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

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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

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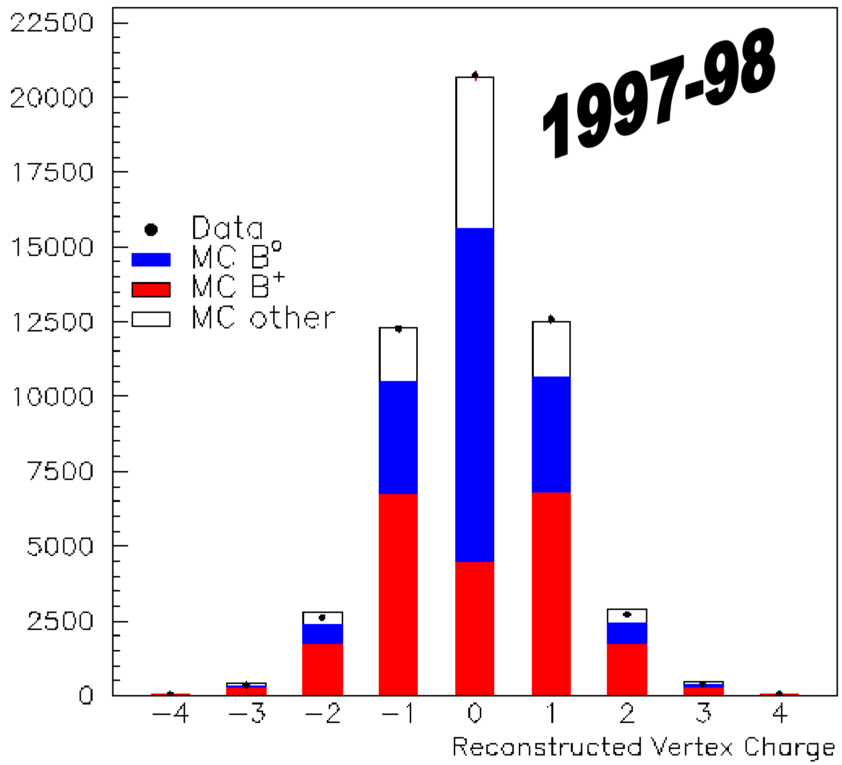
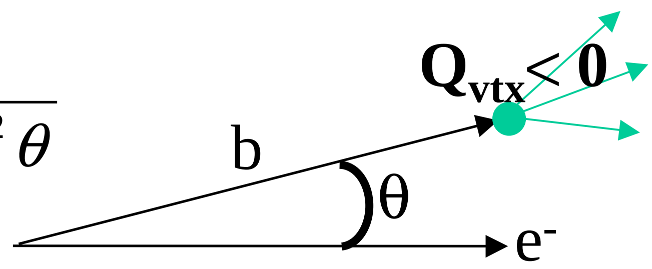
For LP99, we used 1997-98 R16 Data and MC.
However, the tracking corrections were based upon R16.
Now, using R16 trking corrections.

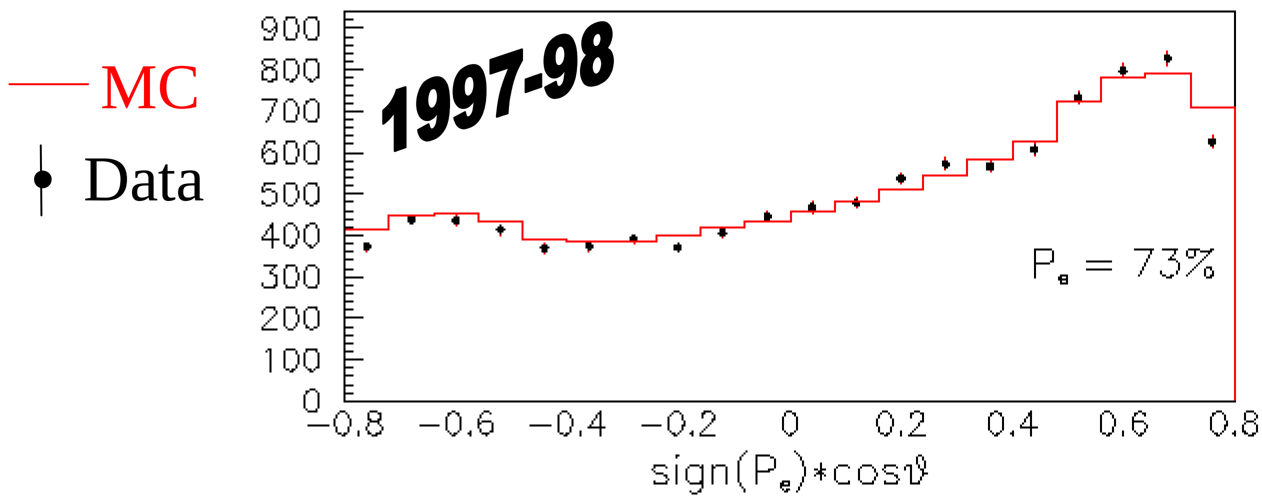


- ~ 30 K charged ($|Q_{vtx}|$=1,2,3)
- ~ 20 K neutral ($|Q_{vtx}|$=0)
- For analysis, require
  - $|Q_{vtx}| \leq 3$
  - L > 1 mm
  - R < 2.2 cm
  - M_{Pt} >2 GeV/c^2
  - M_{Pt} < 5.2 GeV/c^2

