Integrated Remote Entanglement of Trapped Ions

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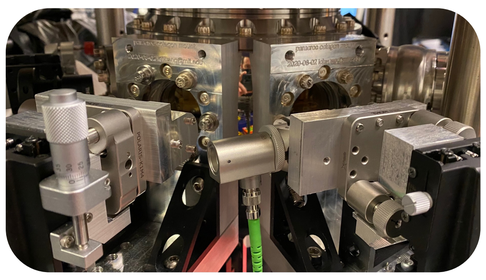
Funding

This material is based on work supported by the U.S Department of Energy, Office of Science, National Quantum Information Science Research Centers, Quantum Systems Accelerator, under Air Force Contract No. FA8702-15-D-0001. Any opinions, findings, conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the Defense Advanced Research Projects Agency or the Department of Energy. The authors wish to acknowledge generous support from the NSF trough QLCI-HQAN (award #2016136) and QLCI-Q-SEnSE (award #2016244).

†This research was supported by an appointment to the Intelligence Community Postdoctoral Research Fellowship Program at Massachusetts Institute of Technology administered by Oak Ridge Institute for Science and Education (ORISE) through an interagency agreement between the U.S. Department of Energy and the Office of the Director of National Intelligence (ODNI)

Challenges

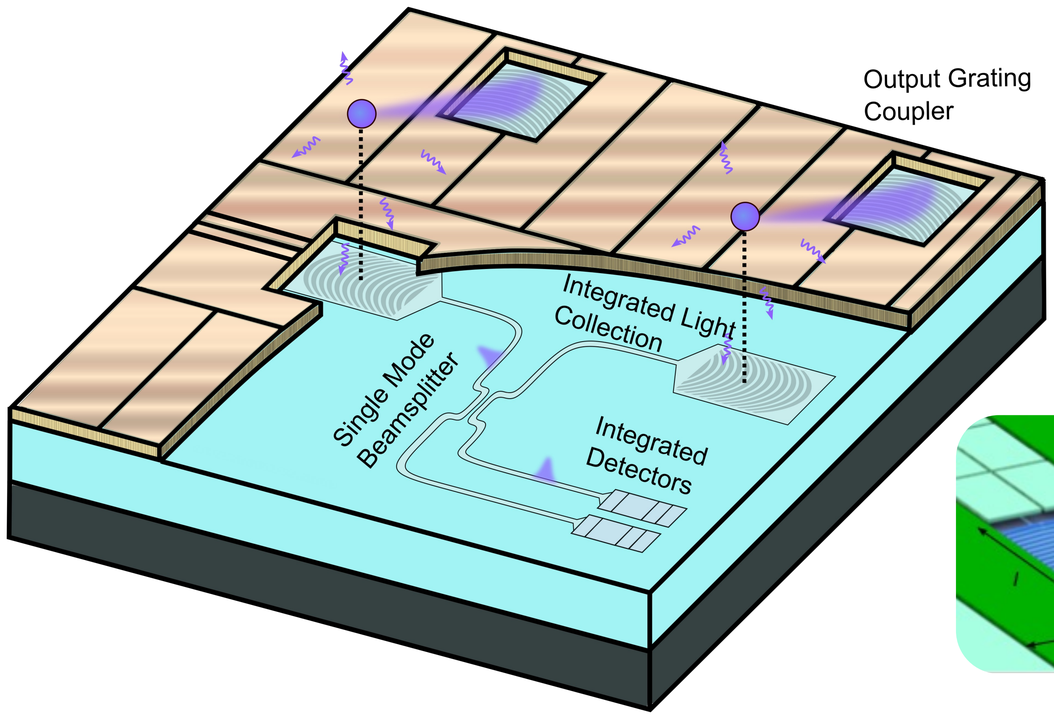
1. Qubit operations are mediated by photons and phonons
2. Spatial constraints limit beam access and thus qubit number in current experiments

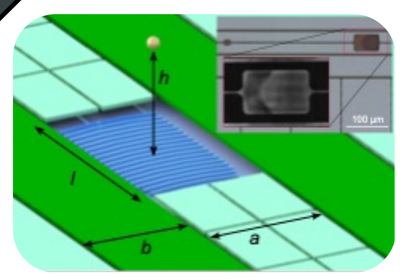


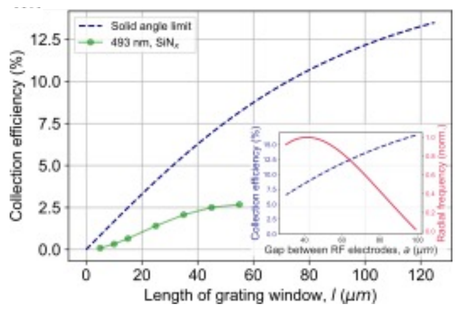
3. Spectral crowding of motional modes (the quantum bus) limits the size of a trapped ion processor
4. Sideband cooling takes ~40% of the duty cycle in current implementations of quantum algorithms[1]

