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Integrated cavities for next generation quantum photonics and quantum sensors

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Linz
20.05.2026

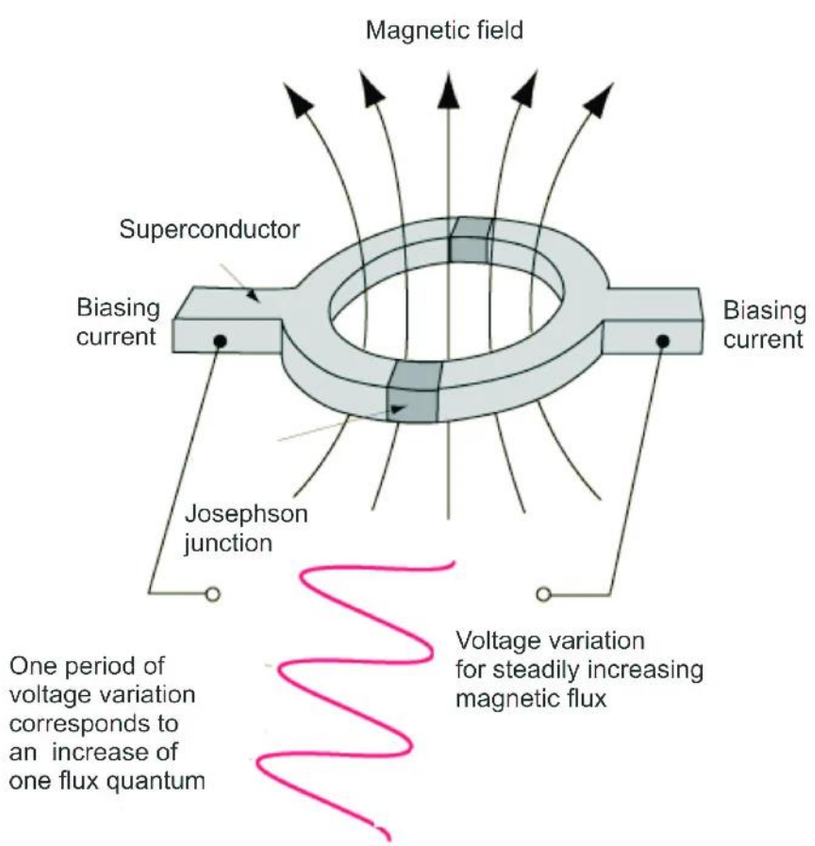
FFG Forschung wirkt.

Overview

1. Examples of quantum sensors
2. Photonic quantum sensors
3. Advantages & Challenges
4. Squeezed photons for Quantum computing with integrated linear resonators (sQore)
5. Quantum-mid-infrared optical coherence tomography (QMIRACT)
6. Conclusion & Outlook

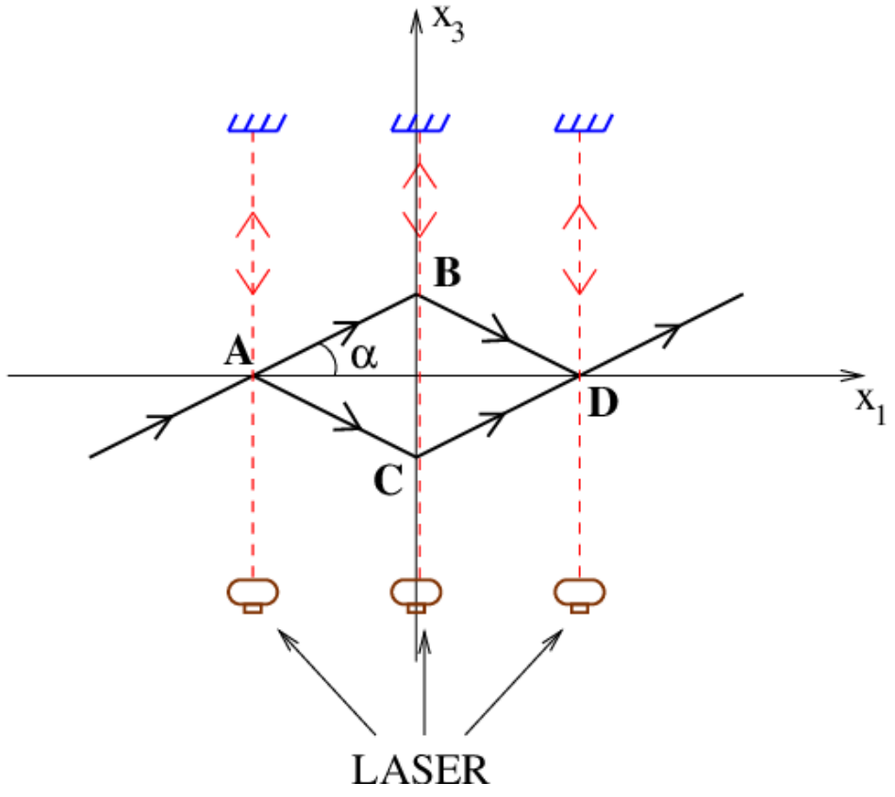
Examples of quantum sensors

SQUIDs



Marcon et al., *Progress in Electromagnetics Research Symposium* (2012)

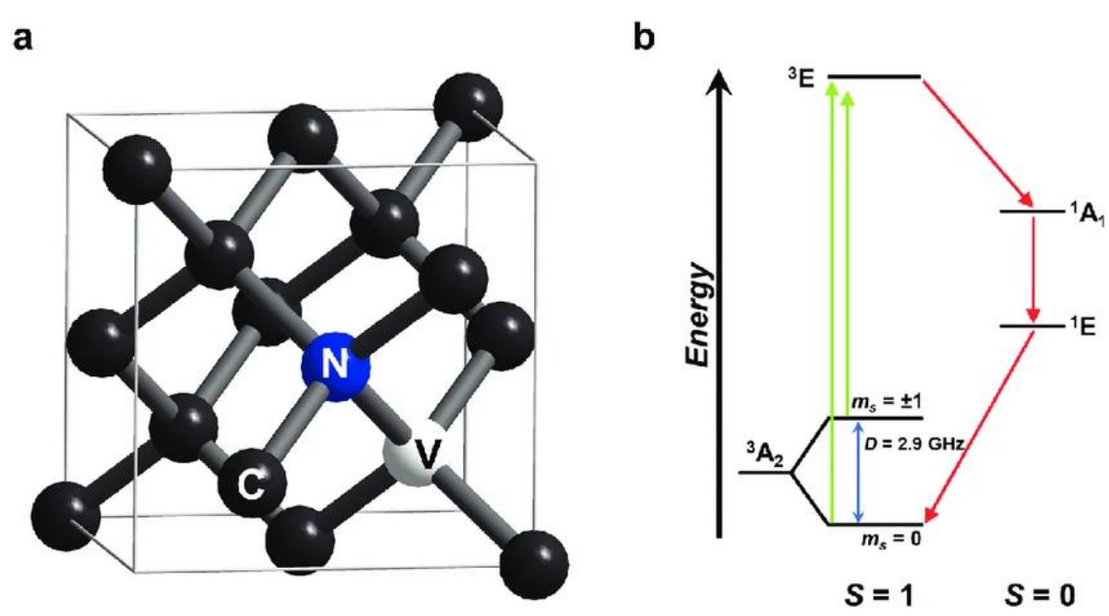
Atomic interferometers



Lamine et al., *The European Physical Journal D* (2002)

