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On-chip Spectroscopy of PbS/CdS Colloidal QDs using Superconducting Nanowire Single Photon Detectors (SNSPDs) on a Silicon Nitride Photonic Platform

SINGLE QUANTUM

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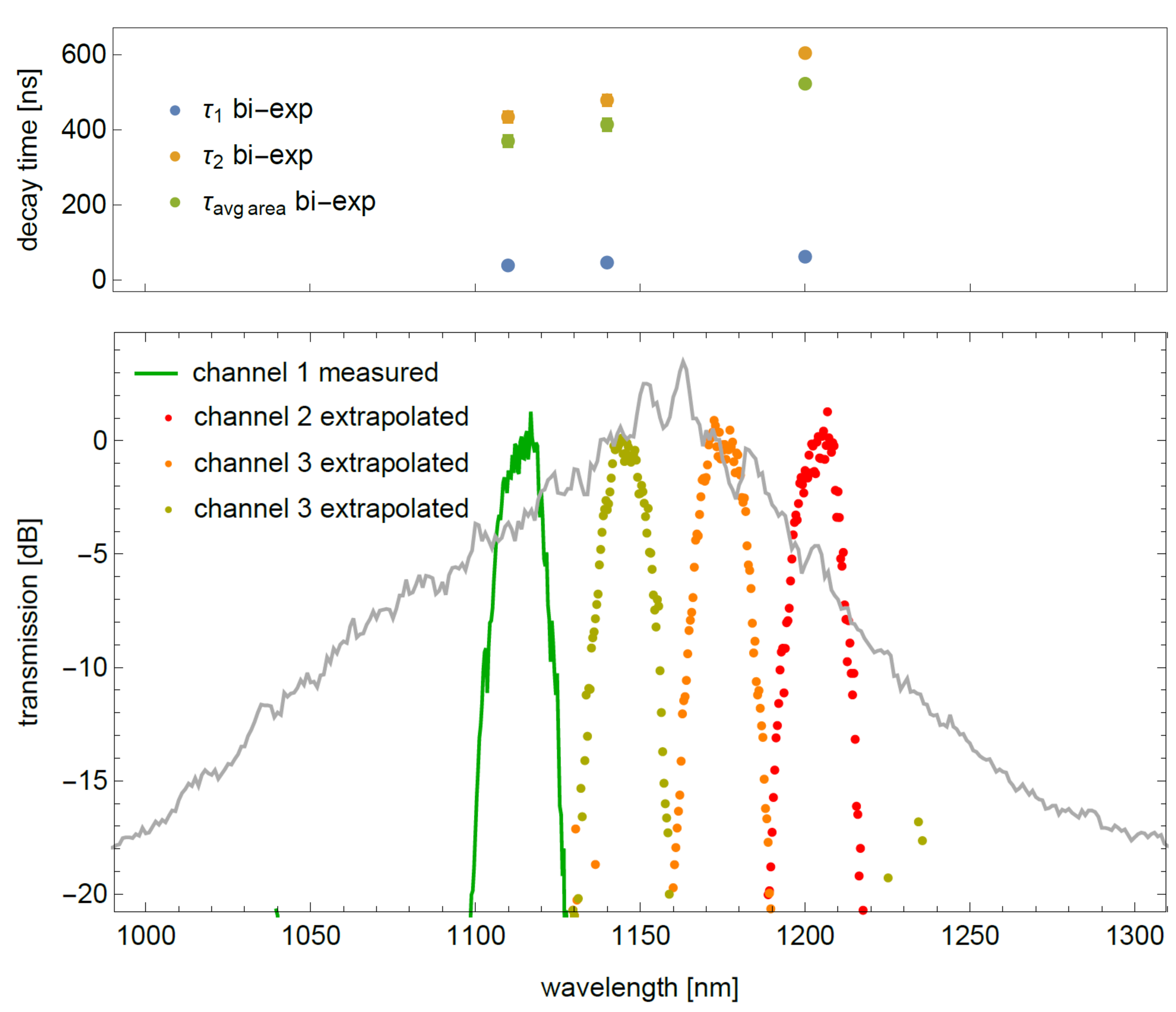
Application of on-chip quantum emitters and single-photon detectors

Single photon source for **quantum key distribution** (competing with attenuated laser + decoy state protocols):
High single-photon rate, but relaxed conditions for photon purity $g^2(0)$, average photon number per pulse <n> and indistinguishability compared to (linear) optical quantum computing

