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Multifunctional neural interfaces
combining optics, photonics and nanotechnology

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Abstract

The possibility of manipulating and monitoring neural activity with light is transforming neuroscience. Owing to the development of genetically-expressed actuators and indicators based on light sensitive proteins, neural circuits can be optically manipulated and monitored in biologically relevant conditions¹. Driven by the demand for better experimental tools, research in the growing field of neuro-photonics is playing a central role towards the ambitious goal of unraveling neural circuits and functions². In this regards, tapered optical fibers (TFs) have recently emerged has a promising tool towards minimally invasive, multifunctional neural interfaces. In this talk, I will focus on the development of TF probes that can manipulate and monitor neural activity at multiple brain locations by controlling the propagation of modal subsets in the waveguide³⁻⁵. At the same time, I will describe the use of nano-patterning techniques to structure light-delivery and to add recording electrodes on the highly-curved fiber's surface^{6,7}. Finally, I will discuss the exploitation of light-matter interactions in implantable neuro-plasmonic architectures towards genetic-free neural interfaces.

1. Häusser, M., *Nat. Methods* **11**, (2014).
2. Packer, A. M. et al., *Nat. Neurosci.* **16**, (2013).
3. Pisanello, F. et al., *Nat. Neurosci.* **20**, (2017).
4. Pisanello, M. et al., *Sci. Rep.* **8**, (2018).
5. Pisano, F. et al., *bioRxiv* 455766 (2018). *Accepted*
6. Pisanello, F. et al., *Neuron* **82**, (2014).
7. Pisano, F. et al., *Microelectron. Eng.* **195**, (2018).

The speaker



Filippo Pisano graduated with a BSc (2010) and MSc (2012) in Physics from the University of Turin. He received a PhD (2017) for his research on advanced technologies for spatio-temporal control of neural circuits in the mammalian retina at the Institute of Photonics, University of Strathclyde (Glasgow, Scotland) and the Santa Cruz Institute for Particle Physics, University of California Santa Cruz (Santa Cruz, CA, US). He now works on the development of multifunctional probes to interface with deep brain regions at the Center for Biomolecular Nanotechnologies-Fondazione Istituto Italiano di Tecnologia in Lecce.