

Sub-nanosecond Cherenkov photon detection for LHCb RICH particle identification in high-occupancy conditions

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The increase in luminosity during the LHC upgrade programme causes a rise in particle multiplicity and hit occupancy in the LHCb detector. To mitigate this effect for the Ring-Imaging Cherenkov (RICH) detectors, it is proposed to use the photon detector hit time information.

The FPGA in the upgraded RICH detector readout chain includes a programmable time gate, which will be fine-tuned with the first data in 2021. During particle beam tests, a 6.25 ns gate yielded a four-fold reduction in detector noise compared to the original 25 ns readout. A time-walk correction is discussed.

Using simulation, the intrinsic time resolution of the RICH detectors is demonstrated to be less than 10 ps. This is important in preparation for a further order-of-magnitude rise in luminosity in 2030. Considering only improvements in timing, a 50 ps resolution can achieve today's particle ID performance in the high-luminosity LHC. R&D towards a single-photon detector with sub-ns time resolution is outlined.

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