B+ and B0 Meson Lifetimes Status and Prospects

- Quick review of Decay Length method
- Comparison of LP99 results to current results
- Discovery made along the way
- Impact Parameter Distributions
- Average Impact Parameter fits
- Finding X_E
- Plans

Feb. 18, 2000
SLD Physics Analysis Meeting

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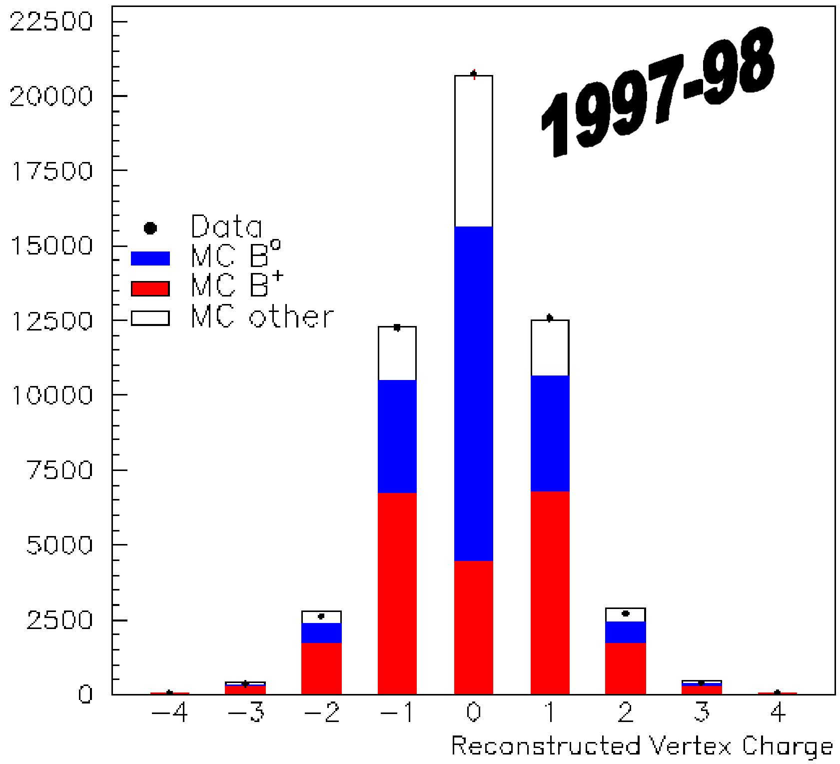
B^+ / B^0 Analysis Outline

- Recon. decay point of B mesons using ZVTOP (not ZVTOP3)
- Divide sample into Charged and Neutral vertices (*)
- Use M_{PT}, Q_{vtx}, and $A_{FB}(\cos\theta)$ to improve purity of charged sample (*)
- Determine lifetime by fitting MC to the Data decay length distribution
- Calculate Systematics
- Shift central values (*)

(*) I'll come back to these later

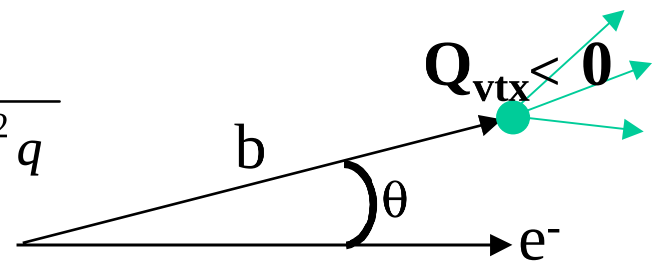
For LP99, we used 1997-98 R16 Data and MC.
However, the tracking corrections were based upon R16.
Now, using R16 trking corrections.

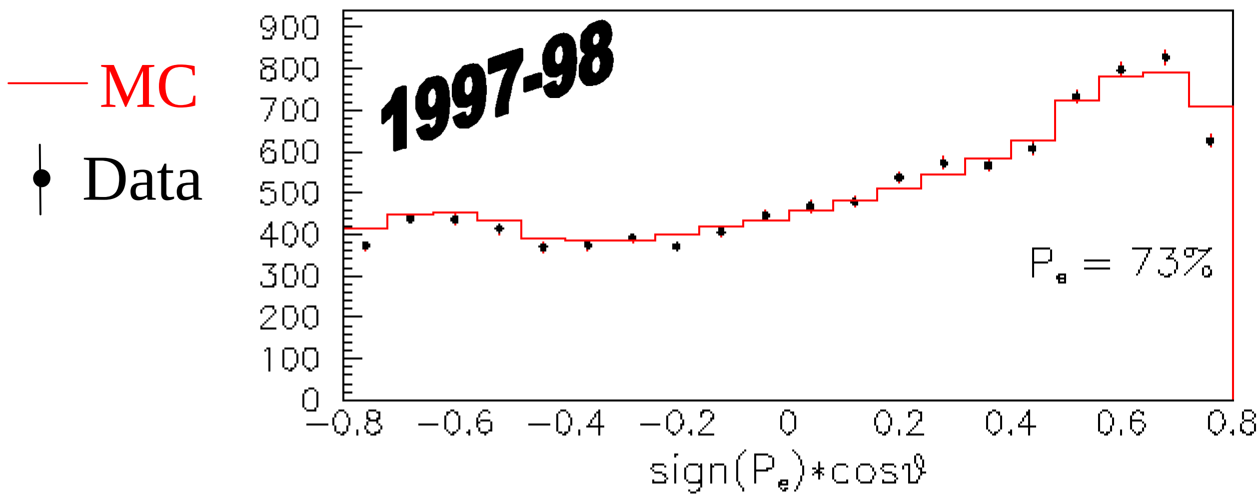


- ~ 30 K charged ($|Q_{vtx}|=1,2,3$)
- ~ 20 K neutral ($|Q_{vtx}|=0$)
- For analysis, require
  - $|Q_{vtx}| \leq 3$
  - L > 1 mm
  - R < 2.2 cm
  - M_{Pt} >2 GeV/c^2
  - M_{Pt} < 5.2 GeV/c^2

