

# Quantum Communication Network Activities Across Canada

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ITU Workshop on Quantum Information  
Technology for Networks

Sheraton Grand Shanghai Pudong 5-7 June 2019

# Quantum Networks in Canada



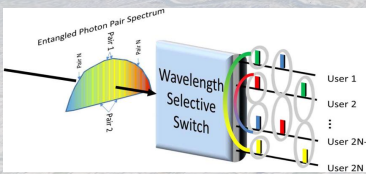
### Real-world quantum network

Quantum teleportation over metro network

6 km  
11 km

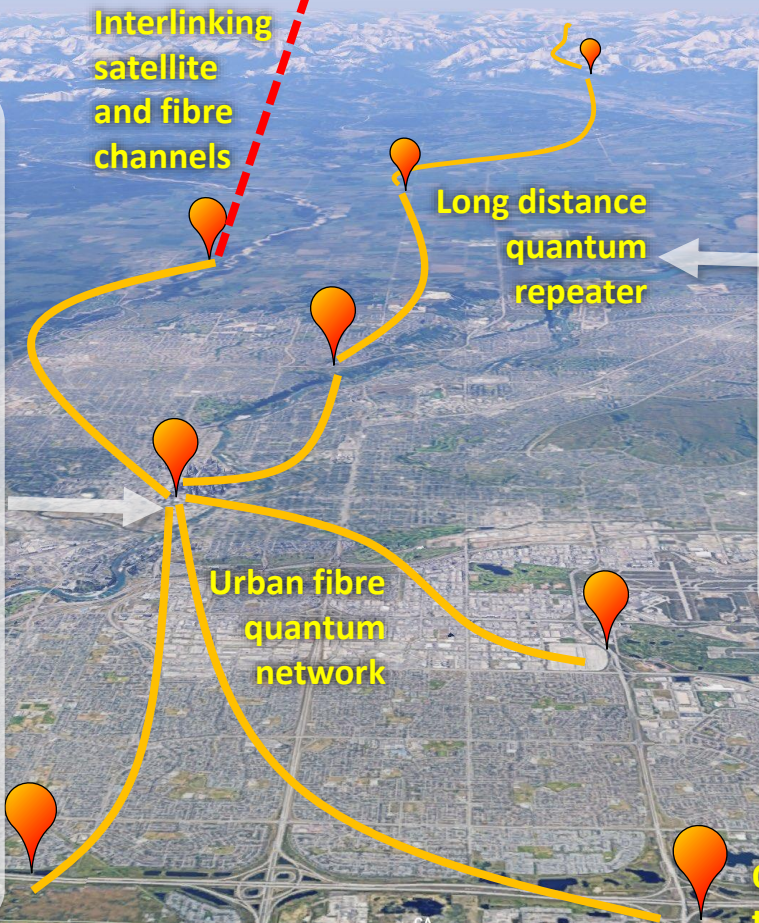
Data Centre  
City Hall  
U of C

Measurement Device Independent QKD  
Multiplexed source for on-demand photons




Single photon sources for QKD

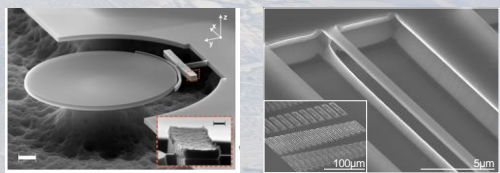
NRC Ottawa



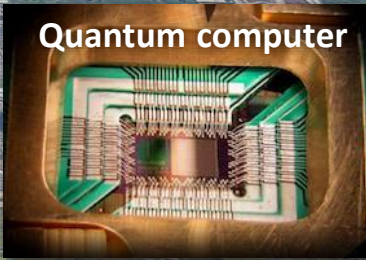
### Quantum memory



### Quantum transducer



### Quantum computer





# Quantum Network Research in Canada



OPEN QUANTUM SAFE

OVERVIEW LIBQOS INTEGRATIONS TEAM

