# Measurement of the Bc cross-section using Bc->J/$\psi\mu\nu$

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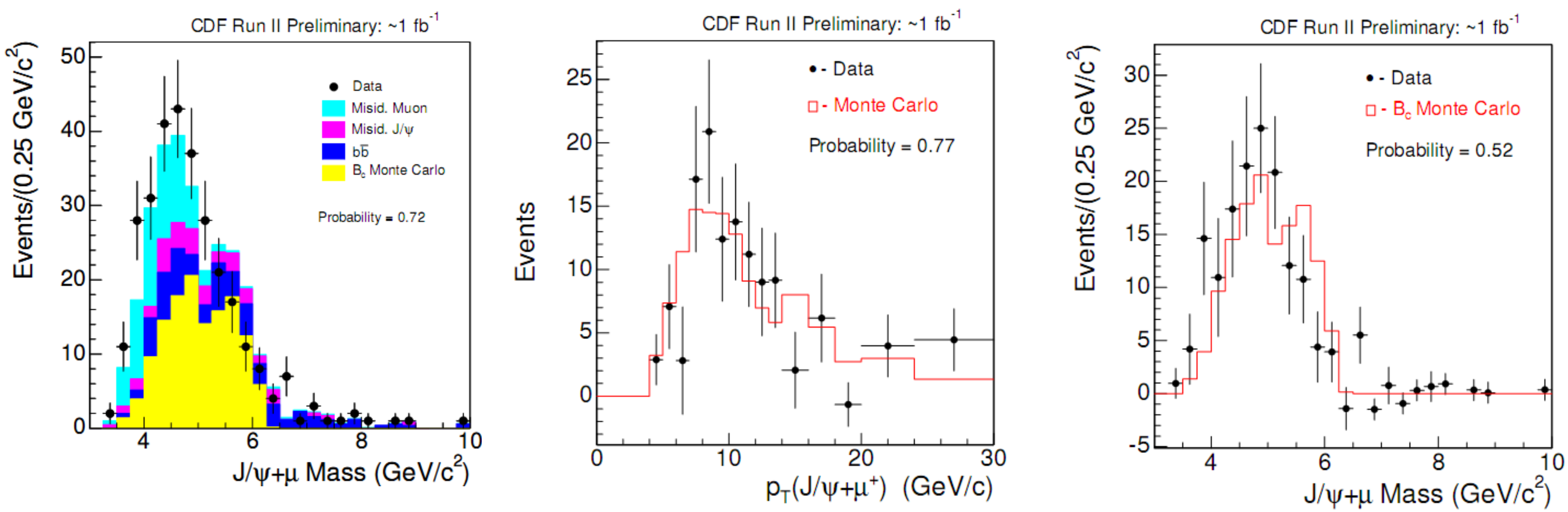
# Outline

- motivation
- Experimental status
- Event generation
- Related parameters
- Event selection
- Acceptance and trigger efficiency
- Calculate differential cross-section in Pt bin
- Next steps…

# CDF Latest Result(1 $fb^{-1}$)

CDF Public Note 9740 09-03-05

| $B_c^+$ excess | $p_T(J/\psi+\mu^+) > 4$ GeV/$c$ | $p_T(J/\psi+\mu^+) > 6$ GeV/$c$ |
|---|---|---|
| $N(B_c^+ \to J/\psi+\mu^+ + X)$, observed | $229 \pm 15.1$ | $214 \pm 14.6$ |
| Total background | $106.2 \pm 8.2$ | $102.1 \pm 8.0$ |
| $N(B_c^+ \to J/\psi+\mu^+ + X)$, bg. sub. | $122.8 \pm 17.2$ | $111.9 \pm 16.6$ |
| Other decay modes | $5.2 \pm 0.5$ | $4.8 \pm 0.4$ |
| $N(B_c^+ \to J/\psi+\mu^+ + \nu)$, bg. sub. | $\boxed{117.6 \pm 17.2}$ | $\boxed{107.1 \pm 16.7}$ |




The monte carlo simulation generator is Bcvegpy1.0(only s-wave)

# First approach(estimate the cross-section of $Bc^+$)

- The "signal" events are then passed through the detector and trigger simulation with all analysis cuts applied and a requirement that pT ($J/\psi+\mu^+$) > 4 (6) GeV/c.

| Efficiencies | $p_T(B) > 4$ GeV$/c$ | $p_T(B) > 6$ GeV$/c$ |
|---|---|---|
| $\epsilon_{B_c^+}$ (%) | 0.0551 | 0.1232 |
| $\epsilon_{B^+}$ (%) | 0.3231 | 0.6005 |

For $p_T$>4Gev/c we obtain

$$\sigma\left(B_c^+\right) * BR\left(B_c^+ \to J/\psi + \mu^+ + \nu\right) = \frac{117.6}{0.000551} = 213\ 430 \text{ fb}$$

For $p_T$>6Gev/c we obtain

$$\sigma\left(B_c^+\right) * BR\left(B_c^+ \to J/\psi + \mu^+ + \nu\right) = \frac{107.1}{0.001232} = 86\ 931.82 \text{ fb}$$

- Then we used the Bcvegpy2.1 (include p-wave) to calculate the cross-section of the $B_c^+$ . At last we get the cross-section $\sigma_{p_t>4}^{theo}(B_c^+) = 8984.48\,pb$ , $\sigma_{p_t>6}^{theo}(B_c^+) = 3945.56$ pb when pt>4(6)Gev/c, mb=4.9Gev, mc=1.376Gev, $\sqrt{s} = 1.96Tev$.

- Set a parameter $BR_{like} = \dfrac{\sigma_{\sqrt{s}=1.96Tev}^{\exp}\left(B_c^+\right) * BR\left(B_c^+ \to J/\psi + \mu^+ + \nu\right)}{\sigma_{\sqrt{s}=1.96Tev}^{theo}\left(B_c^+\right)}$

- $BR_{like}\left(pt > 4Gev\right) = 0.02375$

- $BR_{like}\left(pt > 6Gev\right) = 0.02203$

- To estimate the cross-section of $B_c^+ \to J/\psi + \mu^+ + \nu$ in 10 TeV.
- We define

$$\sigma^{estimate}_{\sqrt{s}=10Tev}\left(B_c^+\right) * BR\left(B_c^+ \to J/\psi + \mu^+ + \nu\right) = \sigma^{theo}_{\sqrt{s}=10Tev}\left(B_c^+\right) * BR_{like}$$

- In all phase space the $B_c^+$ cross-section from Bcvegpy2.1 is 184671.84pb.

- So When CDF $Bc^+$ pt>4GeV, we got the cross-section of $B_c^+ \to J/\psi + \mu^+ + \nu$

$$\sigma^{estimate}_{\sqrt{s}=10Tev}\left(B_c^+\right) * BR\left(...\right) = 184671.84\text{pb} * 0.02375 = 4386.96 \text{ pb}$$

When CDF $Bc^+$ pt>6GeV

$$\sigma^{estimate}_{\sqrt{s}=10Tev}\left(B_c^+\right) * BR\left(...\right) = 184671.84 \text{ pb} * 0.02203 = 4068.84 \text{ pb}$$

# The second approach

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09-03-05

For $p_T > 4$ GeV/$c$ we obtain

$$\frac{\sigma(B_c^+) * BR(B_c^+ \to J/\psi + \mu^+ + \nu)}{\sigma(B^+) * BR(B^+ \to J/\psi + K^+)} = 0.295 \pm 0.040\ (\text{stat.})^{+0.033}_{-0.026}\ (\text{syst.}) \pm 0.036\ (p_T\ \text{spectrum}),$$

while for $p_T > 6$ GeV/$c$ we find

$$\frac{\sigma(B_c^+) * BR(B_c^+ \to J/\psi + \mu^+ + \nu)}{\sigma(B^+) * BR(B^+ \to J/\psi + K^+)} = 0.227 \pm 0.033\ (\text{stat.})^{+0.024}_{-0.017}\ (\text{syst.}) \pm 0.014\ (p_T\ \text{spectrum}).$$

$$\sigma_{B^+}(p_T \geq 6.0\ \text{GeV/c}, |y| < 1) = (2.65 \pm 0.23)\ \mu\text{b}.$$

