



Nonlinear Laser Scanning Microscopy for noninvasive imaging of cells labeled by up-converting $\text{NaY}_{0.65}\text{Gd}_{0.15}\text{F}_4:\text{Yb}_{0.18}\text{Er}_{0.2}$ nanoparticles

Miljana Piljevic¹, Ivana Dinic², Lidija Mancic², Marina Vukovic², Milos Tomic², Maria Eugenia Rabanal³, Milos Lazarevic⁴, Mihailo D. Rabasovic¹



¹Institute of Physics Belgrade, University of Belgrade, Serbia

²Institute of Technical Sciences of SASA, Belgrade, Serbia

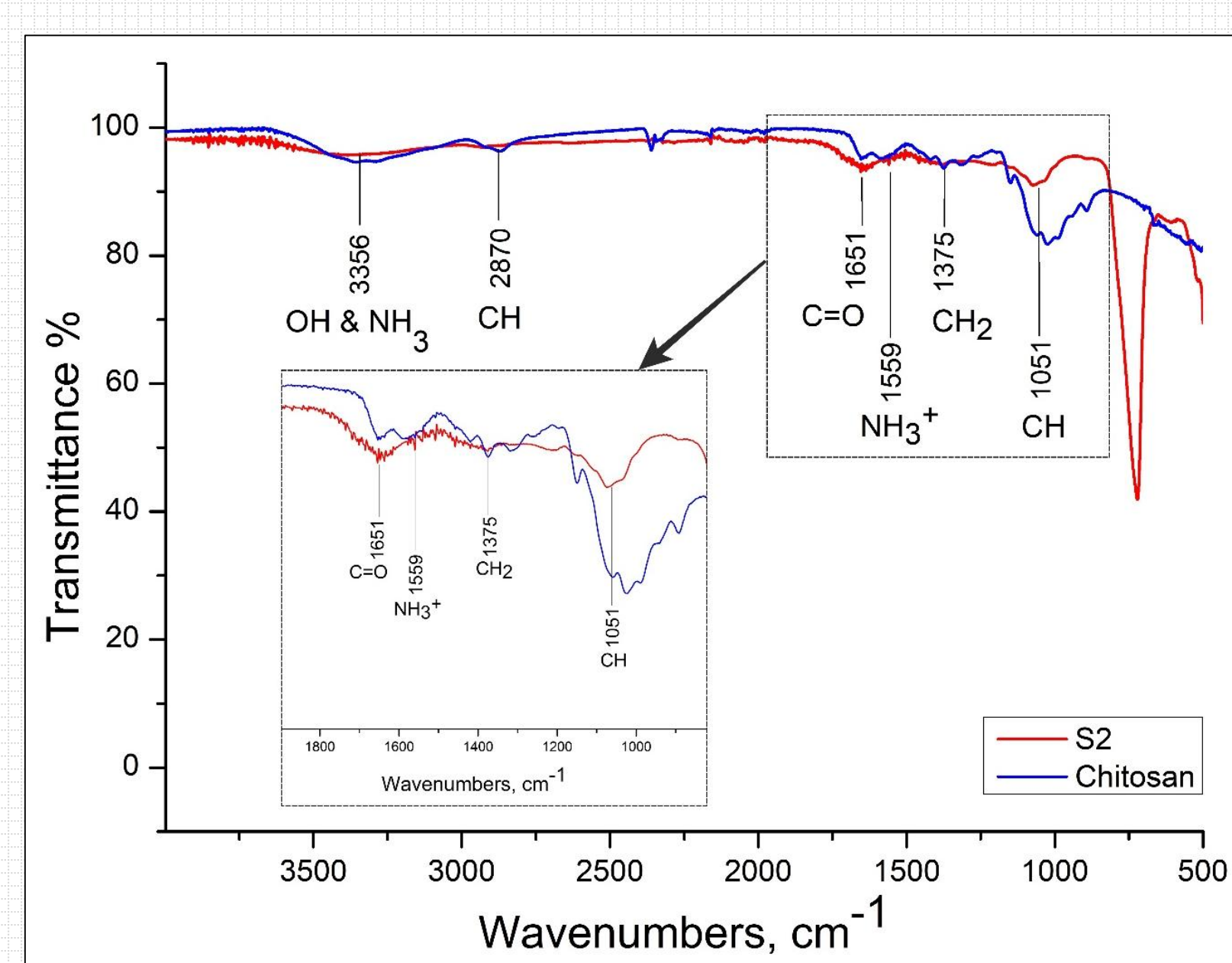
³Universidad Carlos III de Madrid and IAAB, Madrid, Spain

