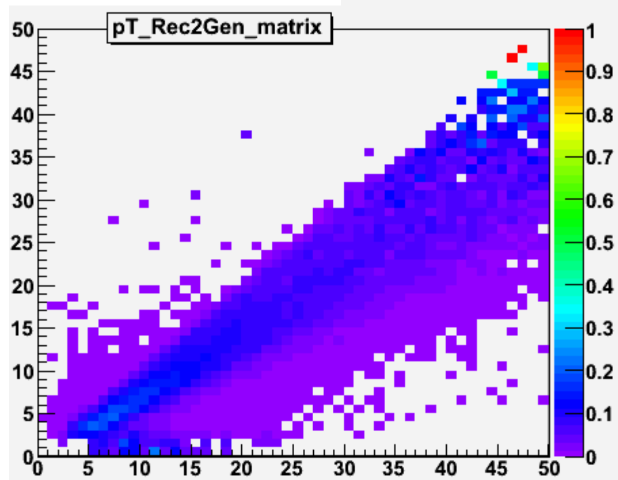
Unfolding on M.C. data

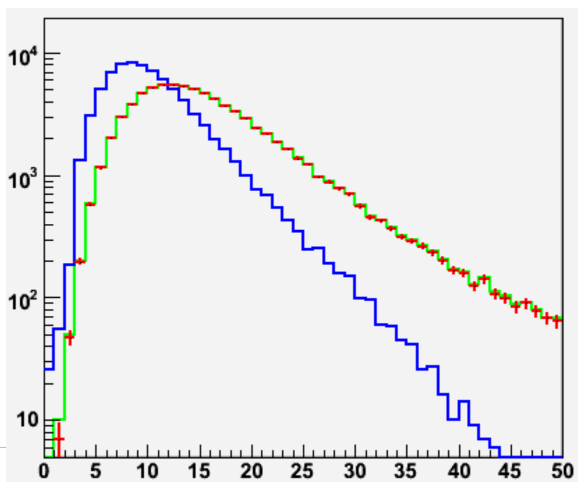


M.C. big sample
Nevt: 80,000

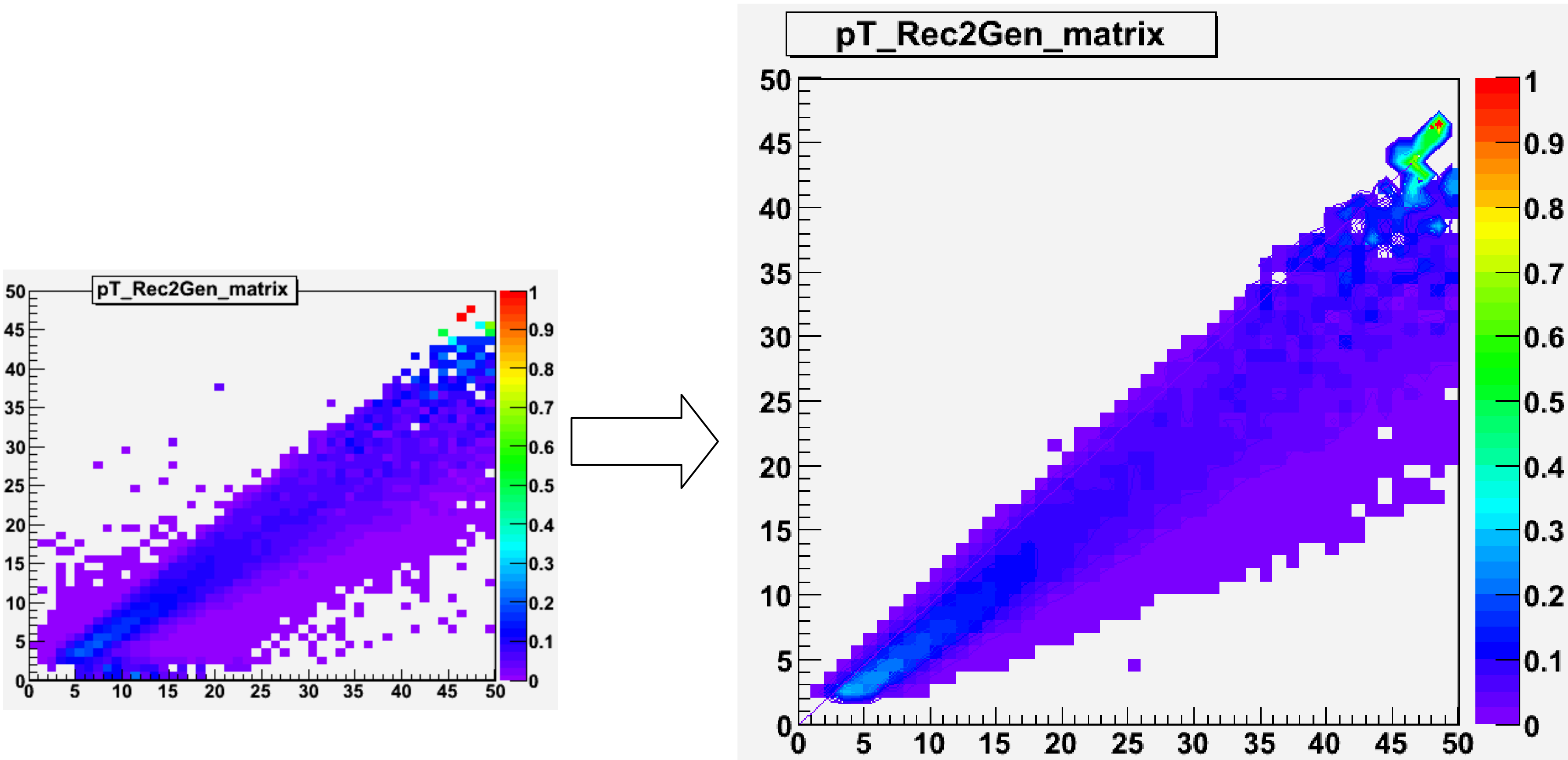
M.C. "real data"
Nevt: 7011







New Correlation Matrix



Done & to do list

- ☐ Acceptance and efficiency
1. Geometric & kinematic Acceptance: A(pT, η)
2. Reco. Efficiency: local reco., matching & selection cuts, Glb muon,etc.
3. Trig Efficiency (Tag& probe in fixing)
- ☐ Unbinned combined MLH fit & analysis method: Offline M.C. Data
- ☐ Unfolding method.

Oncoming:

- ☐ b fraction from M.C. data. very soon!
- ☐ Systematic uncertainties: sources & estimation very soon!
- ☐ Preparation for AN & PAS. into shape!

with CMSSW_1_6_11

backups

Efficiencies from data: Tag&Probe

- Tag-and-Probe
  - Successfully used in experiments: CDF and D∅
- Current availability of code
  - Egamma: EgammaAnalysis/EgammaEfficiencyAlgos
  - Muon: MuonAnalysis/TagAndProbe

adapt code to use under CMSSW_16X with PAT

Efficiency Measurements: Tag&Probe

- **The overall dimuon efficiencies of the measurement are assumed to be the product of several parts**

$$\varepsilon = \varepsilon_{\mathrm{acceptance}} \times \varepsilon_{\mathrm{trigger}} \times \varepsilon^{2}_{\mathrm{offline}}$$

$$\varepsilon_{\mathrm{trigger}} = \varepsilon_{\mathrm{L1}} \times \varepsilon_{\mathrm{HLT}}$$

$$\varepsilon_{\mathrm{offline}} = \varepsilon_{\mathrm{global}} \times \varepsilon_{\mathrm{isolation}} \times \varepsilon_{\mathrm{id}}$$

$$\varepsilon_{\mathrm{global}} = \varepsilon_{\mathrm{standalone}} \times \varepsilon_{\mathrm{tracker}} \times \varepsilon_{\mathrm{matching}}$$

