SAME SIDE TAGGING
for B meson decays

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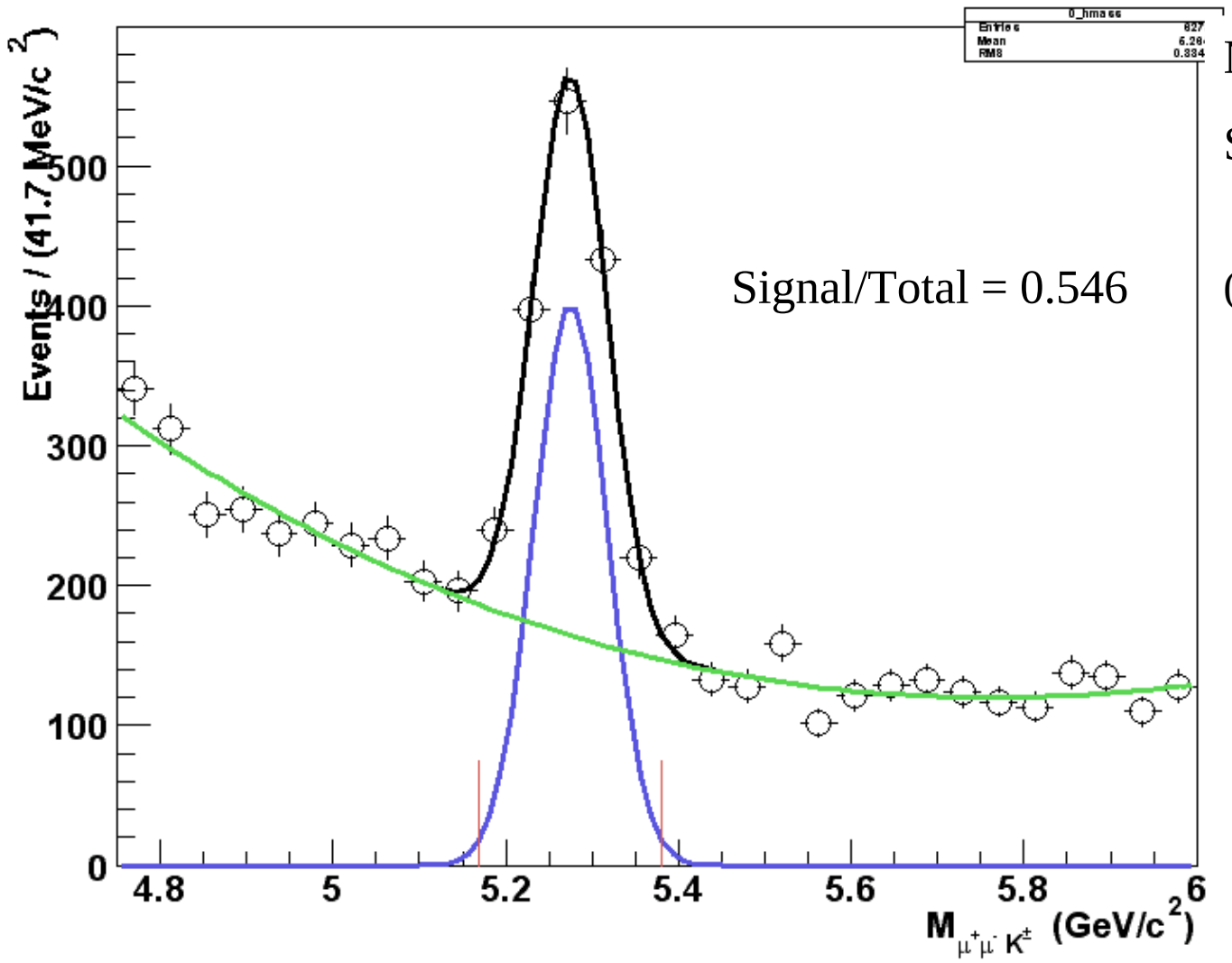
Data Sample

- **Skim file of all the J/Y candidate events for set 1-21, ~ 114 pb^{-1}**
- **To get $B^{\pm}$ vertex we used d0root_btag V7.0**
- **Muon p_T cut is 1.5**
- **New Branch ATRK added, which stores all track information**
  - **maximum 150 track per event, with $p_T > 0.251$**

$B^{\pm}$ event selection

- **After making $B^{\pm}$ vertex using d0root_btag following additional cuts are applied**
  - **J/Y Cuts: p_T ³ 1.5, # of SMT hits ³ 1 (on both tracks),**
    $2.8 < M_{mm} < 3.3$ Gev, $c^2 < 10$
  - **$K^{\pm}$ Cuts: chi2vtx < 10, # of hits ³ 0, $p_T > 1.0$**
  - **$B^{\pm}$ Cuts: $c^2 < 20$, collin. > 0.9, dl_sig > 4.5**

B – mass plot after selection



Mean = 5.27429

Sigma = 0.042442

(Mean ± 2.5 Sigma)

Total = 1852

Signal = 1012

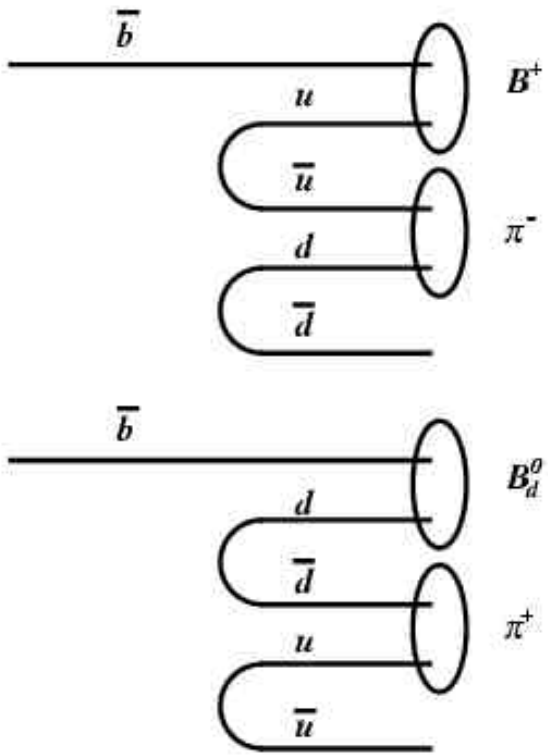
Bkgd = 840

S/B = 1.204

S/T = 0.546

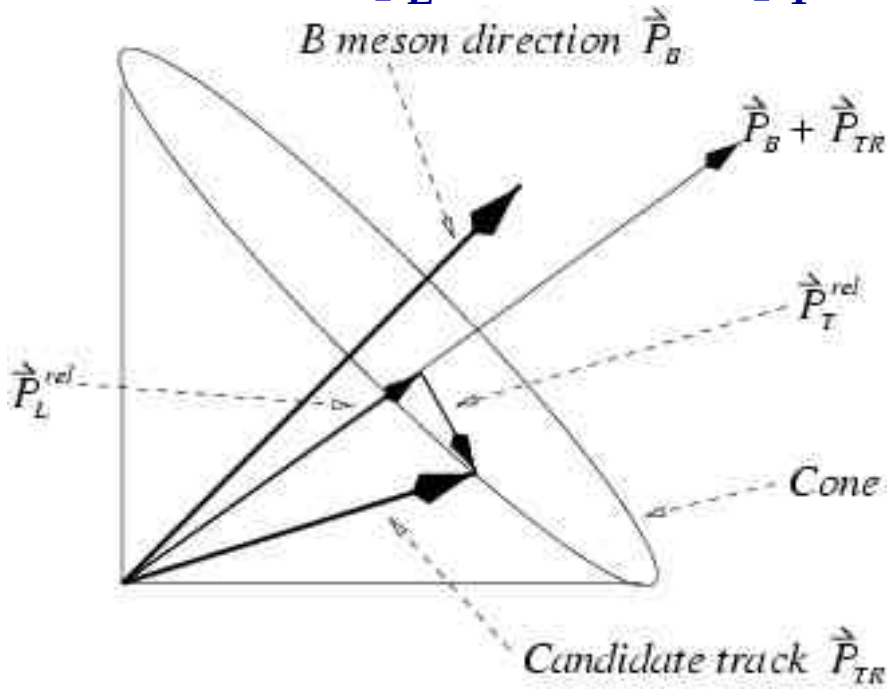
Same Side Tagging

- *In same side tagging we exploit the flavor-charge correlation, to tag initial b-flavor.*
- *Correlation of charged particles is expected to arise from pion, produced along with the B – meson, in the fragmentation chain, and from B** decay*