PRD 75, 012010 2007

$$BR\left(B^+ \to J/\psi\, K^+\right) = \left(1.007 \pm 0.035\right) \times 10^{-3}$$

PLB 667, July 2008

For $p_T$>4Gev/c we obtain

$$\sigma\left(B_c^+\right) * BR\left(B_c^+ \to J/\psi + \mu^+ + \nu\right) = 0.782nb$$

For $p_T$>6Gev/c we obtain

$$\sigma\left(B_c^+\right) * BR\left(B_c^+ \to J/\psi + \mu^+ + \nu\right) = 0.601nb$$

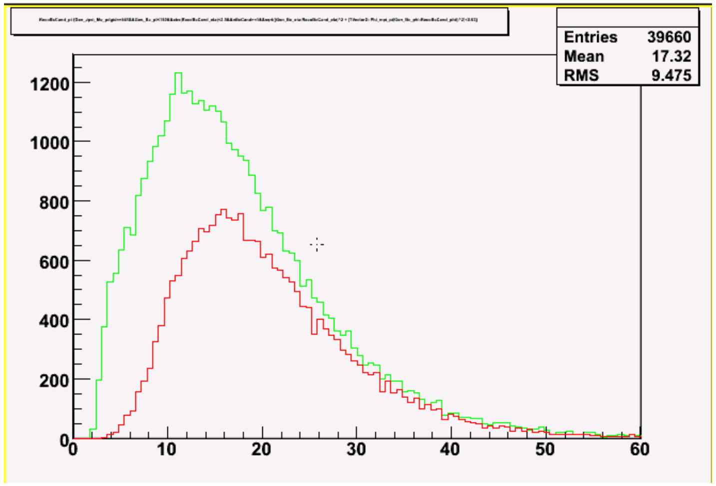
This approach have the problem, first the phase space is different from the Bc$^+$ analysis, second the select criteria is different.

$$\frac{\sigma\left(B_c^+\right) * BR\left(B_c^+ \to J/\psi + \mu^+ + \nu\right)}{\sigma\left(B^+\right) * BR\left(B^+ \to J/\psi + K^+\right)} = \frac{N_{B_c^+}}{N_{B^+}} \times \varepsilon_{rel} = R$$

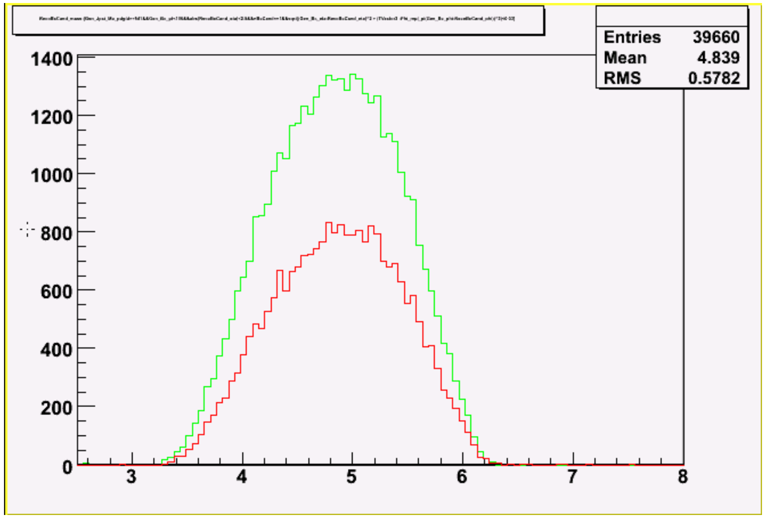
$$\varepsilon_{rel} = \frac{\varepsilon_{B^+}}{\varepsilon_{B_c^+}}$$

$$\frac{\sigma\left(B_c^+\right) * BR\left(B_c^+ \to J/\psi + \mu^+ + \nu\right)}{\sigma\left(B^+\right) * BR\left(B^+ \to J/\psi + K^+\right)} = \frac{N_{B_c^+} / \varepsilon_{B_c^+}}{N_{B^+} / \varepsilon_{B^+}} = R$$

