Same-Side Flavor Tagging at CDF

Nuno Leonardo
Massachusetts Institute of Technology

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- Flavor tagging
- Reconstructing the B decays
- Fragmentation track correlations
- Selecting the Same Side Tag
- Measuring the tagger properties
    - Efficiency, Dilution, εD^2
- Summary

Chicago Flavor Seminar

B-flavor tagging

Observation of mixing in a neutral B system (B_d or B_s) relies on determination of production flavor: b or anti-b

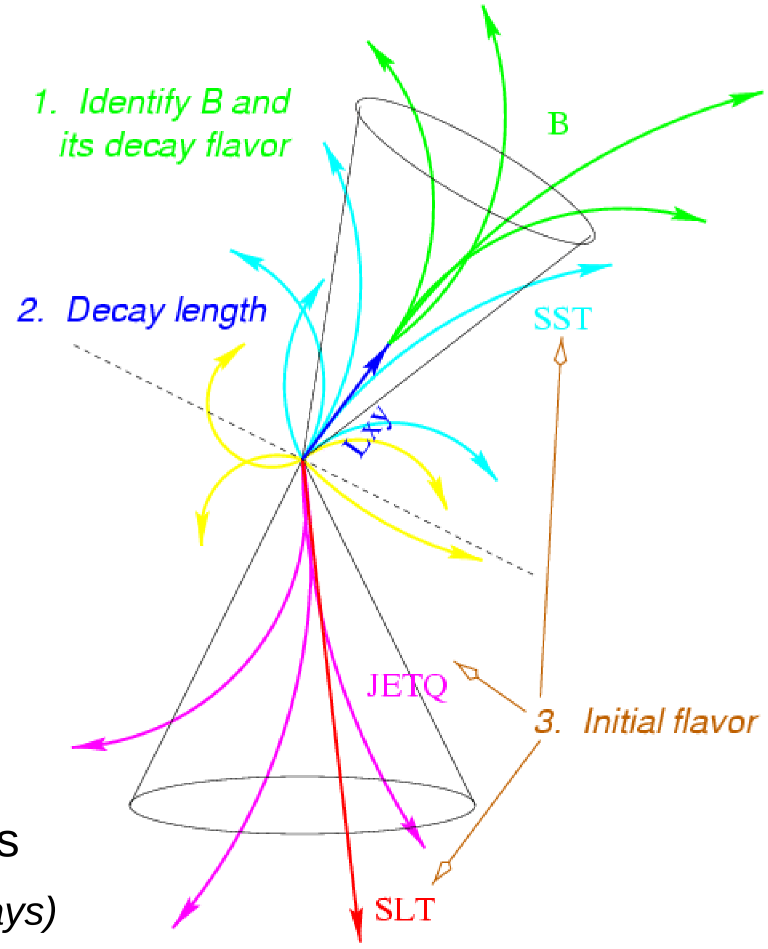
Tagging methods used at CDF:

- Same-Side Tagging (SST)
- Opposite-Side Tagging (JETQ, SLT)

  (see I.Kravchenko's talk for details on OST)

Tagger properties are better accessed in fully reconstructed charged B meson decays

(see J.Piedra's talk for SST applied to neutral B decays)



Reconstructing the B decays (1)

