Ki3 PHOTONICS
Technologies

QUANTUM PHOTONIC INTERCONNECTS

ITU AND IEEE PHOTONICS WORKSHOP | JULY 5, 2026

DR. PIOTR ROZTOCKI

Executive summary

Ki3 PHOTONICS
Technologies

- **Quantum processing units** (QPUs) augment AI, materials science, and dual-use applications
- QPUs require **technically-demanding interconnects** to scale, which include technologies like entangled photon sources, coherent links, and quantum memories
- To address these needs, we build **hardware and software** modules for quantum networking
  - Solutions for narrowband entanglement, precise interferometry, link stabilization, network management
- We welcome **partners** that seek first access to quantum networking technologies, and collaborators for validation and standardization

Contact:
Piotr Roztocki, Ph.D.
CTO & Co-Founder | Ki3 Photonics

Quantum processing units natively access the formalisms of today's hard problems

Ki3 PHOTONICS Technologies

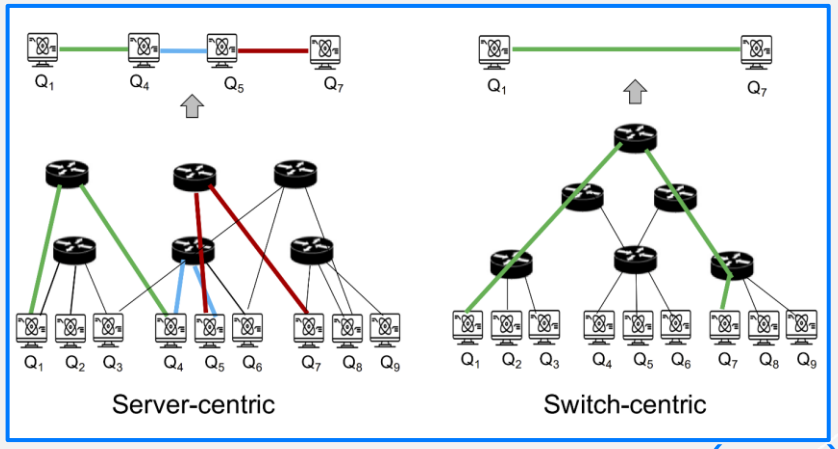
CPU, GPU, TPU, NPU…

QPU

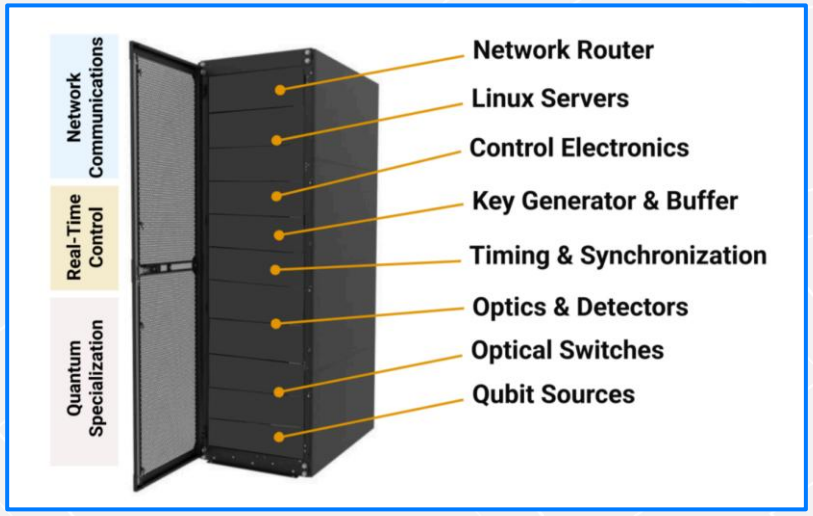
- Hard problems need processing units that operate natively in the relevant mathematical representation
- Quantum systems are described by tensor, statistical, and Fourier formalisms
- QPUs natively access the formalisms of AI, materials science, and dual use

Quantum interconnects are essential to scalability, but demand advanced modules

Ki3 PHOTONICS Technologies



Pouryousef et al., arXiv:2601.01353 (2026)



