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# First operational use of crystal collimation at the Large Hadron Collider (LHC) with high intensity and high energy heavy-ion beams

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An important upgrade program has been deployed for the collimation system of the Large Hadron Collider (LHC) for lead-ion beams, which will achieve their high-luminosity target intensity upgrade during LHC Run 3 (2022-2025). While certain effects like e-cloud, beam-beam interactions, impedance, injection, and dump protection are mitigated with ion beams, halo collimation poses an increasing challenge compared to the operation with

proton beams. This is because the conventional multi-stage collimation system is about two orders of magnitude less efficient for ion beams compared to proton beams. Ion fragments scattered from the collimators in the betatron cleaning insertion pose a risk of quenching cold dipole magnets downstream, potentially limiting performance. Planar channeling in bent crystals has been proven effective for high-energy heavy ions and is now considered the baseline solution for collimation in the High-Luminosity LHC (HL-LHC) era. This paper provides an overview of a first milestone achieved in 2023, where crystal-assisted collimation was used operationally along the entire LHC heavy-ion run.

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