⁴School of Dental Medicine, University of Belgrade, Serbia

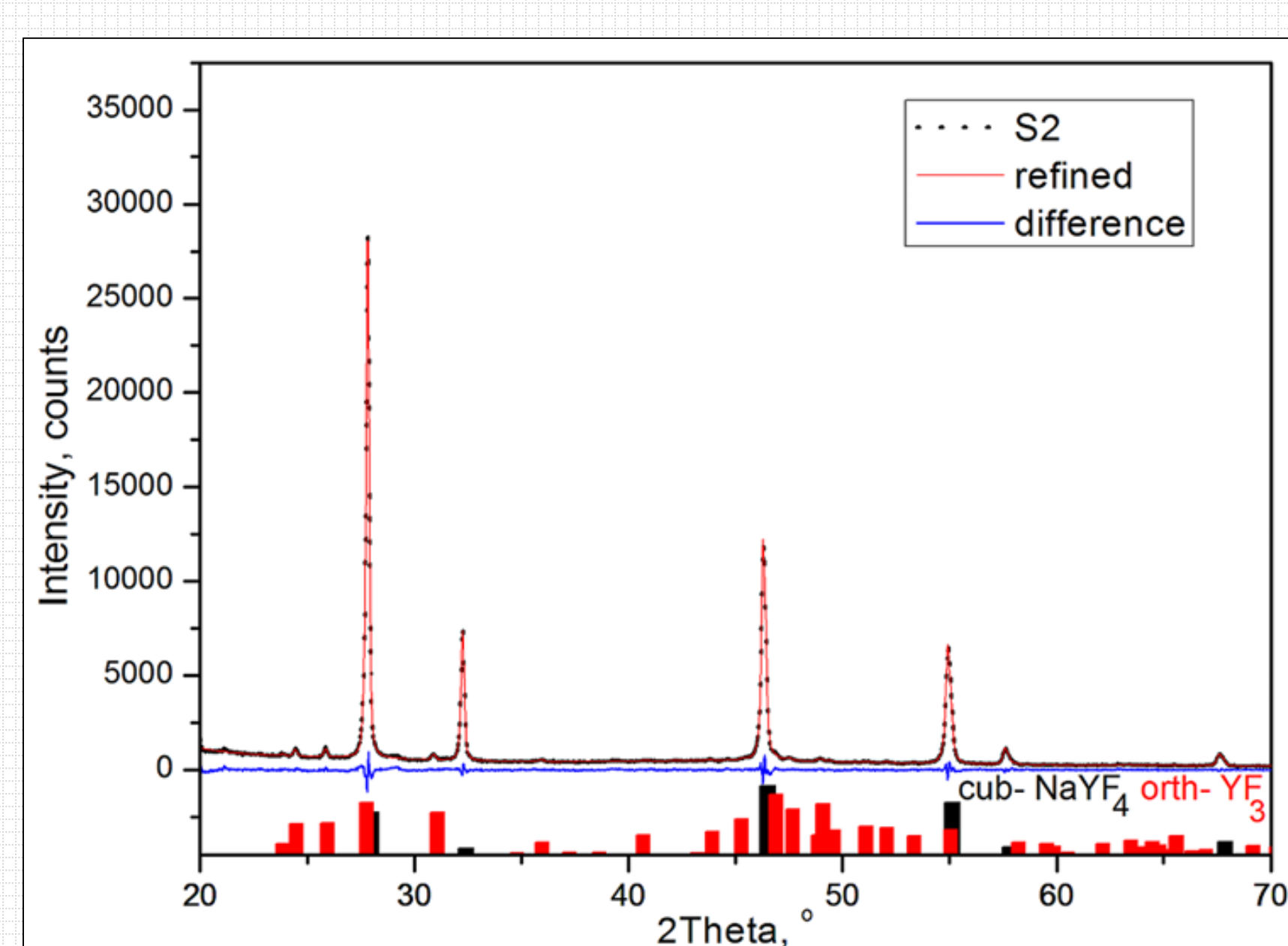


e-mail: miljana@ipb.ac.rs

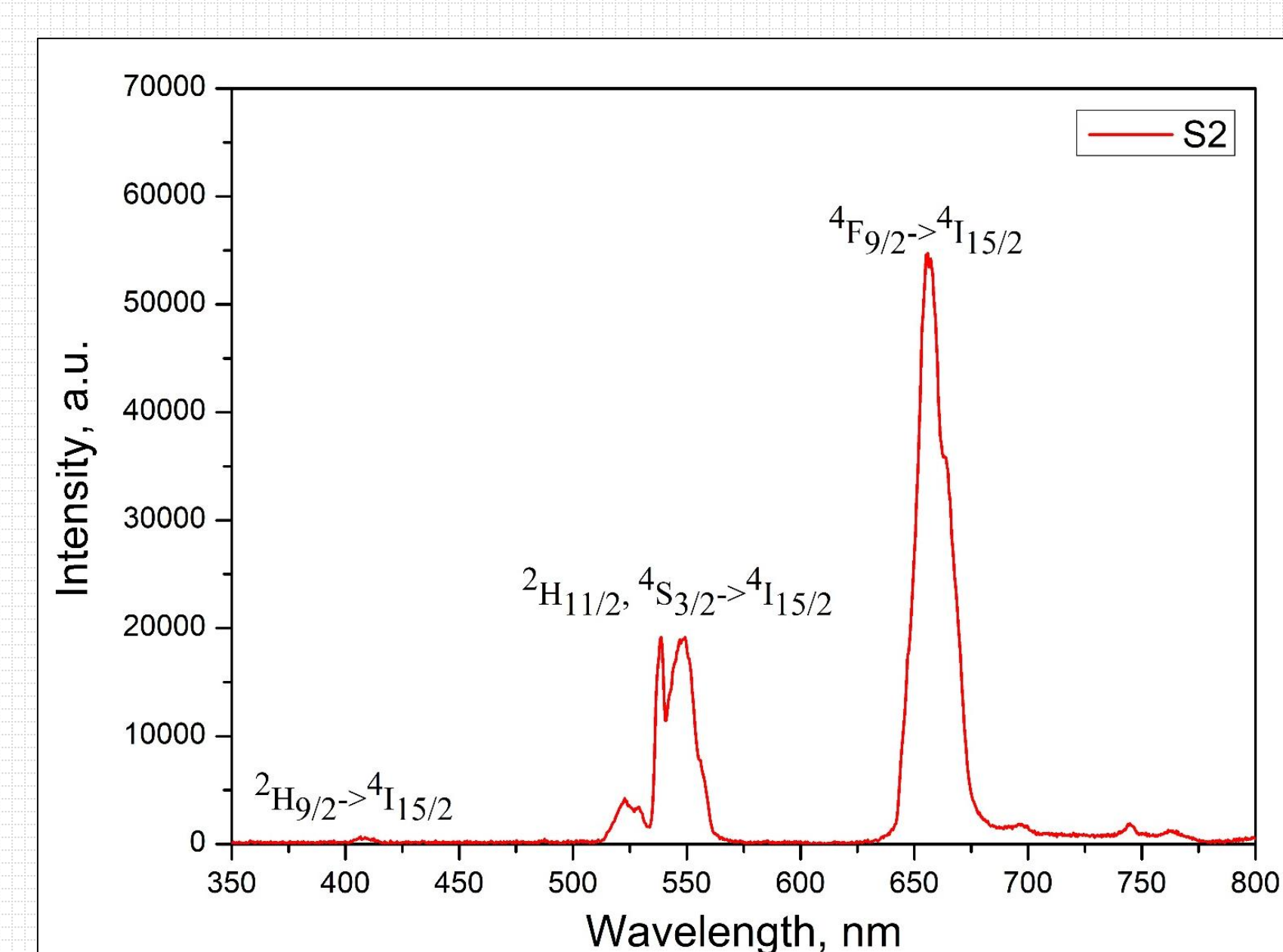
Nonlinear Laser Scanning Microscopy (NLSM) is a powerful technique that enables noninvasive imaging of living cells, due to the utilization of ultrafast-pulsed lasers in the near-infrared (NIR) wavelength range. In this study, $\alpha\text{NaY}_{0.65}\text{Gd}_{0.15}\text{F}_4:\text{Yb}_{0.18}\text{Er}_{0.2}$ nanoparticles, types of lanthanide doped up-converting nanoparticles (UCNPs), which show a significant potential in biomedical sciences as fluorescent probes for early cancer detection, were synthesized through chitosan assisted solvothermal synthesis, their structural characteristics were analyzed and their potential for non-specific cell labeling was investigated using NLSM. These nanoparticles are able to emit visible or ultraviolet photons upon excitation by near-infrared light. Cell lines used for testing are HS-5 fibroblast healthy cells and SCC-25 oral cancer cells.



