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**Trapping long ion chains in a cryogenically cooled trap for quantum simulation**[1] HARVEY KAPLAN, Joint Quantum Institute (JQI), Univ. of Maryland (UMD), GUIDO PAGANO, WEN LIN TAN, JQI, UMD, PAUL HESS, Middlebury College, JESSICA HANKES, JIEHANG ZHANG, ANTONIOS KYPRIANIDIS, PATRICK BECKER, JQI, UMD, PHILIP RICHERME, Indiana Univ, ERIC BIRCKELBAW, MICAH HERNANDEZ, JQI, UMD, YUKAI WU, Univ of Michigan, CHRIS MONROE, JQI, UMD — Long ion chains trapped in a linear Paul trap presents a promising platform for quantum simulation of spin systems. As the number of spins increases, the size of the Hilbert space grows exponentially, and spin systems quickly become intractable to simulate classically, for about 50 spins, where each spin is simulated by an ion. The ion chain lifetime is limited by collisions with background gas, which shortens the lifetime as the number of trapped ions grows. Here we present a new ion trapping system using 171Yb+ in a blade trap in a cryogenic vacuum. The pressure is significantly improved by using differential cryo-pumping. We present progress with building the apparatus, and measurements to understand the vibrations at the trap, the pressure in the vacuum, and the extent to which the ion crystal spacing can be manipulated. Using a 355 nm frequency comb, we have performed coherent spin manipulations through a Raman process, which will serve as the method for generating long range spin-spin couplings. This novel apparatus will enable the simulation of many-body quantum systems that are intractable for classical simulators.

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