$$B^+ \to J/\psi\, K^+ ,\quad J/\psi \to \mu^+\ \mu^-$$

J/ψ

-$p_T(\mu^{\pm}) > 1.5$ GeV/c

K

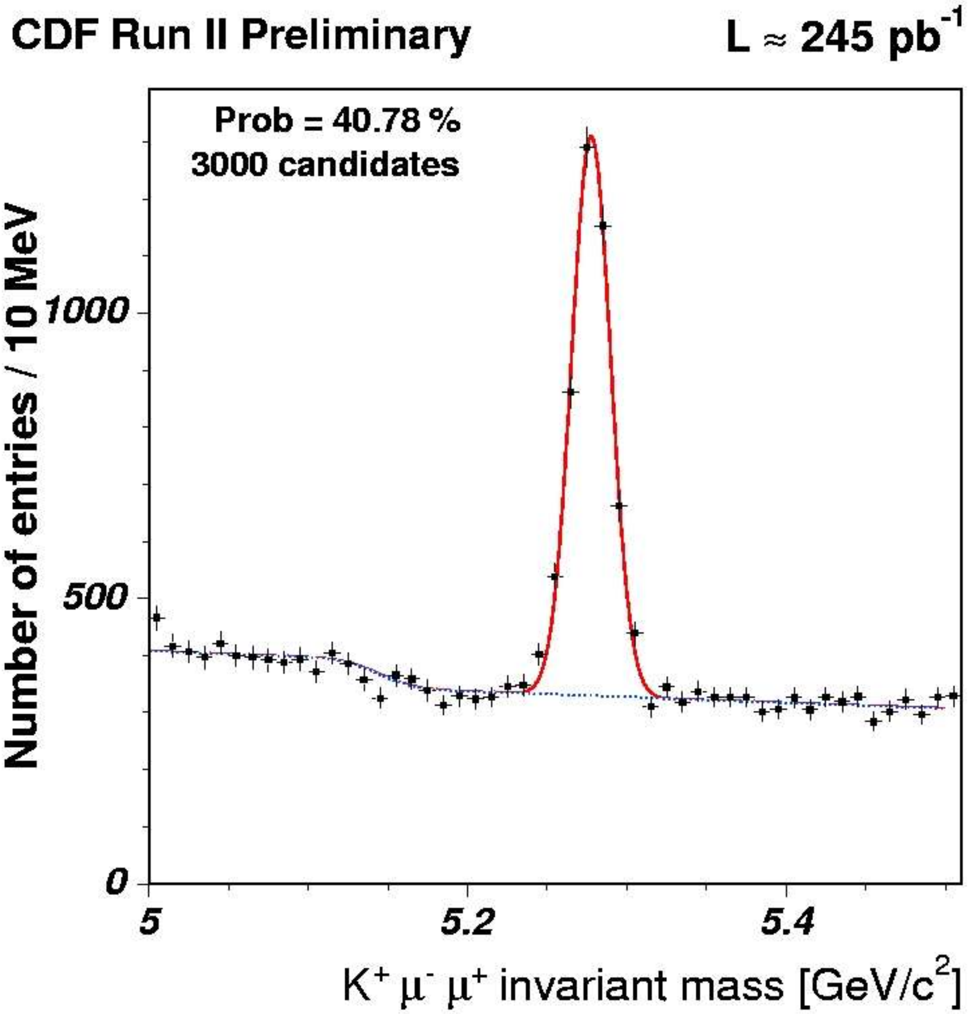
-$p_T > 2$ GeV/c

B

-$p_T > 6.5$ GeV/c

-Vertex probability > 0.1%

-$L_{xy} > 100\ \mu m$



Reconstructing the B decays (2)

$$B^+ \rightarrow \bar{D}^0 \pi^+ , \quad \bar{D}^0 \rightarrow K^+ \ \pi^-$$

D

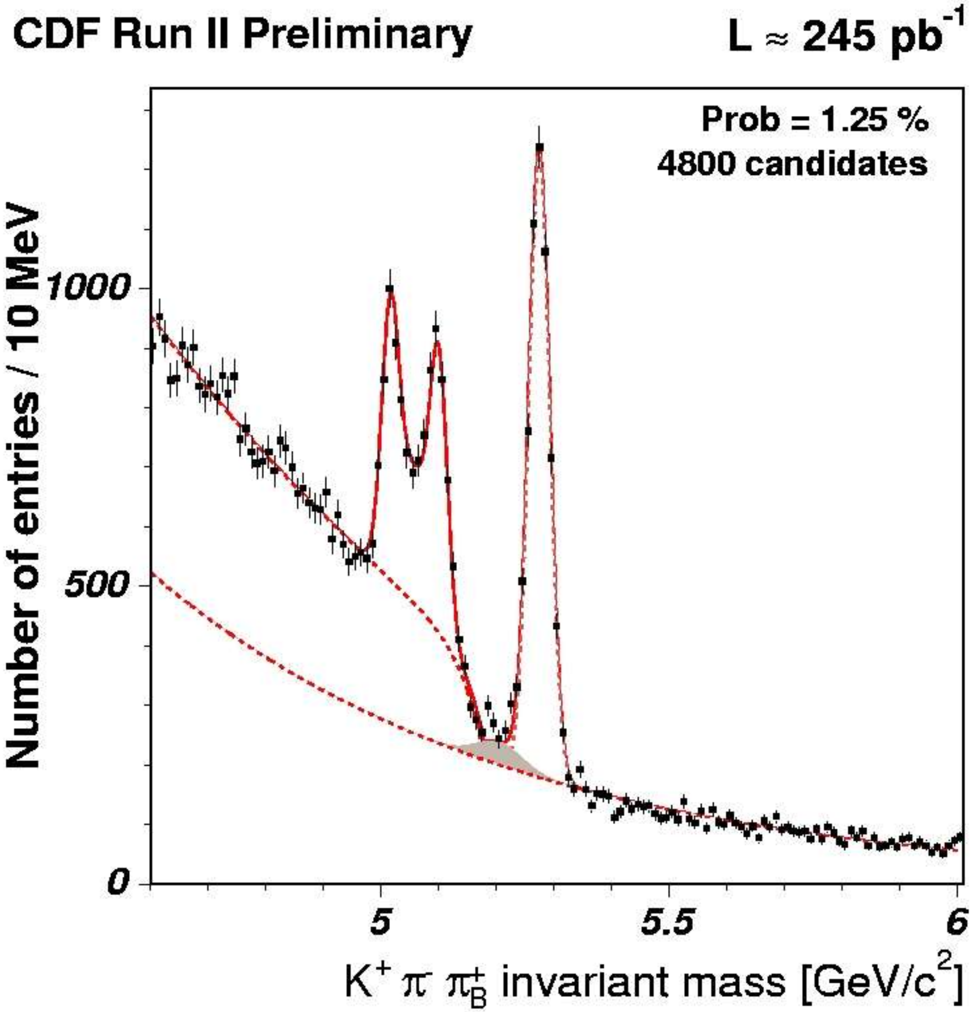
- $\chi^2(r,\phi) < 14$
- $\Delta R(D,\pi_B) < 1.5$

