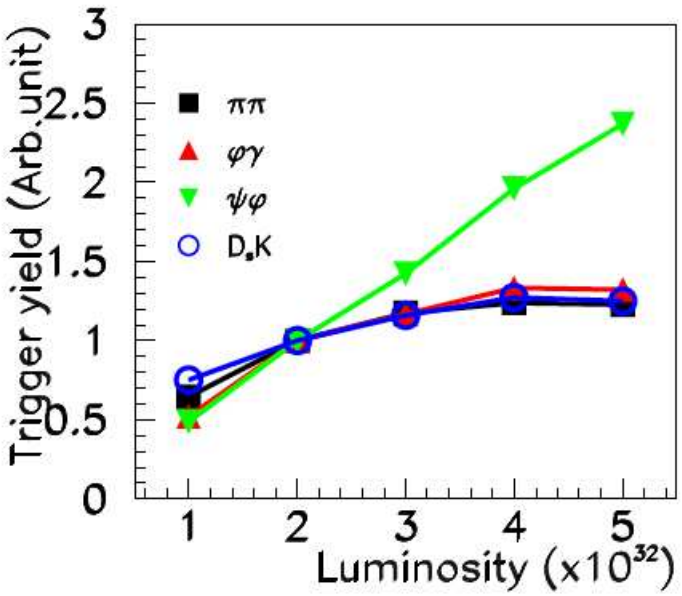

Figure 1.5: The trigger yield for different decays of B mesons. Each point is normalised to the trigger yield expected in nominal conditions at a luminosity of 2×10^{32} cm^{-2}s^{-1}.

rate requires a substantial change in the LHCb read-out architecture.

The present first level trigger (L0) is implemented in hardware [13]. Trigger selections are made at the 40 MHz beam crossing rate using either the Calorimeters or the Muon System. Criteria are based on the deposit of several GeV of transverse energy, $E_{\rm T}$, by charged hadrons, muons, electrons or photons. While this provides high efficiencies on dimuon events, it typically removes half of the fully hadronic signal decays. In these hadronic decays the $E_{\rm T}$ threshold required to reduce the rate of triggered events to an acceptable level is already a substantial fraction of the B meson mass. Any further increase in the rate requires an increase of this threshold, which then removes a substantial fraction of signal decays. As shown in Fig. 1.5, the trigger yield therefore saturates for hadronic channels with increasing luminosity. While it was shown above that LHCb would be able to run at $L = 10^{33}$ cm^{-2}s^{-1}, the decrease in L0-efficiencies, and especially the L0-hadron efficiency, would result in an almost constant signal yield, independent of luminosity, for $L > 2$–3×10^{32} cm^{-2}s^{-1}. Unless the efficiency can be improved by removing the L0 1 MHz limitation and introducing information that is more discriminating than $E_{\rm T}$ earlier in the trigger, the experiment cannot profit from increasing the luminosity.

The most effective way of achieving such a trigger upgrade is to supply the full event information, including whether tracks originate from the displaced vertex that is characteristic of heavy flavour decays, at each level of the trigger. This requires reading out the whole detector at 40 MHz and then analysing each event in a trigger system implemented in software. A detector upgraded in this way would allow the yield of hadronic B decays to be increased by up to a factor of seven for the same LHC machine run-time.

In order to supply displaced vertex information at the first level of the trigger, a tracking