- Choose a *tag* muon
  - A “high quality” reconstructed muon
- Choose a *probe* track
  - A probable muon in tracker or muon system
- Requiring $M_{\mu\mu}$ consistent with $M_{J/\Psi}$ yileds a high-purity and almost unbiased sample of *probe* muons

Description of Tag and Probe

TAG	**Global muon with p_T > 5GeV** **Associated to a L3 muon**

Probe Type	Description
Golden	Global muon that is also a TAG
Matched	Global muon that is not a TAG
Unmatched	Tracker track AND Standalone muon found, but they are not associated with a Global Muon
Tracker Only	Only a tracker track
Stand Alone Muon	Only a standalone muon

With the five types of probes, we get five combinations of tag-and-probe: GG, GM, GU, GS, GT

Tracking and Matching Efficiencies I

- Standalone, Tracking, and Matching efficiencies calculated with simple event counting

$$\varepsilon_{\text{standalone}} = \frac{2N_{GG} + N_{GM} + N_{GU}}{2N_{GG} + N_{GM} + N_{GU} + N_{GT}}$$

$$\varepsilon_{\text{tracker}} = \frac{2N_{GG} + N_{GM} + N_{GU}}{2N_{GG} + N_{GM} + N_{GU} + N_{GS}}$$

$$\varepsilon_{\text{matching}} = \frac{2N_{GG} + N_{GM}}{2N_{GG} + N_{GM} + N_{GU}}$$

$$\varepsilon_{\text{global}} = \varepsilon_{\text{standalone}} \times \varepsilon_{\text{tracker}} \times \varepsilon_{\text{matching}}$$

Unfolding methods I

- Bin-to-bin correction: no into account migrations a bin to the others; neglect correlation between adjacent bins.
- The matrix method: solve the problem of migrations; singular problem; statistical fluctuations; results unstable.
- Regularized unfolding: satisfactory results but technical complications; only with one dimension

Unfolding Method II: Bayes'

A Multidimensional unfolding method based on Bayes' theorem by G.D'Agostini, Nucl. Instr. Meth. A362 (1995) 487-498. -- Model independent method

$$P(C_i|E_j) = \frac{P(E_j|C_i)P_0(C_i)}{\sum_{l=1}^{n_C} P(E_j|C_l)P_0(C_l)}.$$

$$\hat{n}(C_i)|_{obs} = \sum_{j=1}^{n_E} n(E_j)P(C_i|E_j)$$

$$\hat{n}(C_i) = \frac{1}{\epsilon_i}\sum_{j=1}^{n_E} n(E_j)P(C_i|E_j) \quad \epsilon_i \neq 0$$

Ci: cause in i-th bin
Ej: effect in j-th bin
P(Ci|Ej): corelation matrix for Ej to Ci

$$\hat{N}_{true} = \sum_{i=1}^{n_C} \hat{n}(C_i),$$

$$\hat{P}(C_i) \equiv P(C_i \mid n(E)) = \frac{\hat{n}(C_i)}{\hat{N}_{true}},$$

$$\hat{\epsilon} = \frac{N_{obs}}{\hat{N}_{true}}.$$

the unfolding can be performed through the following steps:

1) choose the initial distribution of $P_0(C)$ from the best knowledge of the process under study, and hence the initial expected number of events $n_0(C_i) = P_0(C_i)N_{obs}$; in case of complete ignorance, $P_0(C)$ will be just a uniform distribution: $P_0(C_i) = 1/n_C$;

2) calculate $\hat{n}(C)$ and $\hat{P}(C)$;

3) make a χ^2 comparison between $\hat{n}(C)$ and $n_0(C)$;

4) replace $P_0(C)$ by $\hat{P}(C)$, and $n_0(C)$ by $\hat{n}(C)$, and start again; if, after the second iteration the value of χ^2 is "small enough", stop the iteration; otherwise go to step 2. Some criteria about the optimum number of iterations will be discussed later.