Flavour Tagging at LHCb
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**Flavour tagging**

Two independent methods to tag the production flavour of the $B_s$ meson:

- **Opposite side tagger (OS):**
  - exploit the second quark of the $b\bar{b}$ pair
  - OS kaon: $b \rightarrow c \rightarrow s$
  - OS muon, OS electron: semileptonic B decays
  - OS vertex: charge of the opposite B vertex

- **Same side tagger (SS):**
  - exploit the second quark of the $s\bar{s}$ pair
  - SS kaon: for $B_s^0$
  - SS pion: for $B_{s1/2}$

**Tagging algorithm:**
- cut based selection of tagging particles in signal B events.
- if more than 1 tagging particle remains, take the one with the highest $p_T$

**Neutral B meson mixing**

mass eigenstate ≠ weak eigenstate

$|\beta_s| = |\beta_d| + |\beta_u|$, $|\beta_d| = |\beta_s| - |\beta_u|

$\rightarrow$ neutral mesons oscillate into their anti-particles

mixing frequency $\Delta m$ corresponds to difference between mass eigenstates

**Measurement of $\Delta m_s$ in $B_s^0 \rightarrow D^- \pi^+$ decays**

**This study: Optimization of the OS Kaon tagger**

- **Using the flavour specific channel** $B^+ \rightarrow J/\psi K^+$

**Aim:** Understand the differences between data and MC to reoptimize the tagging algorithm on a corrected MC sample

**Current status of the LHCb flavour tagging performance using 1fb$^{-1}$ data, collected during 2011**

<table>
<thead>
<tr>
<th>Data</th>
<th>$\epsilon$ %</th>
<th>$\omega$ %</th>
<th>$\epsilon D^2$ %</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC</td>
<td>21.01 ± 0.06</td>
<td>39.84 ± 0.16</td>
<td>0.87 ± 0.03</td>
</tr>
<tr>
<td>MC corrected</td>
<td>15.76 ± 0.04</td>
<td>34.89 ± 0.13</td>
<td>1.44 ± 0.02</td>
</tr>
</tbody>
</table>

$\rightarrow$ MC is significantly better!

1. **PID cut efficiency:**
   - checked on clean data samples ($D^+ K, D^+ \pi, \Lambda_{c0}$)
   - data-MC agreement in cut efficiency: $2\% - 3\%$
   - $\Delta \epsilon: 0.1\%$, $\Delta \omega: 0.01\%$

2. **MC underestimates track multiplicity:**
   - correct number of tracks per event in MC, depending on the number of primary vertices and the kinematic range of the tracks
   - $\Delta \epsilon: 3\%$, $\Delta \omega: 1.8\%$

3. **Impact parameter resolution:**
   - MC impact parameter resolution too good in MC $\rightarrow$ smear it
   - $\Delta \epsilon: 4\%$, $\Delta \omega: 0.8\%$

4. **Remaining discrepancy:**
   - track $\chi^2/ndf$ distribution
   - adjust cut in MC, no distribution correction possible
   - $\Delta \epsilon: 1.8\%$, $\Delta \omega: 0.6\%$

5. **Misfit fraction still too low in MC:**
   - possible inefficiency in kaon from opposite B selection in data
   - $\Delta \epsilon: 2.1\%$, $\Delta \omega: 1.6\%$

$\rightarrow$ the differences between data and MC can be explained by these corrections