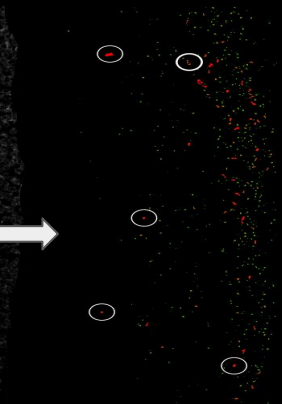
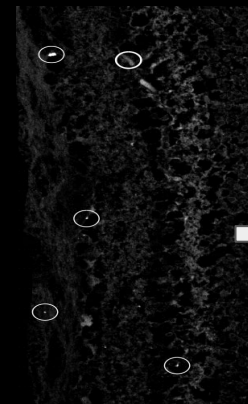
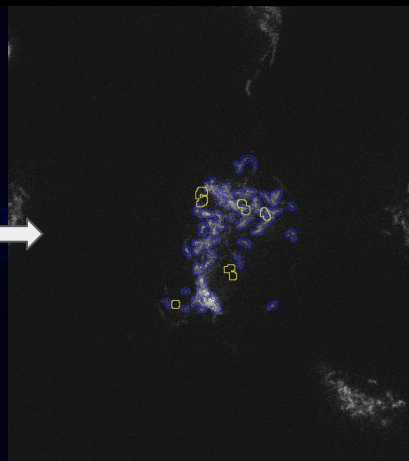
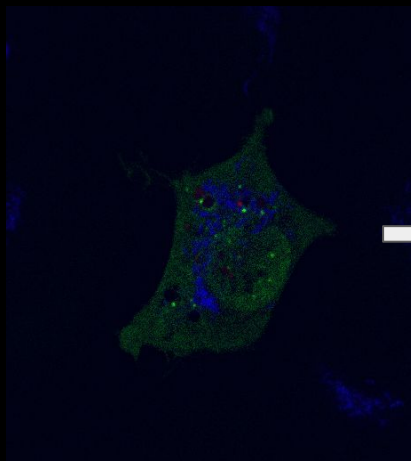
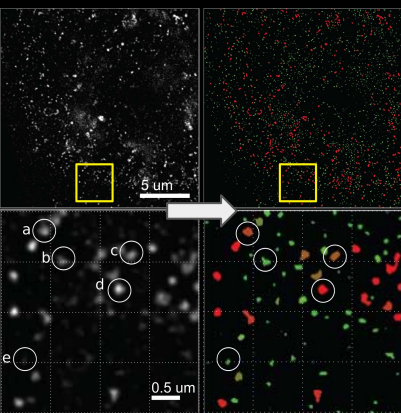
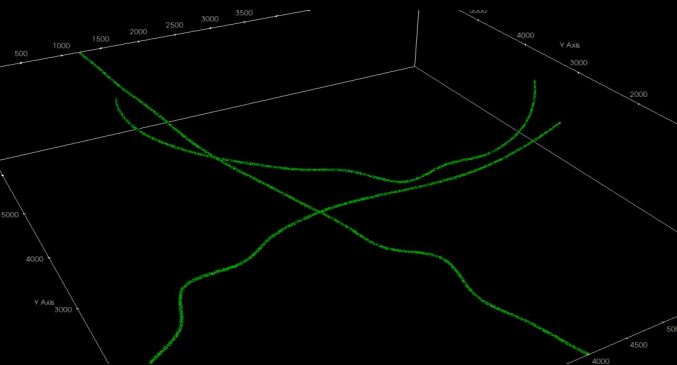