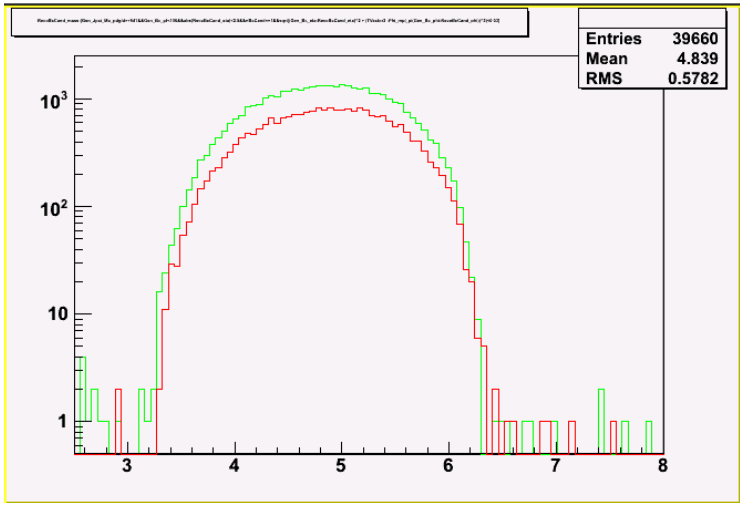
# Bc->JpsiMuNu



Entries 39660
Mean 17.32
RMS 9.475

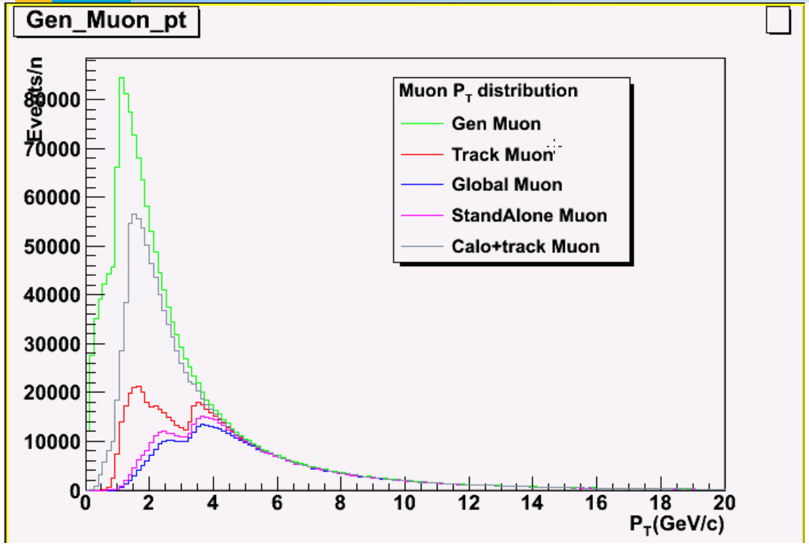



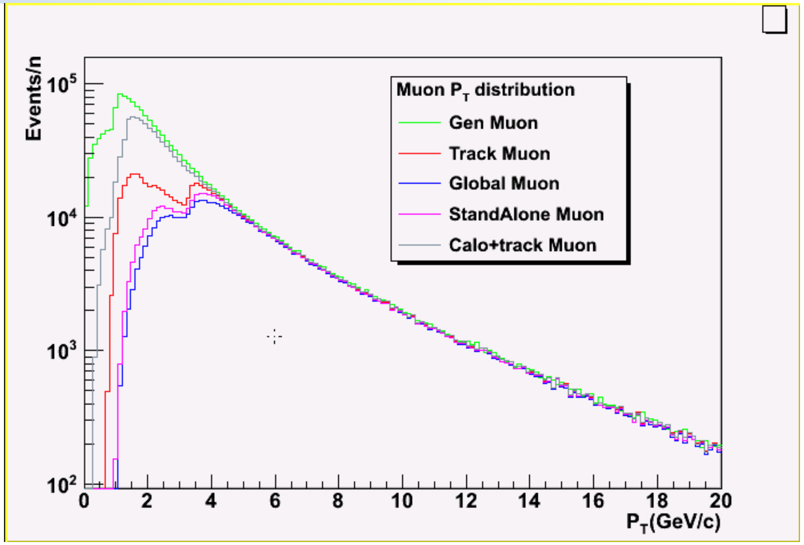
Entries 39660
Mean 4.839
RMS 0.5782

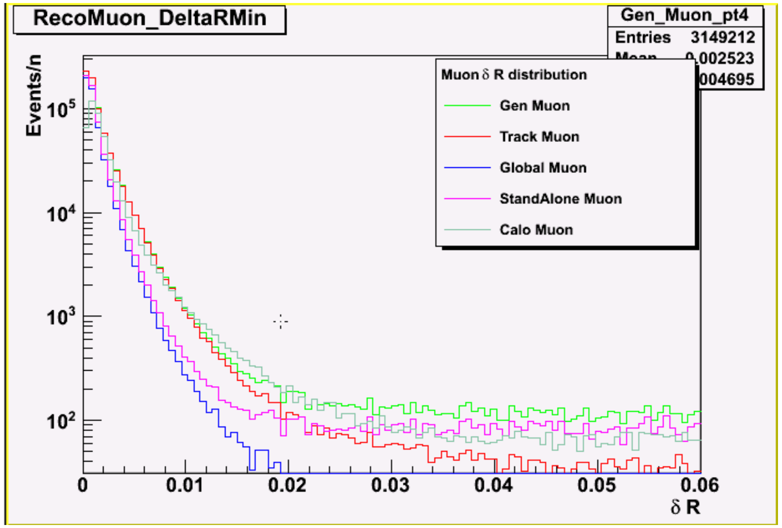
Entries 39660
Mean 4.839
RMS 0.5782

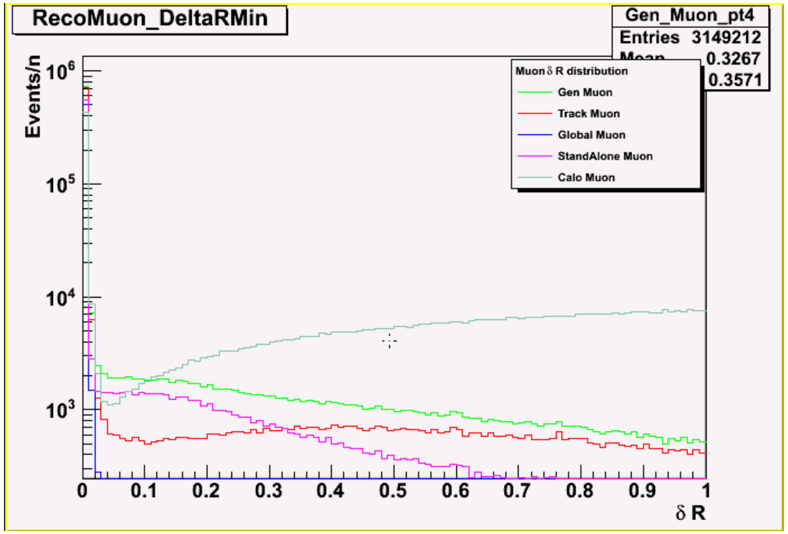
# Muon pt distribution



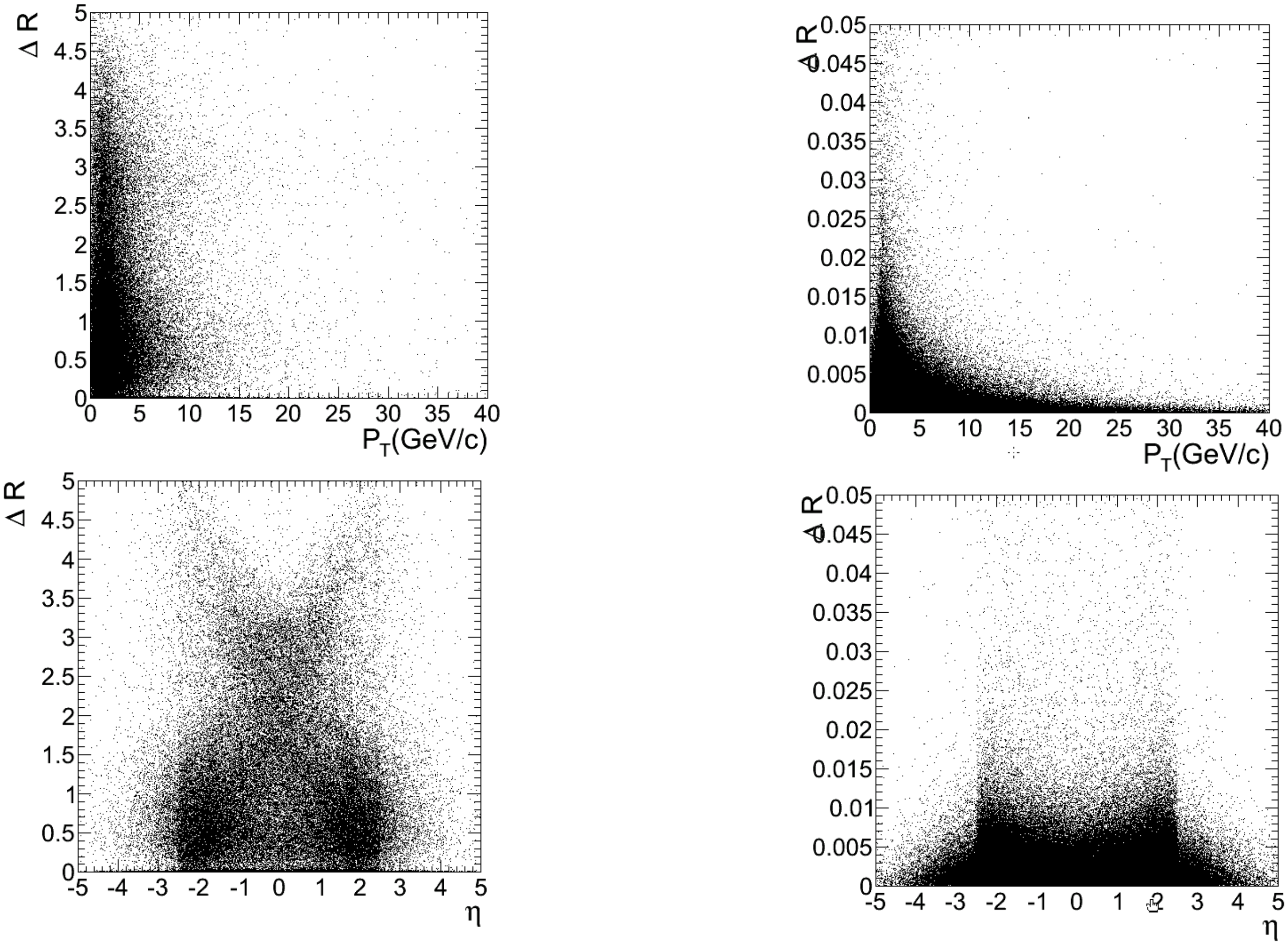



# ΔR distribution

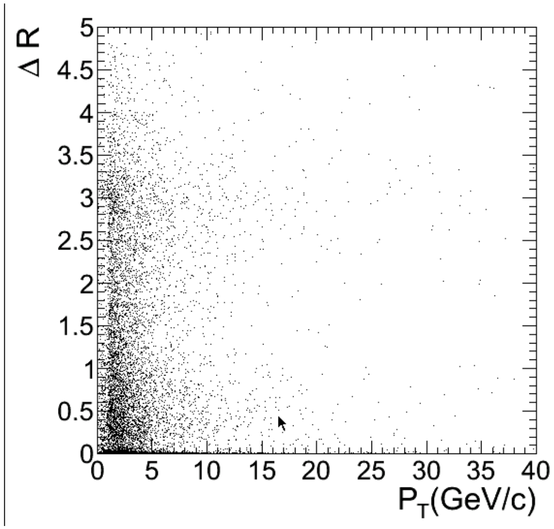


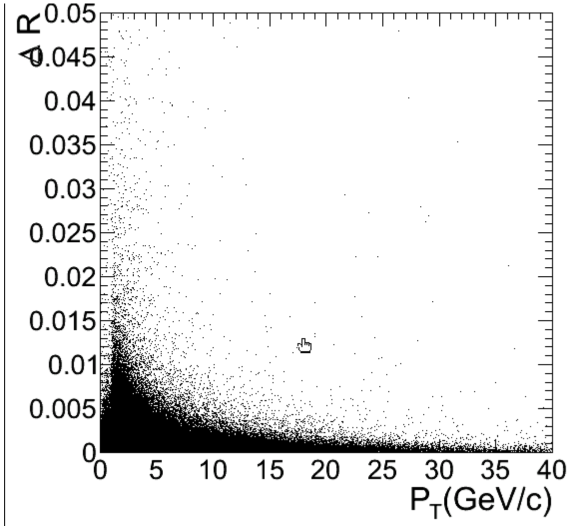



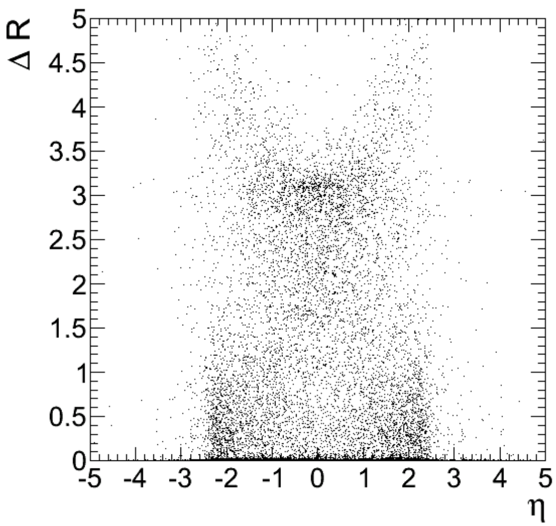
# Track Muon

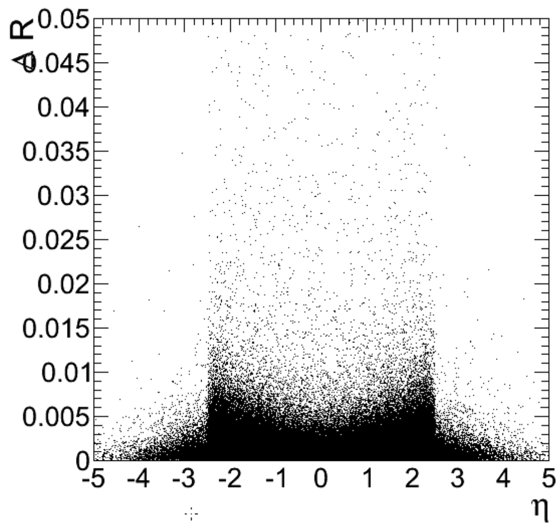


