B Decay Charm Counting Via Topological Vertexing

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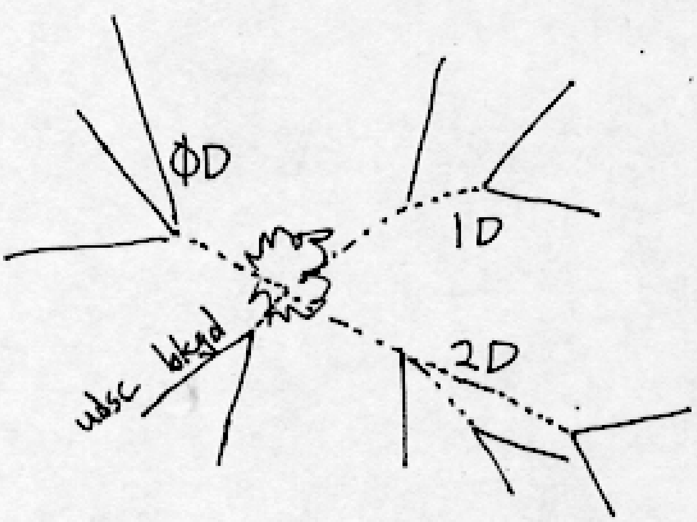


$Z \to b\,\bar{c}\,g$
$\hookrightarrow b\bar{b}$

for illustrative purposes only!

Why?

$b \to \phi D$: 2.5% J/ψ

~1% $b \to u$? $\Rightarrow V_{ub}$

? $b \to s$?

$b \to 2D$: fixes b semileptonic puzzle?

systematics for b lifetime,

B_d, B_s mixing

Analysis:

- Do opposite hemi b tag to get an 'unbiased' b sample.
- Get vertices (ZVTOP3)
- Apply vertexing cuts
- Histogram vertex distributions & fit.

Strategy

Do a 4 parameter fit to ~~the~~ some data histogram

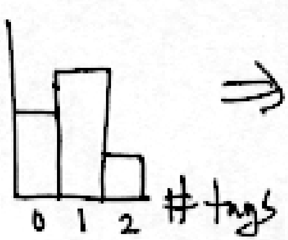
$$F_i = a_0 M_{0_i} + a_1 M_{1_i} + a_2 M_{2_i} + a_b M_{b_i}$$

where the M_i's are characteristic shape histograms derived from the Monte Carlo for the

$b \to \phi c$, $1c$, $2c$, and background components respectively.

In principle, we can extract $(N_{bins} - 1)$ pieces of information.

This is similar to the R_b measurement



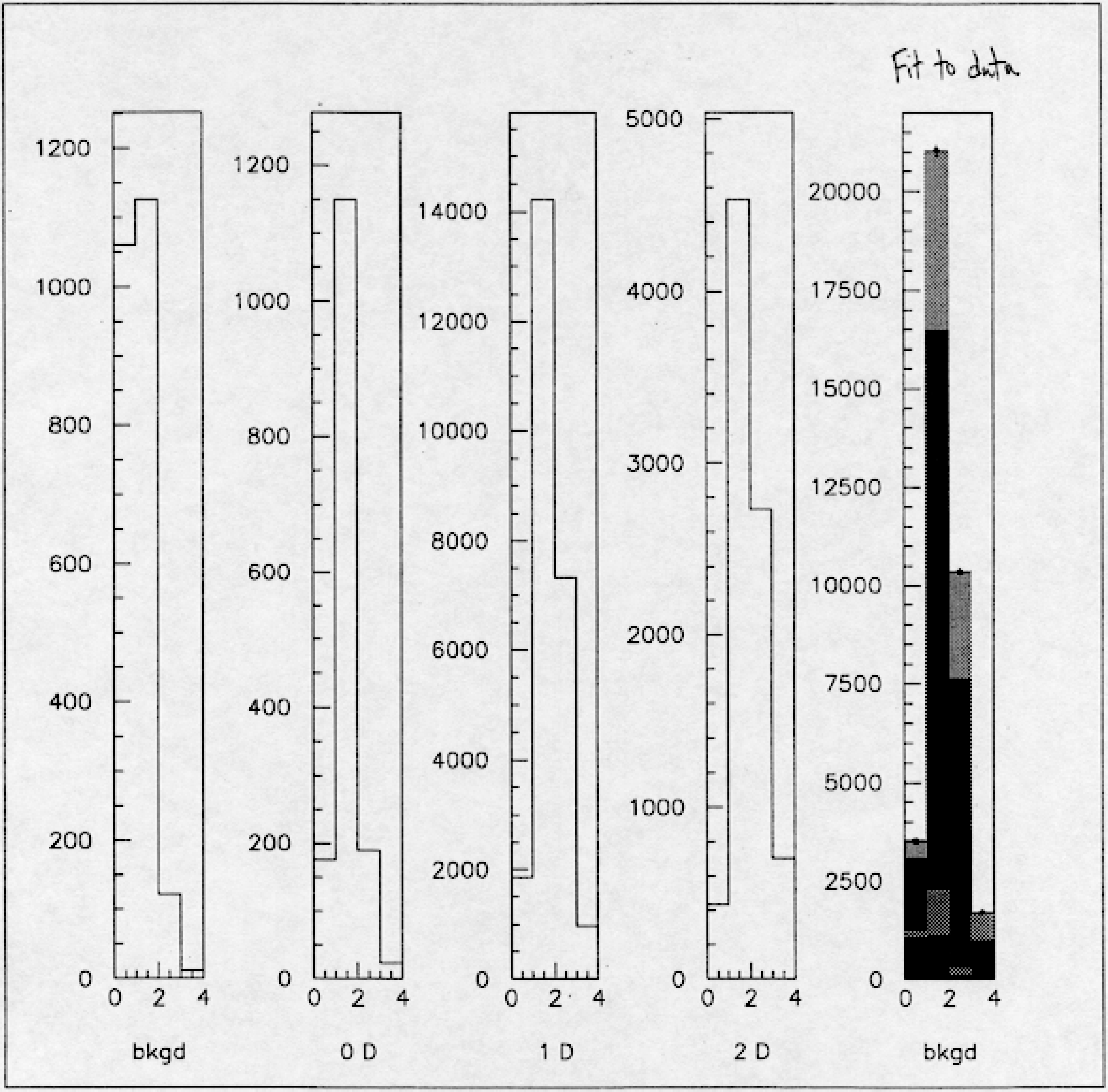
solve

$\Rightarrow$ Assume MC purity π and fit for R_b, ε. $\Rightarrow$ but no χ^2

Alternatively, assume MC ε and fit for R_b, π.

