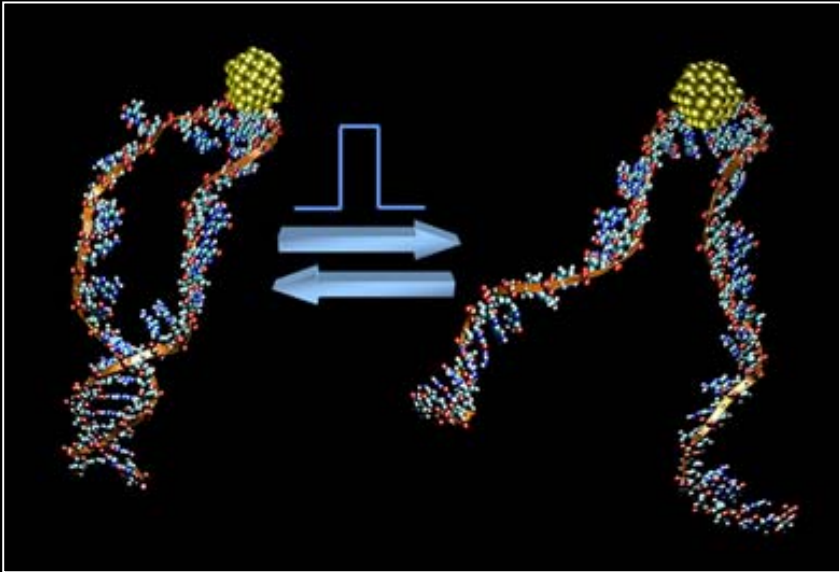
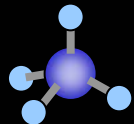


Kimberly Hamad-Schifferli
Departments of Mechanical
Engineering and Biological
Engineering, MIT



Simple molecules
< 1 nm



DNA proteins
nm



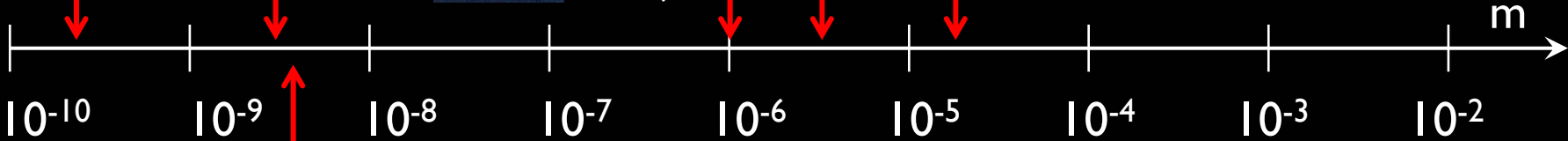
bacteria
1 μm



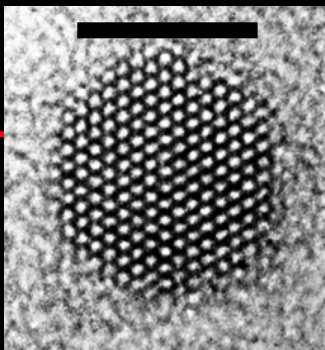
red blood cell
~5 μm (SEM)