# Global Muon

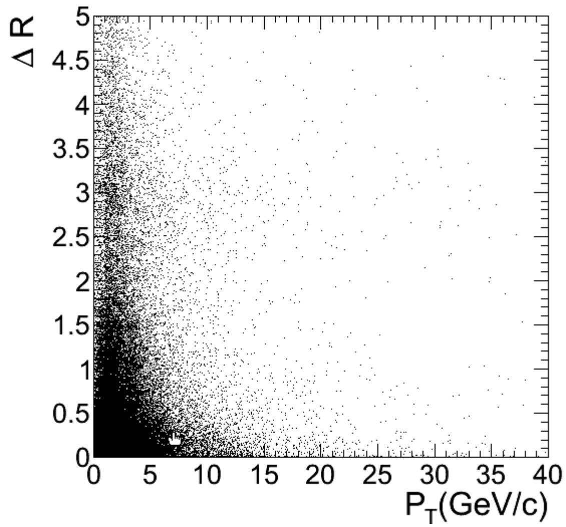

Δ R
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
0 5 10 15 20 25 30 35 40
P_T(GeV/c)

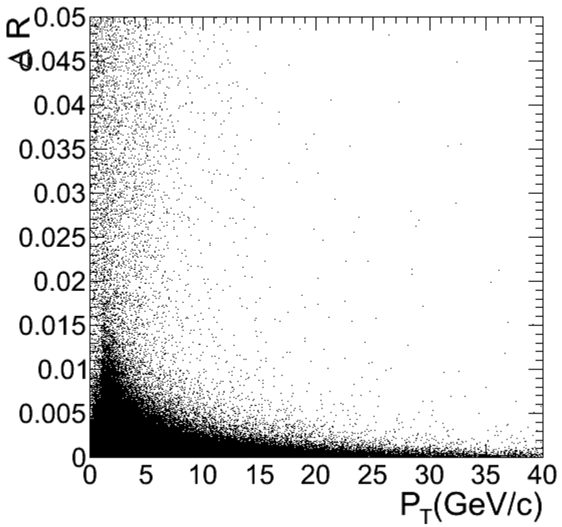

Δ R
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
0.04
0.045
0.05
0 5 10 15 20 25 30 35 40
P_T(GeV/c)

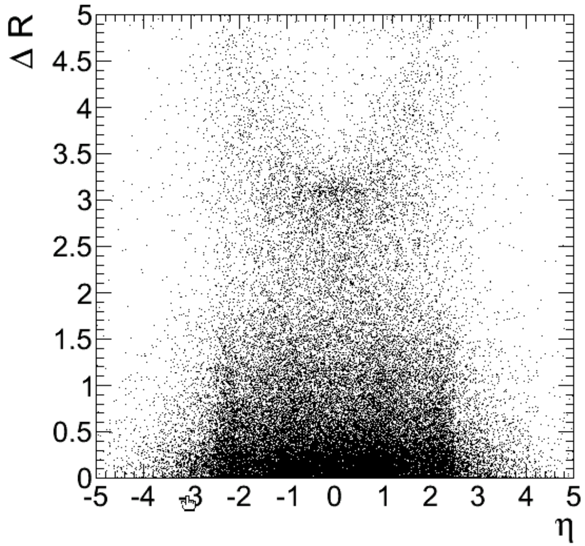

Δ R
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5
-5 -4 -3 -2 -1 0 1 2 3 4 5
η

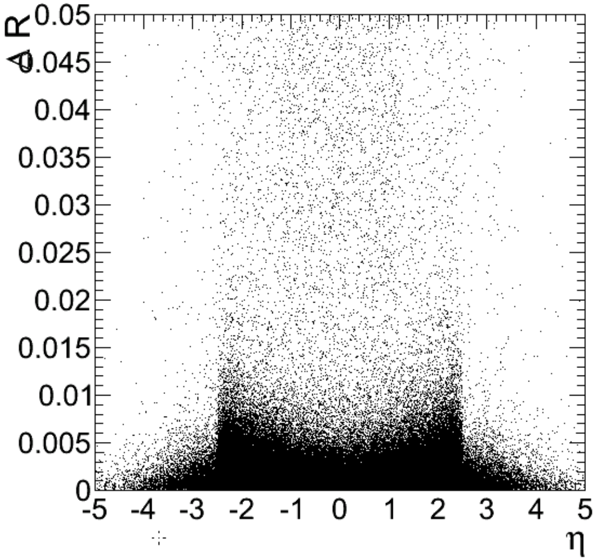

Δ R
0
0.005
0.01
0.015
0.02
0.025
0.03
0.035
0.04
0.045
0.05
-5 -4 -3 -2 -1 0 1 2 3 4 5
η

