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Search for the lepton-flavour violating decays $B^+ \to K^+\mu^\pm e^\mp$

LHCb collaboration†

Abstract

A search for the lepton-flavour violating decays $B^+ \to K^+\mu^\pm e^\mp$ is performed using a sample of proton-proton collision data, collected with the LHCb experiment at centre-of-mass energies of 7 and 8 TeV and corresponding to an integrated luminosity of $3\,\text{fb}^{-1}$. No significant signal is observed, and upper limits on the branching fractions are set as $\mathcal{B}(B^+ \to K^+\mu^- e^+) < 7.0\ (9.5) \times 10^{-9}$ and $\mathcal{B}(B^+ \to K^+\mu^+ e^-) < 6.4\ (8.8) \times 10^{-9}$ at 90 (95)% confidence level. The results improve the current best limits on these decays by more than one order of magnitude.

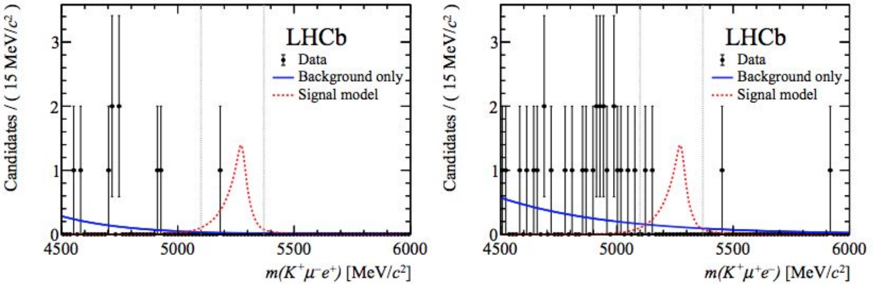

Figure 2: Invariant-mass distributions of the (left) $B^+ \to K^+\mu^- e^+$ and (right) $B^+ \to K^+\mu^+ e^-$ candidates obtained on the combined data sets recorded in 2011 and 2012 with background only fit functions (blue continuous line) and the signal model normalised to 10 candidates (red dashed line) superimposed. The signal window is indicated with grey dotted lines. Difference between the two distributions arises from the effect of the $m(K^+\ell^-)$ requirement.

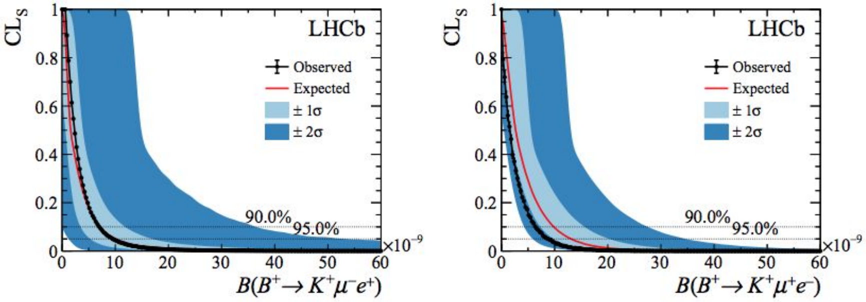

Figure 3: Upper limits on the branching fractions of (left) $B^+ \to K^+\mu^- e^+$ and (right) $B^+ \to K^+\mu^+ e^-$ decays obtained on the combined data sets recorded in 2011 and 2012. The red solid line (black solid line with data points) corresponds to the distribution of the expected (observed) upper limits, and the light blue (dark blue) band contains the 1σ (2σ) uncertainties.

Treatment of external inputs

The formula to measure the BR is:

$$\mathcal{B}(B^+ \to K^+\mu^\pm e^\mp) = N(B^+ \to K^+\mu^\pm e^\mp) \times \alpha,$$

$$\alpha \equiv \frac{\mathcal{B}(B^+ \to K^+ J/\psi(\to \mu^+\mu^-))}{\varepsilon(B^+ \to K^+\mu^\pm e^\mp)} \frac{\varepsilon(B^+ \to K^+ J/\psi(\to \mu^+\mu^-))}{N(B^+ \to K^+ J/\psi(\to \mu^+\mu^-))},$$

We provide:

Table 1: Normalisation factor α for $B^+ \to K^+\mu^- e^+$ and $B^+ \to K^+\mu^+ e^-$ final states. The ratio $\alpha/\mathcal{B}(B^+ \to K^+ J/\psi(\to \mu^+\mu^-))$ is independent of external inputs.

