

A DS (Atwood, Dunietz, Soni) method

GLW method

→ r^2 : difficult to measure.

$$r^2 \equiv \frac{\text{Br}(B^- \rightarrow \bar{D}^0 K)}{\text{Br}(B^- \rightarrow D^0 K)}$$

ADS method

use $B^\pm \rightarrow \bar{D}^0 (\rightarrow f_i) K^\pm$ with
multiple mode

(Both D^0 and $\bar{D}^0$ decay to common final states f_i)

→ fit $\phi_3 \delta_i r$
(δ_i : strong phase)

- We estimated the needed Luminosity
for measurement ϕ_3 at $\pm 15^\circ$

• $B \rightarrow D^0(\rightarrow f_i) K^*$

$\# B^{\pm} = 10^8 \rightarrow 100 \text{ fb}^{-1}$

Mode (f_i)	# event @ $10^8 (N_i)$	δ_i (assumption)
$K^+ \pi^-$	83	10°
$K_S \pi^0$	791	20°
$K^+ \rho^-$	224	30°
$K^+ a_1^-$	146	40°
$K_S \rho^0$	362	200°
$K^{*+} \pi^-$	65	50°

where we assumed $\phi_3 = 60^\circ$

$$\begin{cases} \epsilon_{\text{det}}(B \rightarrow D(f_i) K^*) = 100\% \\ \epsilon_{\text{det}}(D^0 \rightarrow f_i) = 100\% \end{cases}$$

This table was quoted ADS paper Tab II

$$d: Br(B^- \rightarrow \bar{D}'(\rightarrow f_i) K^*)$$

$$\bar{d}: Br(B^+ \rightarrow \bar{D}'(\rightarrow \bar{f}_i) K^{*+}) \rightarrow \text{measurement}$$

$\bar{d}$ is function of $\phi_3 f_i b$

$$\text{where } b: Br(B^- \rightarrow \bar{D}^0 K^{*-})$$

$$a: Br(B^- \rightarrow D^0 K^{*-}) \rightarrow \text{known}$$

$$r^2 = \frac{b}{a}$$

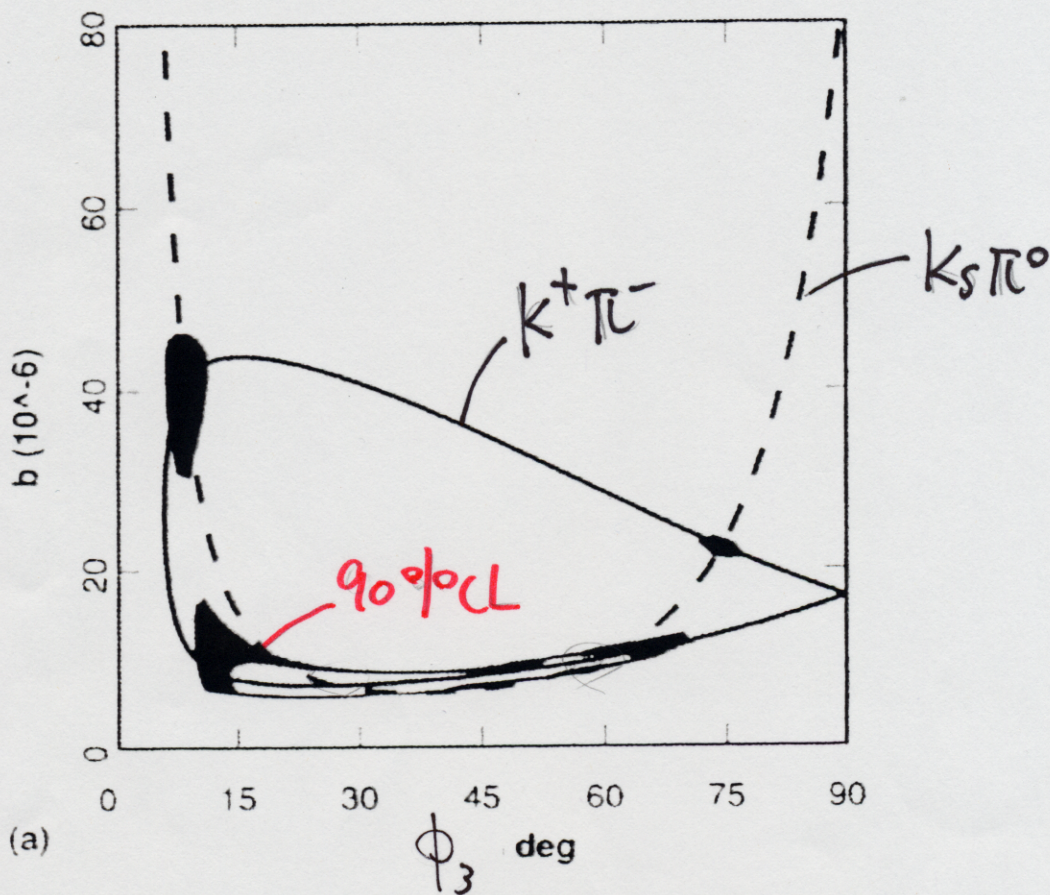
$$\left. \begin{array}{l} d(\phi_3 f_i b) = \text{val} \\ \bar{d}(\phi_3 \bar{f}_i b) = \text{val} \end{array} \right\} \xrightarrow{\text{eliminate } f_i} F(\phi_3 b) = 0$$