diatom
30 μm

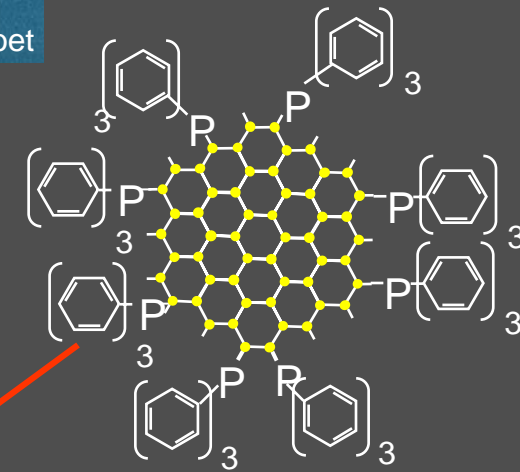
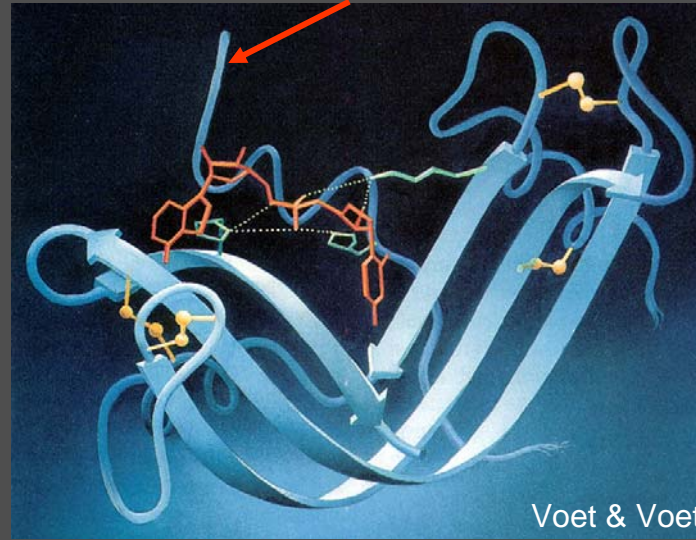
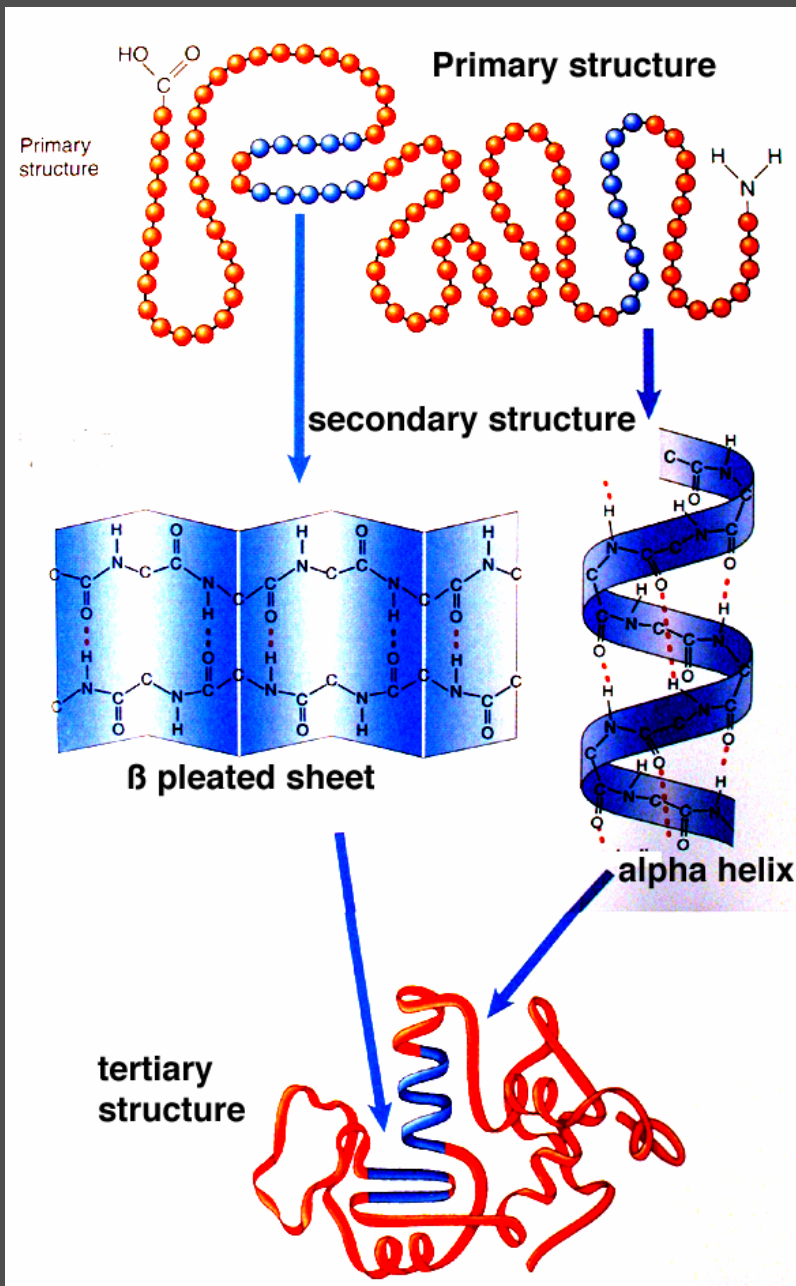