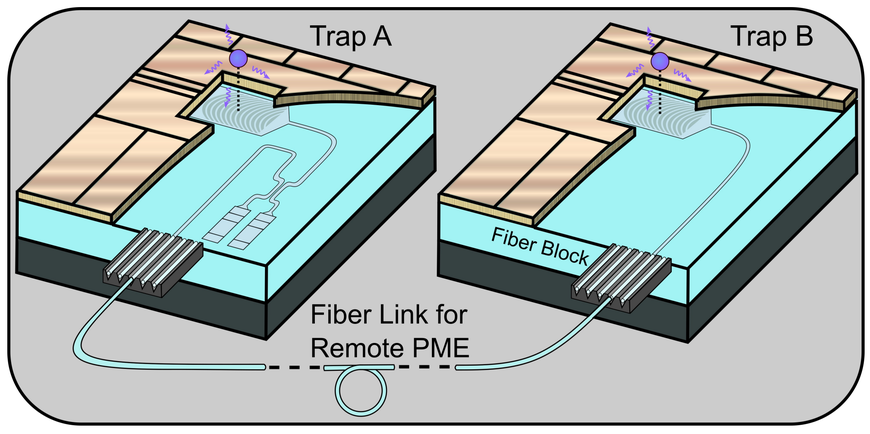
Vision

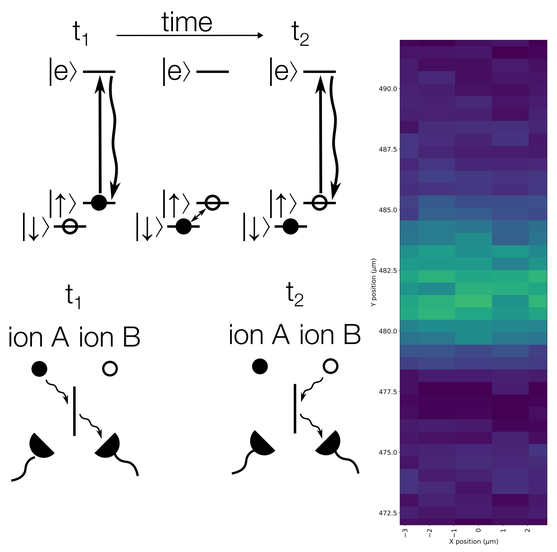
A remote entanglement generation unit cell that can be multiplexed to achieve high-rate modular quantum computing with trapped ions in a single vacuum system



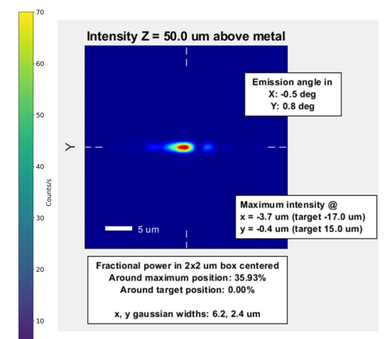








In-situ and Ex-situ Device Characterization

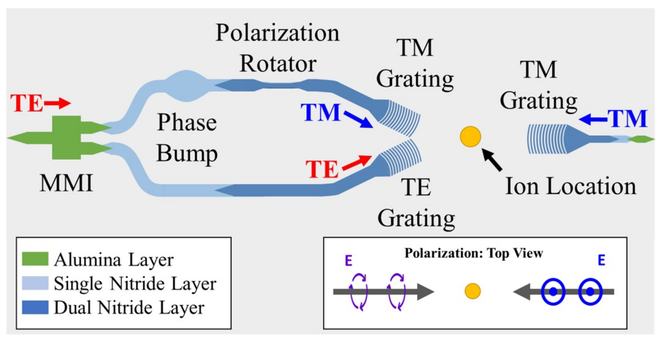


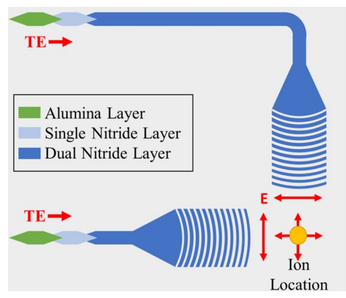
Fast cooling and state preparation

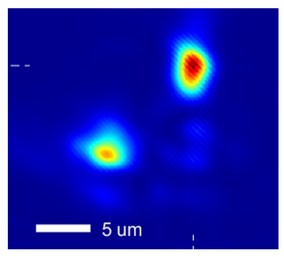
Key operations require circularly polarized light, but current grating designs emit only linearly polarized, TE or TM light

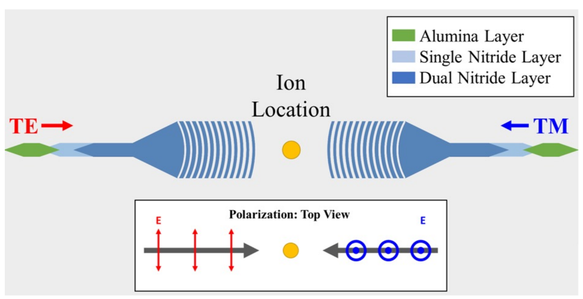
We are developing and testing structures to deliver light of different polarizations for:

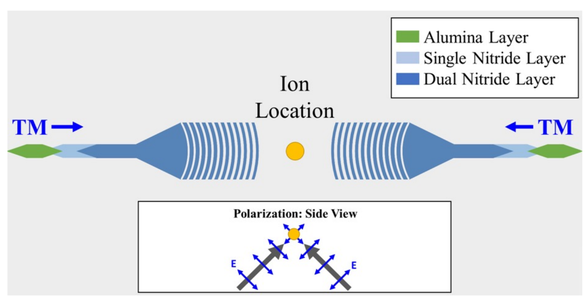
- Fast state preparation
- Remote entanglement generation pulses
- EIT cooling
- Polarization gradient cooling











Consequences

Modular quantum computing in a single vacuum system with up to 100 kHz links

Quantum repeaters when combined with coherent frequency conversion

Improved run time of quantum algorithms by reducing the time spent sideband cooling

References and QR codes

Digital version of poster:

Arxiv link for paper:

[1]Quantinuum: https://doi.org/10.48550/arXiv.2305.03828