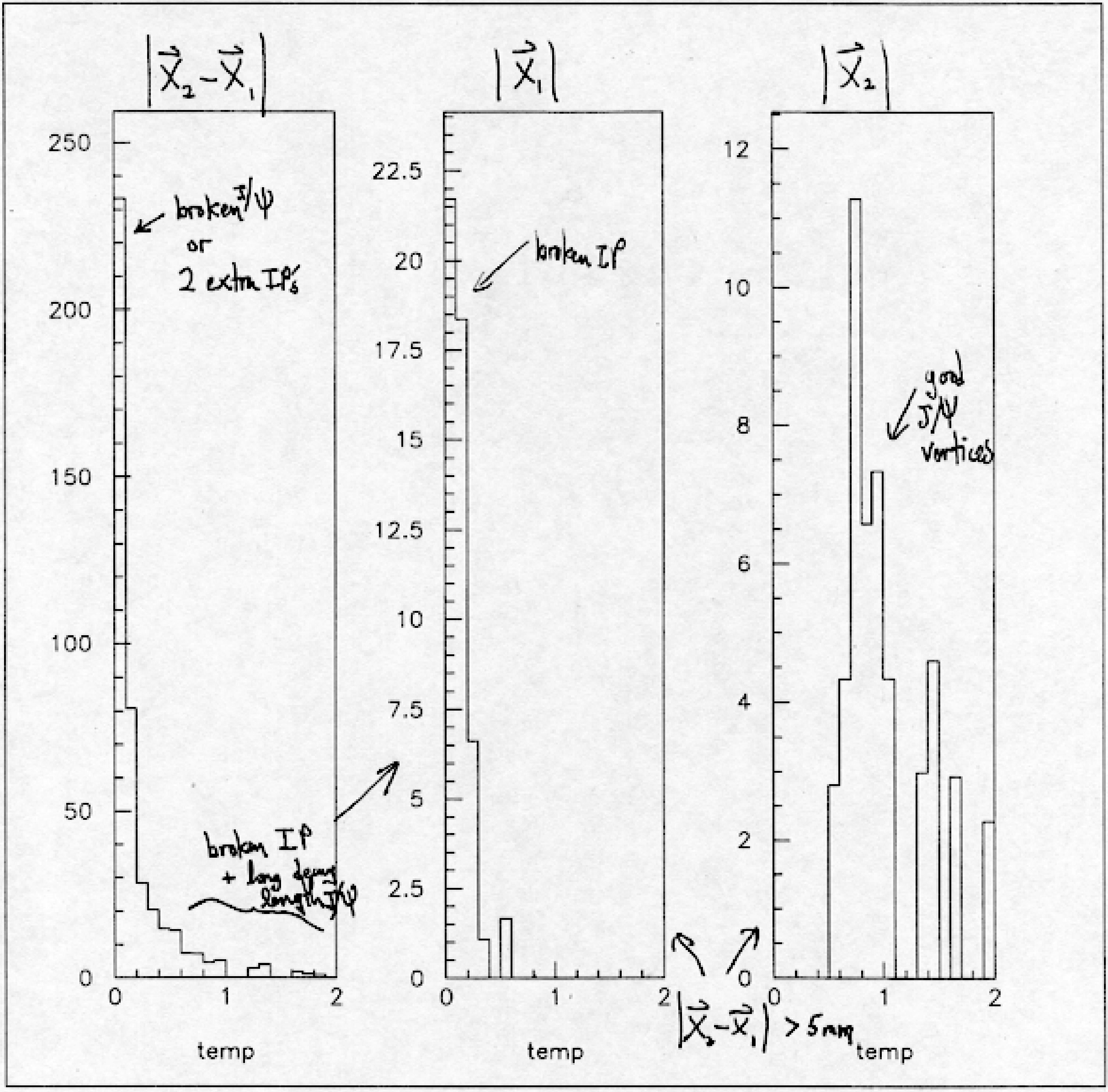
sec. vertices in hemisphere

(no VXOV sample)