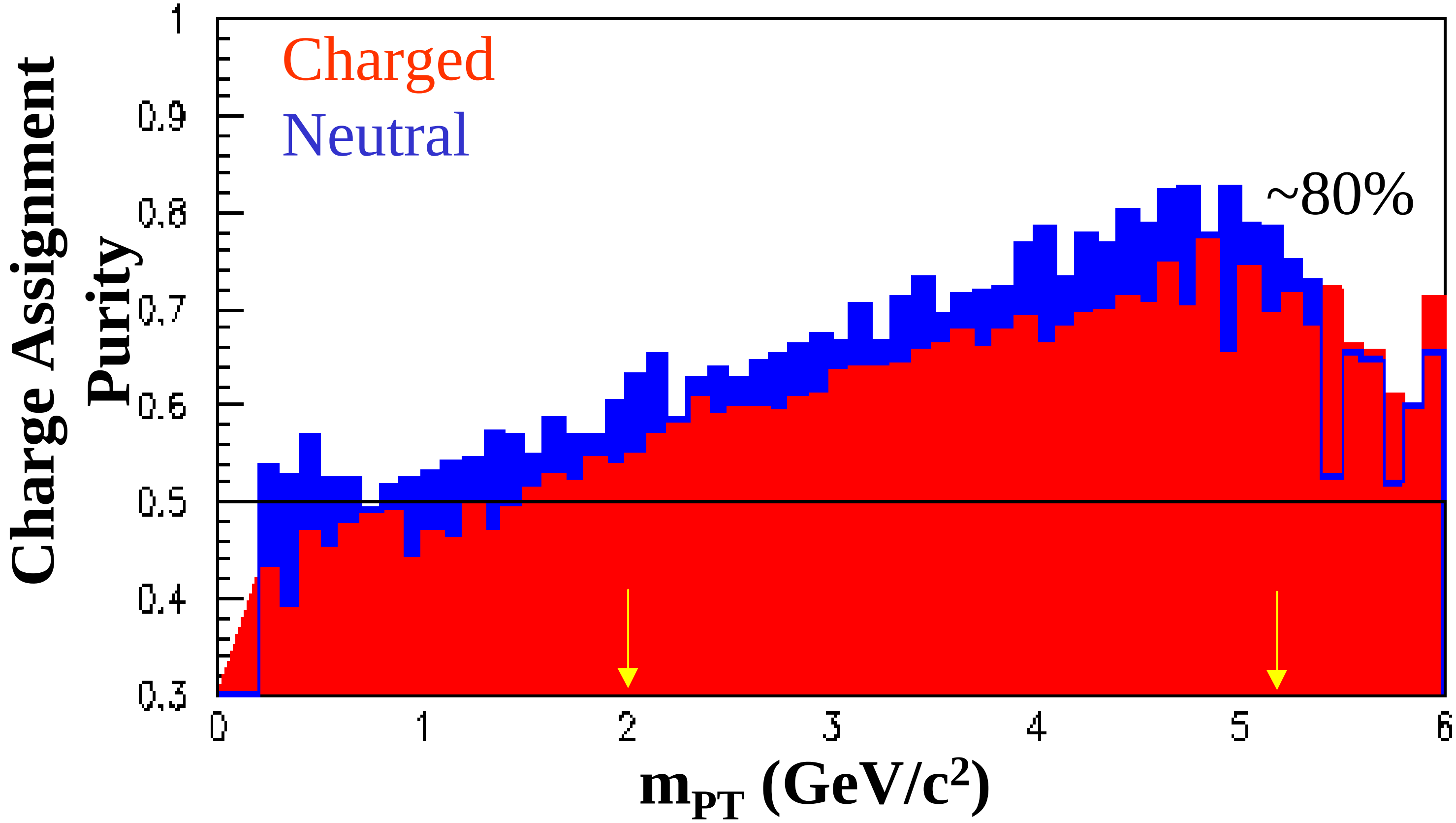
We performed a standard A_{FB} cross check of the charge assignment purity
(for charged vertices only)

$$\tilde{A}_{FB}(P_e, \cos q\,) = 2A_b \frac{A_e - P_e}{1 - A_e P_e} \frac{\cos q}{1 + \cos^2 q}$$