## Learning to look *beyond* what we can see

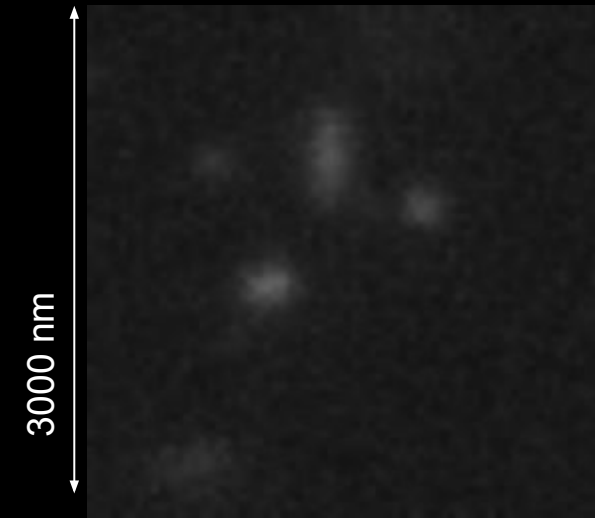
Leveraging statistical learning to improve scientific discovery from fluorescence microscopy

Ben Cardoen

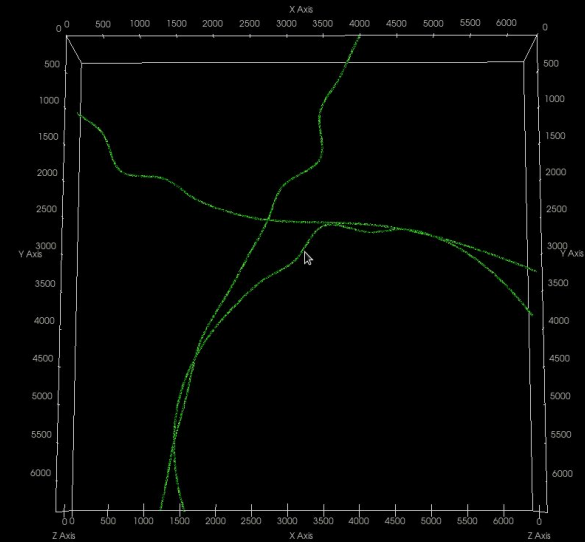


# Reducing false positives and false negatives in 3D single molecule localization microscopy (SMLM).

SMLM : 2D image sequence to 3D point cloud



2D acquisition

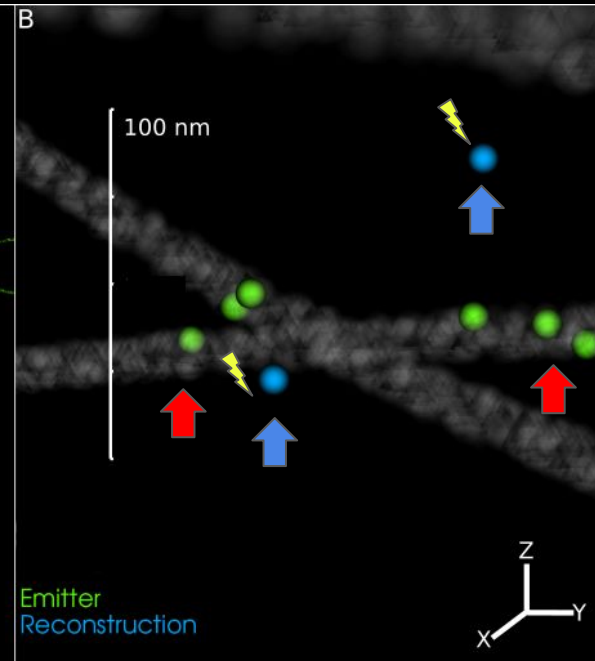
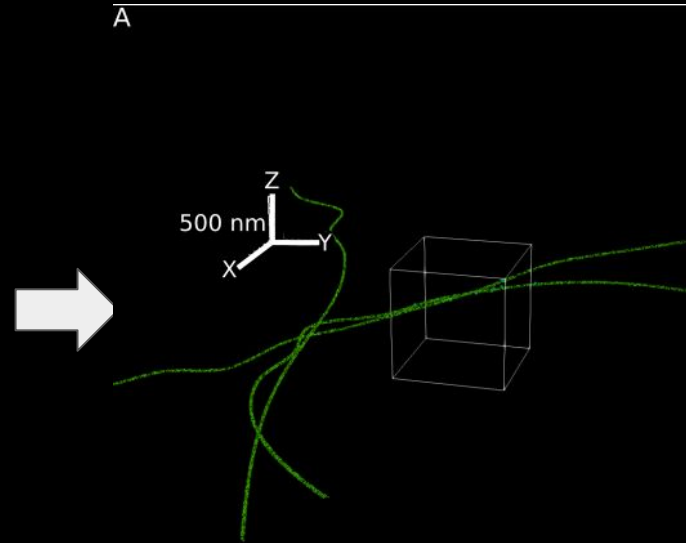
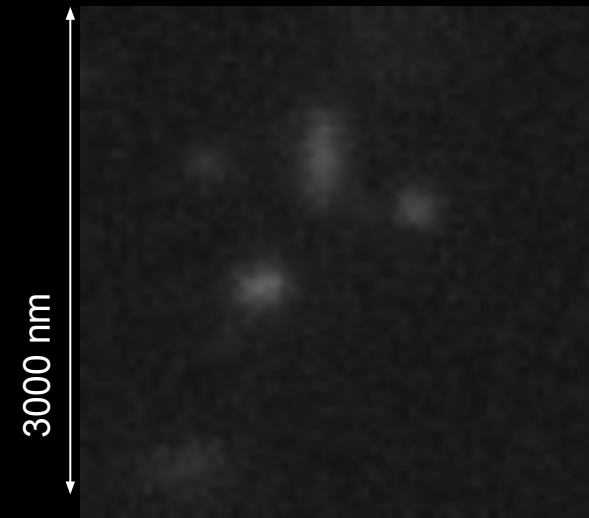


