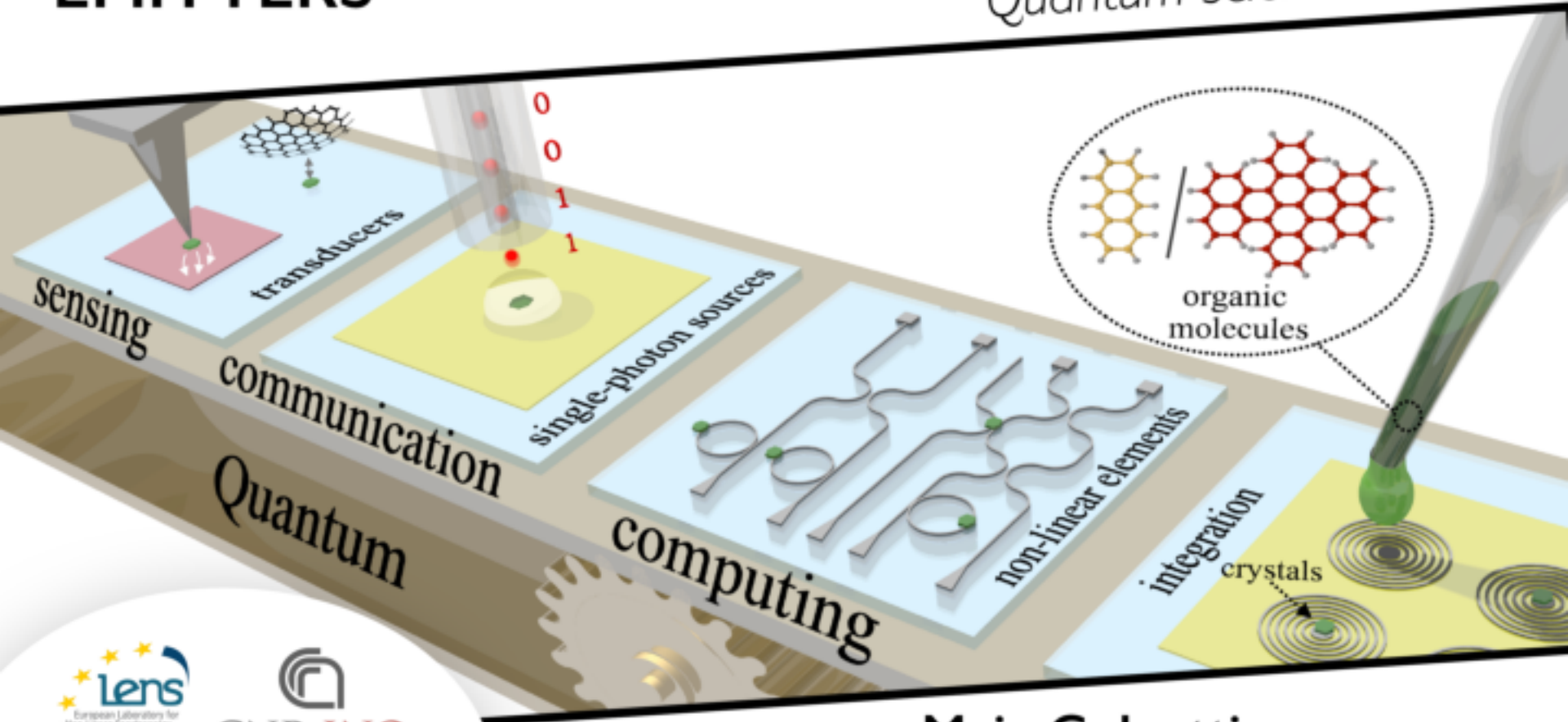


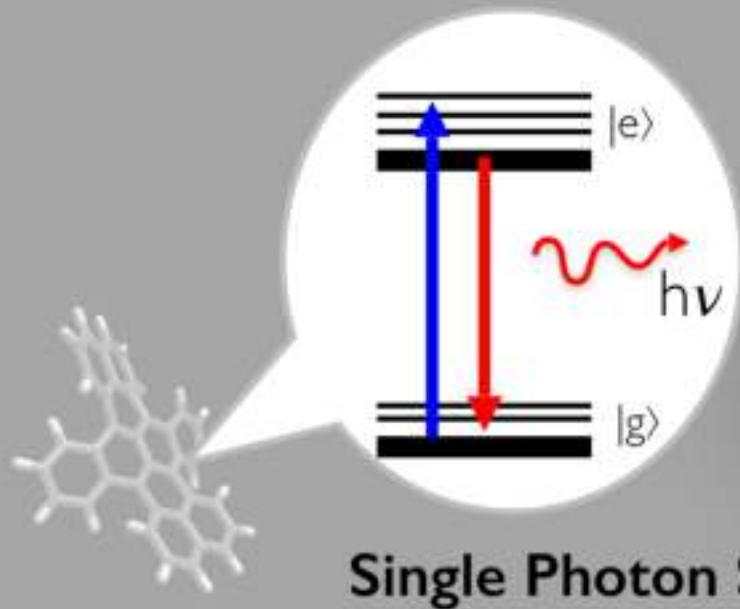
ALL OPTICAL FREQUENCY TUNING of INTEGRATED SINGLE-MOLECULE EMITTERS

Quantum Science Seminar



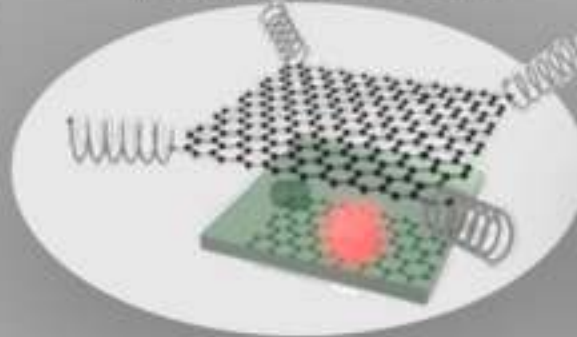
Maja Colautti

Lab of Quantum Nanophotonics
Costanza Toninelli (PI)