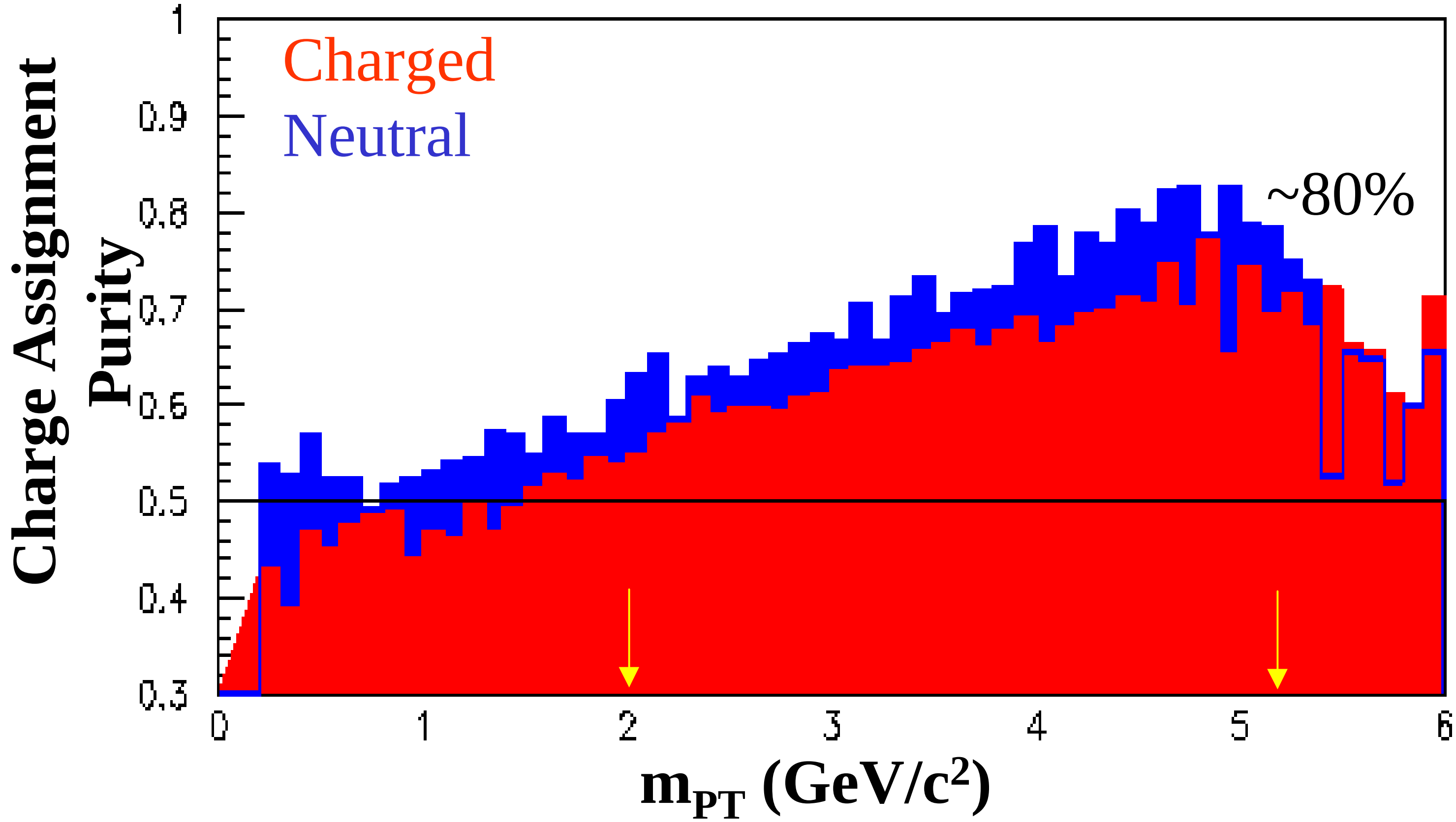
We performed a standard A_{FB} cross check of the charge assignment purity
(for charged vertices only)