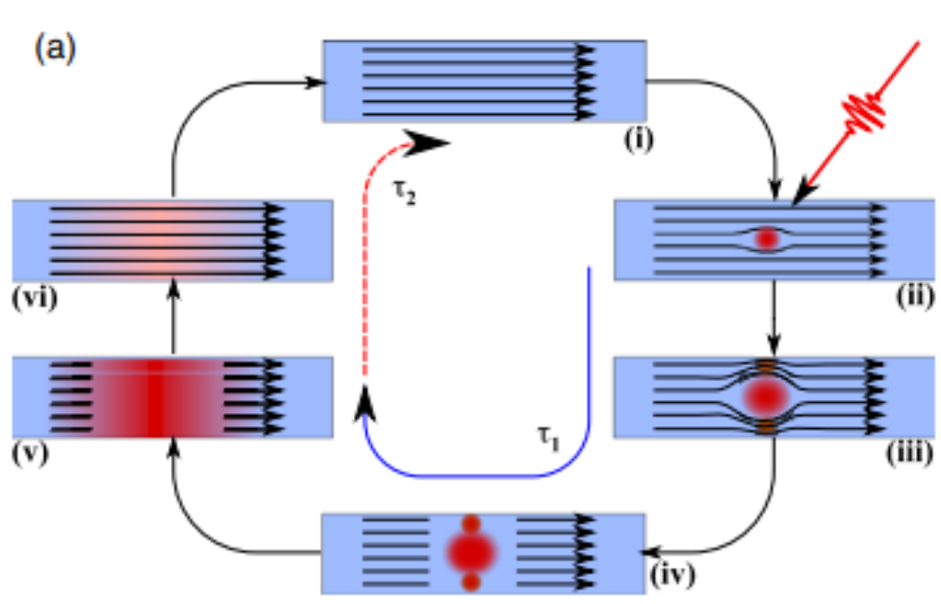
Examples of quantum sensors

NV-centers in diamond



Campanella et al., Comments on Inorganic Chemistry (2023)

SNSPDs

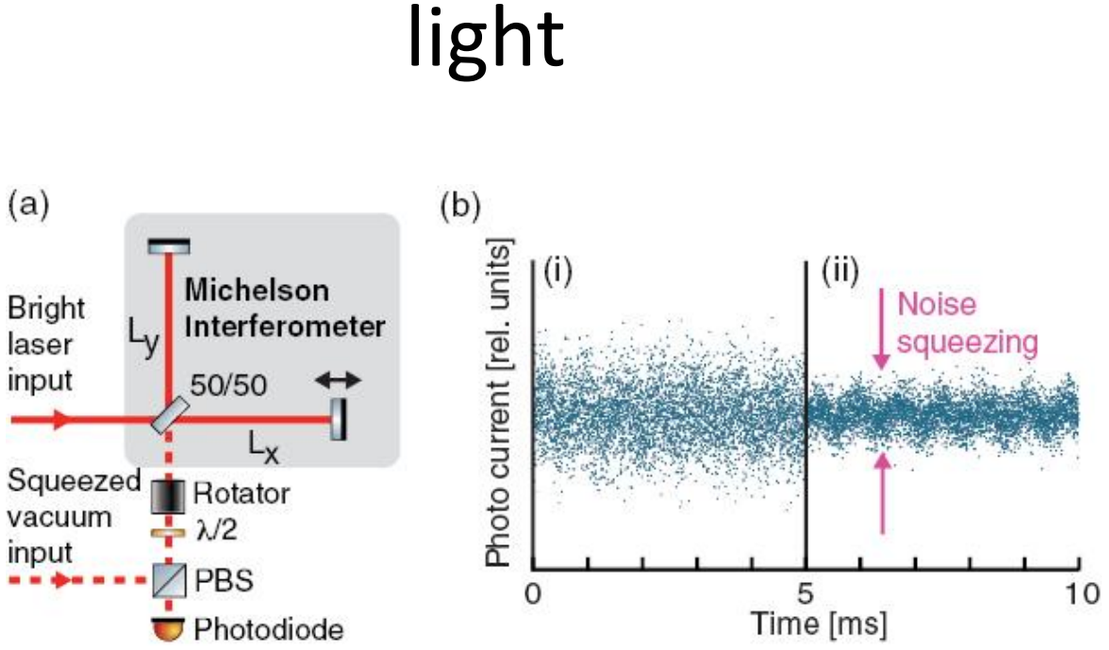


Natarajan et al., Superconductor Science and Technology (2012)

„Quantum leap“ in precision and stability

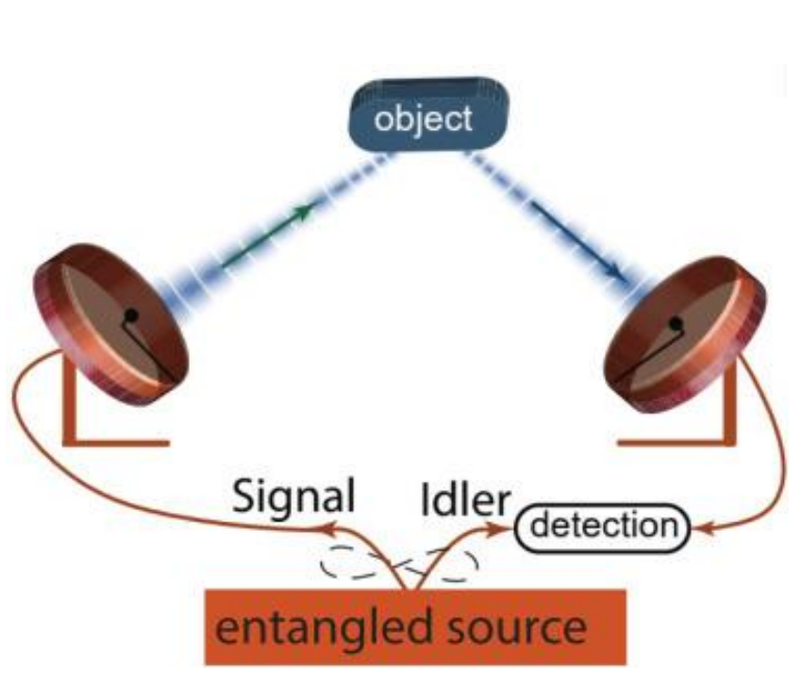
Photonic quantum sensors

LIGO with squeezed light



Barsotti et al., Reports on Progress in Physics (2019)