# Standalone Muon

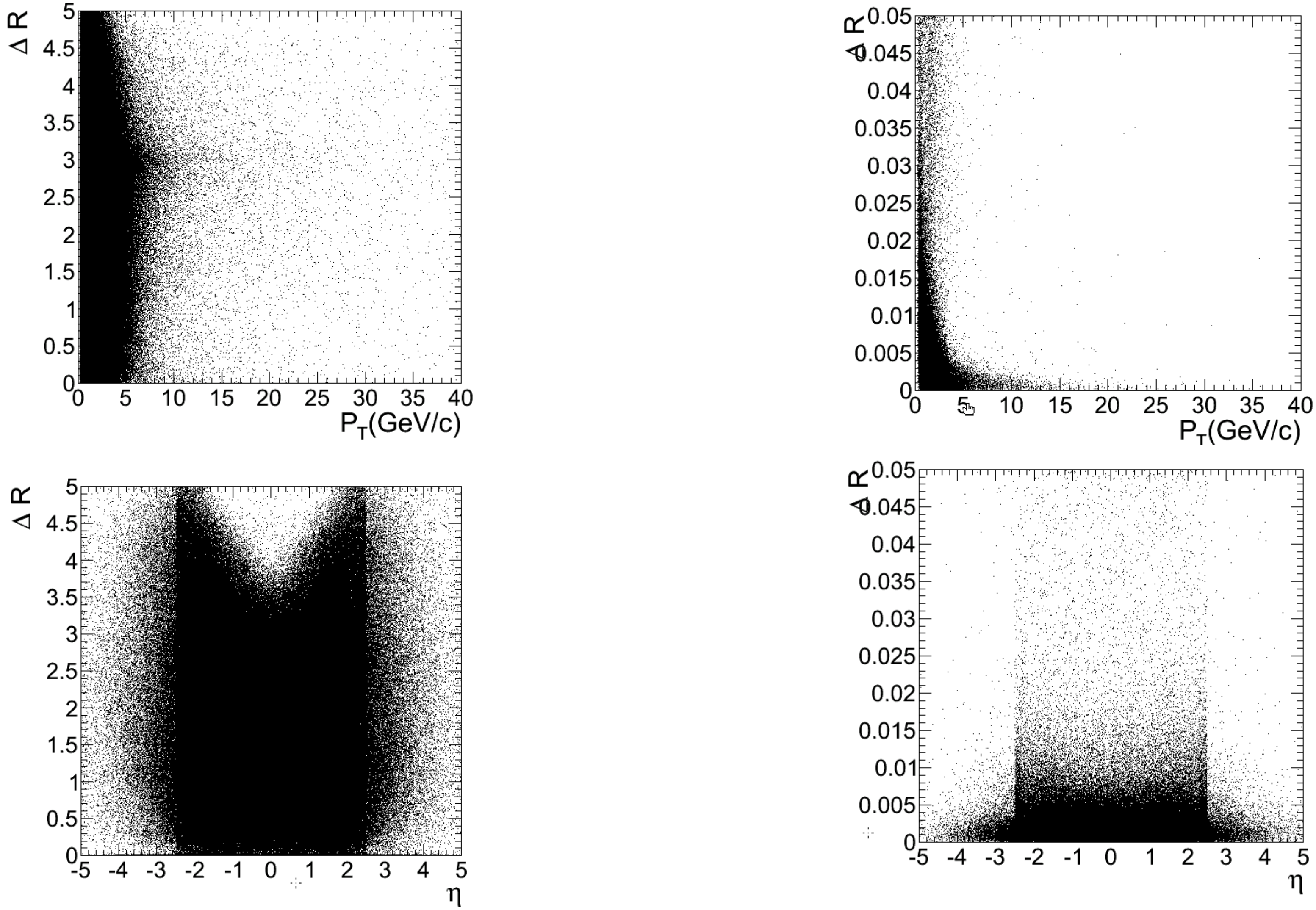


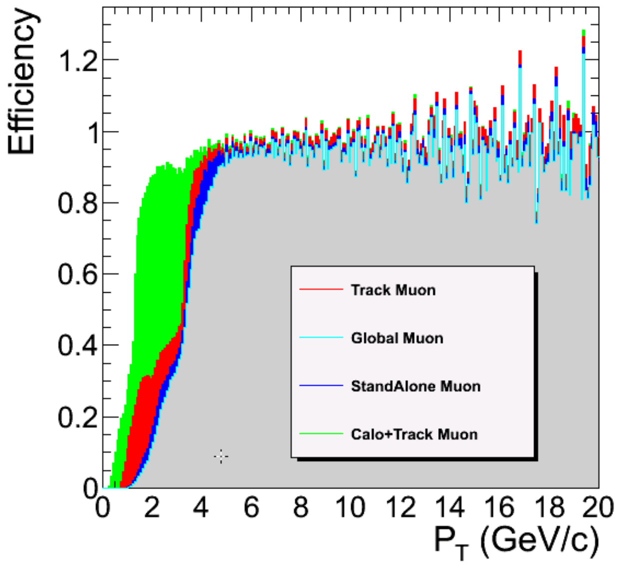



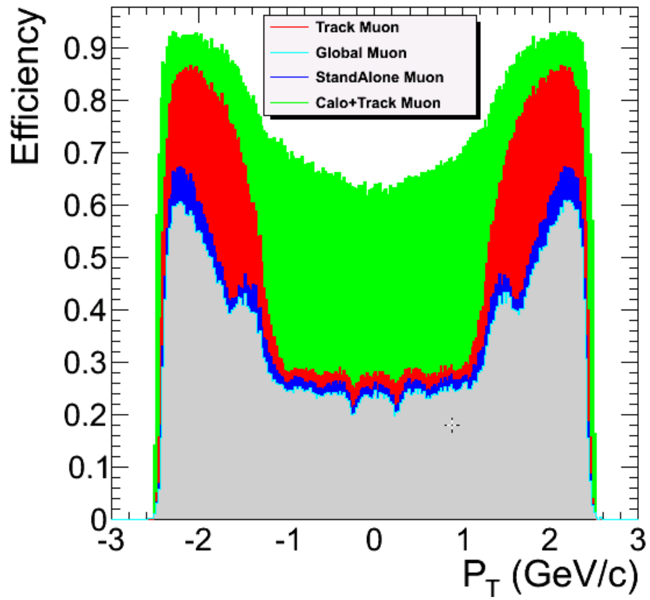



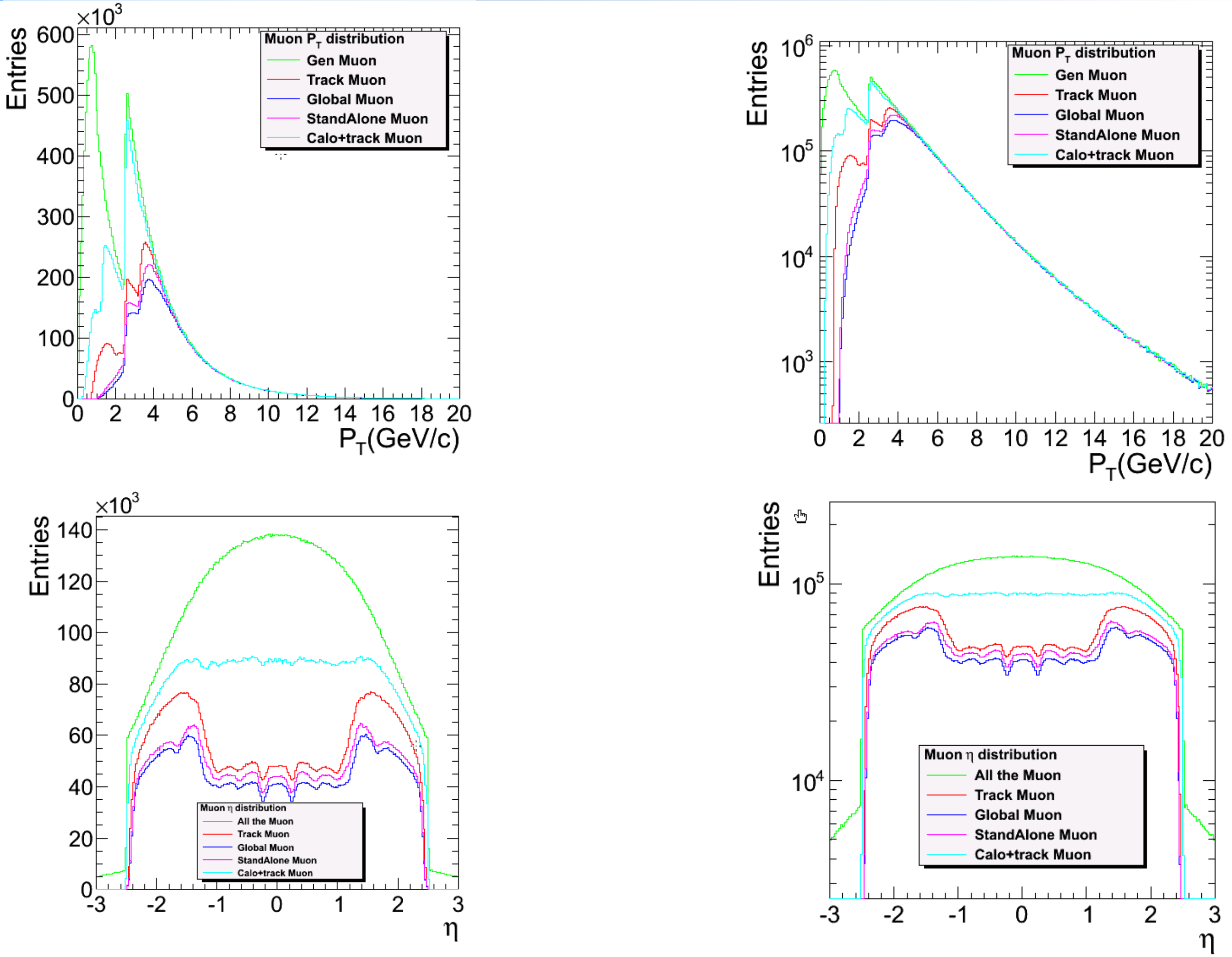
# Calo Muon


Δ R
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5
0 5 10 15 20 25 30 35 40
P_T(GeV/c)
Δ R
0 0.005 0.01 0.015 0.02 0.025 0.03 0.035 0.04 0.045 0.05
0 5 10 15 20 25 30 35 40
P_T(GeV/c)
Δ R
0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5
