Prof. Marco Gersabeck
Department of Physics and Astronomy
The University of Manchester
Oxford Road
Manchester M13 9PL

+44(0)161 306 6466
marco.gersabeck@manchester.ac.uk

18 May 2023

To whom it may concern,

In what follows I review the thesis submitted for the habilitation of Dr Pavel Řezníček at Charles University.

Dr Řezníček has 20 years of experience in B physics at the ATLAS experiment at CERN's Large Hadron Collider and work in this area constitutes the bulk of his thesis. Beyond analysis work, which I review in more detail below, he also has experience with physics trigger infrastructure and characterisation of silicon sensors.

Chapter 2 of the thesis gives an overview of the so-called flavour anomalies. Its introduction gives an overview of non-B physics anomalies, but their discussion could be more balanced as it presents the largest possible anomalies without discussion of potential effects that reduce them such as more recent theory work related to the muon magnetic moment or the experimental discrepancies in the W mass measurement.

In the discussion of the B anomalies, the latest change in the LHCb results on RK(*) could be more precise as this does not just suggest underestimated systematic uncertainties, but the origin was clearly described with the largest effect being a neglected source of mis-identification background. The overall situation of the current picture of b to sll anomalies could discuss more explicitly possible interpretations of the new values for RK(*) in conjunction with the departures indicated in differential branching fractions of the muonic mode, i.e. a situation in which both electrons and muon appear to deviate from SM expectations.

Chapters 3 and 4 give a competent account of the ATLAS experiment and its B physics programme, respectively. When figures such as Fig. 15 are presented, a more detailed discussion of their features, here the differences between data and simulation, would be useful.

Chapter 5 covers CP violation measurements in which Dr Řezníček has long-standing and leading involvement. The introduction states that the levels of CP violation observed to date are compatible with the SM, but this is an open question for charm mesons. For the analysis, a slightly more in-depth discussion of the impact of the leading systematic uncertainties (how do they compare to the statistical uncertainty?) and their relevance in connection to the 3 sigma discrepancy on Gamma_s would have been useful. While the statistical correlation between Gamma_s and phi_s is negligible, it is not clear that, if the discrepancy is caused by underestimated systematic uncertainties e.g. due to alignment as is alluded to in the thesis, such an effect might not also impact the systematic uncertainty on phi_s. The list of references also omits the 2021 LHCb measurement of the final state J/psi e+ e-, which is included in the HFLAV combination shown in Figure 19.

Chapter 6 discusses the angular analysis of B0 decays to the final state K*0 mu+ mu- and gives a concise summary of the analysis. The discussion could have expanded slightly on the areas of potential discrepancy as a statement that all measurements

agree with predictions within three standard deviations is rather vague. In particular, a discussion of the theory input from Reference 202 would have been useful as this contains a fit to experimental data rather than purely the result of calculations.

Chapter 7 turns to exotic multi-quark states. The introduction mentions Pentaquarks but omits the evolution from the initial LHCb discovery, namely that the two reported states are in fact three structures (PRL 122 (2019) 222001). The analysis described is the attempted confirmation of an exotic resonance reported by the D0 collaboration, which was unsuccessful and as such in agreement with other experiments, which also failed to confirm the D0 observation.

Chapter 8 presents an outlook on the future of flavour physics. It starts with a discussion of Belle II for which the stated goal of 10 times the Belle integrated luminosity by 2027 may not be achievable. Regardless of this step, a discussion of the Belle II design goal of 50/ab and its further plans would have been useful. Likewise, a brief discussion of the potential of LHCb's recent and planned, second upgrades would not have been amiss. The remainder of the chapter describes the potential of the flavour physics measurements discussed in earlier chapters at the HL-LHC.

In summary, the thesis presents an impressive body of work, which covers several high-impact flavour physics measurements and related work. It is clear that Dr Řezníček has made leading contributions to the field of flavour physics and to the ATLAS experiment, both as an analyst and in other roles of responsibility including having served as ATLAS B-physics convenor.

The thesis is written in very good scientific English overall. There are occasional typographic errors, especially in relation to definite articles and plural forms; however, they do not impede the understanding of the document.

The plagiarism check shows occasional matches to other sources. These are to a large extent expected due to standard terminology being used. In a few cases there is more extensive overlap in figure captions where these are taken from papers authored by Dr Řezníček. As captions are intended to be concise, this is acceptable and therefore the plagiarism check showed no areas of concern.

yours sincerely,

Prof. Marco Gersabeck
Professor of Particle Physics
Deputy Department Head for Postgraduate Research
Department of Physics and Astronomy
The University of Manchester