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Towards a long-chain trapped ion quantum simulator with in-situ mid- circuit measurement

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Here, we report on the development of a large-scale quantum simulator with programmable individual control of more than 50 $^{171}Yb^{+}$ ions in a segmented 'blade trap' system. The trap allows high NA optical access from four directions and will include high fidelity and low crosstalk in-situ state measurement and reset of individual ions [1]. Our custom monolithic optical breadboards are engineered to provide long-term stability. Through optimized vacuum engineering and extensive outgassing tests, the vacuum system is optimized for long ion storage times. Preliminary tests show a measured pressure of <8E-13 mbar, lower than most existing room temperature ion traps. This system will allow us to perform a wide range of quantum information processing experiments, like exploring measurement-based quantum phases of spin Hamiltonians to hybrid digital-analog quantum algorithms.

[1] S. Motlakunta, N. Kotibhaskar, C.-Y. Shih, A. Vogliano, D. Mclaren, L. Hahn, J. Zhu, R. Habl˙utzel , and R. Islam, Preserving a qubit during adjacent measurements at a few micrometers distance (2023), arXiv:2306.03075

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