Single Photon Sources

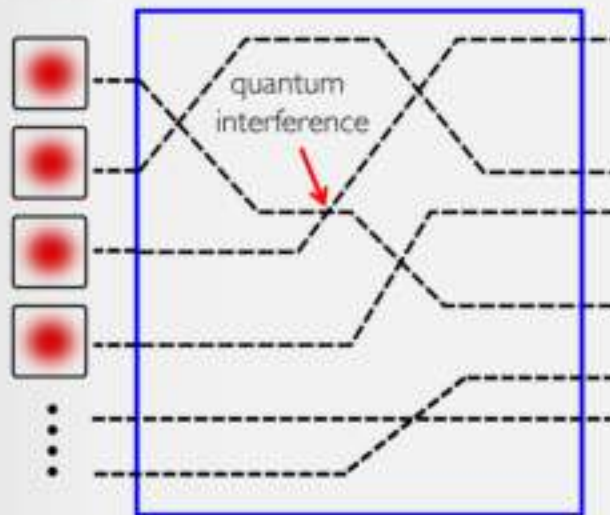
Nano-sensors



Coupling to photonic structures



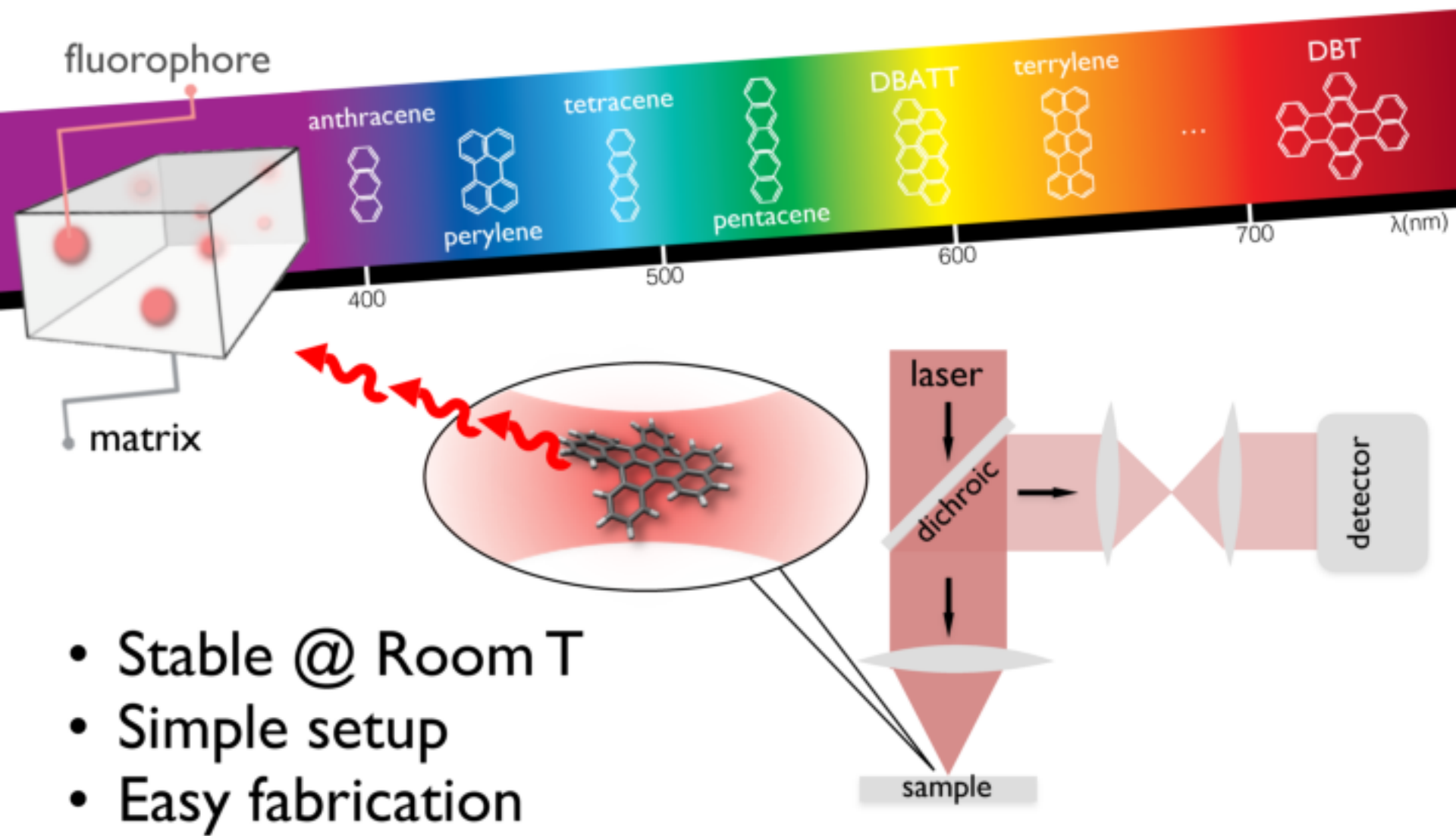
Solid state quantum systems



Integrated Quantum Network

1. SCALABILITY
2. BRIGHTNESS
3. INDISTINGUISHABILITY

Polyaromatic Hydrocarbons

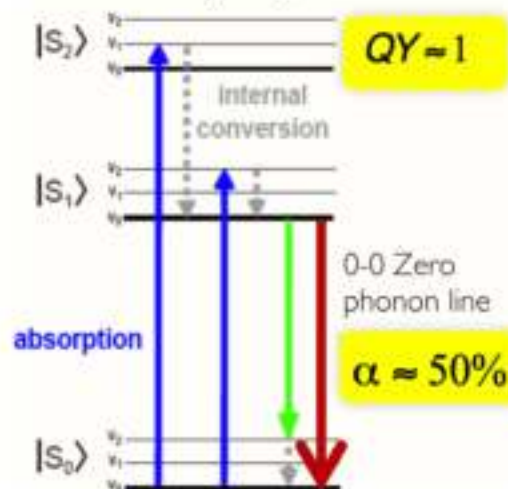
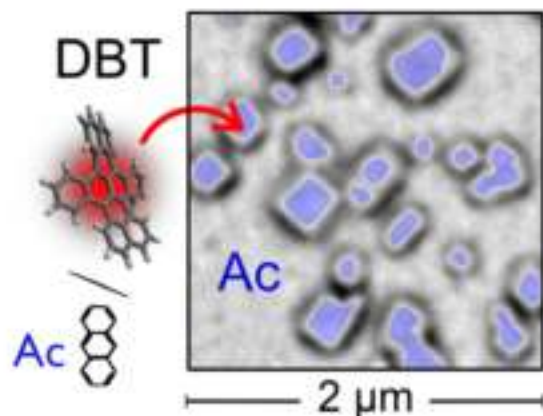