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





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



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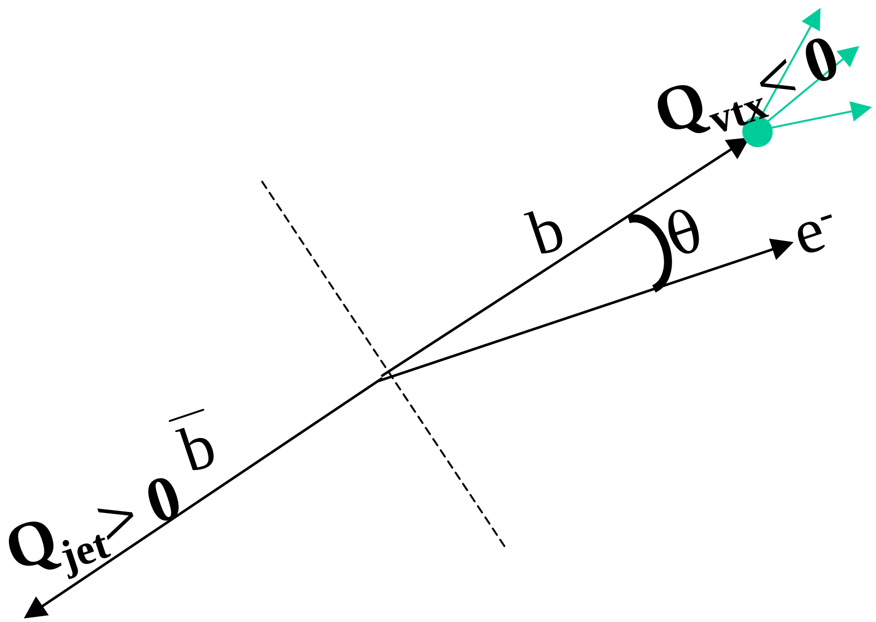
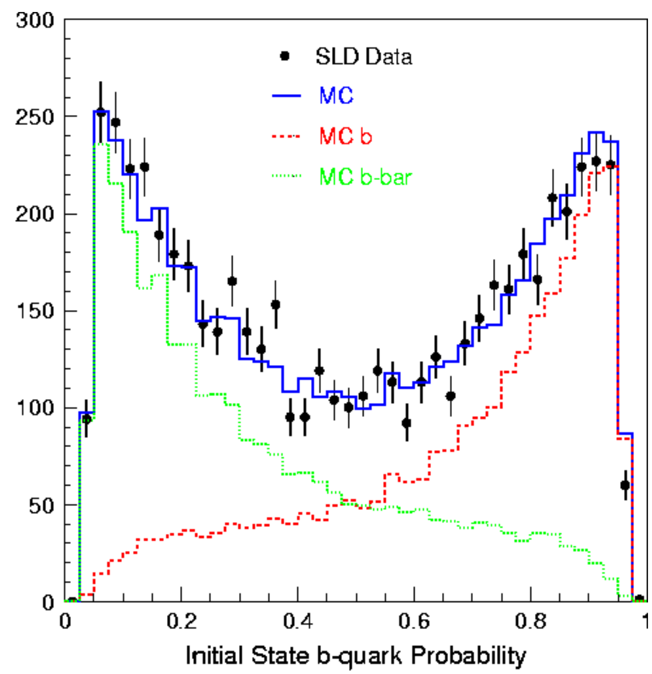
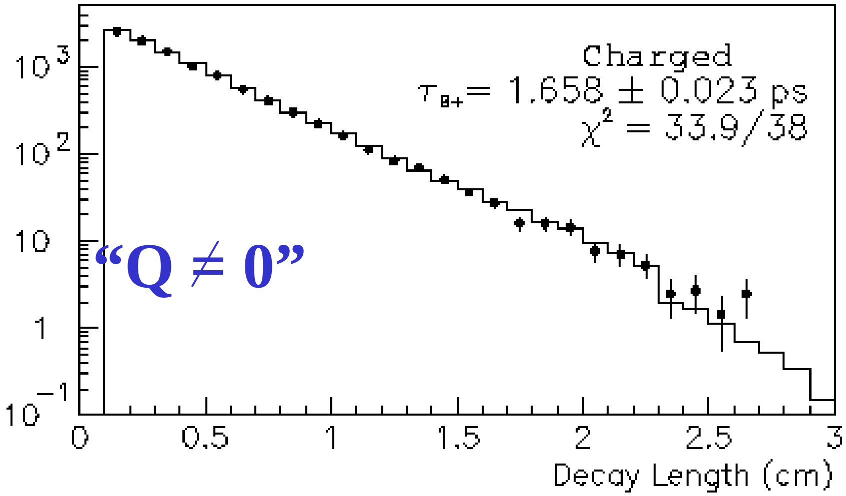
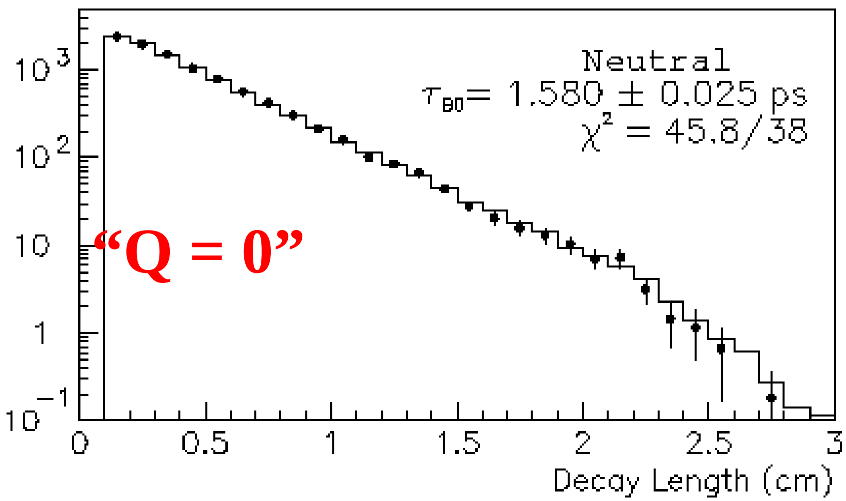
Using Pol+Jet Charge (simple initial state tag), we calculate the probability of the vertex hemisphere being a b or a $\bar{b}$. From this we calc. the probability of vertex being B^+ (B^0) or B^- ($\bar{B}^0$)





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

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

(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.	$.714 \pm .008$	.025	.030	.004
	X_E shape	.011	.009	<.003
$B(B \rightarrow DD)$	$.18 \pm .05$	.015	.014	.016
b baryon fraction	$.072 \pm .040$	.004	.017	.008
B_s^0 lifetime	$1.49 \pm .06$	<.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

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What do we actually report to conferences?