$f_i: 2 \text{ mode} \rightarrow 2 \text{ lines as function of } \phi_3, b$

$\rightarrow$ determination ϕ_3

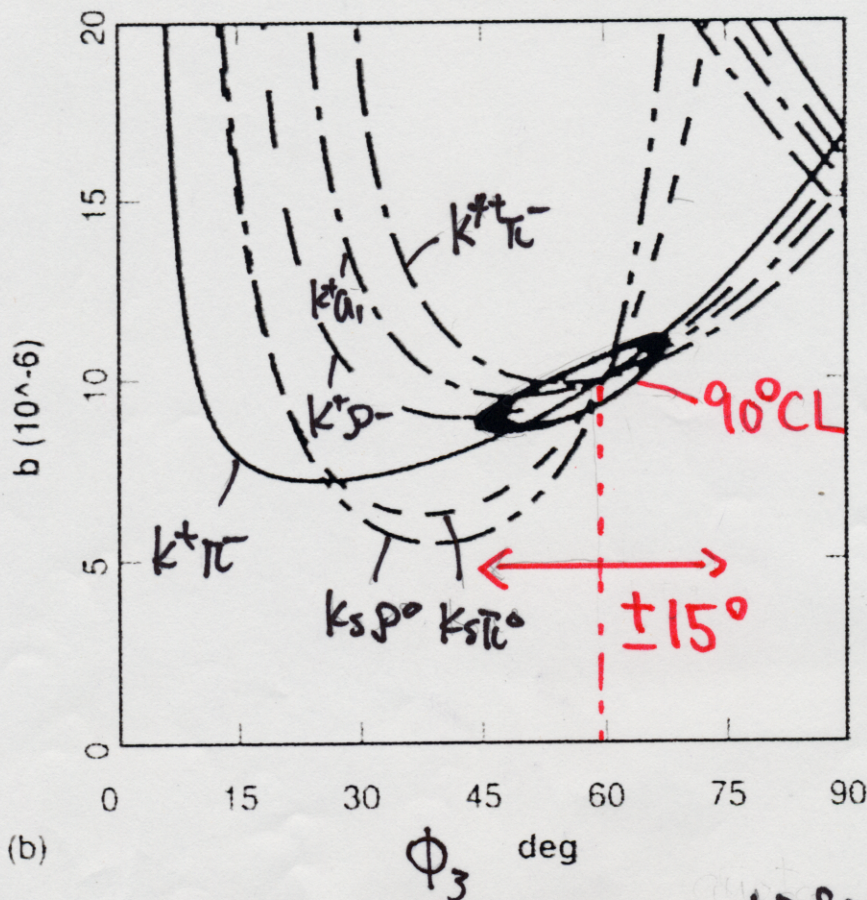
$$\#B^{\pm} = 10^8 (0.1 \text{ ab}^{-1})$$

2 mode



(a)

multiple mode



(b)

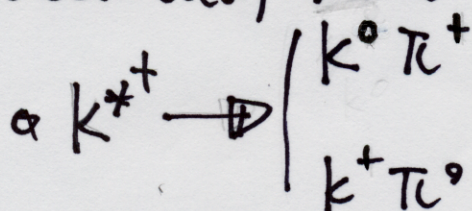
Estimation of efficiency relative to $\bar{D}^0 \rightarrow k^+ \pi^-$ mode

