The LHCb physics programme will focus on high precision studies of CP violation and rare phenomena in B hadron decays.

### RICH calibration with \( \Lambda \rightarrow p\pi^- \)

- Calibration strategies have been devised that will enable the performance to be measured from the data themselves.
- The decay chain \( \Lambda \rightarrow p\pi^- \) can be clearly selected, based on its kinematic signature and lifetime properties, without the use of RICH information.
- These events can be used as an unbiased sample for calibrating the RICH particle identification performance of pions and protons.

### Purities

<table>
<thead>
<tr>
<th>Identified as</th>
<th>Purity</th>
<th>( p )</th>
<th>( \pi^- )</th>
<th>( \Lambda )</th>
<th>No associated track</th>
</tr>
</thead>
<tbody>
<tr>
<td>( p )</td>
<td>98%</td>
<td>3</td>
<td>13713</td>
<td>6</td>
<td>219</td>
</tr>
<tr>
<td>( \pi^- )</td>
<td>99%</td>
<td>2</td>
<td>210</td>
<td>19</td>
<td>21478</td>
</tr>
<tr>
<td>( \Lambda )</td>
<td>95%</td>
<td>6</td>
<td>210</td>
<td>20</td>
<td>21478</td>
</tr>
</tbody>
</table>

Table: Purities and statistics with particle misidentification. The main impurities for pions(\( \pi^- \)) and protons(\( p \)) come from tracks without association, those coming from electrons(\( e^- \)), muons(\( \mu^- \)) and kaons(\( K^- \)) are much smaller.

### Lambda selection method

- Assign to each track in turn the pion and proton mass, and after cuts on transverse momentum and impact parameter significance, we combine them to reconstruct the decay \( \Lambda \rightarrow \pi^- p^+ \).
- Apply cuts on the mass of the pair and on the quality of the two-track vertex.
- Use the Armenteros-Podolanski parametrization to eliminate the \( K_S \) from the sample.

Changing the variables

\[
(p_p, p_\pi \cos \theta_\pi, 1/P_\Lambda) \rightarrow (p_p, \alpha, 1/P_\Lambda)
\]

the energy-momentum relation becomes:

\[
p^2 = \frac{(\alpha - \alpha^*)^2}{(1/M_\Lambda^2 + 1/P_\Lambda^2)} - p^2
\]

where: \( \alpha = \frac{p_p - p_\pi \cos \theta_\pi}{p_\pi}, \alpha^* = \frac{m_\pi - m_\Lambda}{m_\Lambda}, P_\Lambda = p_p + p_\pi \cos \theta_\pi \), \( p^* \) momentum of the decay products in the C.M.S.; \( p_p, p_\pi, p_\Lambda \) are defined relative to \( P_\Lambda \) direction.

\( \Lambda \) sample is obtained after removing the \( K_S \) signal between the fitting curves.

### Identification efficiency plots

Identification/mis-identification efficiency curves for RICH as they are simulated by Monte Carlo are very well described by the efficiency curves obtained using data.

Figure: Black - pions and protons selected using kinematic cuts; Magenta - truth pions and truth protons selected using the same cuts. Up - identification efficiency curves, down - misidentification efficiency curves. Pions/protons are seen by the RICH as light (\( e^- \), \( \mu^- \)) particles or/and heavy (\( K^- \), \( p \)) particles.

We proved that RICH calibration with Lambdas is feasible using real data.