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Design of a hollow hexapole applicable to ECR charge breeder to mitigate the plasma contamination by sputtering

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ECR charge breeders are used to increase the charge state of radioactive ion beams (RIB) from 1+ to N+ in facilities using the isotope online production scheme (ISOL). ECR charge breeders can accept incoming 1+ RIB as high as a few μA, the method reaches ion charge conversion efficiency up to 20% with a characteristic time of the order of 15 ms per charge state. A drawback of ECR charge breeder comes with the minimum-B magnetic confinement of the plasma which forces the plasma to hit the plasma chamber wall both axially and radially. In this work, the classical hexapole used to confine the plasma radially is replaced by a hollow permanent magnet hexapole which forces the plasma to leak on surfaces defined by θ=const rather than r=const in cylindrical coordinated. The alternative magnetic structure proposed, applicable to a 14 GHz booster operation, is presented in detail. The topology of the magnetic field in the plasma chamber and its consequence on the plasma shape and loss surface locations is also assessed and compared to the classical Hallbach permanent hexapole shape. The mitigation of the atom sputtering from the chamber wall with the hollow hexapole is finally discussed, underlying its potential application in an ECR charge breeder to reduce the RIB background contamination.

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