Organic nanocrystals

Lombardi et al, Adv. Quantum Technol. (2019)

Pazzagli et al, ACS Nano (2018)

Dibenzoterrylene (DBT) in Anthracene (AC)

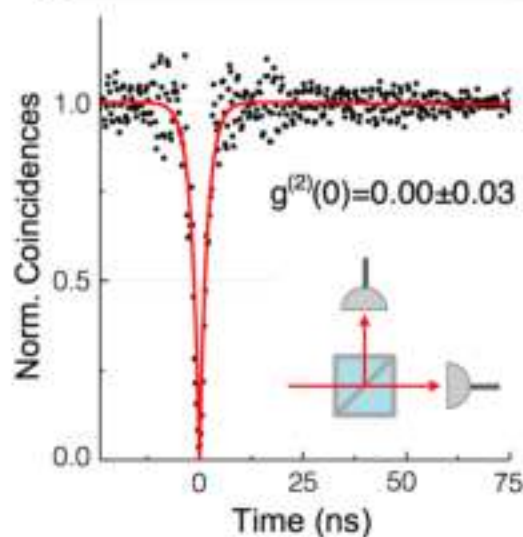


1. SCALABILITY

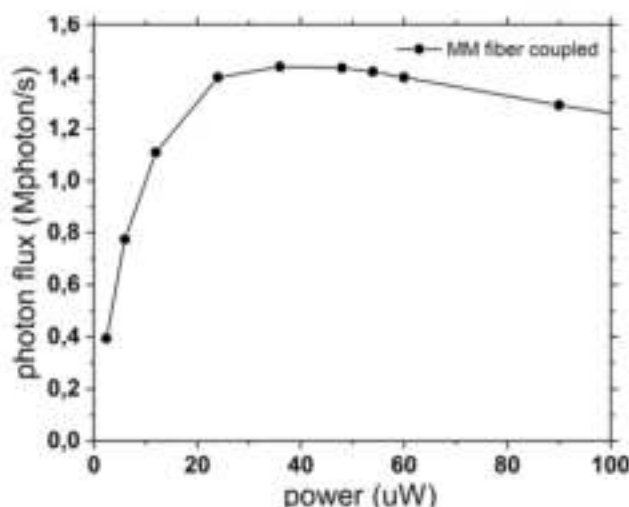
2. BRIGHTNESS

3. PURITY

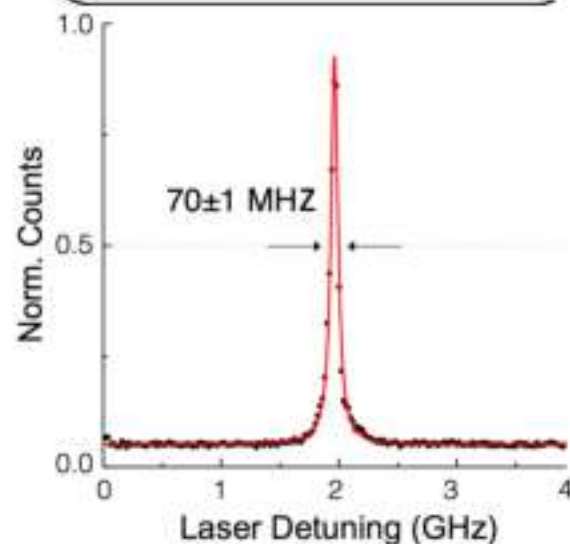
Pure



Bright

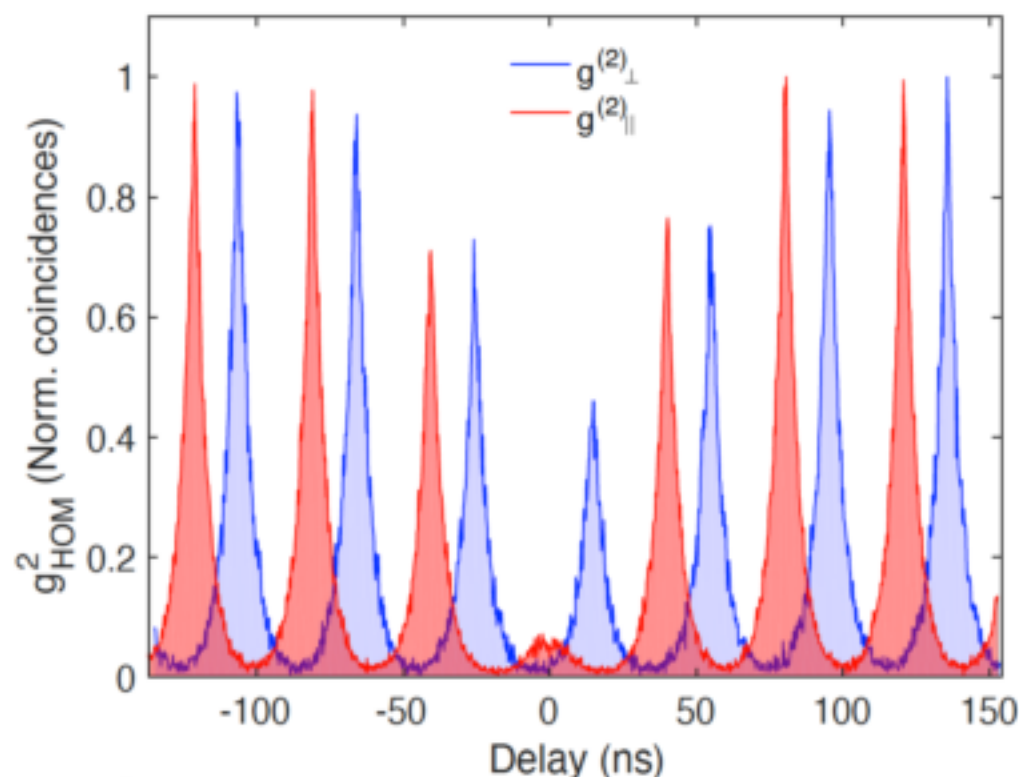


Fourier-limited

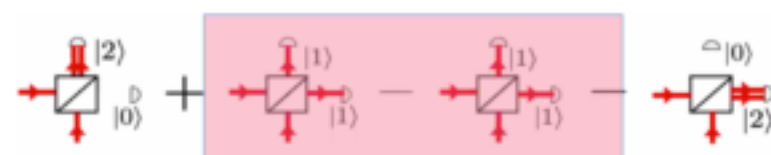