π_B

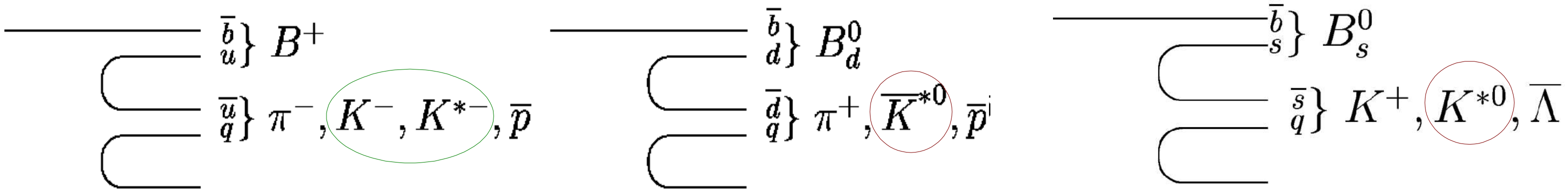
- P_T>1.5 GeV/c

B

- $\chi^2(r,\phi) < 15$
- $|d0| < 80\ \mu m$
- L_{xy}(B->D) > -150 μm
- L_{xy} > 300 μm



Fragmentation track correlations



The SST method is based on expected *flavor-charge correlations*:

- between B meson and particles produced in fragmentation
- between B meson and pions coming from B^{**} decays

B^+(B^-) are accompanied by negative (positive) pions

B^0($\overline{B^0}$) are accompanied by positive (negative) pions

Mistagging probability for neutral decays is expected to be larger

➡ tracks from K^* do not contribute in the neutral case

Selecting the Same Side Tag

The identification of the flavor of a neutral B meson can make use of hadrons produced nearby in phase space. ***M.Gronau, J.Rosner, Phys.Rev. D49 (1994) 254-264***

Consider tracks:

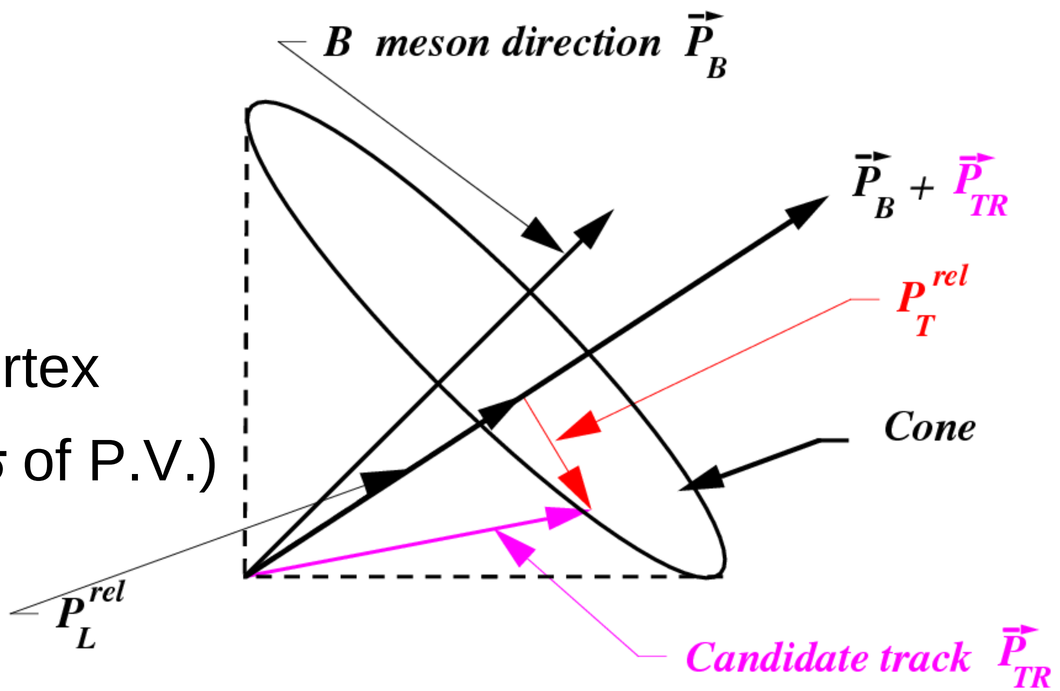
- close to the B meson

$$\Delta R \equiv \sqrt{\Delta\eta^2 + \Delta\phi^2} < 0.7$$

- p_T > 350 MeV
- originating from Primary Vertex

  (impact parameter within 3σ of P.V.)
- track quality cuts
- multiple track candidates:

➡ select track with minimum p_T^{rel}



Measuring the tagger properties

Each B candidate is assigned to one of 3 classes:

- Right-Sign (RS), if *production* flavor = *decay* flavor
- Wrong-Sign (WS), if *production* flavor ≠ *decay* flavor
- Not Tagged (NT), if no SST tag track candidates are found

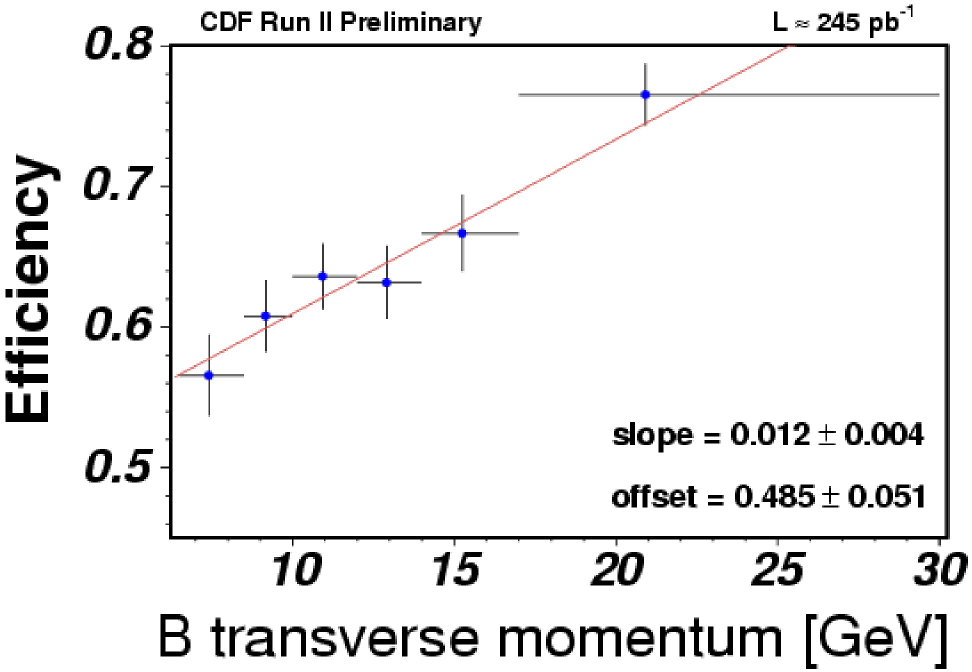
- Definition of tagger properties:

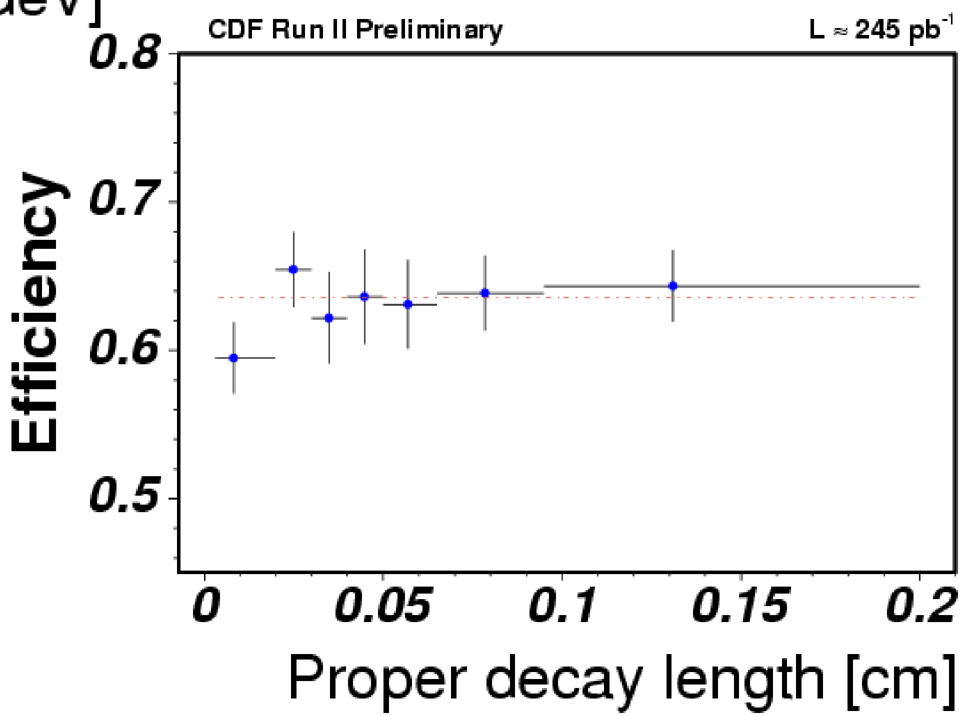
- Efficiency: $$\epsilon = \frac{N_{tagged}}{N_{total}} = \frac{N_{RS} + N_{WS}}{N_{RS} + N_{WS} + N_{NT}}$$

- Dilution: $$D = 1 - 2 P_{mistag} = \frac{N_{RS} - N_{WS}}{N_{RS} + N_{WS}}$$

Sample is further subdivided in bins of $\mathbf{p_T}$ and **ct** of the B meson

Same-Side Tagger efficiency (1)



