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Study of $B^{\pm} \to p\bar{p}K^{\pm}$ decay at LHCb

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Summary. — The study of $B^{\pm} \to p\bar{p}K^{\pm}$ decay channel at LHCb offers great opportunities to study Standard Model and Beyond the Standard Model physics. The selection procedure implemented to extract the signal from background is described. The expected sensitivity on the measurement of the branching ratios is discussed.

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1. – The $B^{\pm} \to p\bar{p}K^{\pm}$ decay

The study of the $B^{\pm} \to p\bar{p}K^{\pm}$ decay channel at LHCb is of great interest since three-body baryonic decays offer a clean environment to study intermediate states, such as charmonium states [1, 2] and exotic states (glueballs, baryonium, pentaquarks). In fact the $p\bar{p}$ final state can be produced through a resonant intermediate state.

A high statistics will be available at LHCb thanks to the large $b\bar{b}$ production cross section ($\sigma_{b\bar{b}} \sim 300\,\mu$b) at a centre of mass energy of $\sqrt{s} = 7\,$TeV. Since the $b\bar{b}$ production cross section is of the order of 1% of the total inelastic cross section and the branching ratios ($\mathcal{B}$) of the interesting channels are of the order of 10^{-5}–10^{-6}, it is necessary to design a selection with high efficiency and a high rejection of the background.

2. – Selection strategy

In order to optimise the selection procedure, a multivariate algorithm based on the TMVA package [3] has been implemented. It uses kinematic and topological variables (such as transverse momentum, goodness of fit of the secondary vertex, displacement of the B decay vertex). The combined particle identification information of the three final state particles, coming from the Ring Imaging Cherenkov detector, is an essential ingredient of the selection procedure. A "Boosted Decision Tree" multivariate method has been implemented on Monte Carlo data.

A signal efficiency of more than 70% with a 10^4 background rejection capability has been obtained with a signal to background ratio of $S/B \sim 1$.

TABLE I. – *Expected yield for* $1\,\mathrm{fb}^{-1}$ *of data at LHCb.*

Decay Type	$\mathcal{B} \times 10^6$ [1,2]	Yield
$B^{\pm} \to p\bar{p}K^{\pm}$(all)	$10.76^{+0.36}_{-0.33} \pm 0.70$	$N(B[\text{all}]) \sim 1.2 \cdot 10^4$
$B^{\pm} \to p\bar{p}K^{\pm}(M_{p\bar{p}} < 2.85\,\mathrm{GeV})$	5.12 ± 0.31	$N(B[M_{p\bar{p}<2.85\,\mathrm{GeV}}]) \sim 5.5 \cdot 10^3$
$B^{\pm} \to J/\psi K^{\pm} \to p\bar{p}K^{\pm}$	2.20 ± 0.10	$N(J/\psi) \sim 2.5 \cdot 10^3$
$B^{\pm} \to \eta_c K^{\pm} \to p\bar{p}K^{\pm}$	1.8 ± 0.2	$N(\eta_c) \sim 2.0 \cdot 10^3$

TABLE II. – *Expected Sensitivity at LHCb with 2011 data.*

	Value available [1,2]: $f \pm \Delta f$	Sensitivity@LHCb: $\Delta f/f$
$N(J/\psi)/N(B[M_{p\bar{p}<2.85\,\mathrm{GeV}}])$	0.43 ± 0.03	2.3%
$N(\eta_c)/N(J/\psi)$	0.82 ± 0.16	3.0%
$N(J/\psi)/N(B[\text{all}])$	0.20 ± 0.02	2.0%
$N(B[M_{p\bar{p}<2.85\,\mathrm{GeV}}])/N(B[\text{all}])$	0.48 ± 0.05	1.7%

3. – 2011 outlook

The expected yield from the 2011 data, assuming an integrated luminosity of $1\,\mathrm{fb}^{-1}$, has been estimated using the Monte Carlo for the $B^{\pm} \to p\bar{p}K^{\pm}$ decay channel, both for the charmless and for the J/ψ and η_c charmonium contributions (table I). Comparing with B-factories LHCb will collect in 2011 a factor ten more data.

An evaluation of the sensitivity of the branching ratio measurements with 2011 data has been performed (table II). We expect to obtain, as it is shown in table II, a sensible improvement on the precision of the charmless decay branching fraction $\mathcal{B}(B^{\pm} \to p\bar{p}K^{\pm})$ (for $M_{p\bar{p}} < 2.85\,\mathrm{GeV}/c^2$) and of the product of branching fractions $\mathcal{B}(B^{\pm} \to \eta_c K^{\pm}) \times \mathcal{B}(\eta_c \to p\bar{p})$. Moreover, we can also study rare charmonium contributions and also possible exotic states can be revealed. We will have the possibility, indeed, to observe or put an upper limit on $\mathcal{B}(B^{+} \to c\bar{c}K^{+}) \times \mathcal{B}(c\bar{c} \to p\bar{p})$, at the level of 10^{-7}.

4. – Conclusions

A study of the $B^{\pm} \to p\bar{p}K^{\pm}$ decay channel at LHCb can be performed. Thanks to the large available statistics in 2011 and to the high performance of the implemented selection procedure, more precise measurements of the branching ratios can be performed. Moreover new charmonium or exotic states can be revealed.

REFERENCES

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