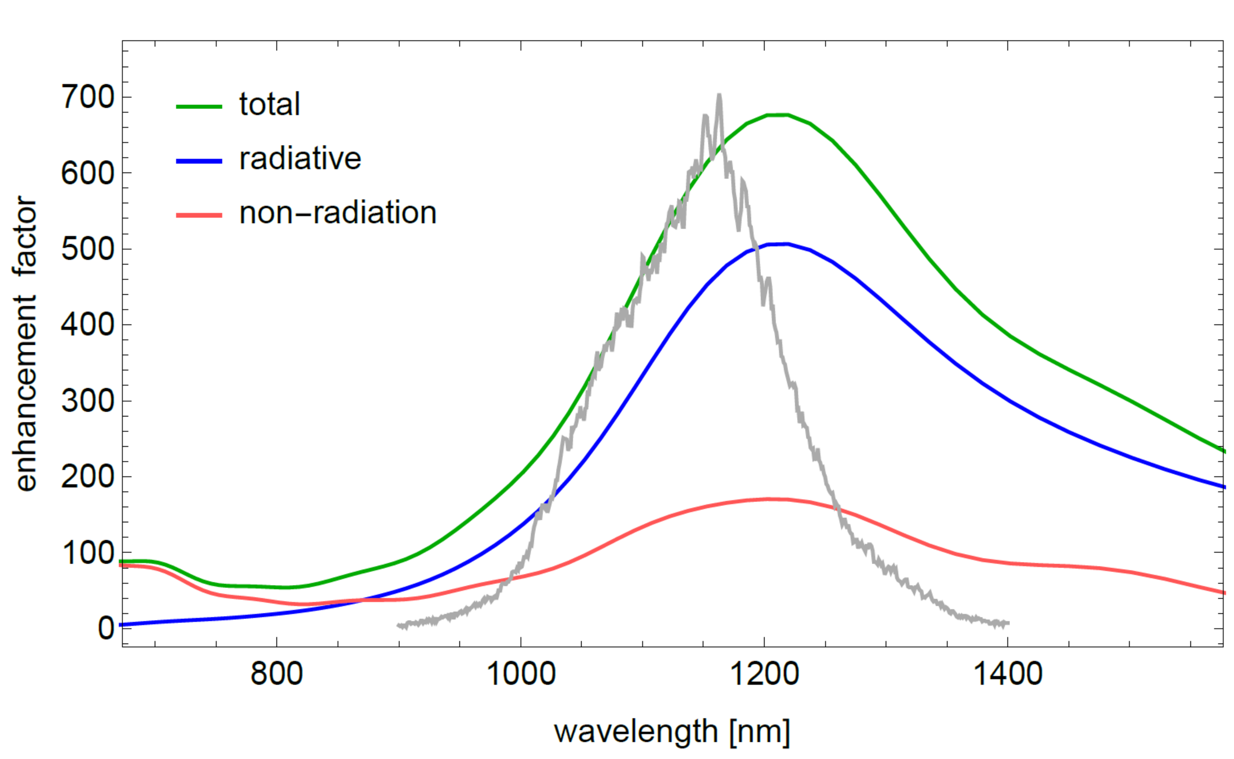
Integration platform for **post-processing** sensitive quantum **emitters** onto waveguides coupled to high-quality SNSPD detectors grown on a flat substrate