Hidden dependence on: lifetimes, boost distributions, resolution

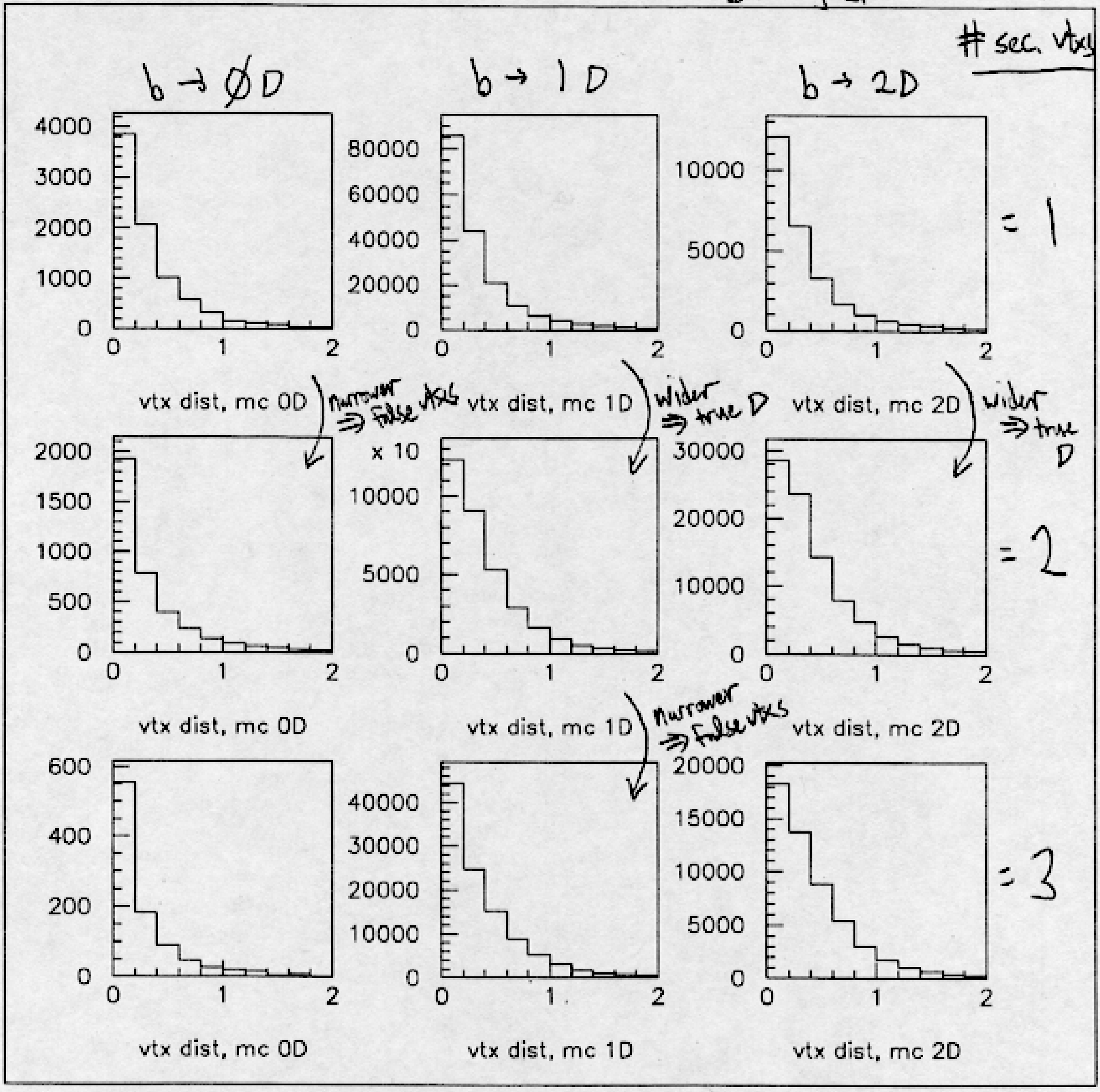
Charmonium → 2 sec. vtx



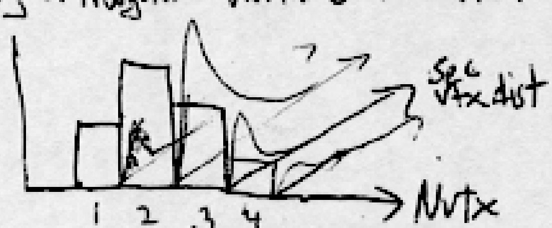
Total # Sec Vtxs

B Decay Type

Sec. Vertex Distances from IP



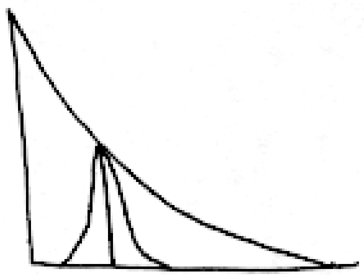
Get roughly orthogonal variable for fit.



Why histogram this way?

Poor control of the track resolution and the estimated error causes vertices to be accidentally broken up.

→ Assume a Gaussian broadening of the decay length distribution



Unbroadened $b \to \emptyset D$ events will stay in the $N_{sv} = 1$ histogram while the broadened distribution will spill over into the $N_{sv} = 2, 3$ histograms.

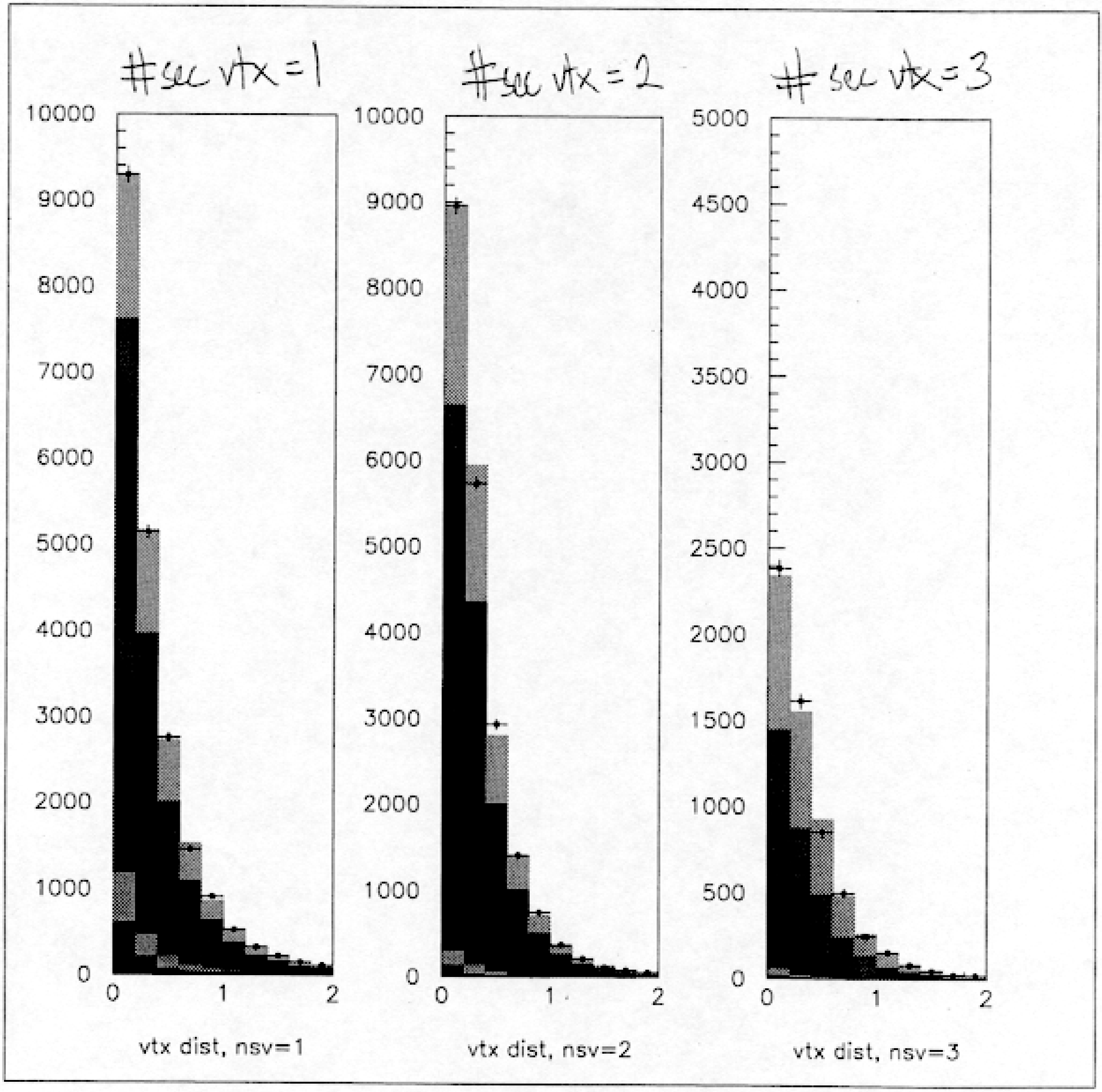
And similarly for $b \to 1D$, $2D$.