-5 -4 -3 -2 -1 0 1 2 3 4 5
η
Δ R
0 0.005 0.01 0.015 0.02 0.025 0.03 0.035 0.04 0.045 0.05
-5 -4 -3 -2 -1 0 1 2 3 4 5
η

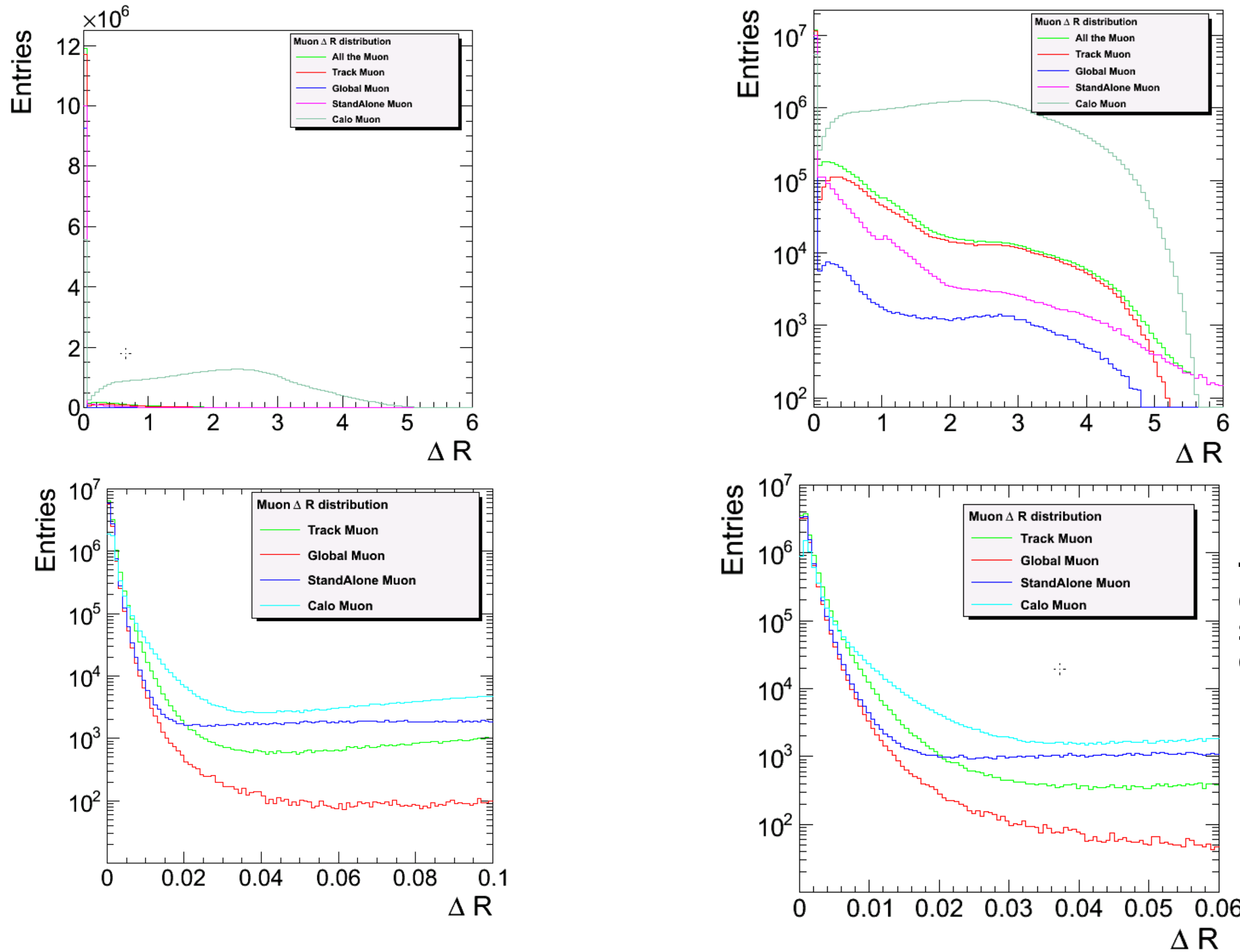

Efficiency
1.2
1
0.8
0.6
0.4
0.2
0
0
2
4
6
8
10
12
14
16
18
20
$P_T$ (GeV/c)
Track Muon
Global Muon
StandAlone Muon
Calo+Track Muon


Efficiency
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-3
-2
-1
0
1
2
3
$P_T$ (GeV/c)
Track Muon
Global Muon
StandAlone Muon
Calo+Track Muon