- $\tau_{B+} = 1.658 \pm 0.023 \pm 0.033$ ps
- $\tau_{B0} = 1.580 \pm 0.025 \pm 0.044$ 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):

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

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

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

- $\tau_{B+} = 1.613 \pm 0.023 \pm 0.033$ ps
- $\tau_{B0} = 1.565 \pm 0.025 \pm 0.044$ ps

1997-98 results
(LP99, after shifts)

Interesting discovery:

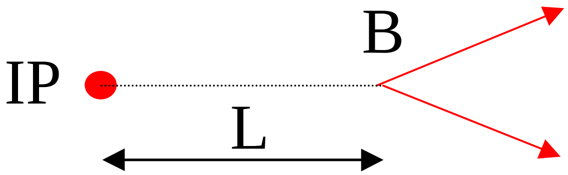
- NO Q = 0 vertices are in the "Q $\neq$ 0" sample
- 23% of the vtxs in the "Q = 0" sample have Q $\neq$ 0 !
  (~19% are Q = $\pm$ 1, ~ 4% are $\pm$ 2, ~.5% are $\pm$ 3)

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

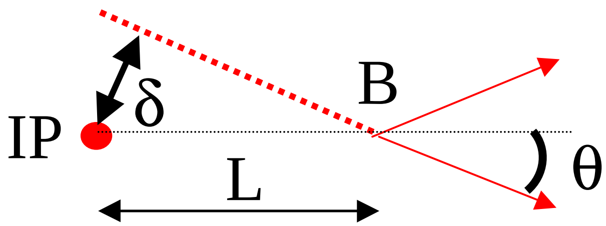
- Suppose had a high degree of confidence that hemisphere w/vtx was from a b-quark (thus B^- or B^0)
- Suppose the vertex had low mass (i.e. probably missed a few trks) and Q = +1

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

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



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



$\delta \sim L \bullet \theta \sim (\tau \bullet E) \bullet \theta \sim (\tau \bullet \cancel{E}) \bullet (1/\cancel{E})$

$\rightarrow$ 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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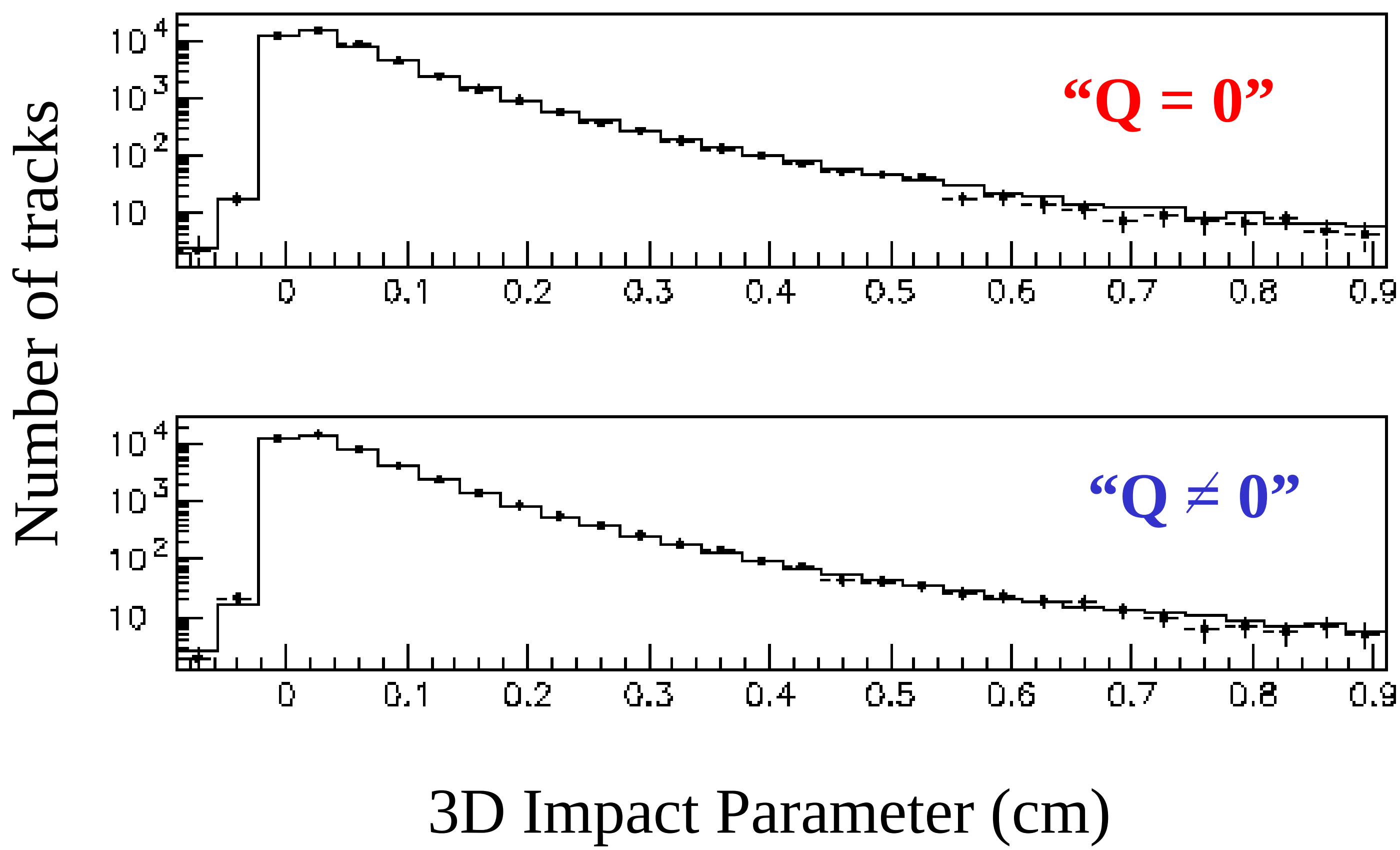
Impact Parameter distributions for Data & MC