⇒ These histograms contain info about:

B, D boosts, lifetimes, track resolution

in addition to the charm yield.

Fit to Data radial decay length dists + #sec vtx = Ø bin



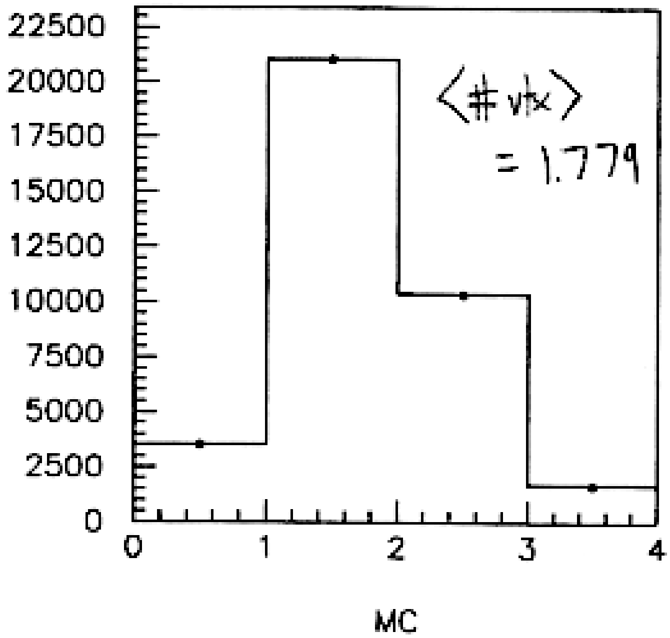
bkgd fraction: 0.063 ± 0.004

BR(b →
ØD : 0.045 ± 0.013
1D : 0.709 ± 0.024
2D) : 0.246 ± 0.015

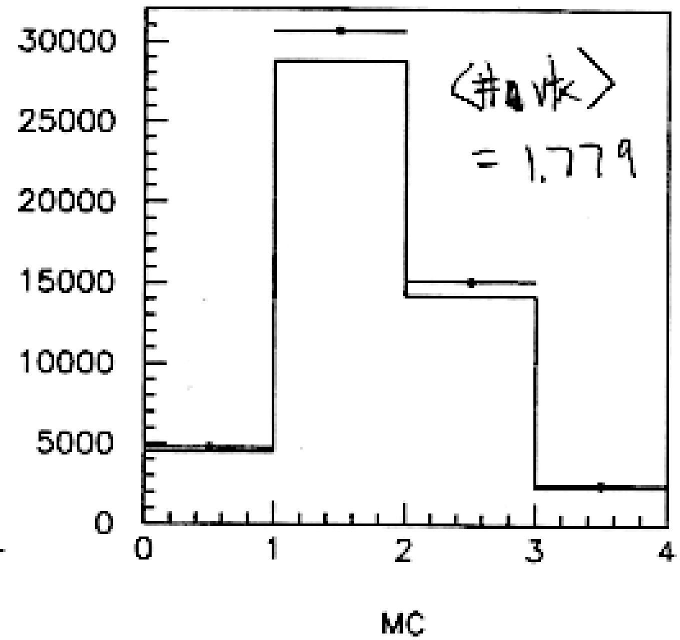
$\chi^2 / 27\,\mathrm{dof} = 1.5$

pcut = 0.005, ipres = 200 um
events without VXDVs

Good fit



Bad fit



W Highest weight constraint

$$\langle \#\,\text{vtxs} \rangle_{\text{Data}} = A \langle \#\,\text{vtx} \rangle_{\phi D} + B \langle \#\,\text{vtx} \rangle_{1D} + C \langle \#\,\text{vtx} \rangle_{2D} + D \langle \#\,\text{vtx} \rangle_{\text{bkgd}}$$