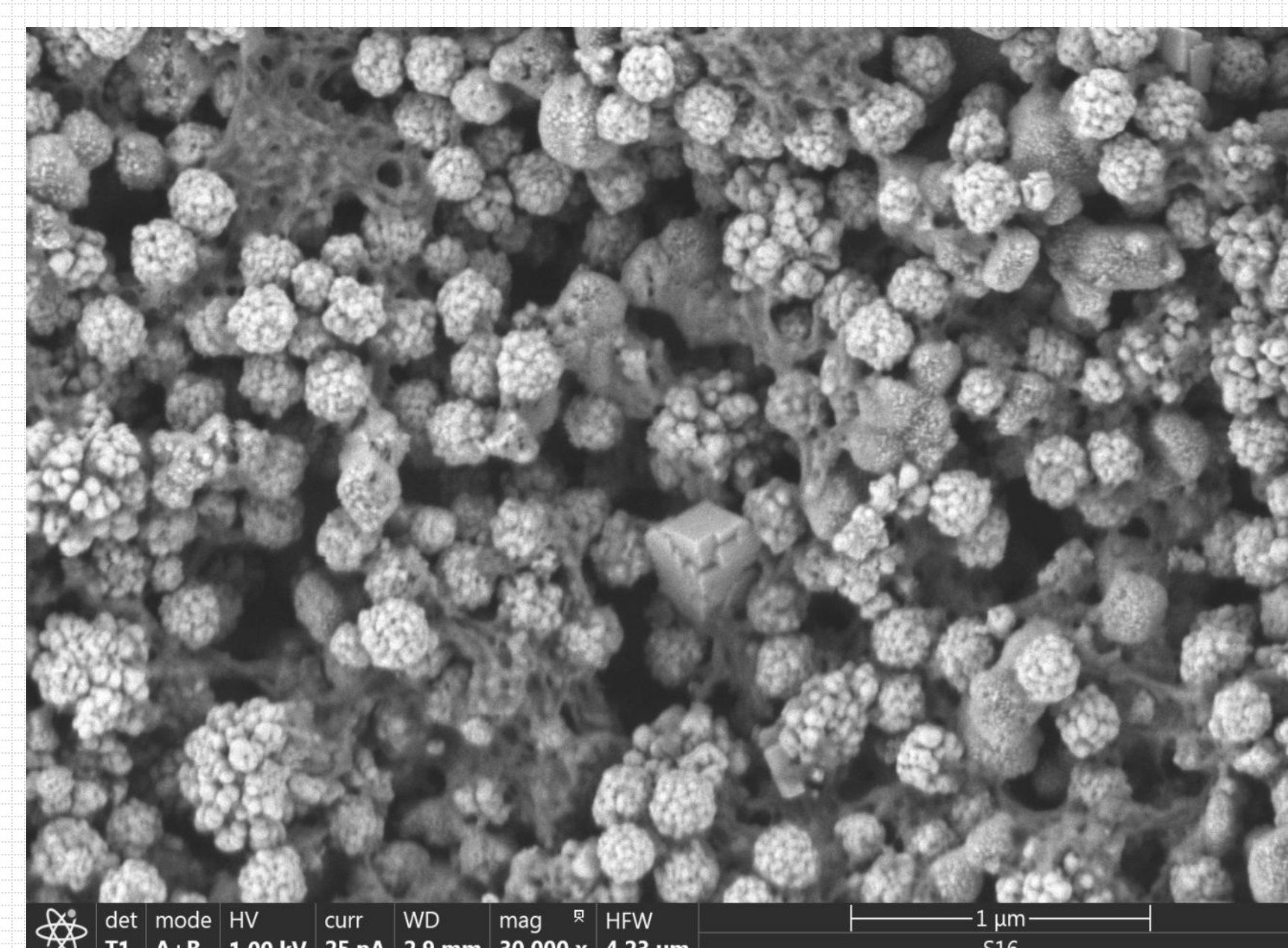
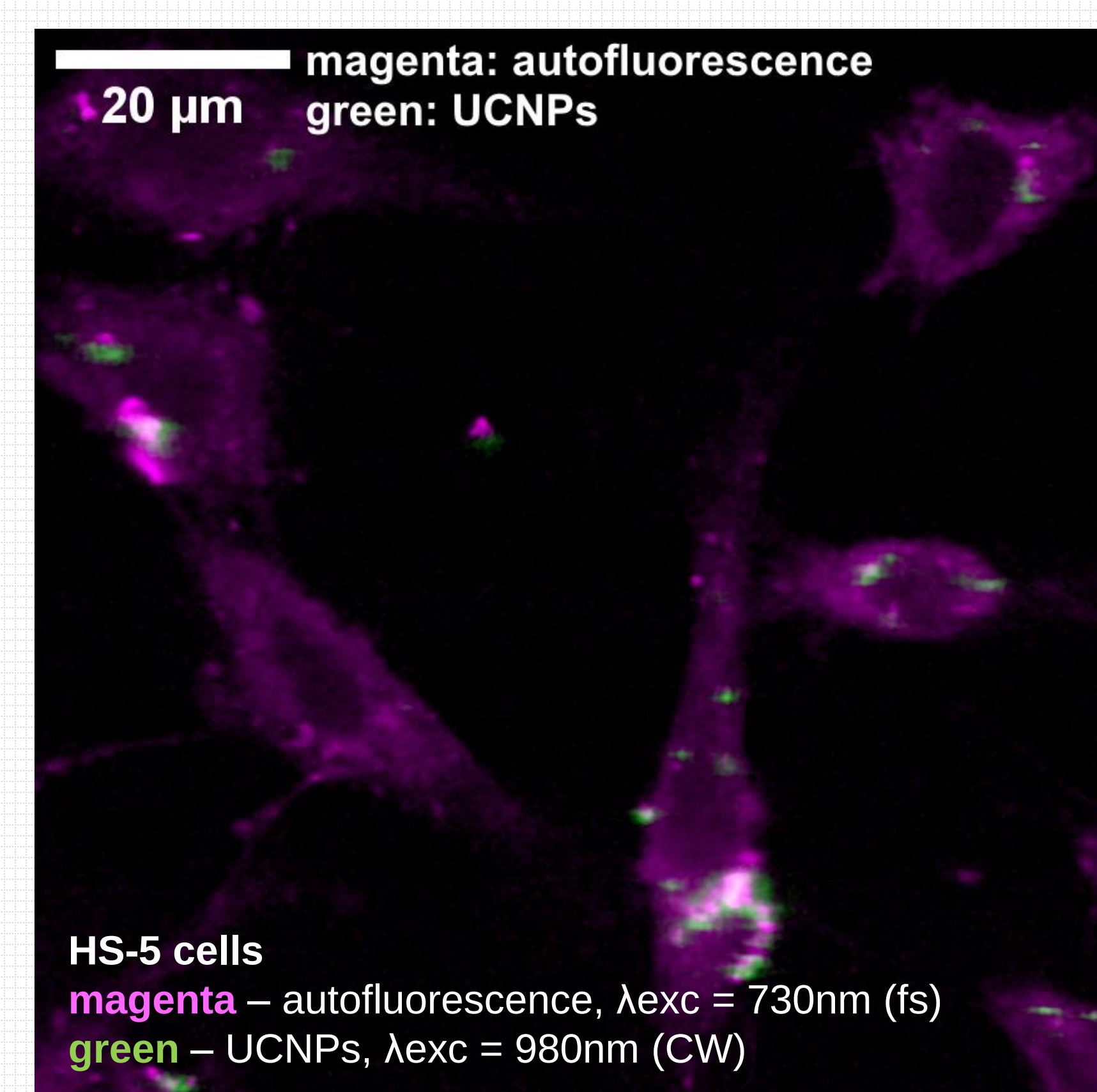
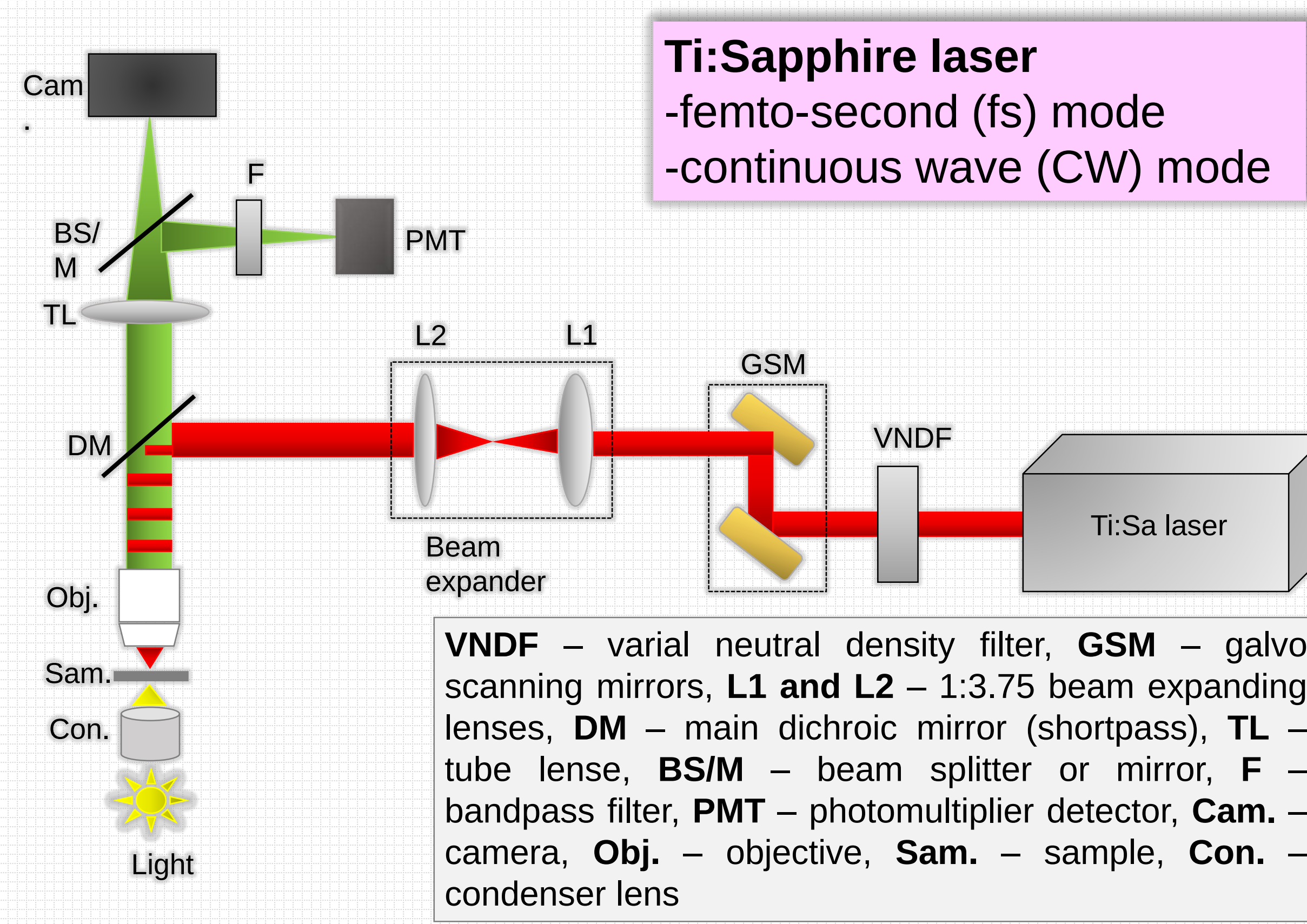