Two-Photon interference

Lombardi et al, arXiv 2102.13055



Single molecule
Hong-Ou-Mandel



$$V = \frac{A_{\perp} - A_{\parallel}}{A_{\perp}}$$

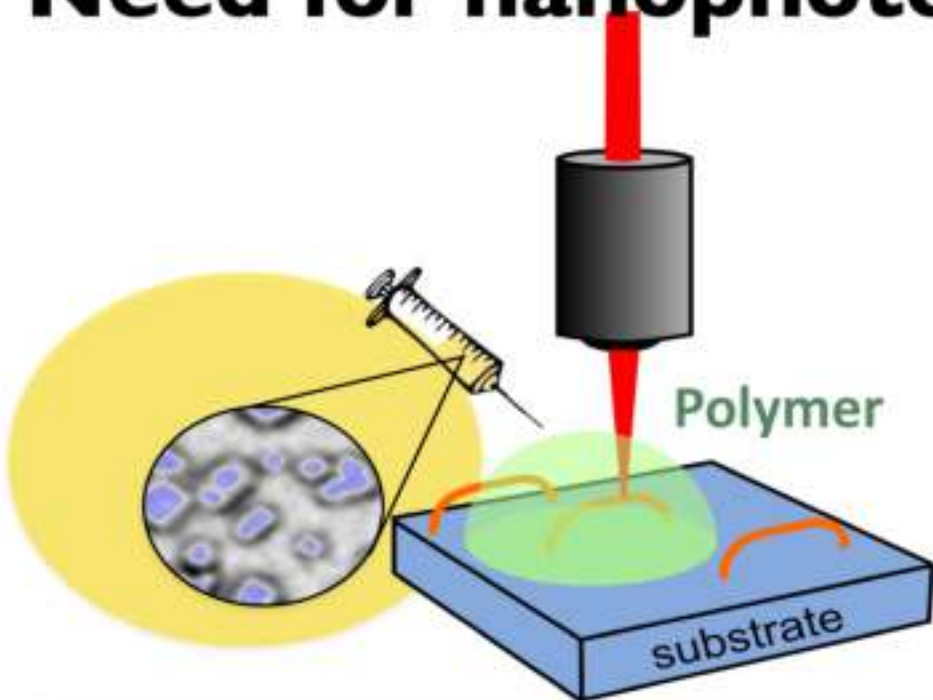
~80% Visibility

(96% @ 1.5 K)

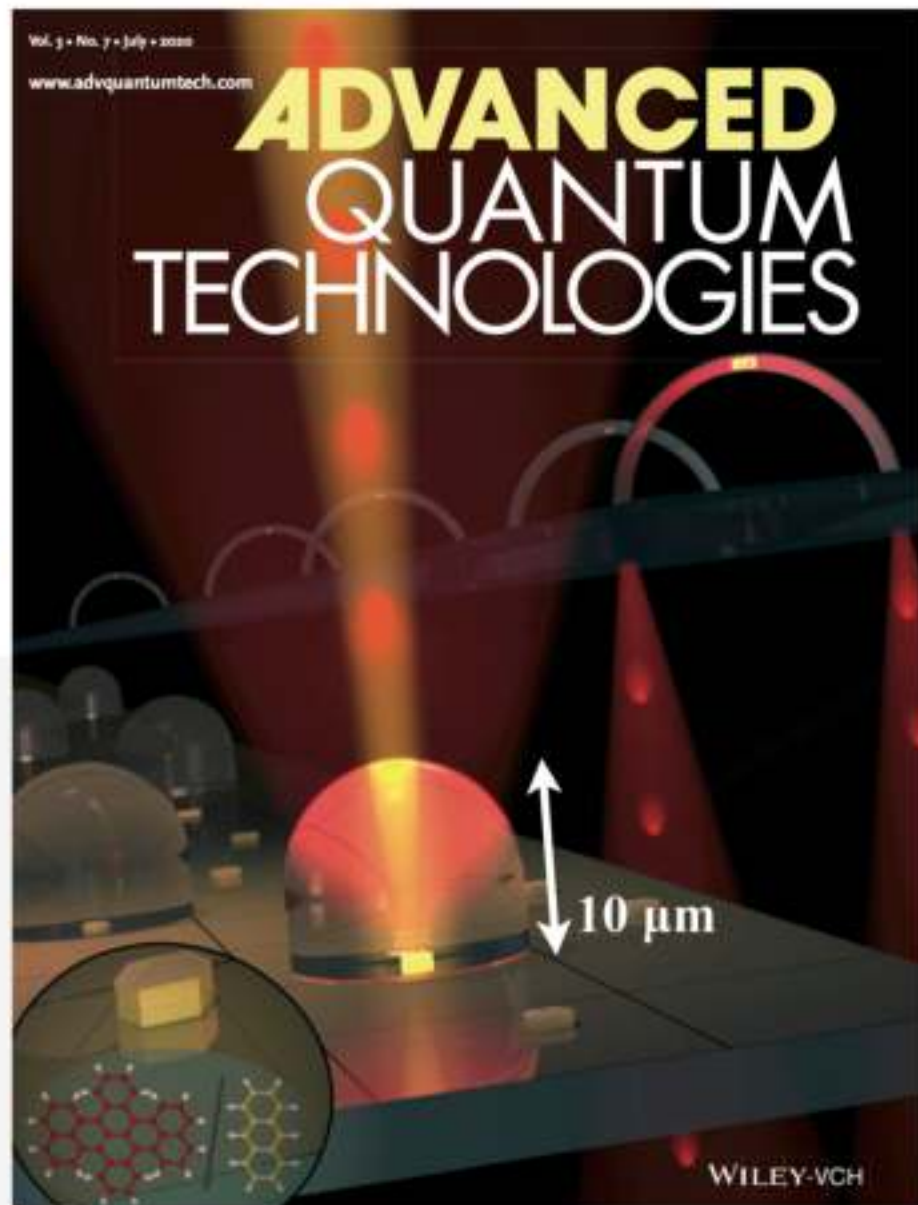
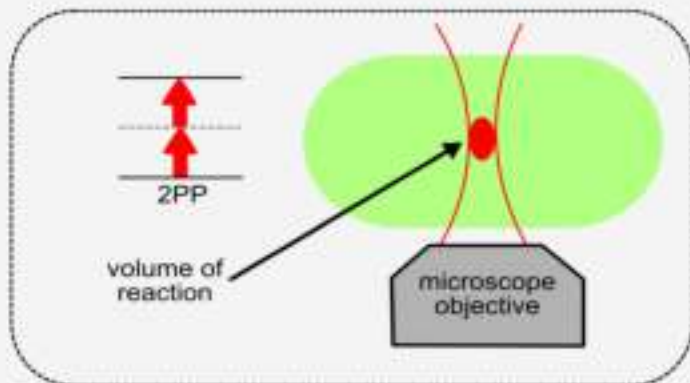
$$\text{Collection Efficiency} = \frac{\# \text{ 1-photon pulses}}{\# \text{ trigger pulses}} = \text{few \% !!!}$$