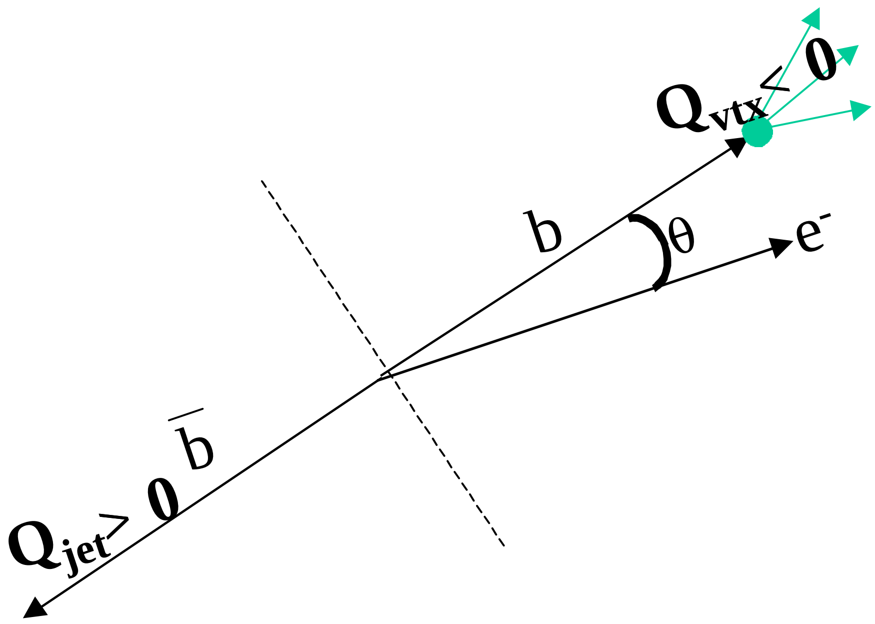


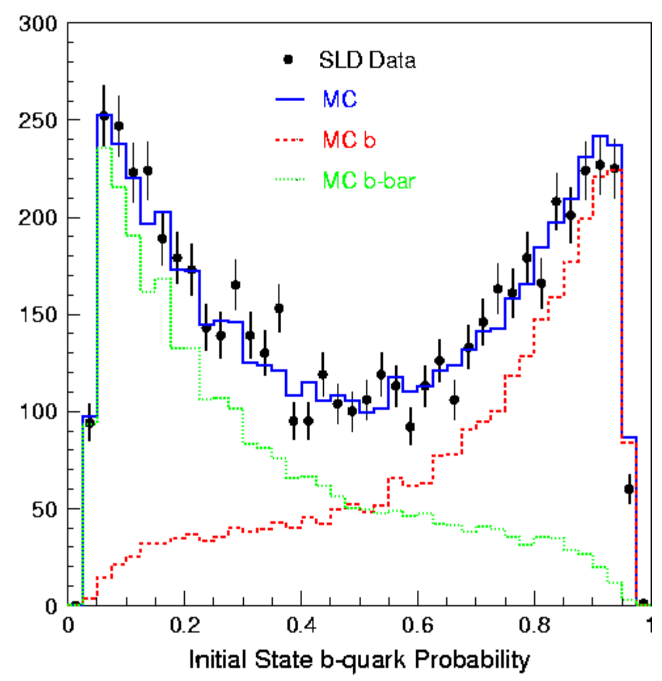


Using vertex mass & charge, we calculate the probability of a vertex being a $B^{\pm}$ or B^0

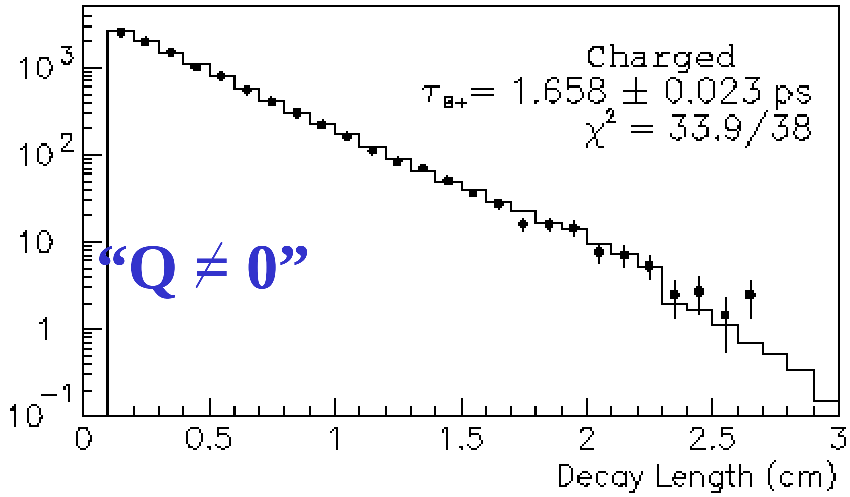


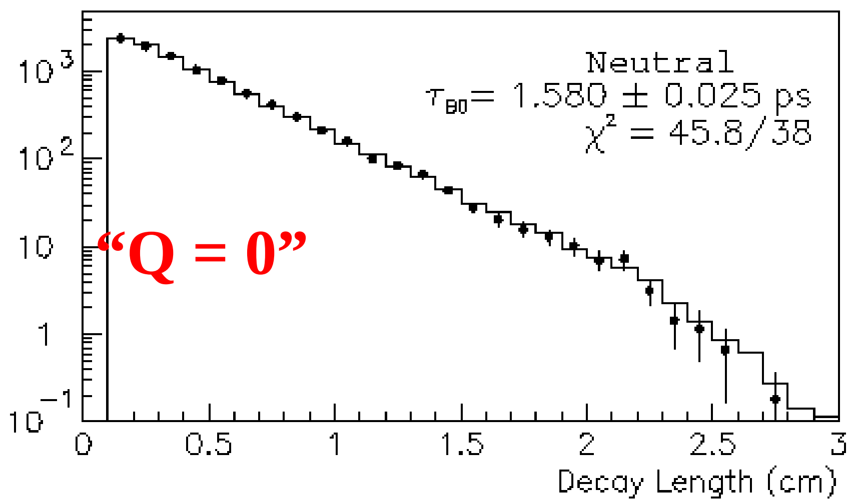
Using Pol+Jet Charge (simple initial state tag), we calculate the probability of the vertex hemisphere being a b or a $\bar{b}$. From this we calc. the probability of vertex being B^+ (B^0) or B^- ($\bar{B}^0$)





Binned Decay Length Fits (1997-98)





LP99 plots

(Before Mean Shifts)

Now:

- $\tau_{B+} = 1.660 \pm 0.024$ ps
- $\tau_{B0} = 1.577 \pm 0.024$ ps

$$\frac{t_{B+}}{t_{B0}} = \mathbf{1.052}^{+0.028}_{-0.026}$$

(Before Mean Shifts)

Lifetime Systematics (97-98 Decay Length Analysis)

Physics Systematics (selected subset)		$\Delta\tau_{B+}$ (ps)	$\Delta\tau_{B0}$ (ps)	$\Delta\,\tau_{B+}/\tau_{B+}$
B frag.	.714 ± .008	.025	.030	.004
	X_E shape	.011	.009	<.003
B(B→DD)	.18 ± .05	.015	.014	.016
b baryon fraction	.072 ± .040	.004	.017	.008
B_s^0 lifetime	1.49 ± .06	<.003	.014	.009
TOTAL (all systs, including trking & detector)		**0.033**	**0.044**	**0.026**

← needs more study

- b fragmentation systematics dominant for individual lifetimes

What do we actually report to conferences?