Simple picture of fragmentation paths for a b-bar quark

- **One can try many variables to tag initial b – flavor, in same side tagging method, based on fragmentation model**
- **We tried following variables (in the vicinity of B-meson) to tag the event from the candidate tracks**
  - **Maximum p_T track**
  - **Minimum dR between B – meson and the candidate track**
  - **Minimum (B–meson + track) mass**
  - **Minimum of p_T^{rel}**
  - **Minimum of p_L^{rel} , where p_T^{rel} and p_L^{rel} are defined below**



Drawing of the momentum vectors determining p_T^{rel} and p_L^{rel} of an SST candidate track

Algorithm

- We start with all tracks in a event having $B^{\pm}$
  - Removing all the muon tracks, and $K^{\pm}$ tracks (used to make $B^{\pm}$ vertex) from all track bank
  - Applying track quality cut, i.e. track must have atleast 2 SMT and 3 CFT hists
- Choosing only those tracks which are inside dR < 0.7 cone, around B-meson direction, these tracks are called candidate tracks
- Among candidate tracks, selecting a track(tag track) for each method
- Returning the charge of the tagged track, say Q_t
  - If $Q_t = -Q_k$ ➔ correctly tagged B,

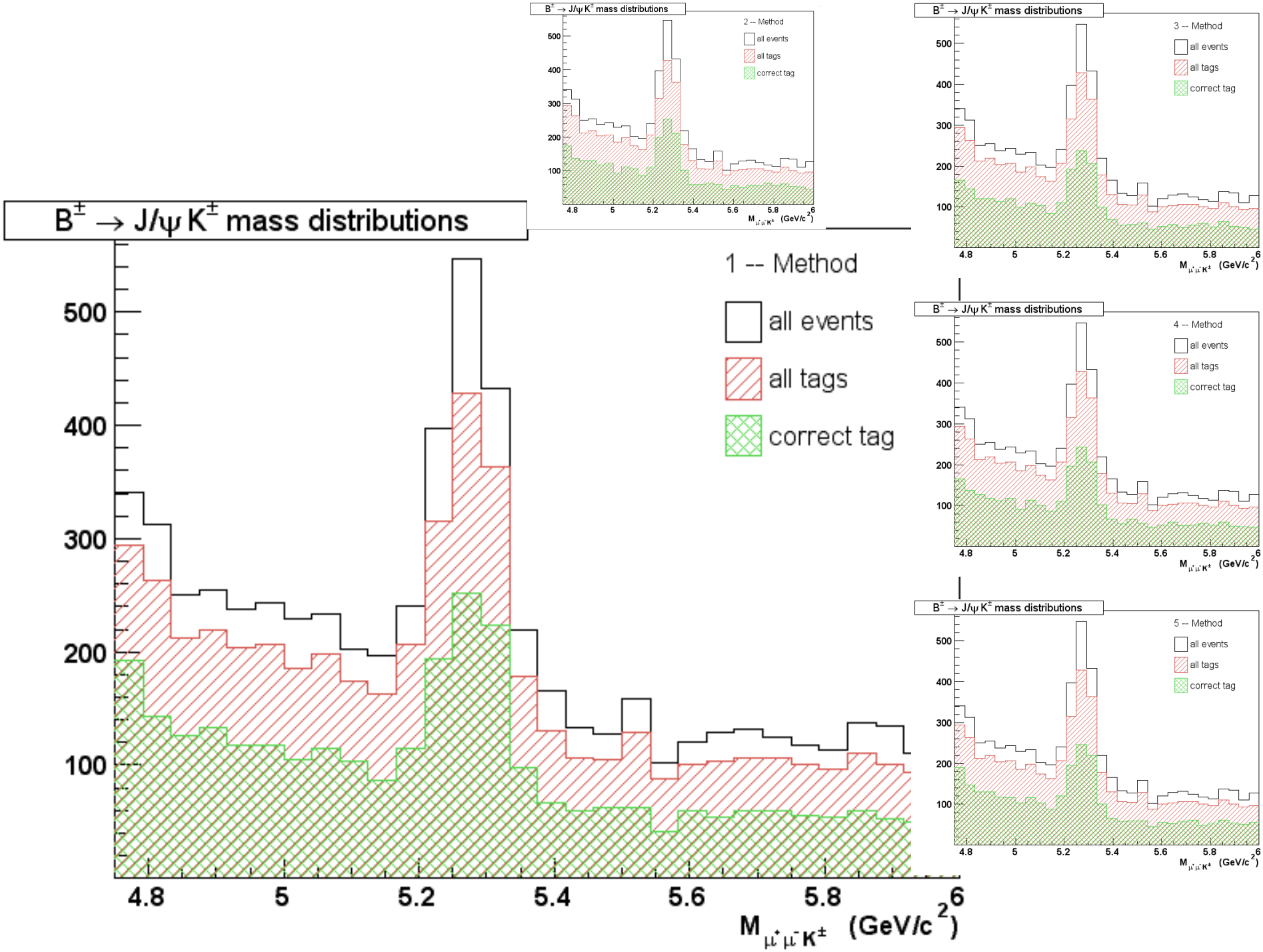
    $Q_t = Q_k$ ➔ wrong tagged B, otherwise ➔ untagged B
- Filling the histos for each case, after fitting calculating total number of events, correct tagged events, wrong tagged events and untagged events (N_T, N_C, N_W & N_U)