Need for nanophotonics

Colautti et al, Adv. Quantum Technol. (2020)

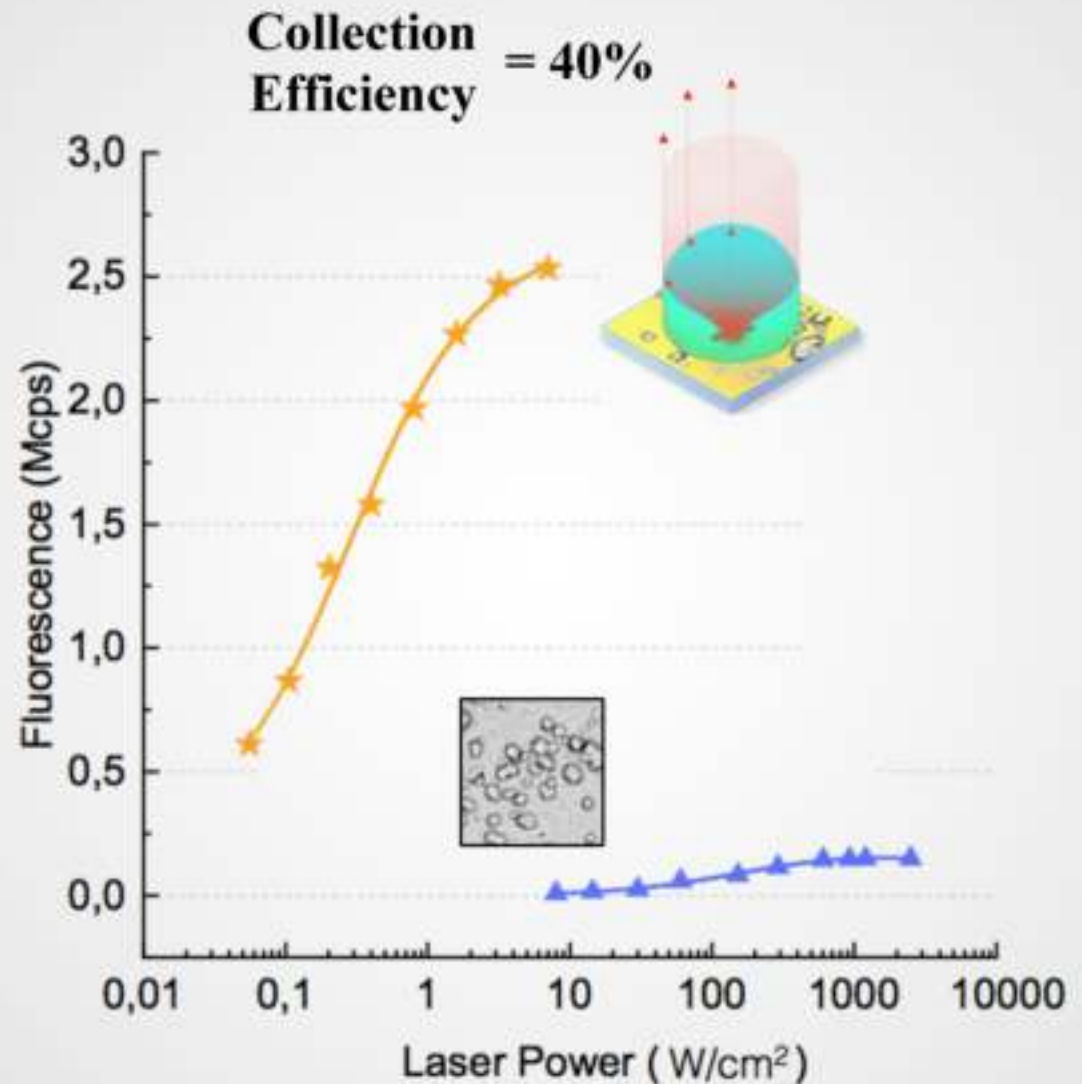
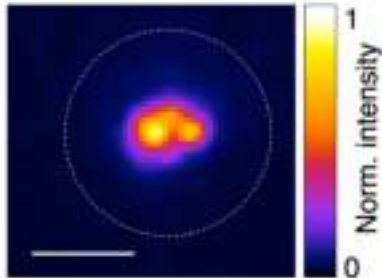
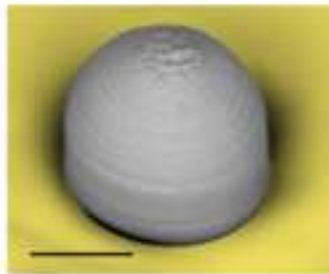


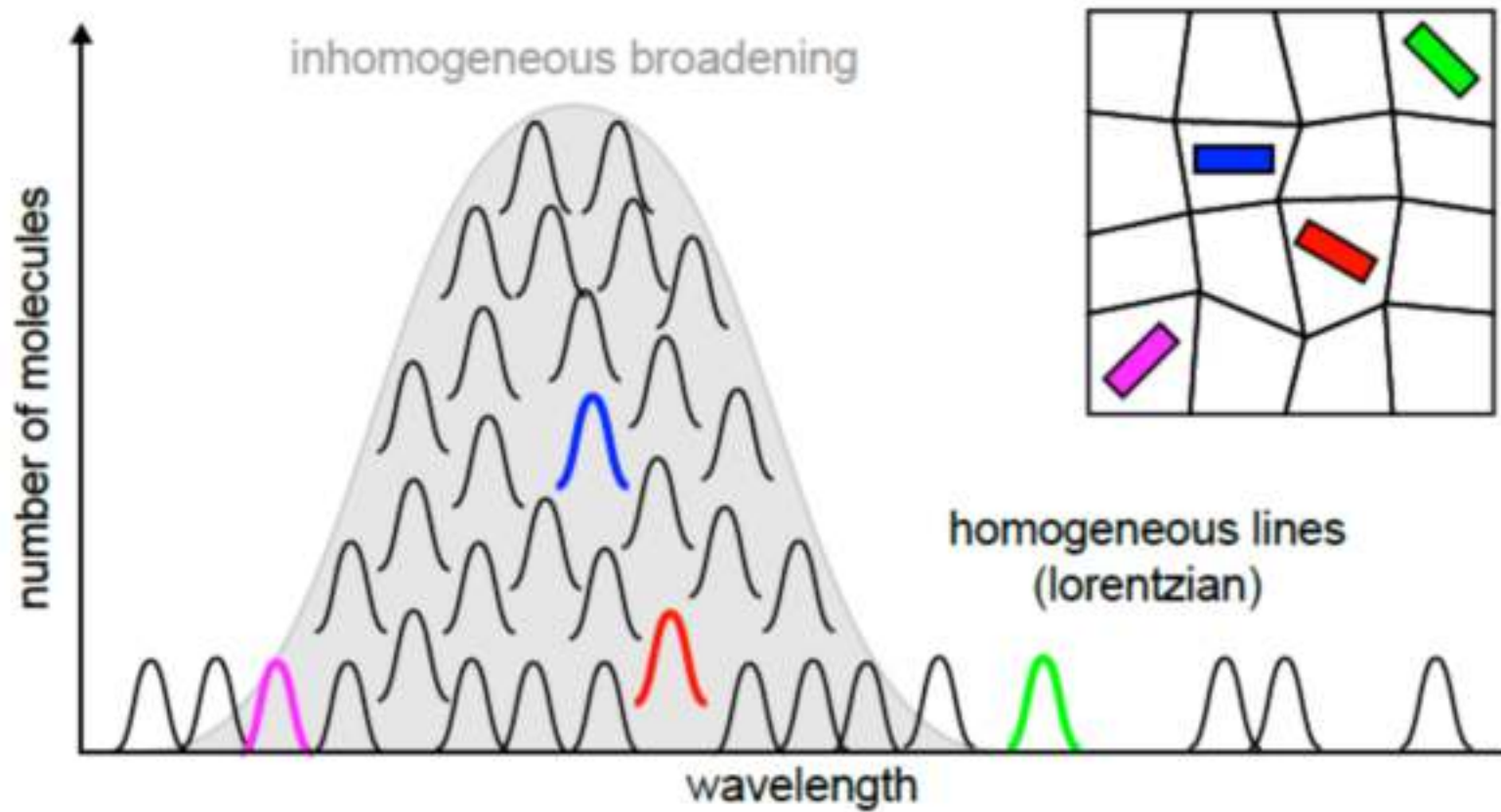
Direct Laser Writing



Integrated source

SEM image



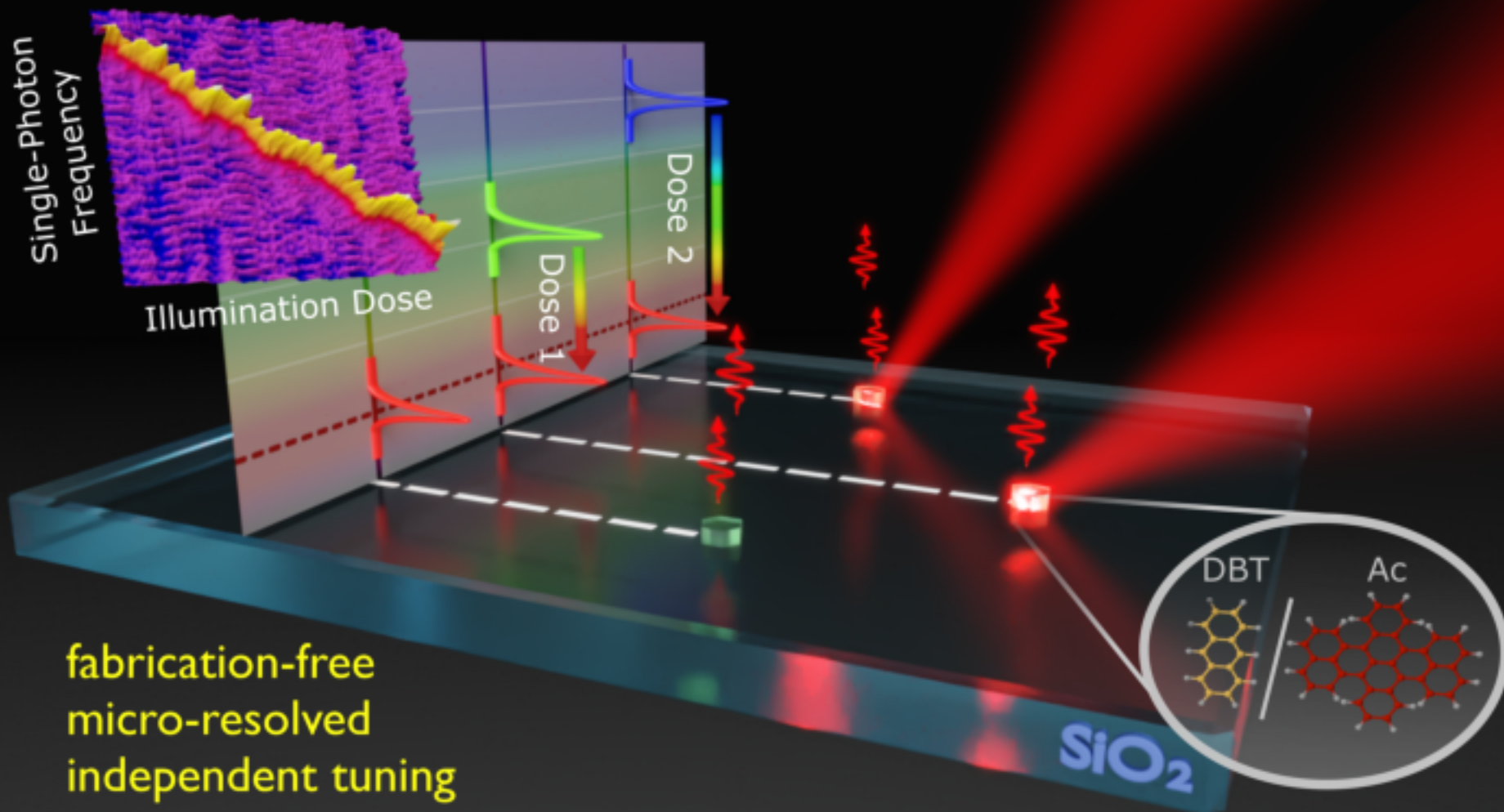


Frequency tuning

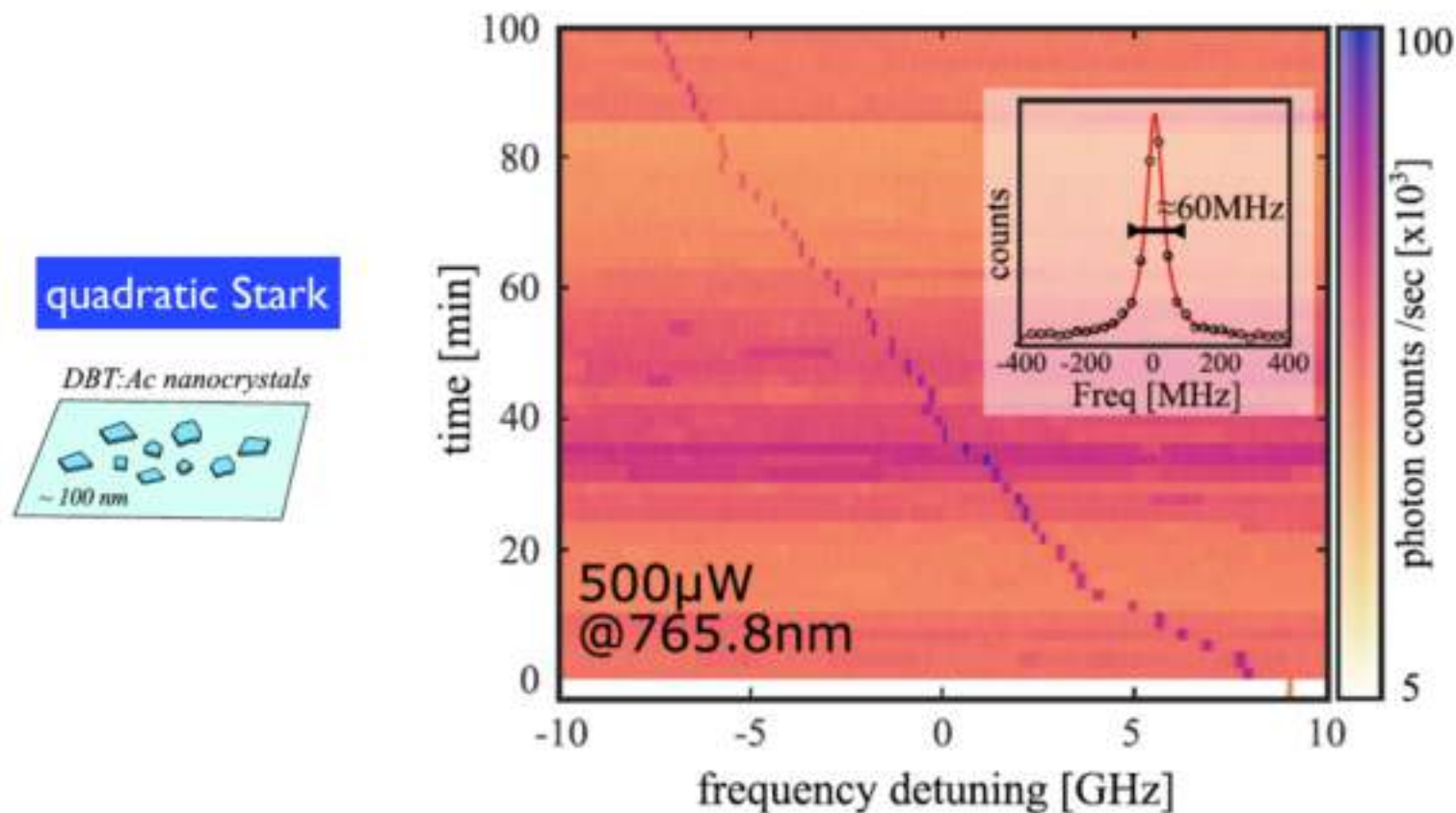
Colautti et al, ACS Nano (2020)



Universiteit
Leiden



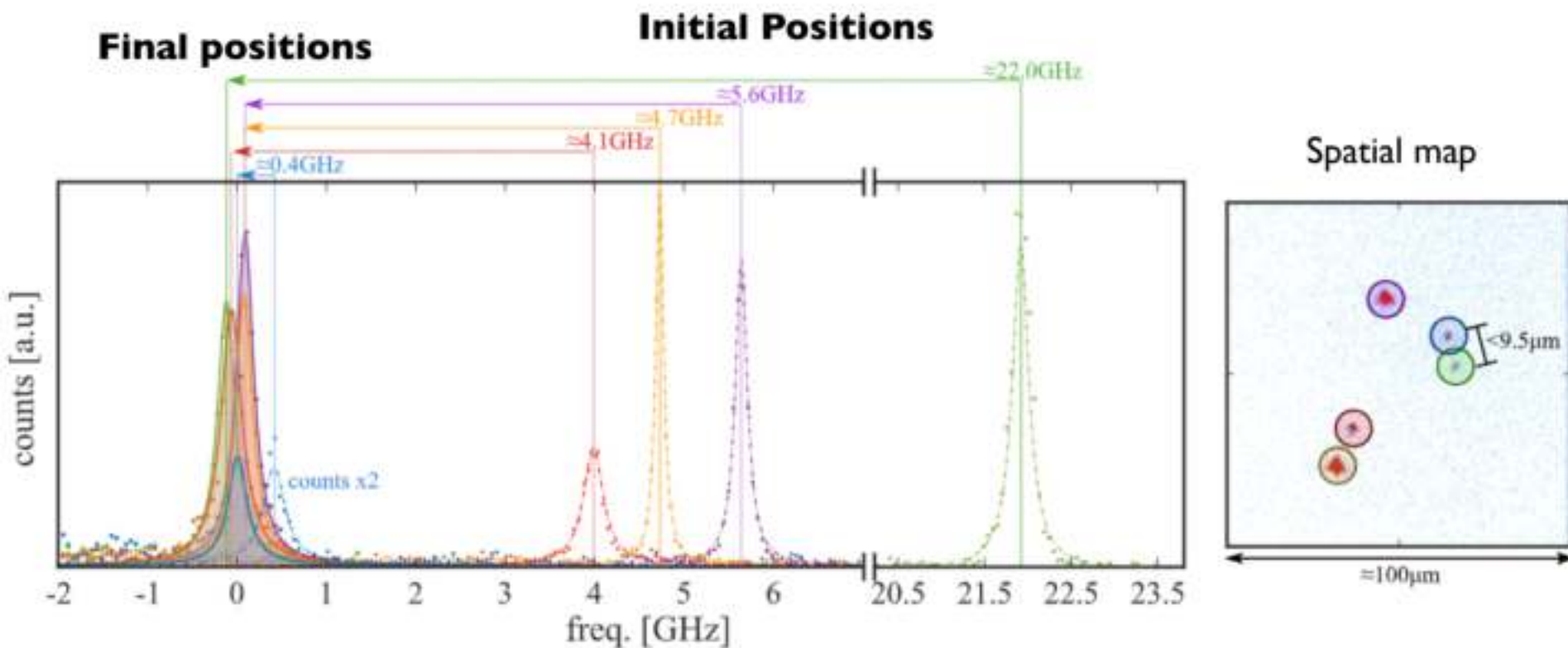
Frequency tuning

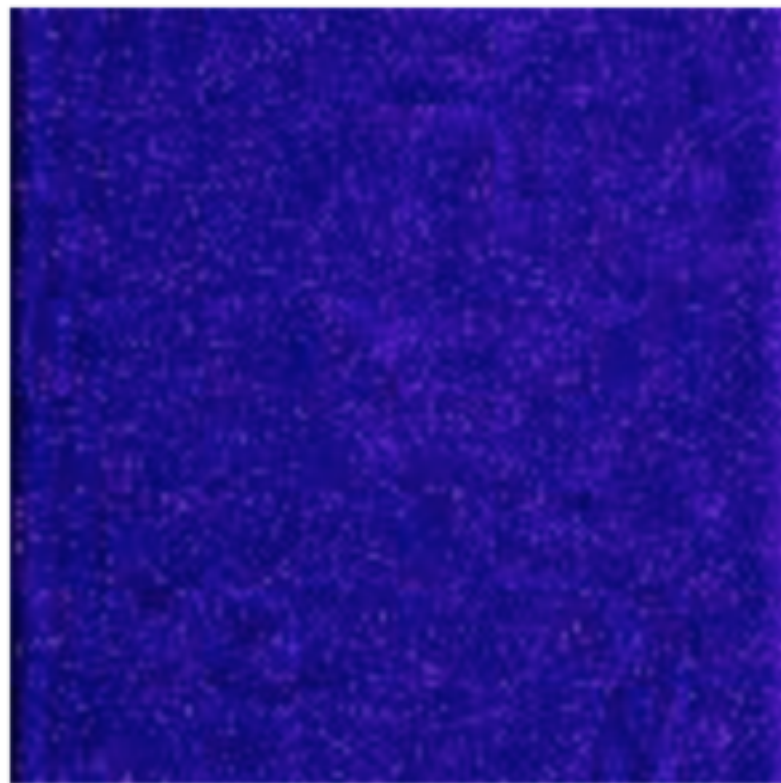


Fourier-limited emission $\rightarrow$ not heating-induced!
Persistent shift for hours

Frequency tuning

Colautti et al, ACS Nano (2020)





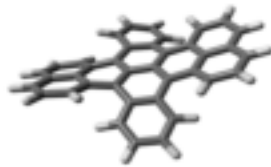
Before...

After tuning

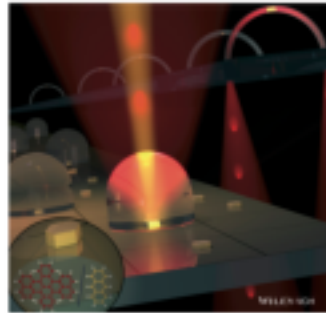


Conclusion

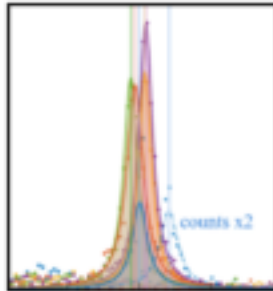
Emitter



3D integration



All optical tuning



Outlook

Single Molecules are
RELIABLE, VERSATILE, EASY
Quantum emitters

Toninelli et al, Nature Materials (2021)
REVIEW on MOLECULES

- Multiple emitters
- On-chip operation
- QKD with true photons!

Quantum Nanophotonics Team!



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F. Koppens, et al. (Barcelona)

M. Orrit et al., (Leiden)

A. Clark et al., (London)

B. Kozankiewicz et al., (Krakow)

A. Gourdon et al., (Toulouse)

PhD&PostDoc
Position
Available!!!



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Laser-induced charge generation