- $\tau_{B^+} = 1.658 \pm 0.023 \pm 0.033$ ps
- $\tau_{B^0} = 1.580 \pm 0.025 \pm 0.044$ ps

1997-98 results
(LP99, before shifts)

Now, shift central values of lifetimes to account for differences between MC centroid values for different systs. & what we want to use as a central value (assume linear extrapolation OK):

$\overline{X_E}$ (MC) =.698 $\rightarrow$ .714 : $\tau_{B^+} \rightarrow$ 1.607 ps

$\overline{\tau_{B_s}}$(MC) = 1.55 ps $\rightarrow$ 1.49 ps : $\tau_{B^+} \rightarrow$ 1.607 ps

$\overline{f_{\text{b-baryon}}}$(MC) =7.2% $\rightarrow$ 10.2% : $\tau_{B^+} \rightarrow$ 1.613 ps

- $\tau_{B^+} = 1.613 \pm 0.023 \pm 0.033$ ps
- $\tau_{B^0} = 1.565 \pm 0.025 \pm 0.044$ ps

1997-98 results
(LP99, after shifts)

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Interesting discovery:

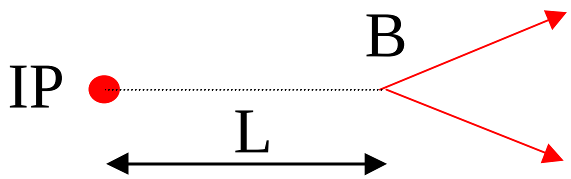
- NO Q = 0 vertices are in the "Q ≠ 0" sample
- 23% of the vtxs in the "Q = 0" sample have Q ≠ 0 !
(~19% are Q = ± 1, ~ 4% are ± 2, ~.5% are ± 3)

A rationalization by John Jaros ***(john@slac.stanford,edu; x2852)***

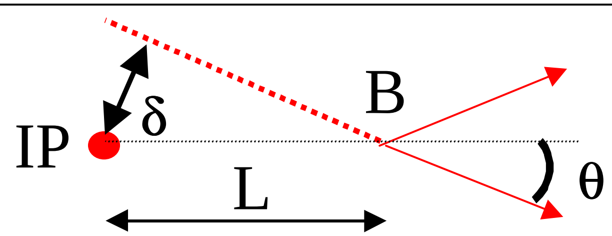
- Suppose had a high degree of confidence that hemisphere w/vtx was from a b-quark (thus B^- or B^0)
- Suppose the vertex had low mass (i.e. probably missed a few trks) and Q = +1

⟶ Place this candidate in "Q=0" sample (w/low weight)

Can we use a variable that is less sensitive to X_E?



$L \sim \tau \bullet E$ ⟷ Large L = Long τ **or** Hard X_E



$\delta \sim L \bullet \theta \sim (\tau \bullet E) \bullet \theta \sim (\tau \bullet \not{E}) \bullet (1/\not{E})$

→ δ independent of X_E

Analysis Outline

- As before, find ZVTOP vertices
- As before, divide sample into charged & neutral
- As before, enhance B+ purity using A_{FB}, M_{PT}, etc.
- Use the Average of the (3D or 2D) Impact Parameters of the Vertex Tracks with respect to the IP