3D labelled microtubules, ~ 100nm diameter.

# Reducing false positives and false negatives in 3D single molecule localization microscopy (SMLM).

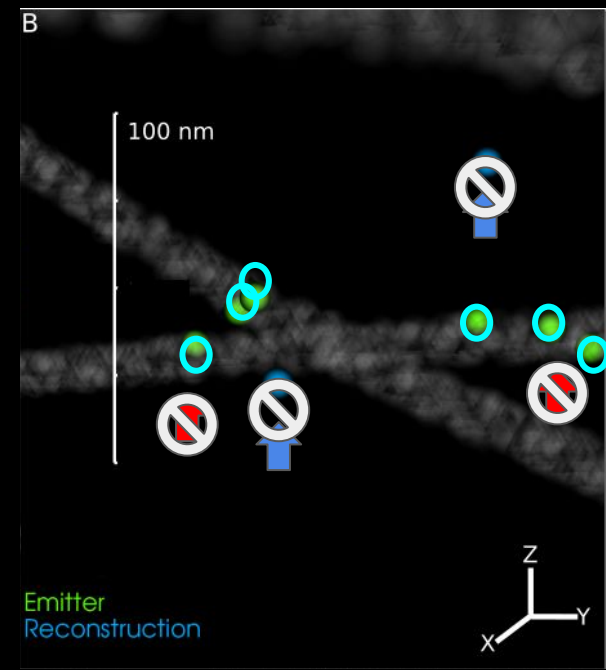
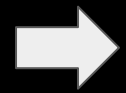
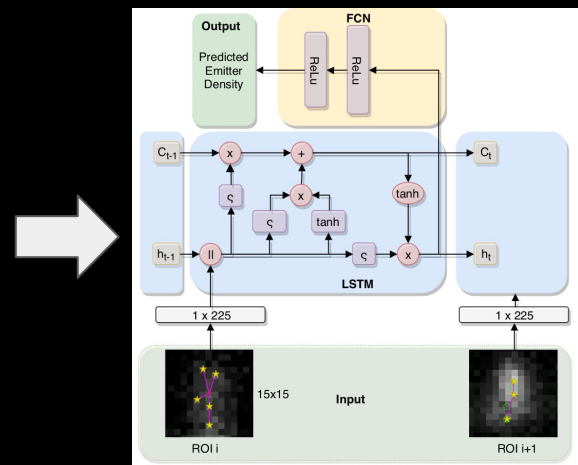
SMLM : 2D image sequence to 3D point cloud

High density can induce artifacts



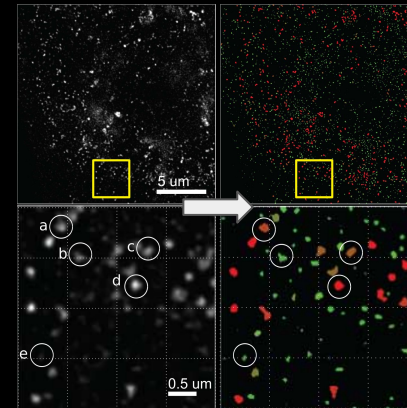
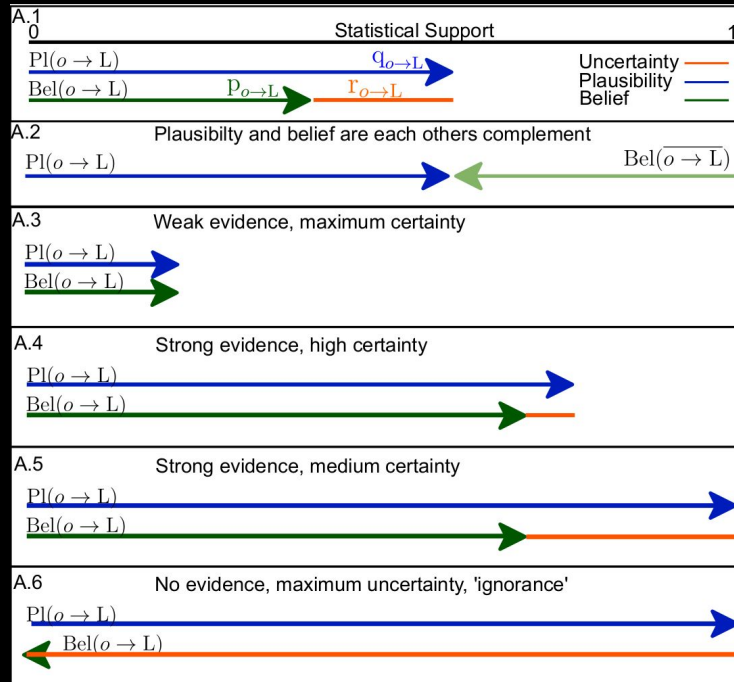
Accurate density prediction can reduce reconstruction errors.

With density known, **Reconstruction** can approximate **emitters** more accurately.



