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Partially Reconstructed Beauty Decays at LHCb for the Phase-II Upgrade

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Semileptonic beauty decays provide a theoretically clean probe of CKM Unitarity since their decay rates factorise into leptonic and hadronic currents. At hadron colliders the full kinematic properties of these decays cannot be determined due to the unreconstructable neutrino. The kinematics can however be inferred through the conservation of momentum perpendicular to the flight direction that can be resolved by the LHCb Vertex Locator (VELO). The RF foil is an essential component of the LHCb vertex locator (VELO), separating the secondary vacuum of the VELO from the primary vacuum of the LHC. The foil protects the VELO modules from beam induced effects such as RF waves, and protects the LHC vacuum from hardware effects such as outgassing. The RF foil contributes to the material budget of the experiment and degrades the quality of tracks resulting in a worsened resolution for the reconstructed production and decay vertices. The phase-II upgrade can greatly improve the performance of semileptonic measurements at LHCb. The additional luminosity provided by the LHC coupled with advances in LHCb's hardware and detector design will allow us to probe previously unobserved decays, while improving our understanding of decays currently under investigation. Improvements in the VELO design will improve the resolution of production and decay vertices, significantly improving the physics performance of semileptonic measurements. In addition, the removal, or thinning, of the RF foil can allow the resolution of measured vertices to be improved even further, while simultaneously improving background rejection, tracking efficiencies and reducing ghost rates. The physics performance increase, solely from improved resolution on semileptonic kinematics due to the removal of the RF foil is estimated.

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