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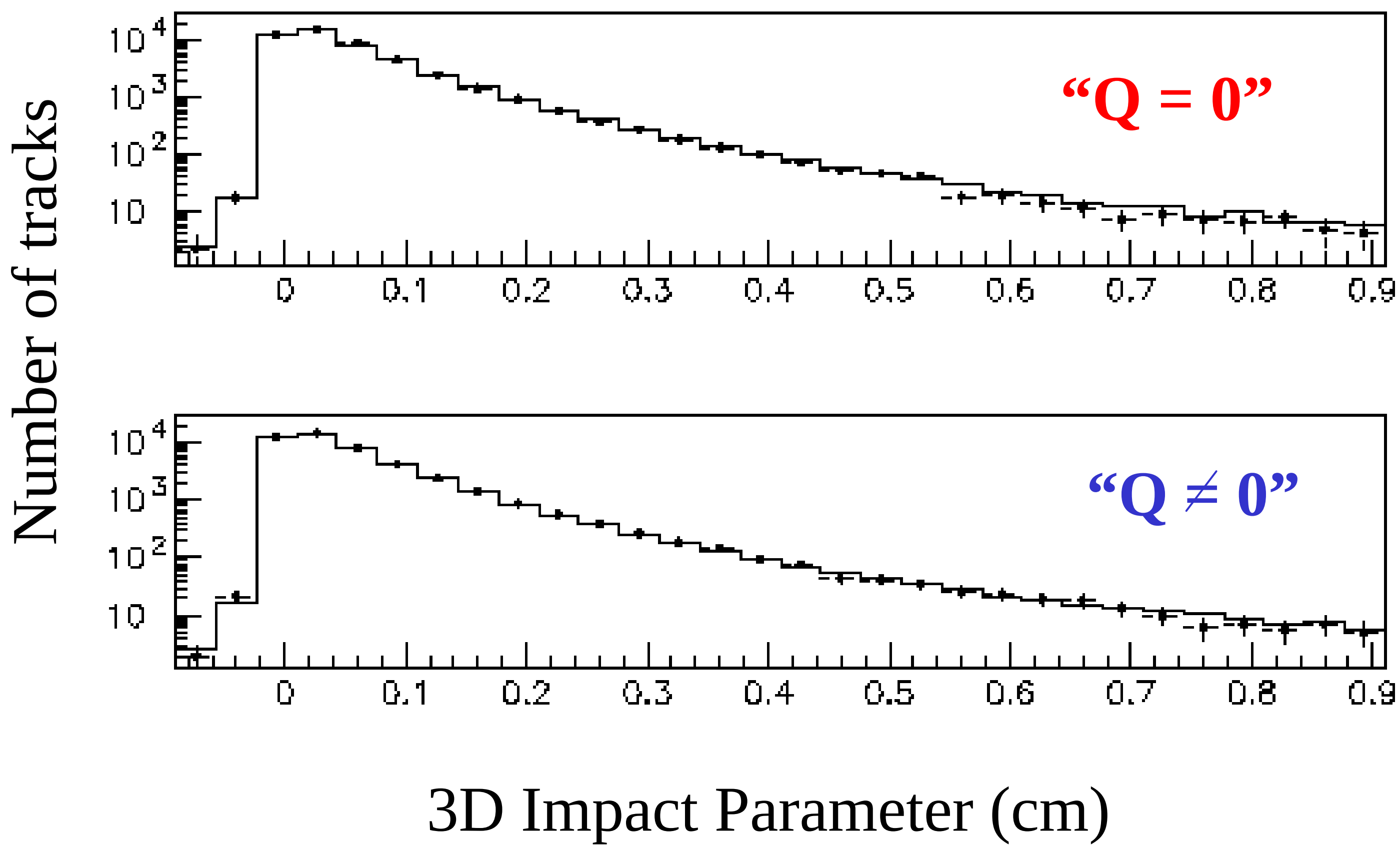
Impact Parameter distributions for Data & MC



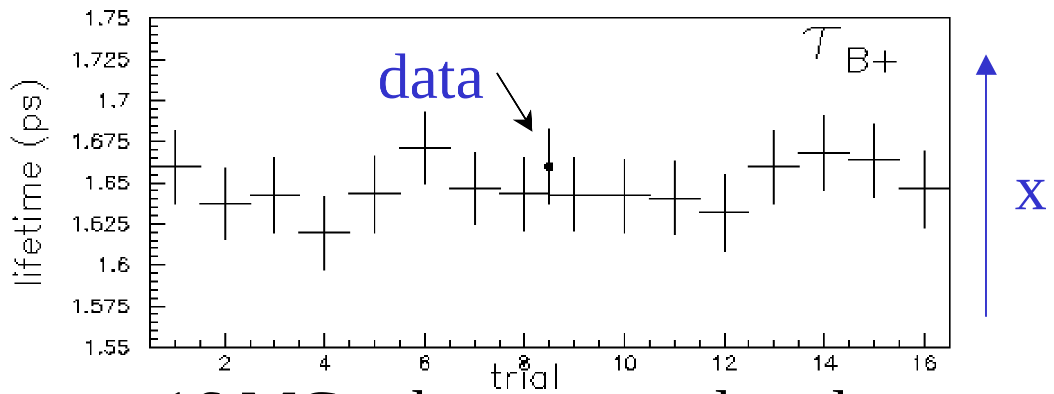
Instead, look at the Average of the 3D(2D) impact parameters for the trks in the vertex (nice thing: one entry per event)

	τ_{B+} (± stat) *psec*	τ_{B0} (± stat) *psec*	τ_{B+}/τ_{B0} (± stat)	Total χ^2 (76 dof)
Decay Length	1.660 ± .024	1.577±.024	1.052±.027	80
Ave. of 3D impact Parameters	1.638 ± .025	1.547 ± .027	1.057±.032	79
Ave. of 2D impact parameters	1.664 ± .028	1.538 ± .024	1.067 ± .035	89

Degree of correlation between dkl analysis and other analysis				
	3D	65.1%	74.0%	75.1%
	2D	72.5%	70.5%	80.2%

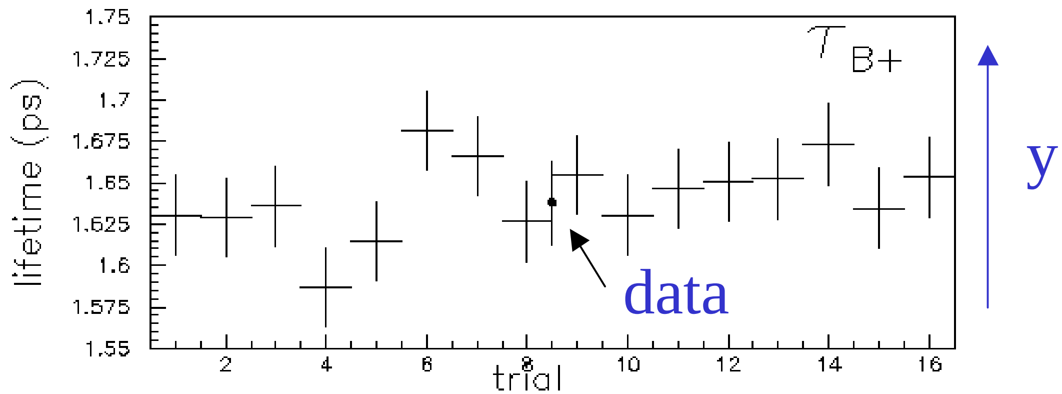
Degree of correlation between two analyses

From Decay Length Method:



16 MC subsets treated as data

From Ave. 3D impact Method:



Correlation Coefficient:

$$C = \frac{\langle (x - \bar{x})(y - \bar{y}) \rangle}{\sqrt{\langle (x - \bar{x})^2 \rangle \langle (y - \bar{y})^2 \rangle}}$$

Physics systematics for both analyses

Decay Length

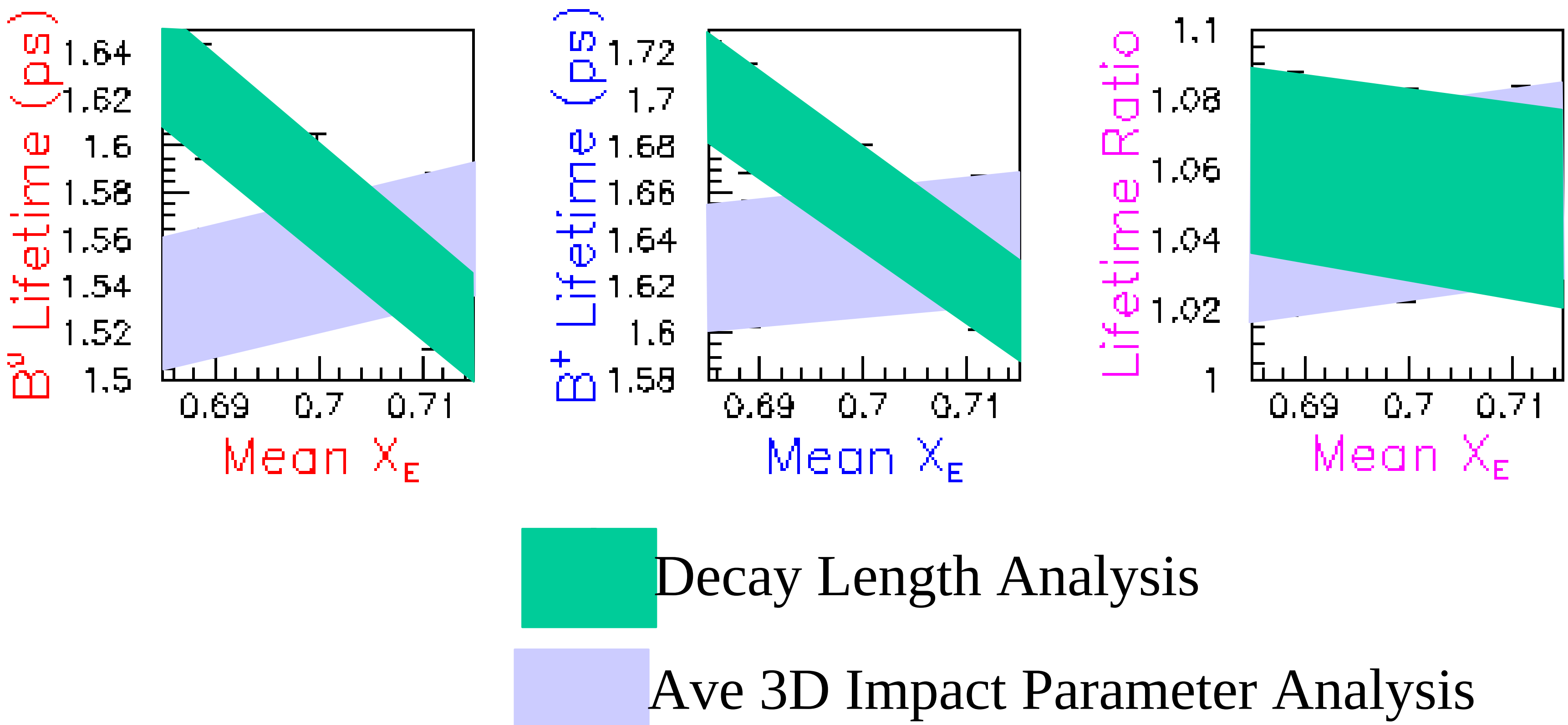
BR(B-->DX)	0.00505	0.00846	0.00712
B_s fraction	0.00298	0.00116	0.00266
b_baryon frax.	0.00410	0.01656	0.00826
b_s lifetime	0.00003	0.01356	0.00891
D decay multi.	0.00327	0.00536	0.00559

Average 3D imp. param.

BR(B-->DX)	0.00963	0.03648	0.02464
B_s fraction	0.00217	0.00305	0.00327
b_baryon frax.	0.00278	0.01862	0.01005
b_s lifetime	0.00030	0.01535	0.00998
D decay multi.	0.00555	0.01396	0.00535

Recall from last collab. mtg :

