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Light-Ion Collisions at the LHC: Hard Probes and Nuclear Structure

The dedicated 2025 LHC light-ion run delivered p+O, O+O and Ne+Ne datasets, opening a new opportunity to study QCD in collision systems intermediate between proton–nucleus and large heavy-ion collisions. These new data broaden the range of systems available for investigating nuclear structure, initial-state effects and the emergence of final-state medium phenomena.

This talk will review the first results from the 2025 LHC light-ion programme, with emphasis on hard and electroweak probes complementary to the broader jet-quenching programme. Measurements of charged-particle production, electroweak bosons, heavy flavour and quarkonia will be discussed as probes of nuclear parton distribution functions, collision geometry and possible final-state medium effects. Selected jet-related observables will be included where they provide essential context for the emerging picture of parton energy loss.

Particular attention will be given to comparisons between O+O, Ne+Ne, p+Pb and peripheral Pb+Pb collisions, and to what these measurements reveal about the interplay between nuclear structure, initial-state modifications and the onset of QGP-like behaviour in small and intermediate collision systems.

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