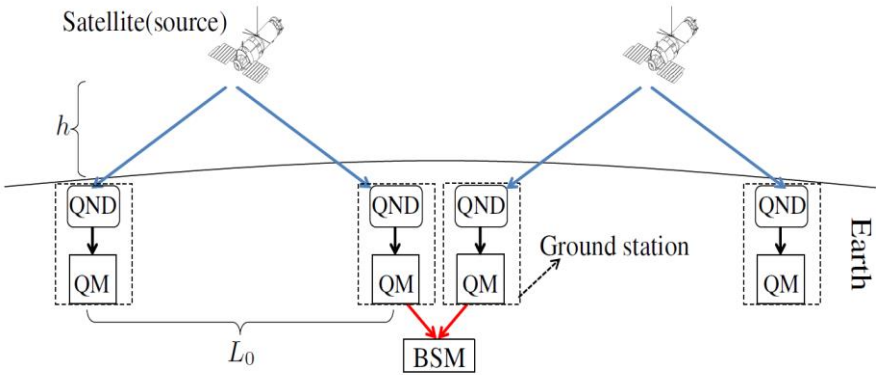
## OPEN QUANTUM SAFE

software for prototyping  
quantum-resistant cryptography



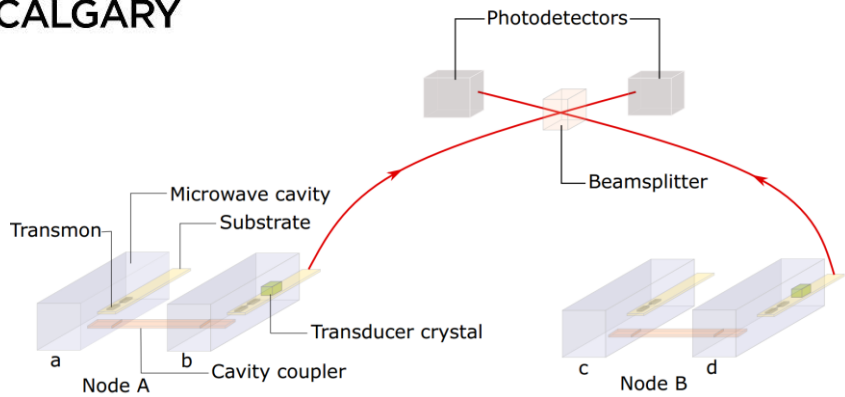
**Quantum-Safe  
CANADA**

# Quantum Networks theory



Protocol for satellite quantum repeaters

Room-temperature quantum networks with spins in diamond



Networking superconducting quantum computers via quantum transduction

# Network security and architecture



## 1) Security Analysis of Practical QKD Protocol

- Analytical tools
- Numerical toolbox for open-source software

## 2) Optical Multi-party Secure Computations/ Quantum Communication with Coherent States

## 3) Quantum Repeater Architectures

- 4-layer architecture
- QKD technology agnostic
- **Open source:**  
[www.github.com/open-QKD-network](https://www.github.com/open-QKD-network)

