Integrated Photonics for trapped-ion state detection and photon mediated entanglement generation

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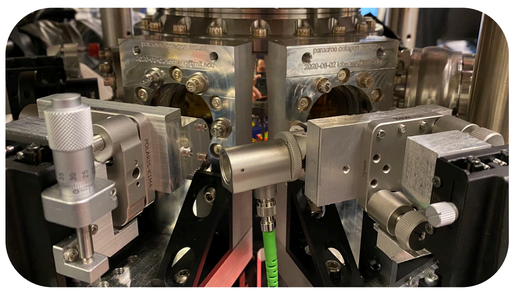
Motivation

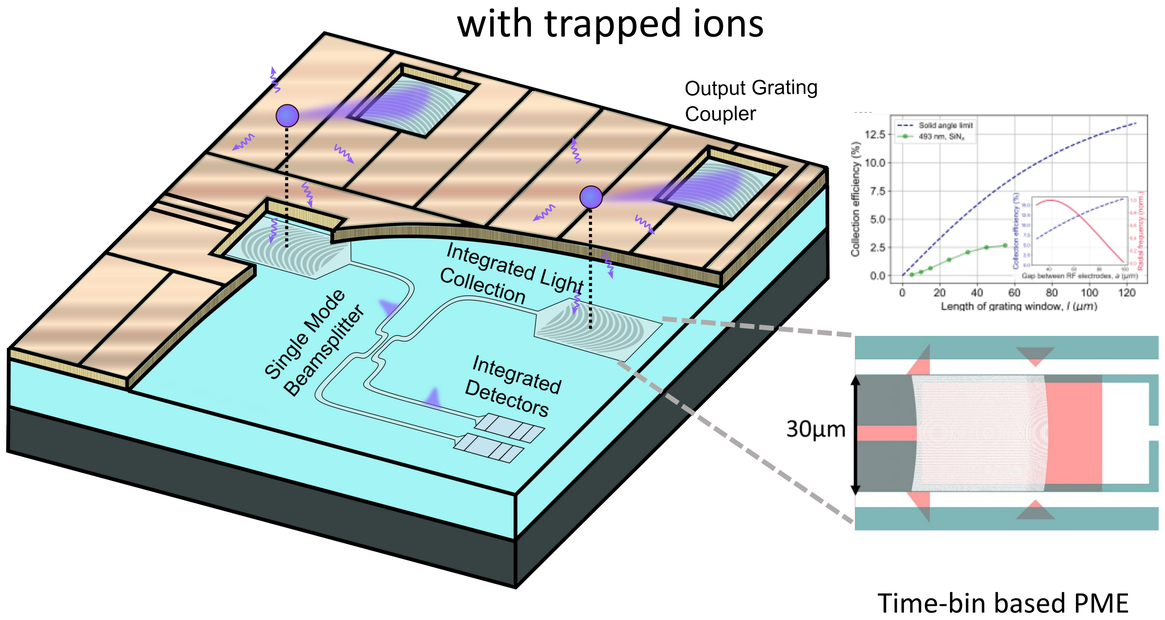
1. Entanglement between spatially separated ions is a resource that is needed or beneficial in many applications of trapped-ion platforms
2. Spatial constraints limit optical access limiting the scalability of photon mediated entanglement (PME) with trapped-ions



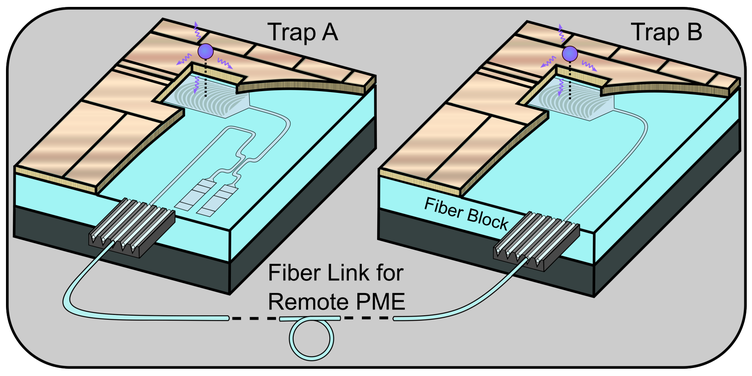
3. Integrating photonic circuits into trapped-ion platforms offers an avenue for scaling-up the number of entangled ion nodes