Quantum-LiDAR



Torromé et al., Progress in Quantum Electronics (2024)

Using quantum states to surpass classical limits

Advantages and Challenges

Advantages:
- Big bandwidth and velocity
- Small decoherence
- No cooling
- Chip-integration

Challenges:
- Optical losses

Solution: Photonic devices with cavities

But: Cavities are bulky and precise allignment needed

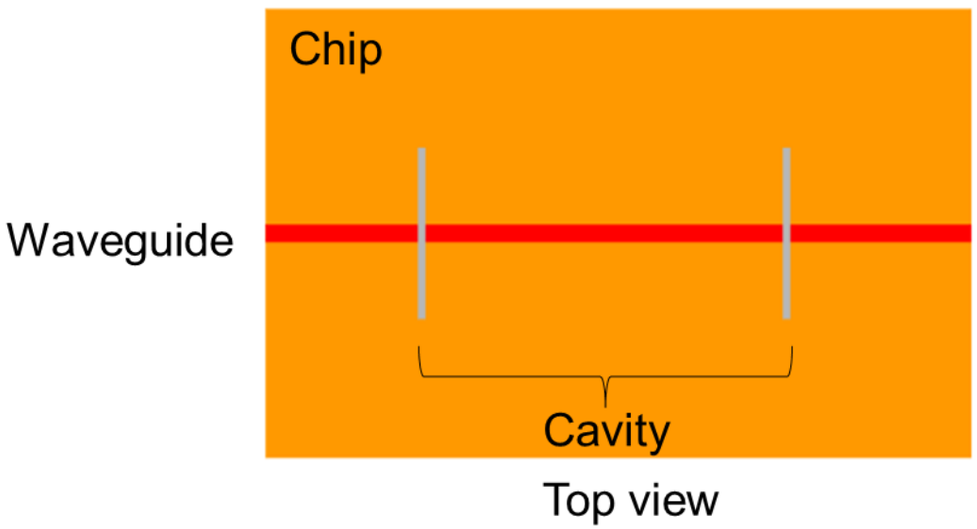
➔ Integrated Cavities

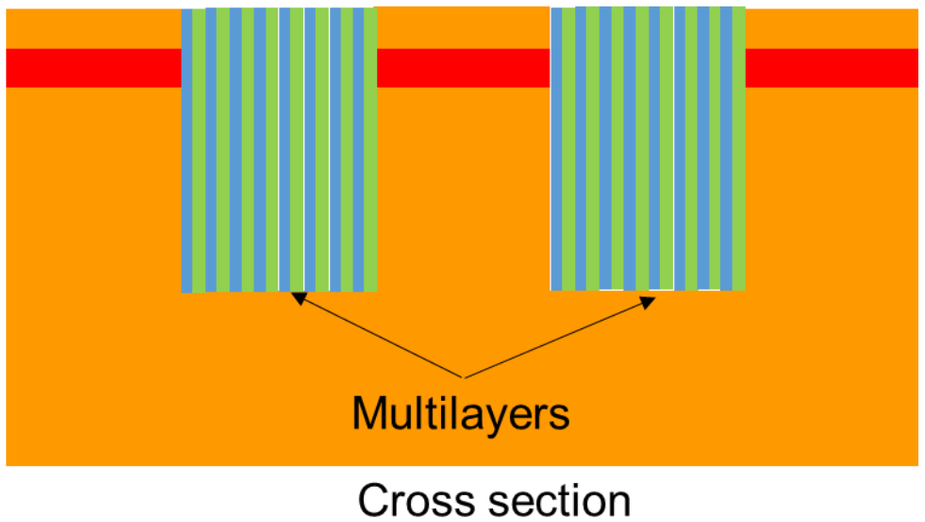
Idea of sQore (squeezed photons for Quantum computing with integrated linear resonators)

