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

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About me

- PhD student at Technische Universität Dortmund, completed my undergraduate Master's here at Manchester!
- Background in particle physics analysis; member of the LHCb Experiment for over a year.
- Interests include: travelling 🚄 baking 🍰 physics outreach 🔭, also a huge Ipswich Town fan! 🔵⚪

My research journey

- Started in civil engineering, looking at railway sleepers with Newcastle University.
- Entered particle physics through a RISE internship at TU Dortmund measuring CP asymmetry in B^0 decays.
- Master's project at University of Manchester, searching for new physics through CP asymmetry of B_s^0 decays at LHCb.
- Returned to TU Dortmund for PhD study, working on SMARTHEP project ESR7!

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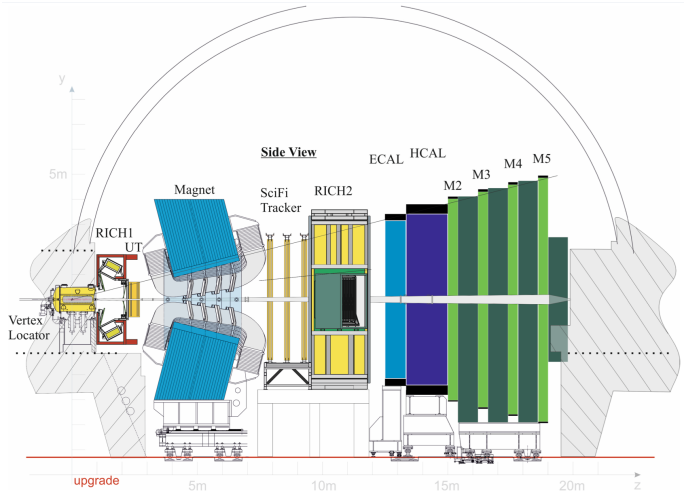
Introducing ESR7

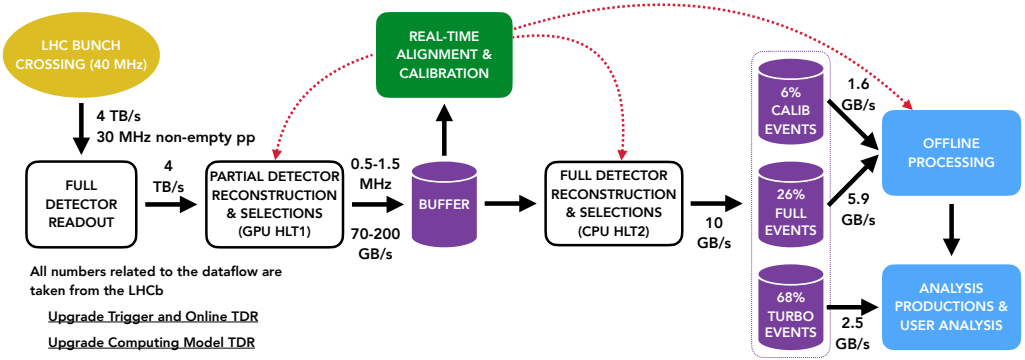
- Based at TU Dortmund 🇩🇪 studying dilepton selections at the LHCb Experiment
- Two planned collaborations:
  - Academic collaboration at Universidade de Santiago de Compostela 🇪🇸
  - Industry collaboration at Ximantis 🇸🇪

The LHCb experiment



[1]Schematic diagram of the LHCb Upgrade I detector.

Real Time Analysis in Run 3



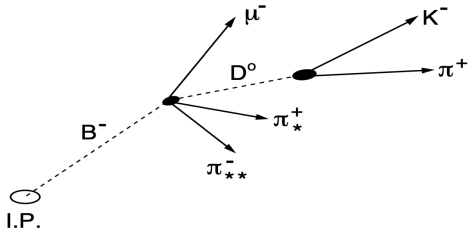
[2] LHCb Run 3 Dataflow, LHCB-FIGURE-2020-016.

Dilepton physics at LHCb

- The dilepton programme of the LHCb Experiment falls within the remit of the Rare Decays working group. Highlights from Run 1/2 include:
  - Observation of $B_s^0 \to \mu^+\mu^-$ decay: $\mathcal{B}(B_s \to \mu\mu) = \left(3.09^{+0.46+0.15}_{-0.43-0.11}\right) \times 10^{-9}$ (*rarest decay observed at LHCb!*) [PRL 128, 041801]
  - Disagreements with SM predictions probed in measurements of angular observables in $B^0 \to K^*\mu^+\mu^-$ decays.
  - Lepton universality tests, comparing branching fractions ratios such as $\mathcal{R}_{\mathcal{K}} = \mathcal{B}(B^+ \to K^+\mu^+\mu^-)\,/\,\mathcal{B}(B^+ \to K^+e^+e^-)$ (each $\mathcal{B}$ integrated over q^2) observed to a discrepancy of 3.1σ with the SM. [arXiv:2103.11769]
- Thus far considering dimuon decays, though project will include full scope of dilepton physics at LHCb.

Existing dimuon triggers

- A range of exclusive (i.e. decay specific) selection-based high level triggers exist for dimuon decay channels, e.g. $B_s^0 \to \mu^+\mu^-$, $B^0 \to K^*\mu^+\mu^-$, $B^+ \to J/\psi\,(\mu^+\mu^-)\,K^+$.
- Two main MVA-based trigger lines for inclusive selection:
  - Inclusive dimuon trigger, using general muon/dimuon signatures.
  - Topological trigger, using topology of b decays.



Topology of a typical b decay, Phys. Lett. B 345 (1995) 103-114

Project aims

- Aim to produce an inclusive (i.e. decay non-specific) selection-based high level trigger.
  - Intended to provide redundancy to MVA-based lines for additional robustness, though not expected to compete in terms of efficiency.
  - Allows for data taking to continue without waiting for tuning/retuning of MVA.
  - A useful tool for cross-checks/systematic studies in later analyses.
- Studies to examine existing lines underway, with initial results presented internally.

Conclusion and next steps

- Set to start developing dimuon high-level trigger line shortly.
- Preliminary studies almost complete, currently examining dependence of existing line rates on selection cuts.
- Plan to expand study to other lepton flavours once dimuon line complete.

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