Vision

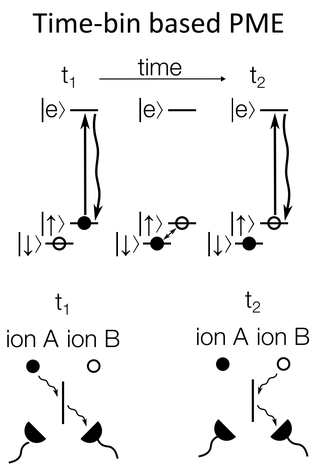
A remote entanglement generation unit cell that can be multiplexed to achieve high-rate entanglement generation with trapped ions



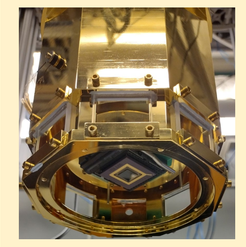
Remote Entanglement Generation

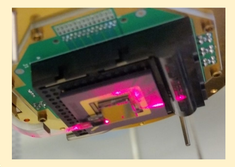


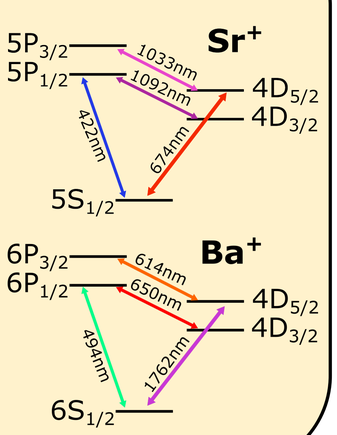
Time-bin based PME



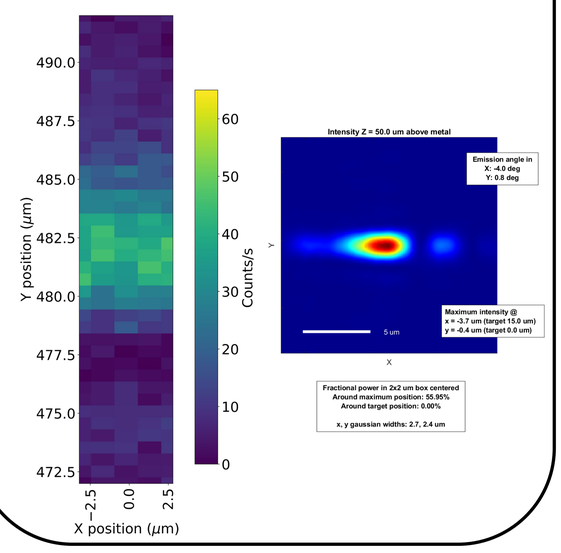
Our System







In-situ and Ex-situ Device Characterization



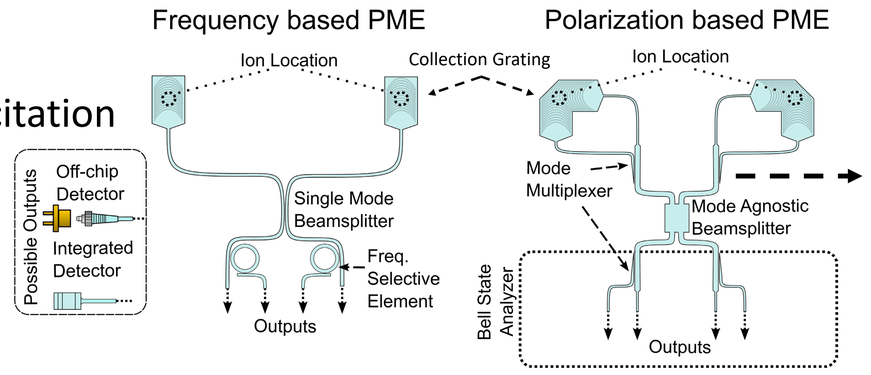
Implementation

Output grating couplers for pulsed excitation

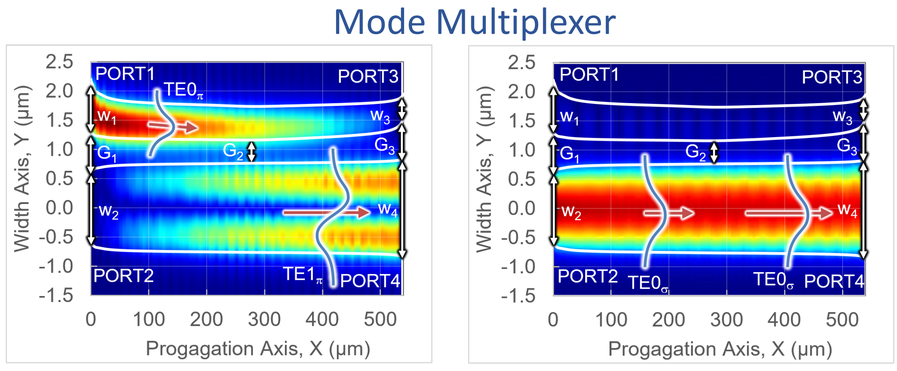
Photon collection gratings

Integrated beam splitters