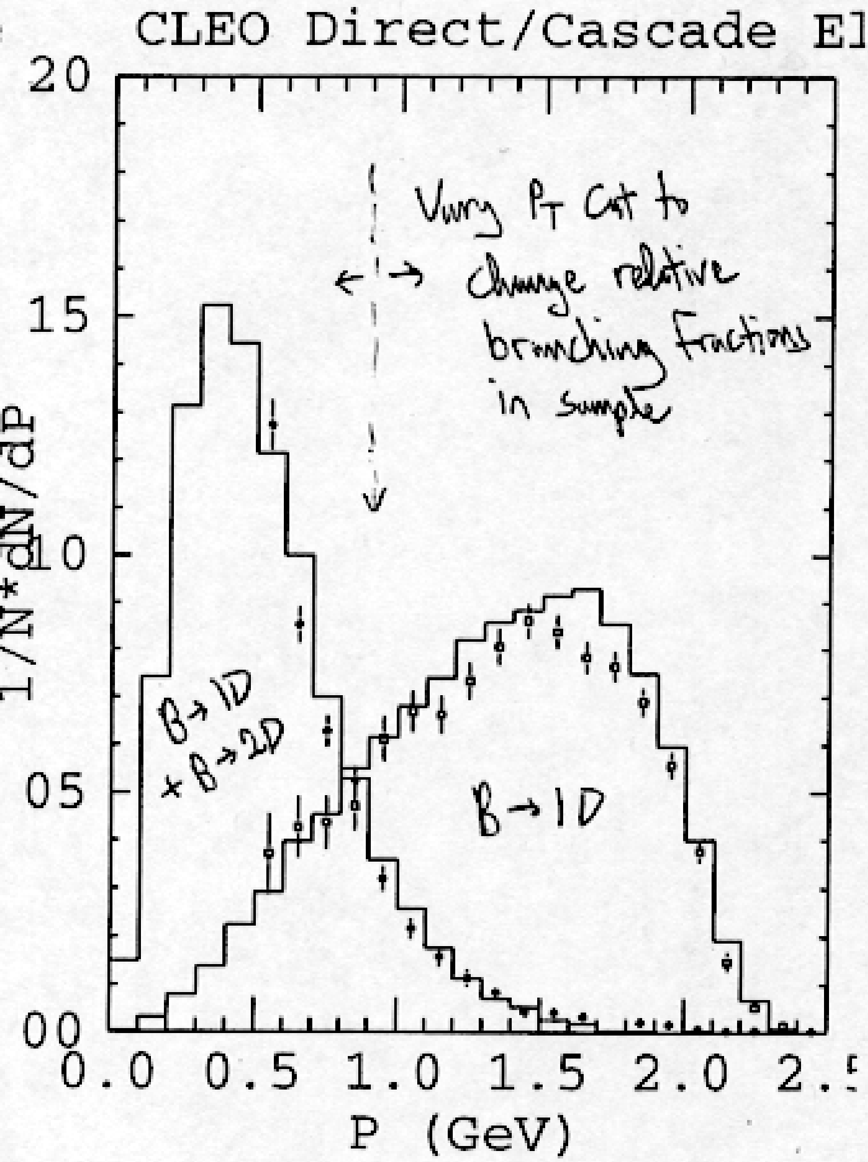
W/4 Middle weight constraint

$$\langle \#\ n\text{-vtx hemis} \rangle = A \cdot \langle \#\, n\text{-vtx hemis} \rangle_{\phi D} + \ldots$$

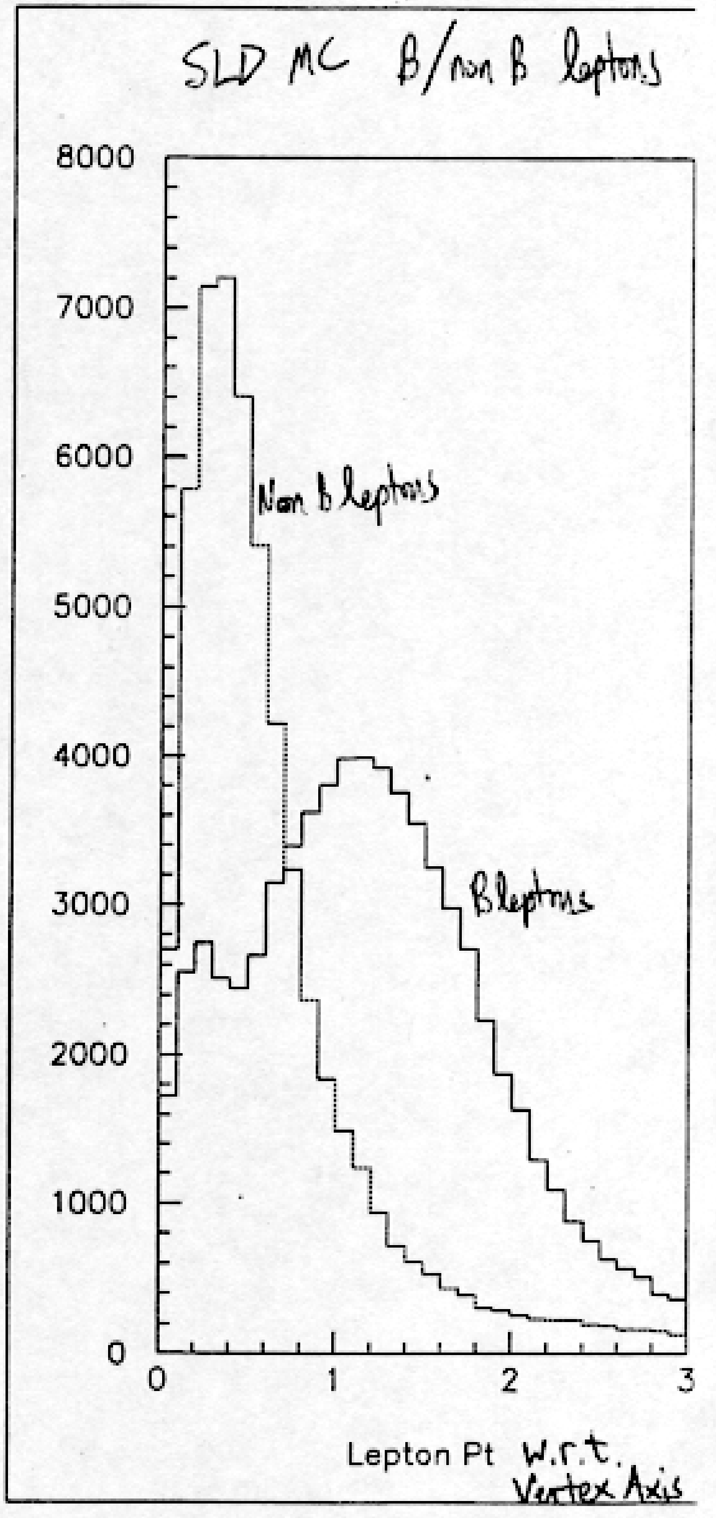
W/30 Lowest weight constraints ⇒ enforces correctness of vertex position distribution and hence, vertex resolution

(4)