Quantum Network Deployment: Aliro

Entanglement, phase, and timing solutions:

- Leverage mass-producible platforms (e.g., silicon photonics)
- Align with telecom packaging standards
- Encode quantum information in robust degrees of freedom
- Leverage dense wavelength division multiplexing (DWDM) technologies
- Manage resources and routing across dynamic topologies

Classical networks and telemetry protocols are not optimized for quantum signals

Ki3 PHOTONICS
Technologies

- Measurement and noise destroy quantum information
- Relative to classical networking, quantum networking needs:
  - Noise—9 orders of magnitude lower
  - Timing—5 orders of magnitude better
- Network telemetry and control protocols must simultaneously:
  - Be non-invasive (i.e., faint light probes separable from quantum signals)
  - Grant access to state-of-the-art performance
  - Work with deployed optical fiber / free-space links

Acknowledgement: Thomas Gerrits, NIST

Our approach – Hardware and software for scalable quantum networks

Ki3 PHOTONICS
Technologies

- **Reconfigurable modules**
  Solutions for narrowband entanglement, precise interferometry, and link stabilization
- **Integration and scalability**
  Compatibility with optical fiber, chip foundries, and rack cabinets
- **Streamlined network management**
  Unified Pythonic control for integration into telecom networks and custom workflows

Outline

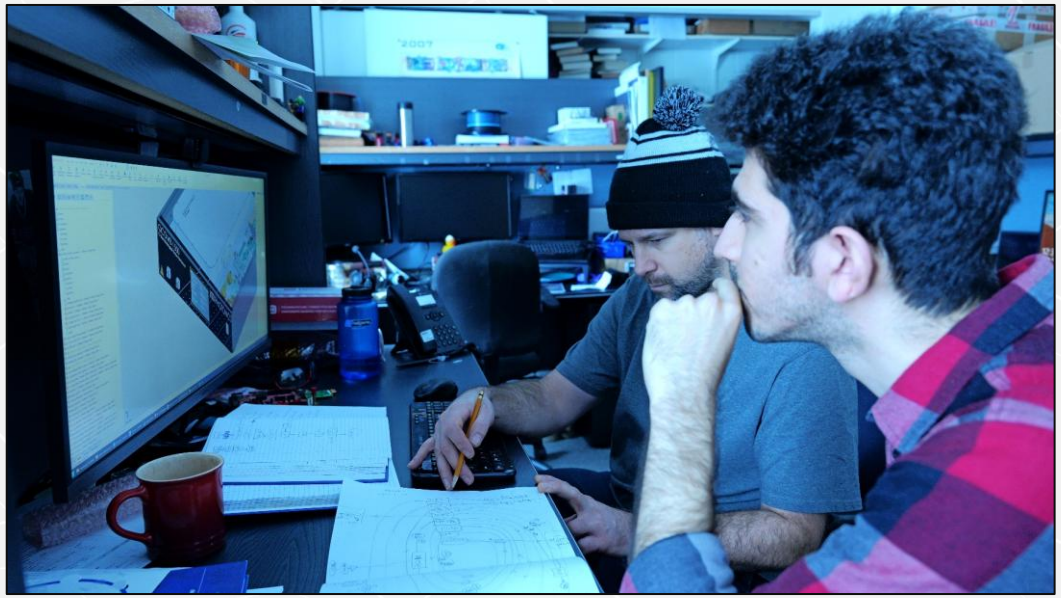
Ki3 PHOTONICS
Technologies

- Who we are
- Scaling quantum networks:
  - Entanglement
  - Phase
  - Timing
- Quantum cryptography

Who we are:

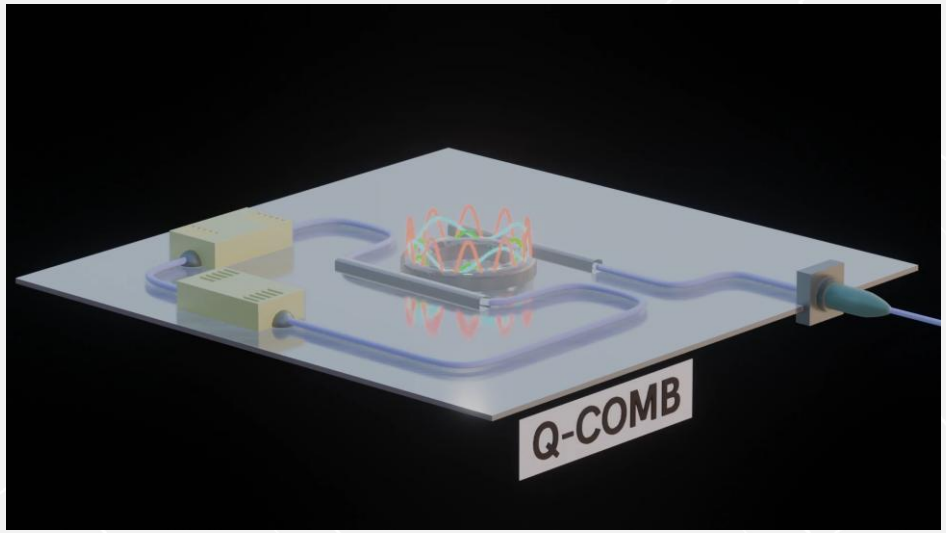
Ki3 PHOTONICS
Technologies

- Founded in 2015 in Montreal, Canada
- Expertise in integrated quantum photonics, fiber optics, electronics, software, packaging
- Active support of quantum workforce development:
  - Trained >40 physics and engineering interns, many returning for full-time positions
  - Three NSERC quantum consortia
- Sales and validation with leading academic and industrial research labs



