Background rejection study in the search for $\Lambda^0 \rightarrow p^+ \mu^- \bar{\nu}$

The LHCb collaboration

Abstract

A background rejection study has been made using LHCb Simulation in order to investigate the capacity of the experiment to distinguish between $\Lambda^0 \rightarrow p^+ \mu^- \bar{\nu}$ and its main background $\Lambda^0 \rightarrow p^+ \pi^-$. Two variables were explored, and their rejection power was estimated applying a selection criteria. In addition, we included the measured $\Lambda^0 \rightarrow p^+ \pi^-$ yield at LHCb.
1 Figures

![Figure 1: Reconstructed invariant mass under the proton-muon hypothesis ($M(p\mu)$). The $\Lambda^0 \rightarrow p^+\mu^-\bar{\nu}$ candidates are given by a solid black line, while the $\Lambda^0 \rightarrow p^+\pi^-$ background is displayed in filled red. The histograms are area-normalised.](image1)

![Figure 2: Scatter plot of the Reconstructed Mass vs. the Missing Momentum in the plane transverse to the $\Lambda^0$ flight direction for the $\Lambda^0 \rightarrow p^+\mu^-\bar{\nu}$ decay (in blue) and $\Lambda^0 \rightarrow p^+\pi^-$ background (in red).](image2)
The explored planes in Fig. 1 and Fig. 2 were suggested to separate between $\Lambda^0 \to p^+\mu^-\nu$ and its main background, $\Lambda^0 \to p^+\pi^-$. In fact the channels have contrasting signatures. In Table 1 the estimated results of a selection criteria are shown.

Table 1: Selection requirements in the $M(p\mu)$ vs $p_T$ plane and its estimated results.

<table>
<thead>
<tr>
<th>Cut in $p_T$</th>
<th>Cut in $M(p\mu)$</th>
<th>$\Lambda^0 \to p^+\pi^-$ rejected</th>
<th>Signal selected</th>
</tr>
</thead>
<tbody>
<tr>
<td>$p_T &gt; 25$ MeV/c</td>
<td>$M(p\mu) &lt; 1080$ MeV/c$^2$</td>
<td>94.8 %</td>
<td>58.7 %</td>
</tr>
</tbody>
</table>

Figure 3: Mass spectrum $M(p\pi)$ at LHCb for $\Lambda^0 \to p^+\pi^-$ and its charge-conjugated decay for a data sample corresponding to an integrated luminosity of $\mathcal{L} = 1.6$ fb$^{-1}$, with a trigger prescale (downscaling of the data rate) of $10^{-3}$ applied. The measured yield is $107320 \pm 330$, corresponding to an approximate rate of $65.2 \times 10^6$ per fb$^{-1}$ before the prescale, and thus $(391.5 \pm 1.2) \times 10^6$ $\Lambda^0 \to p^+\pi^-$ in 6.0 fb$^{-1}$ before the prescale.

References