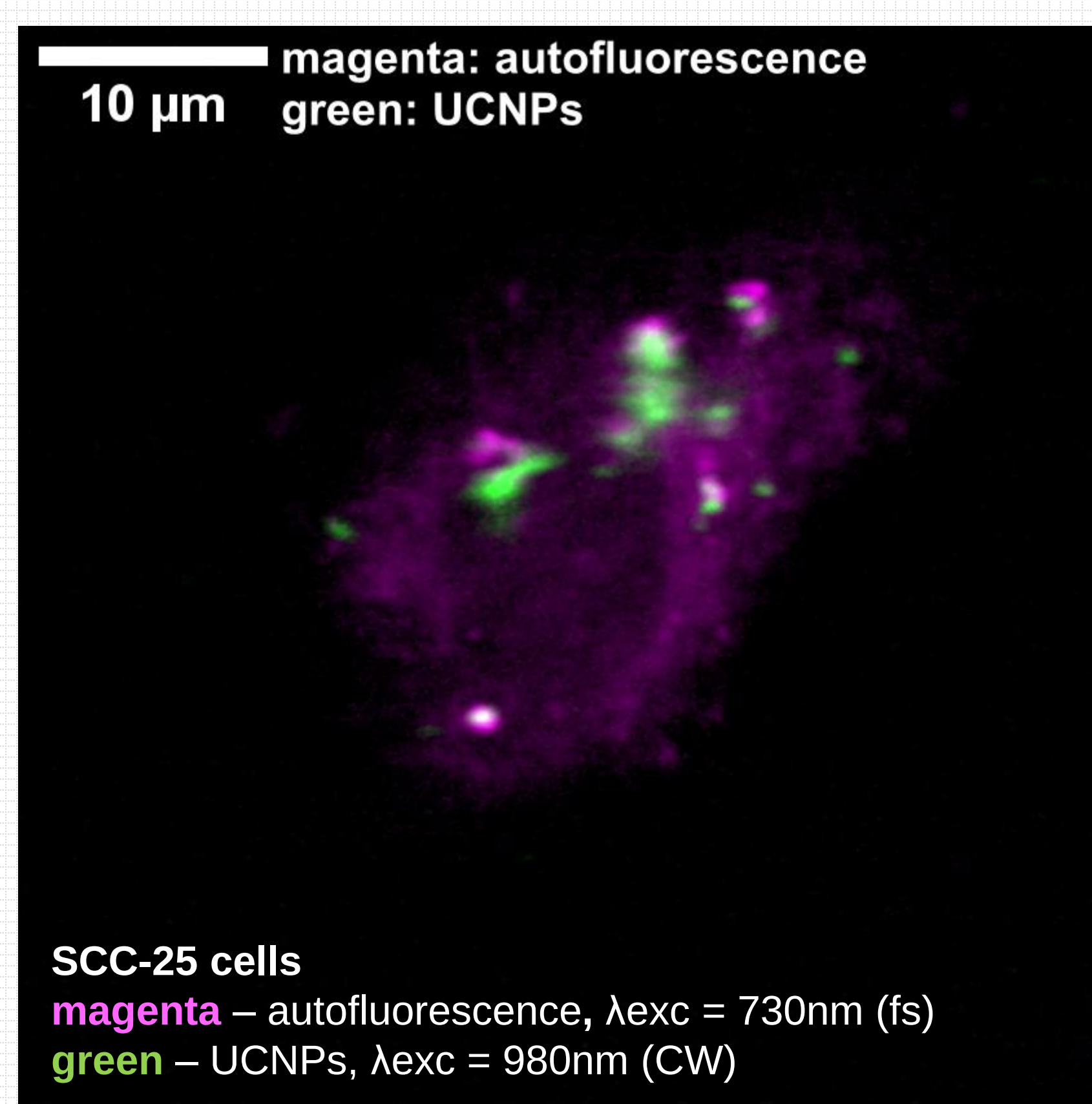
FTIR spectra of chitosan and $\alpha\text{NaY}_{0.65}\text{Gd}_{0.15}\text{F}_4:\text{Yb}_{0.18}\text{Er}_{0.2}$ confirmed presence of chitosan on the surface of nanoparticles



