A new tool for time-resolved hyperspectral nano-imaging of up-converting nanoparticles

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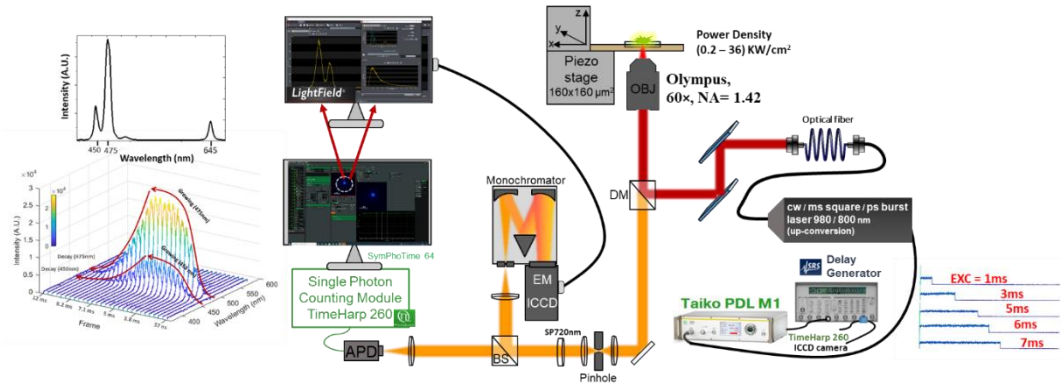
Up-conversion nanoparticles are lanthanide-doped nanoparticles which present the unique feature of being able to emit light up to the blue region of the visible spectrum while being excited by near infrared light. Hence, they represent very attractive probes for bio-imaging because of the absence of autofluorescence and a great penetration depth into tissues. They can also be used to design new photonics materials[1] with specific spatial nano-organization. Having a hyperspectral nano-imaging method to record spatially resolved spectra and emission lifetimes for different UCNP nano-organizations, from single UCNP to 3D clusters, would allow to probe the intra and inter-particle up-conversion dynamics controlling their emission properties. However, the long lifetime of these systems prevents from using classical fluorescence lifetime imaging microscopes (FLIM). We have thus developed a new confocal microscope based on a millisecond-square pulse NIR excitation and an intensified gated CCD camera in order to measure space- and time-resolved spectra. We will discuss here two applications of this new tool: (i) we first investigated the emission properties of Tm- and Er-based core and core-shell UCNP 2D layer. According to the nanometric spatial arrangement of the particles, we could demonstrate that the emission dynamics of single particles, 2D monolayer or 3D aggregates differ in terms of power-dependent emission band ratios and lifetimes. (ii) We studied the energy transfer dynamics of single UCNP to organic dyes films. We could follow the transfer of the exciton from UCNPs to organic dye in the vicinity and its diffusion within the film.



[1] C. Lee et al., *Nature* **2021**, 589,230-237