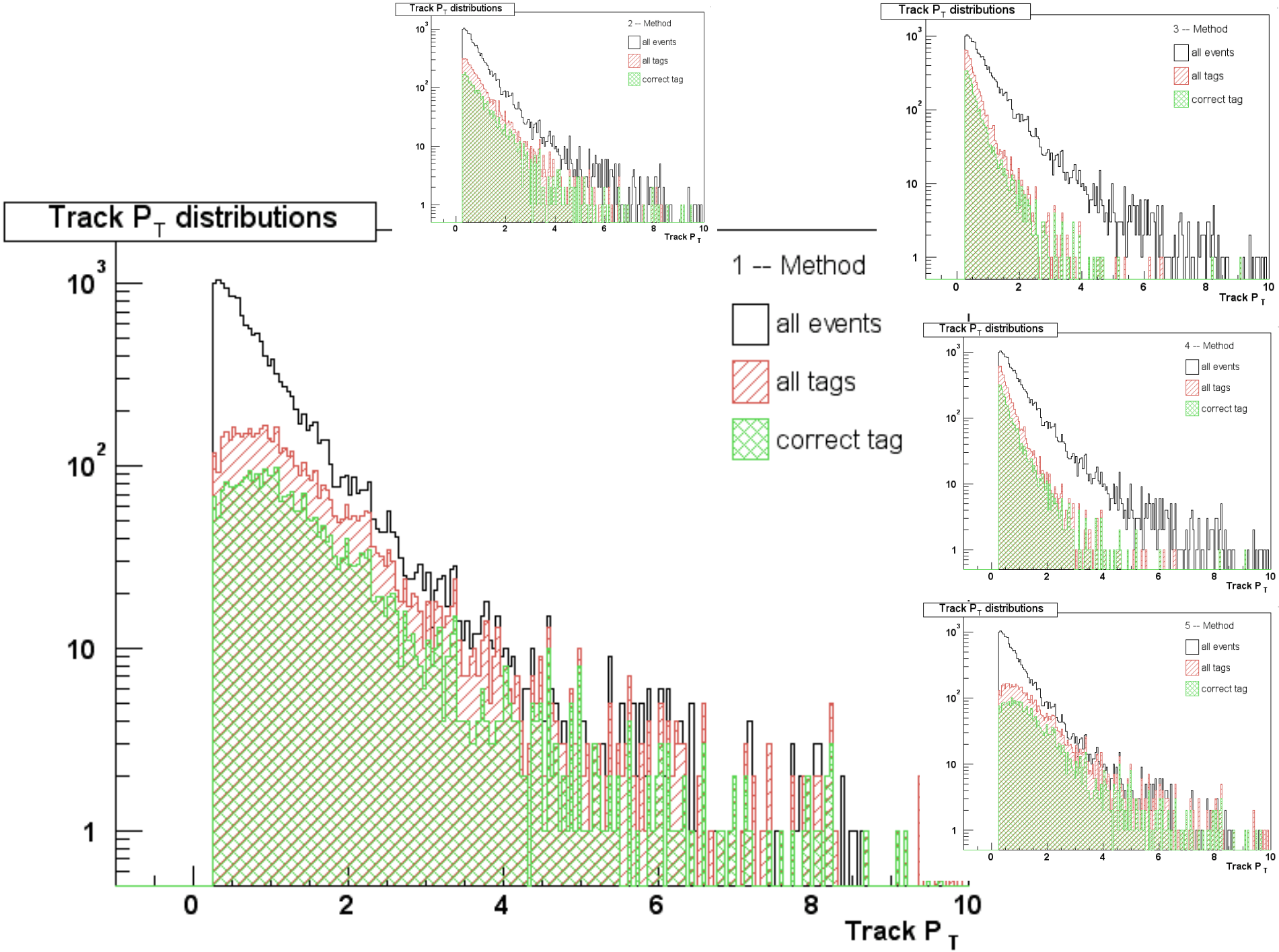
$$\text{Dilution(D)} = (N_C - N_W) / (N_C + N_W)$$

$$\text{efficiency(e)} = (N_C + N_W) / N_T$$

$$\text{Tagging Power(TP)} = eD^2$$

$$\text{Merit} = \text{Sqrt}(TP*S*S / (S+B))$$


B± → J/ψ K± mass distributions
1 -- Method
all events
all tags
correct tag
500
400
300
200
100
4.8
5
5.2
5.4
5.6
5.8
6
M μ+μ- K± (GeV/c 2)
2 -- Method
3 -- Method
4 -- Method
5 -- Method


Track P_T distributions
1 -- Method
all events
all tags
correct tag
Track P_T
2 -- Method
3 -- Method
4 -- Method
5 -- Method

Cone size -- 0.7

(Method) Tagged with	Total # Of events	Correctly tagged events	Wrong tagged events	ε (%) (error)	D (%) (error)	εD^2(%) (error)
Max. p_T track	1012	500	291	79.2 (2.1)	26.4 (4.8)	5.5 (2.0)
Min. dR	1012	501	302	79.2 (2.1)	24.8 (4.7)	4.9 (1.8)
Min. (B+ trk) mass	1012	471	329	79.2 (2.1)	17.8 (4.8)	2.5 (1.3)
Min. $\mathbf{p_T^{rel}}$	1012	483	321	79.2 (2.1)	20.1 (4.7)	3.2 (1.5)
Max. $\mathbf{p_L^{rel}}$	1012	497	304	79.2 (2.1)	24.1 (4.7)	4.6 (1.8)

Attempt to match the CDF analysis

- **We are already applying following cuts**
  - **J/Y Cuts:** p_T ³ 1.5, # of SMT hits ³ 1 (on both tracks),
    2.8 < M_{mm} < 3.3 Gev, c^2 < 10
  - **$K^{\pm}$ Cuts:** chi2vtx < 10, # of hits ³ 0, p_T > 1.0
  - **$B^{\pm}$ Cuts:** c^2 < 20, collin. > 0.9, dl_sig > 4.5

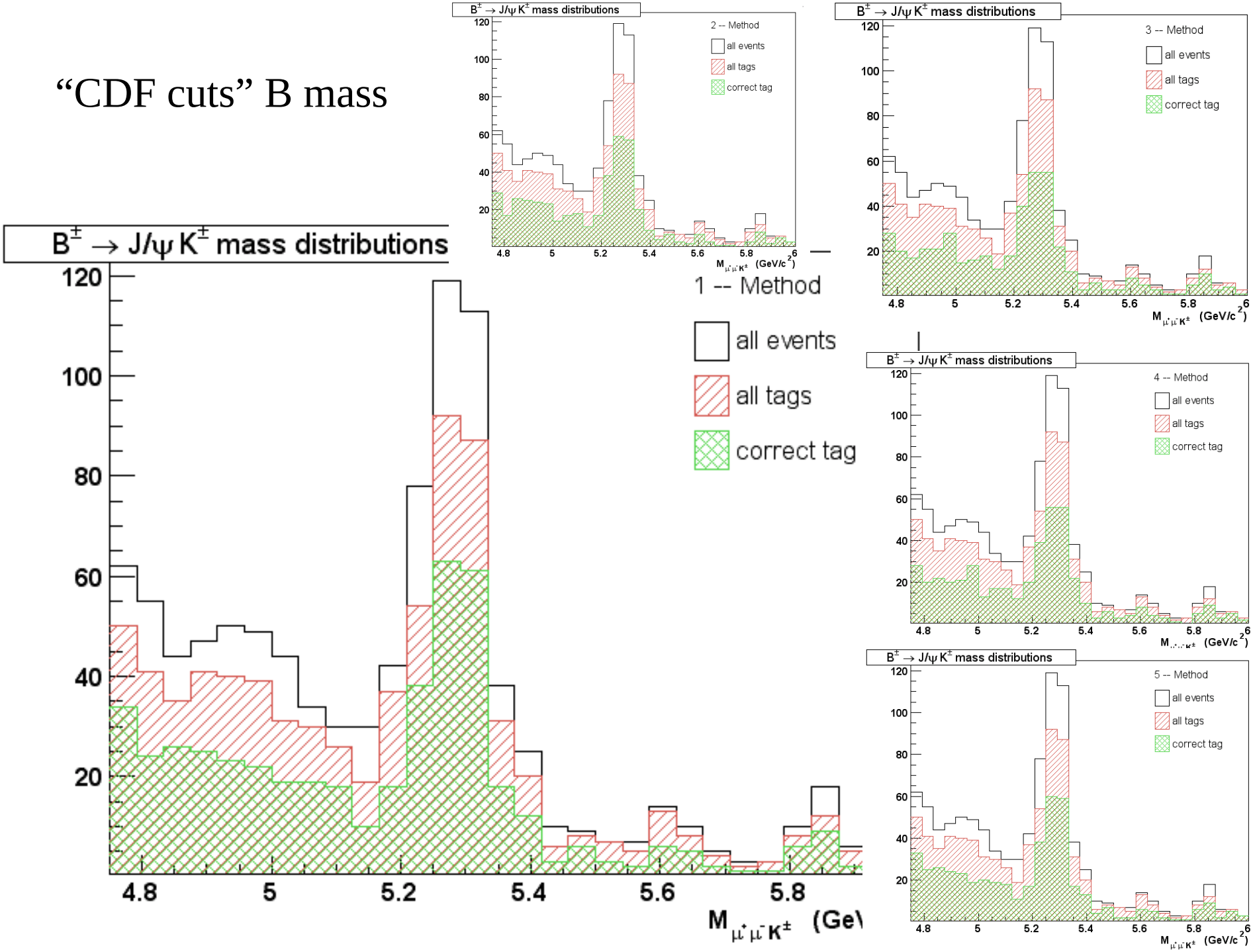
- **On top of above cuts, we applied following additional cuts to match CDF cuts**
  - **J/Y Cuts:** |h| of both the muons < 1.1
  - **$K^{\pm}$ Cuts:** p_T > 1.75 & |h| < 1.1
  - **$B^{\pm}$ Cuts:** p_T > 4.5
  - **All tracks:** must have p_T > 0.4 & |h| < 1.1