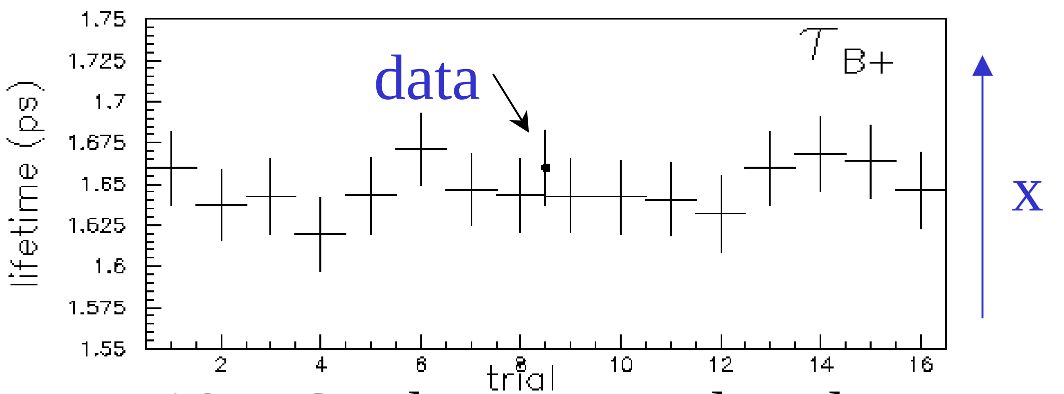
Instead, look at the Average of the 3D(2D) impact parameters for the trks in the vertex (nice thing: one entry per event)

	τ_{B+} ($\pm$ stat) *psec*	τ_{B0} ($\pm$ stat) *psec*	τ_{B+}/τ_{B0} ($\pm$ 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%

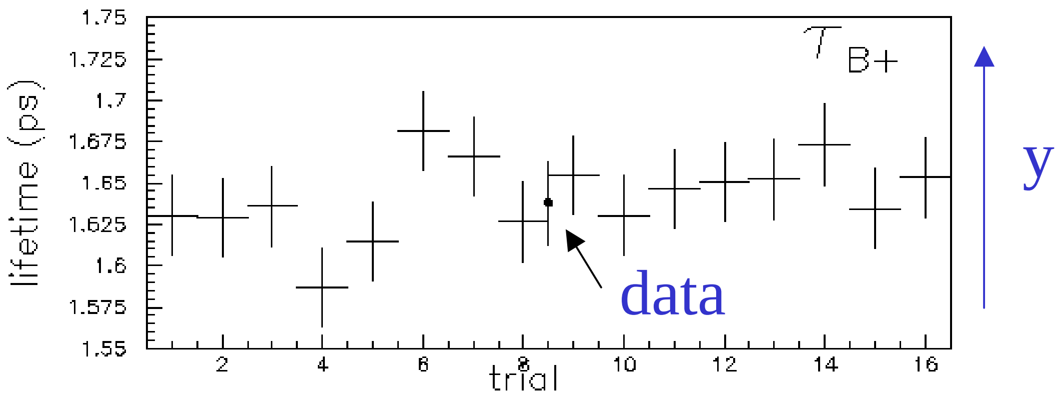
Degree of correlation between two analyses