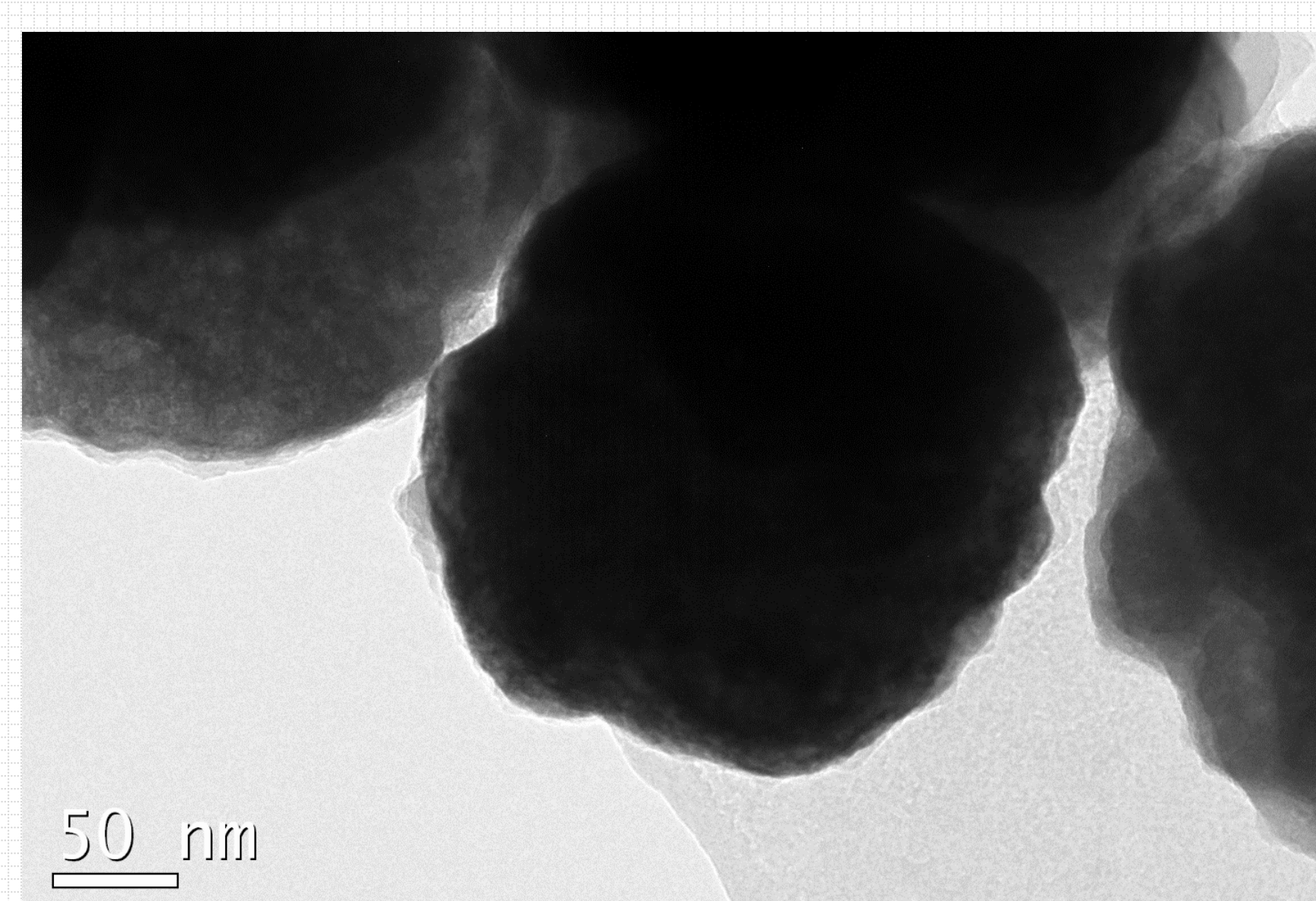
XRPD pattern showing presence of cubic phase ($Fm\bar{3}m$), JCPDS 01-77-2042 and minor content of YF_3 phase ($Pnma$), JCPDS 01-074-0911