Nanoparticle
nm



Nanoparticle linkages to proteins

- Much more complex than with DNA
- More amino acids to interact with
- Where does nanoparticle link?
- Structure key to function

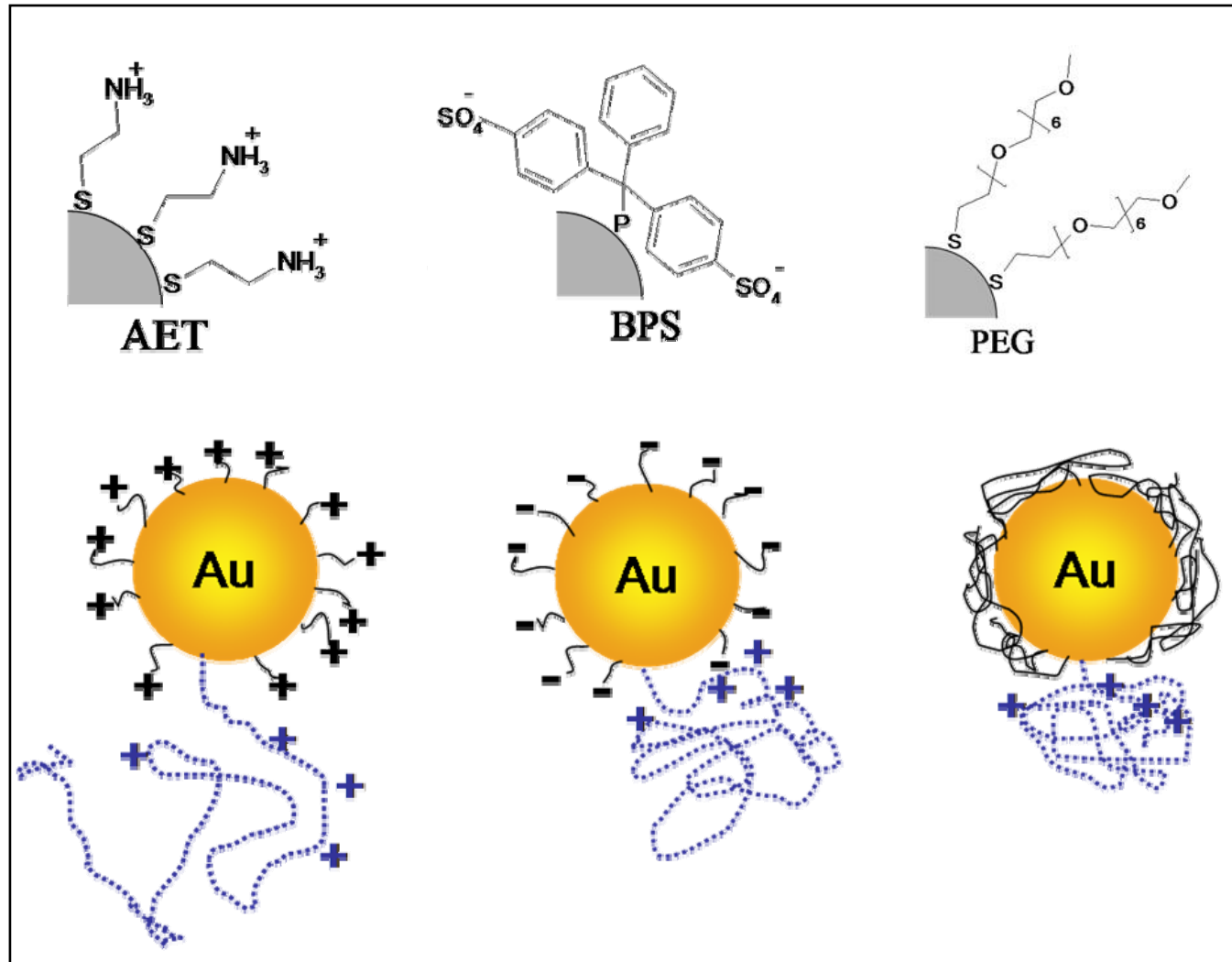
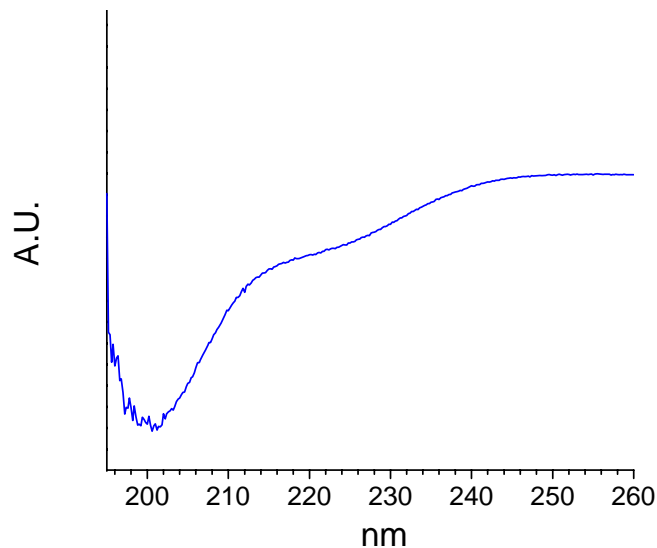
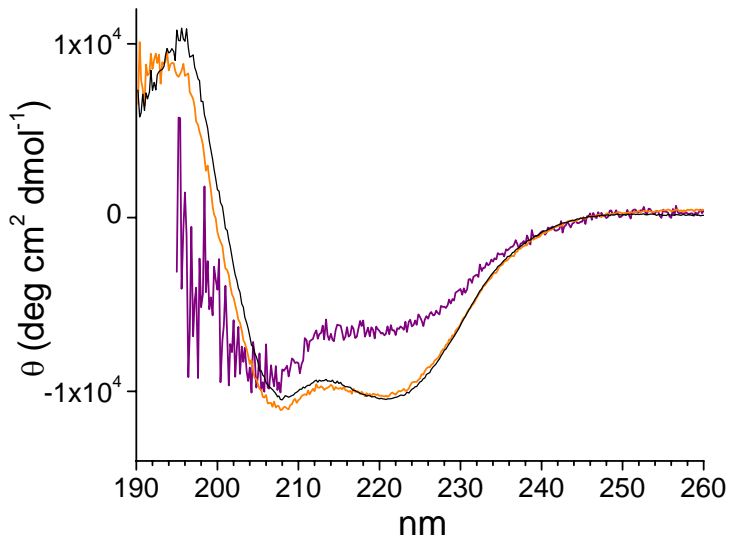


