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Superconducting Single-photon Detectors (SSPDs) for OCT and QOCT

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Classical optical coherence tomography (OCT) and quantum OCT measurement methods are important for characterizing thickness of very thin reflective biological samples. Measurement resolution for both methods is enhanced by the use of a broadband short coherence length light source that must be detected over the full spectral range.

Classical OCT:

- Reflective biological sample is placed in one arm of a Michelson interferometer and a single detector records intensity. $I(\tau) \propto \Gamma_0 + 2 \text{Re} \{ \Gamma(\tau) e^{-i\omega \tau} \} \text{ as function of optical delay } \tau \text{ as the mirror in the reference arm is scanned.}$

Quantum OCT:

- Biological sample is placed in one arm of an HOM beamsplitter interferometer and two detectors record the coincidence counting rate $C(\tau) \propto \Lambda_0$ -Re{ $\Lambda(2\tau)$ } at the output of the beamsplitter as an optical delay τ is scanned in the other arm.

Detector Technology for OCT and QOCT:

- Silicon Avalanche Photodiode (APD)
 Maximum count rate is 5-10 MHz; quenchtime limited.
- Bandgap limited long wavelength cutoff at 1100 nm.
 Superconducting single-photon detector
- (SSPD) - E-beam patterned NbN light sensitive nanostructure operates at 2.0 °K with low darkcount rate and high sensitivity over a broad spectral range.
- We have demonstrated with our detectors maximum count rate of 80 MHz and high quantum efficiency at 810 nm and 1550 nm wavelength.

Both OCT and QOCT measurement methods will have increased axial resolution if SSPDs are used for detection of the broadband light source.





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