Alan Brown

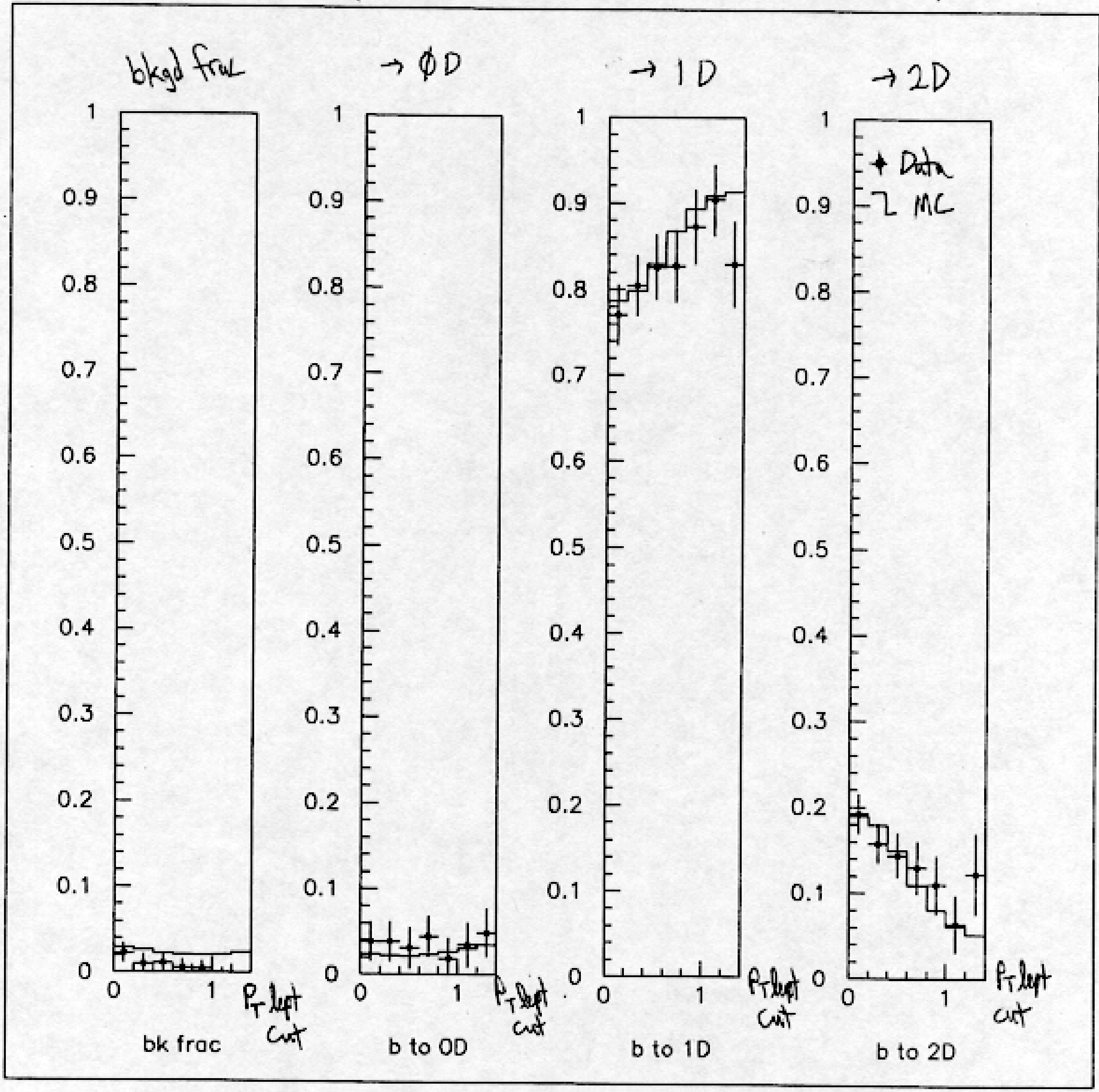


CLEO Direct/Cascade El
1/N*dN/dP
P (GeV)
Vary P_T Cut to change relative branching fractions in sample
B→1D + B→2D
B→1D



SLD MC B/non B leptons
Non B leptons
B leptons
Lepton Pt w.r.t. Vertex Axis

Meas. Branching Fractions as function of lepton P_T cut.
(Measured Data compared with tuned MC)



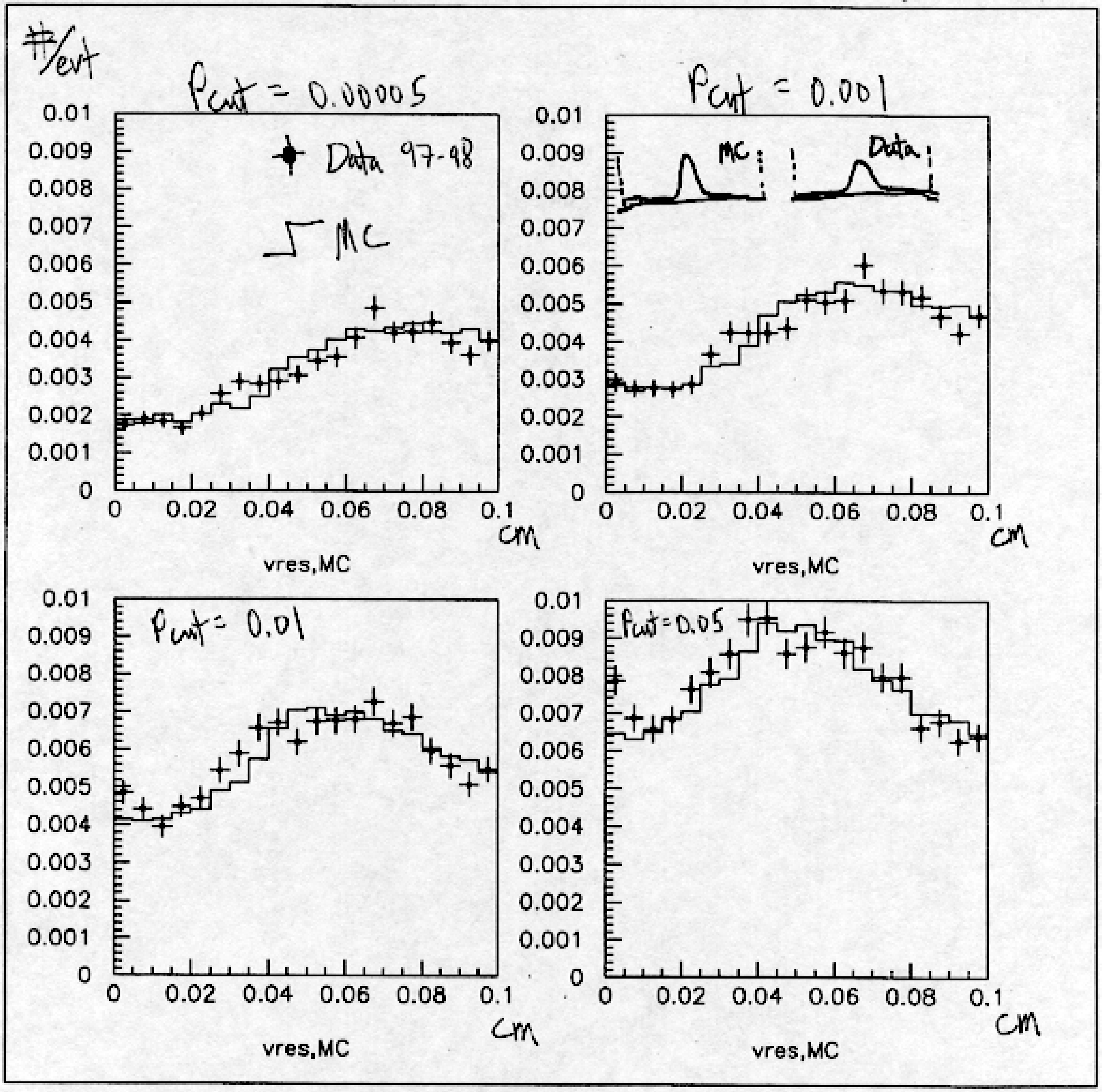
The points are correlated, but the data seems to favor a lower b. semileptonic BR. (15% lower)