# Belief theory enables weakly supervised object detection in fluorescence microscopy

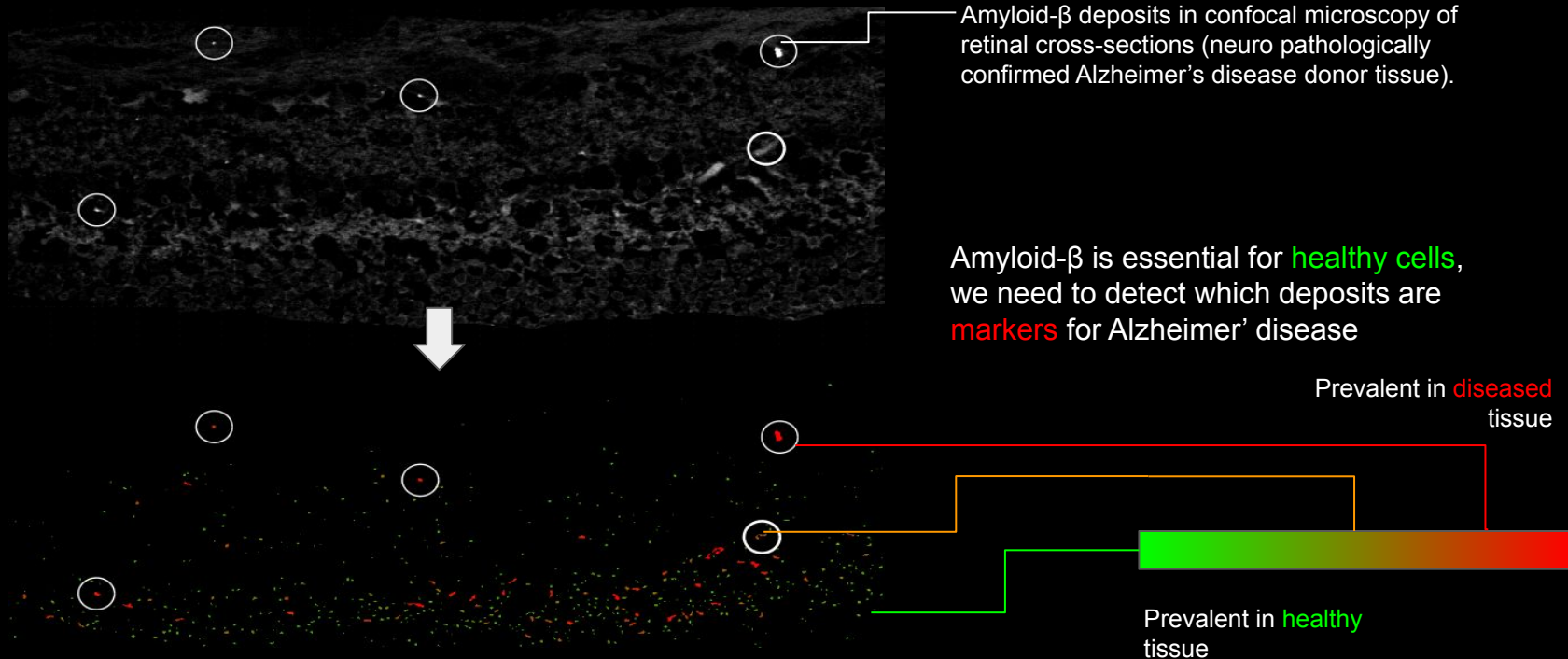
## Belief theory principles



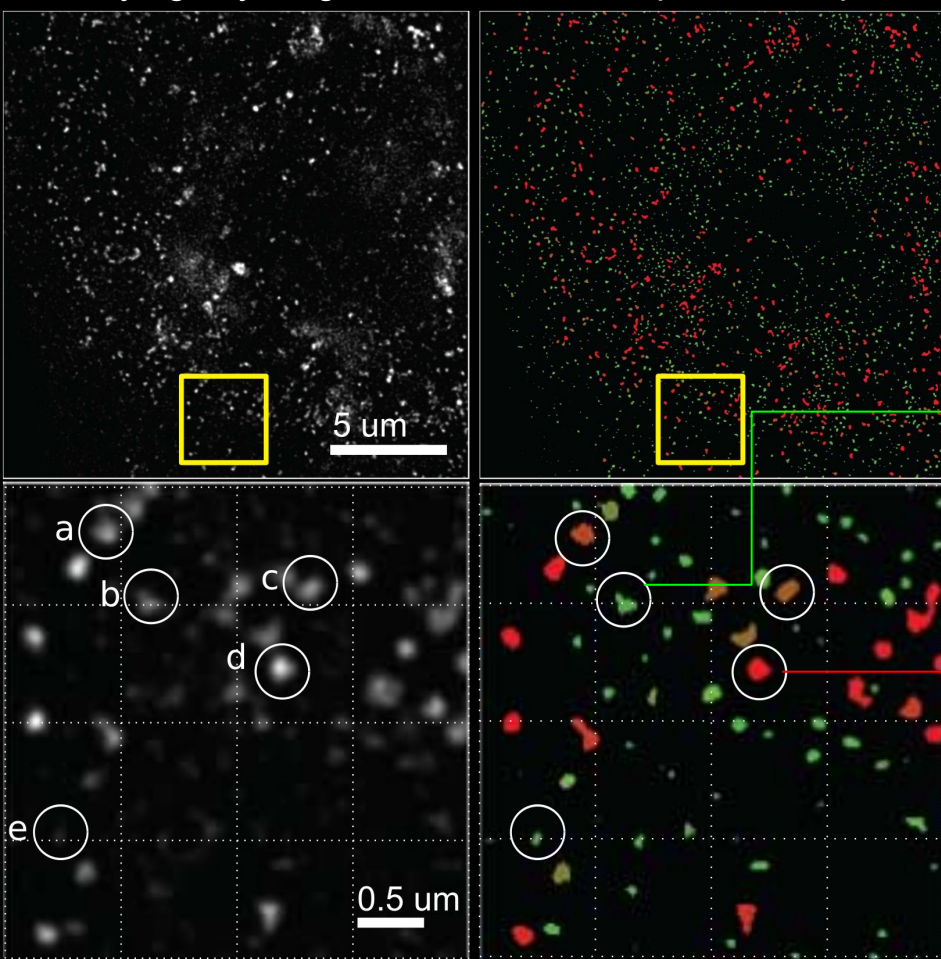
# Detecting Alzheimer-associated amyloid- $\beta$ deposits in confocal retinal tissue.

