# Anti-Stokes Förster Resonant Energy Transfer – advantages and pitfalls

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Förster Resonant Energy Transfer is a versatile (bio)sensing mechanism, which, owing to close proximity of donor and acceptor molecules and their spectral overlap, enable studying biomolecular interactions and perform diagnostics *in-situ, in-vitro* and *in-vivo*. However, organic donor and acceptor molecules suffer from photodegradation and spectral bleed-through – thus hindering detection in complex (absorbing, fluorescent, scattering) samples.

Using luminescent lanthanide doped particles (LnNPs) as energy donors solves many technical challenges. However, while LnNPs offer photostable, narrowband anti-Stokes emission, their sensitivity is hampered by relatively large size of such LnNPs and complex energy transfer mechanisms. In consequence the sensitivities are suboptimal, luminescence kinetics is poorly responsive to presence of acceptors and kinetic and steady state readouts differ.

This lecture will overview state-of-the-art, present challenges and opportunities related to using upconverting (UCNPs) and photon avalanching (ANPs) nanoparticles as FRET energy donors [1-4].

[1] A. Pilch-Wróbel et al., Small 18.18 (2022): 2200464
[2] A. M. Kotulska et al., Light: Science & Applications 11.1 (2022): 256
[3] A. Bednarkiewicz et al., J. Physical Chemistry C, 114.41 (2010): 17535-17541
[4] G. Bękarski et al., ACS nano, 19(48), (2025): 41110-41120

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