Curriculum Vitae - Mark Peter Whitehead

Date of birth:	11^{th} August 1986
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Education

Postgraduate	University of Warwick (2008 – 2012) Ph.D. in Particle Physics
Undergraduate	University of Warwick (2004 – 2008) Physics MPhys (Hons.): First class

Employment History

2012 – Present	University of Warwick, Research Associate
Summer 2014	Spent one month at LAPP as an invited visiting researcher

Positions of responsibility

2010 – 2012	Responsible for LHCb DecFiles package
2012 – 2013	Monte Carlo liaison for the B2OC physics WG
Oct 2014 – Present	Convener of amplitude analysis sub-working group with around 25 active members

Long-term attachments abroad

CERN, October 2009 – October 2010

Research

Physics Analysis	– Analysing decays of B mesons to final states including D mesons: – Dalitz plot analysis of $B_s^0 \to DK\pi$ decays – First observation of a B^0 decay mode obtained – Now performing amplitude analysis of $B^0 \to DK\pi$ decays
Simulation	– Performed LHCb Evtgen maintenance (2009–2010) – Maintained and improved the VELO geometry description (2009 –2010)

Teaching and Supervising

Teaching	– Taught undergraduate physics problem classes in 2009
Supervision	– Responsible for day to day direction and supervision of two graduate students in the Warwick LHCb group – Co-supervised M.Phys project students in 2013 and 2014 – Experience as the lead co-supervisor of two Warwick URSS summer students working on LHCb projects

Conference talks

– B hadron decays to charming final states at LHCb, PHENO, 2011
– Measuring γ with B meson decays to charmed final states at LHCb, HQL, 2012
– Studies of hadronic B decays to final states containing open charm mesons at LHCb, EPS-HEP, 2013
– New results in B decays, LHCP, 2014

Skills

Languages	– Basic French and German
Computing	– Experience of programming in C++
	– Vast experience with many software packages e.g. ROOT, LaTeX
	– Developer of the Laura++ Dalitz-plot analysis fitting package
	– Familiar with Linux, Mac OSX and Windows operating systems
	– Experienced user of the simulation package EvtGen
Other	– Full, clean driving licence

Summer Schools

– School on Amplitude Analysis in Modern Physics from hadron spectroscopy to CP phases, Bad Honnef, 2011
– Sixth CERN-Fermilab Hadron Collider Physics Summer School, CERN, 2011
– School for Experimental High Energy Physics Students, Oxford, 2009

References

Prof. Tim Gershon	Department of Physics, University of Warwick, Coventry, CV4 7AL, UK T.J.Gershon@warwick.ac.uk
Dr. Vincent Tisserand	Laboratoire d'Annecy-le-Vieux de Physique des Particules, 9, Chemin de Bellevue, 74941 Annecy-le-Vieux Cedex, France tisserav@lapp.in2p3.fr
Dr. Vladimir Gligorov	CERN, CH-1211, Geneva, Switzerland Vladimir.Gligorov@cern.ch

List of Publications

I have been a member of the LHCb collaboration since December 2008 and I am named on over 300 LHCb publications. These are the five publications on which I have been a lead author:

1. R. Aaij *et al.* (LHCb collaboration), Observation of $B^0 \to \bar{D}^0 K^+ K^-$ and evidence of $B_s^0 \to \bar{D}^0 K^+ K^-$, Phys.Rev.Lett. **109**, 131801 (2012), This analysis was performed for my Ph.D. thesis, so I was responsible for every aspect of the study. I was also involved writing the journal paper, which documents the first observation of the decay $B^0 \to \bar{D}^0 K^+ K^-$ and first evidence for the $B_s^0 \to \bar{D}^0 K^+ K^-$ decay mode. The analysis framework and techniques developed in this study have been used in several subsequent LHCb publications.

2. R. Aaij *et al.* (LHCb collaboration), Search for the decay $B_s^0 \to D^{*\mp}\pi^{\pm}$, Phys.Rev. D **87**, 071101 (2013), The analysis was performed by myself and I also took a lead role in the writing of the journal paper. I developed novel techniques to improve the sensitivity of the analysis.