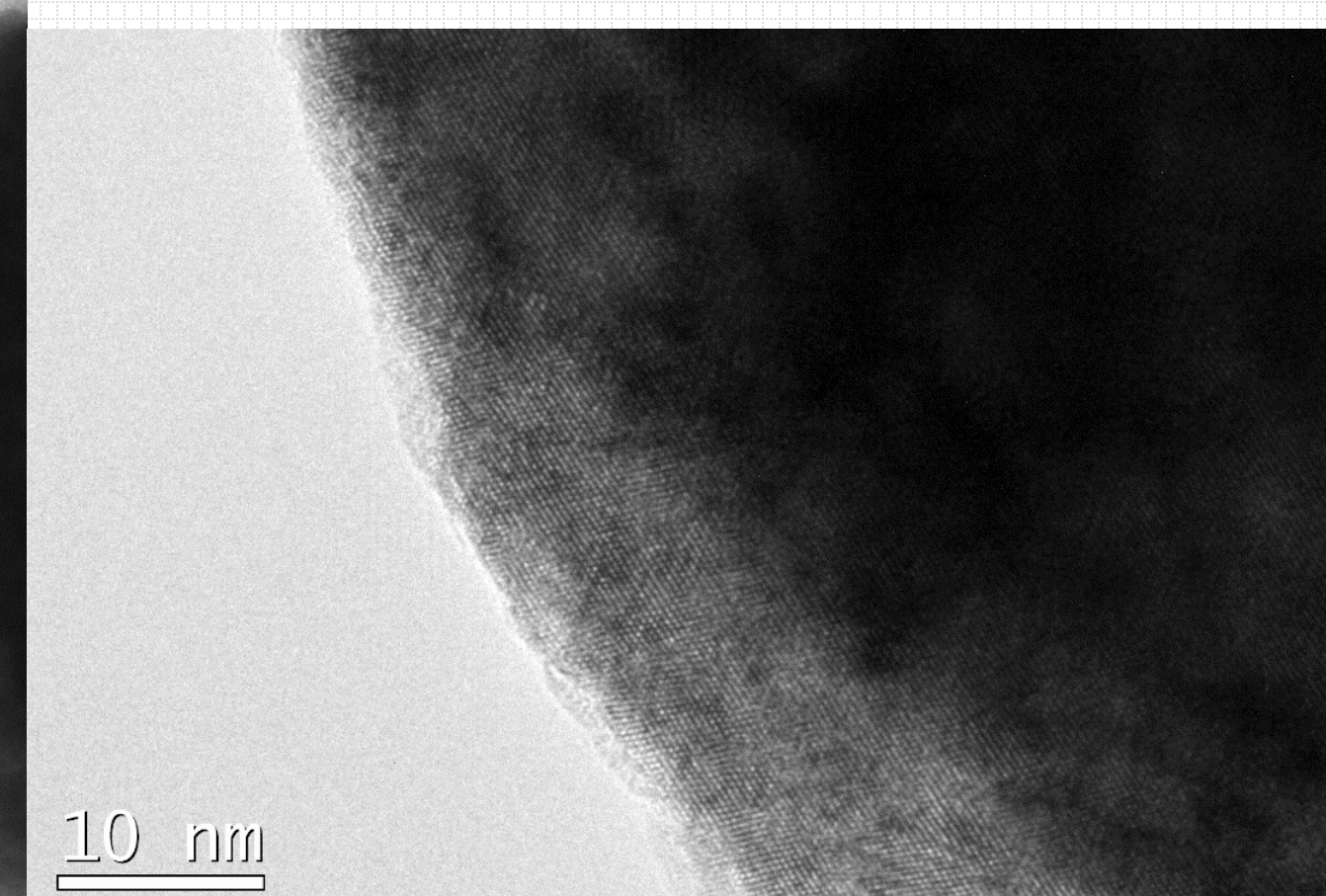
Up-conversion luminescence spectrum of $\alpha\text{NaY}_{0.65}\text{Gd}_{0.15}\text{F}_4:\text{Yb}_{0.18}\text{Er}_{0.2}$ /chitosan UCNPs, excitation 980nm



