Ac using K+ vertex chg and Ab using K+ chg

by T. Wright
$A_c$ using K+VTX charge

$A_b$ using K charge

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Status of $A_c$

Preliminary results have been released for 93-95 R12 using the MC analyzing power and for 96-98 R15 using a self-calibrated analyzing power.

- $A_c = 0.670 \pm 0.066 \pm 0.042$ (93-95)
- $A_c = 0.589 \pm 0.031 \pm 0.025$ (96-98)
- $A_c = 0.603 \pm 0.028 \pm 0.023$ (93-98 combined)

Tag performance for 96-98

\[
\begin{align*}
\Pi_c &= 0.821 \pm 0.005 & p_c &= 0.942 \pm 0.012 \\
\Pi_b &= 0.158 \pm 0.005 & p_b &= 0.605 \pm 0.036
\end{align*}
\]

The charm hemisphere tag is $\sim 16\%$ efficient.

Main systematic errors

<table>
<thead>
<tr>
<th>Source</th>
<th>$\delta A_c$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p_c$</td>
<td>0.0163</td>
</tr>
<tr>
<td>$p_b$</td>
<td>0.0146</td>
</tr>
<tr>
<td>$P_e(\pm 0.8%)$</td>
<td>0.0065</td>
</tr>
<tr>
<td>$\cos \theta, P_{VTX}$ shape</td>
<td>0.0060</td>
</tr>
</tbody>
</table>
$A_c$ Prospects

- Move to R16 reconstruction
  - Have seen $\sim 30\%$ increase in $\eta_c$
  - Many of the new vertices will be neutral
    (because of $D^0/D^+$ lifetime difference)
  - Can hope for $\pm 0.027 \pm 0.023$
    (simply scaling stat. and $p_c$ syst.)

- Use $P_e$ to calibrate $p_b$
  (to get a more efficient/powerful high-mass sign in the mixed events)

- Analyze 93-95 data using self-calibration technique

- Extend cos $\theta$ coverage

- More work on likelihood function

- SLD note / conference paper / PRL / thesis
Issues for $A_b$ self-calibration

$B$-decay $K$'s are softer than from direct $D$'s, so lower $p_{\text{correct}}$ expected due to lower $K$-purity.

Kaon ID efficiency

The error on $p$ for self-calibration is $\sigma_p = \frac{1}{2} \sqrt{\frac{r(1-r)}{N(2r-1)}}$, where $r = p^2 + (1-p)^2$ is the fraction of same-sign events.

For $A_c$ we found $p_c \simeq 0.9$, while for $A_b$ we expect $p_b \simeq 0.7$.

$$\Rightarrow \frac{\sigma_{p_b}}{\sigma_{p_c}} \sim 2.6 \Rightarrow \frac{\delta A_b}{\delta A_c} \sim 7.3$$ for same $N$.

It's clear that very high efficiency is required to make this a viable technique.

Fortunately, the low-mass vertices are useful because we're only interested in tracks from the cascade $D$ vertex.
Hemisphere and Event Selection

Use two types of hemisphere tags:

- High-mass \( h \): \( M > 2, \sigma_d/d > 5 \)
- Low-mass \( l \): any vertex which isn't 'h'

The 'h' tag is high-\( b \) purity, while the 'l' tag is \( \sim 50\% \) pure. Calibrate by counting the fraction of events containing the different combinations of \( h, l, \) and no vertex. These can be written in terms of \( \epsilon^h, \epsilon^l, \) and \( R_f \).

Solving for \( \epsilon^l, \epsilon^h, R_c, \) and \( R_b \) we find the following \( b \)-fractions:

<table>
<thead>
<tr>
<th>tag comb.</th>
<th>MC truth</th>
<th>Data SC</th>
</tr>
</thead>
<tbody>
<tr>
<td>0+l</td>
<td>0.2390</td>
<td>0.2267</td>
</tr>
<tr>
<td>0+h</td>
<td>0.9243</td>
<td>0.9214</td>
</tr>
<tr>
<td>1+l</td>
<td>0.4590</td>
<td>0.4464</td>
</tr>
<tr>
<td>1+h</td>
<td>0.9736</td>
<td>0.9731</td>
</tr>
<tr>
<td>h+h</td>
<td>0.9994</td>
<td>0.9994</td>
</tr>
</tbody>
</table>

Use l+h and h+h for \( p \) calibration, and also 0+h for \( A_b \) fit. The average purity for these three subsets is \( f_b = 0.9634 \pm 0.0007 \) (MC truth 0.9641).
**$K$ Track Selection**

Use CKID routine to tag tracks as $K$. The track cuts are:

- $\cos\theta < 0.68$
- $p > 0.8$ GeV
- $\chi^2/dof < 5$
- CRID on, live TPC, MIP ring if applicable, etc.

Cuts on the ln $\mathcal{L}$ differences are:

<table>
<thead>
<tr>
<th></th>
<th>$p &lt; 2.5$ GeV</th>
<th>$p &gt; 2.5$ GeV</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K - \pi$</td>
<td>$&gt; 5$</td>
<td>$&gt; 3$</td>
</tr>
<tr>
<td>$K - p$</td>
<td>$&gt; -1$</td>
<td>$&gt; -1$</td>
</tr>
</tbody>
</table>

CKID has been tuned using $K_s$'s to match the MC $\pi \to K$ mid-ID rate to the data.
Calibration of $p_{\text{correct}}$

Can solve for $p$ from the fraction of doubly-charged events which are oppositely signed.

$$r = f_b [p_b^2 + (1 - p_b)^2] + f_c [p_c^2 + (1 - p_c)^2]$$

The data sample (for 97-98 only) is:

<table>
<thead>
<tr>
<th>tag comb.</th>
<th># events</th>
<th>$r$</th>
</tr>
</thead>
<tbody>
<tr>
<td>l+h</td>
<td>644</td>
<td>0.601±0.019</td>
</tr>
<tr>
<td>h+h</td>
<td>1237</td>
<td>0.581±0.014</td>
</tr>
</tbody>
</table>

The MC indicates that $p$ is $\sim 0.5\%$ higher in this sample compared to all tagged hemispheres. This correlation is accounted for in solving for $p$.

Can we use one $p_b$ for both l and h?

$$p_b^l = 0.7199 \quad p_b^h = 0.7243 \quad \text{(MC truth)}$$

For our purposes these are equal. The results are:

<table>
<thead>
<tr>
<th></th>
<th>MC truth</th>
<th>Data SC</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p_b$</td>
<td>0.7234</td>
<td>0.7078±0.0134</td>
</tr>
<tr>
<td>$p_c$</td>
<td>0.8460</td>
<td></td>
</tr>
</tbody>
</table>
$A_b$ Likelihood Fit

$A_b$ will be extracted using a likelihood fit to the cross-section. There are two ingredients which are not ready, however:

- Need to include $\cos \theta$ shape of $p_{\text{correct}}$
- May need new QCD correction compared to R12

Once these are done, we can expect:

$$\delta A_b \sim \pm 0.042_{\text{stat}} \pm 0.055_{\text{syst}}$$

Where the systematic error is due only to $p_{\text{correct}}$.

Can probably have this ready by next SLD Week if no problems crop up.