Ki3 Q.COMB: Our multi-channel, narrowband entangled photon source

Ki3 PHOTONICS Technologies

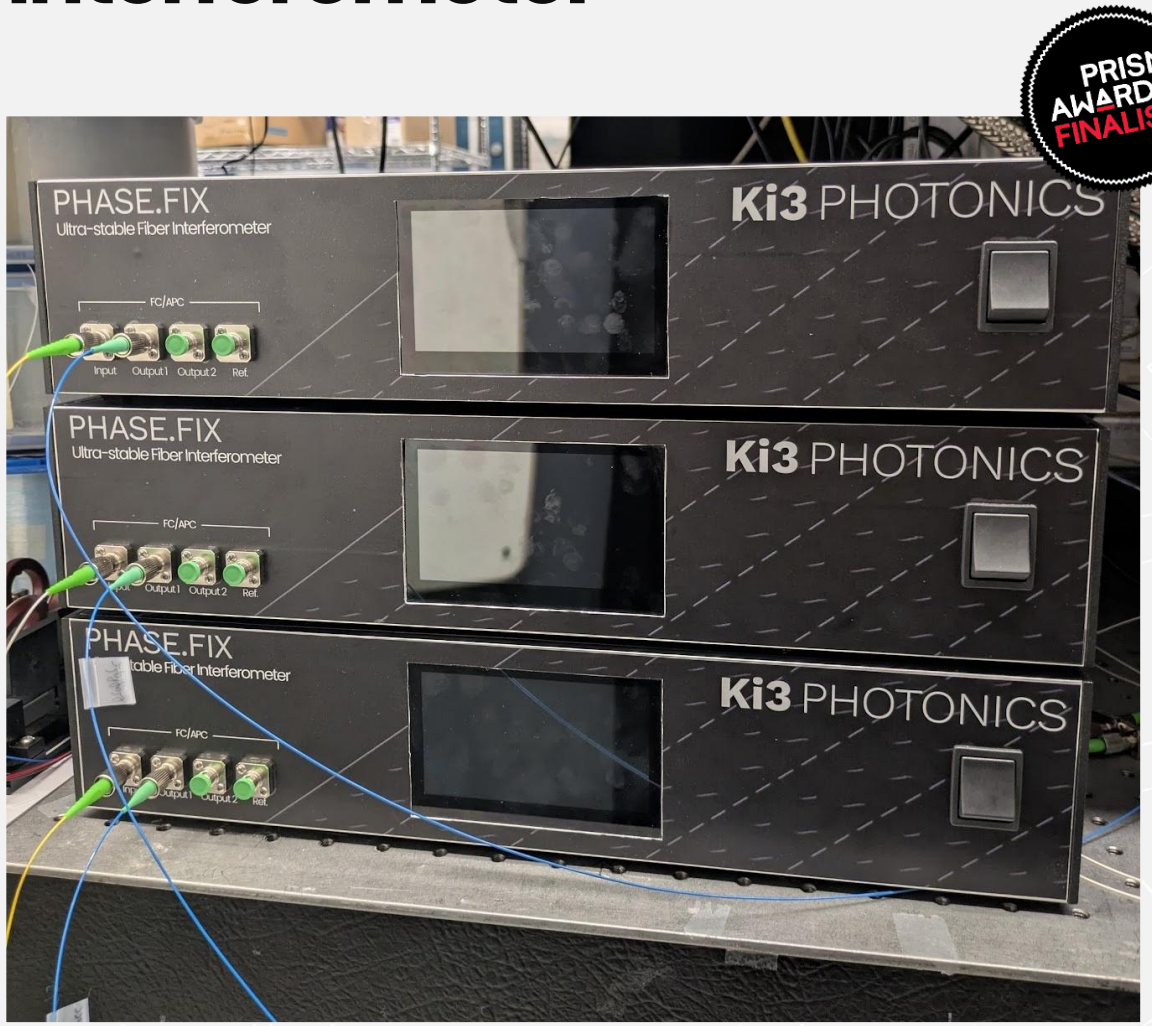


- **Turn-key photon entanglement**
  Multi-channel entanglement at 1550 nm (S, C, L-band) or 1350 nm (O-band)
- **Seamless integration and control**
  Standard network interfaces (fiber, Ethernet, TCP/IP, YANG, RESTCONF)
- **Narrowband photon channels**
  Spontaneous four-wave mixing on mass-producible integrated photonics

Patent #: US10505335B2, CA2978360A1

Ki3 PHASE.FIX: Our ultra-stable fiber interferometer

Ki3 PHOTONICS
Technologies



- **Precise phase control**
  State-of-the-art phase stability, with long-term and low-loss performance
- **User-defined setpoints**
  Multiple modules can be locked to a common, distributed reference signal
- **Versatile scheme**
  Supports both continuous-wave and pulsed modes, facilitating precise synchronization in quantum networks