Systematics

	$b \to$ $\emptyset D$	$1D$	$2D$
• Using no VXOV sample	0.005	0.010	0.010
• $b \to 1D$ mixture (Vary 10% D^0, 10% $D^\pm$, 25% D_s, 30% c-baryon)	0.005	0.010	0.010
• b fragmentation type (Vary 10% B_d, 10% B_u, 25% B_s, 30% b-baryon)	0.003	0.006	0.007
• b energy ($x_b = 0.707$, $x_b = 0.714$) χ^2 rapidly gets worse as decay length is shortened	0.003	0.014	0.009
• P_{cut} (= 0.010, 0.005, 0.001)	0.006	0.017	0.016
• Tracking efficiency (reject 1.6% of 1, 2 prong vtxs)	0.010	0.010	0.016
Total:	0.013	0.027	0.033

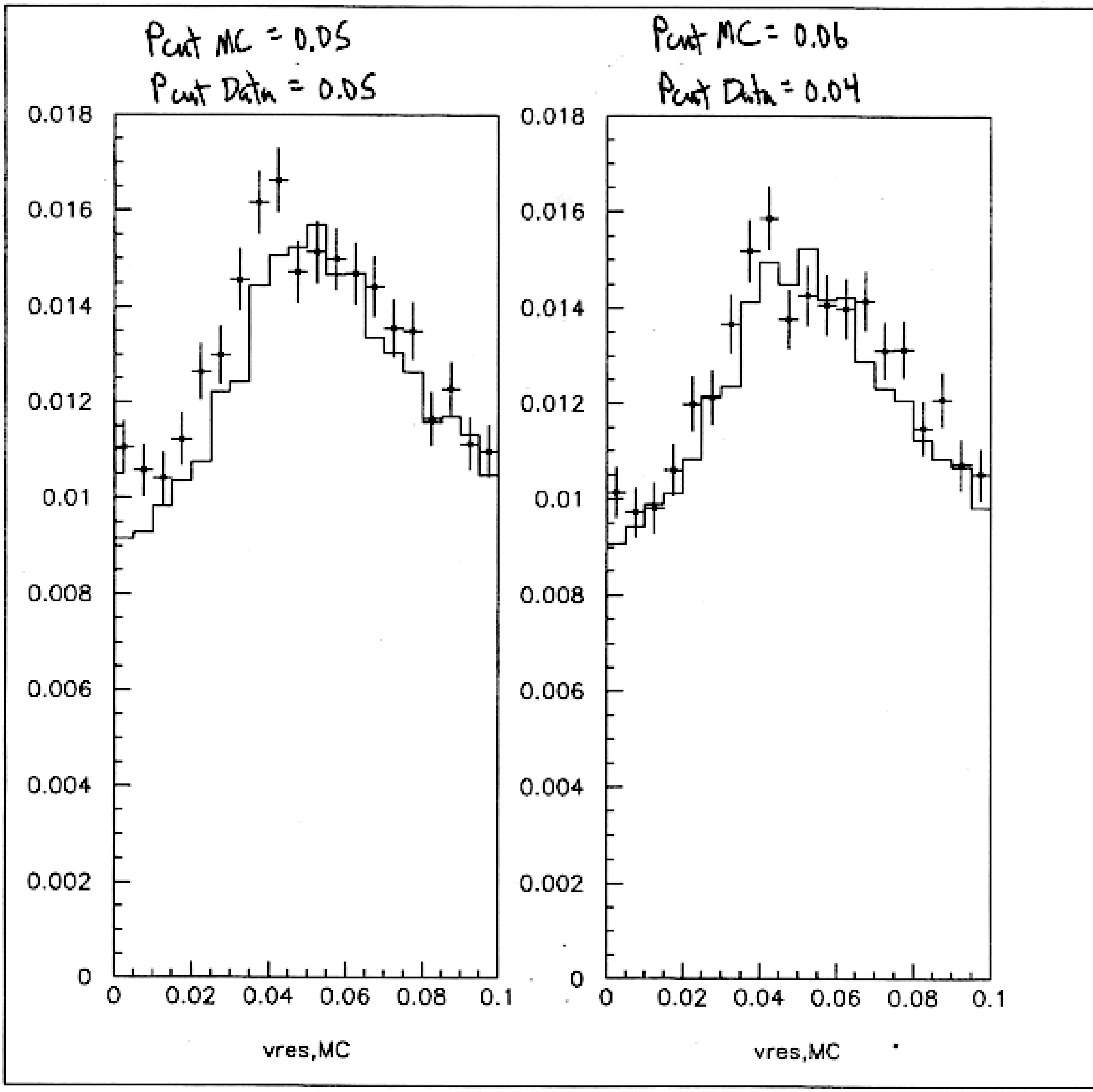
Still to do: lifetimes, decay multiplicities...

Nearest Neighbor Vertex Separation Distance (as fcn of Pcut)



⟹ By cutting far in the tails, we can effectively ignore any slight mismatch in impact param. resolution.