“CDF Cuts” results

Cone size -- 0.7

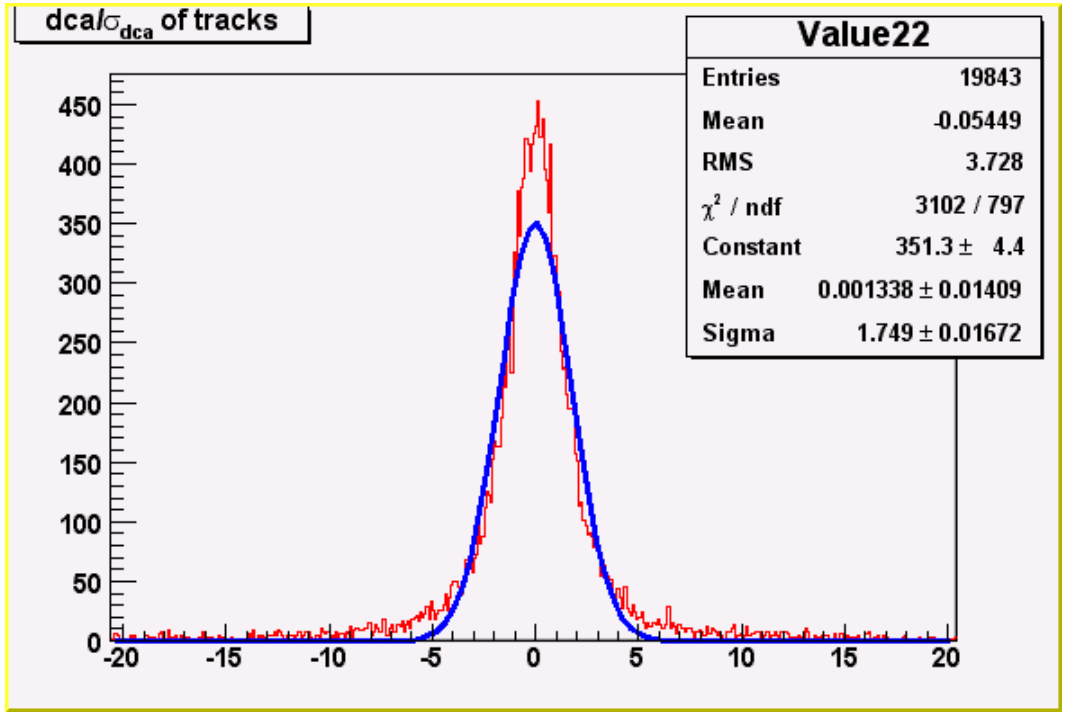
(Method) Tagged with	Total # Of events	Correctly tagged events	Wrong tagged events	ε (%) (error)	D (%) (error)	εD^2(%) (error)
Max. p_T track	296	157	64	75.3 (3.7)	41.9 (7.4)	13.2 (4.7)
Min. dR	296	149	77	75.3 (3.7)	31.5 (7.4)	7.5 (3.5)
Min. (B+ trk) mass	296	148	73	75.3 (3.7)	33.9 (7.2)	8.7 (3.7)
Min. $\mathbf{p_T^{rel}}$	296	151	74	75.3 (3.7)	33.8 (7.4)	8.6 (3.8)
Max. $\mathbf{p_L^{rel}}$	296	149	75	75.3 (3.7)	32.8 (7.2)	8.1 (3.8)