Lifetime dependence on X_E



Use intersection to constrain X_E

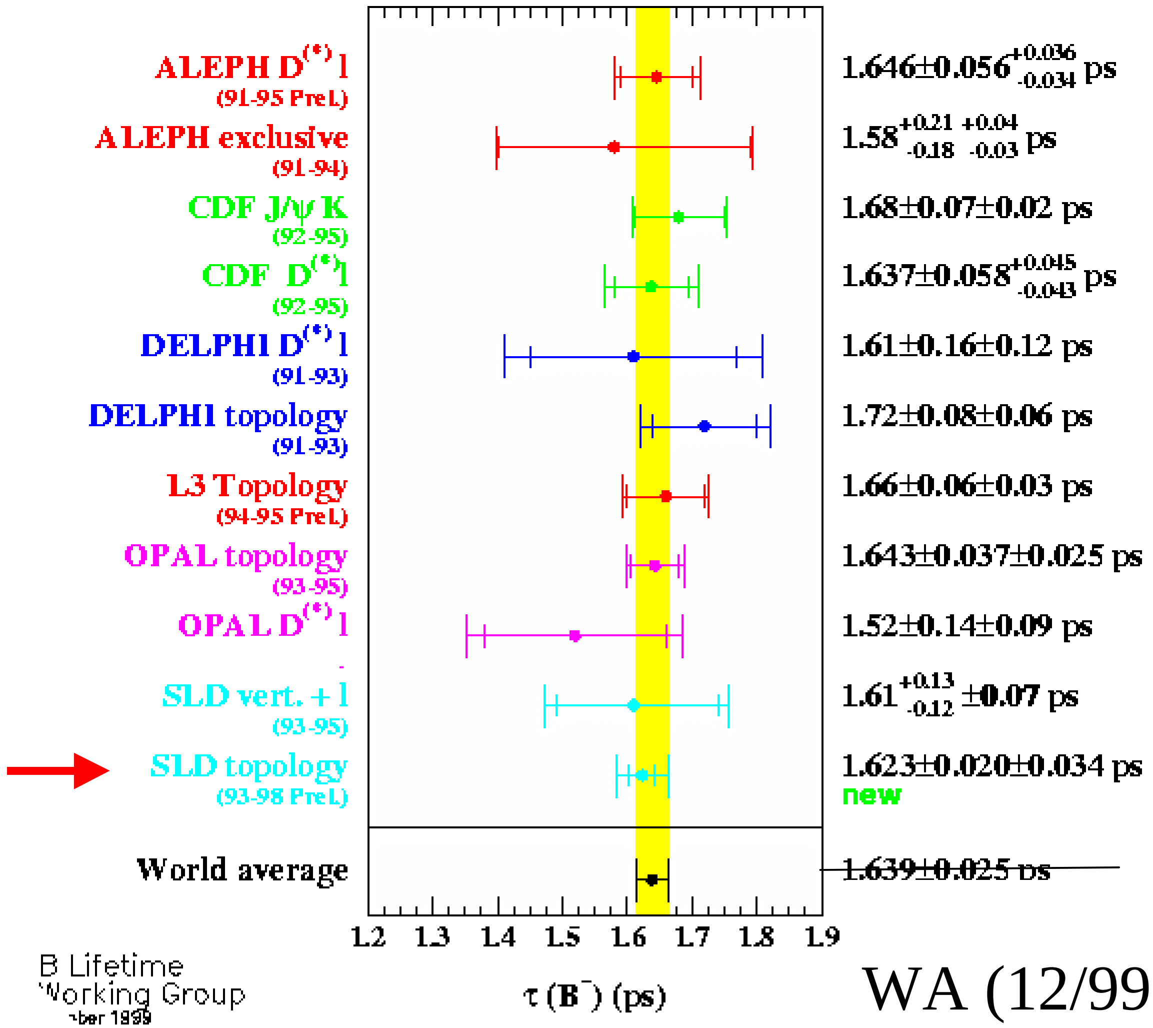
very preliminary!

For B+: $\overline{X}_E = 0.7013 \pm 0.0048$ $\overline{\tau}_{B+} = 1.641 \pm 0.039$ ps

For B0: $\overline{X}_E = 0.7014 \pm 0.0046$ $\overline{\tau}_{B0} = 1.553 \pm 0.053$ ps

X_E much lower than what Danning found !?!

