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 bring quantum solutions to real world problems.
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.

NSF GRANTS
- National Science Foundation: “QWS: Demonstration of a Quantum-Driven Secure Network,” Tao Yang (PI)
- National Institute of Standards and Technology: “QUANTUM: Quantum Key Distribution,” Tao Yang (PI)

CQSE Center for Quantum Science and Engineering
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.

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 iPhones and Androids that gives the public free access to quantum technology; download with the QR code to the right.

STEVEN'S INSTITUTE of TECHNOLOGY
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 suppressing 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

<table>
<thead>
<tr>
<th>Detector</th>
<th>Total Detection efficiency, $\eta$ (%)</th>
<th>Detection bandwidth, $\lambda$(nm)</th>
<th>Detection gate (ps)</th>
<th>Detector Dark count rate (Hz)</th>
<th>Dynamic Range (dB)</th>
<th>Net Poisson Noise count rate (Hz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>QPMS</td>
<td>3.6@1555 nm</td>
<td>0.8 (PM bandwidth)</td>
<td>6</td>
<td>230</td>
<td>45</td>
<td>27</td>
</tr>
<tr>
<td>InGaAs-APD</td>
<td>7.5@1555 nm</td>
<td>1.6</td>
<td>300</td>
<td>250</td>
<td>46</td>
<td>210000</td>
</tr>
</tbody>
</table>

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.