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Fast Quantum Control of Bose-Einstein Condensates for Inertial Sensing Applications[1] SKYLER WRIGHT, CHRIS LARSON, E. CARLO SAMSON, Miami University — We report on our numerical simulations of high-fidelity, fast quantum control of Bose-Einstein condensates (BECs), as we extend them to full 3D simulations, while performing a new set of 2D simulations. We simulate a painted potential that provides transverse confinement to the atoms, in unison with a harmonic potential for vertical confinement. This combination results to arbitrary and dynamic 3D traps, which control the spatial transport of the BEC. To maintain high fidelity after transport, we implement shortcuts-to-adiabaticity (STAs) to design the BEC trajectory in our simulations. STAs allow fast movement while suppressing excitations that can result due to the rapid transitions of the quantum state. In our 3D simulations, quantum fidelities resulting from different, experimentally viable transport times and trap-depths are compared. In our 2D simulations, we further our study of the directionality of the quantum control by commuting the BEC at a 45-degree angle as well as reflecting the movement halfway through the transport time. This new set of 2D simulations is in preparation for the analysis of STA implementation during the operation of a BEC Mach-Zehnder interferometer.

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