“CDF cuts” B mass



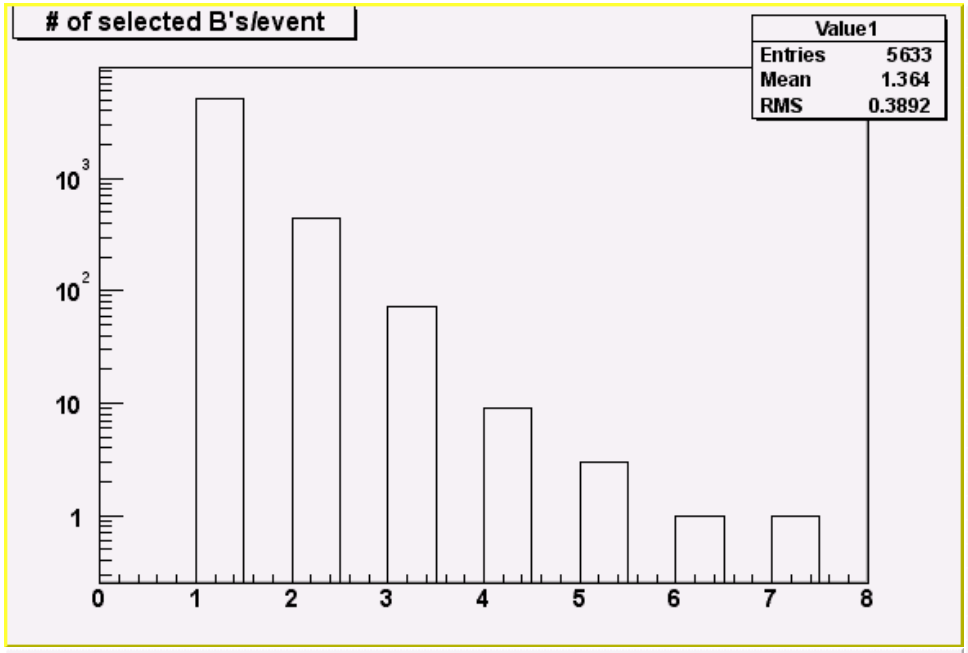
Recent Work on the Analysis

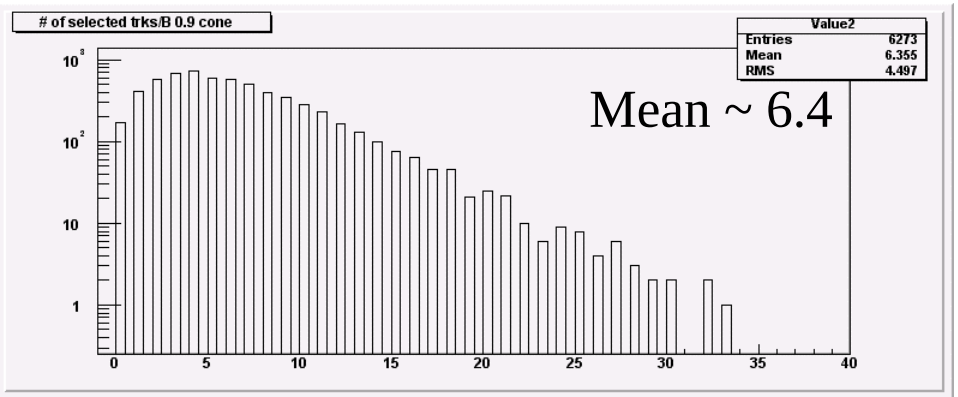
- **We were running d0root_btag V7**
  - **Some known problems**
  - **e=79.4%, D_1=26.4%, eD^2=5.5%**
- **Ran with V8 of d0root_btag**
  - **e=84.0%, D_1=25.8%, eD^2=5.6%**
- **With dca/sigdca<4, zca<5cm**
  - **Really a 2.3 sigma cut (see plot)**
  - **e=76.1%, D_1=26.8%, eD^2=5.5%**

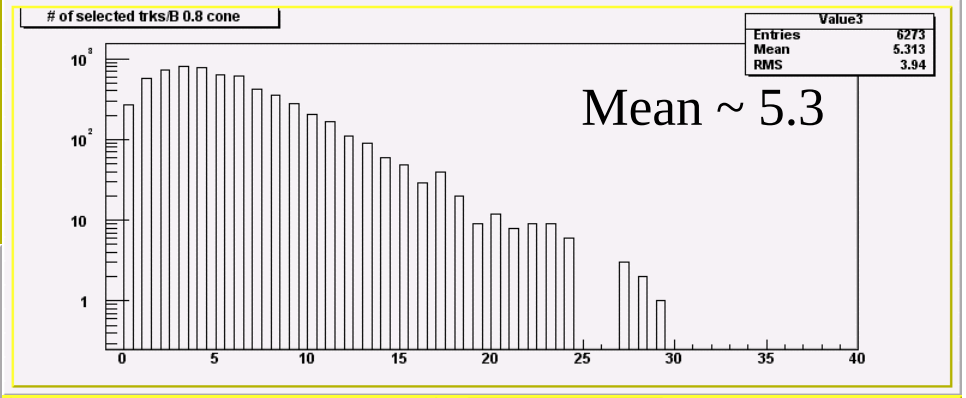


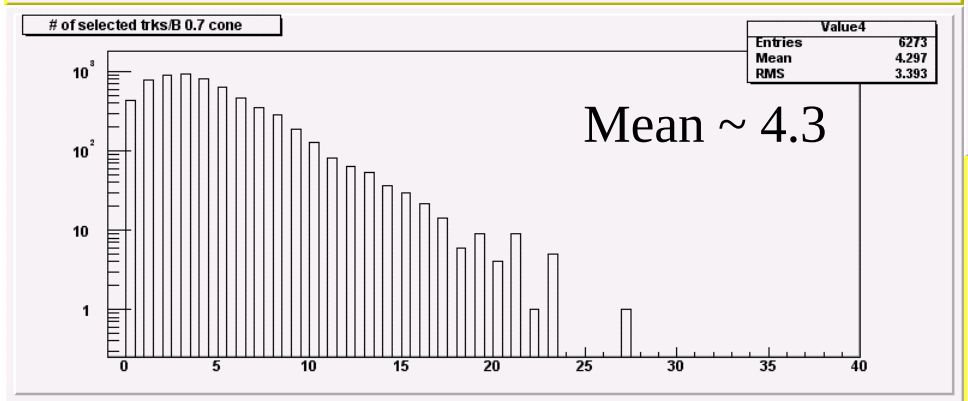
Summary/Outlook

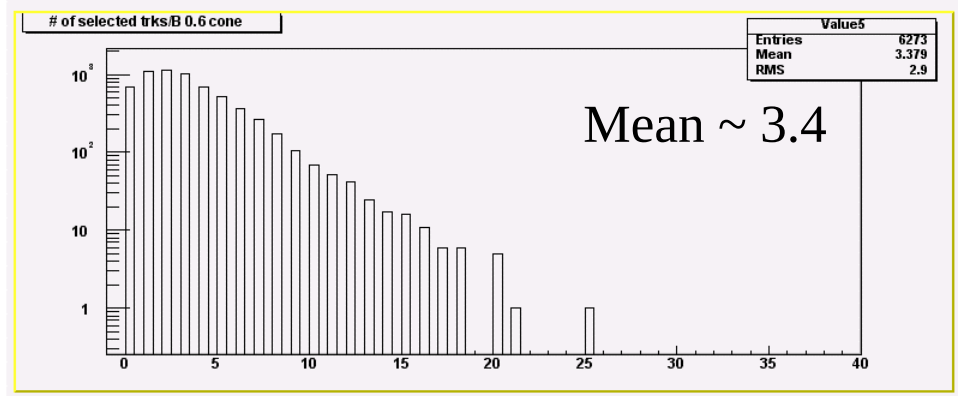
- **We are getting good efficiency (~79%) with 0.7 cone size and eD^2 is ~3.0 % (average of all method)**
- **We need to understand, why there is a significant difference between tagging with (B+track) mass and other methods**
  - **High p_T tags are more effective, as expected**
  - **Maximum p_L rel. should in theory be best, but max p_T is better**
  - **We need to understand "CDF Run I cuts" results – Why so much better?**
- **Refining analysis**
  - **Ran with V8 of d0root_btag: e=84.0%, D_1=25.8%, eD^2=5.6%**
  - **With dca/sigdca<4, zca<5cm: e=76.1%, D_1=26.8%, eD^2=5.5%**
- **Code is being integrated into bflavor_tag package**
- **Working on Monte Carlo**
  - **B spectrum is too soft**
  - **Tag track spectrum is too soft**

