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## High-fidelity transport of trapped-ion qubits in a multilayer array

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Chip-based trapping technology has emerged as a promising approach for multi-dimensional quantum simulations and entanglement using individually controllable trapped ion qubits arrays. Previous studies have demonstrated successful local control, inter-site coupling, and floquet-engineered couplings in such architectures[1-3]. Here we present the extension of the existing toolbox by introducing tools from the QCCD architecture[4], enabling deterministic transport of a single trapped ion qubit across a three-dimensional landscape. We also showcase the preservation of quantum coherence in the electronic degrees of freedom throughout the transport process[5]. Additionally, we address technical limitations, such as anomalous heating through Argon-ion bombardment and challenges related to the dephasing of motional and electronic degrees of freedom[6].

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**Primary authors:** PALANI, Deviprasath (University of Freiburg); Mr HASSE, Florian (University of Freiburg); Mr DAS, Apurba (University of Freiburg); Dr WARRING, Ulrich (University of Freiburg); Dr SCHAETZ, Tobias (University of Freiburg)

**Presenter:** PALANI, Deviprasath (University of Freiburg)

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