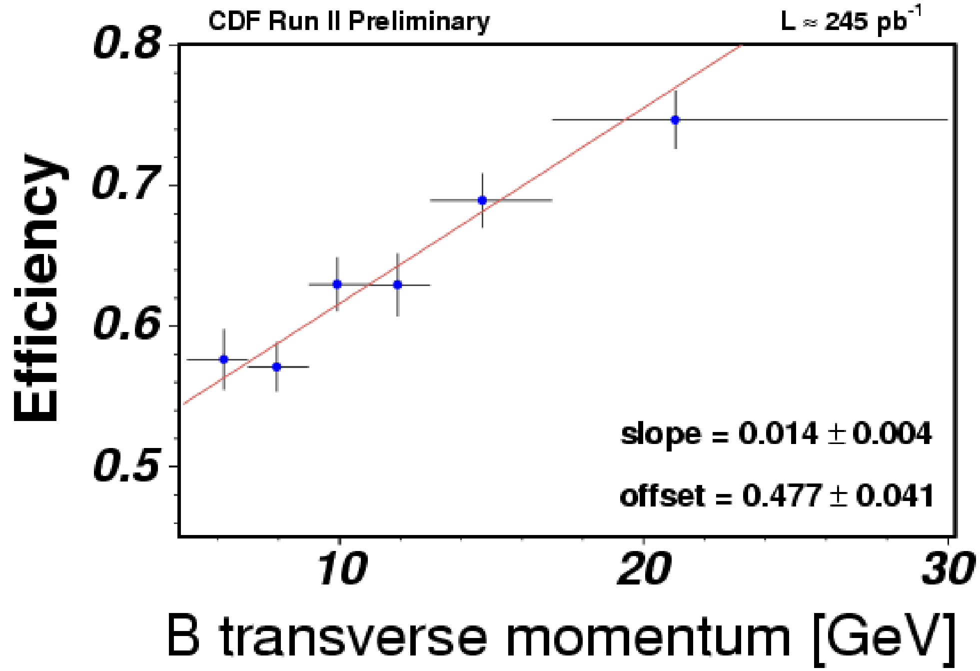


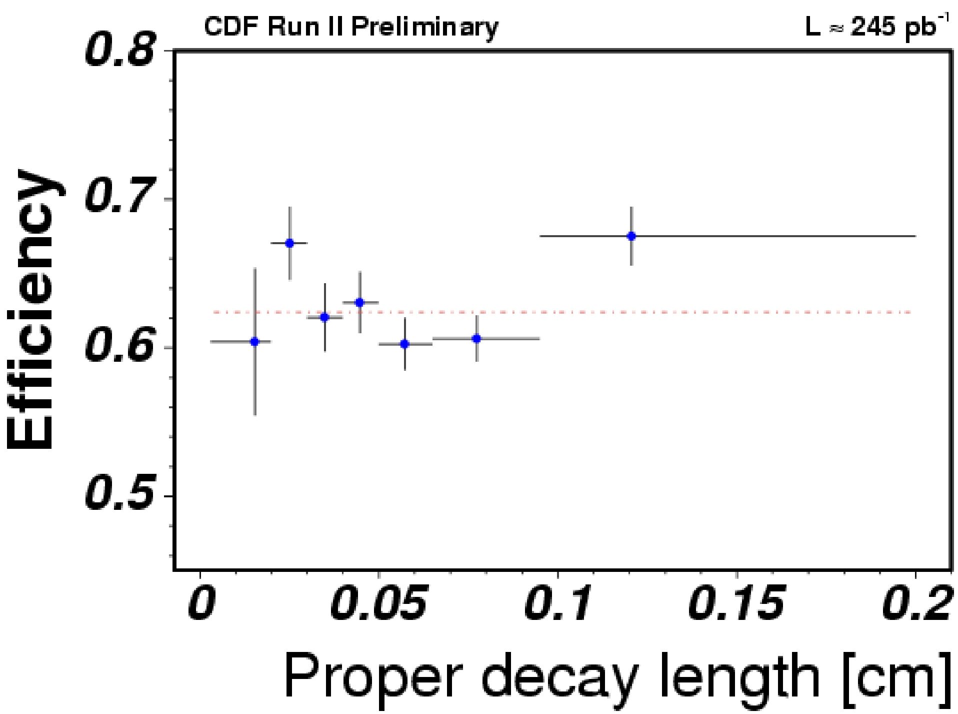
$\varepsilon = 63.5 \pm 1.2\ \%$

$$B^{\pm} \to J/\psi\, K^{\pm}$$

$$[\, J/\psi \to \mu^{+}\ \mu^{-}\ ]$$

Same-Side Tagger efficiency (2)



