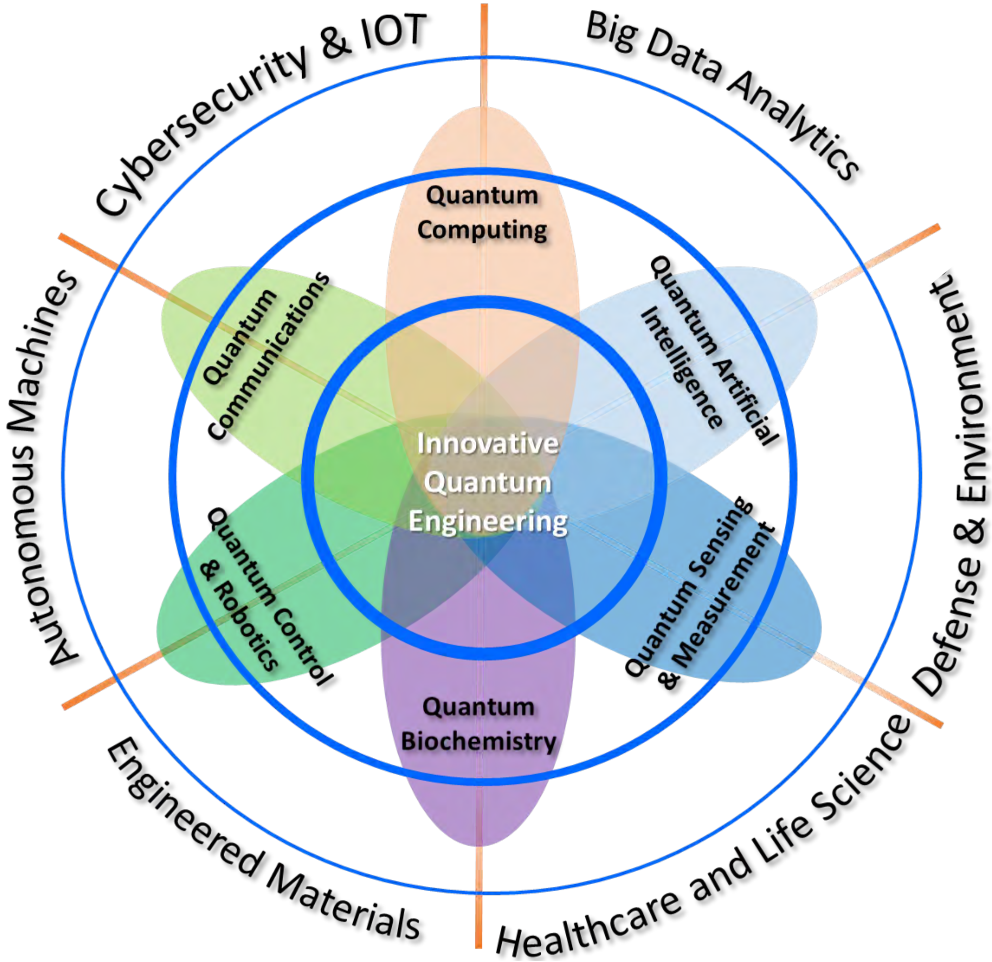
Center for Quantum Science and Engineering (CQSE)



CQSE is an interdisciplinary hub at Stevens, where innovative quantum engineering research, development, and education are inspired and facilitated cutting across disciplines and through collaboration and partnership with government institutions and private sectors to <u>bring quantum solutions to real world problems.</u>

Quantum Campus at Stevens

quantum network, quantum corner, quantum sensing, quantum internet of things...

QUANTUM CORNER

The Quantum Corner in Williams Library features a quantum receiver hosted in a transparent enclosure, a messaging terminal based on quantum technology and educational materials on quantum physics and technology. This open quantum platform gives the public hands-on access to quantum technology, and inspires students to join the quantum workforce.

QUANTUM CHIPS

A central part of our interdisciplinary effort is to develop low-loss, high-efficiency, functional quantum chips capable of complex quantum functionalities. Thus far, we have developed a lithium niobate nanophotonic platform for quantum frequency conversion, all-optical switching, entanglement generation, photon modulation, and their integration. We have also developed single-photon sources from defects in 2D materials, which could form the basis for the future scalable quantum technology on chip.

