Measurement of the relative branching fraction of $\Lambda_b^0 \to \Lambda_c^+ \overline{D}^{(*)0} K^-$ and $\Lambda_b^0 \to \Lambda_c^+ D_s^{*-}$ decays – WG review round 3

Based on v1r2, Feb. 17 2023.

Comments from Zan Ren

Q **Fig. 8** I am wondering if the gen-level fast-simulated distributions can be a perfect-enough description of the single-charmed decays? Can you compare it to the full-simulation (after your nominal selection criteria)? By searching Sec 5.1, I found that the systematics of this kind of line-shapes are not considered.

A There seems to be a misconception. The single charm decay is a fully reconstructed one and does (almost) not depend on its decay dynamics. I'm writing almost, as the $K^-K^+\pi^-$ system can marginally shape the slope on the wider distributions (c) and (g). Those restrict the $K^-K^+\pi^-$ mass range to the one used for 3D fits. However, in 3D fits we account for this background in a data-driven way, namely by fitting the diagonal band you see in (f) (and less pronounced in (b)). In the final fits, we cut tighter in the $K^-K^+\pi^-$ or $K^+\pi^-$ mass to select D_s^- or $\overline{D}^0$. As you can see in (d) and (h), there is almost no plateau left which could be shaped by dynamics in the $K^-K^+\pi^-$ system.

Q I am fully agree with you that it is indeed the dynamics of NDC decay won't show significant difference, but I didn't mean ask questions on this point. For fast simulation of NDC decay, the detector resolution might not be well-considered, as well as some parameter which is related to goodness-of fit for tracking or IP/vertex (especially) can not be simulated. From my personal experience on analyzing relevant decays, the online& offline cuts one these variables will sometimes reshape the generator-level m(KKpi) distribution.

Q **L. 579** Why the uncertainty due to assumptions in normalisation of single-charmed decay should be statistical uncertainty instead of the systematics?

A In an ideal world, you would be able to fit the normalization and get the uncertainty estimate and the impact on the parameter of interest directly – thus account for it as statistical uncertainty. We try to do the next best thing: get and propagate it from the 3D fit. Why would you want to count it as a systematic uncertainty?

Q Yes, in your explanation it should be statistical uncertainty. However, for the fit procedure: first you fix it as a constant, then you perform the nominal fit, after that you artificially assign 10 % the uncertainty on the yield of this component independently. These steps will make the fitter report *incorrect* statistical uncertainties on the yields of other fit components, since you fix the yield on one of the components. I don't think this should be big bias but it still need to be checked.

A Both points are addressed now with a new fit systematic "H", that constrains the $\Lambda_b^0 \to \Lambda_c^+ K^+\pi^-K^-$ normalization instead of fixing it. It also increases the width of the $\Lambda_b^0 \to \Lambda_c^+ K^+\pi^-K^-$ component by roughly 20 %. The changes do not have an effect on the final result.

Q **Table 14** Could you add one as the last row to show the total systematic uncertainties?

A Prefer to keep as is.

Q Why "prefer to keep as is"? I don't think this comment is too difficult to accept.... If given the specific source of the uncertainties, calculating the total relative systematics is not a time consuming task. Every analysis that measures the branching ratio gives the value of total systemactics.

A After iterating by mail, it's understood now that the total relative uncertainty was asked for. This is now added to the table.