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System Stability Optimization and Gate Operations in a Compact Cryogenic Ion Trap Setup ZHUBING JIA, Department of Physics, Duke University, ROBERT SPIVEY, ISMAIL INLEK, Department of Electrical and Computer Engineering, Duke University, KE SUN, Department of Physics, Duke University, STEPHEN CRAIN, MARK KUZYK, RACHEL NOEK, Department of Electrical and Computer Engineering, Duke University, KENNETH BROWN, JUNGSANG KIM, Department of Electrical and Computer Engineering and Department of Physics, Duke University, EURIQA/LOGIQ TEAM — We describe one- and two-qubit operations in a compact ion trapping system at cryogenic temperature. A low-vibration closed-cycle cryostat is utilized with all optics mounted on machined plates for operations with higher stability. We use Sandia High-Optical Access (HOA) surface traps and install the trap into a compact package, enabling easier system integration and characterization. The surface trap is mounted on a ceramic pin grid array (CPGA) package and covered with a copper lid with a meandering channel for differential pumping. The whole package is cooled down to a base temperature of 7K. We set up a Michelson interferometer to characterize and optimize the vibrations from the cryostat to the ion trap with respect to control lasers and give a quantitative analysis on the effect of vibrations on gate fidelity. We show the latest result of Mølmer-Sørensen gate fidelity with an analysis of the source of errors, which are dominated by motional decoherence.

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