STEVENS QUANTUM CAMPUS

The Stevens Quantum Campus project promotes innovative quantum engineering and technology through carefully structured synergy among faculty and students across disparate disciplines. The Stevens Quantum Campus provides a multiscale testbed for:

- Analyzing and testing new quantum devices and techniques.
- Identifying and addressing critical challenges facing quantum technology transition.
- Stimulating system engineering research on complex quantum networks.
- Bridging quantum research with industrial R&D, and facilitating entrepreneurship and technology commercialization.
- Creating broader impact and promoting Stevens to be a world's topmost institute in quantum engineering, where students enjoy access to and take part in creating transformative technologies of tomorrow.

NSF GRANTS

NATIONAL SCIENCE FOUNDATION/ECCS #1521424: "QP: Collaborative Research: Quantum Zeno Photonics on Chip," Yuping Huang (PI)

NATIONAL SCIENCE FOUNDATION/EFMA #1641094: "EFRI ACQUIRE: Development of Heterogenous Platform for Chip-Based Quantum Information Applications." Yuping Huang, Stefan Strauf (co-PI)

NATIONAL SCIENCE FOUNDATION/ECCS #1842680: "RAISE-EQuIP: A Chip-Integrated Platform for Photon-Efficient Quantum Communications," Yuping Huang (PI)

NATIONAL SCIENCE FOUNDATION/ECCS # 1531237: "MRI: Acquisition of cryogen-free low temperature scanning probe spectroscopy system for nanophotonic and nanoelectronic device characterization," Stefan Strauf (PI), Yuping Huang (co-PI)

NATIONAL SCIENCE FOUNDATION/PHY #1806523: "Collaborative Research: Parity-Time Symmetry and Anti-Symmetry in Quantum Optics" Yuping Huang (PI)

Office of Naval Research #N00014-15-1-2393: "Persistent Maritime Quantum Key Distribution," Yuping Huang (PI)

EOIR Technologies: "Innovation Systems Based Photonic Research for Military Applications," Phase I & II, Yuping Huang (PI).

NSF/DMR #1809235: "Collaborative Research: Plasmonic lasing with two-dimensional heterostructures in the intrinsic regime," Stefan Strauf (PI)

NSF/DMR #1506711: "Collaborative Research: Cavity-Enhanced Exciton Emission from Carbon Nanotubes in the Intrinsic Regime," Stefan Strauf (PI)

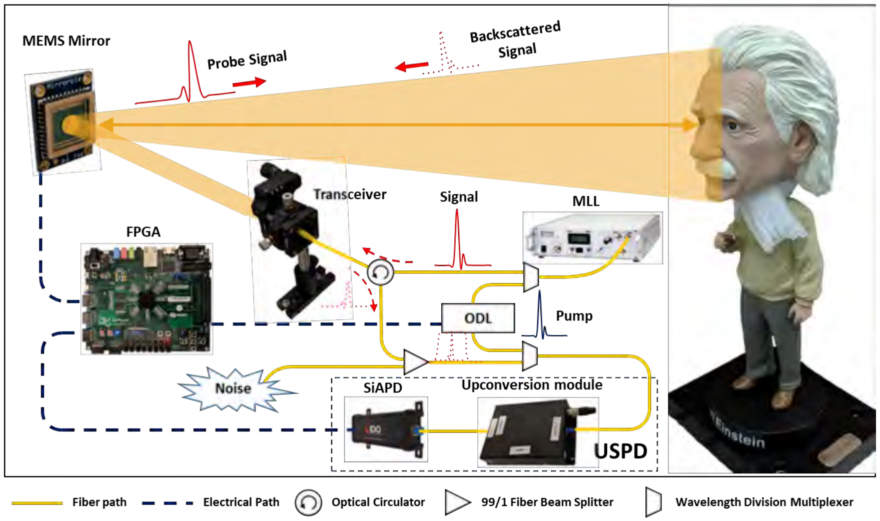
NSF/ECCS #1842612: "RAISE-EQuIP: Integrated Higher-Dimensional Quantum Photonic Platform," Stefan Strauf (co-PI)