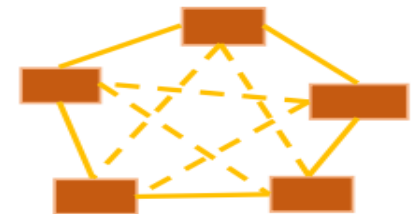
**Host Layer\***



**Key Mgmt Service Layer (KMS)**



**QKD Network Layer (QNL)**

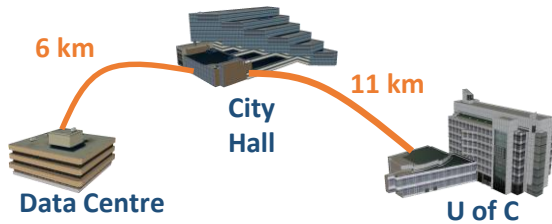


**QKD Link Layer (QLL)**

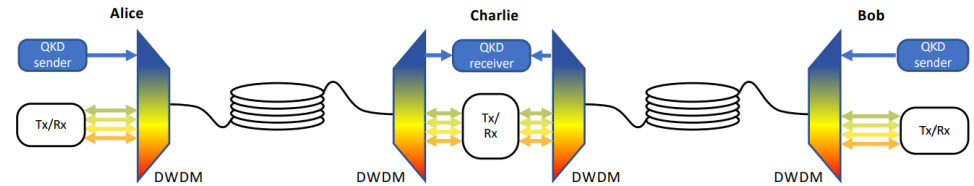


# Quantum Networks

## Quantum teleportation over metro network



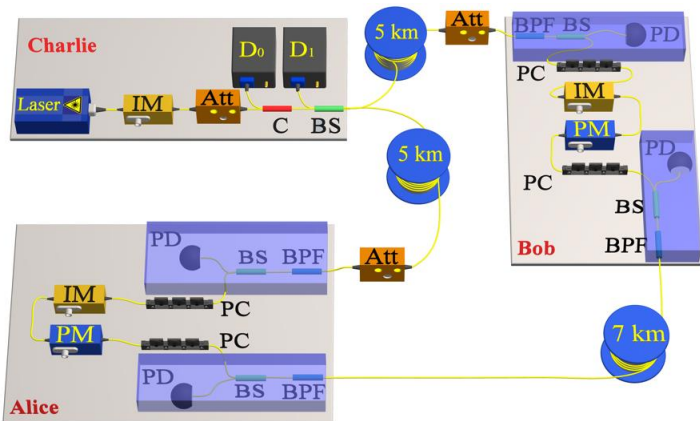
## Coexisting classical and quantum communication



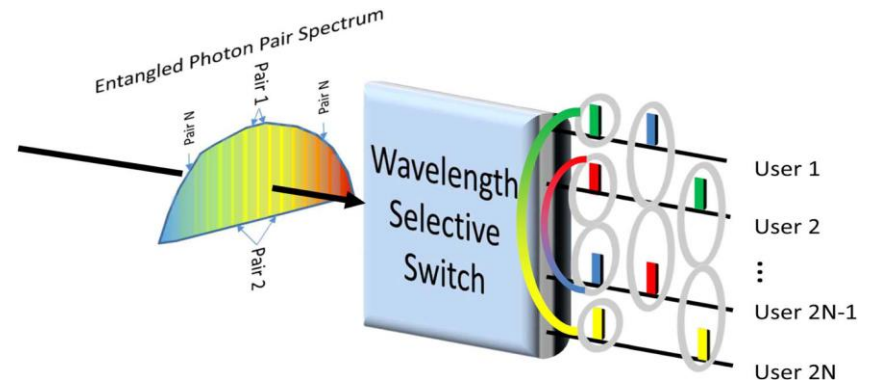
## Broadband polarization-entangled source



