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Prospects of search for $B^+ \to \mu^+\nu_\mu$ decay with the Belle II experiment

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Belle II is a next-generation B-factory experiment located at the SuperKEKB e^-e^+ collider, with the focus on examining the decays of $B\bar{B}$ meson pairs. The collider is energy-asymmetric, with a planned record-breaking instantaneous luminosity of 8×10^{35} cm^{-2}s^{-1}, 50 times that of its predecessor, KEKB. This will enable Belle II to gather 30 times more data than both previous-generation B-factories, Belle and BaBar, combined.

A search for the $B^+ \to \mu^+\nu_\mu$ decay can probe both the Standard Model and its parameters, and multiple scenarios for New Physics. The Standard Model predicts the branching fraction for this decay mode to be $(3.80 \pm 0.31) \times 10^{-7}$. This is a helicity-suppressed decay; the branching fraction depends on the lepton mass. Previously the Belle experiment performed an inclusive search on their full data sample and obtained a 2.4 standard-deviation excess above background level, determining the branching fraction to be $(6.46 \pm 2.22_{stat} \pm 1.60_{syst}) \times 10^{-7}$. Higher precision and a larger dataset is expected to enable Belle II to make the first observation of this mode.

An inclusive search will be performed on the Belle II dataset. A single monoenergetic muon constitutes the signal. Signatures from the other B-meson involved in the event will be combined and the missing neutrino from the signal side will be indirectly reconstructed. Various background suppression methods need to be implemented to maximally reduce the continuum and peaking backgrounds. An analysis method is being developed using 1 ab^{-1} of Belle II Monte Carlo simulation. Reconstruction and background suppression methods will be presented, leading to a discussion of the prospects for this measurement with the Belle II experiment.

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