UNIVERSITÉ CÔTE D'AZUR

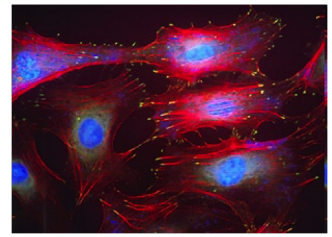
BISET: Biological Image Super-resolution Enhanced with Tensor

- MORPHEME team - I3S Lab, INRIA SAM - (**Eric Debreuve**, Laure Blanc-Féraud)
  Image processing
- SIGNET team - I3S Lab, (Gérad Favier, Henrique Goulard)
  Signal processing, Tensor
- iBV Lab, (Sébastien Schaub, Guillaume Sandoz)
  Optics, biology (ion channels)

Academy 1 of UCA, 4, dec. 2017

Fluorescence microscopy

- Structure of interest in living cells can be imaged through the microscope using fluorescent proteins
- Gene of fluorescent molecule can be combined with gene of proteins of structure we want to study
  Nobel Prize of chemistry 2008
- Illumination with a laser causes the fluorophores to emit photons



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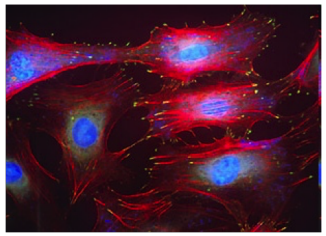
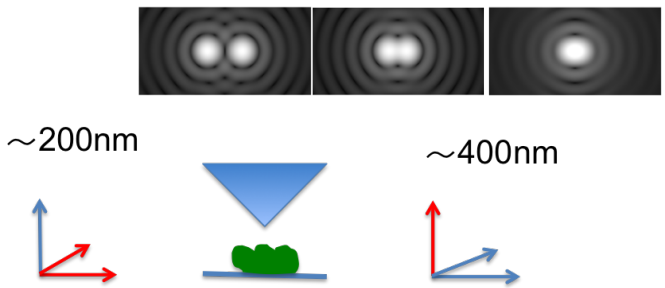


Resolution limits

- physical diffraction limit of optical systems
- 200nm lateral, 400 axial.



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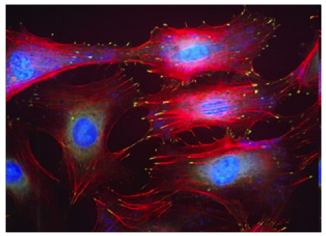

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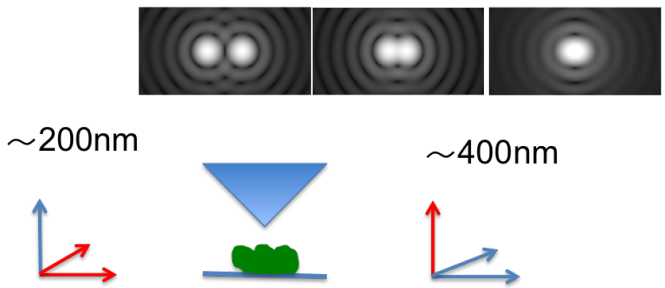
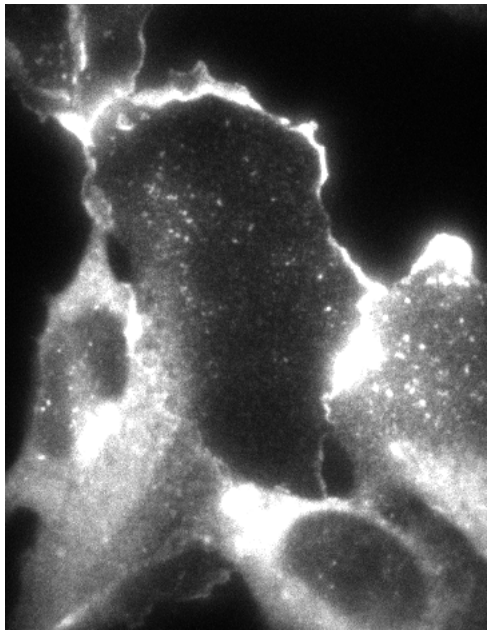


- Study of ion channels, membrane proteins that allow the passage of ions through the cell membrane. Resolution needed less than 50 nm.

Multi-Angle TIRF $\longrightarrow$ *axial super-resolution*



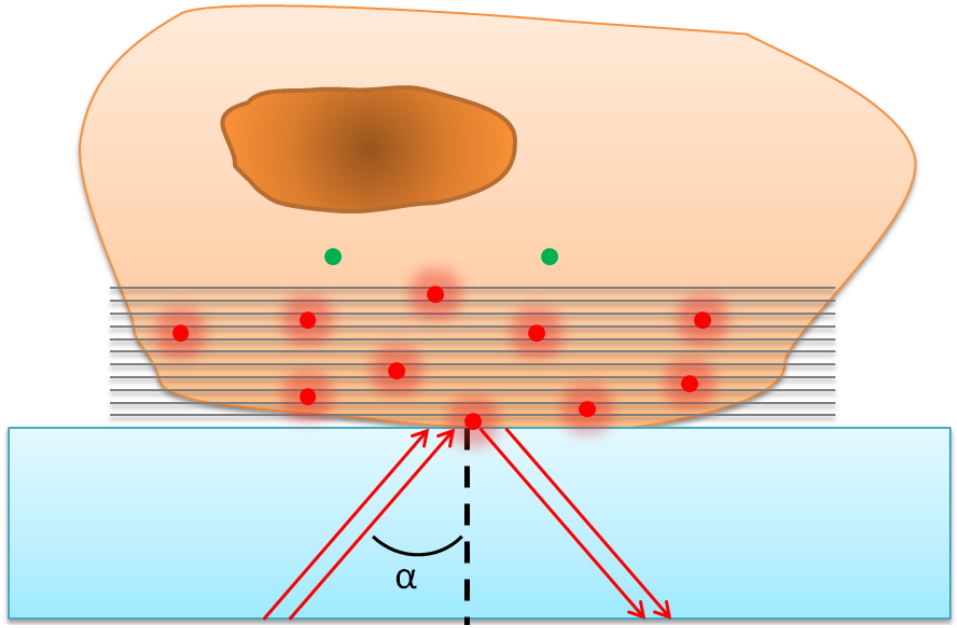


Figure: TIRF Acquisitions.

- TIRF *Total Internal Reflexion Fluorescence* Microscope is a commercial system
- Multiple Angle TIRF prototype at iBV, no more than 3 prototypes in France,
- Reconstruction algorithm for the depth information, 30nm of resolution over 400nm thick layer over the coverslip.
- Method of choice to visualize processes around the plasma membrane

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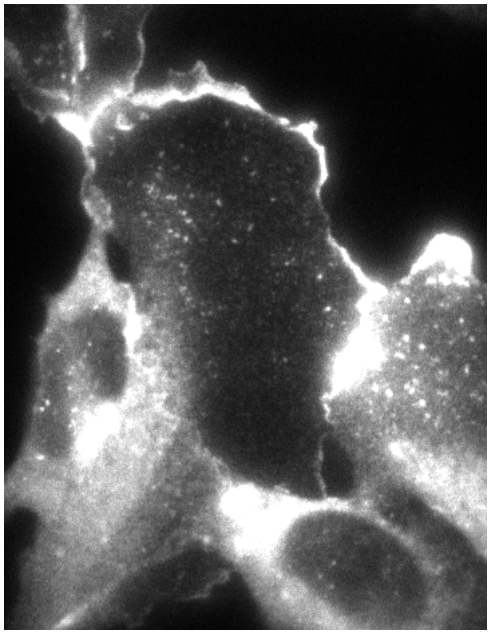

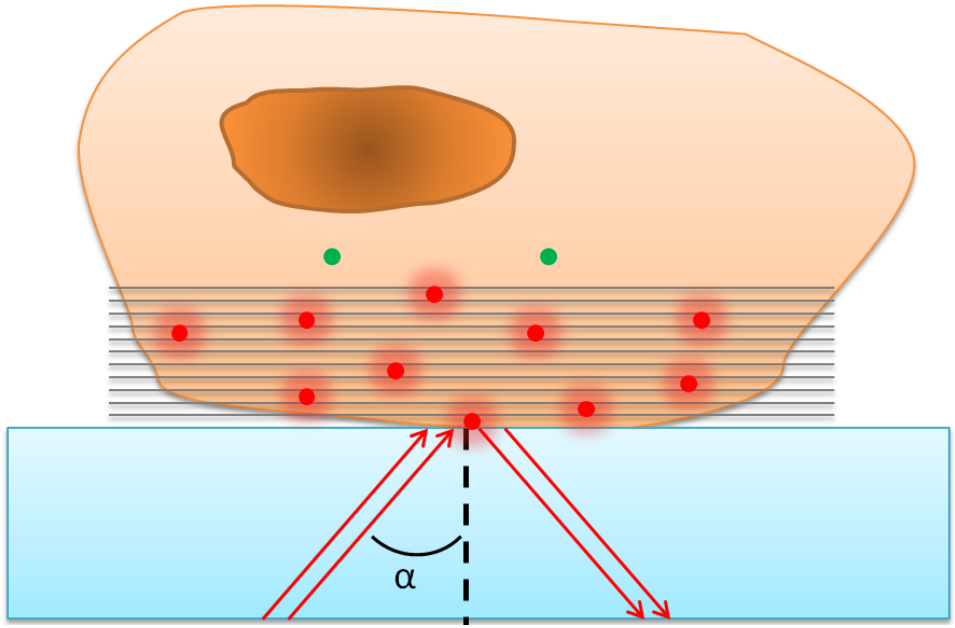

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3D super-resolution by mixing MA-TIRF and SIF

Optical axial Fluctuation $\longrightarrow$ *lateral super-resolution*

- use axial SIF *Super-resolution Intensity Fluctuation* (blinking): Acquisition of 100 images in 1 second,
- each image is blurred and low level SNR (signal on noise ratio), but the temporal fluctuation of fluorescent molecule will be used to localize precisely the fluorophore
- analysis of the temporal image series: cumulant, source separation

Mixing MA-TIRF and SIF $\longrightarrow$ *Tensor analysis*

- MA-TIRF + SIF gives both axial and lateral super-resolution but big volume of 3D + t data to process
- Two possible tensor-based approaches:
  1. Separation of independent sources based on decomposing high-order cumulants of temporal image series
  2. Direct decomposition of MA-TIRF + SIF data: joint exploitation of several diversities for deterministic (blind) source separation.

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