Alzheimer incidence is rising **quickly**, detection is often **too late to reverse/treat**.

Can we detect Alzheimer signature in retinal tissue ?



# Identifying key stages of the formation process of protein complexes in the cell membrane.



**Caveolae** are ~100 nm spherical invaginations that buffer the **cell membrane** against shock.



**Scaffolds** combine into **caveolae**

**Caveolae**



**Scaffold**

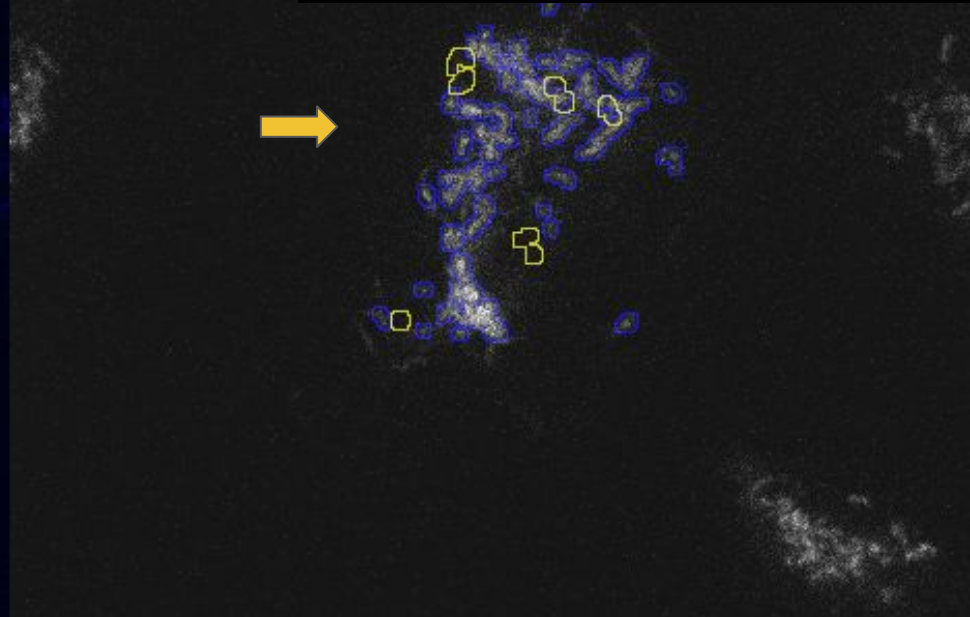
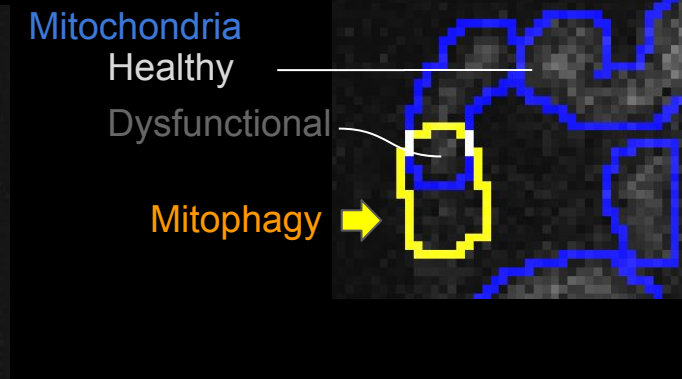
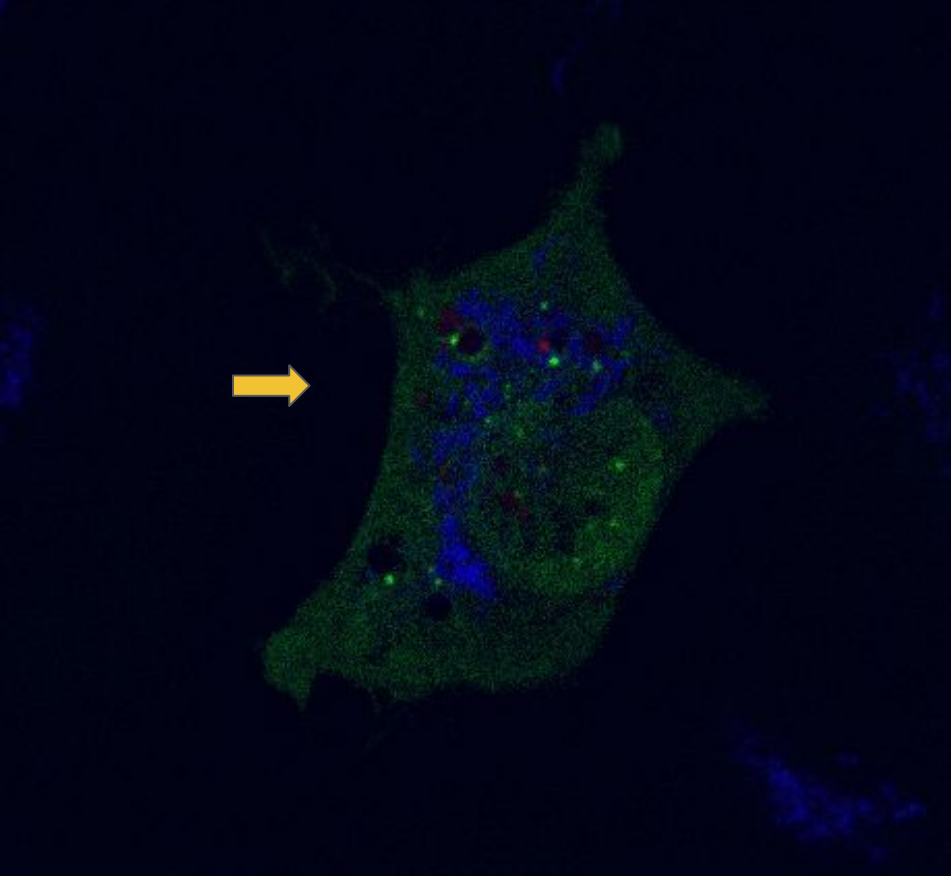


Formation process is largely unknown, therefore key to capture and quantify



Capturing mitophagy in live cells.

Mitophagy removes damaged or dysfunctional mitochondria from the cell.



Mitophagy in a cancer cell (fibrosarcoma) recorded over time



Cardoen, Ben, Hanene Ben Yedder, Anmol Sharma, Keng C. Chou, Ivan Robert Nabi, and Ghassan Hamameh. "Ergo: efficient recurrent graph optimized emitter density estimation in single molecule localization microscopy." *IEEE transactions on medical imaging* 39, no. 6 (2019): 1942-1956.

Cardoen, Ben, Timothy Wong, Parsa Alan, Sieun Lee, Joanne Aiko Matsubara, Ivan Robert Nabi, and Ghassan Hamameh. "SPECHT: Self-tuning Plausibility Based Object Detection Enables Quantification of Conflict in Heterogeneous Multi-scale Microscopy." (2020).

Alan, Parsa, Bharat Joshi, Ben Cardoen, Kurt R. Vandevoorde, Guang Gao, Yahya Mohammadzadeh, Ghassan Hamameh, and Ivan R. Nabi. "Gp78-mediated basal mitophagy promotes mitochondrial health and limits mitochondrial ROS production." *bioRxiv* (2021).

