A next-generation trapped ion quantum computing system - a.k.a. "brassboard"

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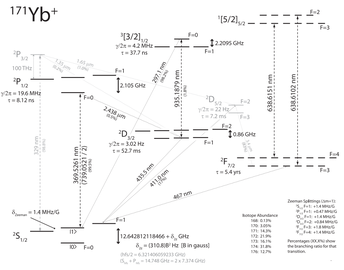
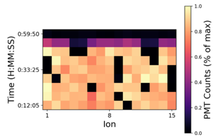
Trapped Ion Quantum Computing



Vacuum System

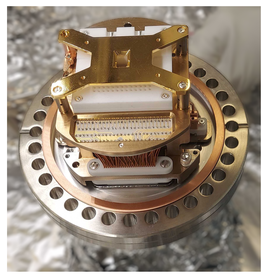
- Vacuum fired components
- Reduce ion-chain reordering rate
- 10^{-11} Torr measured pressure



15-ion chain reordering in 1st gen EURIQA system.

Consistent with 10^{-10} Torr.

Cetina, et al.

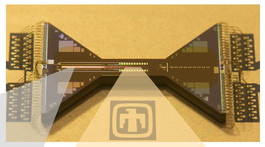


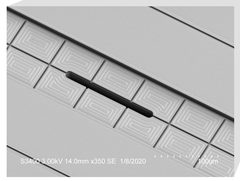
Phoenix Surface Trap

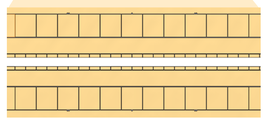
- Better metallization
  - Reducing noise
  - Less charging/photovoltaic effect

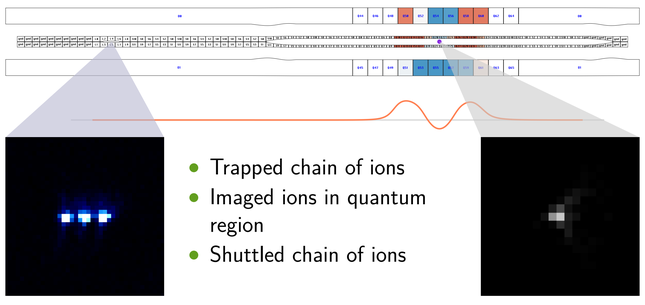
  30 quanta/s heating rate @ 3 MHz

  Measured by Sandia
- Segmented outer electrodes
- Better and faster ion loading





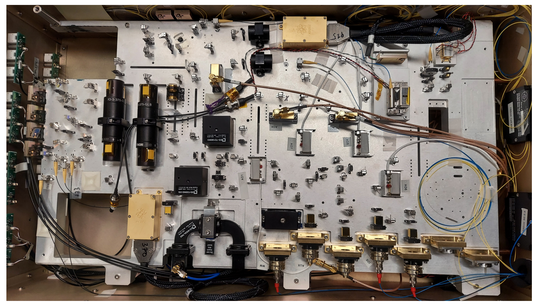




- Trapped chain of ions
- Imaged ions in quantum region
- Shuttled chain of ions

Raman System

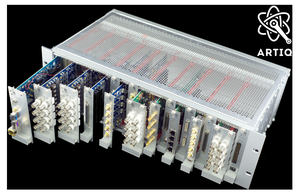
Miniaturized 369/399/780/935nm Beam Path



Control System

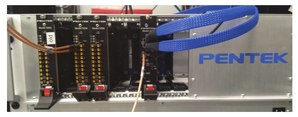
ARTIQ

- Artiq software
- Sinara hardware



RFSoC/Pentek

- integrated pulse-level control
- phase synchronization



Duke Artiq Extensions

- modular control software
- system code organization

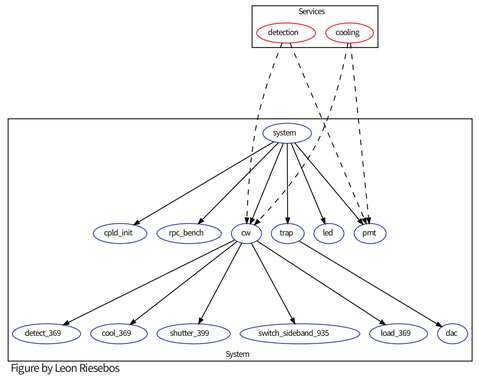
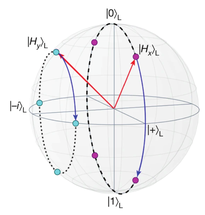


Figure by Leon Riesebos

Imaging System

Applications



- Universal Quantum Computer
- 20+ qubits and high fidelity
- Quantum simulations of many body physics
- Quantum chemistry
- Quantum gravity
- Nuclear theory
- Quantum Error Correction