## Twin-field QKD

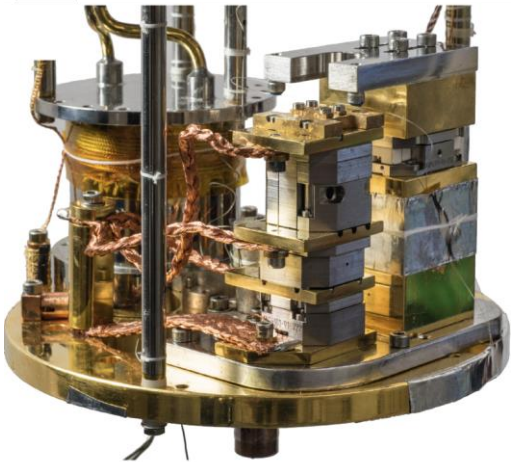


## Reconfigurable multi-user QKD network

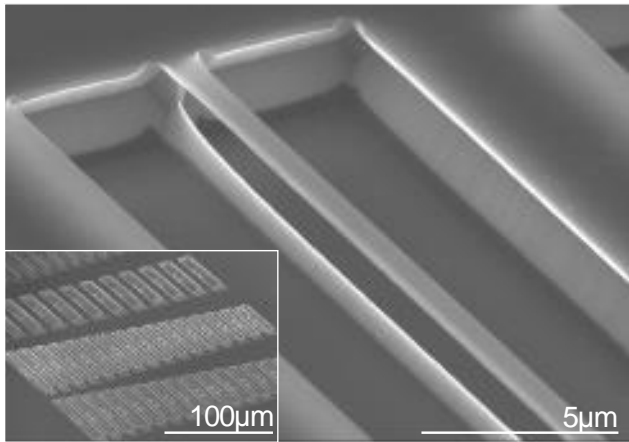
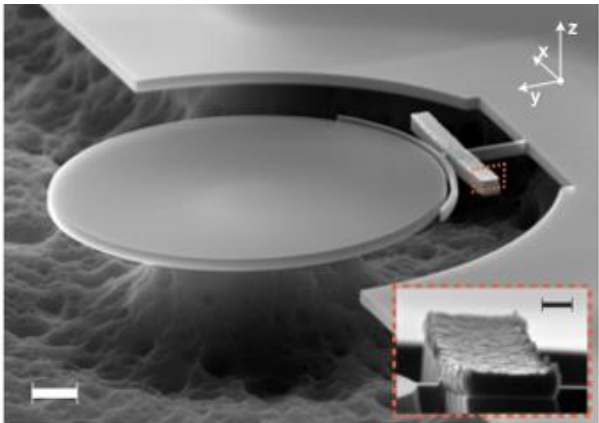




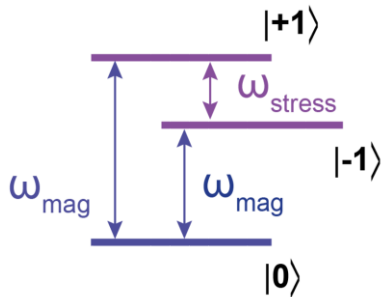
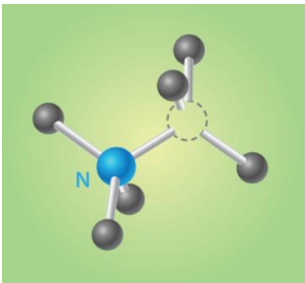
# Quantum Transduction