Fluorescence lifetime spectroscopy using an integrated planar concave grating

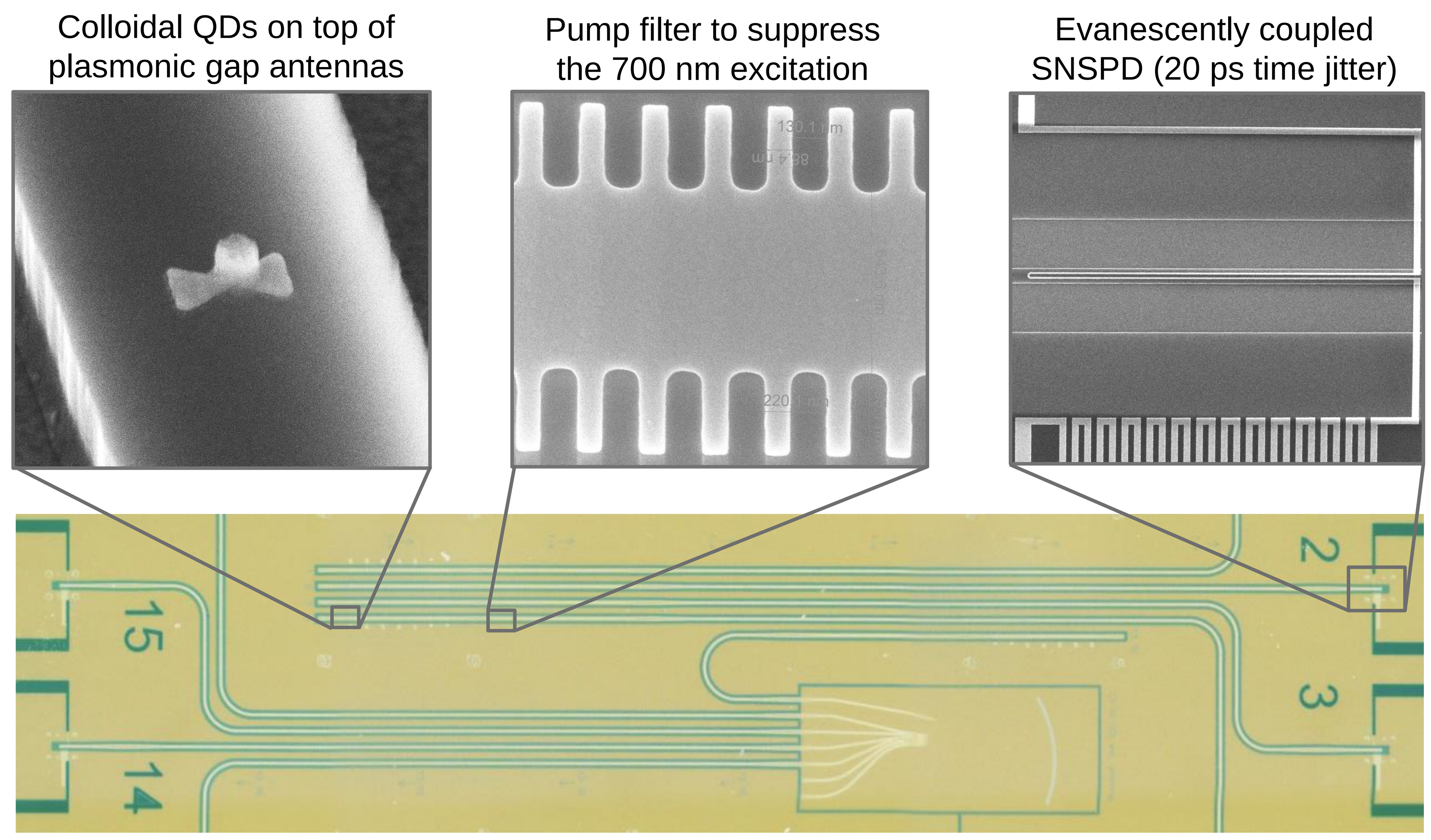
revealed a wavelength-dependence of the PbS/CdS QDs luminescence decay for an embedded film.



The PbS/CdS QD emission spectrum at 4K overlaps with the antenna resonance simulated using dimensions from SEM images. This was confirmed by separate transmission measurements not shown here.

