Molecules that are altered as a result of a pathological condition are generally present in very low abundance, and pose a “needle-in-a-haystack” problem. Using nanophotonics tools, our Advanced Cytometry Labs @ Macquarie University explores time-domain strategies and identified several viable solutions to unlock the restraints of sensitivity and throughput issues, which are currently limiting the advanced cell imaging and molecular sensing. While introducing our recent progresses in the underpinning areas of both lanthanide-based luminescent probes and time-resolved luminescence instrumentation, my talk will focus on our new generation of nanophotonic luminescent probes (τ-Dots), based on purpose-engineered upconversion nanocrystals that are ultrabright, low background interference, and have large-scale multiplexing capacity. I will showcase significant applications spanning the fields of immunofluorescence imaging, rare-event cell detection and quantification, security printing, and super-resolution nanoscopy. These demonstrations radically extends the current optical capability by adding the yet untapped temporal dimension of luminescent signals and opening viable avenues to cope with the complexity challenges in the life sciences, medicine and data storage and security.

(key reference: Nature Nanotechnology, DOI: 10.1038/nnano.2013.171; Nature Photonics, DOI: 10.1038/nphoton.2013.322;