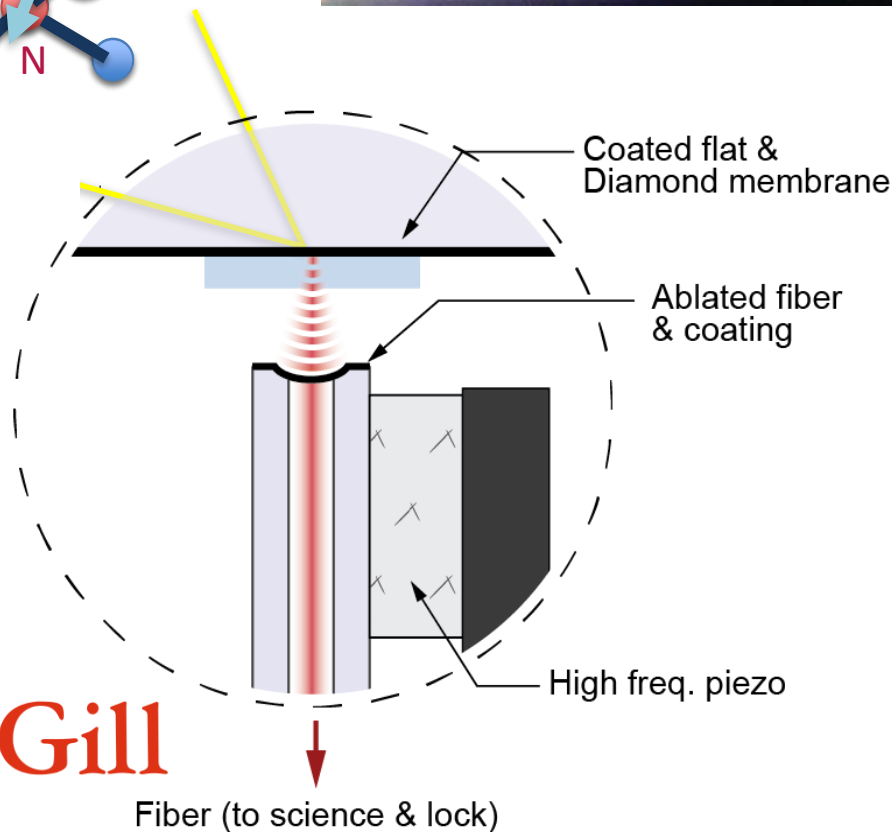
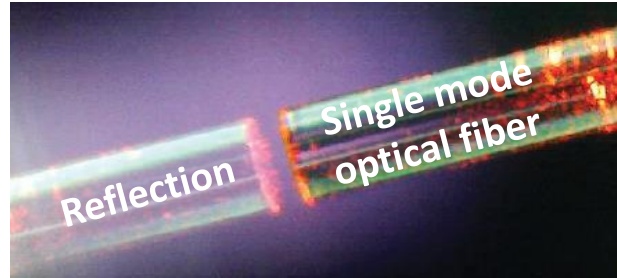
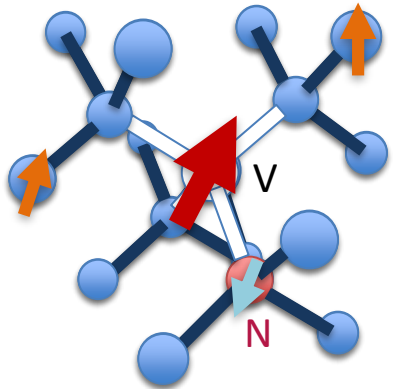
Optomechanical resonators in quantum ground state



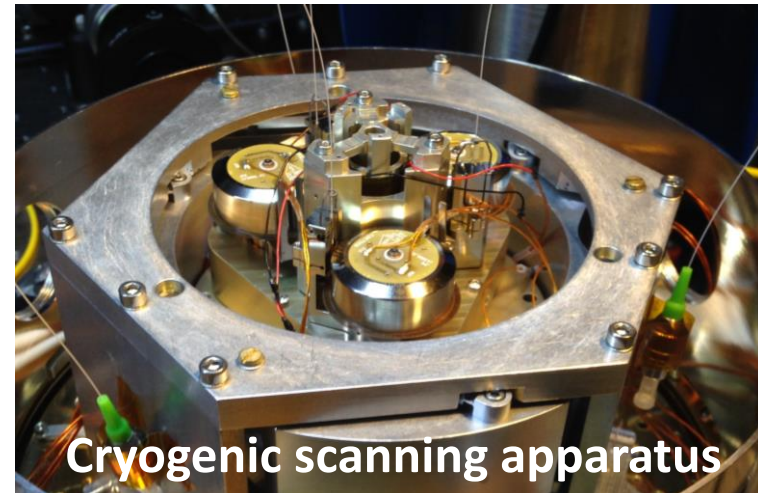
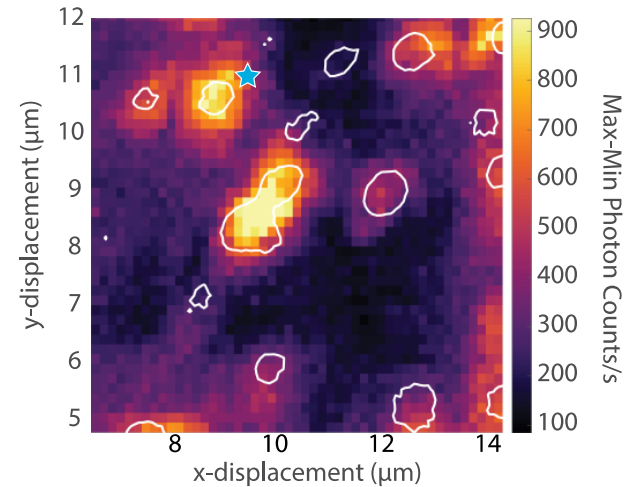
Mechanical stress coupling to NV centres in Diamond