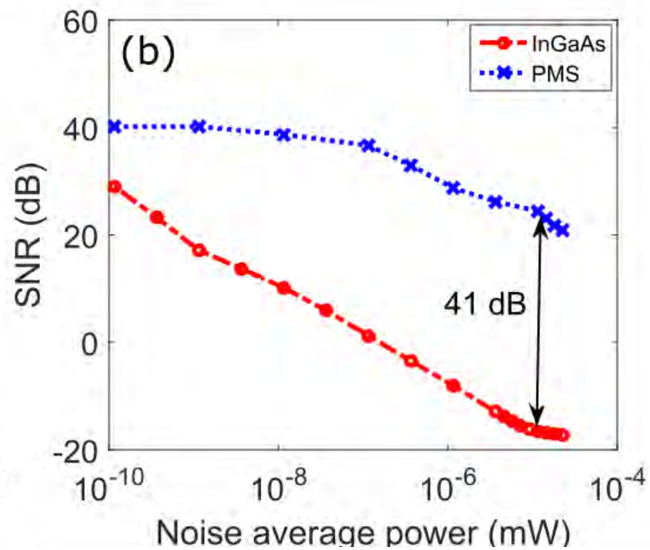
PROGRAMMABLE QUANTUM RANDOM NUMBER GENERATION AND SIMULATION

Stevens has developed a quantum random number generator that is post-processing free and can directly produce arbitrary, user-defined chaotic statistics. It has been applied to big data simulation to demonstrate significant advantage. To promote broader impact, we have also developed a "Quantum Decision" App for iPhone and Android that gives the public free access to quantum technology; download with the QR code to the right.

Quantum LiDAR

- Use bright coherent beams for probing (instead of entangled photons)
- Exceptional detection signal to noise by Quantum Parametric Mode Sorting (QPMS)





QPMS outperforms the direct single-photon detection by 43.6 dB in supressing noise or 41 dB in improving signal to noise ratio [Scientific reports 7 (1), 6495; Optics express 26 (12), 15914-15923]

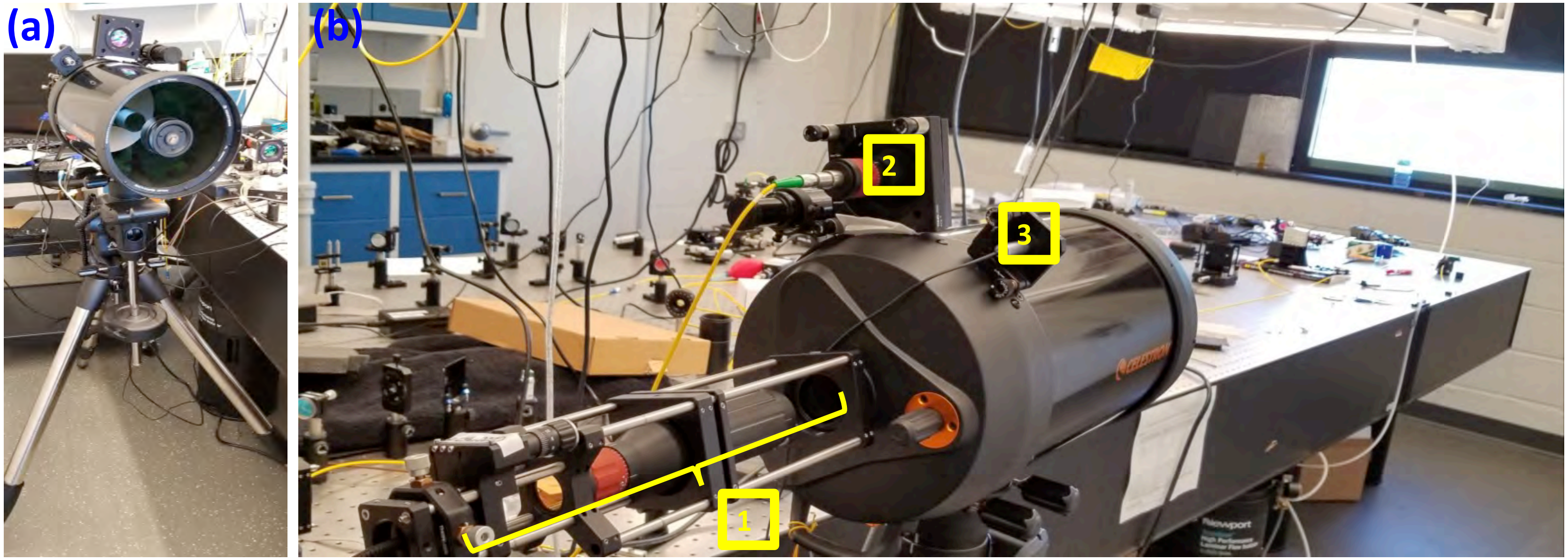
Spatial Resolution is sub-millimetre [CLEO postdeadline, JTh5A. 10]