Ring resonators: Big and bending losses

Idea: Small linear resonators on a photonic chip

Integration density, FSR, SPDC, Squeezing





Sezer et al., in preparation

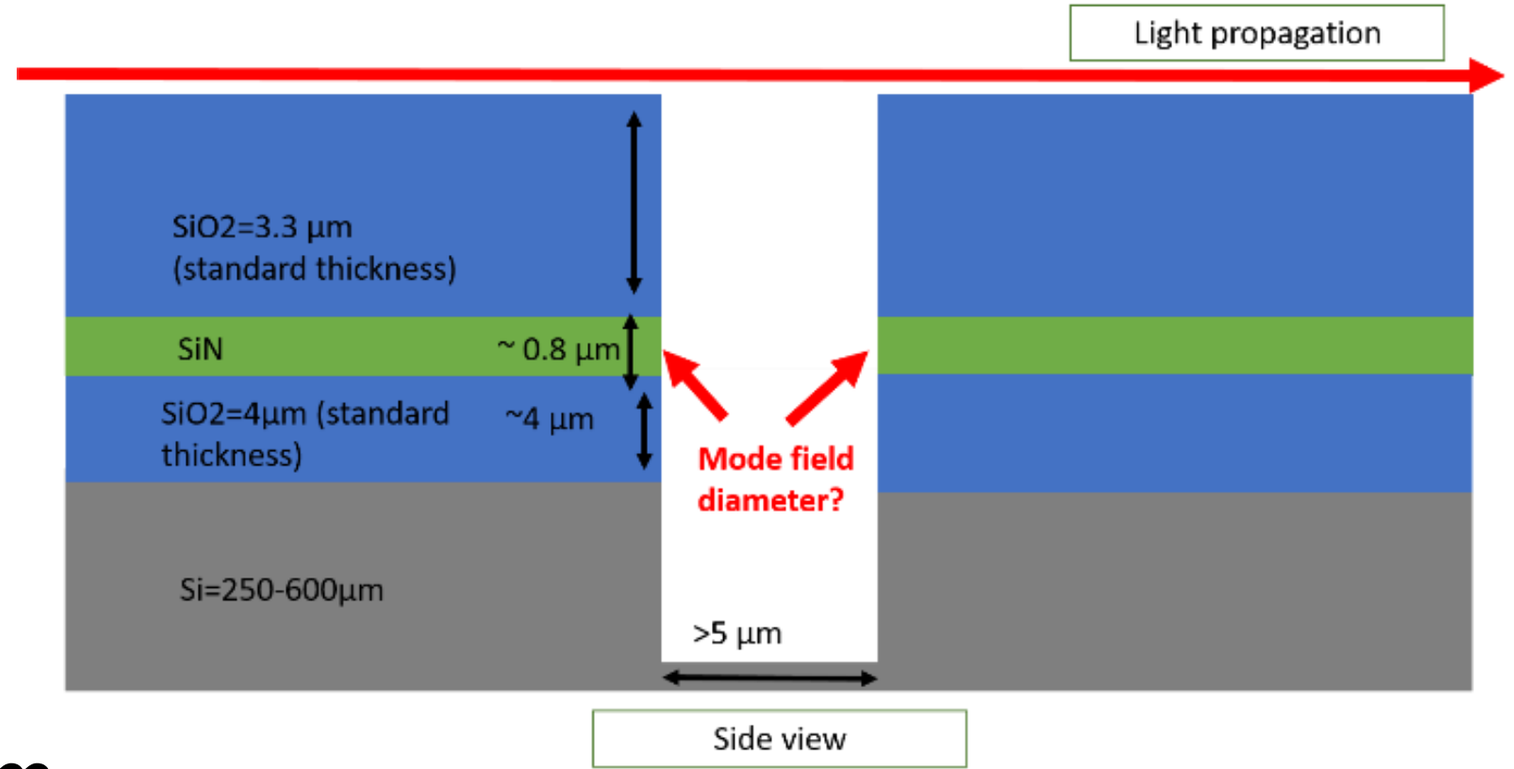
Design & fabrication process

Modified Bosch process: High-aspect ratio trenches with smooth side-walls

Integration of passive optical elements

➔ On-chip (squeezed) lasers?

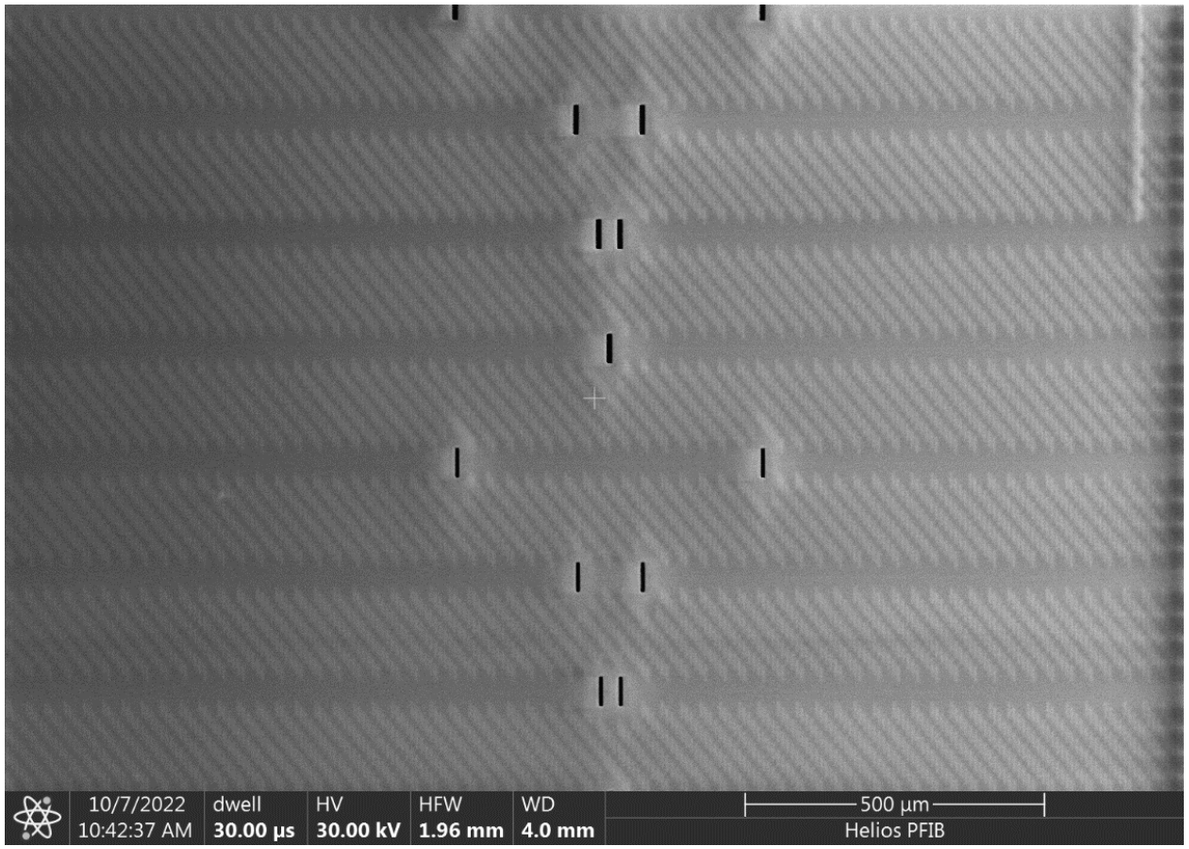
➔ On-chip quantum computing?



