$B^0 \rightarrow K^{*0}\mu^+\mu^-$ Angular Analysis (and more)

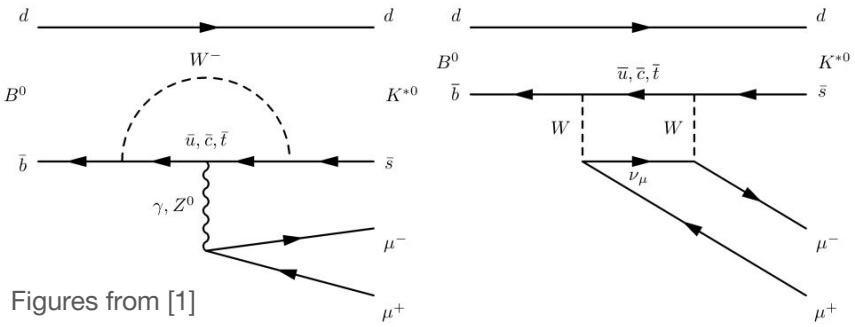
Riley Henderson
MWAPP PhD student

About me

- Recently commenced joint award Monash/Warwick PhD
- Based at Monash
- Working within the LHCb collaboration
- Supervisors:
  - Ulrik Egede
  - Michal Kreps
  - Peter Skands
- Tentative thesis topic
  - The LHCb Electromagnetic Calorimeter (ECAL) Upgrade
- Other research contributions
  - $B^0 \rightarrow K^{*0}\mu^+\mu^-$ angular analysis
  - Deuteron production at LHCb

$B^0 \to K^{*0}\mu^+\mu^-$ Decays

- Flavour changing neutral current decays
  - $b \to s\, l^+l^-$
- Electroweak penguin and box diagrams at lowest order in the Standard Model



Figures from [1]

- Can also occur as $b \to s q\bar{q}$ ($\to l^+l^-$) where the $q\bar{q}$ makes up a vector meson resonance ⇒ non-local interference effects

$B^0 \to K^{*0}\mu^+\mu^-$ Angular Analysis

MONASH University

- Full unbinned angular analysis aims to quantify the interference between penguin and resonant amplitudes
  - ➢ Isolate any SM interference contributions to existing $B^0 \to K^{*0}\mu^+\mu^-$ anomalies i.e. shift in vector Wilson Coefficient C_9
- Decay rate is parameterised via an effective field theory (EFT)

$$\frac{d^4\Gamma[B^0 \to K^{*0}\mu^+\mu^-]}{dq^2 d\vec{\Omega}} = \frac{9}{32\pi} \sum_i J_i(q^2) f_i(\cos\theta_l, \cos\theta_K, \phi)$$

angular observables — built up from Wilson coeffs., form factors etc.

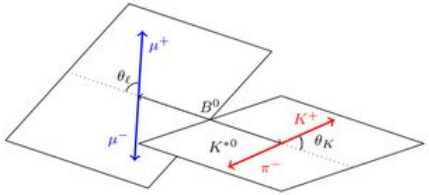
Spherical Harmonics

- q^2 : dilepton invariant mass
- θ_K, θ_l, and ϕ are decay angles

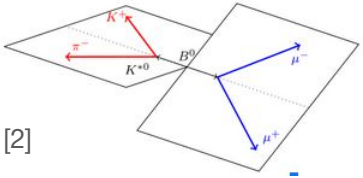
$B^0 \rightarrow K^{*0}\mu^+\mu^-$ Angular Analysis

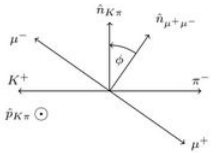
MONASH University

- Decay rate described in terms of 3 angles θ_K, θ_l, and ϕ

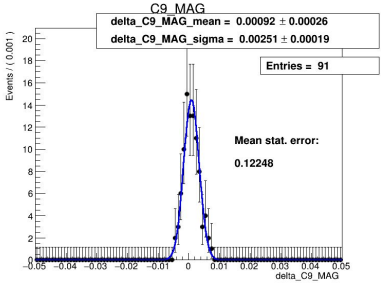


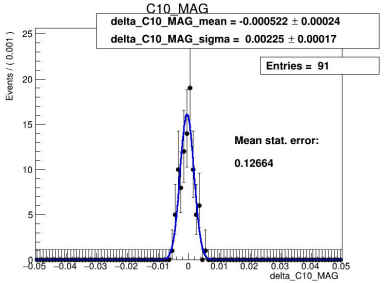
Figures from [2]





- My contribution so far…
  - Systematic uncertainty checks — e.g. Imperfect angular resolution of detector ignored in analysis
    - ➢ Quantified systematic uncertainty in fit parameters (e.g. C_9, C_{10}, …) due to angular resolution

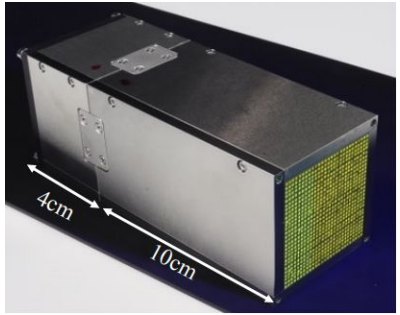


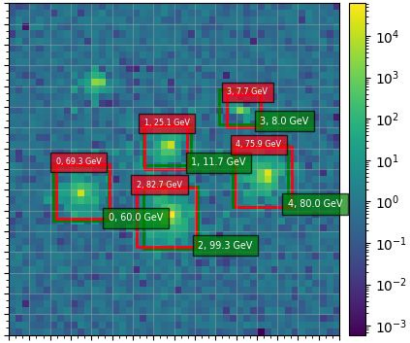


Riley Henderson

Plans for the future

- The main focus of my PhD is a study surrounding the LHCb Upgrade II ECAL
- Specifically…
  - Applying machine learning (ML) to real-time data analysis (calorimeter reconstruction) in an upgraded version of the ECAL
    - ➢ Developing and implementing an ML based clustering algorithm in ECAL readout hardware (FPGAs)





References

[1] *Feynman Diagram Library*, https://www.physik.uzh.ch/~che/FeynDiag/index.php

[2] LHCb, R. Aaij et al., *Differential branching fraction and angular analysis of the decay* $B^0 \to K^{*0} \mu^+\mu^-$, JHEP 08 (2013) 131, arXiv:1304.6325