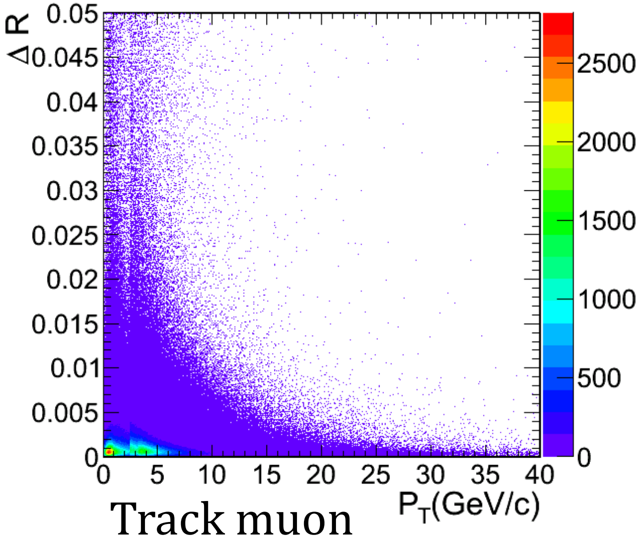
# B2JpsiMuMu analysis result



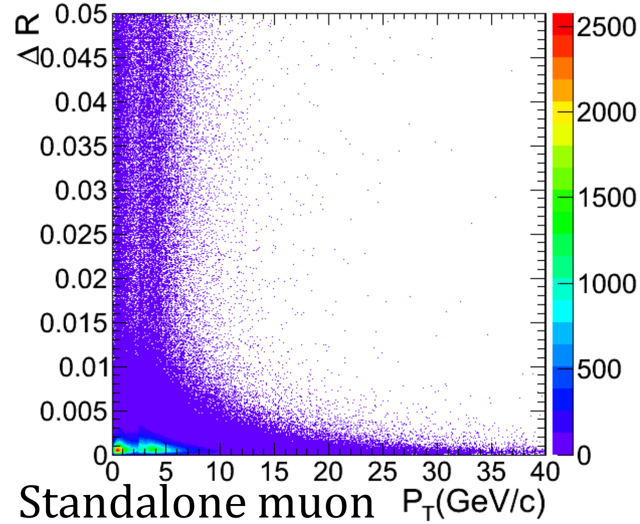
# Muon ΔR distribution



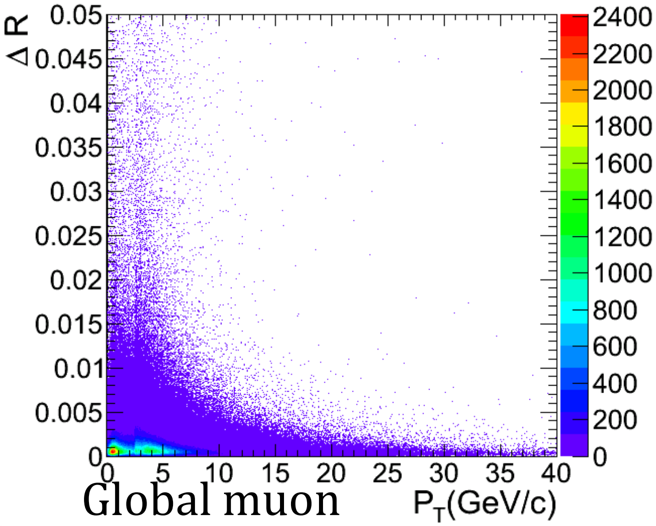

| | |
|---|---|
| Tracker | 0.025 |
| Global | 0.03 |
| Standalone | 0.015 |
| Calo | 0.03 |



