Search for $\Lambda_b^0$ and $\Xi_b^0$ charmless 4-body decays at LHCb

**Motivation**

Search for seven $\Lambda_b^0/\Xi_b^0$ charmless decay modes, proceeding through tree $b \rightarrow u$ and penguin $b \rightarrow s$, $d$ quark transitions.

- $\Lambda_b \rightarrow p\pi^+\pi^- - \Lambda_b^0 \rightarrow pK\pi$
- $\Lambda_b \rightarrow pK\pi \rightarrow \Lambda_b^0 \rightarrow pK\pi$
- $\Xi_b \rightarrow pK\pi - \Xi_b^0 \rightarrow \Xi b \rightarrow pK\pi$
- $\Xi_b \rightarrow pK\pi$

**Measurements**

- Aim to measure CP-asymmetries by comparing charmless decays to $b \rightarrow c$ transitions in order to subtract out b-quark production and charged particle detection asymmetries.

$$\Lambda_b^0 \rightarrow \Lambda_c^+\pi^- - \Xi_b^0 \rightarrow \Xi_c^+\pi^-$$

Branching fractions are also determined.

**Method**

Simultaneous fit of the five selected spectra and control channels, split in proton and antiproton, 2011 and 2012, all built in a mutually exclusive way.

Charmless signal regions as well as the measured yields were hidden while developing the fit model.

**Simultaneous fit**

- The particle identification selection is designed so that a candidate appears in one spectrum only.

- Signal events with a pion or a kaon misidentified will appear in a companion spectrum. This will be referred as cross-feed background.

- Cross-feed yields are determined from the yield measured in the original spectrum and the particle (mis)identification probabilities measured in data control samples.

- The model is fit simultaneously to the five signal spectra and control channels.

- Several parameters are shared between spectra, reducing systematic uncertainties.

**Background contributions and fit model**

- There are at least five main categories of backgrounds identified.

  - Peaking background, partially reconstructed background, decays of B mesons, cross-feed background and combinatorial background.

- There are at least five main categories of backgrounds identified.

  - 5-body decays where one track is not reconstructed.
    - Modelled with an ARGUS function convolved with a Gaussian.
  - 4-body decays coming from $B^0$ or $B_s^0$ with a $K$ or $\pi$ misidentified as a proton.
    - Modelled with a Cruijff function.
  - Combination of several tracks unrelated to the signal.
    - Modelled with a polynomial function.

- True signal events may appear as a cross-feed in other spectrum if a track is misidentified.
- Modelled with a double CrystalBall function.

**Combined invariant mass spectra**

- The simultaneous fit technology allows CP-asymmetry measurements as well as branching fraction measurements of the seven modes of interest.

- The latter is made by summing the proton and anti-proton individual PDFs for each component while keeping blind the charge-dependent spectra. The sum of their yields is unveiled after the fit model has been developed.

- Branching fraction relative to the charmed mode

$$\Lambda_b^0 \rightarrow \Lambda_c^+ (\rightarrow pK\pi^+)\pi^-$$

to be determined for the first time.