► site specific labeling of protein with NP that preserves protein structure

NP-cytochrome c interfaces

Site specifically link 1.4nm Au NPs to *Saccharomyces cerevisiae* cytochrome c:

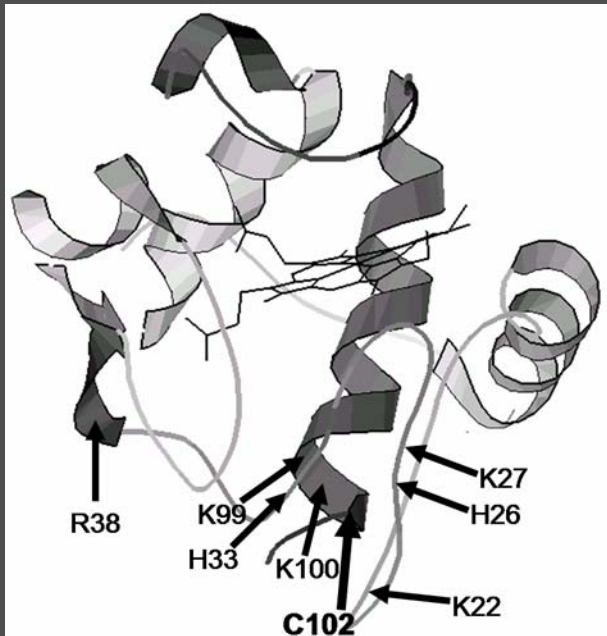
TEFKAGSAKKGATLFFKTR**CLQ**CHTVEKGGPHKVGPNLHGIFGRHSGQAEG
 YSYTDANIKKNVLWDENNMSEYLTNPKKYIPGTKMAFGGLKKEKDRNDLI
 TYLKKACE



