



ESR Talks — ESR7: Jamie Gooding

Machine Learning for Real-Time Analysis of Lepton Flavour Violation in neutral meson decays and traffic predictions

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Introduction

Full name: James Andrew Gooding

Date of birth: 17th November 1999

Place of birth: Leicester, United Kingdom

Recruiting beneficiary: Technische Universität Dortmund

Start of contract: 15th September 2022

Academic qualifications:





University of Manchester, 2018-2022: Physics (MPhys), 1st Class with Honours

Previously carried out research internships in Civil Engineering at Newcastle University (NERC REP, 2020) and Particle Physics at TU Dortmund (DAAD RISE, 2021) and the University of Manchester (ERC, 2022).



ESR7: ML for RTA of Lepton Flavour Violation in
neutral meson decays and traffic predictions

Introducing ESR7

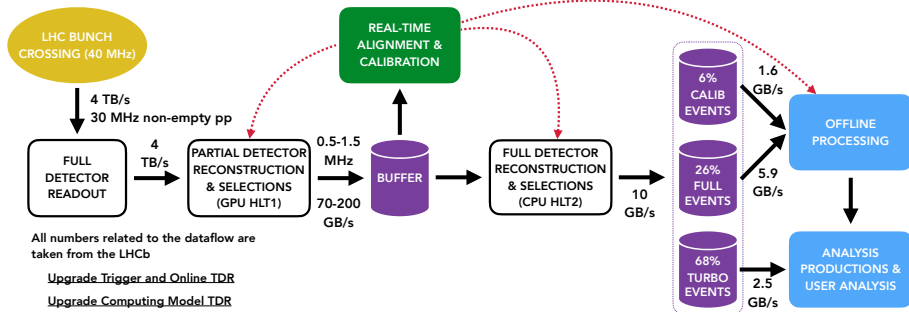
- Based at TU Dortmund , working on the Large Hadron Collider beauty (LHCb) Experiment at CERN  :
 - Working on dilepton trigger selections in rare B meson decays for the Run 3 LHCb data-taking period.
 - Currently developing trigger selection algorithms with the aim of carrying out commissioning of the Rare Decays trigger lines in Run 3.
 - To include time working on-site at CERN, approx. 5-6 months over the 3 years.
- Planned industry collaboration at Ximantis :
 - 3-4 month secondment to work on traffic modelling and predictions.

Dilepton physics at LHCb

- Decays containing a pair of leptons (electrons and their heavier cousins, the muon and tau) are typically rare, so new physics could provide significant enhancement.
- Highlights at the LHCb Experiment to date:
 - Observation of $B_s^0 \rightarrow \mu^+ \mu^-$ decay: $\mathcal{B}(B_s \rightarrow \mu\mu) = (3.09^{+0.46+0.15}_{-0.43-0.11}) \times 10^{-9}$ (*rarest decay observed at LHCb!*) [PRL 128, 041801]
 - Disagreements with SM predictions probed in measurements of angular observables in $B^0 \rightarrow K^* \mu^+ \mu^-$ decays. [PRL 125, 011802]
 - Lepton universality tests, comparing branching fractions ratios such as recent R_K and R_{K^*} measured to be consistent with the SM [arXiv:2212.09152].

Real-Time Analysis at LHCb in Run 3

In Run 3, LHCb will be the first LHC experiment to employ a software-only trigger.



LHCb Run 3 Dataflow, LHCb-FIGURE-2020-016.

Selection algorithms now operate in real-time to reduce the dataflow by discarding “uninteresting” events, i.e. those not relevant to the experiment physics goals.



Objectives

Construct a trigger (set of selection algorithms) to select dilepton candidates.

- Once analysis-quality data has been recorded, plan to carry out measurement(s) to probe lepton flavour violation.
- Additional objectives
 - Measurement of rates of new and existing lines with the trigger framework.
 - Tuning of said lines to fit within the hardware requirements of the experiment.
 - Commissioning of trigger lines for Run 3 data-taking.

Progress

- Within project:
 - Preliminary trigger lines have been developed and should become part of the LHCb software shortly.

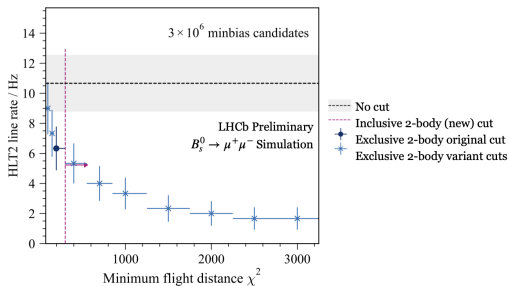


Figure 1: Example of scan over cut in existing 2-body exclusive dimuon line, with new line cut as inferred.

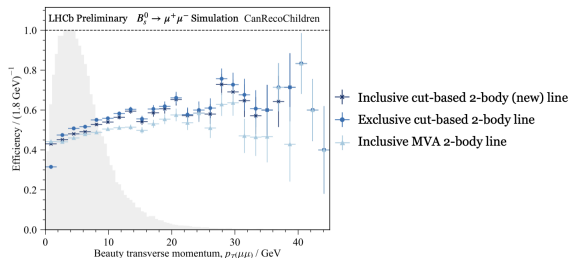


Figure 2: Transverse dependence of efficiencies for existing and new 2-body dimuon lines.



Progress

- Within project:
 - Preliminary trigger lines have been developed and should become part of the LHCb software shortly.
 - Progress on the dilepton trigger selections has been presented twice to the relevant RTA groups withing LHCb.
 - Currently serving as ESR Representative until late May 2023.
- Wider contributions:
 - Currently tutoring for the undergraduate course “Kern- und Elementarteilchenphysik” (*Nuclear and Elementary Particle Physics*).
 - Attended LHCb Week in Dortmund, August 2022, and Annual Meeting of German LHCb Groups in Heidelberg, October 2022.



Post-programme career expectations

- Upon completing the programme, I will receive a physics doctorate from TU Dortmund.
- At present, I hope to stay within academia, moving on to a postdoc position.
- Additionally, I hope to continue working within the LHCb Experiment.
- If I decide to instead enter industry, I feel that I will have acquired valuable technical knowledge through the project to be well-equipped for this transition.