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Analysis twiki page for AN-21-041

This is the page where the relevant information for AN-21-041 is documented. In this analysis note, the measurement of absolute fragmentation fraction ratios(FFRs) of B+, Bs, B0 mesons in D meson-related decay modes and using the B parking dataset collected in 2018 is presented.

Links to the relevant information

Presentation by Greg Landsberg on the motivation of this study: fsfd_woes

Theory paper on the theoretical motivation of this study: arxiv:2007.10338

Presentations by Taeun Kwon on the analysis details: presentation on 20 Sep 2020, presentation on 16 Feb 2021, presentation on 27 Sep 2021

Link to the analysis note: AN2021_041_v3.pdf

Q/A from conveners

Q) confusion between the notions of "fragmentation fraction" and "fragmentation function". The expression
"fragmentation function" should be replaced by "fragmentation fraction" everywhere in the text and captions.

A) **Fixed**. We had confusion on terms when writing a note. As you pointed out, this is the study about fragmentation fraction, We will replace "fragmentation function" with "fragmentation fraction" and update the note soon.

Q) I do not quite understand yet what it means to distinguish a "correlated" from an "uncorrelated" uncertainty when quoting an integrated result(for the differential result the distinction is clear).

A) About the usage of "correlated" and "uncorrelated" uncertainty in the final FFR values, basically in this study, we extract the FFR values from differential yield results, under the no-dependence hypothesis. Only integrated FFR result presented in the note is in Sec 6.2, and uncertainties of the integrated FFR are divided by statistical and systematic in the section.

Q) Can you please also elucidate a bit more how, in your view, this analysis relates to the similar analysis BPH-21-001, apart from obviously the different final states?

A) The b -> J/psi q type of analysis is incapable of doing the extraction of the absolute values for the FFRs involving the strange quark (fs/fu and fs/fd) as the Bs(J/psi phi) branching fraction measurement that dominated the world average is normalized to the B(J.psi K) branching fraction using the original LHCb FFR measurement in hadronic channels. Thus, what you measure is the LHCb FFR, not its absolute value.

Q) Why are you using the highest pt^2 vertex rather than the muon trigger vertex?

A) **Fixed**. The PV is changed to the trigger muon vertex

Q) More explanation on the reason why we use B0->KD instead of B0->piD added

More explanation is added in the main text as follow. "The advantage of using a theoretically clean channel is the measured absolute FFR values can be an important theoretical input. There exists a recent theory paper that showed a significant discrepancy between the experimental value and theoretical prediction of fs/fd, and posed a possibility of contributions from beyond the Standard Model. By using the theoretically clean channel, the measured absolute FFRs values are expected to be important inputs for follow-up studies."

Q) I am not sure I understand your statement about the "signal" and "background" decays and the relation of their width to the branching fractions. The width of final state peaks is unrelated to the partial widths which are responsible for the branching fractions. In general, I do not understand why you call B0->pi D "background".

A) **Fixed**. We agree that the word signal/background could be confusing in this case, so signal -> decay of interest and background -> decay with one misidentified track

Q) You talk about "kinematic vertex fitting" for the D meson fit only. What is kinematic about it here, rather than just vertex fitting? I would expect the kinematic fit to enter when you fit the D meson

candidate to a B hadron vertex, then e.g. using a D meson mass constraint. Is that what you do?

A) In this study, to reconstruct signal vertices, we used a kind of sequential kinematic vertex fitting. As you pointed out, I reconstruct D meson vertices using kinematic vertex fit and apply several constraints on the D meson candidates(e.g. D meson mass, vertex probability, Lxy significance). After that, with reconstructed D meson candidates and one additional hadron track, we reconstructed B-meson vertices again, using kinematic vertex fit.

Q) You obviously use simulated samples for the efficiency calculations, but there is no description of these samples (yet) in the note.

A) **Fixed**. We added the expression "Simulated events are required to have at least one muon with the transverse momentum larger than 5GeV and in the range |eta| < 2.5 to improve the trigger efficiency in the simulated sample.

Q) You are discussing "control regions in data" for the S/B optimization. How are these defined? From what you describe there, it is not clear to me how you normalize the signal to the background.

A) **Fixed**. FOM for cut optimization is changed from S/sqrt(S+B) to S/sqrt(B) so that normalization MC to Data doesn't affect and all FOM plots are reproduced. You can find the details in Appendix B.

Q) It is not clear to me how you combine/merge the results from the four different triggers.

A) Because we use the "probe" side in this study, the type of parking triggers doesn't affect the result. So we simply collect events with trigger muon passed any of four triggers, and make the result.

Q) The non-Gaussian shape of the peak in Fig. 4b is very intriguing. Can you please explain?

A) The reason why the peak in Fig. 4b is not Gaussian, we used a mass hypothesis to reconstruct B meson. When we reconstruct B with D candidate and one additional hadron, we don't know if the additional hadron is pion or kaon. So, for example, in the Bs->pi Ds channel, we simply assigned pion mass on the additional hadron track. Then, the background process in this case, Bs->K Ds channel, has a K track with mal-assigned mass(as pi mass) and so, as you can see in Fig. 4b, has an asymmetric shape.

Q) It is interesting to see that the 'upturn' of the fs/fu ratio towards low pt observed in BPH-21-001 (and LHCb) is not observed in this analysis, although the two results are presumably consistent when considering statistical uncertainties.

A) In results of BPH-21-001, the 'upturn' in low pT usually occurs at pT < 10 GeV. In this study, the FFR result in this low pT region is not considered now, mainly because the hadron track reconstruction in such a low pT is not as good as we expected. But we are still working on extending results below 10 GeV and will update the AN whenever we have the result.

Q) Comparisons to other measurements are mentioned in the summary, but not (yet) quantified.

A) **Fixed**. A pT dependent trend reported by LHCb is overlaid with our result in the conclusion

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-- TaeunKwon - 2021-10-12

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