

Minor corrections

Thesis: Rare hadronic decays of B mesons at LHCb

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This document lists the changes that have been made to the thesis as minor corrections. Changes are highlighted in red. Page numbers refer to the version of the thesis used in the Viva.

1 Acknowledgements

- [Add acknowledgements section](#)
- [Add quote](#)

2 Introduction

- Page 4: ... have **an** electromagnetic charge...
- Page 4: ... there exists **an** antimatter...
- Page 6: ... described **as** a non-Abelian...
- Page 13: ... production **of** Gravitons...

3 Theory

- Page 15: ... Ground state hadrons **containing a single b-quark** can only...
- Page 15: Added citation for Fermi coupling.
- Page 16: ...decay **was** measured ...
- Page 17: [cite ratio](#)
- Page 18: Added the definitions of λ , A , ρ , η in terms of V_{qq}
- Page 18: Double checked sizes of diagonal CKM elements

- Page 18: [add description of unitarity triangle](#)
- Page 19: [How do \$K^0\$ and \$\bar{K}^0\$ mix into \$K_S^0\$ and \$K_L^0\$](#)
- Page 19: Added details of the different types of CP violation and stated that direct CP violation is the only relevant method.
- Page 20: [explain why colour suppressed or favoured](#)
- Page 21: ...expensive [and](#) requires the...
- Page 22: ...mass [of the](#) charged lepton...
- Page 22: [what allows?](#)
- Page 22: [what do you mean by mutually exclusive?](#)
- Page 23: Added minus sign to limit order of magnitude 6.1×10^{-7}
- Page 23: .. this can [potentially](#) limit the sensitivity [to](#) the...
- Page 23: [I think you should emphasis that this is in fact the final state you are looking for](#)
- Page 24: removed [dominantly](#)
- Page 27: ... SM values given [in Table 2.2](#) ...

4 The LHCb experiment

- Page 30: ... at the [shallowest and deepest](#) points...
- Page 30: [Add LEP reference](#)
- Page 34: [Add LHCb detector reference](#)
- Page 35: [Add description of T1, T2, T3 to figure caption](#)
- Page 36: [Add reference for figure](#)
- Page 39: [Define FPGA](#)
- Page 42: [which of the planes X1, U, V, or X2 are shown in Figure 3.9?](#)
- Page 46: ...in the [maximum](#) value...
- Page 48: Defined calorimeter acronyms
- Page 51: ...to determine [if](#) the innermost...
- Page 53: ...trigger is composed [of](#) two parts...

- Page 54: You could add a table with the thresholds for completeness
- Page 54: ...pattern recognition to identify track candidates...
- Page 55: Can you show how this variable distinguishes between each b-hadron and background. Or add reference

5 Event selection

- Page 64: Which normalisation final states are you considering?
- Page 65: Which samples? Clarify
- Page 65: ...Samples are generated assuming...
- Page 66: What are the final states? Clarify
- Page 66: Removed The event selection aims to reduce overall rate of collisions, whilst maximising the signal efficiency.
- Page 66: Which triggers are you therefore using in your analysis? clarify.
- Page 66: Clarify what is meant by hits in final paragraph.
- Page 67: Thresholds of what? Energy? Please clarify
- Page 67: ...if the deposit matched to a reconstructed...
- Page 68: ...hadronic hardware trigger (L0Hadron)...
- Page 68: Define L0Global using logic.
- Page 70: Check why numbers don't add up
- Page 72: ...products with respect to the proton beam axis...
- Page 74: Add figure to show why track chi2 cut is 4
- Page 76: What is the rough purity of the PIDK cut?
- Page 79: Reword description of asymmetric sidebands.
- Page 80: Clarify why residual yields vary so much in caption
- Page 81: Explain shape in caption
- Page 82: Clarify the source of peaking structures of invariant masses
- Page 84: Add introduction to give more context to MVA methods, i.e. more normal to train using MC, but this requires separate PID and MVA optimisation

- Page 88: Add small amount of detail giving context and justification, i.e. DLL just specific detectors, ProbNN uses all
- Page 90: Why are p_T and χ^2_{FD} used to do efficiencies.
- Page 90: Add reference to page where efficiencies are discussed.
- Page 91: Add justification for $a = 5$ from Punzi paper.
- Page 91: ...Requirements are placed on the impact...
- Page 93: Caption: The ϕ (left) and D_s^+ (right) invariant mass
- Page 93: Much slower rate: explain
- Page 94: Caption: The D^0 (left) and D_s^+ (right) invariant mass
- Page 95: Caption: The K^+K^- (left) and D_s^+ (right) invariant mass

6 Mass fit to $B^+ \rightarrow D_s^+ K^+ K^-$ candidates

- Page 106: ...The parameters of interest in the two fits are...
- Page 106: ...These figures show the distribution...
- Page 106: ...in the negative log likelihood minimisation...
- Page 108: ...Similarly the mass shifts vary between the two, but are consistent within the quoted uncertainties.
- Page 110: ...The relative charmless efficiency...
- Page 110: ...dependency on the position in phase-space...
- Page 111: ...dependence on the position in phase-space...
- Page 112: As a function??
- Page 113: Can you show the agreement?
- Page 116: Add the extent of this variation
- Page 119: Phi could also be annihilation

7 Mass fit to $B^+ \rightarrow D_s^+ \phi$ candidates

- Page 126: ...pair **from** the ϕ meson, $m(K^+K^-)$, and the cosine of **the** angle $\cos\theta_K$...
- Page 126: ...The total extended **negative log likelihood** (NLL) for...
- Page 127: **cite minos**
- Page 127: **add description of categories in figure.**
- Page 130: **Which fractions? Difference between which fractions? Clarify.**
- Page 134: ...These PDFs are **updated** to...
- Page 139: ...so the **parameter** would be expected...
- Page 140: **change colour scheme to highlight signal component**
- Page 151: ...The **significance** of the measured branching fraction, $BF(B^+ \rightarrow D_s^+ \phi) = (1.2_{-1.4}^{+1.6} \pm 0.8 \pm 0.1) \times 10^{-7}$, is **not large enough to constitute evidence** for the $B^+ \rightarrow D_s^+ \phi$ decay and **the branching fraction is consistent with a value of zero**...

8 Conclusions

- Add conclusions

9 Appendix A

- Page 161: swapped figures A.3 and A.4
- Page 168: **Check numbers in table... 5.6 out of order**

10 Appendix C

- Page 176: **add description about figures like in C.2**

11 Appendix D

- Page 180: ...the **pull** is defined...
- Page 180: ...different D_s^+ decay modes are shown in **Fig. D.3**...

12 Appendix D

- **Change fit colour scheme**

13 References

- Page 189: Ref [1] ...JHEP 01 (2018) 131...
- Page 191: Ref [23] ...P. Dirac, The quantum...
- Page 199: Ref [199] Add name to reference