TOWARDS READOUT OF WIDE FIELD FLUORESCENCE FUNCTIONAL SIGNALS THROUGH HIGHLY SCATTERING TISSUE

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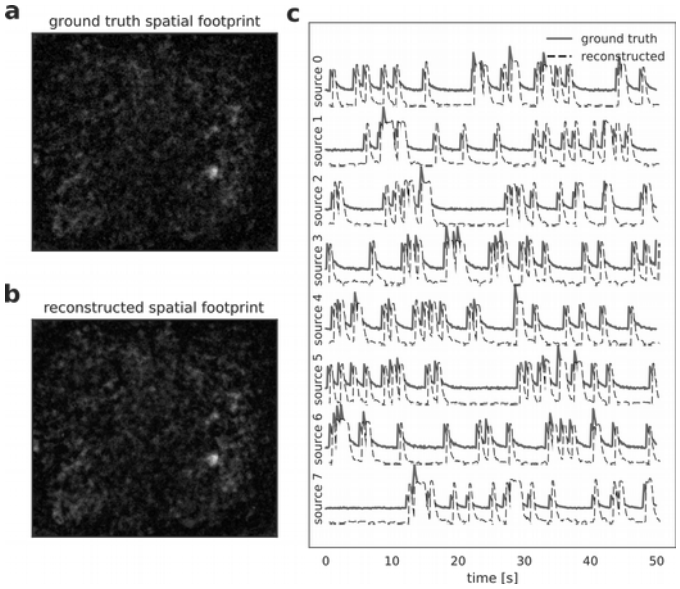

*Figure 1 : Groundtruth and extracted data related to spatial footprints (**a**,**b**) and temporal signals (**c**) of fluorescent sources through a scattering skull*

Fluorescence represents nowadays an irreplaceable tool to non-invasively probe neuronal activity in the mammalian brain. However, when neurons are very deep, fluorescent light propagation through the upper layers of tissues scatter and scramble seemingly beyond recovery the original information. This problem can be circumvented in many ways, for instance by rejecting scattered light, by confining the excitation (e.g. 2PEF), or via invasive methods such as endoscopy. However, a non-invasive method to record fluorescent functional activity from several sources simultaneously, in the multiple scattering regime, is still lacking.

Our work is based on recent signal processing insight, indicating that multiple scattering of light does not destroy its information content [1]. We generate temporally varying fluorescent sources, emulating signals from neuronal calcium activity reporters, and we let the light go through a highly scattering mouse skull (beyond the ballistic regime). The time-fluctuating low contrasted speckle is then recorded on a camera. Using an NMF algorithm, similar to [2, 3], we demonstrate we can retrieve the temporal traces of individual neurons and their spatial footprint (fig1). We study the performances and separability on the number of sources, and their spatial/spectral extend. Importantly, we do not rely here on ballistic light, nor on the presence of speckle correlation, as in [4-6]. Our work is therefore of relevance for ultra-deep or through-skull functional recording.

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