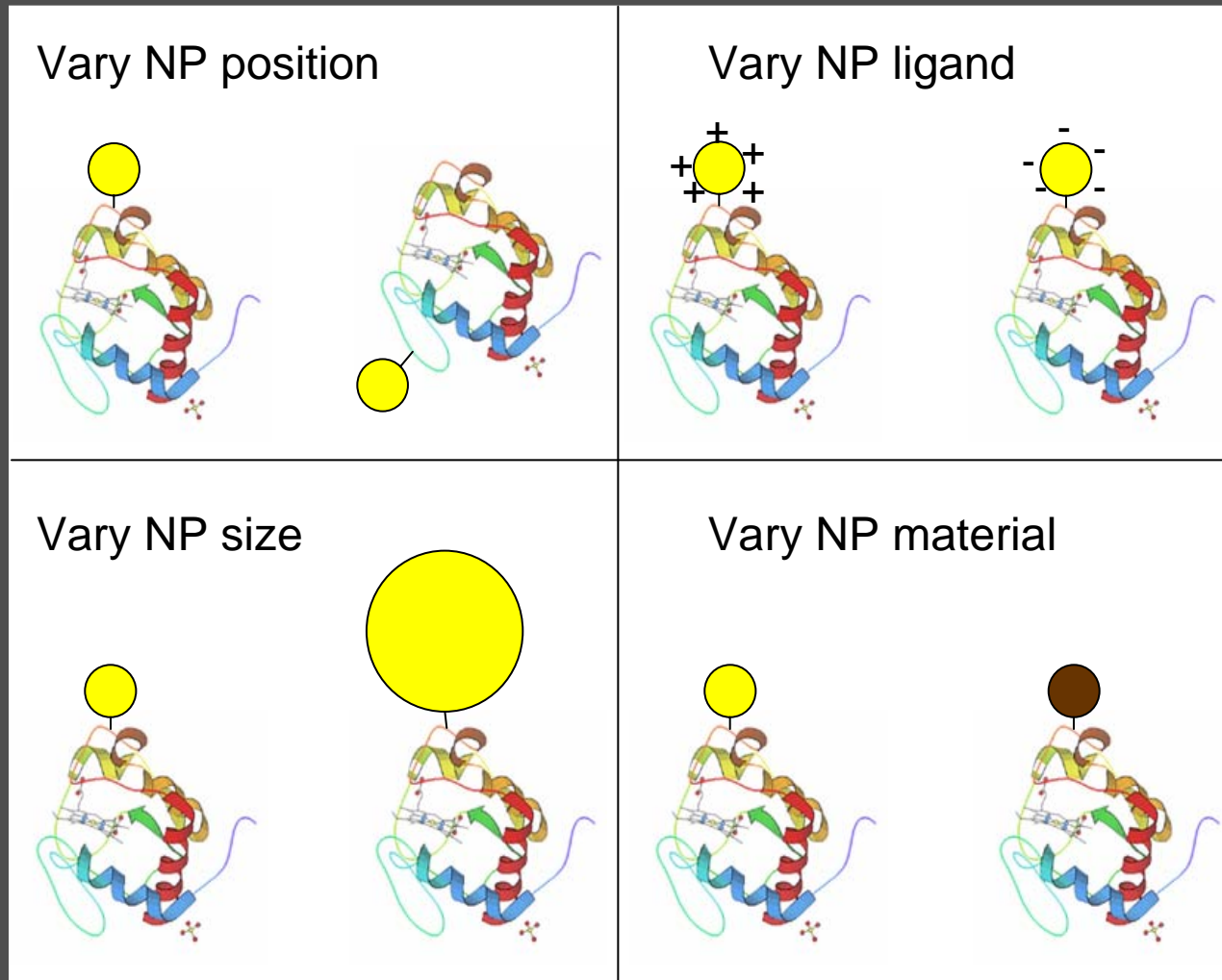
► Charged ligands result in greatest denaturation

Amino acids in vicinity

- Many charged amino acids closest to linking site

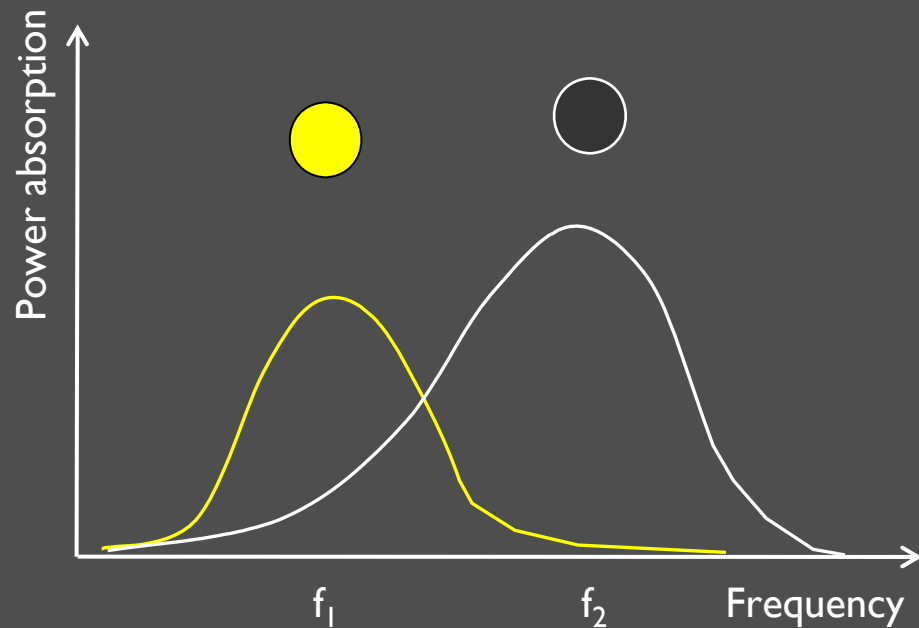
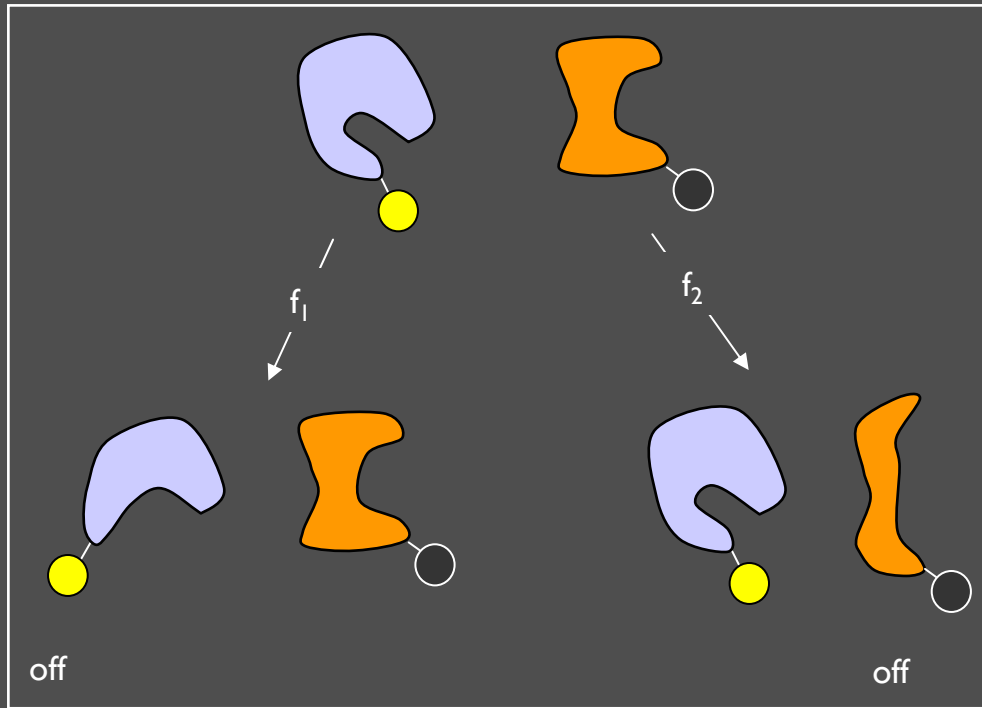