Patent #: US10578421B2, CA2989040A1

Ki3 API: Our network management software

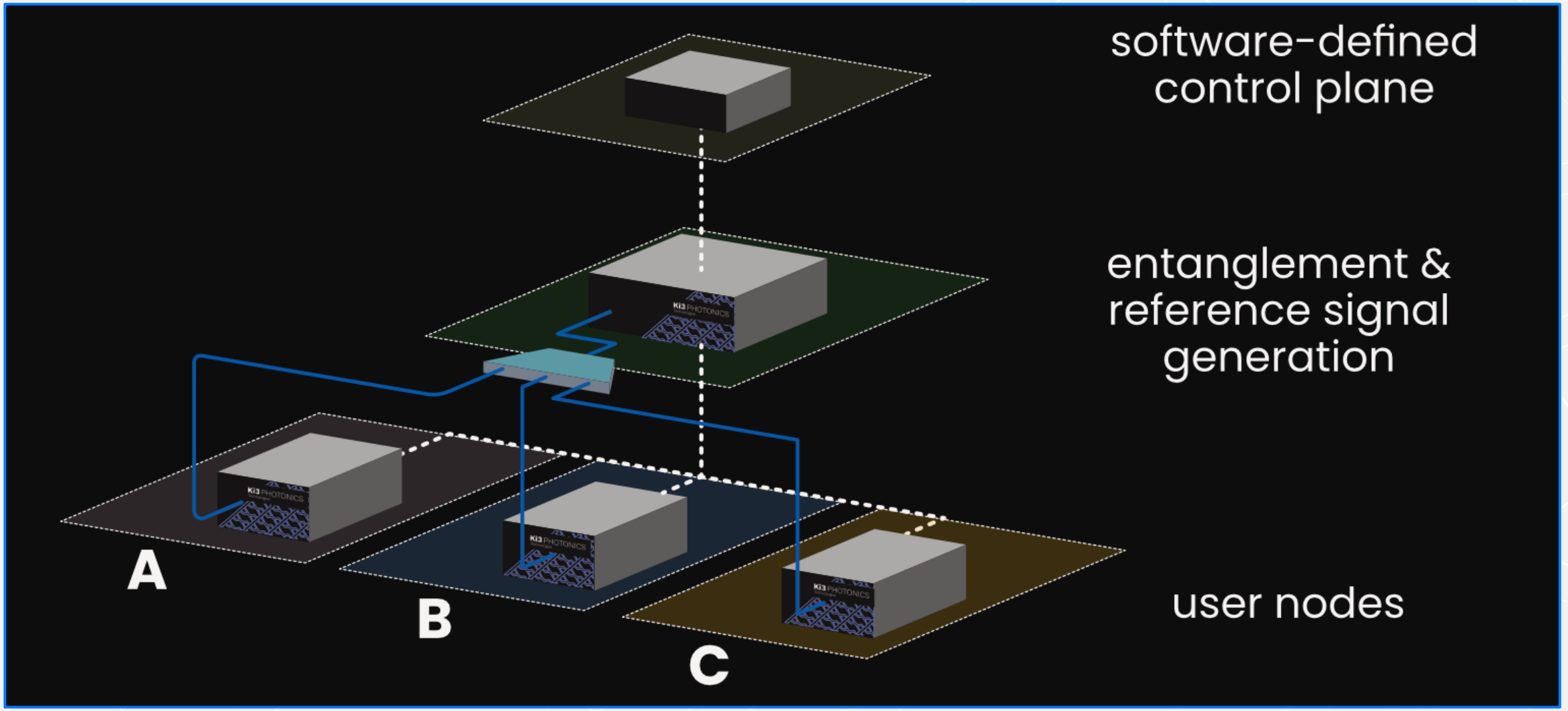
Ki3 PHOTONICS
Technologies

```python
from ki3_api.devices import QComb, PhaseFix, LinqSynq

# connect to devices
qcomb = QComb(ip="X.X.X.X")
phasefix = PhaseFix(ip="Y.Y.Y.Y")
linqsynq = LinqSynq(ip="Z.Z.Z.Z")

# query device parameters
print(phasefix.phase)  # rad/pi
print(linqsynq.time_offset)  # ns

# update device parameters
qcomb.laser.power = 40.1  # mW
phasefix.setpoint = 0.5  # rad/pi
```

- **Control, configure, monitor**
  Interactive dashboards for device health, uptime, and network performance
- **Unified Python API**
  Update device configurations and operational parameters within experimental and network workflows
- **Quantum network orchestration**
  RESTCONF-based device interoperability (e.g., via Aliro Orchestrator™)

A flex-grid, multi-user quantum networking testbed with agile control & routing (DRDC)

