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Pursuing forbidden beauty

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Propositions belonging to the PhD thesis

Pursuing forbidden beauty

Search for the lepton-flavour violating decays $B^0 \rightarrow e^\pm \mu^\mp$ and $B_s^0 \rightarrow e^\pm \mu^\mp$ and study of electron-reconstruction performance at LHCb

Maarten van Veghel

1. Tensions have been found in lepton-universality measurements of b -hadrons, but more lepton-flavour violation measurements are needed to get a more complete picture.
2. Despite the fact that no $B^0 \rightarrow e^\pm \mu^\mp$ and $B_s^0 \rightarrow e^\pm \mu^\mp$ decays have been found in the Run 1 dataset of LHCb, the upper limits derived from the analysis have been useful in constraining new physics models.
3. Including the use of electrons that can only be reconstructed upstream of the magnet at LHCb is a great way to enhance the efficiency of dielectron channels.
4. To calibrate the detector response, techniques based only on simulation or only on data are not sufficient. Both are needed.
5. The use of track segments in the VELO of LHCb is ideal for determining electron reconstruction efficiencies, as these segments of the track are the least affected by bremsstrahlung and the VELO's material map is relatively well known.
6. Electron-reconstruction efficiency ratios of data over simulation can be used to reduce systematic uncertainties in future lepton-universality measurements at LHCb.
7. Although machine learning classifiers might seem like a black box, they actually derive their behaviour from the input datasets. Hence, calibrating selections on these classifiers do not need more statistical rigor than individual selections on the same set of variables. Both deserve scientific rigor.
8. Modelling invariant-mass distributions of decay candidates with misidentified backgrounds can be fully done from first principles using the knowledge of the momenta of the final-state particles. This should be the standard, rather than using empirical functions that often have to be calibrated on simulation.
9. If mathematics is the language of physics, statistics is the language of (physics) measurements. Hence, statistics should be taught accordingly.
10. As much as possible, scientists should publish confidence intervals on measurable quantities instead of p -values on their hypotheses.
11. While one liners can be useful, one should never forget that the truth is more nuanced.