Nearest Neighbor Vtx separation Distance



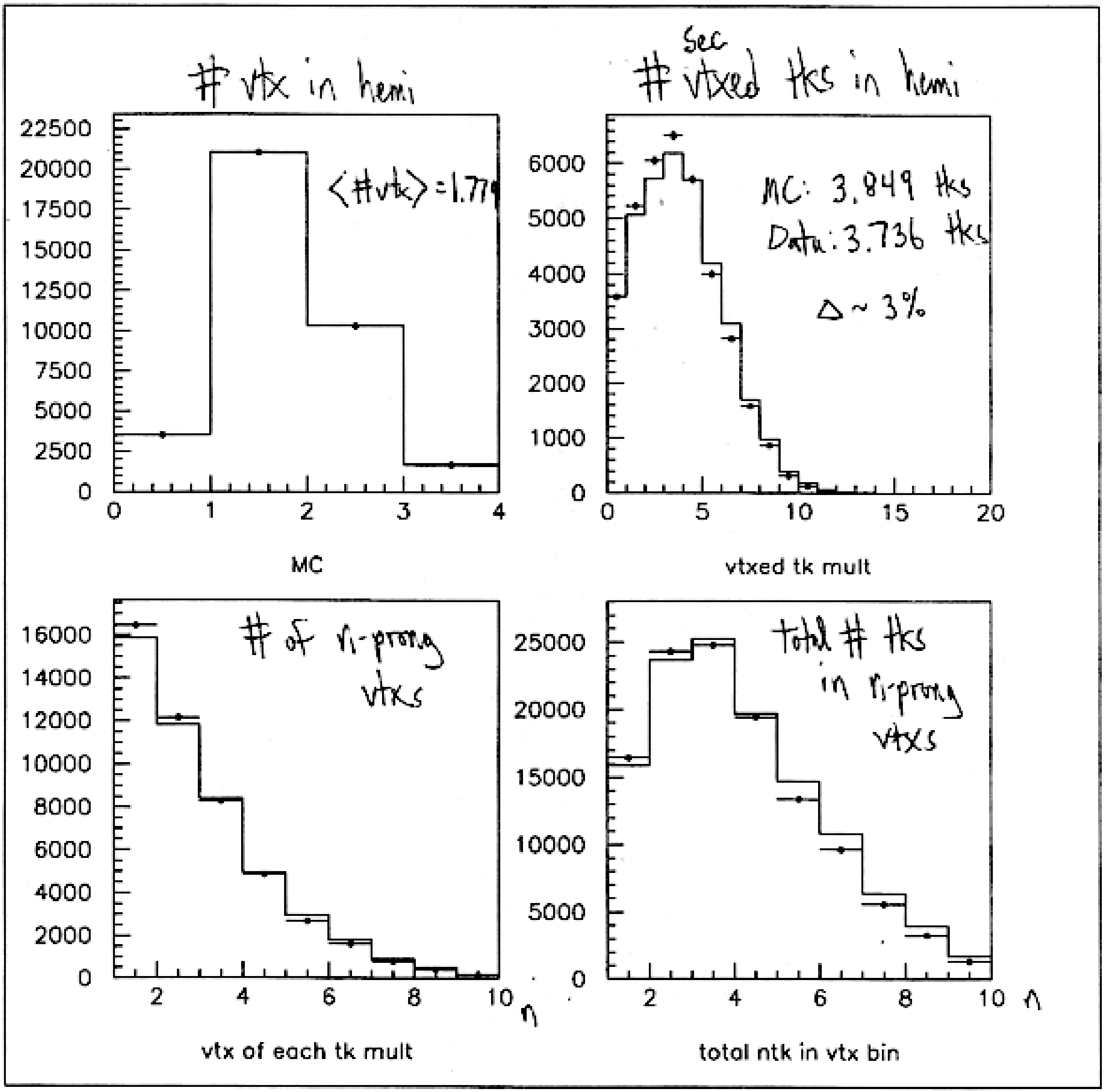
⇛ Consistent with a resolution mismatch.

Need to cut further in the tails : Pcut = 0.005

3σ ~ 100 um, B,D separation ~ mm ⇒ still can discriminate between 1D, 2D

Data / fitted MC comparison

no vxov sample



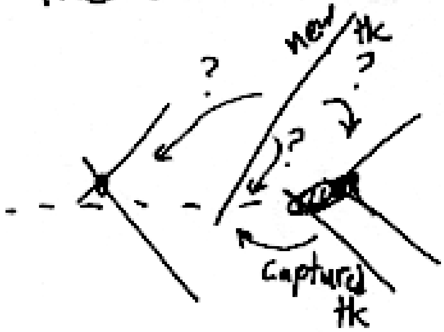
⇒ Excess MC tracks are in high mult. vertices.

⇒ Most of discrepancy is at generator level
(high mult inclusive modes to reproduce low p pion dist.)

Tk ε correction Assumptions

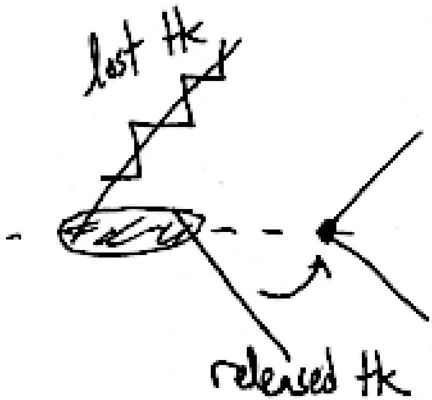
- Adding Tks makes the #vtxs increase.

  i.e. the extra tk won't cause separated vtxs to coalesce.



The added tk will either form a new vtx (perhaps stealing tks from old vtxs)
or be ~~glommed~~ put onto an existing vtx.

$\Rightarrow$ Removing tks causes the #vtxs to decrease.



- Lost vtxs are most likely low multiplicity vtxs.

$\Rightarrow$ Remove an appropriate fraction of 1, 2 prong vtxs from MC.

(% #tk discrepancy) $\times$ (prob. tk is in 1, 2 prong) $\approx 1.6\%$.

Summary

			stat		sys
$BR(b \to \phi D$		0.045	$\pm$ 0.013	$\pm$	0.013
$1D$	=	0.709	$\pm$ 0.024	$\pm$	0.027
$2D)$		0.246	$\pm$ 0.015	$\pm$	0.033

$\langle n_c \rangle = 1.20 \pm 0.08$

To Do: - lifetimes, ← not much freedom decay multiplicities, ← hopefully vtx resolution is under control

- Include entire sample with VXOVs : stat × 1.6
- Do tracking ε carefully, replacing PHCHRGs with PHVXOVs