Decay	α	$\alpha/\mathcal{B}(B^+ \to K^+ J/\psi(\to \mu^+\mu^-))$
$B^+ \to K^+\mu^- e^+$	$(1.97 \pm 0.14) \times 10^{-9}$	$(3.27 \pm 0.22) \times 10^{-5}$
$B^+ \to K^+\mu^+ e^-$	$(2.21 \pm 0.14) \times 10^{-9}$	$(3.68 \pm 0.22) \times 10^{-5}$

This is probably enough to get rid of the dependence from the normalization mode BR, right?

Information to allow for recasting

A phase-space MC is used to model the signal.

This is used for elaborating the selection strategy (so it might be sub-optimal for some models, but not much can be done for this...) and especially to measure the selection efficiencies.

We provide efficiencies over the Dalitz plot.

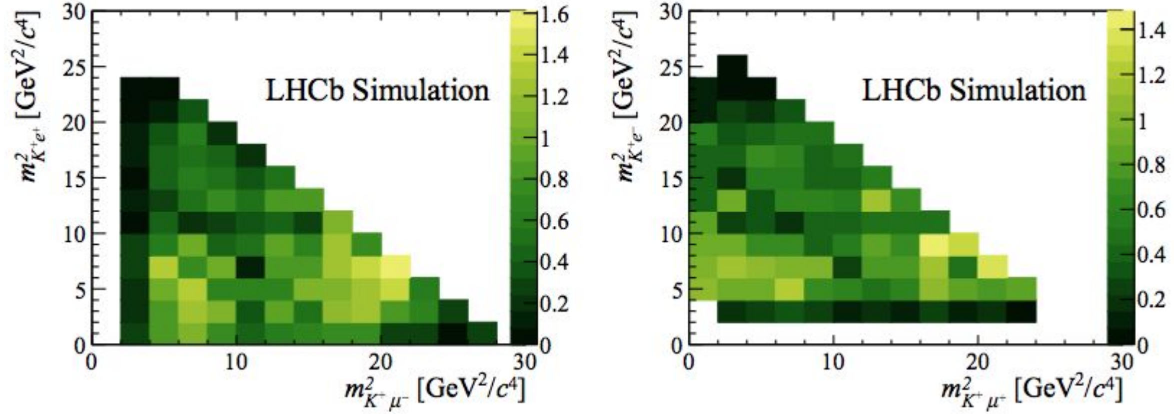

Figure 1: Efficiency of (left) $B^+ \to K^+\mu^-e^+$ and (right) $B^+ \to K^+\mu^+e^-$ as function of the squared invariant masses $m^2_{K^+e^\pm}$ and $m^2_{K^+\mu^\mp}$. The variation of efficiency across the Dalitz plane is due to applied vetoes. The efficiencies are given in per mille.

I am wondering:

1) ***is this enough for a recasting or additional information should have been provided?***

2) ***Should have we rather been using the true momenta to calculate the invariant masses? (I am thinking about electrons doing bremsstrahlung….)***

B -> K* tau mu search (with tau-> pi pi pi nu)

We are also using phase space MC for the B decay (not for the tau)

*Potentially we can follow the same approach, and provide efficiencies in a Dalitz plot. The candidate would be the K*tau vs tau mu plane. But here we have 6 tracks in the final state and a neutrino….plus a model assumed for the decay of the tau….Again:*

1) *Is this enough for a recasting or additional information should be provided?*
2) *Should we also provide the pseudo-Dalitz efficiency for the tau decay? Or we can assume it is ok because the new physics we are searching for has no impact on the tau decay itself that will stay SM like?*
3) *There is a missing neutrino...should we use the true momentum of the tau (i.e. including the neutrino) to provide the efficiency maps?*
4) *Any other suggestion?*