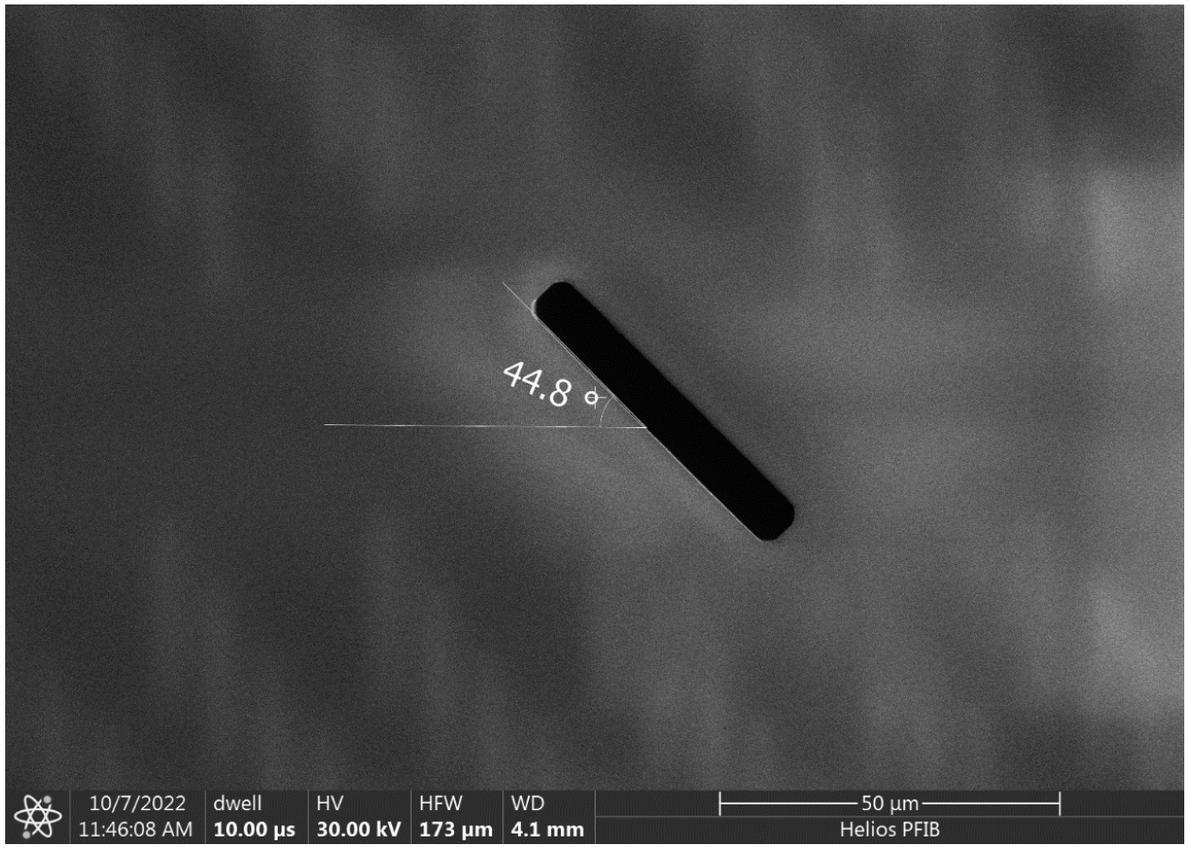
Sezer et al., in preparation

SEM images of the chip

Linear resonators



Tilted mirror



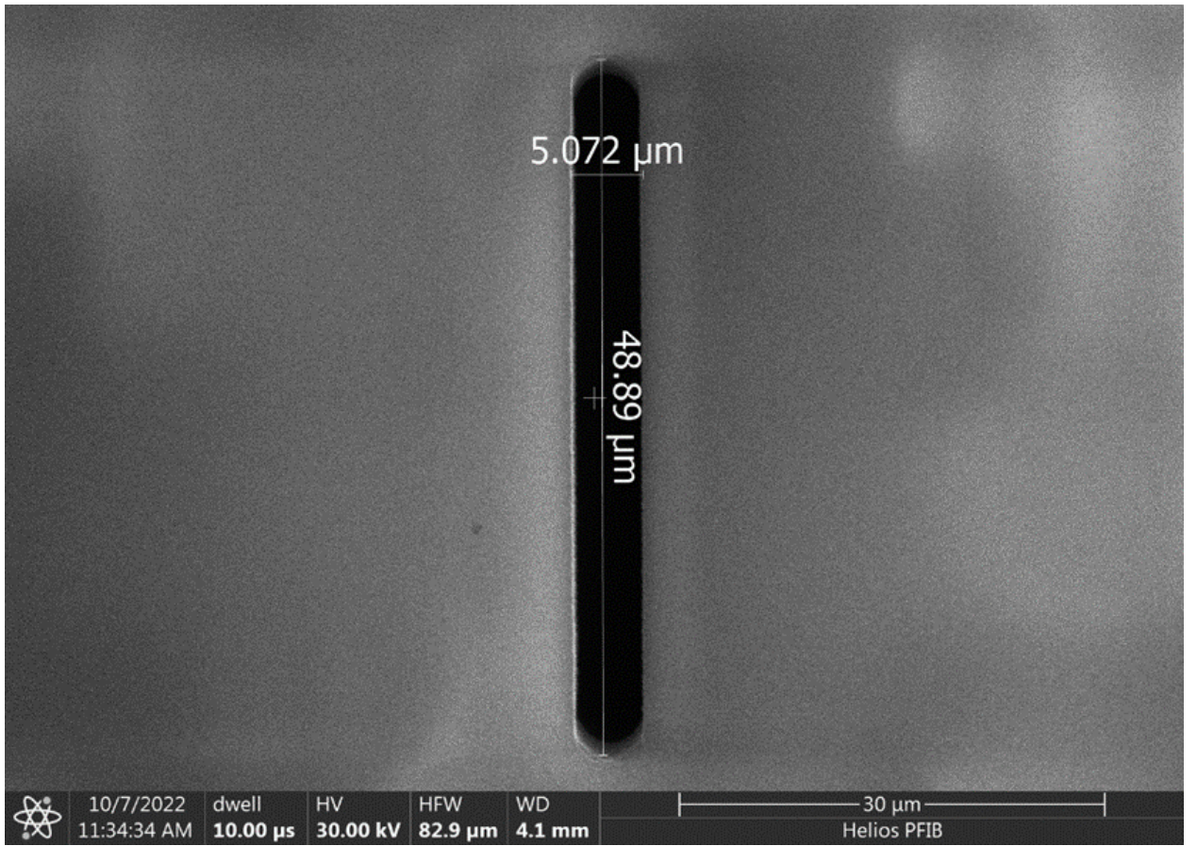
Sezer et al., in preparation

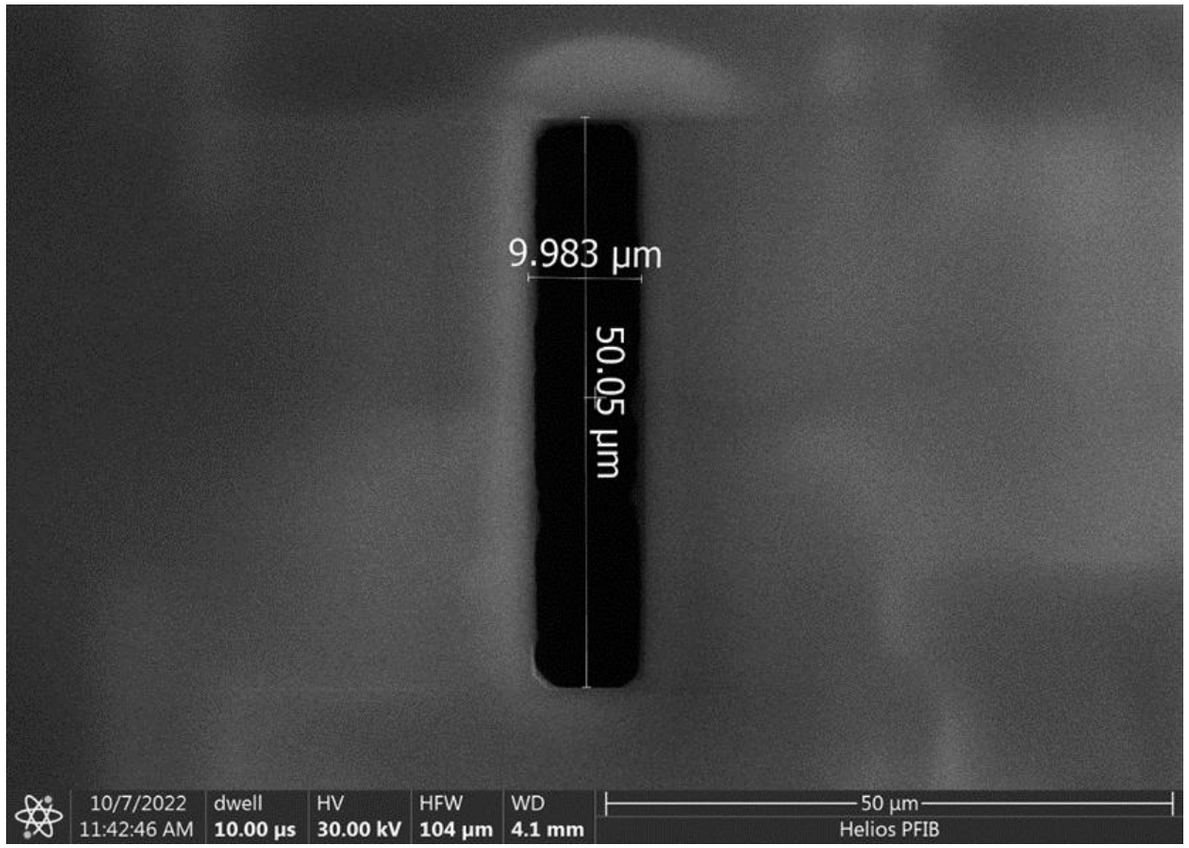
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Versatility of mirror dimensions

