

STED microscopy for fluorescent nitrogen vacancy defects in diamond

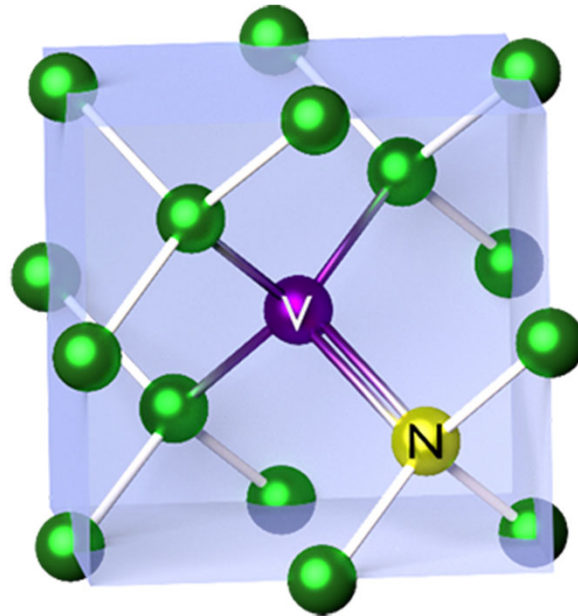
Achieving 5.8nm resolution using far field optics

Clemens Wolter

Outline

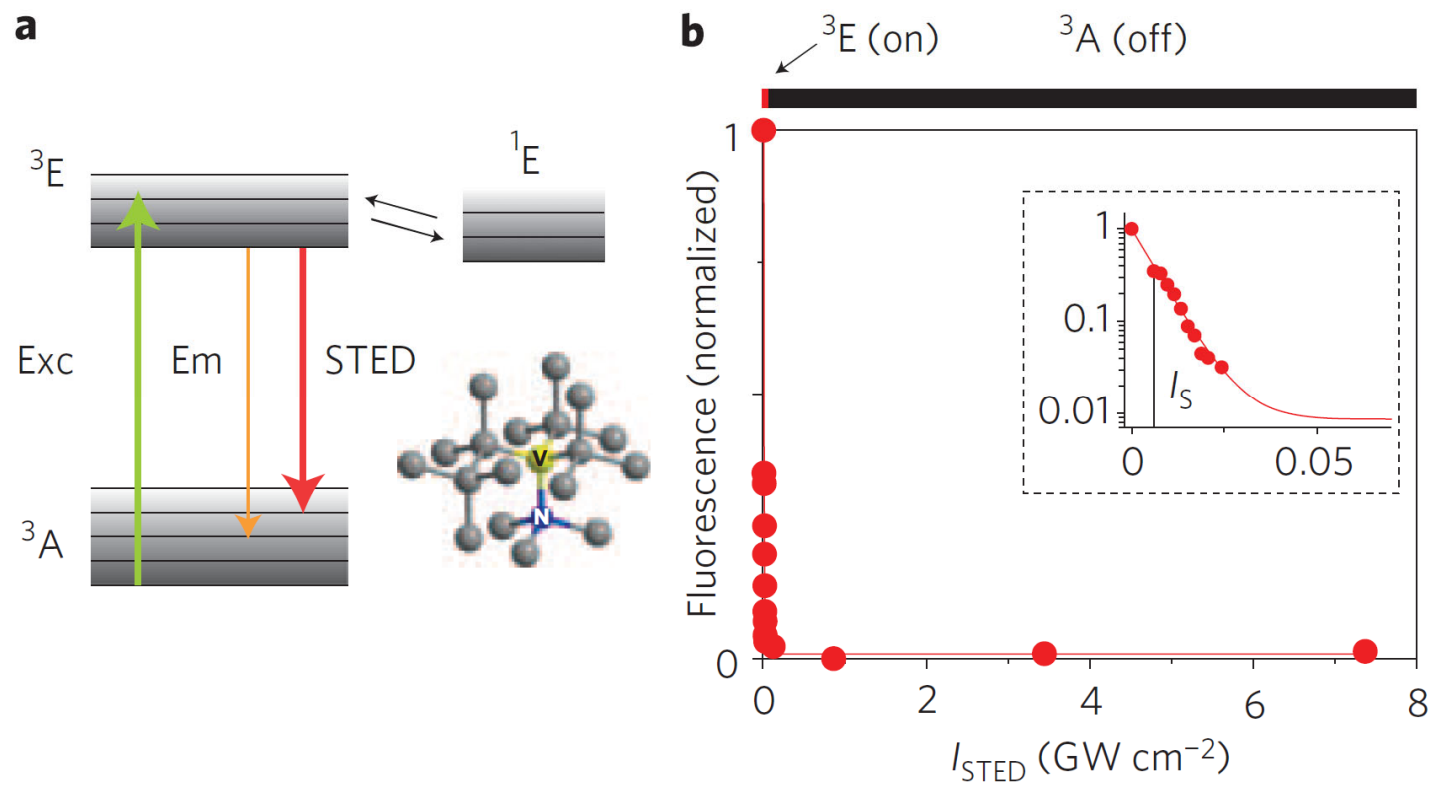
- What is a Nitrogen-Vacancy Defect?
- Fluorophore Properties
- Why Nitrogen-Vacancy Defects as fluorophores?
- Comparison between confocal and STED images
- Proof of no bleaching
- Maximizing the resolving power by optimizing STED in a single direction

What is a Nitrogen-Vacancy Defect?



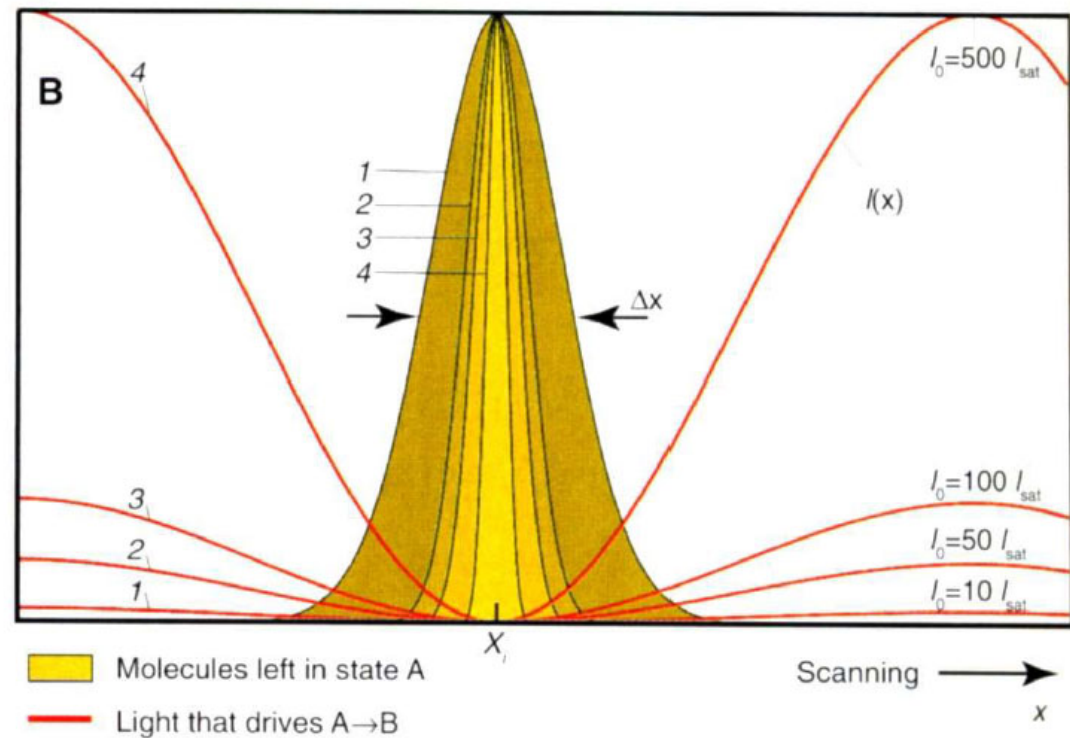
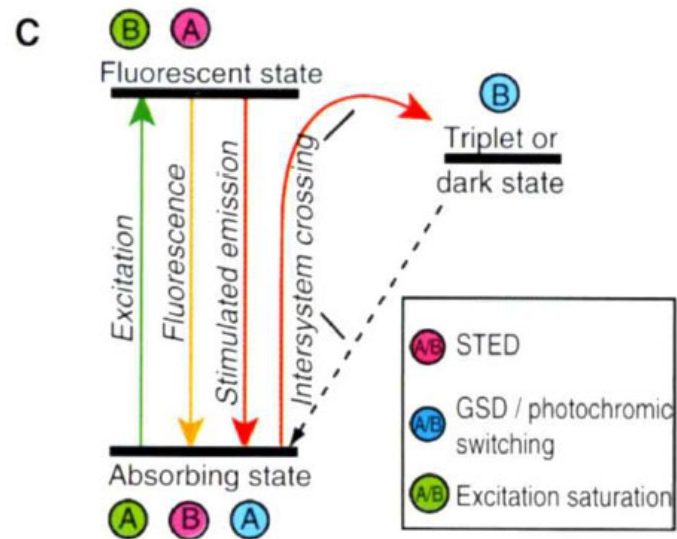
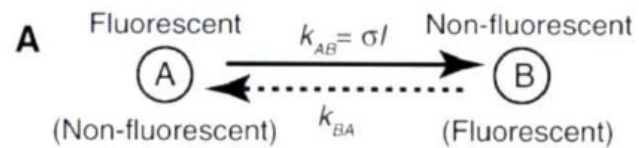
https://commons.wikimedia.org/wiki/File:Nitrogen-vacancy_center.png

Fluorophore Properties



Source: Rittweger et al.

Why Nitrogen-Vacancy defects as fluorophores?



Source: Lecture

Why Nitrogen-Vacancy defects as fluorophores?

- Resolution in STED is governed by

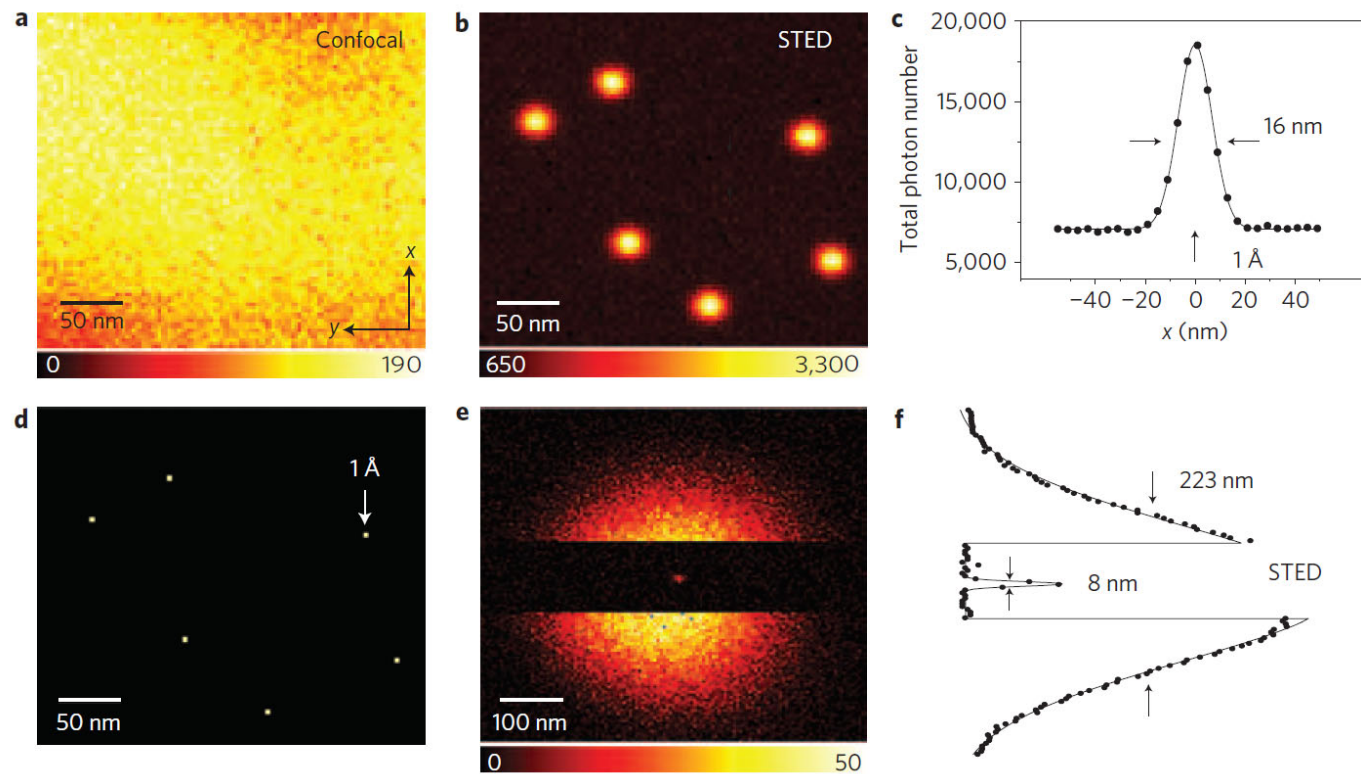
$$\Delta r \approx \frac{\lambda}{2n \sin \alpha \sqrt{1 + I_{max}/I_s}}$$

- Increasing I_{max} increases resolution

$$\frac{I_{max}}{I_s} \rightarrow \infty \leftrightarrow \Delta r \rightarrow 0$$

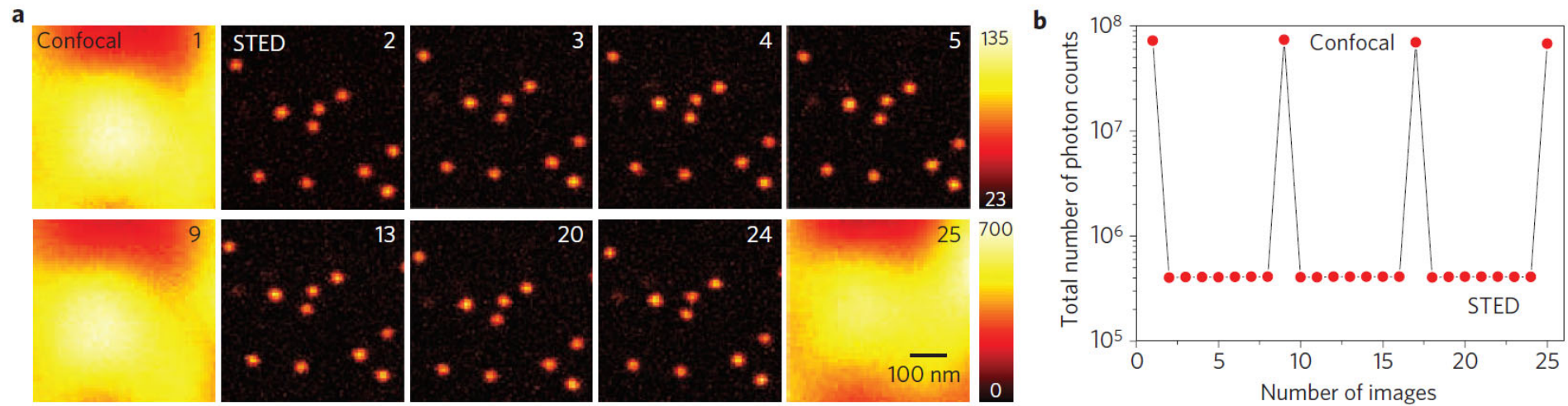
- Organic fluorophores bleach for high intensities
 - Nitrogen-Vacancies do not bleach
- They are ideal candidates for a fluorophore

Comparison between confocal and STED images



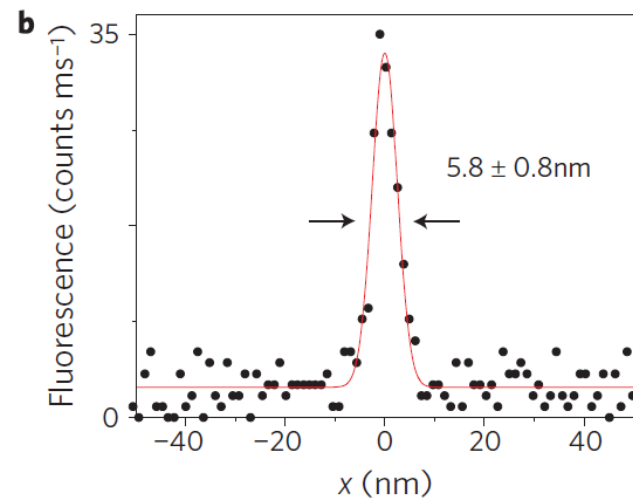
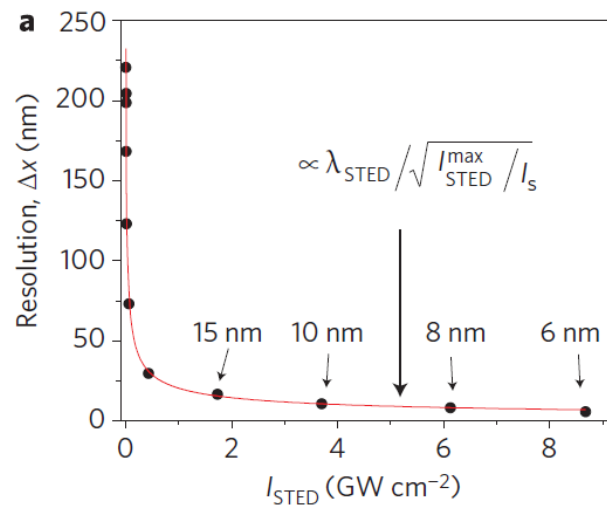
Source: Rittweger et al.

Proof of no bleaching



Source: Rittweger et al.

Maximizing the resolving power by optimizing STED in a single direction



Source: Rittweger et al.

Sources

- Dr. Nabers Lecture
- Rittweger et al.: STED microscopy reveals crystal colour centres with nanometric resolution (PUBLISHED ONLINE: 22 FEBRUARY 2009; DOI: 10.1038/NPHOTON.2009.2)
- Hell, et al.: Far-Field Optical Nanoscopy (Science 316, 1153 (2007); DOI: 10.1126/science.1137395)
- Wikipedia contributors. 2023. Nitrogen-vacancy center — Wikipedia, The Free Encyclopedia. https://en.wikipedia.org/wiki/Nitrogen-vacancy_center. [Online; accessed 10-February-2023]