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Towards measuring $B_c^+ \to \tau^+\nu_\tau$ at LHCb

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The first experimental measurement of the leptonic decay $B_c^+ \to \tau^+\nu_\tau$ is eagerly awaited by the high energy particle physics community.
Such a measurement provides a sensitive probe of physics beyond the Standard Model and complements the measurements of $\mathcal{R}(D)$ and $\mathcal{R}(D^*)$, which show puzzling differences with the Standard Model predictions, as both probe the $b \to c\tau\nu$ quark-level transition. However, the measurement of $B_c^+ \to \tau^+\nu_\tau$ at LHCb is experimentally challenging due to the presence of neutrinos and large backgrounds from hadronic decays and material interactions.

This work presents the first steps towards measuring the branching ratio of $B_c^+ \to \tau^+\nu_\tau$ using the data collected by LHCb since 2024. To suppress the hadronic background, a dedicated algorithm is applied that searches for hits in the silicon sensors of the Vertex Locator (VELO) consistent with the crossing of the charged B_c^+ meson or the τ^+ lepton. However, exploring the first data, a significant source of background originating from vertices produced by hadronic interactions with the VELO detector material was found. These material-induced events are studied in detail, and dedicated techniques are applied to distinguish them from genuine b-hadron decays.

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