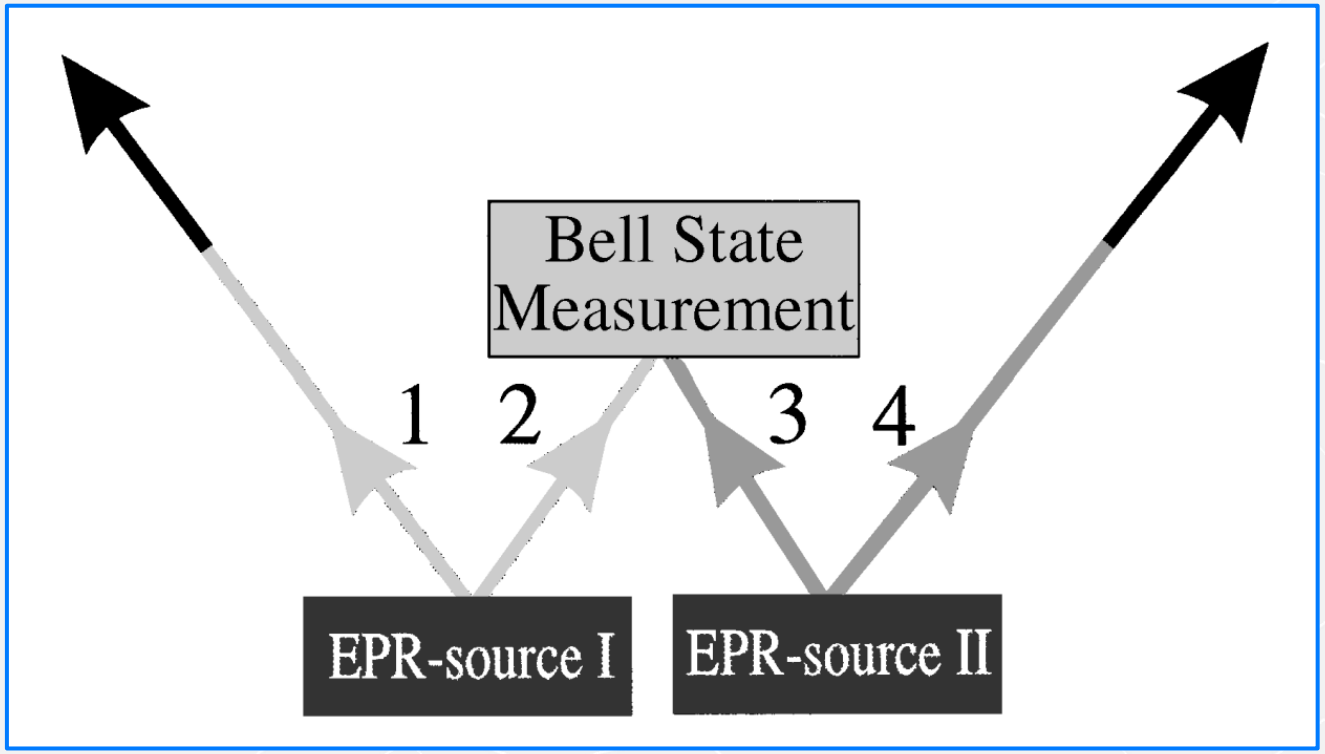
Ki3 PHOTONICS Technologies



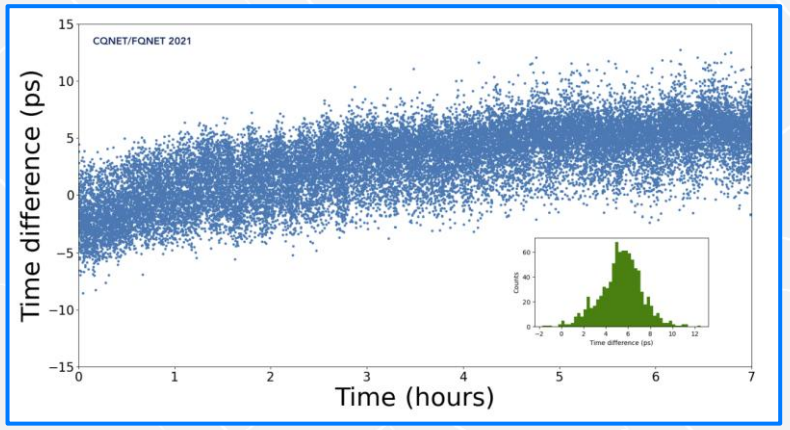
P. Parsa et al., OFC 2026

Two-photon interference requires ps-scale synchronization between network nodes