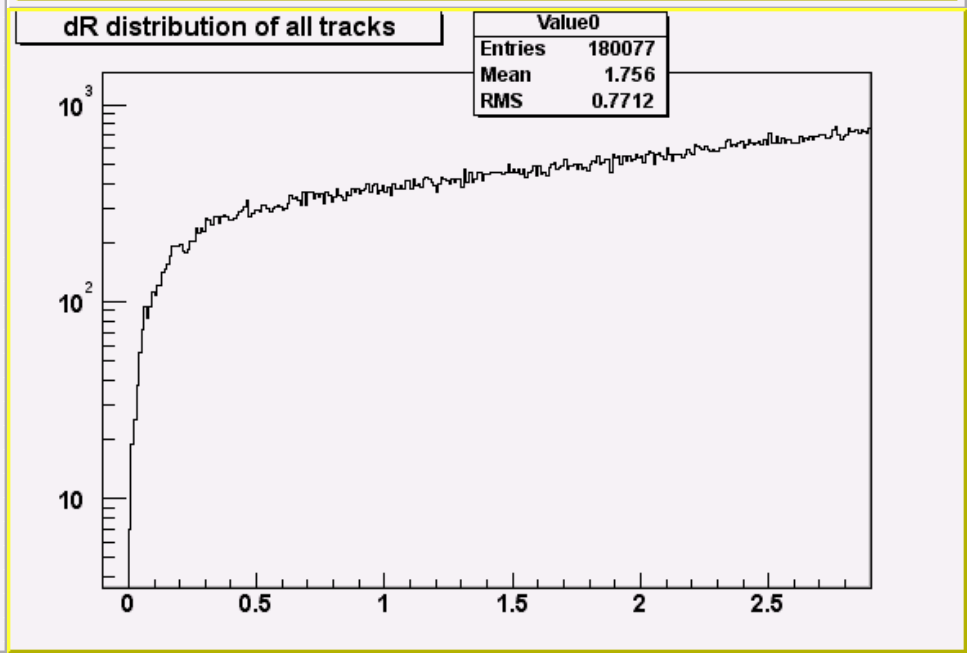

# of selected B's/event
Value1
Entries 5633
Mean 1.364
RMS 0.3892

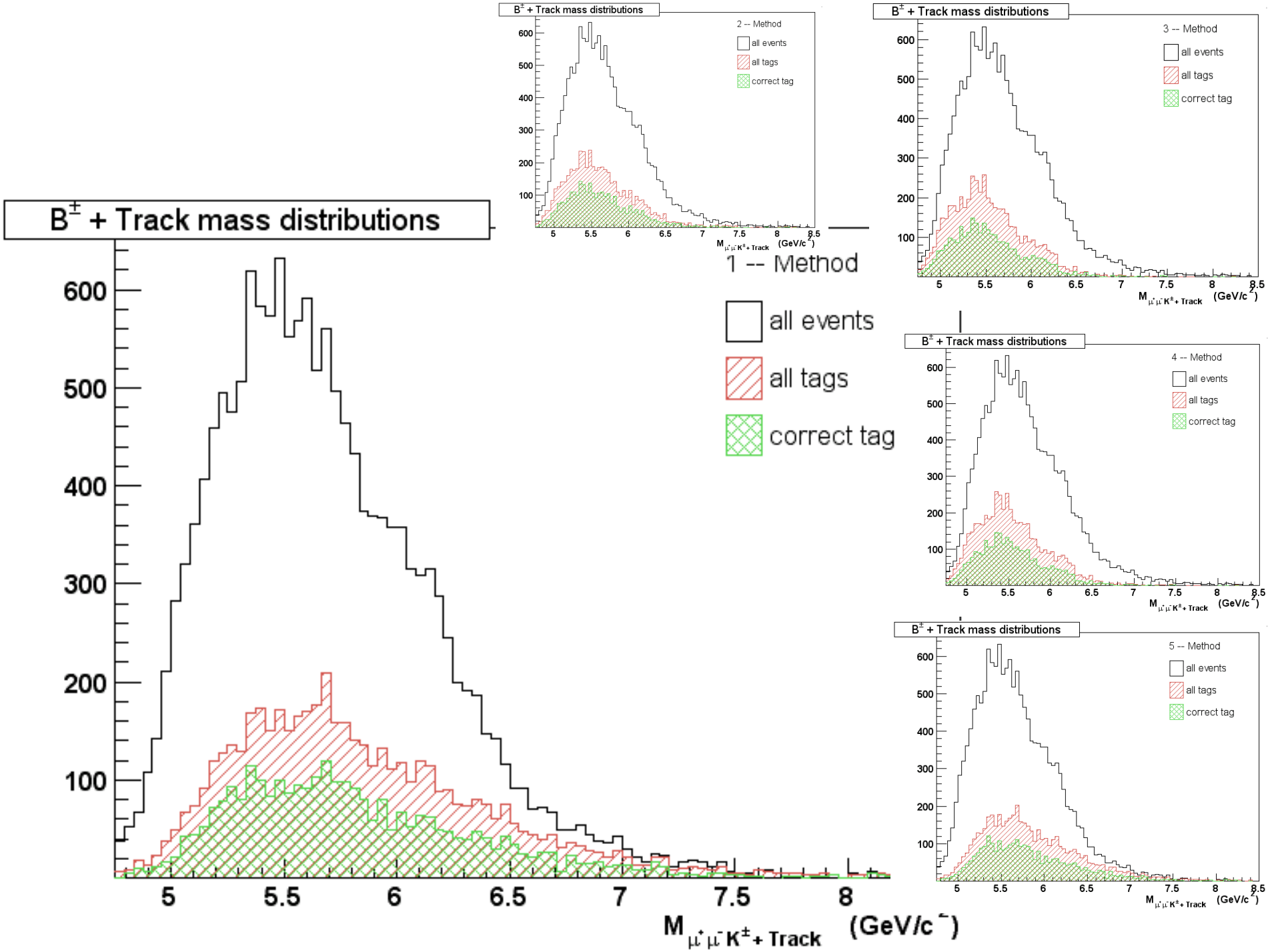

# of selected trks/B 0.9 cone
Value2
Entries 6273
Mean 6.355
RMS 4.497
Mean ~ 6.4

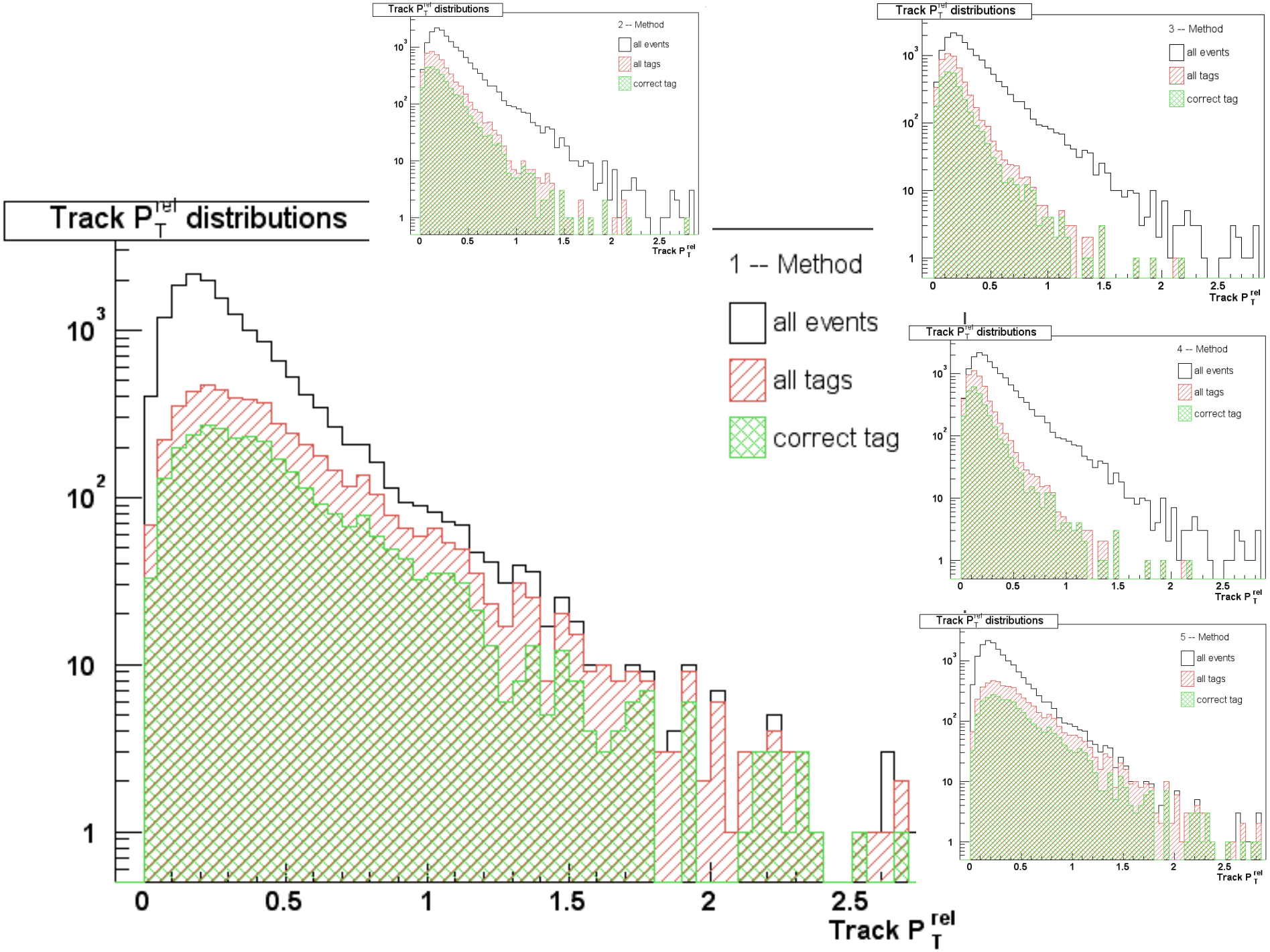

# of selected trks/B 0.8 cone
Value3
Entries 6273
Mean 5.313
RMS 3.94
Mean ~ 5.3

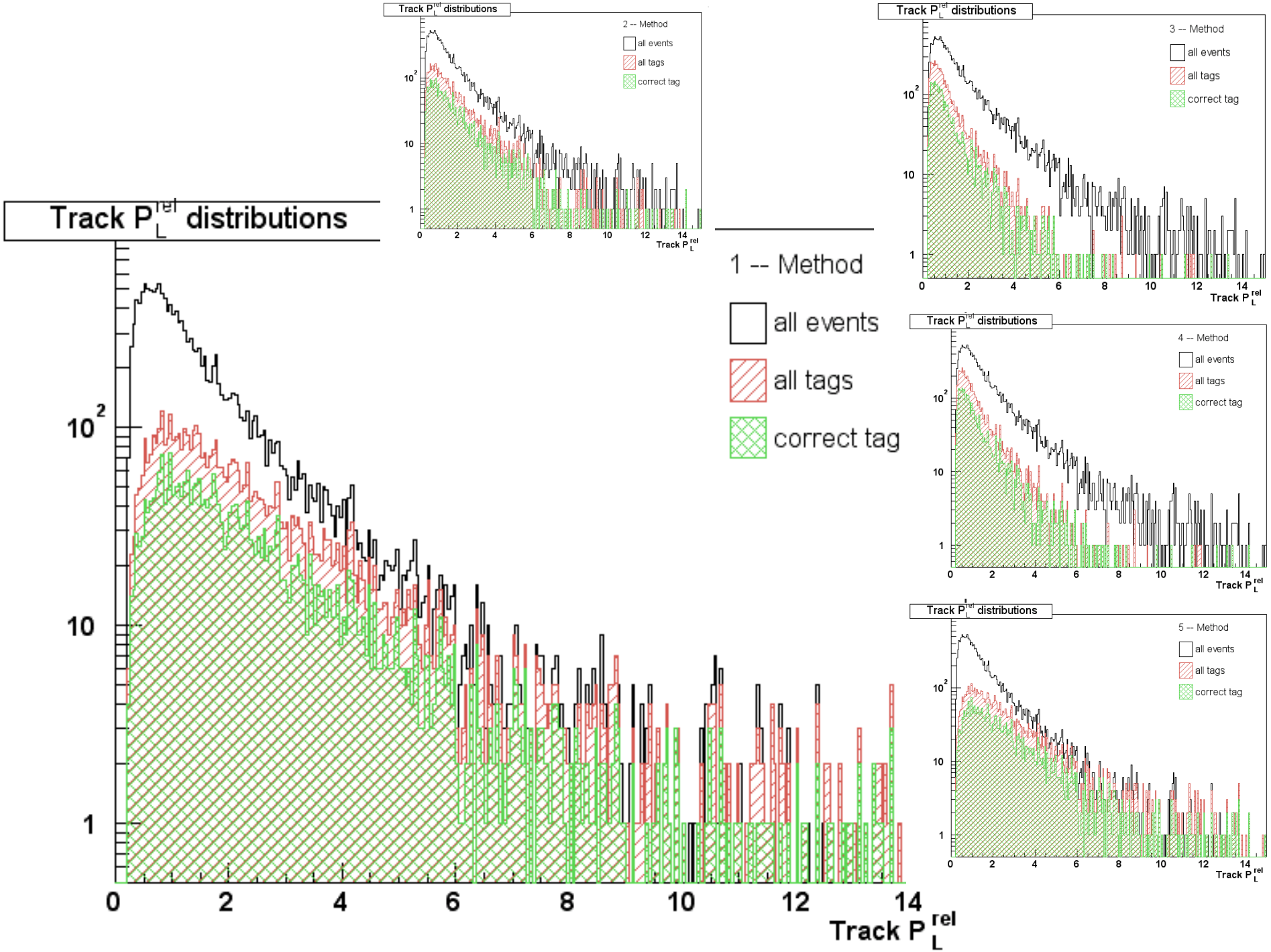

# of selected trks/B 0.7 cone
Value4
Entries 6273
Mean 4.297
RMS 3.393
Mean ~ 4.3

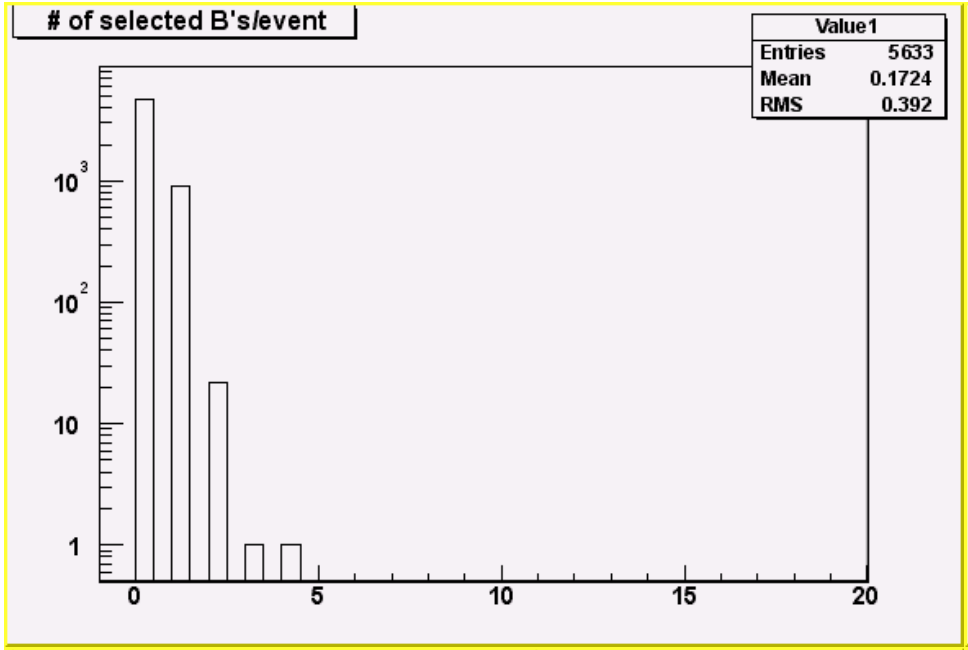

# of selected trks/B 0.6 cone
Value5
Entries 6273
Mean 3.379
RMS 2.9
Mean ~ 3.4

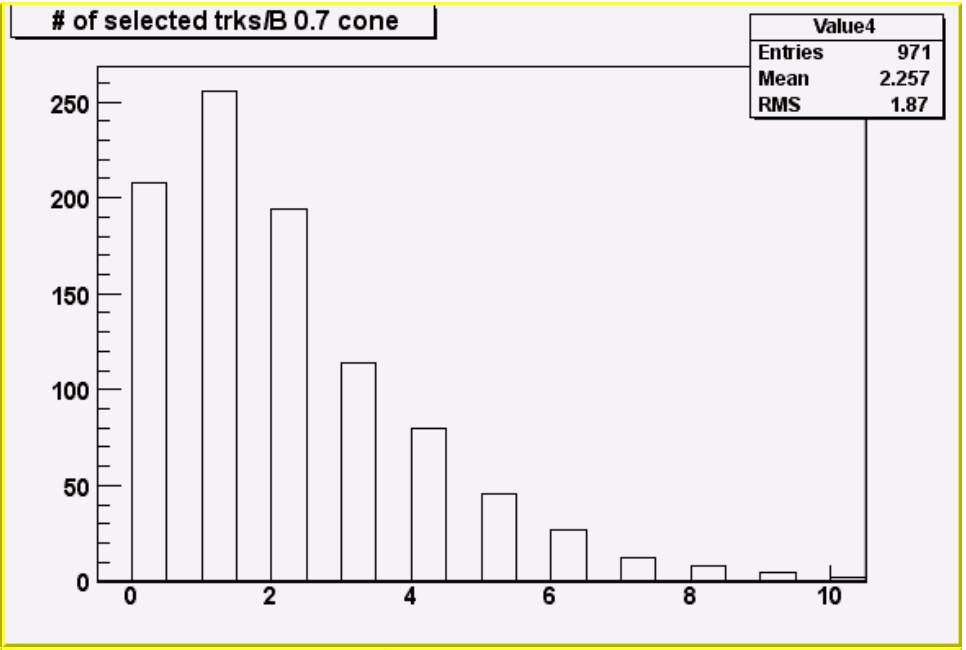