# Quantum transduction

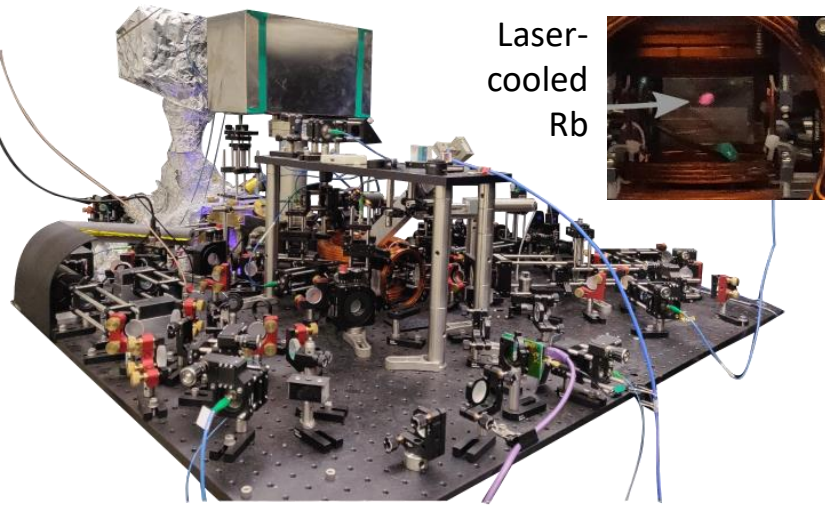


Scanned image of cavity-coupled single GeV defects (300K)