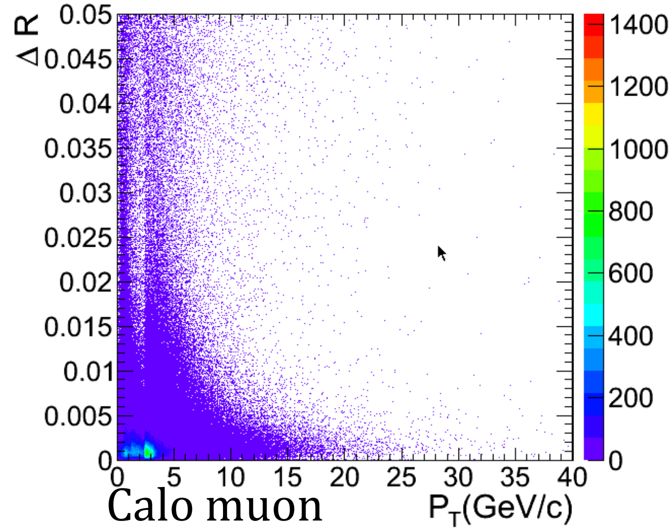

Track muon



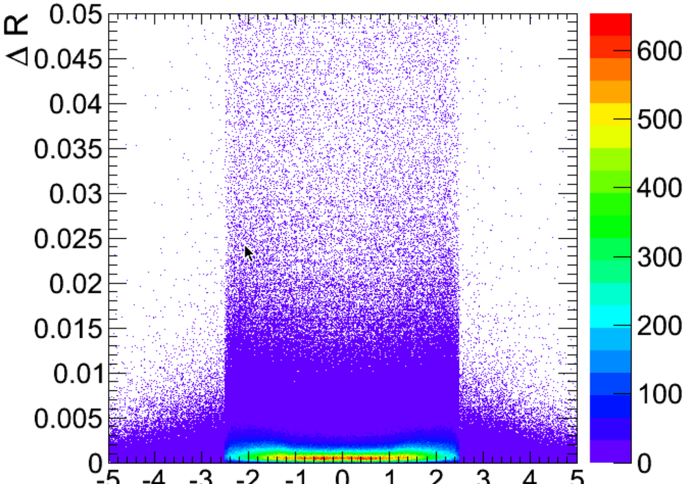

Standalone muon



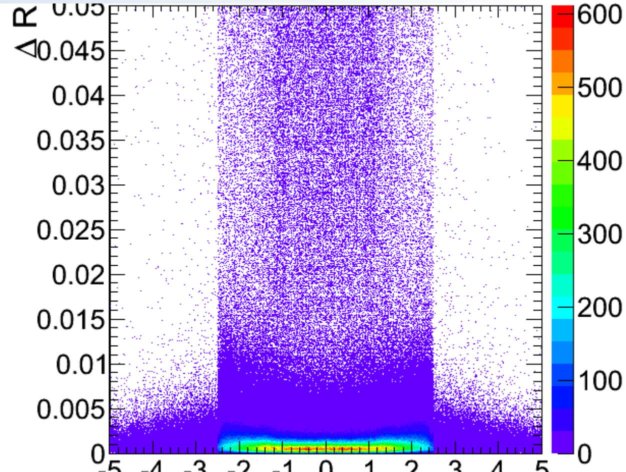

Global muon



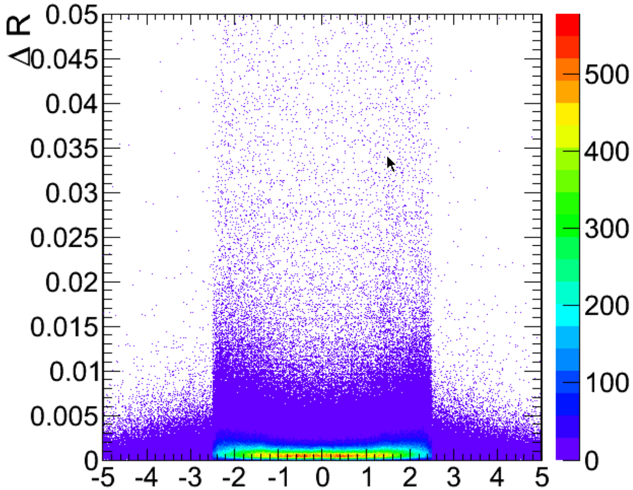

Calo muon



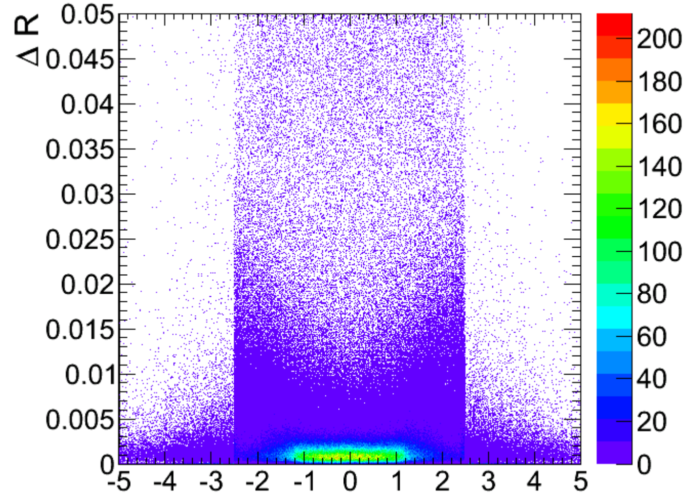
Tracker muon



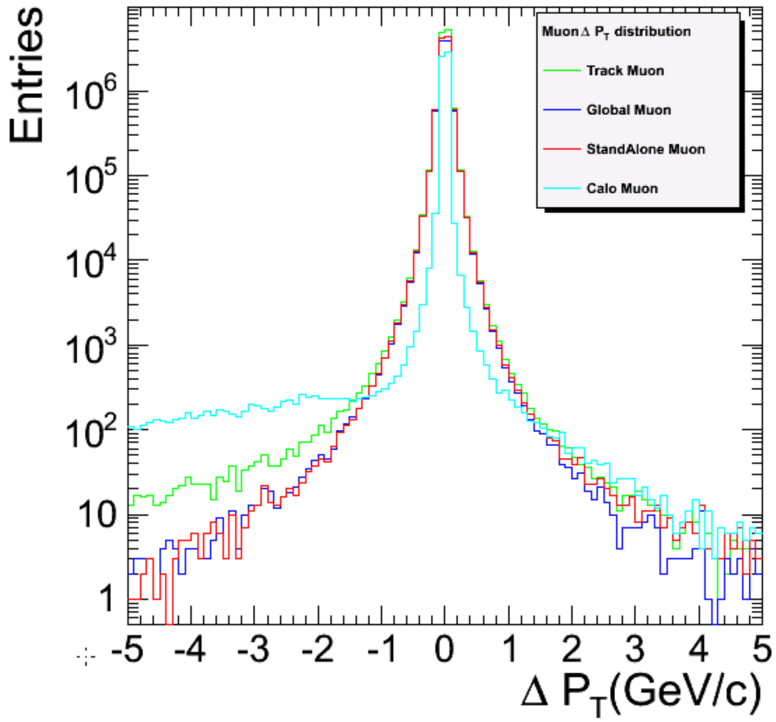
Standalone muon

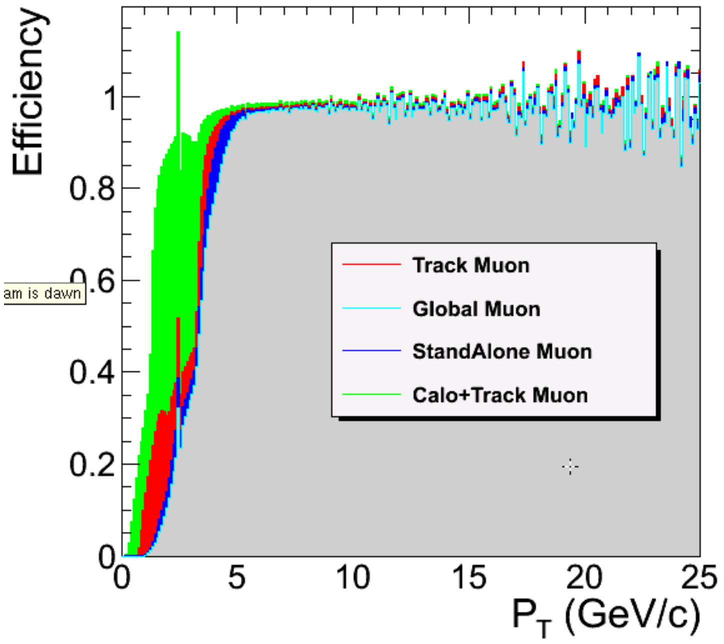


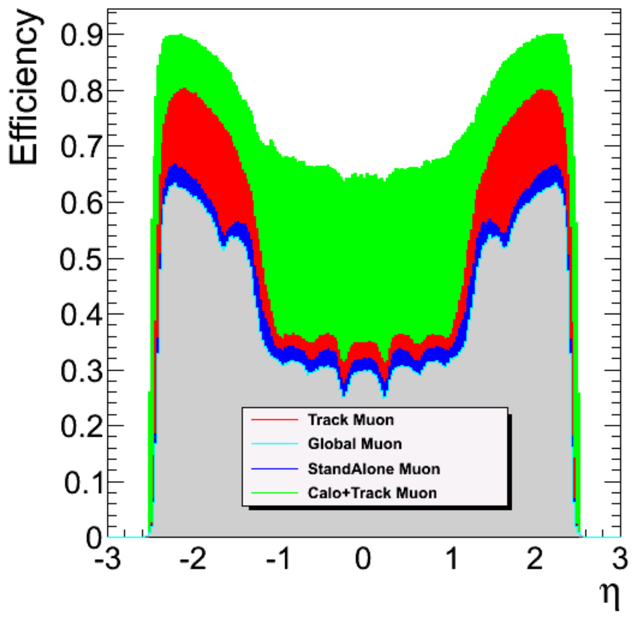
Global muon

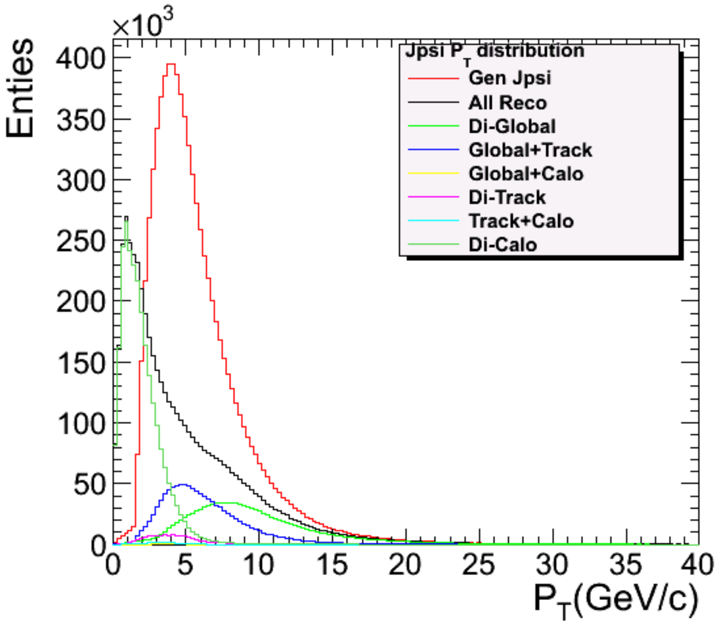


Calo muon

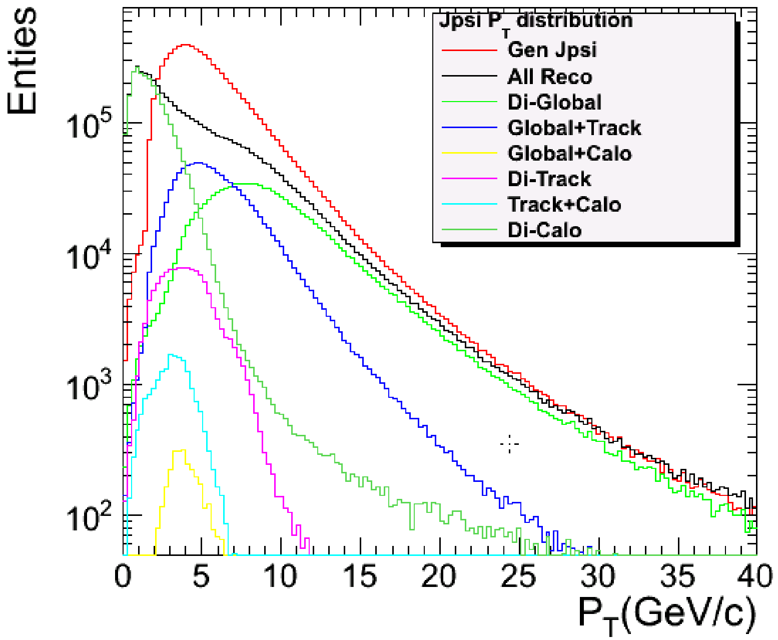

Entries
Muon Δ P_T distribution
Track Muon
Global Muon
StandAlone Muon
Calo Muon
10^6
10^5
10^4
10^3
10^2
10
1
-5 -4 -3 -2 -1 0 1 2 3 4 5
Δ P_T(GeV/c)


Efficiency
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
$P_T$ (GeV/c)
Track Muon
Global Muon
StandAlone Muon
Calo+Track Muon
am is dawn


Efficiency
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-3
-2
-1
0
1
2
3
η
Track Muon
Global Muon
StandAlone Muon
Calo+Track Muon



Enties
×10^3
400
350
300
250
200
150
100
50
0
0 5 10 15 20 25 30 35 40
P_T(GeV/c)
Jpsi P_T distribution
Gen Jpsi
All Reco
Di-Global
Global+Track
Global+Calo
Di-Track
Track+Calo
Di-Calo

Enties
10^5
10^4
10^3
10^2
0 5 10 15 20 25 30 35 40
P_T(GeV/c)
Jpsi P_T distribution
Gen Jpsi
All Reco
Di-Global
Global+Track
Global+Calo
Di-Track
Track+Calo
Di-Calo

# Next step

- Jpsi reconstruction efficiency.
- Fit validation.
- Use track muon to analyze Bc->J/psimunu
- Bc->J/psi Pi analysis.
- Low pt track muon and cola muon analysis in CMSSW_3_1_x.

# Thank you!