(5)

$$\#B^{\pm} = 10^8$$

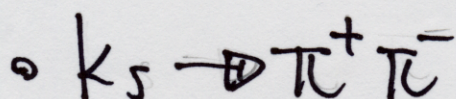
	#trk	# π^0	Br	$\epsilon_i = \left(\frac{2}{3}\right)^{\#trk} \left(\frac{1}{2}\right)^{\#\pi^0} Br / \left(\frac{2}{3}\right)^2$	N_i	$N_i \times \epsilon_i$
$k^+ \pi^-$	2	0	1	1	83	83
$k_S \pi^0$	2	1	$1/2$	$\frac{1}{4}$	791	198
$k^+ p^-$	2	1	1	$\frac{1}{2}$	224	112
$k^+ a_1^-$	4	0	$1/2$	$\frac{2}{9}$	146	32
$k_S p^0$	4	0	$1/2$	$\frac{2}{9}$	362	80
$k^{*+} (k^+ \pi^0) \pi^-$	2	1	1	$\frac{1}{2}$	$65 \times \frac{1}{3}$	11
$k^{*+} (k^0 \pi^+) \pi^-$	4	0	$1/2$	$\frac{2}{9}$	$65 \times \frac{2}{3}$	10
Sum					<u>1671</u>	<u>526</u>

Used decay mode



$$\bullet \quad \epsilon_{trk} = \frac{2}{3}$$

$$\bullet \quad \epsilon_{\pi^0} = \frac{1}{2}$$



$$\frac{\text{Sum}(N_i \times \epsilon_i)}{\text{Sum}(N_i)} = \frac{526}{1671} = 0.31$$

efficiency relative to $k^+ \pi^-$ mode

6)
• for $B^{\pm} \rightarrow \bar{D}^0 K^{*\mp}$

$$\bullet \epsilon_{\text{det}}(D(\rightarrow K^+ \pi^-) K^*) = 0.35 \times \frac{1}{4}$$

$$\hookrightarrow \begin{cases} \epsilon_{\text{det}}(D(\rightarrow K^+ \pi^-) K) = 0.35 \text{ (BELLE)} \\ \epsilon_{K^*} / \epsilon_K = \frac{1}{4} \end{cases}$$

$$\bullet S/N = 1/1 \text{ (assumption)}$$

How much statistic do we need?

$$\frac{1}{\epsilon_{\text{det}}} \times \frac{1}{0.31} \times 2 = 67 \text{ times of } 10^8 B^{\pm} \text{ (0.1ab)}$$

$\uparrow$ efficiency $\uparrow$ S/N
relative to $K^+ \pi^-$ mode

$$\int \mathcal{L} dt = 0.1 \text{ ab}^{-1} \times 67$$

$$B \rightarrow \bar{D}^0 K^* = 6.7 \text{ ab}^{-1}$$

• We need 6.7 ab^{-1} for measurement ϕ_3
at $\pm 15^\circ$ precision
(90% CL)

(7)

for $B^\pm \rightarrow \bar{D}^0 K^\pm$

• $\frac{\text{Br}(B^- \rightarrow D^0 K^{*-})}{\text{Br}(B^- \rightarrow D^0 K^-)} = \underline{\underline{2.5}} \rightarrow \text{use as correction factor}$

• $\epsilon_{\text{det}}(D \rightarrow K^+ \pi^-) K = 0.35 \text{ (BELLE)}$

• $S/N = 1/1 \text{ (assumption)}$

$$\frac{1}{\epsilon_{\text{det}}} \times \frac{1}{0.31} \times 2 \times 2.5 = 3 / \text{times of } 10^8 B^\pm \text{ (0.1ab)}$$

$$\int \mathcal{L} dt = 0.1 \text{ab}^{-1} \times 31 \\ = \underline{\underline{3.1 \text{ab}^{-1}}}$$

$B \rightarrow \bar{D}^0 K$

• We need 3.1ab^{-1} for measurement ϕ_3
at $\pm 15^\circ$ (90% CL)

• Summary

- For measurement ϕ_3 at $\pm 15^\circ$

We need $\left\{ \begin{array}{l} 6.7 \text{ ab}^{-1} \text{ for } B^\pm \rightarrow \bar{D}^0 K^{*\pm} \\ 3.1 \text{ ab}^{-1} \text{ for } B^\pm \rightarrow \bar{D}^0 K^\pm \end{array} \right.$

Used D^0 decay mode ($K^+\pi^-$, $K_S\pi^0$, $K^+\rho^-$, $K^+a_1^-$,
 $K_S\rho^0$, $K^{*+}\pi^-$)

- Efficiency of $B^\pm \rightarrow \bar{D}^0 (\rightarrow K^+\pi^-) K^\pm = 35\%$

Is it true?

- $S/N = 1/1 \rightarrow$ This is assumption.