Waveguide-coupled detectors



Mode Multiplexer



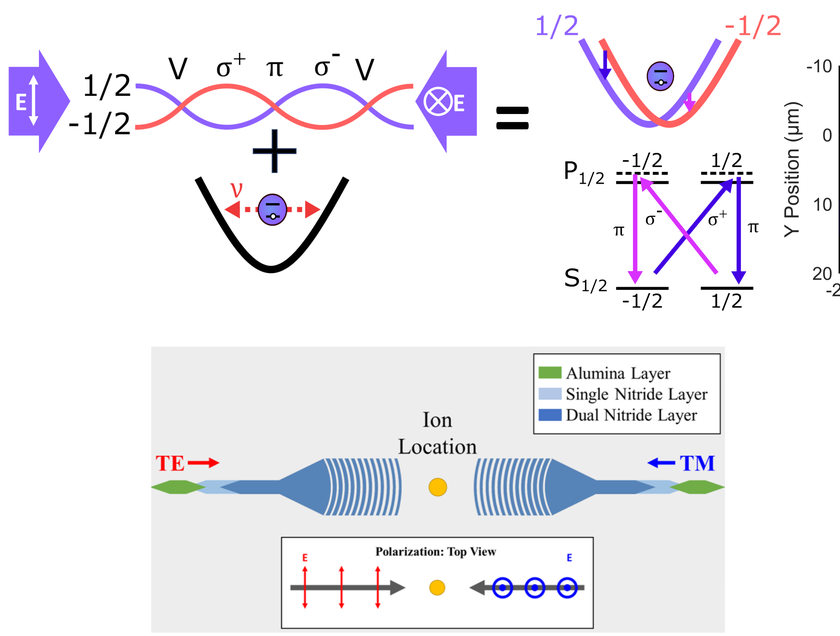
Fast cooling and state preparation

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*

***(QUARC) For more info see S. Corsetti's poster in session 3**

Integrated Photonics for Advanced Cooling of Trapped-Ion Quantum Systems



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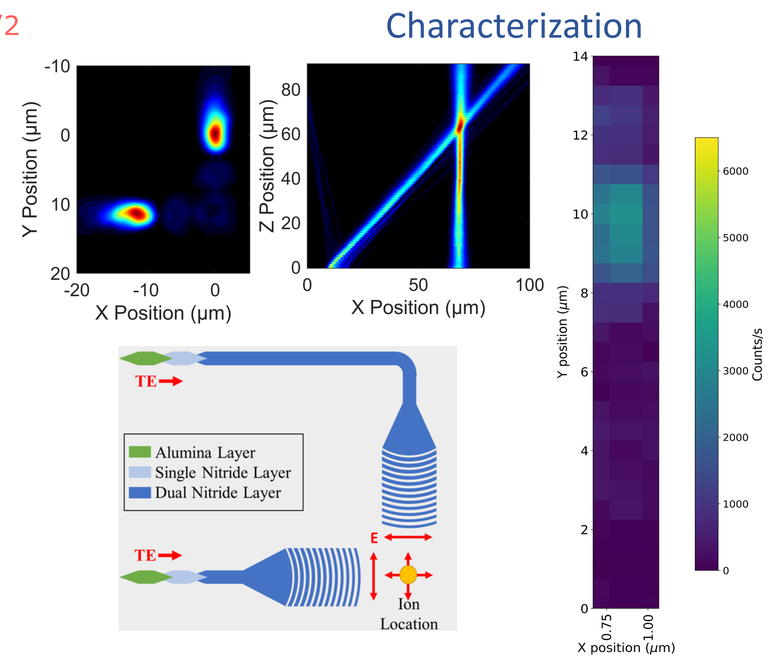

Consequences

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

Quantum repeaters for long distances when combined with coherent frequency conversion

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

QR codes

Digital version of poster:

Arxiv link: