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First demonstration of $O(ns)$ timing resolution in the MicroBooNE liquid argon time projection chamber

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MicroBooNE is a neutrino experiment located in the Booster Neutrino Beamline (BNB) at Fermilab, which collected data from 2015 to 2021. MicroBooNE's liquid argon time projection chamber (LArTPC) is accompanied by a photon detection system consisting of 32 photomultiplier tubes used to measure the argon scintillation light and determine the timing of neutrino interactions. Analysis techniques combining light signals and reconstructed tracks are applied to achieve a neutrino interaction time resolution of $O(1ns)$. The result obtained allows MicroBooNE to access the nanosecond beam structure of the BNB for the first time. The timing resolution achieved will enable significant enhancement of cosmic background rejection for all neutrino analyses. Furthermore, the ns timing resolution opens new avenues to search for long-lived-particles such as heavy neutral leptons in MicroBooNE, as well as in future large LArTPC experiments, namely the SBN program and DUNE.

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