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Towards robust single qubit gates on a trapped-ion quantum computer MING LI, NIKODEM GRZESIAK, REINHOLD BLUMEL, YUNSEONG NAM, IonQ, Inc — As fundamental building blocks of digital quantum computation, single qubit gate operations need to be implemented with high fidelity and efficiency for any quantum computing architecture to be scalable. In trapped-ion quantum computers, the implementation utilises spin-changing transitions driven by an electromagnetic field, which could also couple to motional sidebands of the ion chain. Such off-resonant couplings are usually neglected in theoretical studies by applying the rotating wave approximation. As the number of motional modes increases with the number of qubits, and as the frequencies of some modes lower, the validity of the approximation becomes questionable. We theoretically investigate coherent errors and decoherence induced by these off-resonant couplings. To mitigate the resulting infidelity, we implement pulse shaping techniques and study their behaviors in terms of phase space closure, power requirement, and more.

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