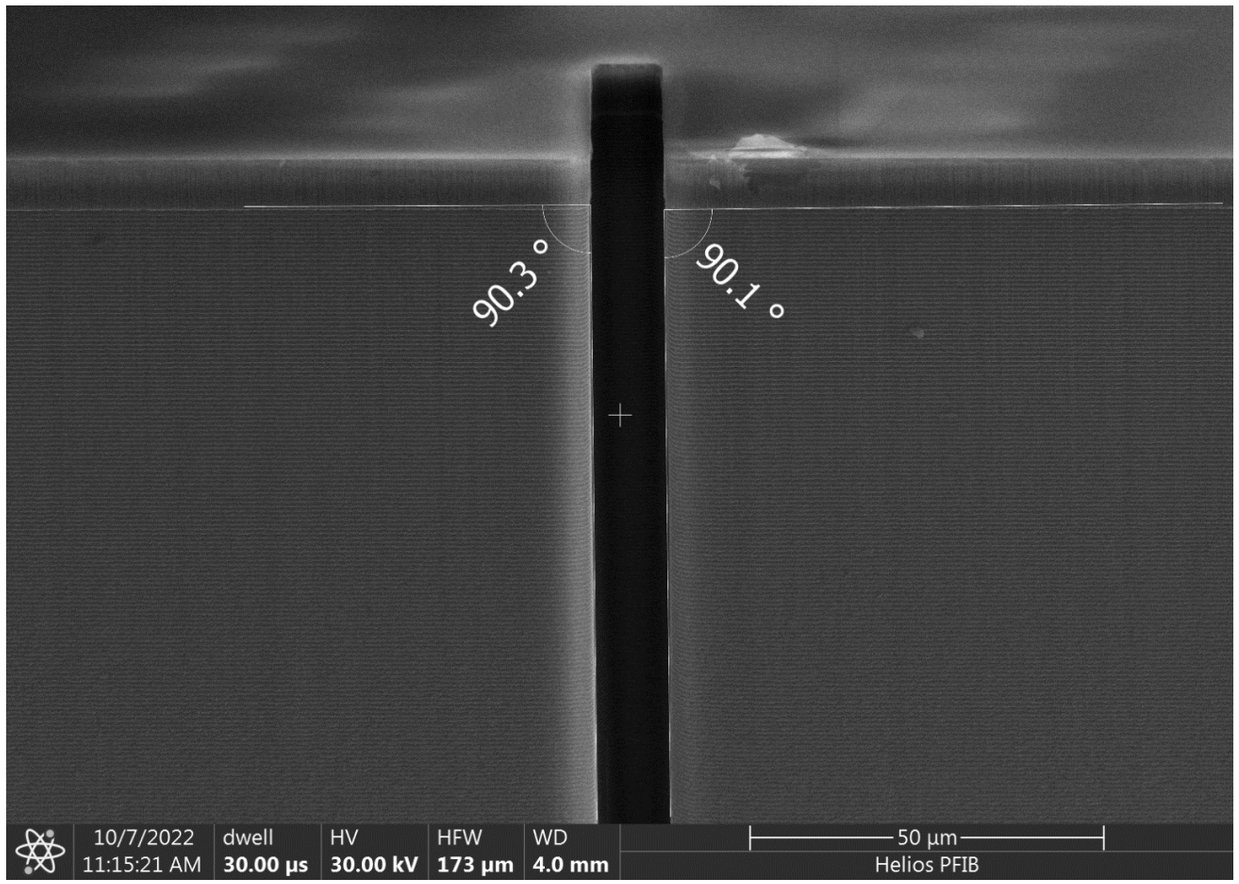




Sezer et al., in preparation

Quality of trenches

- Minimizing transmission losses by trench quality:
  - Angles
  - Side wall parallelism
  - Side wall surface roughness



