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Research and development study on nanobeam formation using laser-cooled ions for high-precision single-ion irradiation

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To realize high-precision single-ion irradiation or implantation, we have proposed a nanobeam formation scheme where single cold ions selectively separated from a two-component Coulomb crystal in a linear Paul trap (LPT) are accelerated to 100 keV and focused on the nanometer scale using electrostatic bipotential lenses. The entire process of laser cooling of trapped ions in the LPT, ion-selective ejection from the LPT, acceleration, and focusing in the lens system is investigated by detailed multiparticle tracking simulations to show the feasibility of ultralow-emittance nanobeam formation and ion focusing properties. According to the simulation results, the fabrication and commissioning of such a single-ion irradiation system are ongoing at Takasaki Institute for Advanced Quantum Science, National Institutes for Quantum Science and Technology toward the application of research and development of quantum materials and devices. We will discuss the simulation results on the behavior of cold ions in the irradiation system and report the latest status of the system development including preliminary experimental results.

Footnotes

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