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

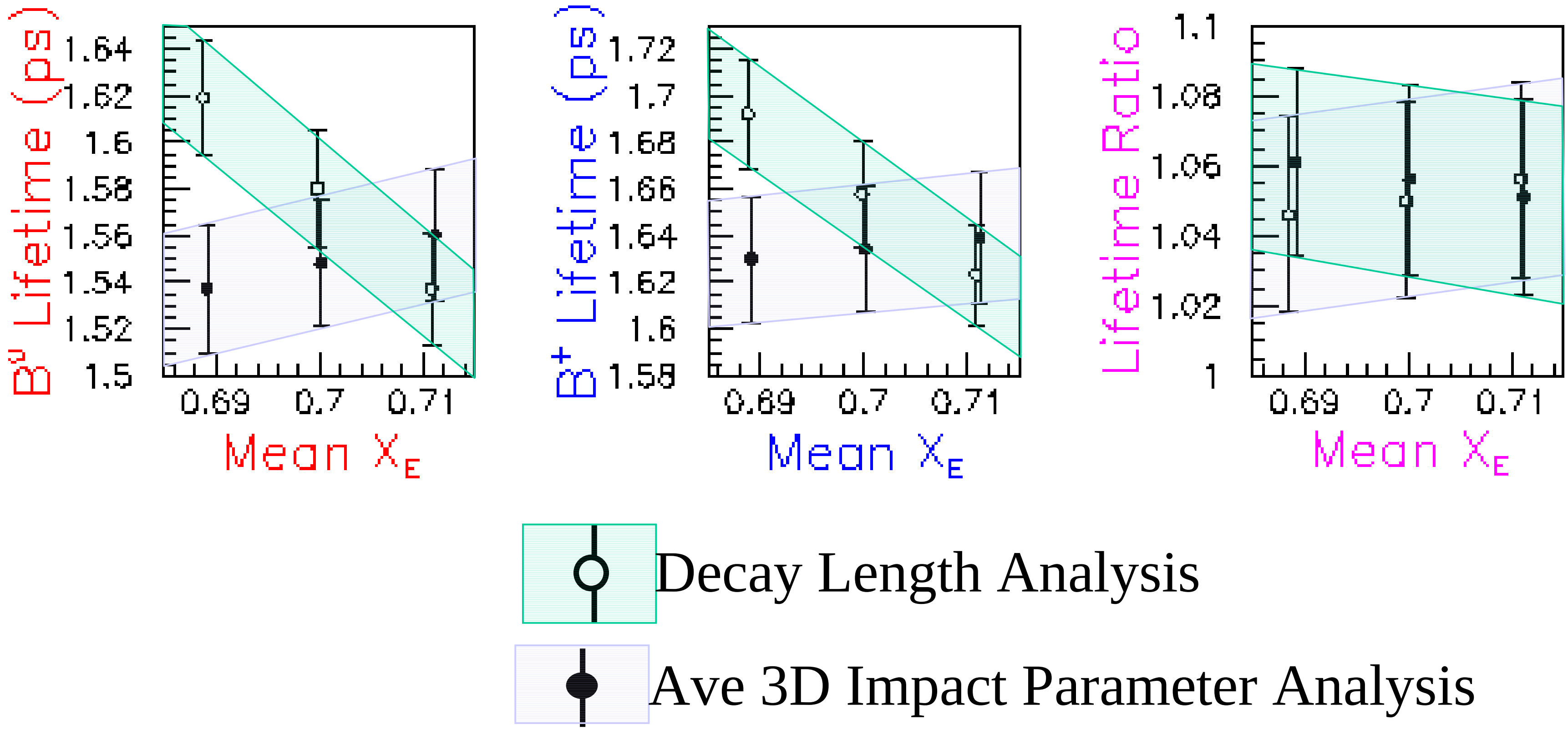
b fragmentation	0.02456	0.02934	0.00363
bowler shape	0.01044	0.00863	0.00098
BR(B-->DX)	0.00505	0.00846	0.00712
BR(B-->DDX)	0.01445	0.01365	0.01602
B decay multi.	0.00072	0.00267	0.00126
B_s fraction	0.00298	0.00116	0.00266
b_baryon frax.	0.00410	0.01656	0.00826
b_s lifetime	0.00003	0.01356	0.00891
B baryon life	0.00036	0.00528	0.00324
D decay multi.	0.00327	0.00536	0.00559
D decay K0 yield	0.00153	0.00832	0.00452

Average 3D imp. param.

b fragmentation	0.00359	0.00821	0.00297
bowler shape	0.00409	0.00541	0.00598
BR(B-->DX)	0.00963	0.03648	0.02464
BR(B-->DDX)	0.00665	0.00596	0.00727
B decay multi.	0.01850	0.01281	0.01935
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
B baryon life	0.00057	0.01123	0.00686
D decay multi.	0.00555	0.01396	0.00535
D decay K0 yield	0.01127	0.00659	0.01119

Recall from last collab. mtg :

Lifetime dependence on X_E



Use intersection to constrain X_E

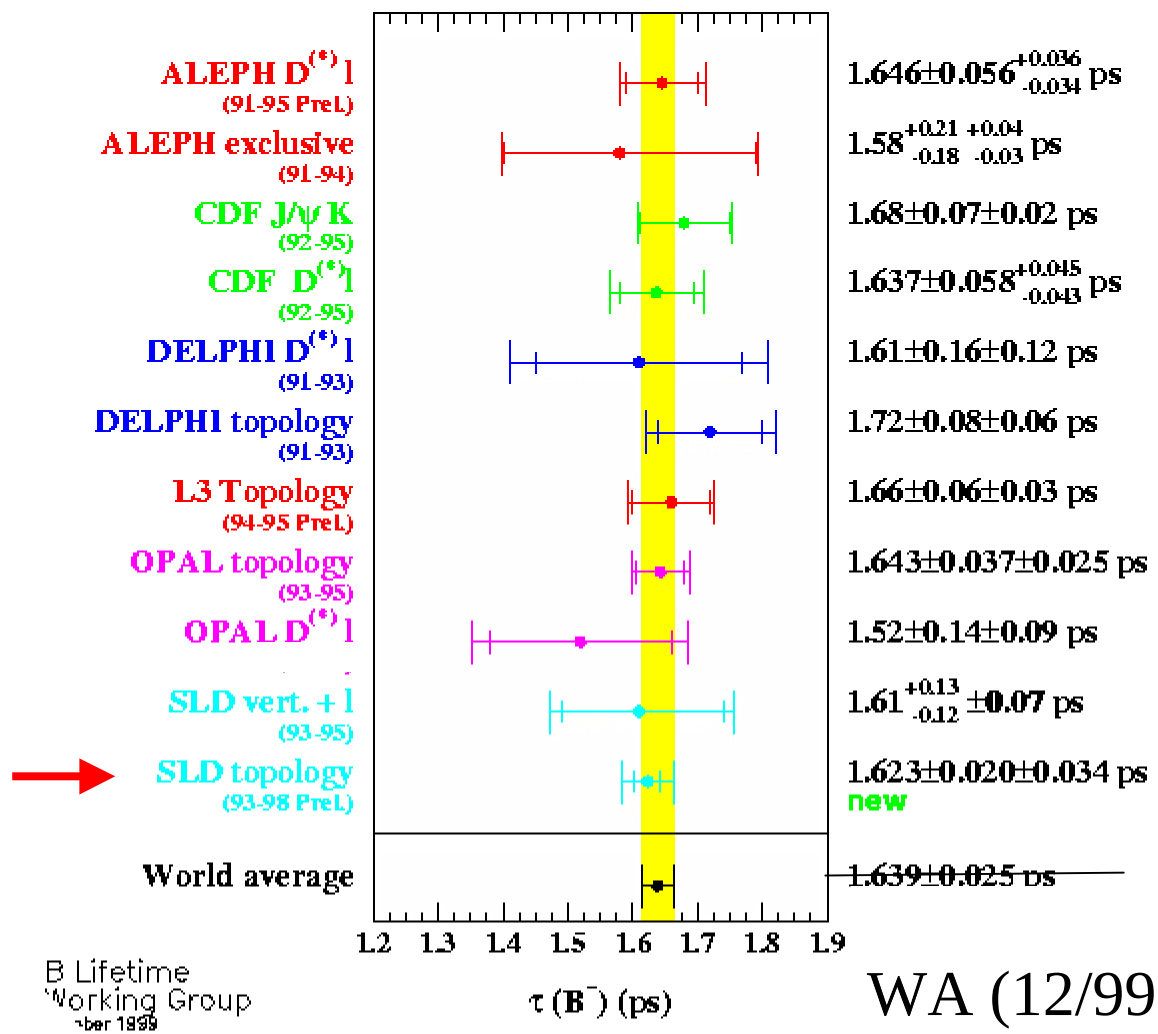
very preliminary!

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 !?!