- Systematic study:



▶ electrostatic interactions with amino acids in local vicinity

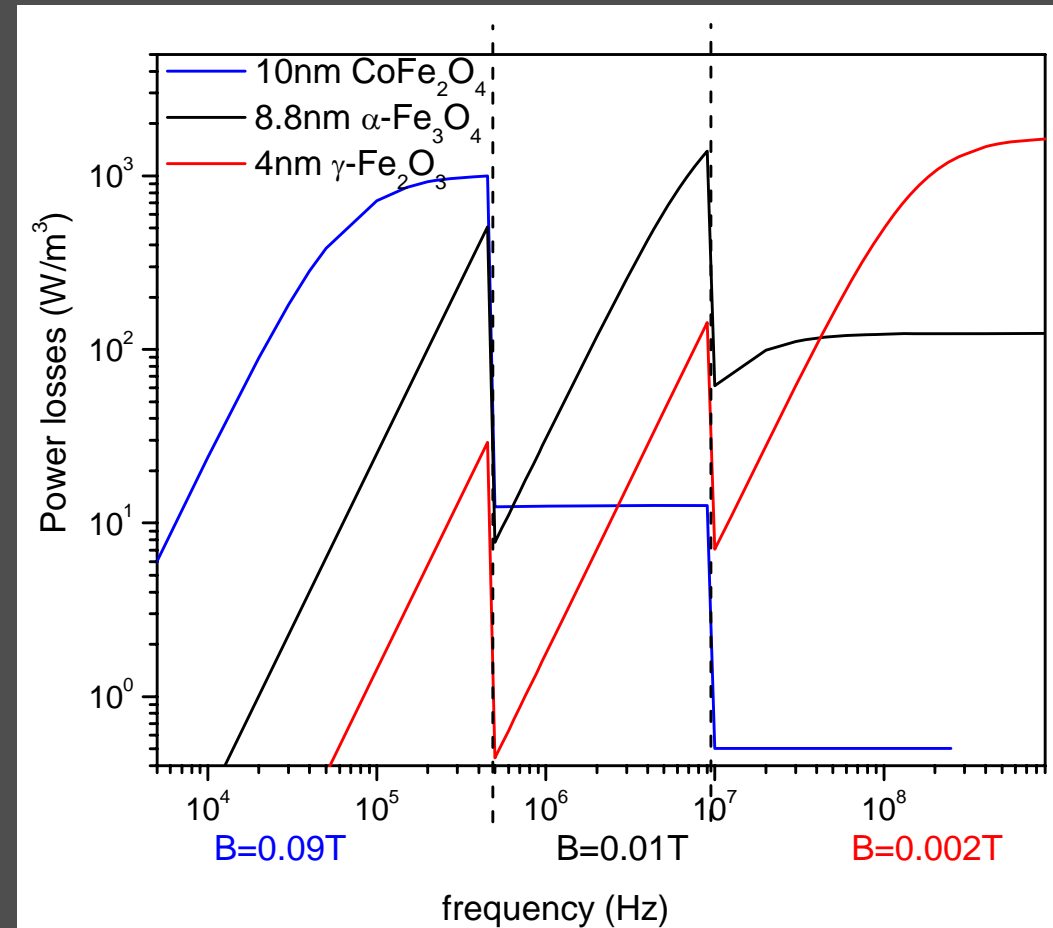
Orthogonal heating of NPs



A. Wijaya et al., 2006

$P = f$ (material properties, R , H , ω)

3-Variable Tuning = Multiple Control



► independent heating possible