Detection range >10 miles

Sunlight/ambient background rejection

Applications: remote 3D mapping of trace-gases, acoustic waves.

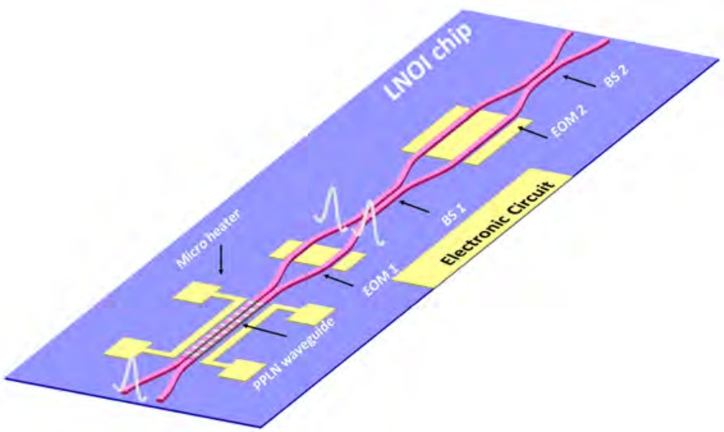
Field Test: Sunlight Rejection

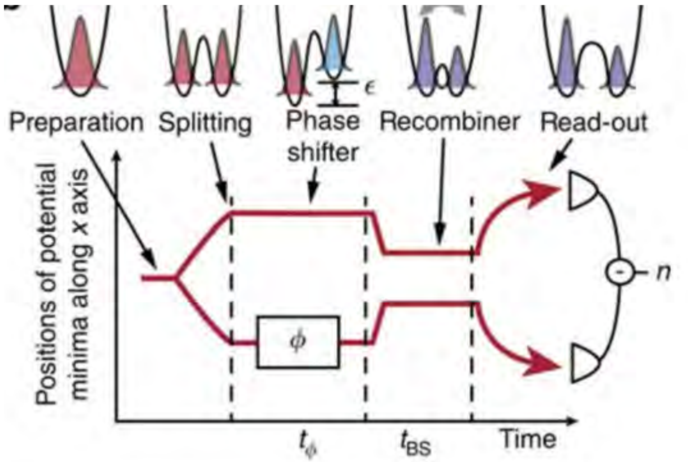


Detector	Total Detection efficiency, η (%), λ(nm)	Detection bandwidth (nm)	Detection gate (ps)	Detector Dark count rate(Hz)	Dynamic Range (dB)	Net Poisson Noise count rate(Hz)
QPMS	3.6@1555 nm	0.8 (PM bandwidth)	6	230	45	27
InGaAs -APD	7.5@1555 nm	1.6	300	250	46	210000

Nearly 40 dB advantage

Quantum Interferometer





- Using two-mode squeezed states can improve the interferometry sensitivity to approach the Heisenberg limit, orders of magnitude higher than shot noise. [YP Huang, MG Moore, Physical review letters 100 (25), 250406].

- The two-mode squeezed states can be created by parametric downconversion with strong optical nonlinearity demonstrated recently on chip [Optica 6 (9), 1244-1245].

- A chip layout is shown in the left figure, consisting of (1) the generation of two-mode number-squeezed states, (2) splitting and phase acquisition, and (3) differential photon number measurement.

- Similar advantages can be established in other interferometry configures, such as fiber sensors, Sagnac interferometers, and gyroscopes.