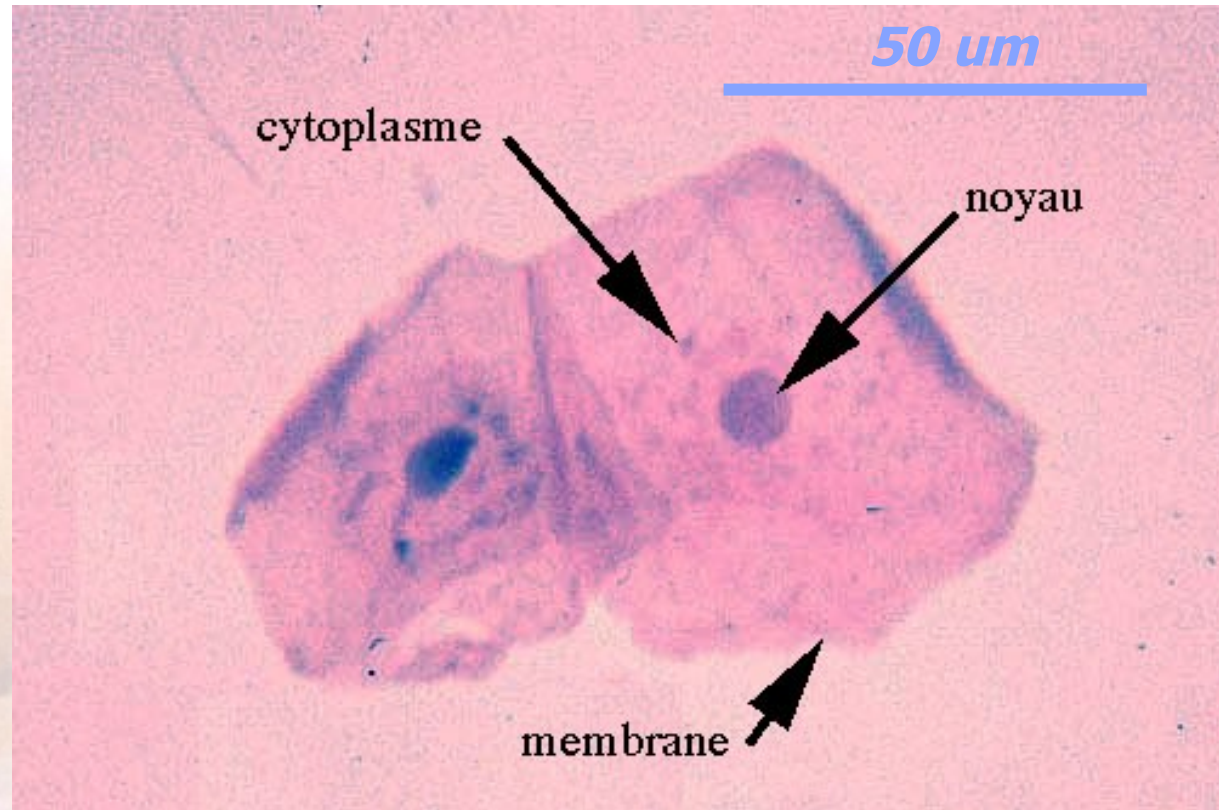
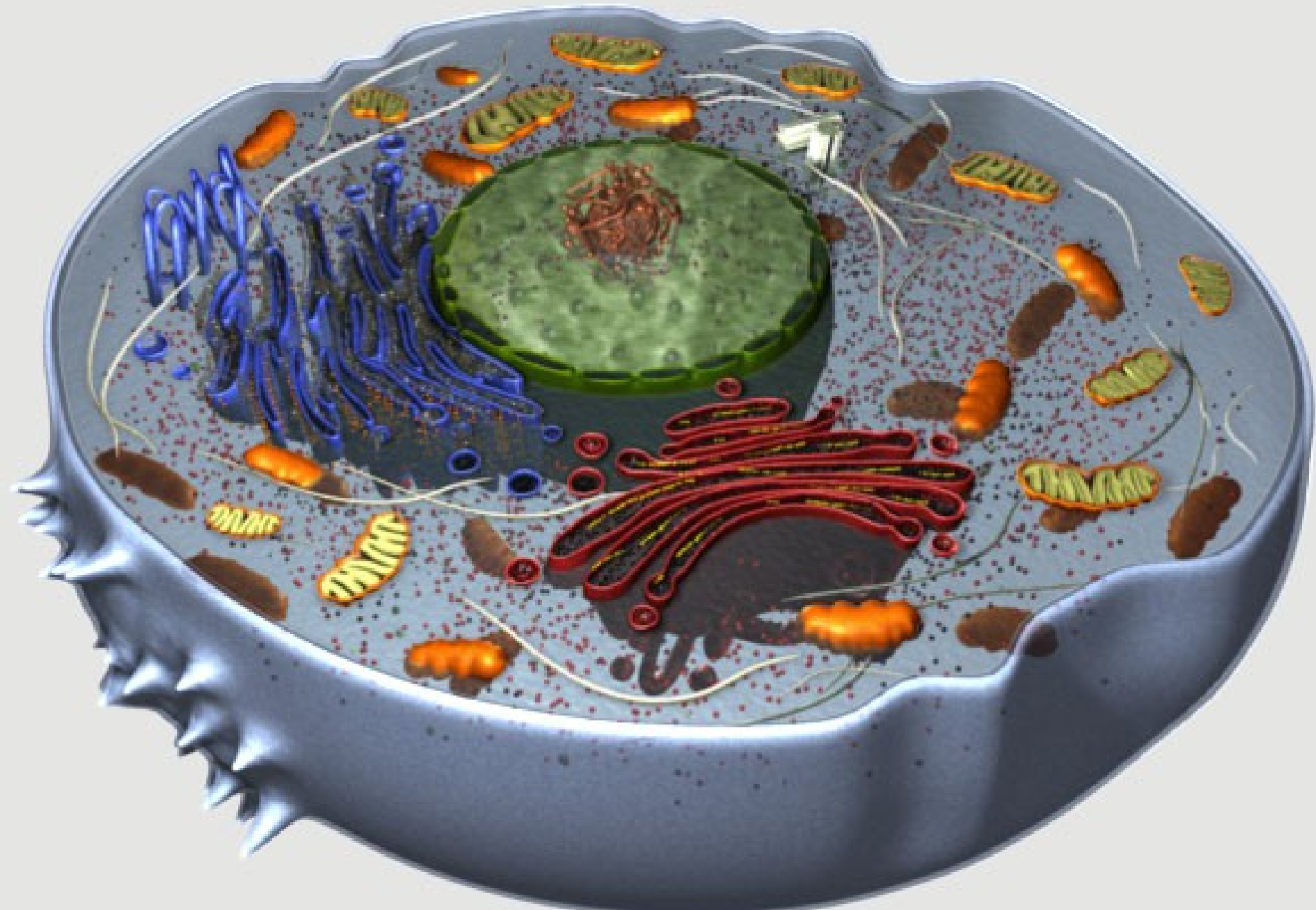
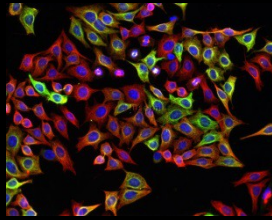


La microscopie super résolution

La microscopie optique

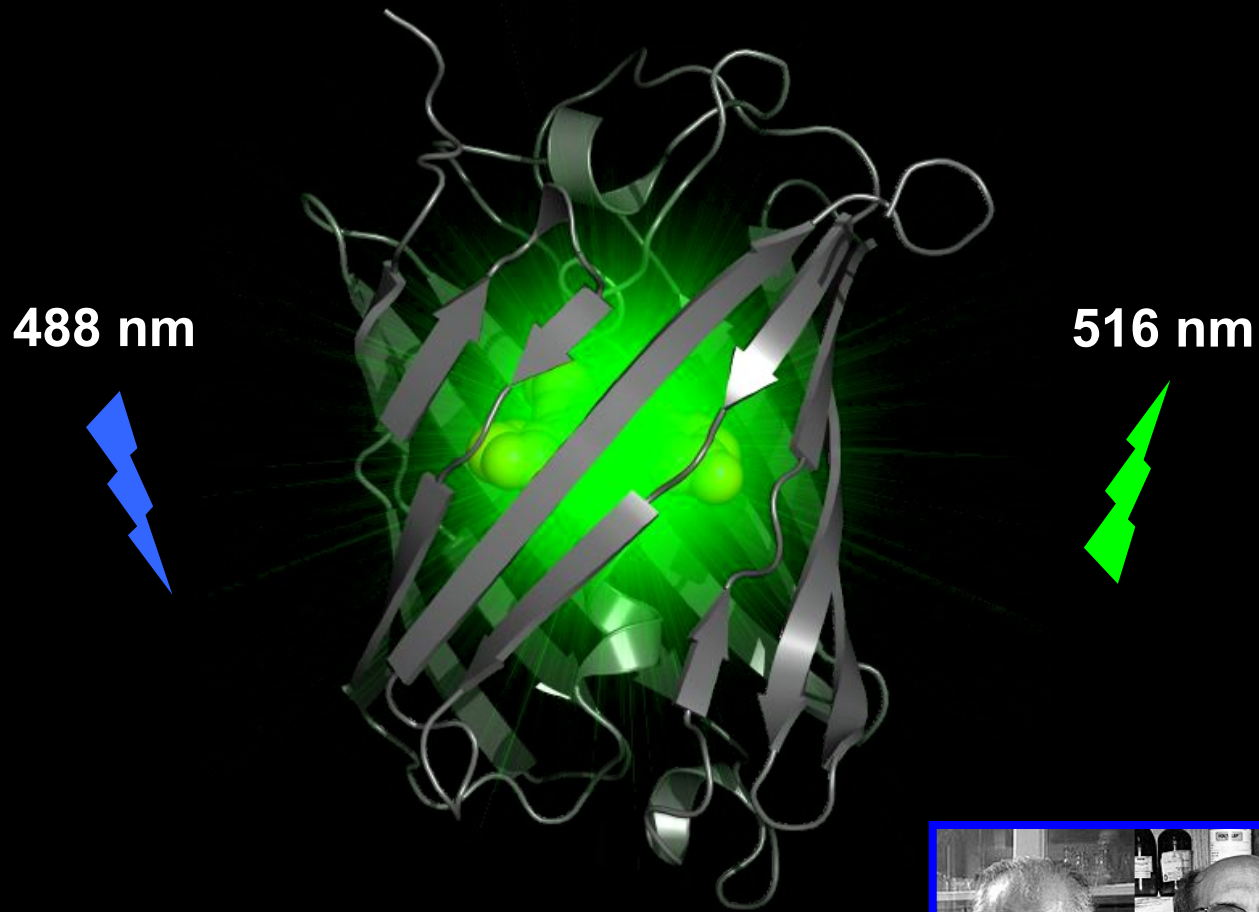


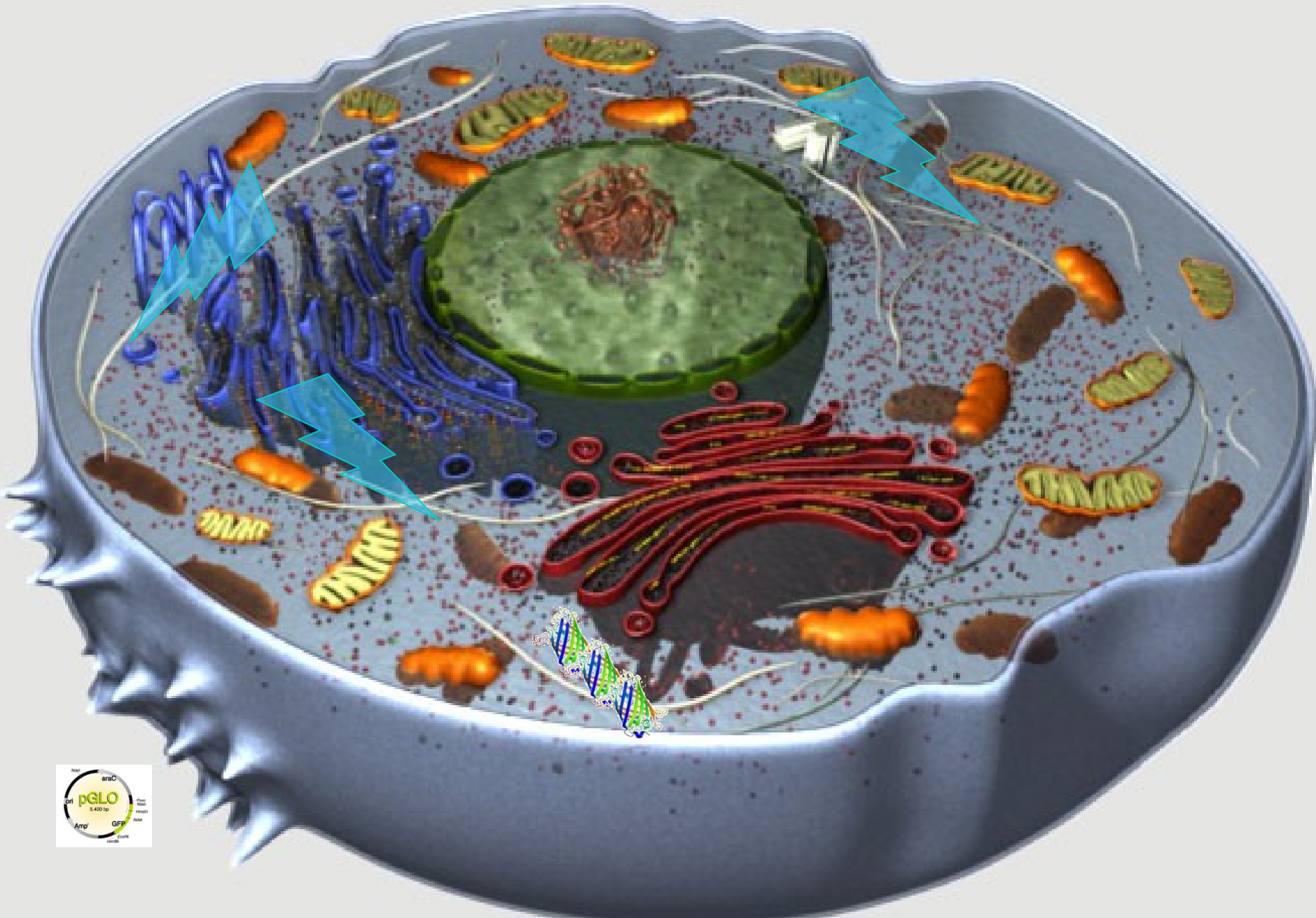


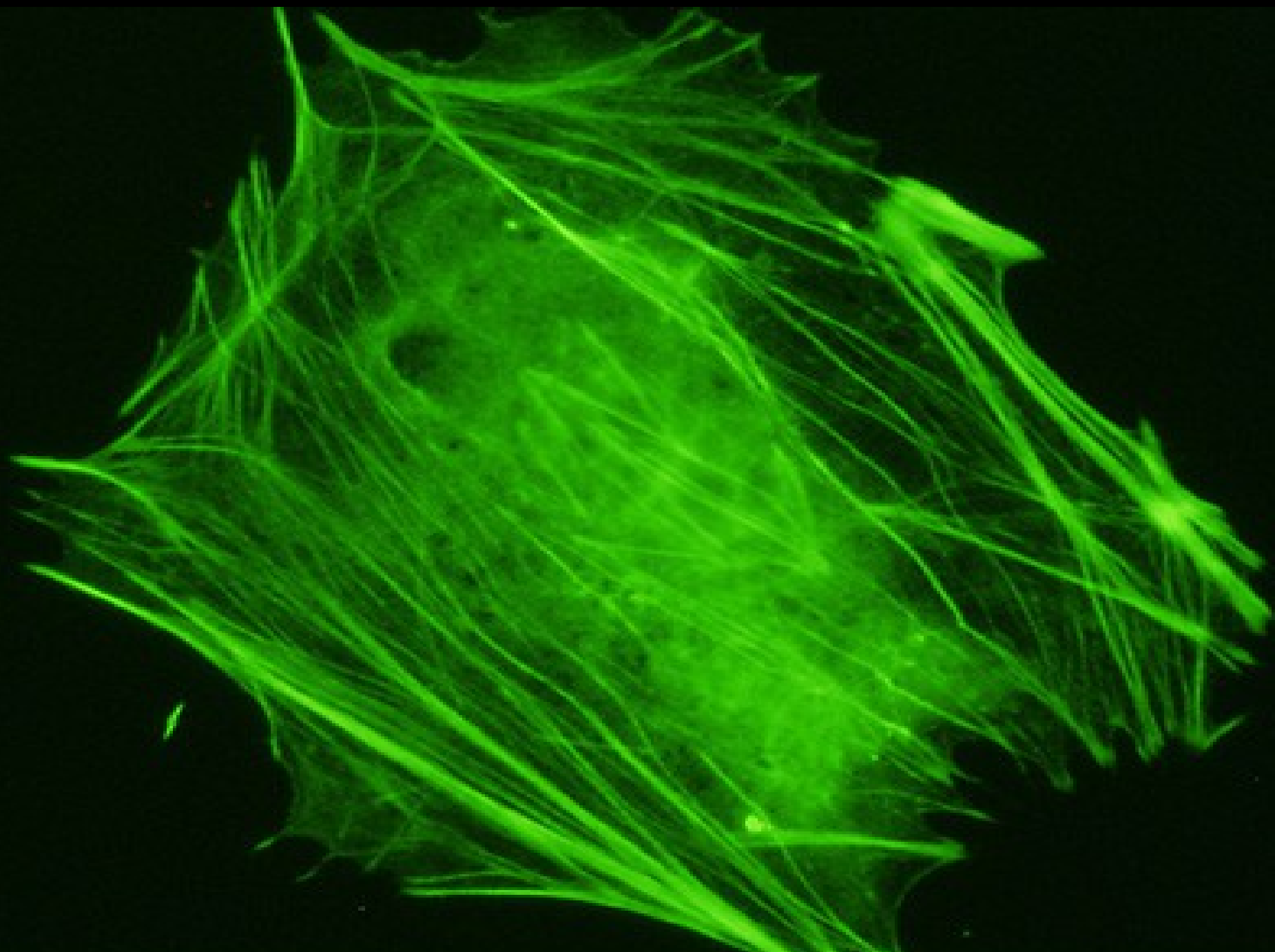




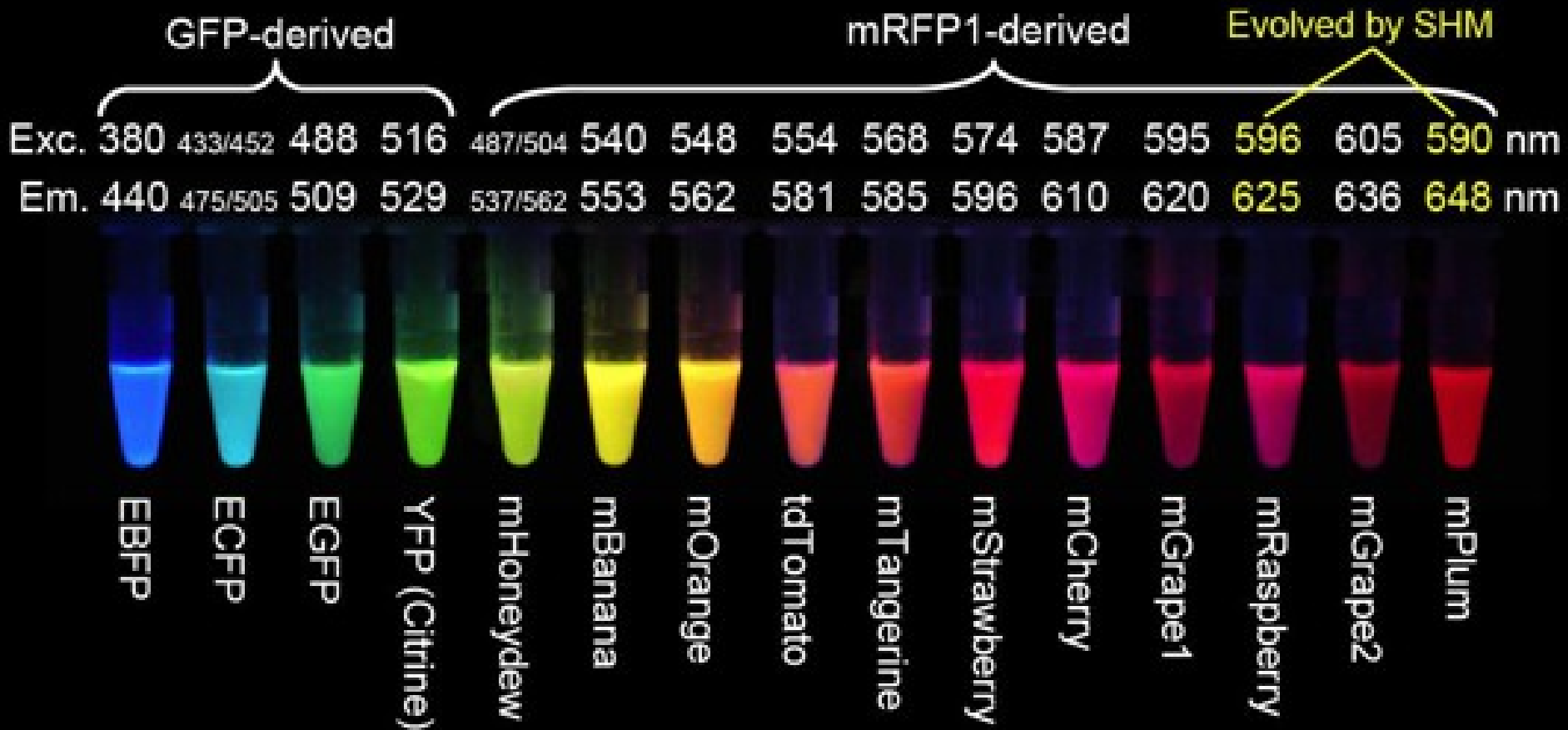
La protéine fluorescente verte (GFP)

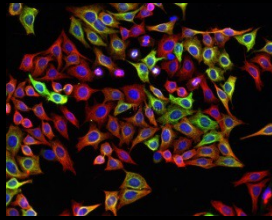






Protéines fluorescentes



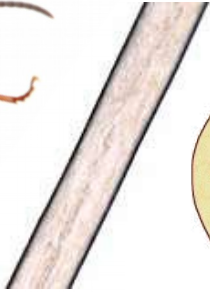


Fourmi



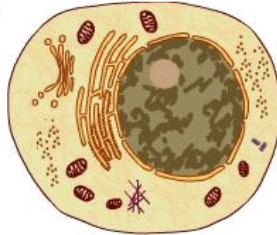
1 mm

Cheveu



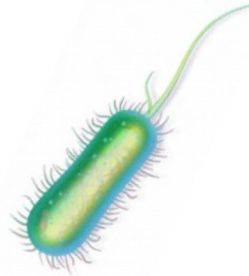
100µm

Cellule



10µm

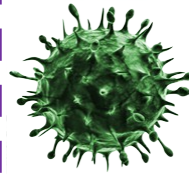
Bactérie



1µm

Limite de diffraction

Virus



100 nm

Protéine



10 nm

Petite molécule

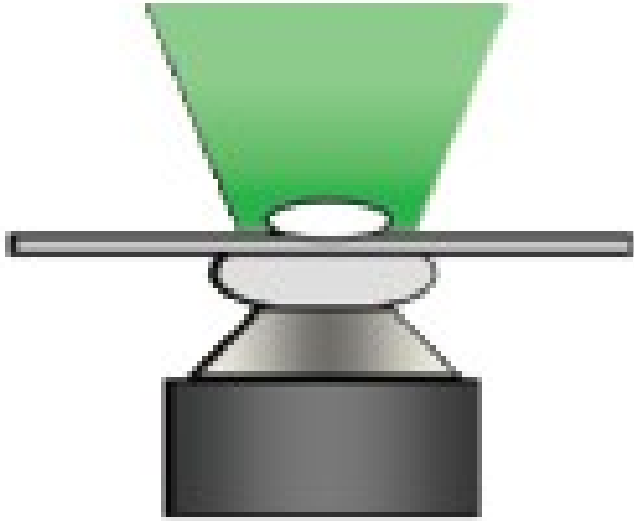


1nm

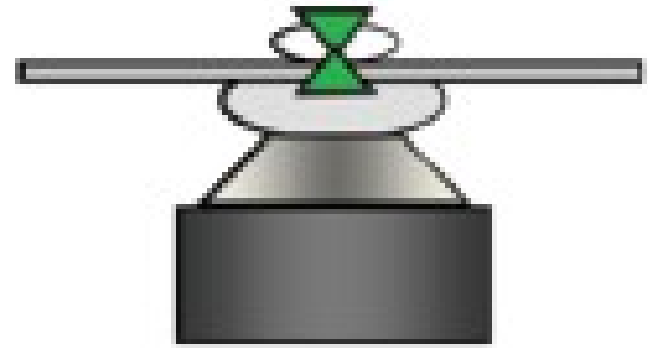
La limite de diffraction



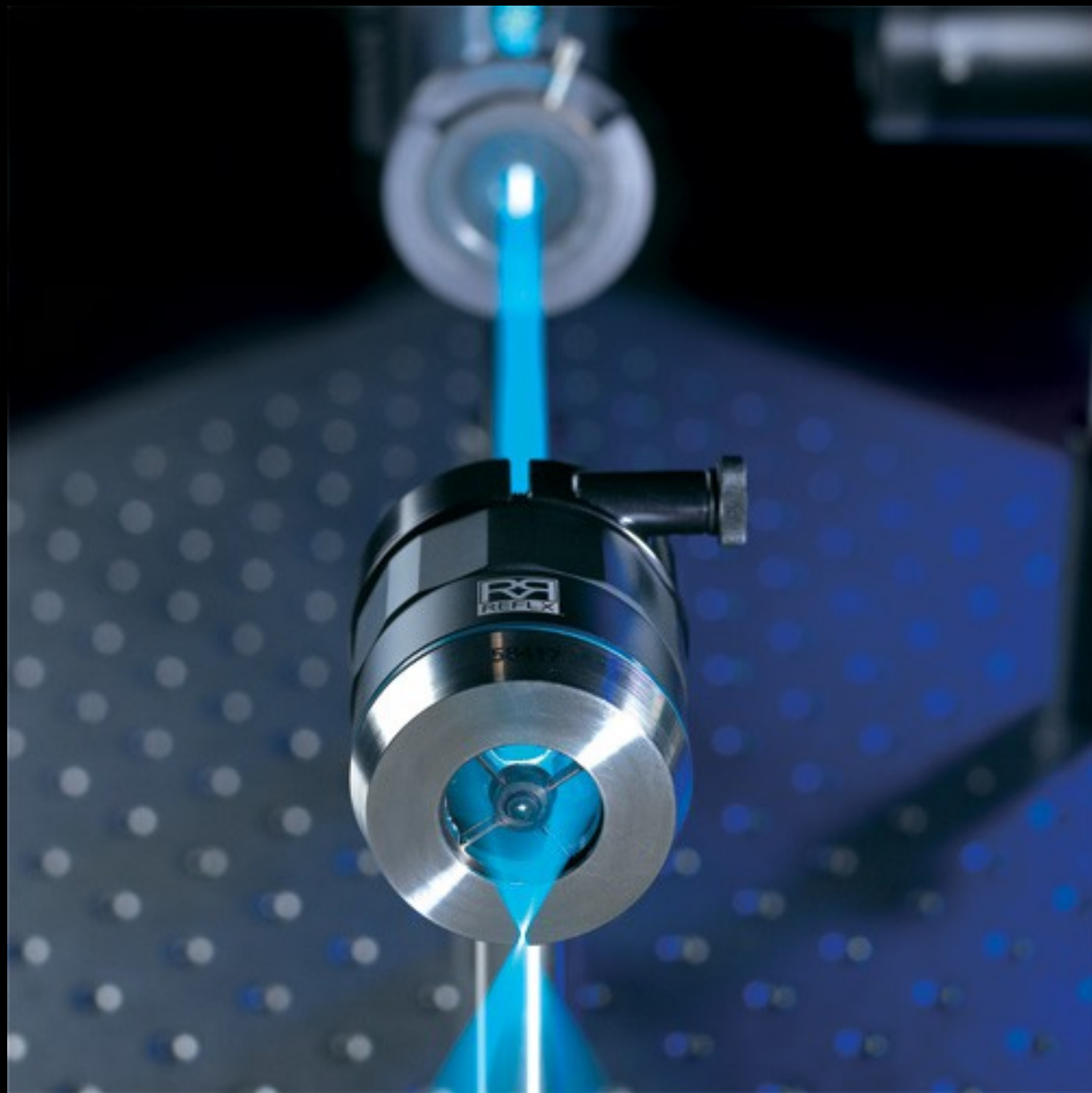
Imagerie en champ large et imagerie confocale



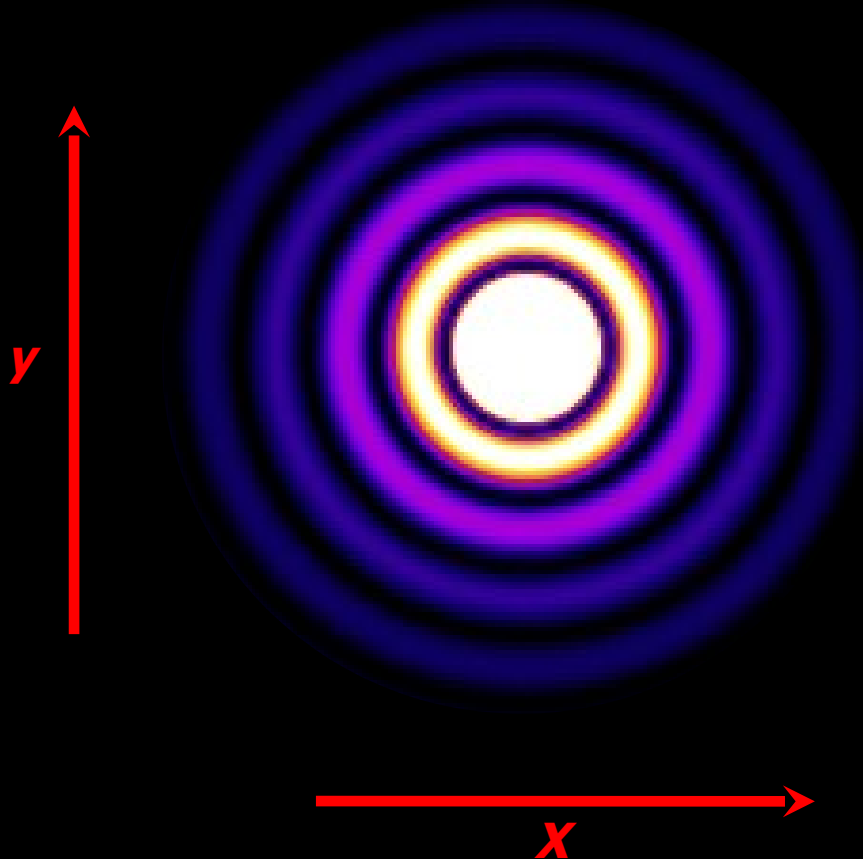
Champ large



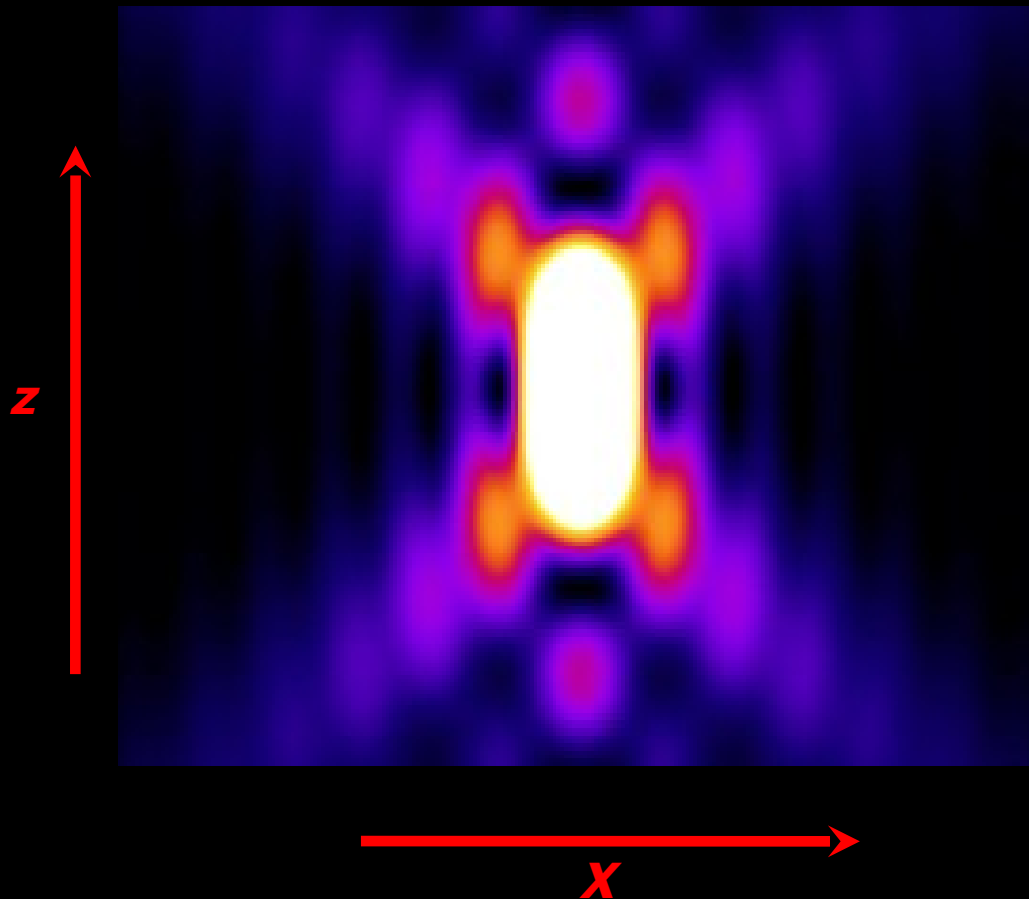
Balayage laser



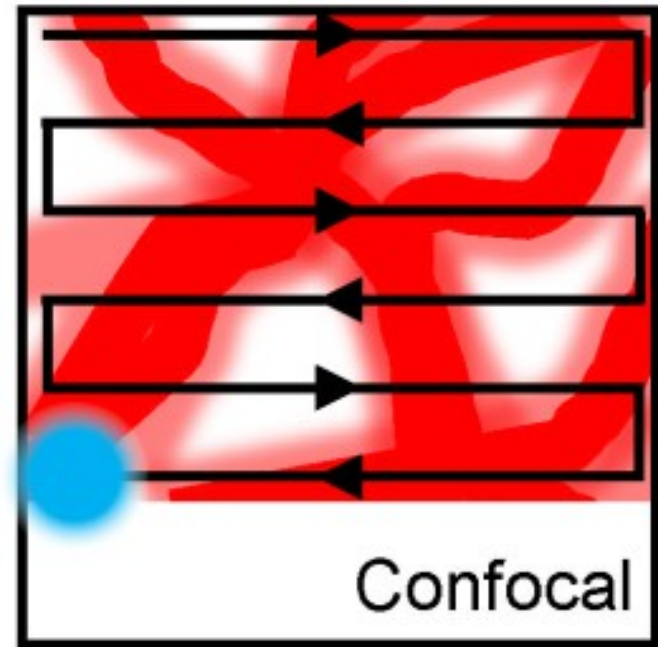
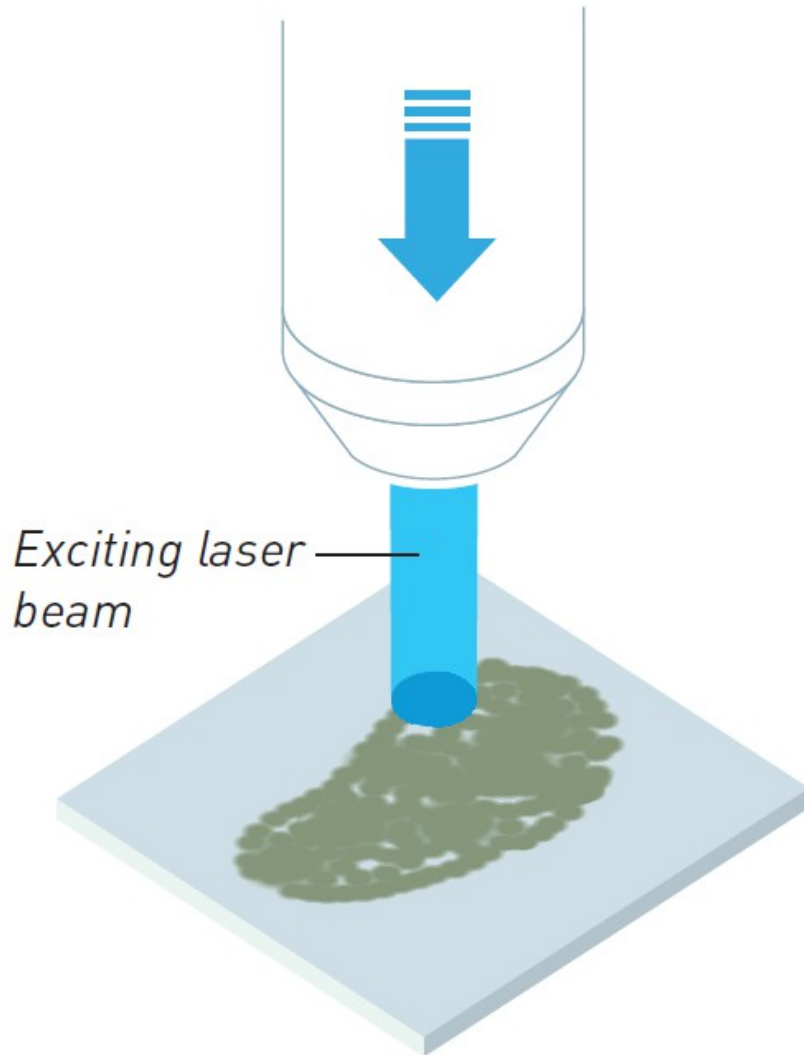
La PSF (point spread function)



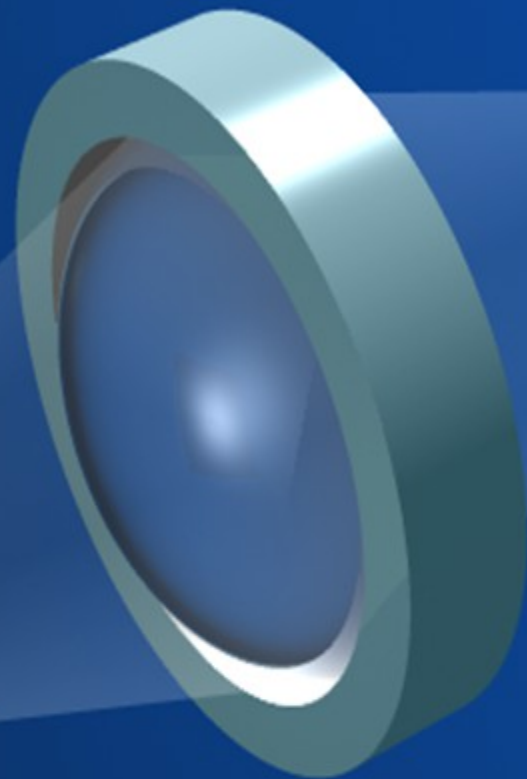
La PSF (point spread function)



Imagerie confocale



POINT SOURCE



PSF

Systeme Optique

Resolution limit

Unresolved

Resolved

Airy disks

Airy patterns

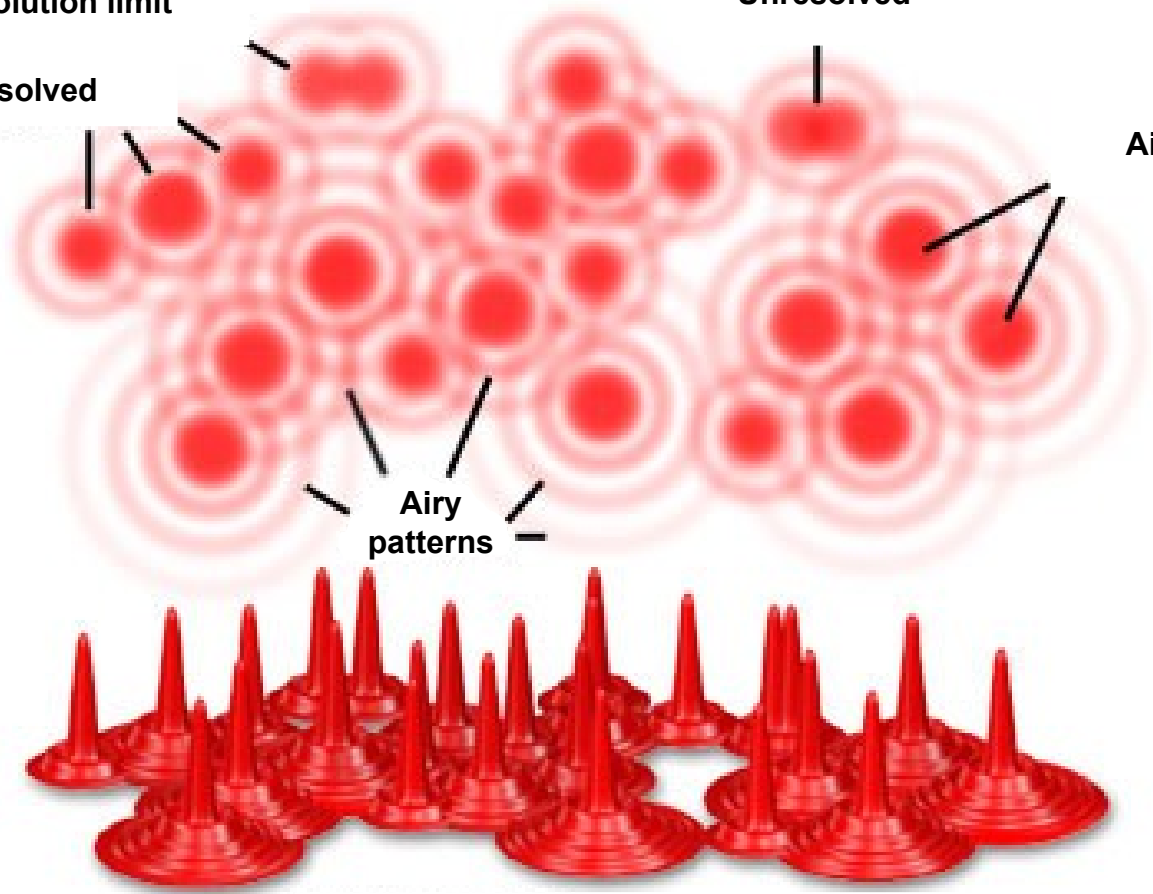
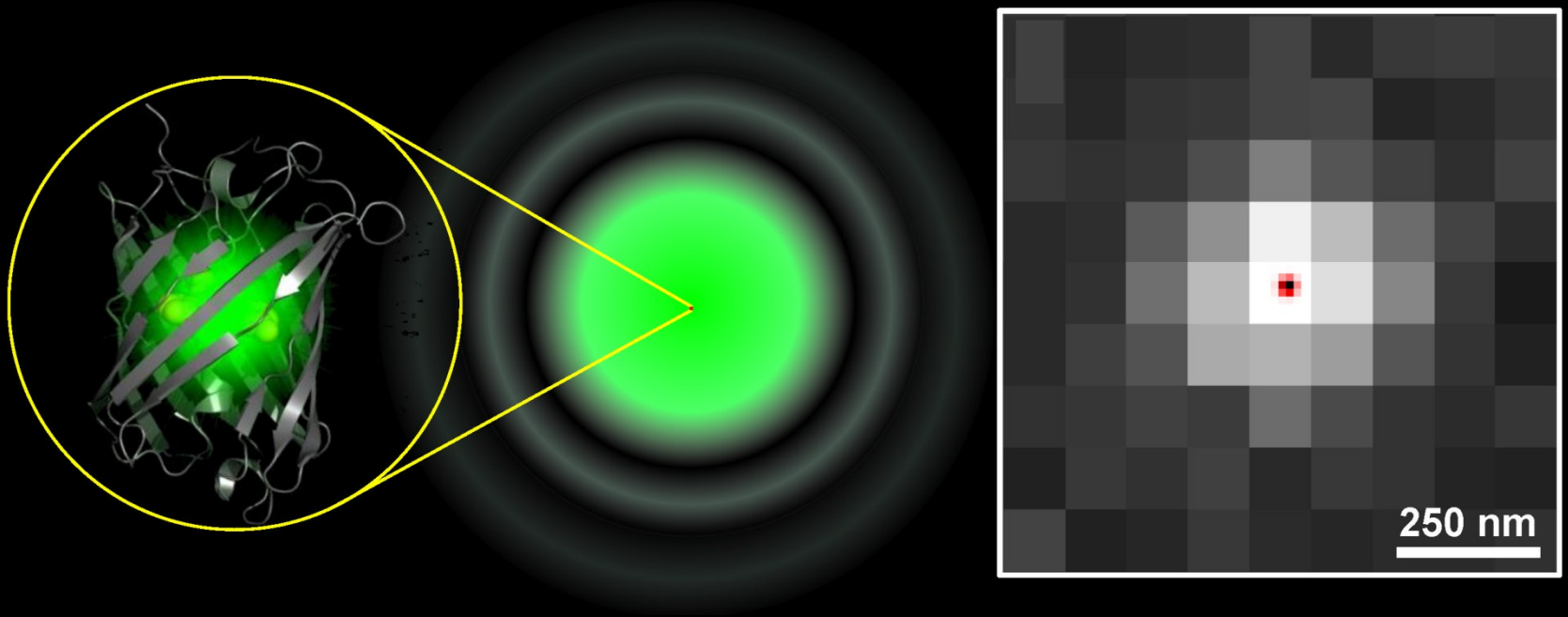


Image d'une molécule unique



Contourner la limite de diffraction ?



*Détection de
molécules
uniques*

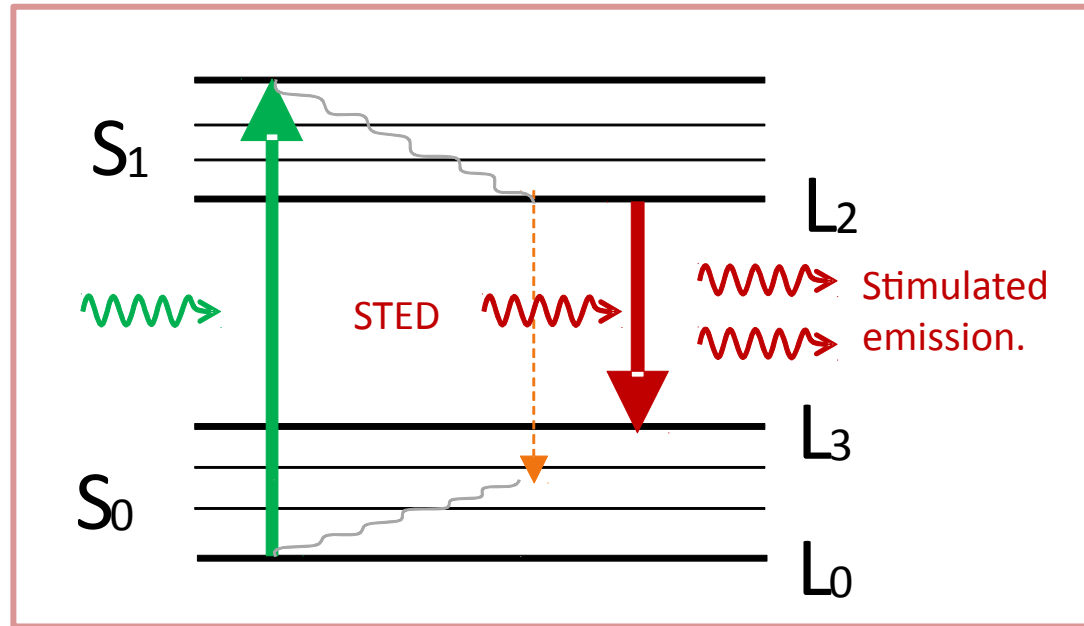


*Confocal :
réduire la PSF
en excitation*

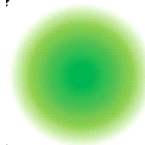


*Champ large :
réduire la PSF
en emission*

STED Microscopy (STimulated Emission Depletion)



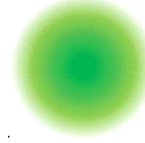
Excitation



Fluorescence

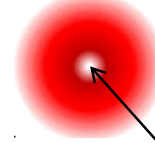


Excitation



STED

+

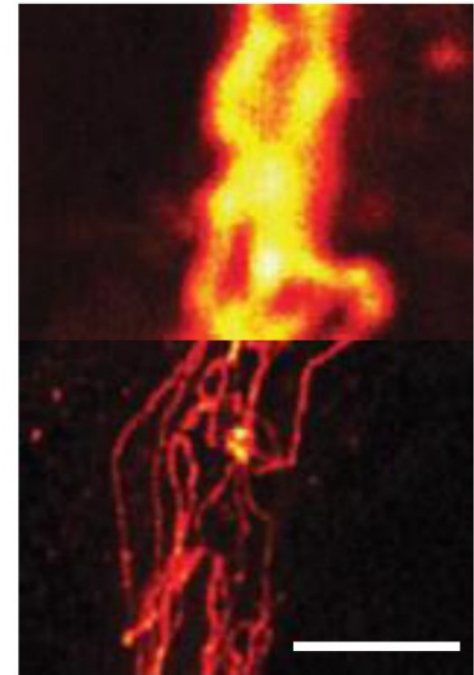
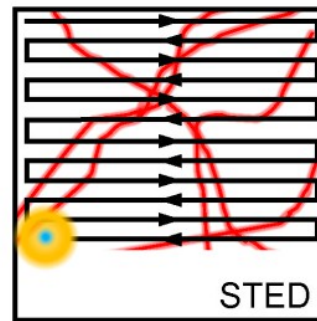
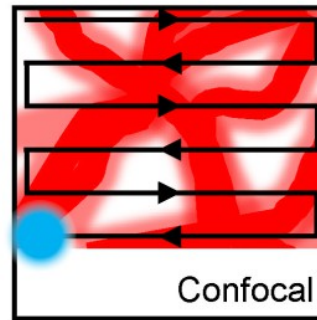
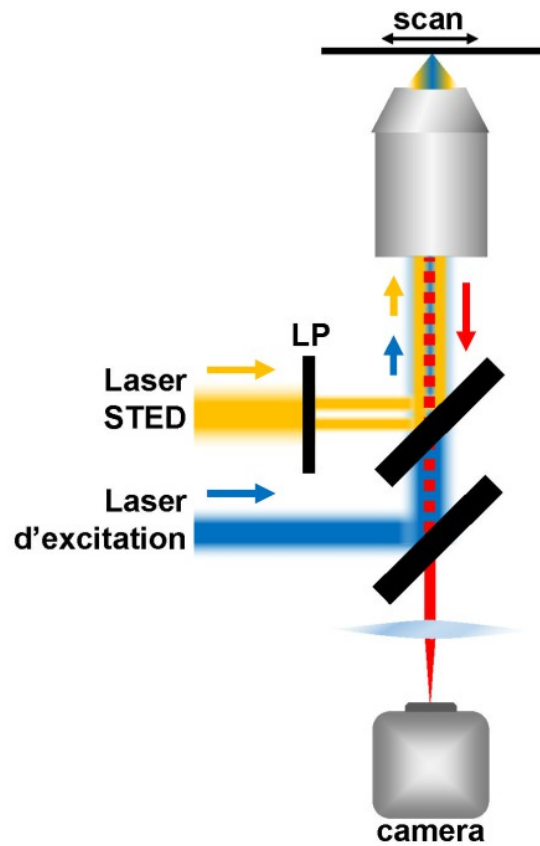


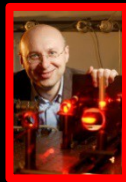
Fluorescence



Zero intensity

STED Microscopy (technique confocale)

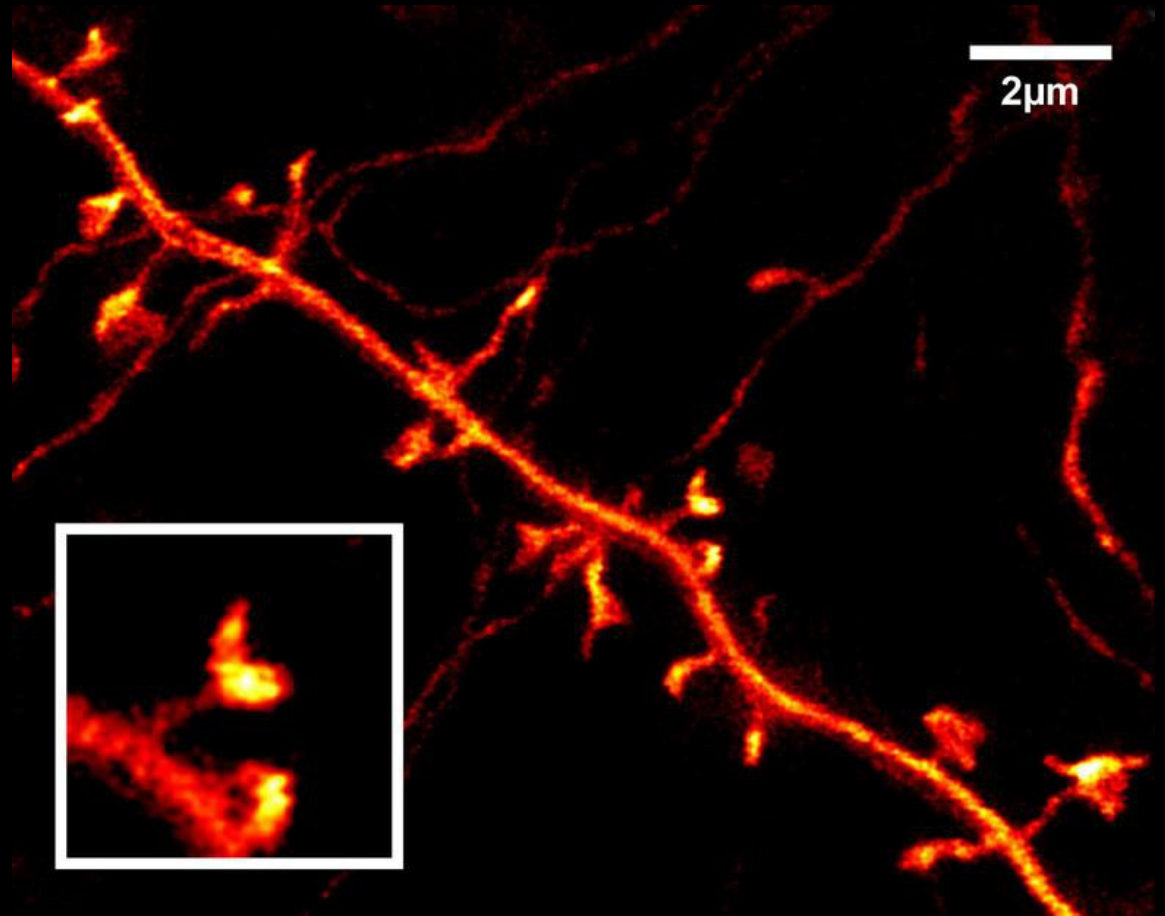


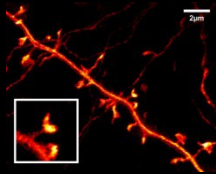




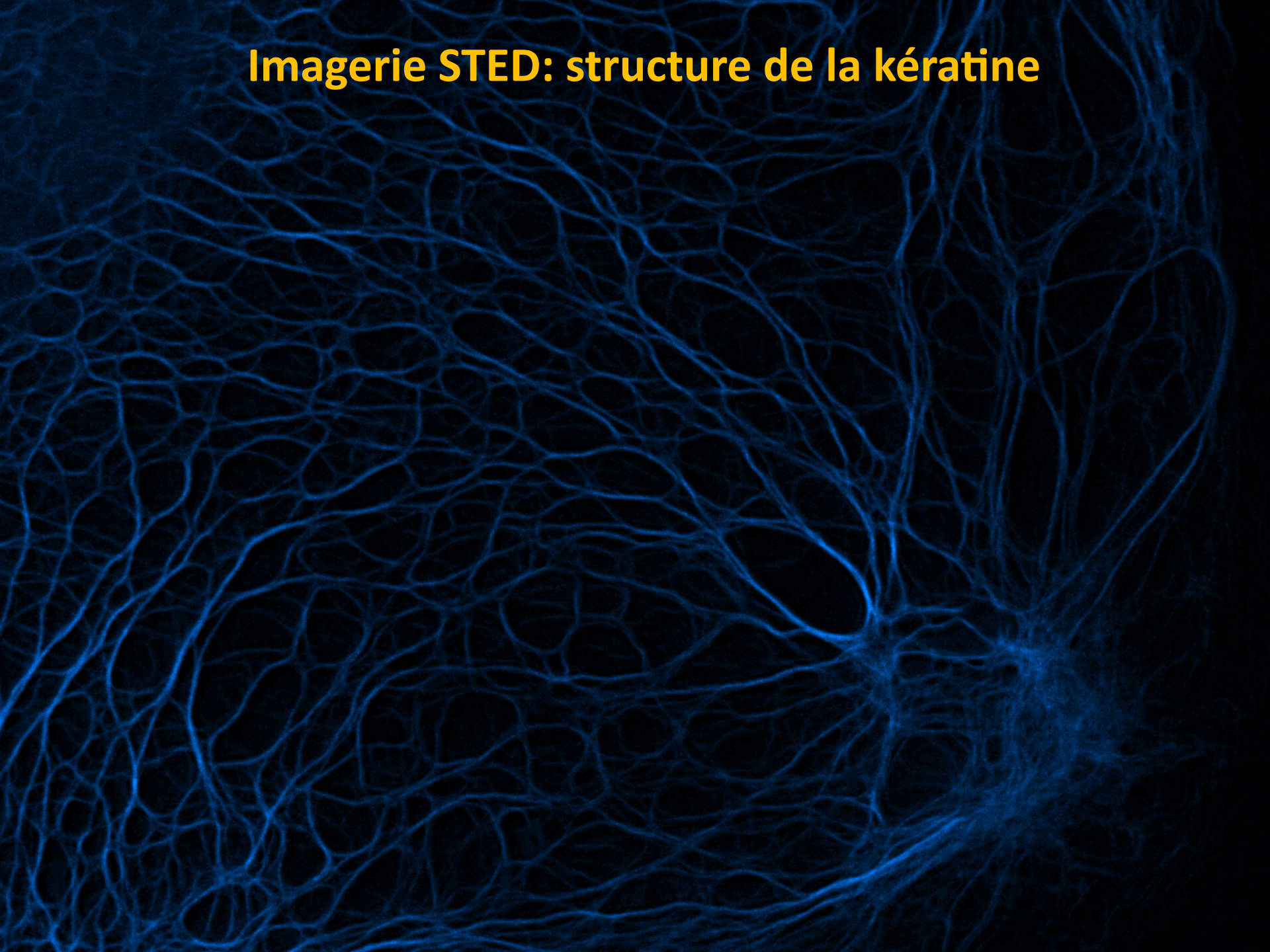
Franklin
Wasson '14

Imagerie STED d'un neurone sur une souris vivante

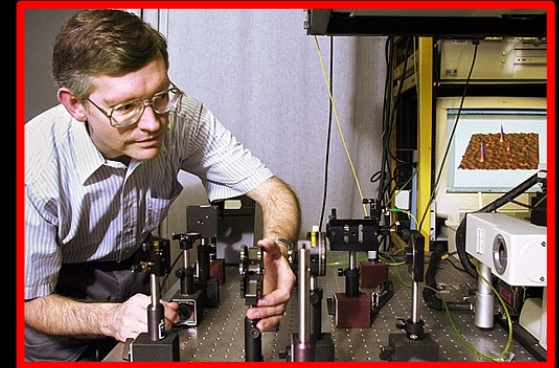
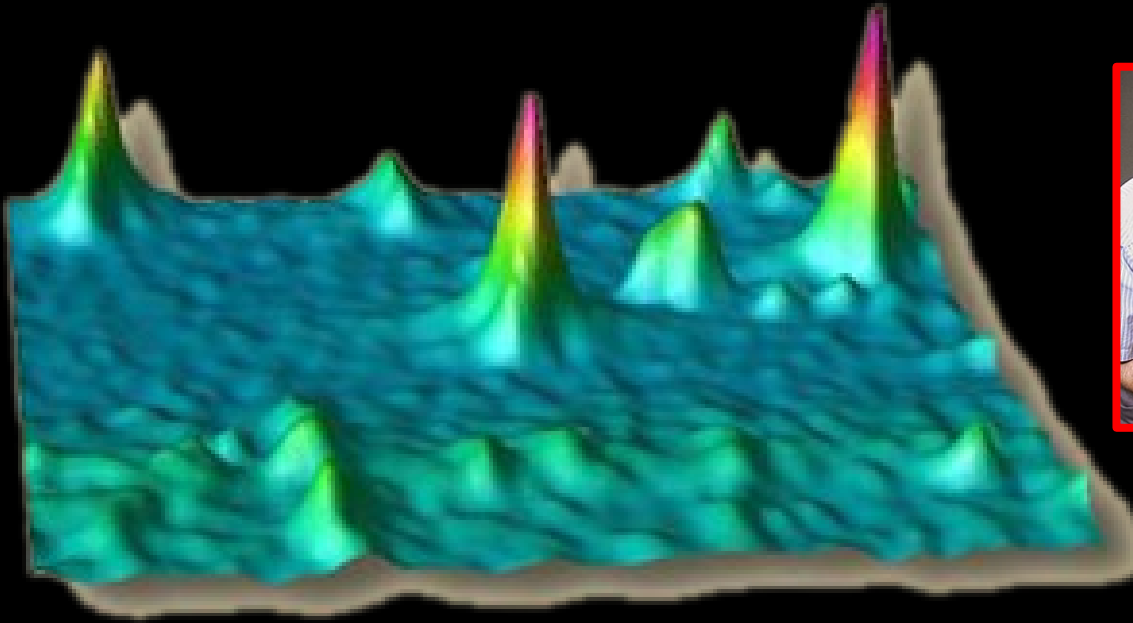




Imagerie STED: structure de la kératine



Détecter une molécule unique ?



Nombre d'Avogadro: $6.02 \text{ E}+23$ molécules/mol

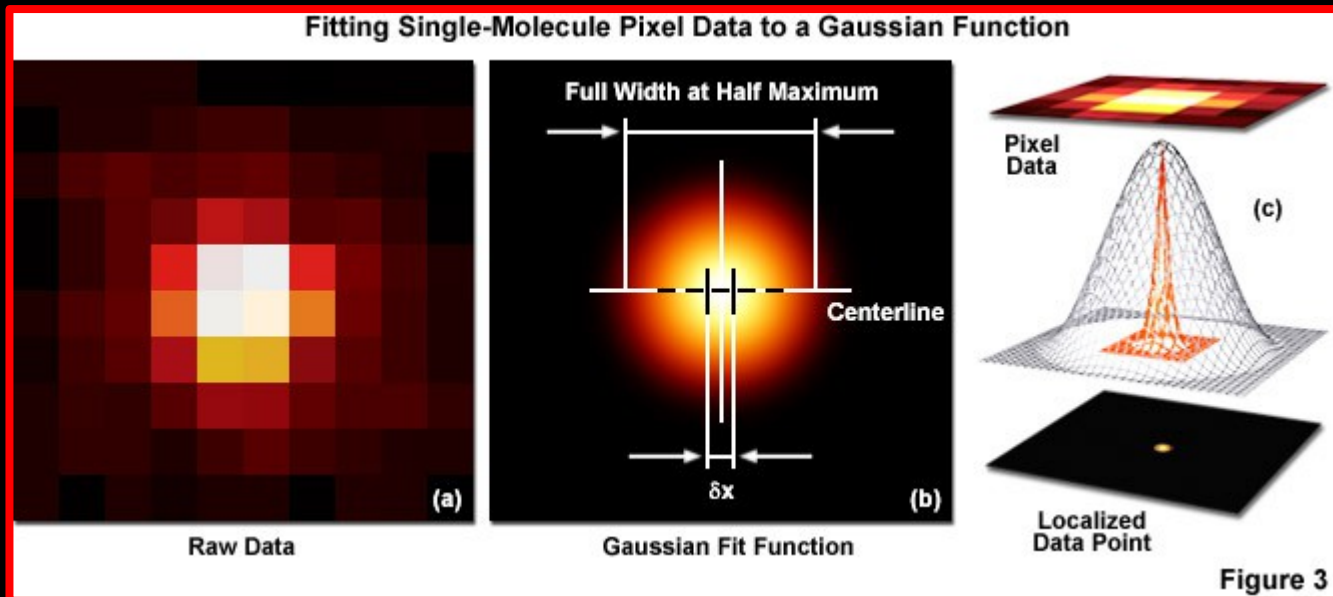
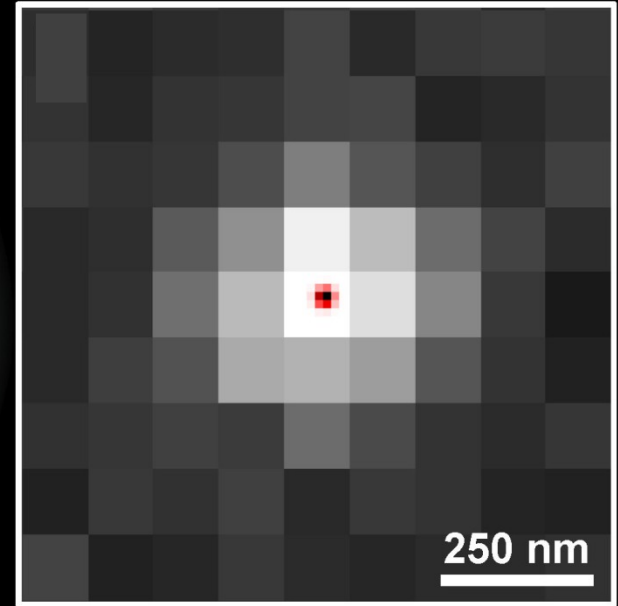
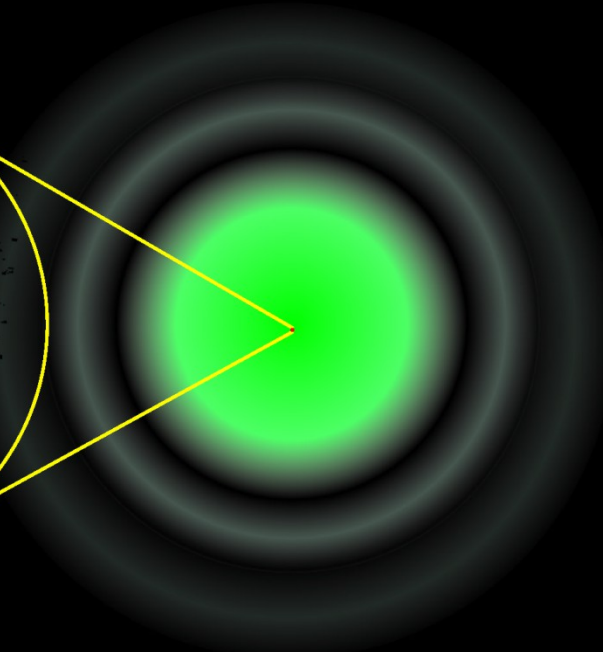
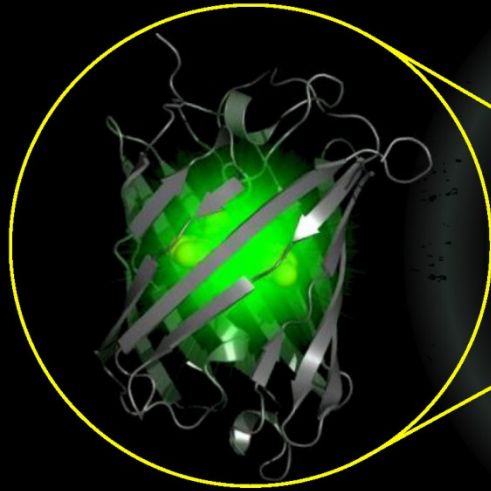
Nombre de protéines dans une bactérie: ~ 600000

1 pMol: $6.02 \text{ E}+11$ molécules

1 fMol: $6.02 \text{ E}+8$ molécules

1 guacamole = $1 / (\text{Avocado's Number})$ of moles.

Super-localisation d'une molécule unique

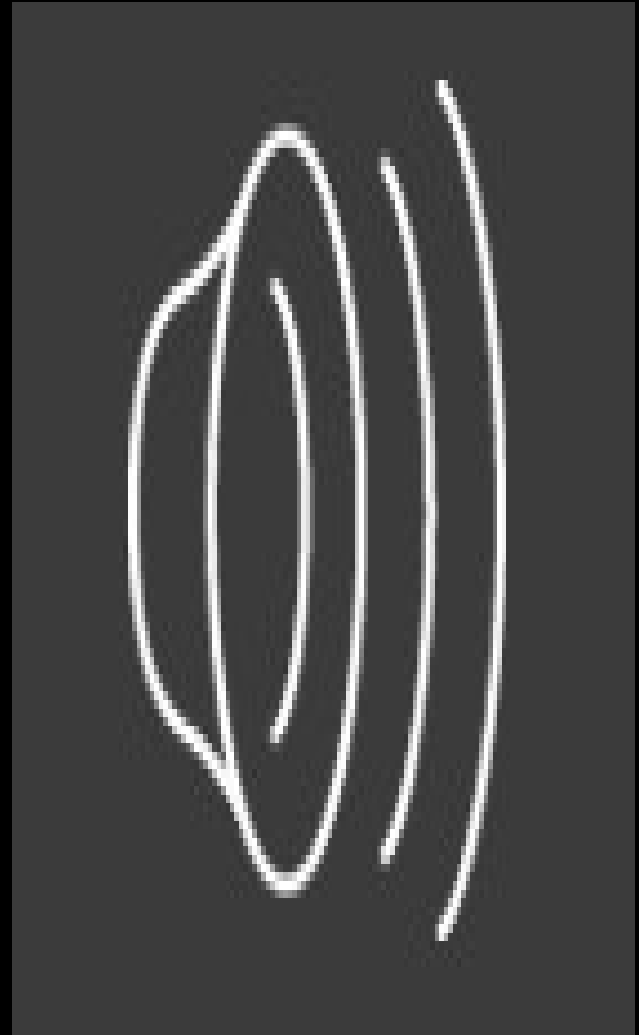
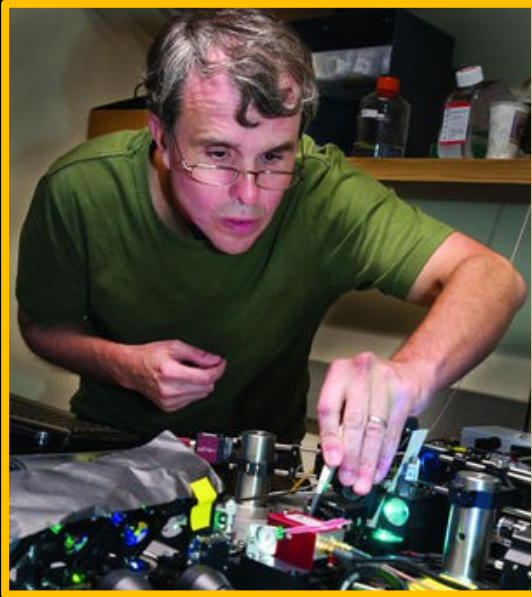




Photoconvertible fluorescent proteins



PALM: Photo-Activated Localization Microscopy



Reconstruction PALM de la tour Eiffel

Eiffel



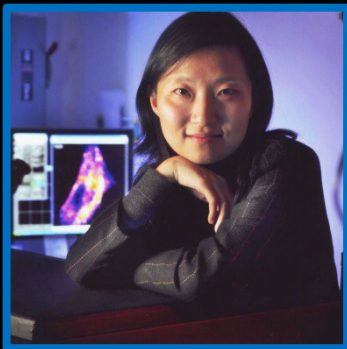
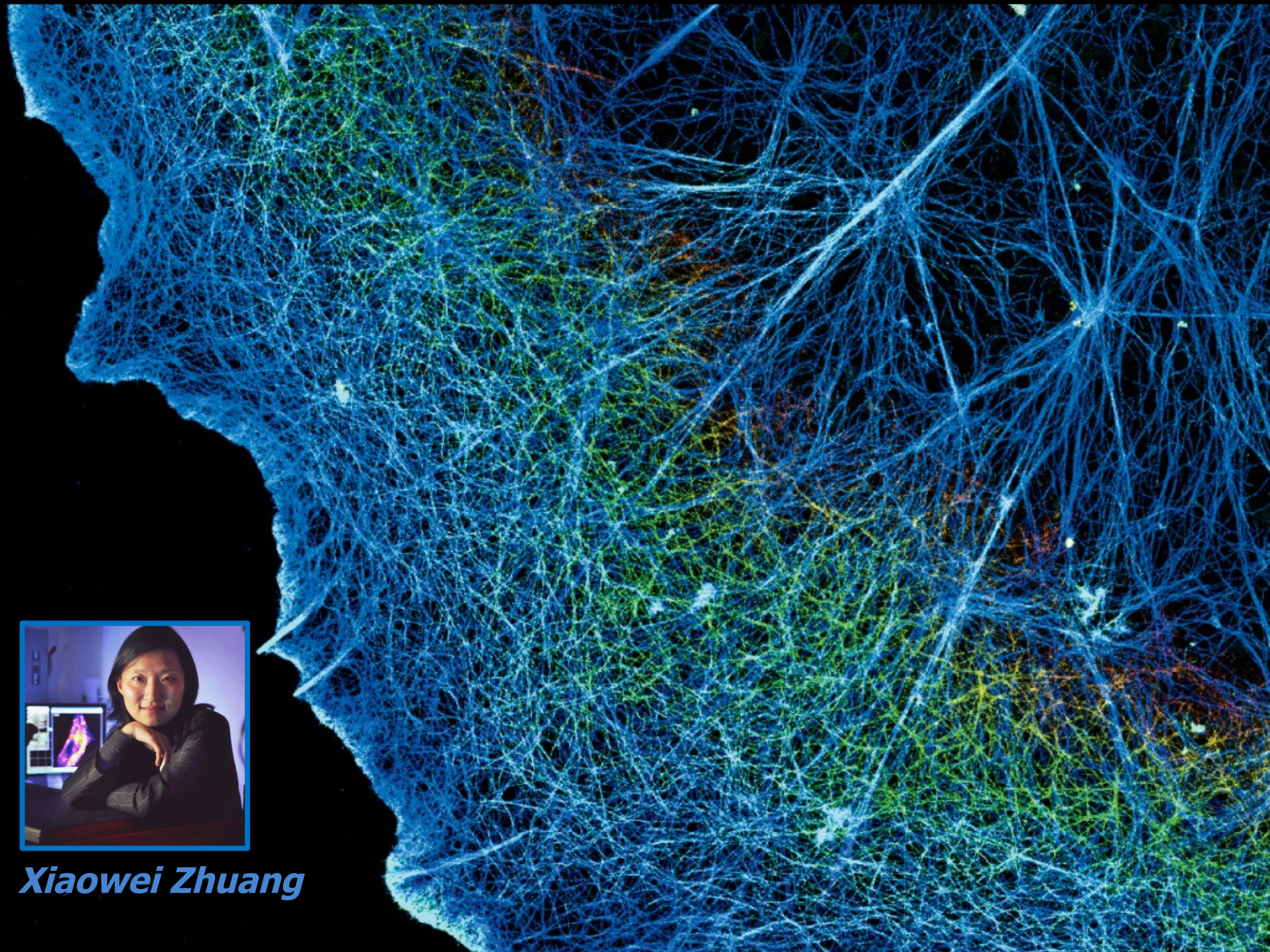
Original Image



Particle Detection



Reconstruction



Xiaowei Zhuang

