

Error-Correction in Long Ion Chains

M. Cetina^{*1}, **T. Wang**¹, **S. Huang**^{1,2}, **A. V. Horn**², **J. Kim**², **K. Brown**^{1,2,3}

1. Duke University Department of Physics

2. Duke University ECE Department

3. Duke University Department of Chemistry

We employ the high connectivity of a chain of 23 $^{171}\text{Yb}^+$ ions to implement one round of fault-tolerant Steane-type Z-stabilizer readout of the Bacon-Shor $[[9,1,3]]$ quantum error-correcting code. We demonstrate twofold suppression of the error in the logical data and in the Z-syndrome compared to a fault-tolerant Shor-style protocol. The dominant errors in our platform are caused by axial motion of the ions. To counter this, we demonstrate deterministic sorting of mixed-species $^{171}\text{Yb}^+$ - $^{172}\text{Yb}^+$ chains. Sympathetic cooling using $^{172}\text{Yb}^+$ opens the door to partial readout and qubit reuse in long circuits and the study of controlled dissipation in individually-addressed long ion chains.

*marko.cetina@duke.edu