Exploring New Technologies For Neutral Atom Quantum Computing

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We have developed a next-generation apparatus to advance neutral atom quantum computing with ^{88}Sr. The apparatus incorporates a cryostat and will contain a microwave shield inside a glass cell. In contrast to more traditional cryostats, our apparatus is designed to provide the benefits of cryogenics, such as exceptionally long lifetimes and blackbody radiation shielding, while simultaneously allowing for full optical access and integration with existing and proven designs and components. The microwave shield could enable long lifetimes of circular Rydberg states and high-fidelity two-qubit gates by shaping background electric fields and suppressing UV-induced charges on the glass cell. With this machine, we also made a push towards more compact and modularized setups. The footprint of the apparatus is significantly reduced compared to similar experiments, primarily due to the use of multi-drawer racks that contain most of the laser setups. One rack can replace one standard optical table and, at the same time, is easier to maintain and operate. This platform will enable us to scale the qubit numbers to ∼100k and explore the circular Rydberg states of alkaline-earth elements for quantum simulation and quantum computing.

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