

# A next-generation trapped ion quantum computing system

Yichao Yu

Lei Feng, Liudmila Zhukas, Marko Cetina, Crystal Noel, Debopriyo Biswas,  
Andrew Risinger, Alexander Kozhanov, Christopher R Monroe

Monroe Group/Duke Quantum Center

June 2, 2022

# $^{171}\text{Yb}^+$ qubit

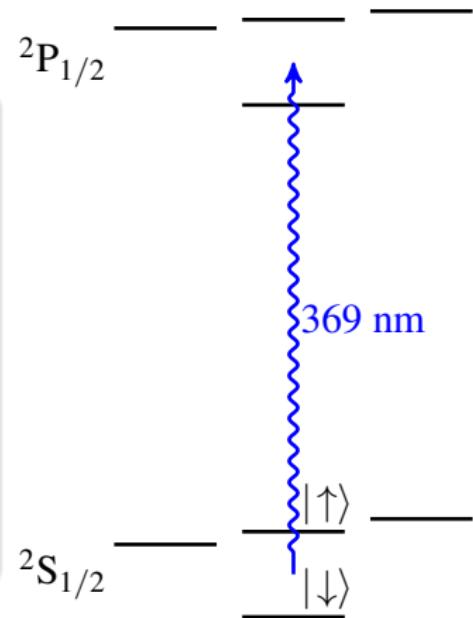
- Long coherence time:  $T_2 \approx 1\text{hr}$

Wang, et al., Nat Commun 12, 233 (2021)

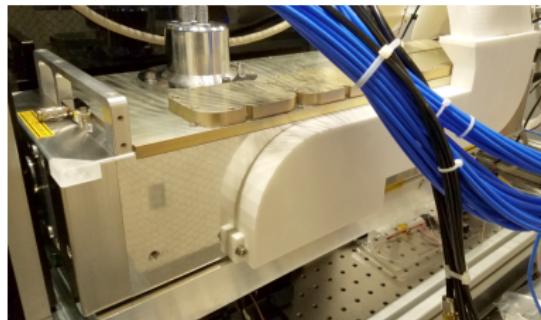
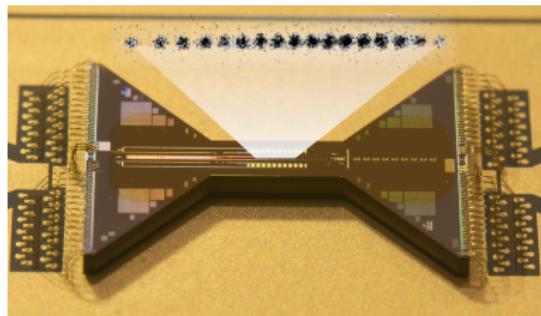
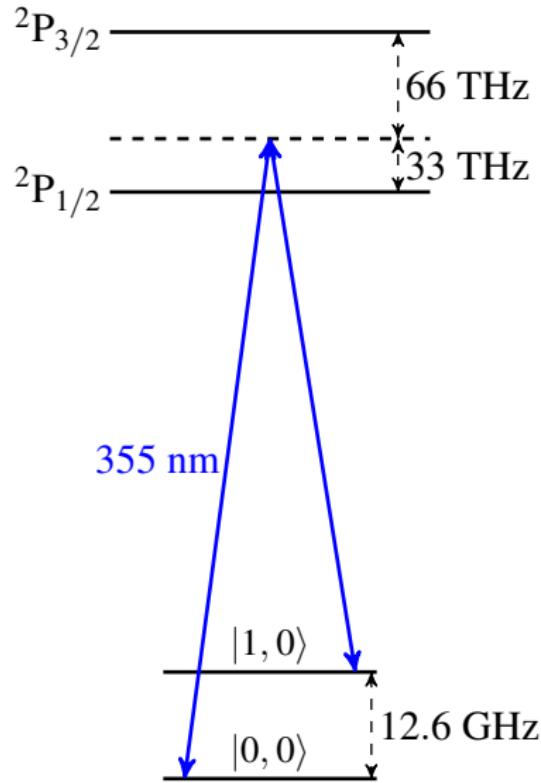
- High fidelity state preparation:  
 $> 99.9\%$  in  $\approx 10\mu\text{s}$
- High speed and high fidelity readout:  
 $> 99.3\%$  in  $\approx 100\mu\text{s}$

Harty, et al., PRL. 113, 22051, (2014)

Christensen, et al., NPJ Quantum Inf. 6, 35 (2020)



# $^{171}\text{Yb}^+$ chain and coherent manipulation



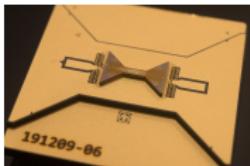
# 1<sup>st</sup> generation EURIQA system

## Error-corrected Universal Reconfigurable Ion-trap Quantum Archetype

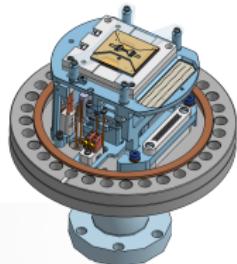


- 15-24 qubits
  - High fidelity single and two qubit gates
  - Universal reconfigurable
  - Remote operations
- 
- E06: Programmable N-body interactions with trapped ion qubits
  - E06: Implementing Real-Time Logical Qubit Error Detection & Correction on a Trapped Ion Quantum Computer
  - Q07: Implementation of interactive proofs for quantum advantage on an ion-trap quantum computer
  - U05: Using a trapped ion quantum computer to simulate NMR spectra\*

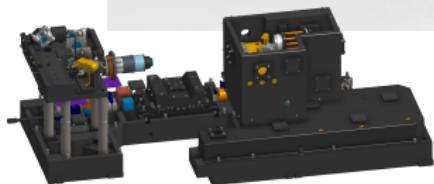
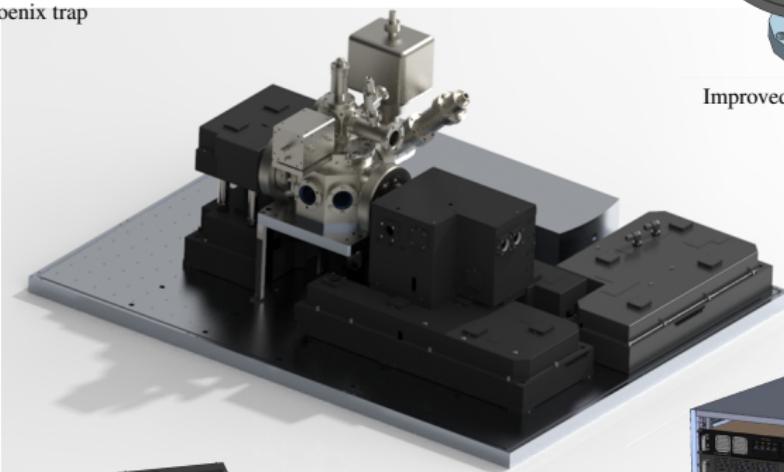
## 2<sup>nd</sup> generation EURIQA system



Sandia Phoenix trap



Improved vacuum system



L3Harris Raman beam path



CW lasers

## 2<sup>nd</sup> gen EURIQA: Pheonix trap

## 2<sup>nd</sup> gen EURIQA: Raman geometry

## 2<sup>nd</sup> gen EURIQA: New Yb atom source

## 2<sup>nd</sup> gen EURIQA: Improved vacuum

## 2<sup>nd</sup> gen EURIQA: Raman beam path

## 2<sup>nd</sup> gen EURIQA: CW lasers

# 2<sup>nd</sup> gen EURIQA: status and first ion

