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Assessing the origin of the LHC beam halo

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Measurements of the transverse beam-halo population at large amplitudes in the Large Hadron Collider (LHC) provide crucial insights into the stored beam energy near the LHC collimators. These particles do not contribute significantly to the luminosity but their loss could impose limitations on accelerator performance through sudden loss spikes or even collimator damage in case of fast beam failures. A thorough understanding of the beam halo formation, along with the physical mechanisms driving its behaviour and evolution throughout the final stage of the LHC injection chain and during the acceleration cycle, is essential to define appropriate mitigation strategies to ensure reliable operation in view of High Luminosity LHC beam parameters. In this study, we explore potential origins of the transverse beam halo by examining experimentally multiple contributing factors to halo formation, including electron cloud effects, beam injection dynamics from the Super Proton Synchrotron (SPS), and the energy ramping process within the LHC.

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Author: RAKIC, Milica (École Polytechnique Fédérale de Lausanne)

Co-authors: MONTANARI, Carlo Emilio (University of Manchester); BUTTI, Daniele (European Organization for Nuclear Research); MIRARCHI, Daniele (European Organization for Nuclear Research); RONCAROLO, Federico (European Organization for Nuclear Research); BARTOSIK, Hannes (European Organization for Nuclear Research); HOSTETTLER, Michi (European Organization for Nuclear Research); HERMES, Pascal (European Organization for Nuclear Research); KOSTOGLOU, Sofia (European Organization for Nuclear Research); REDAELLI, Stefano (European Organization for Nuclear Research); BURGER, Stephane (European Organization for Nuclear Research)

Presenter: HERMES, Pascal (European Organization for Nuclear Research)

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