3. R. Aaij *et al.* (LHCb collaboration), Measurement of the branching fractions of the decays $B_s^0 \to \bar{D}^0 K^- \pi^+$ and $B^0 \to \bar{D}^0 K^+ \pi^-$, Phys.Rev. D **87**, 112009 (2013), The decay $B_s^0 \to \bar{D}^0 K^- \pi^+$ was observed for the first time and the branching fraction of the $B^0 \to \bar{D}^0 K^+ \pi^-$ decay mode was updated. I was involved in all aspects of this analysis, which was performed in collaboration with a student in the Warwick LHCb group. I was also involved writing and editing the journal paper.

4. R. Aaij *et al.* (LHCb collaboration), Observation of overlapping spin-1 and spin-3 $\bar{D}^0 K^-$ resonances at mass $2.86\mathrm{GeV}/c^2$, Phys.Rev.Lett **113**, 162001 (2014), We observe a spin-3 resonance from a B hadron decay for the first time by resolving a known state into a spin-1 and a spin-3 component, providing two first observations of the $D_{s1}^*(2860)^-$ and $D_{s3}^*(2860)^-$ states. I was involved at each stage of the analysis and I also set the direction. I took a lead role in writing and editing the journal paper that was selected as part of the Editors' highlights.

5. R. Aaij *et al.* (LHCb collaboration), Dalitz plot analysis of $B_s^0 \to \bar{D}^0 K^- \pi^+$ decays, Phys.Rev. D **90**, 072003 (2014), This is the sister paper of the above journal paper, documenting all of the details of a very sophisticated amplitude analysis. This fit to the Dalitz plot distribution was performed with the Laura++ package that I have helped to develop. Again, I had a lead role in both the analysis and the writing of the journal paper. This paper was also selected in the Editors' highlights.

The following papers, on which I am a lead author, are currently in preparation:

1. First observation and amplitude analysis of the $B^- \to D^+ K^- \pi^-$ decay, LHCb-PAPER-2015-007, to be submitted to PRD. This analysis documents a clear first observation of $B^- \to D^+ K^- \pi^-$ decays and a full amplitude fit using the Laura++ package. An interesting feature of the study was the use of partial wave analysis to guide the amplitude fit model. I am co-supervising the student performing the analysis, given daily guidance and I have a leading role in writing the paper.

2. Search for $B_s^0 \to \bar{D}^0 f_0(980)$ decays, LHCb-PAPER-2015-012, to be submitted to JHEP. A search is performed for $B_s^0 \to \bar{D}^0 f_0(980)$ decays to provide additional information on

the nature of the $f_0(980)$ state. To increase the sensitivity of the analysis, the fit to the B candidate invariant mass distribution was performed simultaneously in bins of the neural network output variable. This makes use of the full statistics available without sacrificing the purity of the sample. I am the lead analyst and I am taking responsibility for writing the paper.

3. Laura++: a Dalitz plot fitter, paper in preparation. This paper documents the Laura++ Dalitz plot fitting package used in several of the analyses that I have worked on. As a developer of the package I am helping to write the paper. I am responsible for the amplitude formalism, goodness of fit and future plans sections.

Conference proceedings written for talks that I have given:

1. M. Whitehead (for the LHCb collaboration), Measuring γ with B meson decays to charmed final states at LHCb, POS (HQL 2012) 035, Talk presented at the XIth International Conference on Heavy Quarks and Leptons, Prague, Czech Republic, June 11-15, 2012

2. M. Whitehead (for the LHCb collaboration), Studies of hadronic B decays to final states containing open charm mesons at LHCb, POS (EPS-HEP 2013) 385, Talk presented at the European Physical Society Conference on High Energy Physics, Stockholm, Sweden, France, July 18-24, 2013

3. M. Whitehead (for the LHCb collaboration), New results in B decays, arXiv:1408.6060, Talk presented at the Second Annual Conference on Large Hadron Collider Physics, New York, U.S.A, June 2-7, 2014

In addition, I have given a talk at the following conference:

1. B hadron decays to charming final states at LHCb, Talk presented at the Phenomenology 2011 Symposium, Madison, U.S.A, May 9-11, 2011

I was the chair of the internal review committee for the following paper:

1. R. Aaij *et al.* (LHCb collaboration), Observation of the decay $B_c^+ \to \psi(2S)\pi^+$, Phys. Rev. D **87**, 071103 (2013), arXiv:1303.1737 [hep-ex]

Research interests

My research interests focus on three-body b-hadron decays to finals states with a c-hadron and two other particles. I've developed expertise in the analysis of these decays since 2012, when I performed the first observation of $B^0 \to \bar{D}^0 K^+ K^-$ decays and saw the first evidence of $B_s^0 \to \bar{D}^0 K^+ K^-$ decays. These types of decays provide access to a rich programme of physics, including CP violating parameters and spectroscopy. For example, $B^0 \to \bar{D}^0 K^+ \pi^-$ decays are sensitive to the unitarity triangle angle γ. Reducing the experimental uncertainty on γ is a core goal of the LHCb experiment, and heavy flavour physics in general. Using amplitude analysis, an area where I have experience, it is expected that $B^0 \to \bar{D}^0 K^+ \pi^-$ decays can provide a very competitive measurement of γ. This could be possible using the LHCb run 1 data sample. The unitarity triangle angle, β, is accessible using $B^0 \to \bar{D}^0 \pi^+ \pi^-$ decays. Using a time-dependent amplitude analysis both $\cos(2\beta)$ and $\sin(2\beta)$ can be measured with high precision. Sensitivity to $\cos(2\beta)$ is interesting because the most precise knowledge of β comes from measurements of $\sin(2\beta)$, so ambiguities can be removed by measuring $\cos(2\beta)$ as well.

Amplitude analyses of three-body charmed decays of b-hadrons provide an excellent opportunity to perform spectroscopy measurements. In the analysis of $B_s^0 \to \bar{D}^0 K^- \pi^+$ decays, which I was heavily involved in, two new excited D_s mesons, denoted $D_{s1}^*(2860)^-$ and $D_{s3}^*(2860)^-$, were observed for the first time. The $D_{s3}^*(2860)^-$ state is the first spin-3 resonance observed in b-hadron decays. This analysis demonstrates the power of amplitude analyses to observe new states and measure their properties, including spin, precisely.

This year will see many new opportunities to study these three-body decays, with the LHCb experiment expected to take run 2 data. The run 2 data sample in addition to the run 1 data allows for the study of rarer decay modes with high statistics. Using the novel techniques I have helped develop during run 1, the full statistical power of the data samples can be exploited. The flagship analysis will likely be measuring γ with $B^0 \to \bar{D}^0 K^+ \pi^-$ decays and is something I wish to drive forward myself.

Most Dalitz plot analyses use decays of a spin 0 meson to three spin 0 daughter mesons. This limits the decay modes that can be looked at, so I believe that a vital part of the future of this area of research is to consider non-zero spin particles. This is not a simple task because polarisation and helicity amplitudes complicate the description of the decays. As a developer of the Laura++ Dalitz plot fitting package this is a key area for improvements. With run 2 starting soon, it is a perfect time to extend the reach of the the analyses we can perform in order for us to continue producing the high impact results published during run 1.

Simulated data samples form an important part of analyses of these decay modes, they are used to determine the shape of functions in invariant mass fits and to provide the reconstruction and selection efficiency. An important way to improve the accuracy of the simulated data samples is to include the resonant structures observed in data to make the simulation more realistic. One method to do so would be to interface the Laura++ package with EvtGen, a package used to decay B hadrons in the LHCb simulation chain. Given my considerable experience with both of these software packages, I think this would be an interesting way to improve these analyses in the future where data samples will be much larger.

In summary, the decays of b-hadrons to three-body charmed final states can provide the chance to perform many interesting analyses on the LHCb run 1 data sample. As the run 2 data sample starts to be recorded the possibilities will only increase. My experience of analysing these decays mean that I am well placed to exploit the full potential of the LHCb run 1 data sample and beyond using these decay modes.