Sezer et al., in preparation

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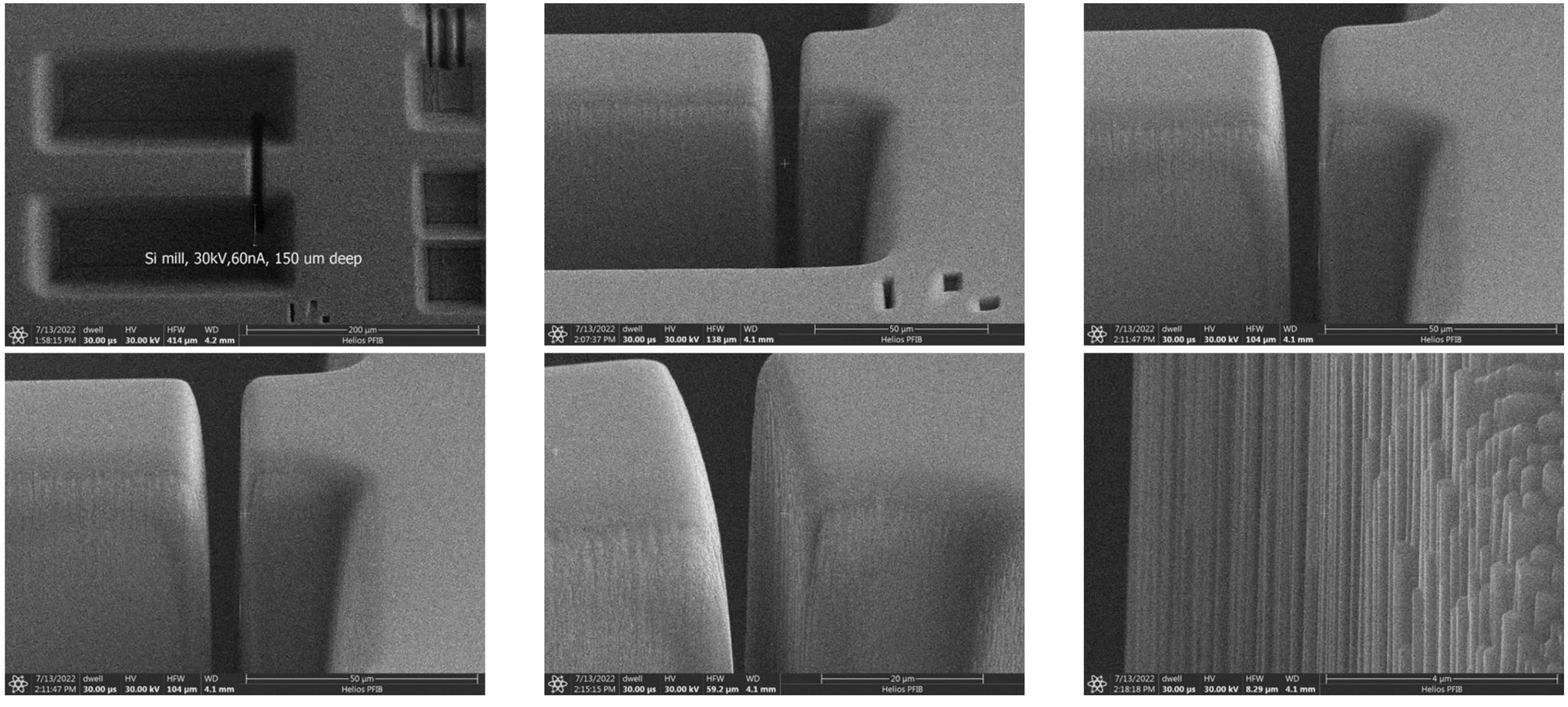
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Trenches in $LiNbO_3$

By focused ion beam etching:

High aspect ratio trenches in $LiNbO_3$ for the first time



Sezer et al., in preparation

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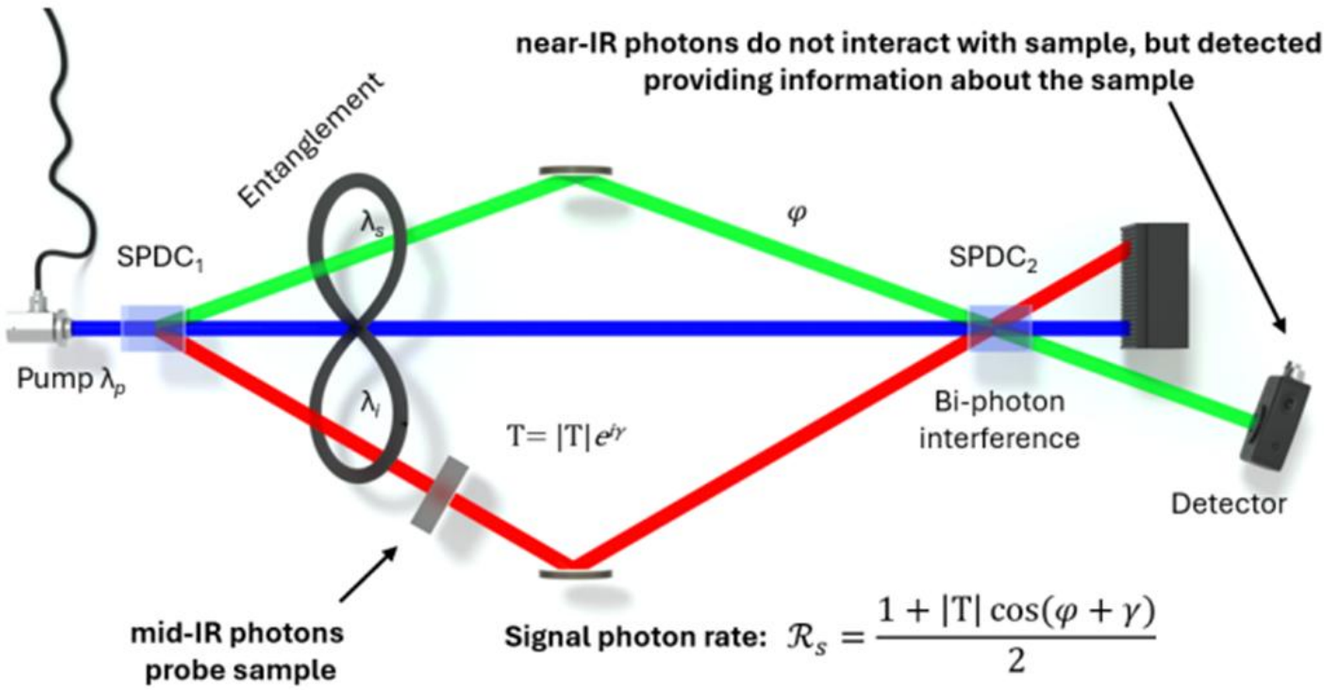
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Idea of QMIRACT (Quantum mid-infrared optical coherence tomography)

- Optical coherence tomography (OCT): Imaging by interferometry
- By SPDC: OCT with entangled photons

Advantages:

- VIS light source
- Probing in mid-IR
- Detecting in near-IR



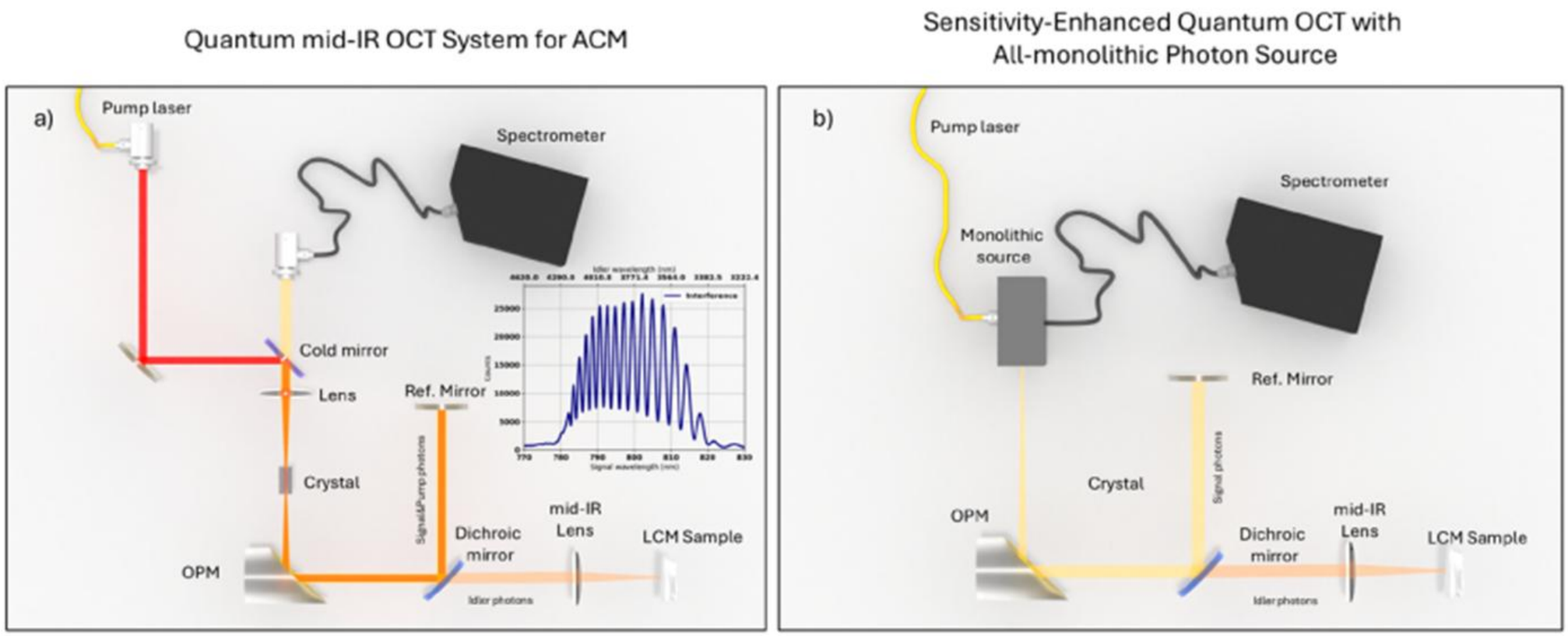
Inhaltliche Beschreibung QMIRACT, 2025

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Cavity-enhanced QMIRACT

⊕ Fiber-coupled, monolithic, cavity-enhanced setup
Advantages: Compact and stable, more effective SPDC



Inhaltliche Beschreibung QMIRACT, 2025

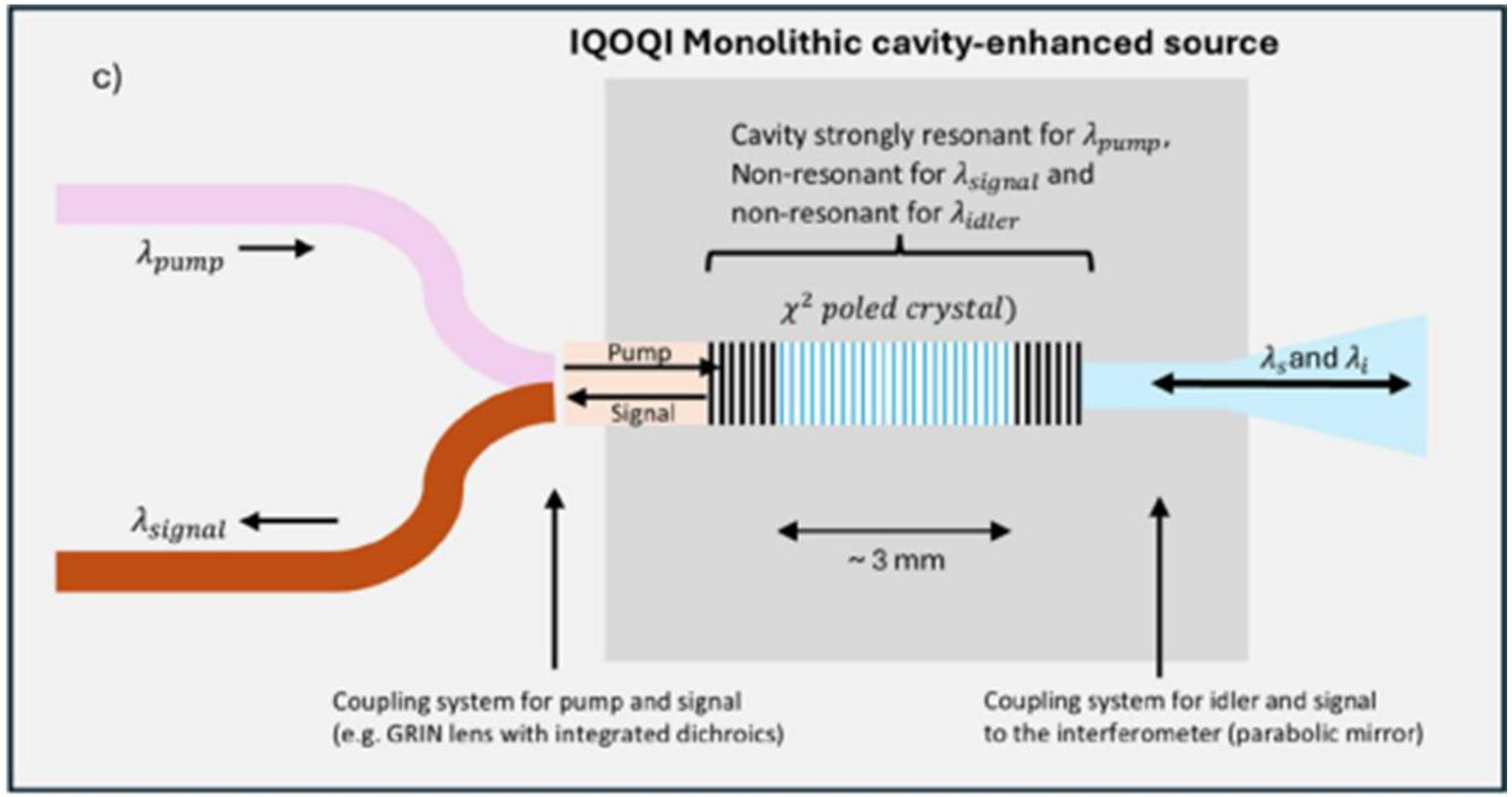
Chip-integrated QMIRACT

Further Improvement: Chip integration

Advantages:

- More compact
- More stable
- Improved SPDC & FSR
- Scalability

➔ On-chip quantum sensing?



Inhaltliche Beschreibung QMIRACT, 2025

Conclusion and outlook

Photonic quantum sensing: Advantages of quantum sensing and photonics

Optical Resonators: Enhancing these effects

Integrated linear resonators: Further enhancement, compactness and scalability

Chance for effective, scalable quantum computers and sensors

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Thanks for your interest and attention ☺