1. What is Lepton Flavour Universality (LFU)?

- In the Standard Model (SM), the only difference between the three lepton families are their masses.
- LFU violation could hint at New Physics beyond SM!
- Experimental results and SM predictions on LFU show a significant tension.

2. Why is LHCb good for LFU probes?

- Single-arm forward spectrometer, designed to study beauty and charmed hadrons.
- Excellent particle identification.
- Good momentum and spatial resolution.

3. How is LFU tested in this analysis?

- Ratio observables are powerful LFU tests - accurate theoretical predictions and reduced systematic uncertainties.
- The goal of this analysis is the simultaneous measurement of these ratios:

\[
R(D^{(*)0}) = \frac{\mathcal{B}(B^+ \rightarrow D^{(*)0} \ell^+ \nu_\ell)}{\mathcal{B}(B^+ \rightarrow D^{(*)0} \mu^+ \nu_\mu)},
\]

where \(D^{(*)0}\) is either \(D^0\) or \(D^{*0}\) and \(\ell^+\) is \(e^+\) or \(\mu^+\).

4. What is the analysis strategy?

- 3-prong tau reconstruction: \(\tau \rightarrow 3\pi^\pm (\pi^0) \nu_\tau\) (allows for higher background suppression).
- \(D\) meson reconstruction: \(D^0 \rightarrow K^- \pi^+\) and \(D^{*0}\) to either \(D^0\pi^0\) or \(D^0\gamma\) (neutral pions and photons are not reconstructed).
- Optimised candidate selection, including boosted decision trees (BDT).
- Detailed study of control samples to describe different background contributions - bottom left picture: example of subsample for the main component \(B \rightarrow D^0 D_s(X)\).

5. How is this ratio computed?

- The normalisation channel \(B^- \rightarrow D^0 D_s^- (\rightarrow 3\pi^\pm)\) is introduced so the ratio may be arranged as:

\[
R(D^{(*)0}) = \frac{N_x}{N_n} \cdot \frac{\epsilon_n}{\epsilon_x} \cdot \left( \frac{\mathcal{B}(B^- \rightarrow D^0 D_s^- (\rightarrow 3\pi^\pm))}{\mathcal{B}(B^+ \rightarrow D^{(*)0} \ell^+ \nu_\ell)} \right)_{\text{ext}}
\]

- The second fraction requires external inputs.
- Signal and normalisation efficiencies are extracted from Monte Carlo (MC) samples.
- The normalisation yield is obtained from a fit to the \(m(D^0 D^-)\) invariant mass.
- Signal yields are estimated by using a 3D fit on the tau decay time, the BDT output and \(q^2 = (p_B - p_D)^2\).

6. What is the outlook for \(R(D^{(*)})\)?

- In this analysis, the signal yield is blinded.
- Current disagreement is significant (combined tension at \(\sim 3\sigma\)).
- More LFU precision tests needed in order to reduce systematic uncertainties.