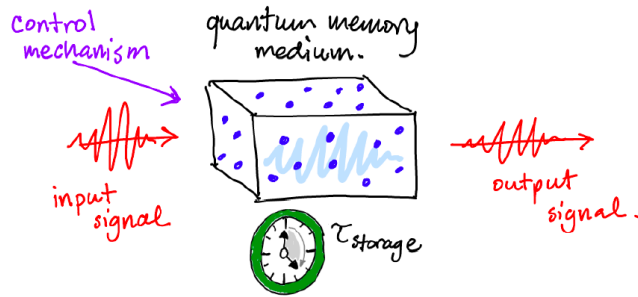


# Broadband atomic quantum memory

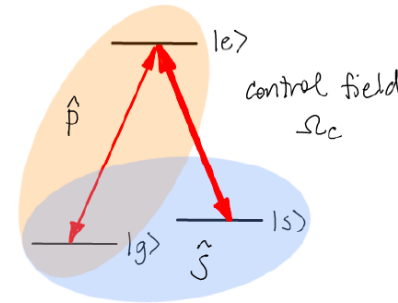


Laser-cooled Rb

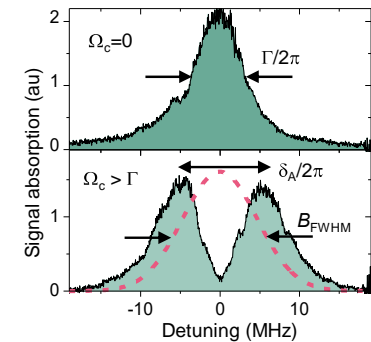
Ultracold atoms apparatus



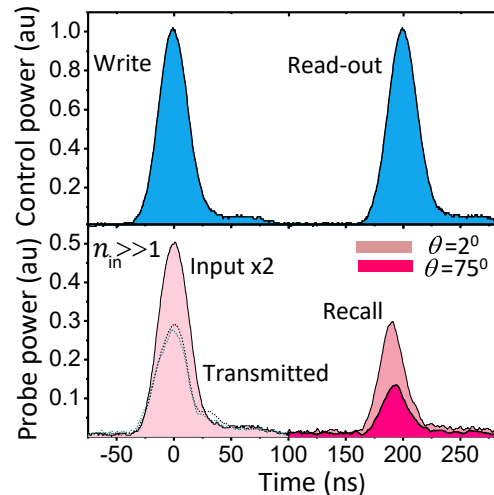
Coupled 3-level system →



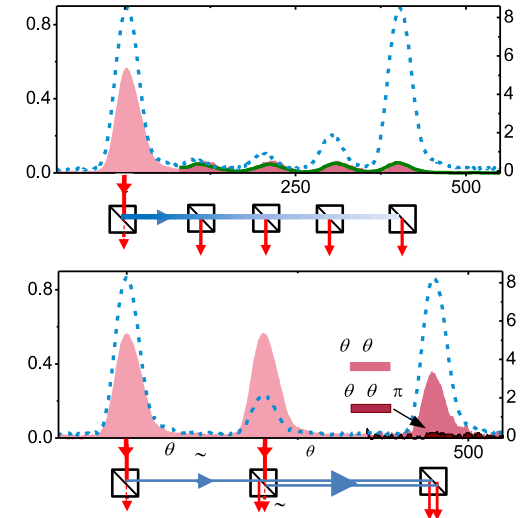
Autler-Townes splitting



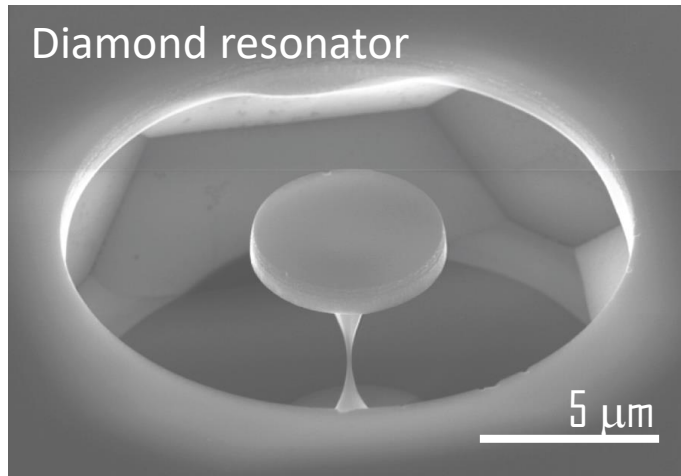
Pulsed control → memory pulsed stored + retrieved



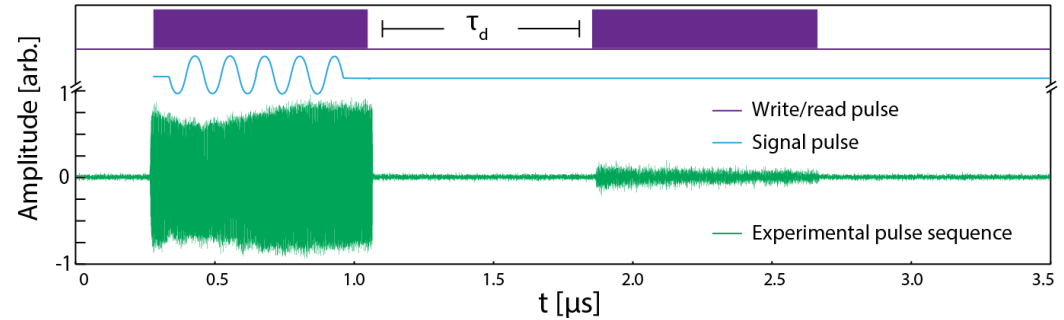
Tailored retrieval → temporal beamsplitting



# Quantum Memory



optomechanical quantum memory



Rare-earth ion doped materials – atomic frequency combs:

