Nanoscale imaging of live brain tissue with super-resolution microscopy. Carbon nanotubes can really help!

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Sub-wavelength localization of single nano-emitters allows super-resolution imaging and subtle probing of spatio-temporal nano-environments [1]. Based on this general feature, I will present different types of nano-emitters used to study the complexity of the brain. Following a general introduction presenting the current state-of the art in this domain, I will introduce an original nanoparticle delivery method in the brain of live animals which made possible single quantum dot tracking in intact brain slices [2]. I will then introduce a recent strategy based on phase imaging which pushes the performance of 3D single particle tracking and 3D super-resolution microscopy deep into biological tissues [3]. Interestingly, for deep tissue imaging, single walled carbon nanotubes, which bear optical resonances in the near infrared, nanoscale dimensions and high aspect ratios, are particularly promising [4,5]. I will show that nanotubes diffusing in the brain extracellular space can be recorded at the single nanotube level. Analysis of their specific movements provides super-resolved maps of tissue architecture which can be modulated upon biochemical digestion of the brain extracellular matrix in live animals [6] or in neurodegenerative brains. If time permits, I will finally discuss the possibility to use sp^3-defect functionalized nanotubes for single particle tracking [7].

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[3] Bon et al *Nat. Meth.* (2018) accepted
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[5] N. Danné, et al *ACS Nano* 5, 2, (2018) 359-364
[6] A. G. Godin, et al *Nat. Nanotechnol.* 12 (2017) 238
[7] N. Danné, et al *submitted*