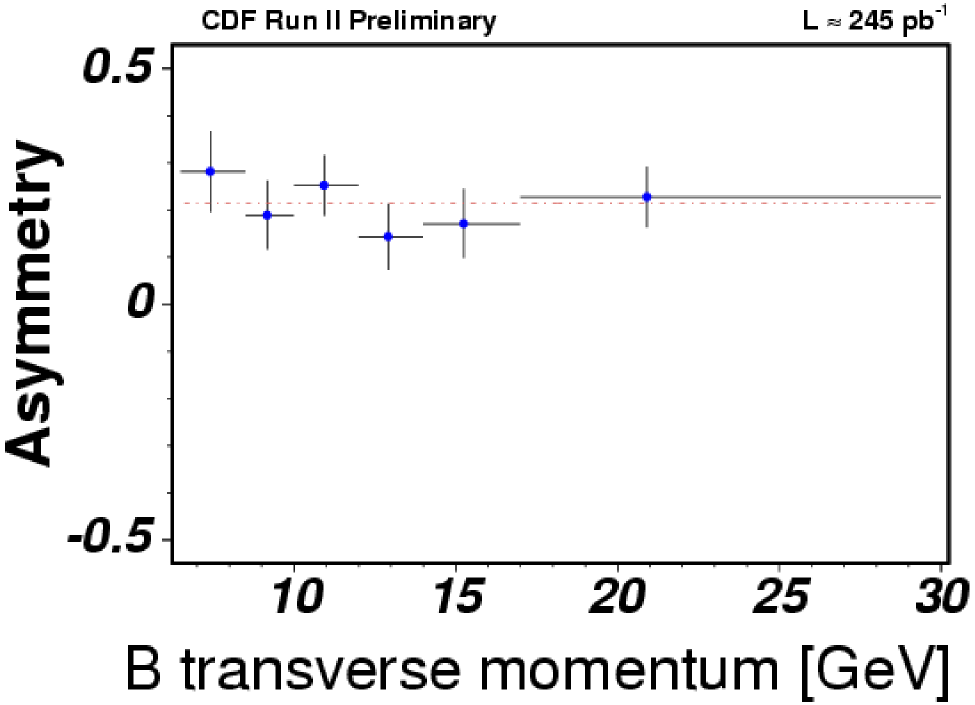


$\varepsilon = 62.4 \pm 0.8$ %

$$B^+ \rightarrow \bar{D}^0 \pi^+$$

$$[\bar{D}^0 \rightarrow K^+ \pi^-]$$

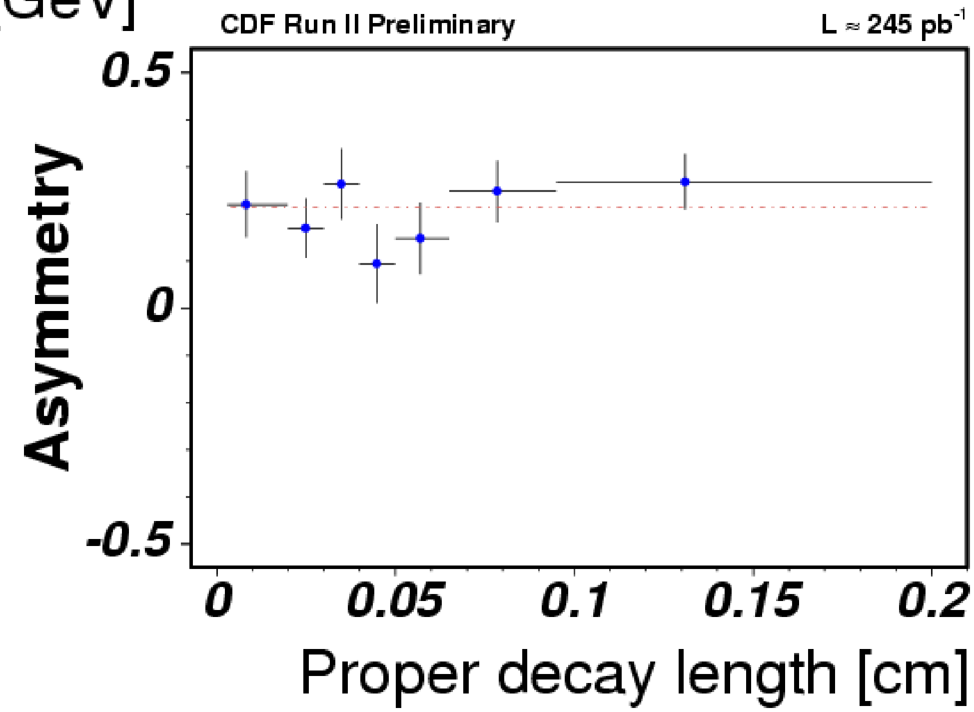
Same-Side Tagger dilution (1)



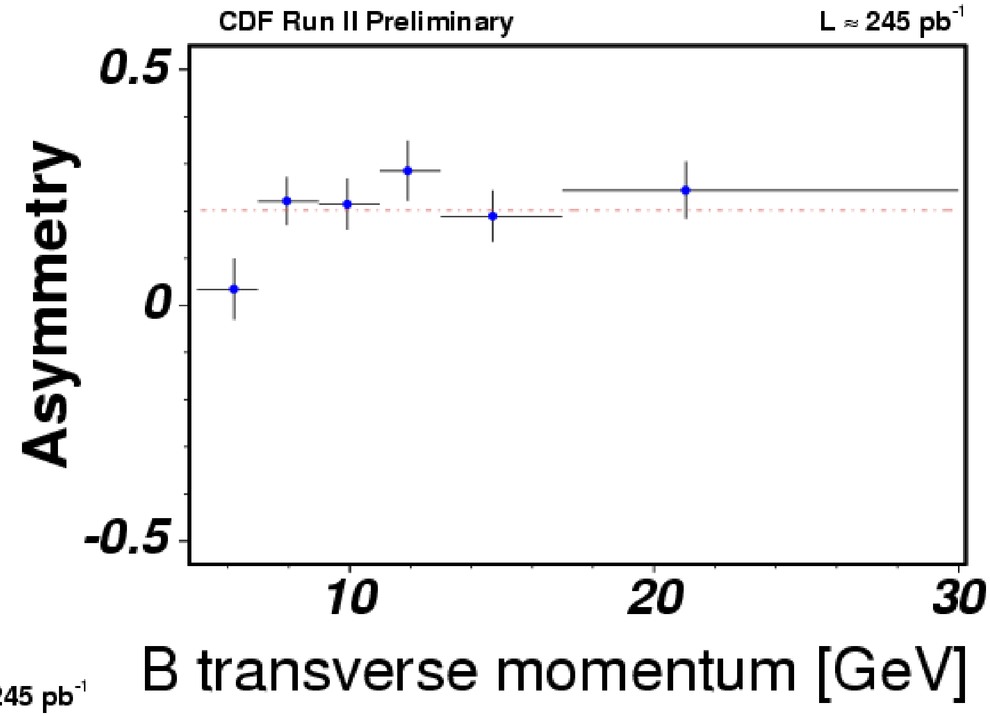
$D = 22.2 \pm 3.4\ \%$

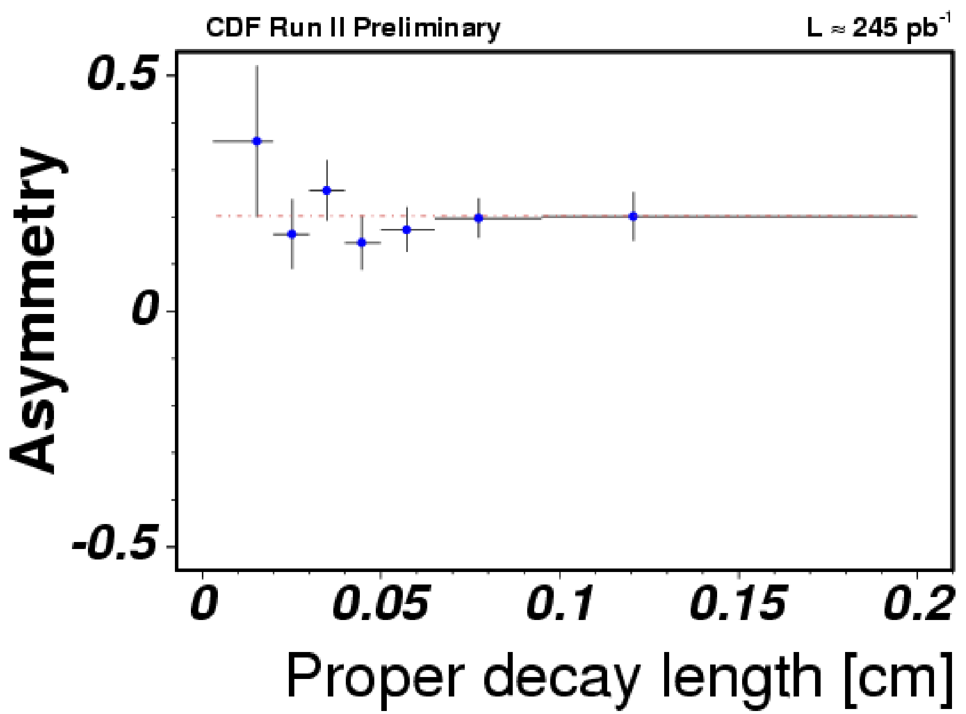
$$B^{\pm} \to J/\psi\, K^{\pm}$$

$$[\, J/\psi \to \mu^{+}\ \mu^{-}\,]$$



Same-Side Tagger dilution (2)





D = 20.2 ± 2.4 %

$$B^{+} \rightarrow \bar{D}^{0} \pi^{+}$$

$$[\bar{D}^{0} \rightarrow K^{+} \pi^{-}]$$

Summary

- The Same-Side Tagging technique has been studied in two fully reconstructed charged B meson decays

- The observed behavior and tagger properties agree well for the studied decays

- The measured tagger properties for charged decays is

$\varepsilon(B^+)$ = 62.7 ± 0.7 (stat.) %

$D(B^+)$ = 21.2 ± 2.0 (stat.) %

$\varepsilon D^2(B^+)$ = 2.8 ± 0.5 (stat.) % $\neq \varepsilon D^2(B^0) \neq \varepsilon D^2(B_S)$

- Further SST studies under way towards B_S mixing

➜ Optimize tagger for B^0 mixing

➜ Reproduce SST with Monte Carlo

➜ Include particle identification (TOF, dE/dx)