Room-temperature ultrabright single photon sources for free space and fiber-based applications

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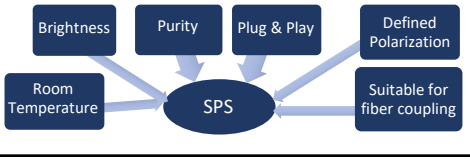
1) Room Temperature Single-photon sources (SPS)

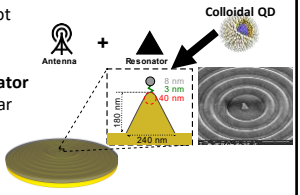
- Compact
- Scalable
- Simple operation

2) Requirements for applicable SPS



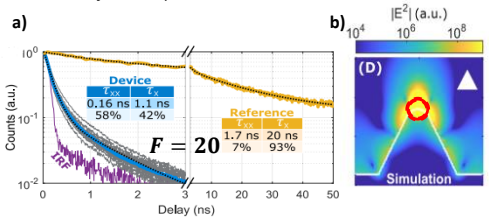
3) SPS device – a quantum dot on a nano-resonator

- CdSe/CdS Quantum dot used as a **quantum emitter**
- Au nanocone – **Resonator**
- Metal-dielectric circular nano - **antenna**

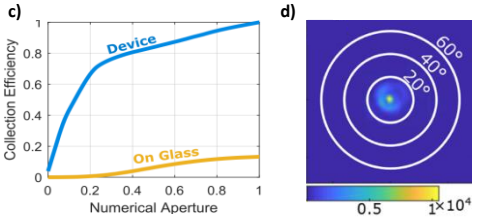


3.1 Brightness – $\Phi \propto \Gamma \cdot \eta_{coll}$

The nano-cone decreases the Radiative lifetime (Down to 1.1ns), thus enhancing total brightness up to 10^7 $photons/sec$.

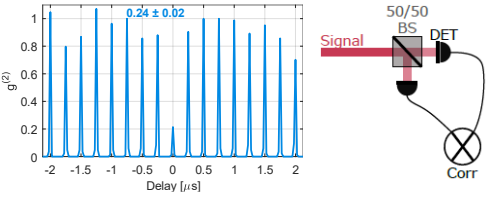


a) Decay time of QD-antenna Device compared to QD on glass, showing a Purcell factor of 20. b) Simulation of the near-field intensity of a radiating dipole on a nanocone



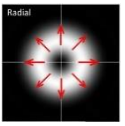
c) Measured collection efficiency of QD-antenna Device compared with a QD on glass. d) back focal plane of the emission from of QD-antenna Device

3.2 Purity

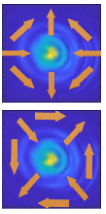


Second correlation measurements **of QD-antenna Device** showing **anti-bunched emitter**

4) Radial polarization emission

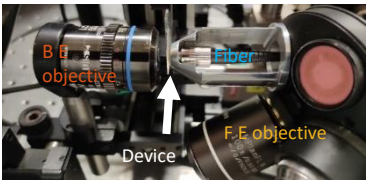


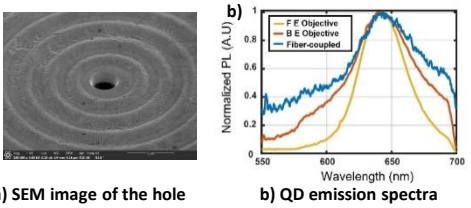
- Nano-cone enhances z-dipole resulting in radially polarized emission in the far field.
- Wave plate → Hybrid polarizations → multi-dimensional Quantum key distribution.



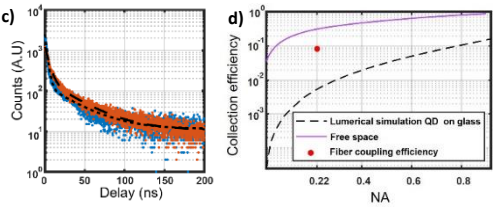
5) Fiber coupling of a Quantum emitter

- Metal-dielectric antenna, hole in the center
- Quantum emitter at the center, excited by laser
- back excitation and front collection (free space and fiber)





a) SEM image of the hole **b) QD emission spectra**



c) Emission decay of QDs-antenna device in free space (orange) and fiber-coupled (blue). d) Measured Collection efficiencies

Summary

- Significant Brightness enhancement and collection efficiency of single broadband emitters
- Well-defined radial polarization suitable for Quantum Key Distribution applications
- Versatile RT SPS device for free space and fiber application

References

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[2] Abudayyeh et al., *Quantum Sci. Technol.* **2 034004** (2017)
[3] Abudayyeh, et al. APL Photonics 6, **036109** (2021)
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