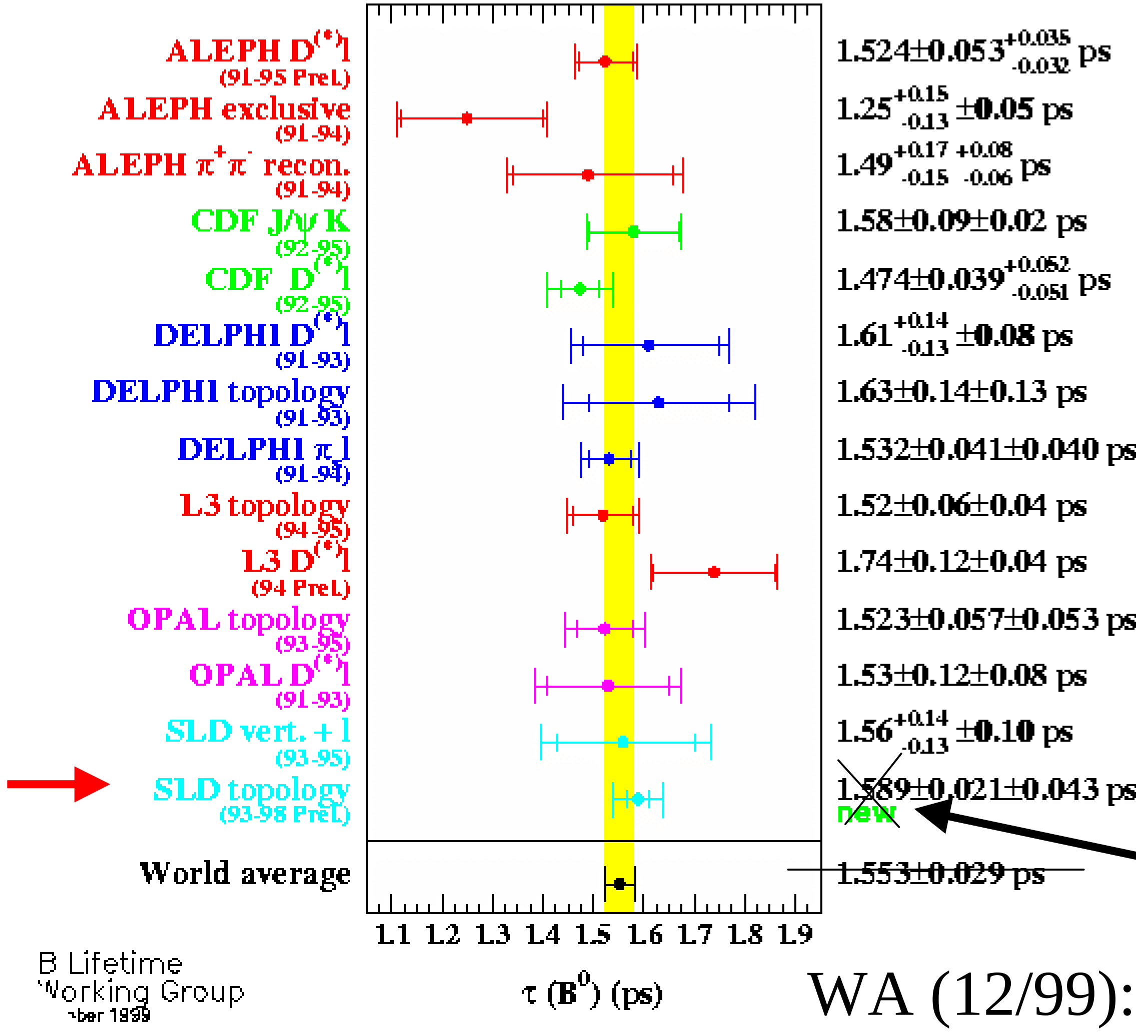
τ_{B+} Summary



1.623 ± 0.03 ps

WA (12/99): 1.656 ± 0.025 ps

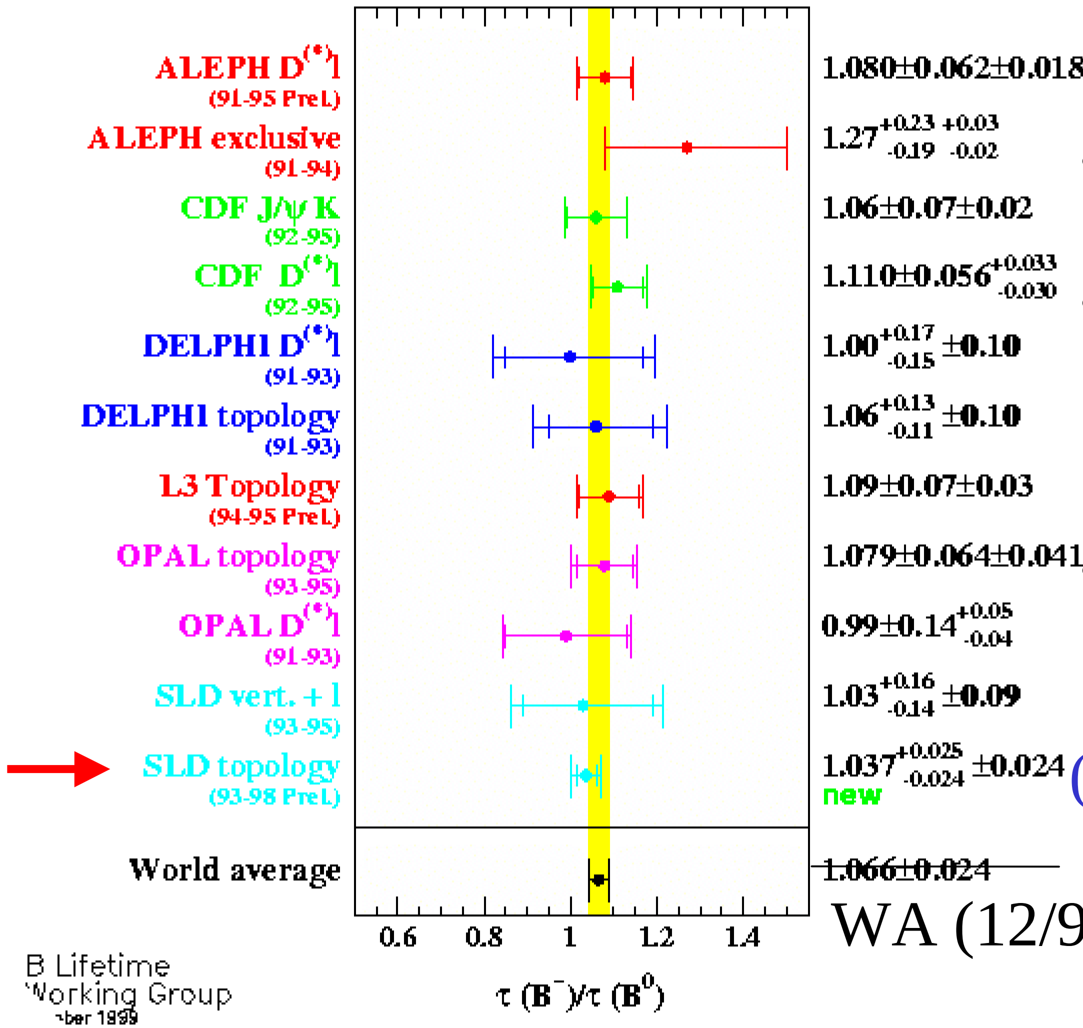
τ_{B0} Summary



1.565
(typo - my fault)

WA (12/99): 1.562 ± 0.029 ps

τ_{B+} / τ_{B0} Summary



(ok)

WA (12/99): 1.065 ± 0.023

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

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