dR distribution of all tracks
Value0
Entries 180077
Mean 1.756
RMS 0.7712

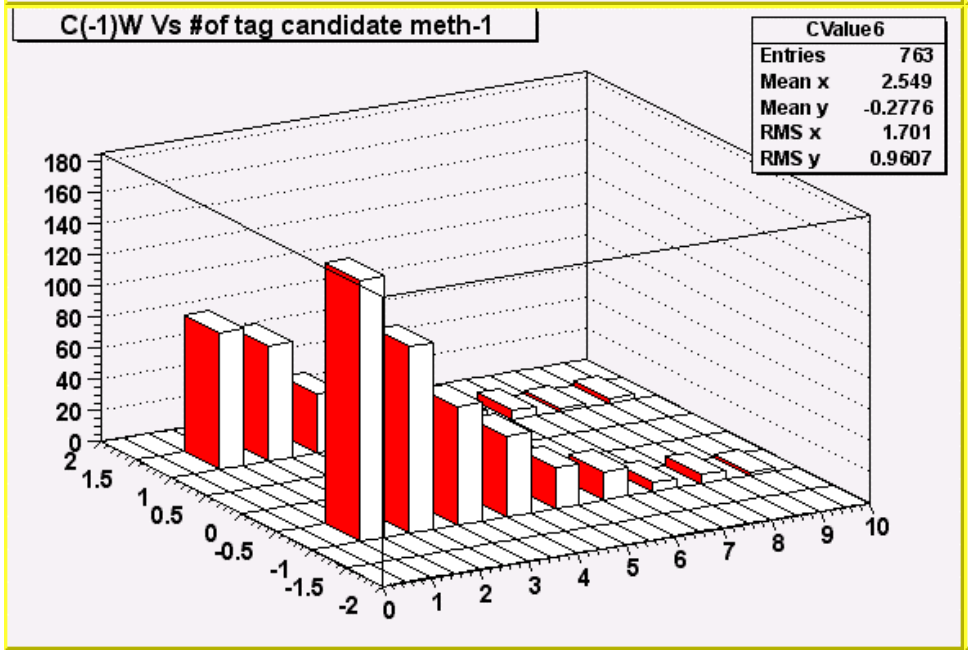

B± + Track mass distributions
1 -- Method
all events
all tags
correct tag
600
500
400
300
200
100
5
5.5
6
6.5
7
7.5
8
M μ+μ-K±+ Track (GeV/c²)
B± + Track mass distributions
2 -- Method
all events
all tags
correct tag
B± + Track mass distributions
3 -- Method
all events
all tags
correct tag
B± + Track mass distributions
4 -- Method
all events
all tags
correct tag
B± + Track mass distributions
5 -- Method
all events
all tags
correct tag

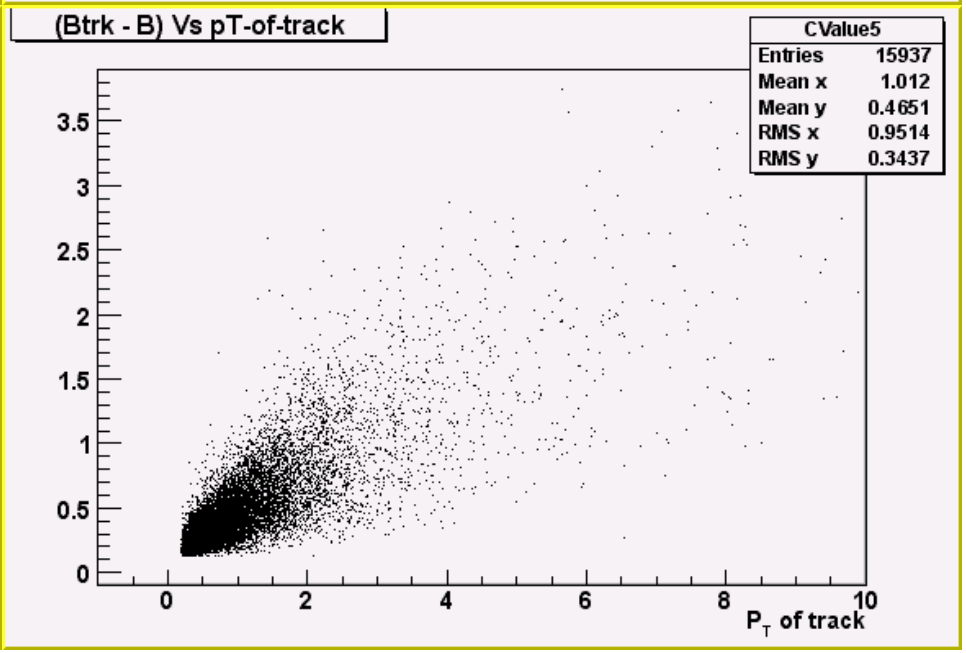

Track P_T^{rel} distributions
1 -- Method
all events
all tags
correct tag
2 -- Method
3 -- Method
4 -- Method
5 -- Method
Track P_T^{rel}


Track P_L^{rel} distributions
1 -- Method
all events
all tags
correct tag
2 -- Method
3 -- Method
4 -- Method
5 -- Method
Track P_L^{rel}


# of selected B's/event
Value1
Entries 5633
Mean 0.1724
RMS 0.392


# of selected trks/B 0.7 cone
Value4
Entries 971
Mean 2.257
RMS 1.87


C(-1)W Vs #of tag candidate meth-1
CValue6
Entries 763
Mean x 2.549
Mean y -0.2776
RMS x 1.701
RMS y 0.9607


(Btrk - B) Vs pT-of-track
CValue5
Entries 15937
Mean x 1.012
Mean y 0.4651
RMS x 0.9514
RMS y 0.3437
P_T of track