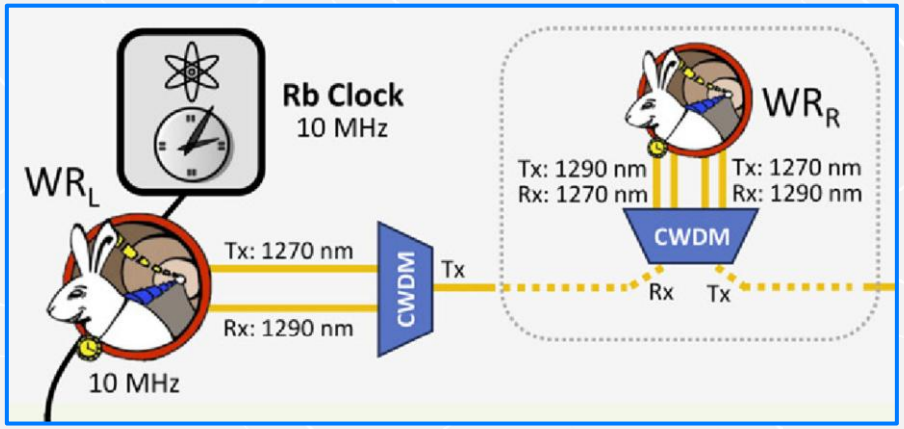
Ki3 PHOTONICS
Technologies



Phys. Rev. Lett. 71, 4287 (1993)
Phys. Rev. Lett. 80, 3891 (1998)



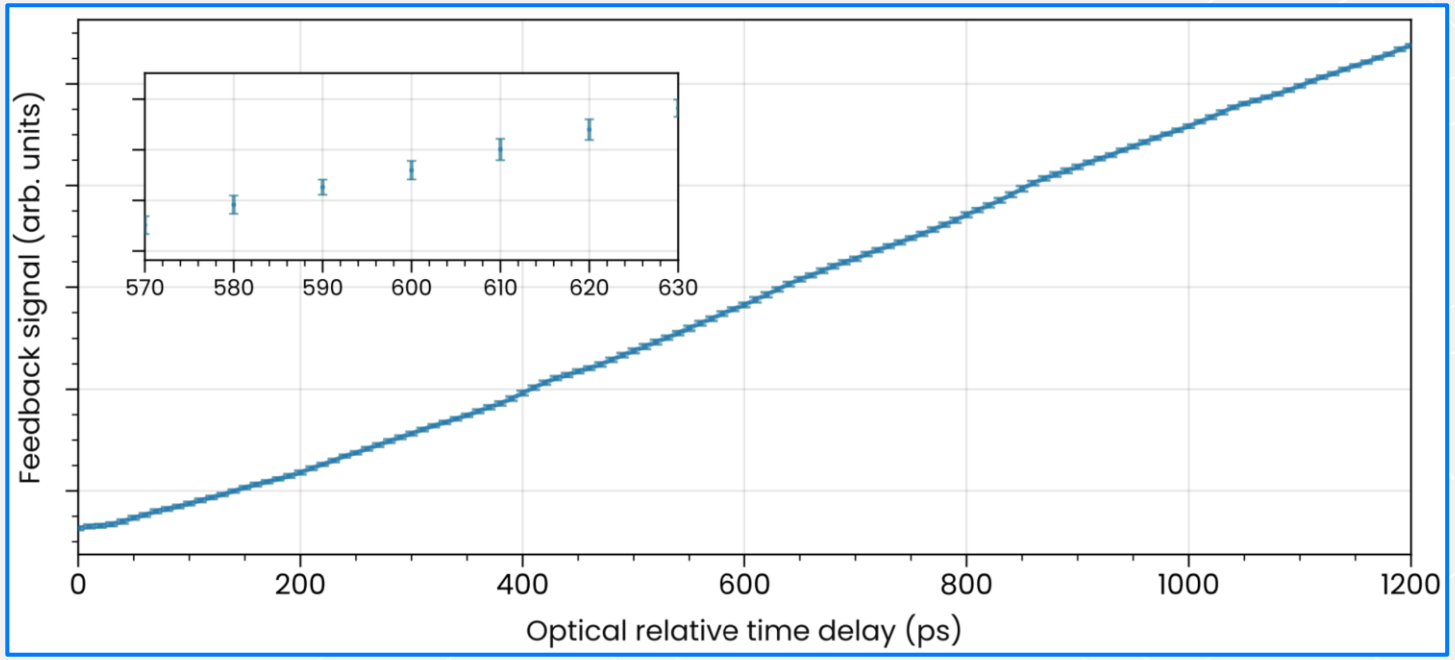
Fermilab [*JLT* 40, 23, 7668 (2022)]