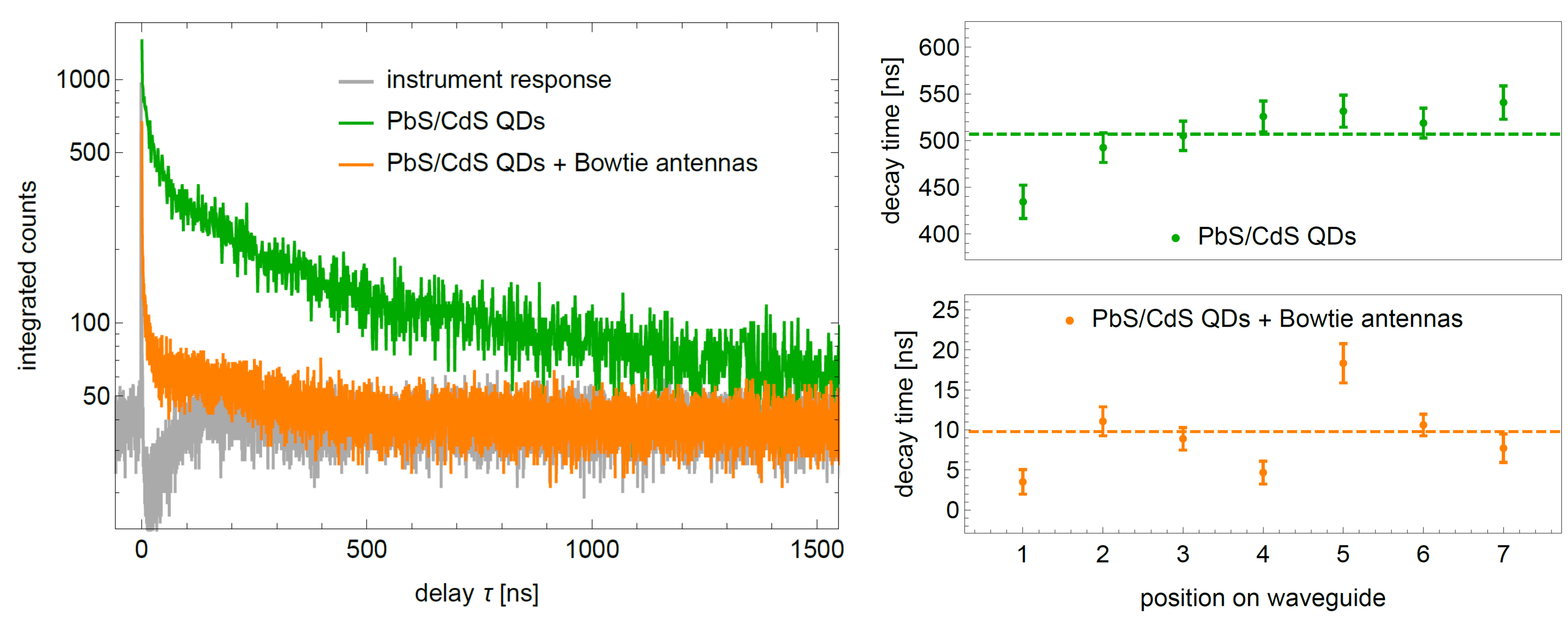


Emission enhancement of PbS/CdS QDs using plasmonic gap antennas measured with integrated superconducting nanowire detectors



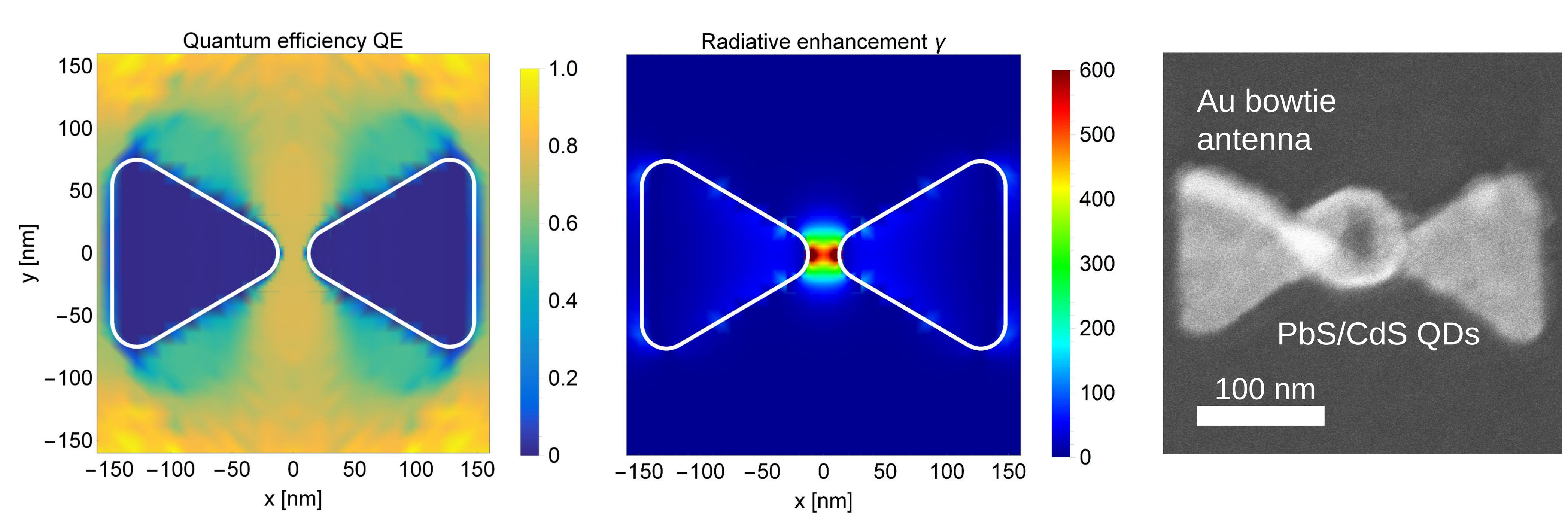
Low loss (<1dB/cm @1300 nm) low fluorescence PECVD silicon nitride waveguide circuits on a photonic chip inside a He cryostat @ 4K.

An **average enhancement factor of 50** and a **maximum of 125** was obtained by area-averaging the decay times extracted from a bi-exponential fit of the fluorescence decay trace.



FDTD Simulation: Up to 500-fold radiative enhancement, QE >70%

SEM pictures show a good overlay accuracy of colloidal QDs post-processed on plasmonic bowtie antennas on top of SiN waveguides, suggesting that we should achieve higher average radiative enhancement by reducing the size of the QD patches.



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