Contribution ID: **88** Type: **Invited Poster**

Improving a trapped-ion quantum computer with a cryogenic sapphire oscillator

We describe an agile microwave synthesis system devised of an ultra-low phase-noise cryogenic sapphire oscillator (CSO) that serves as a master clock for a ytterbium ion (Yb+) qubit. We report a 10X improvement of qubit coherence time from 0.9 to 8.7 seconds and single-qubit quantum gates with errors of 1.6e-6 achieved with the synthesis system. Using a filter function approach [1], we find evidence that the precious coherence of 0.9 seconds was limited by the phase noise of a precision-grade commercially off-the-shelve microwave synthesizer [1]. Furthermore, we also leverage the agility of the microwave synthesis system to demonstrate a Bayesian learning algorithm that can autonomously design informationally-optimised control pulses to identify and calibrate quantitative dynamical models to characterize a trapped-ion system. We experimentally demonstrate that the new algorithm exceeds the precision of conventional calibration methods with few samples [2].

References:

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Author: TAN, Tingrei

Presenter: TAN, Tingrei

Track Classification: Precision and Low Noise Signal Generation and Techniques