SEM image showing mainly spherical particles and a smaller portion of bigger polyhedron-shaped particles



TEM images showing good crystallinity of spherical $\alpha\text{NaY}_{0.65}\text{Gd}_{0.15}\text{F}_4:\text{Yb}_{0.18}\text{Er}_{0.2}$ nanoparticles



► biocompatible up-converting nanoparticles successfully obtained *in situ*
► $\text{NaY}_{0.65}\text{Gd}_{0.15}\text{F}_4:\text{Yb}_{0.18}\text{Er}_{0.2}$ UCNPs - potential probes for NIR-excited fluorescence imaging - up-conversion emissions can be achieved using continuous wave NIR laser
► both healthy and cancer cells labeled by synthesized nanoparticles and their visualization under NIR excitation achieved

Miljana Piljević, Ivana Dinić, Lidija Mančić, Marina Vuković, Miloš Tomić, Maria Eugenia Rabanal, Miloš Lazarević, Mihailo D. Rabasović, *In situ* synthesis of biocompatible $\text{NaY}_{1-x}\text{Gd}_x\text{F}_4:\text{Yb}/\text{Er}$ nanoparticles for cell labeling and temperature sensing, Inorganic Chemistry Communications, 2025, 114239, ISSN 1387-7003, <https://doi.org/10.1016/j.inoche.2025.114239>.