NIST [*Opt. Exp.* 33, 15, 31258 (2025)]

Ki3 LINQ.SYNQ: Our low-crosstalk optical link stabilization module

Ki3 PHOTONICS
Technologies

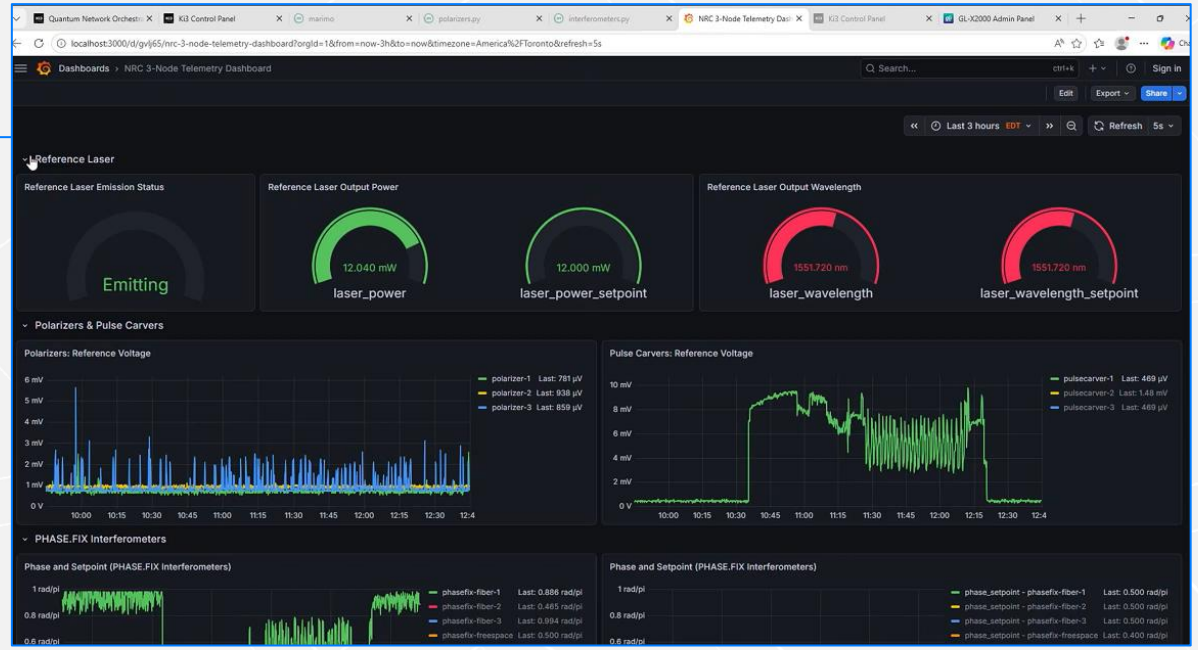


- **Automated tracking and compensation**
  Stabilizes fiber length and polarization, ensures precise quantum interference
- **State-of-the-art precision**
  Tracks fiber length deviations at a resolution of <5 ps
- **Low crosstalk**
  Probe signal does not disturb quantum signal fidelity (>85 dB demonstrated)

Patent pending

Rack installation into the NRC Metrology Group quantum networking testbed

Ki3 PHOTONICS
Technologies



- Plug-and-play, multi-channel time/frequency state distribution
- Automated network synchronization (ps-level) and agile signal routing
- Standard network interfaces (fiber, Ethernet, TCP/IP, YANG, RESTCONF)

Conclusion

Ki3 PHOTONICS
Technologies

- **Quantum processing units** (QPUs) augment AI, materials science, and dual-use applications
- QPUs require **technically-demanding interconnects** to scale, which include technologies like entangled photon sources, coherent links, and quantum memories
- To address these needs, we build **hardware and software** modules for quantum networking
  - Solutions for narrowband entanglement, precise interferometry, link stabilization, network management
- We welcome **partners** that seek first access to quantum networking technologies, and collaborators for validation and standardization

Contact:
Piotr Roztocki, Ph.D.
CTO & Co-Founder | Ki3 Photonics