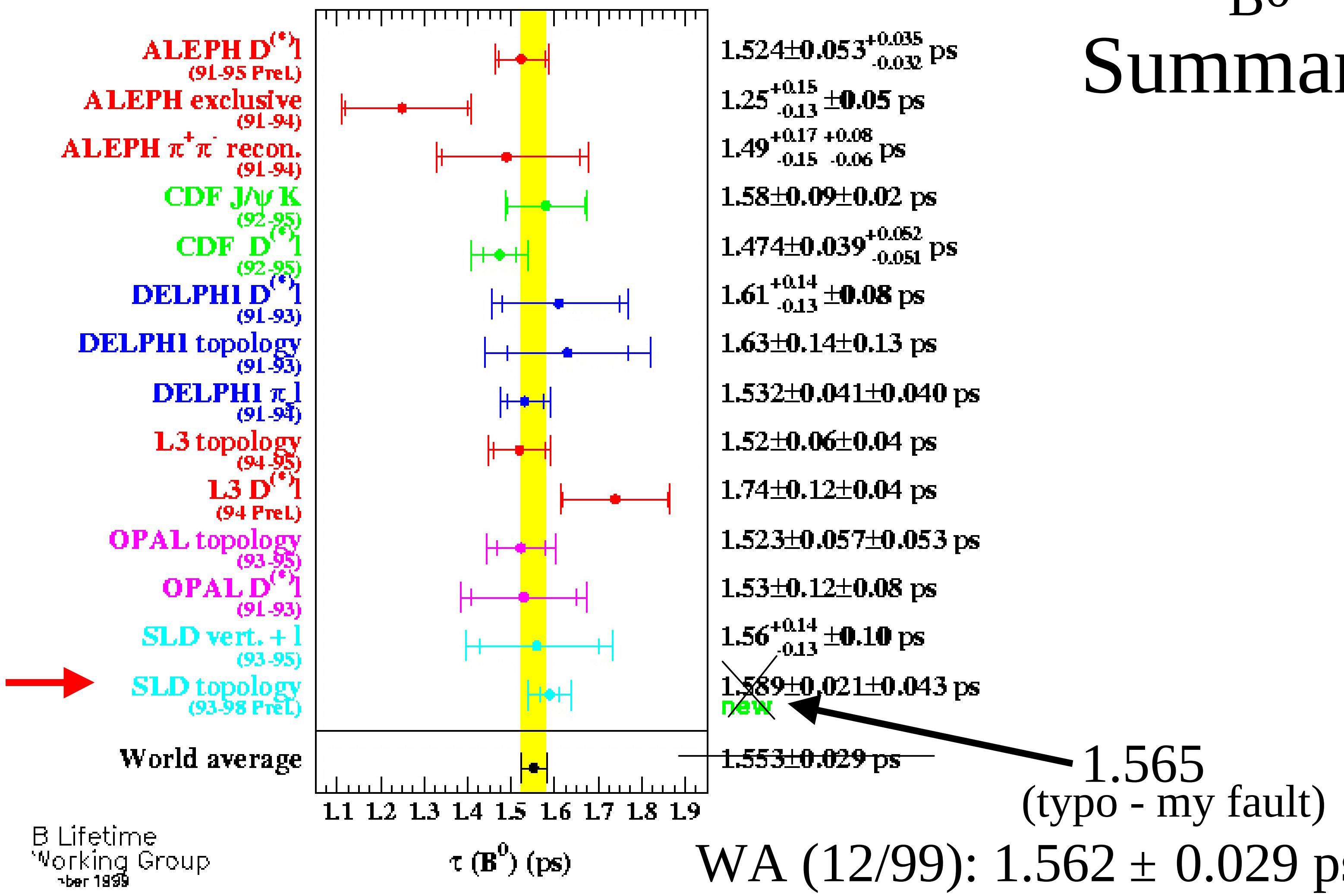
τ_{B^+} Summary



1.623 ± 0.03 ps

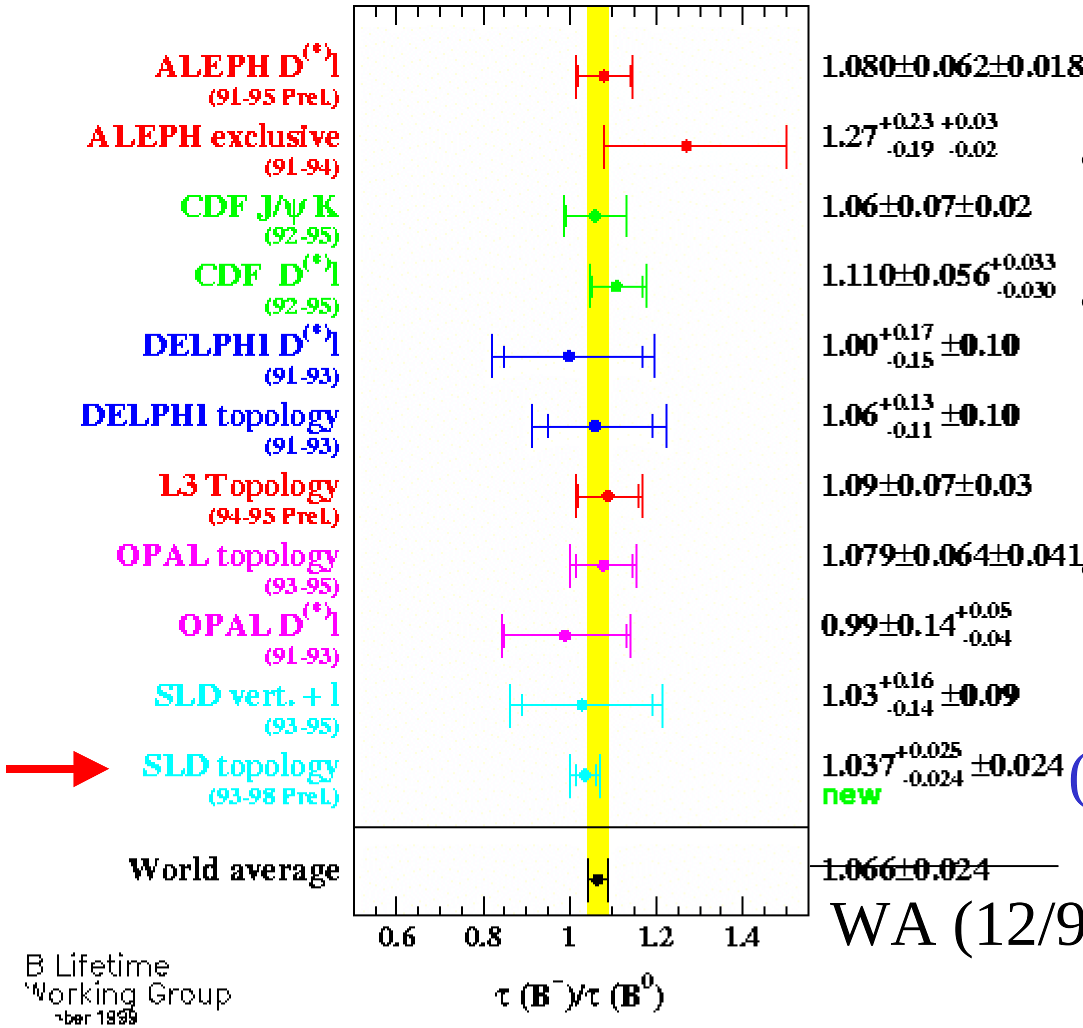
WA (12/99): 1.656 ± 0.025 ps

τ_{B0} Summary



WA (12/99): 1.562 ± 0.029 ps

τ_{B+} / τ_{B0} Summary



(ok)

- SLD Measurement most precise
- Starting to see (~ 2.8 σ) deviation from naïve spectator model prediction
- need greater precision to discriminate between theoretical predictions

WA (12/99): 1.065 ± 0.023

Plans & Goals

- By 3/15 review:
  - finish cleaning up decay length analysis
    - use results to "calibrate" boost algorithms for B mixing group
  - finish up average 3D impact parameter "analysis"
    - at this point, plan is to use only to constrain X_E
    - get better feel for mean X_E from intersections
  - Start Looking at VXD-only tracks
    (to improve charge purity)

- Goal #1: for summer conf., **finalize** R?? 1996-98 analysis
- Goal #2: start PRL draft by mid-summer

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