



Metallomic Scientific Network No. 11440027

# Particle size analysis and distribution

Assoc. Prof. Dr. KLEDI XHAXHIU

Brno, 21.08.2015



**The disciplines that require and apply particle size determination and distribution**

 **Biochemistry, biotechnology**

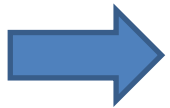
 **Chemistry (Colloid Chemistry)**

 **Physics**

 **Geology**

 **Agriculture**

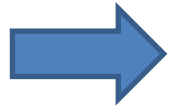
# Methods of PSD analysis



**Aerodynamic methods**



**Electrical zone sensing method**



**Electrical mobility and condensation method**

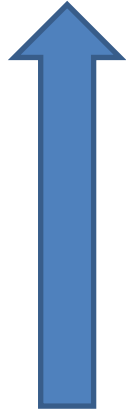


**Optical methods**



**Sedimentation methods**

$$\vec{G} = m\vec{g}$$



Sieves of different mesh



Torsion balance

Andreasen pipette



Particles > 0.1 μm

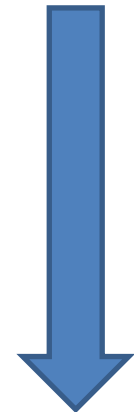
**Sedimentation methods**



Particles < 0.1 μm



$$\vec{F}_C = \frac{mv^2}{R}$$



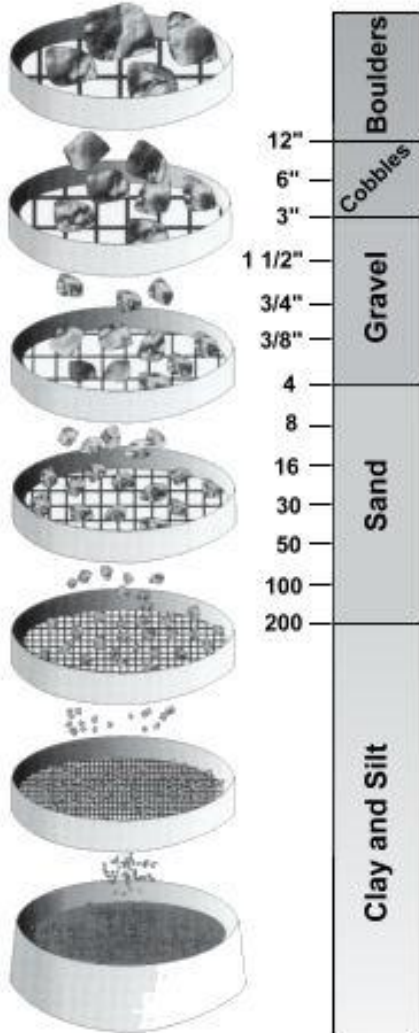
Ultracentrifuge



# Sieving and sedimentation

# Sieving for coarse particles

Sieve Test

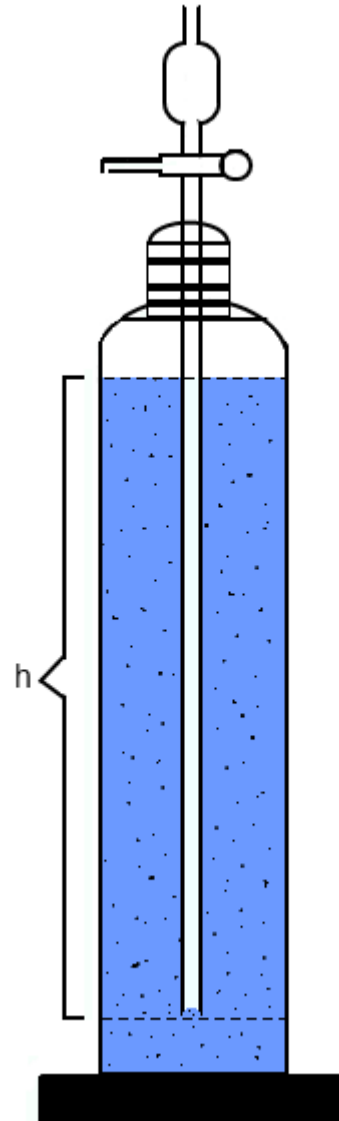


## Torsion Balance



$$Q (\%) = f(t, d)$$

## Andreasen pipette

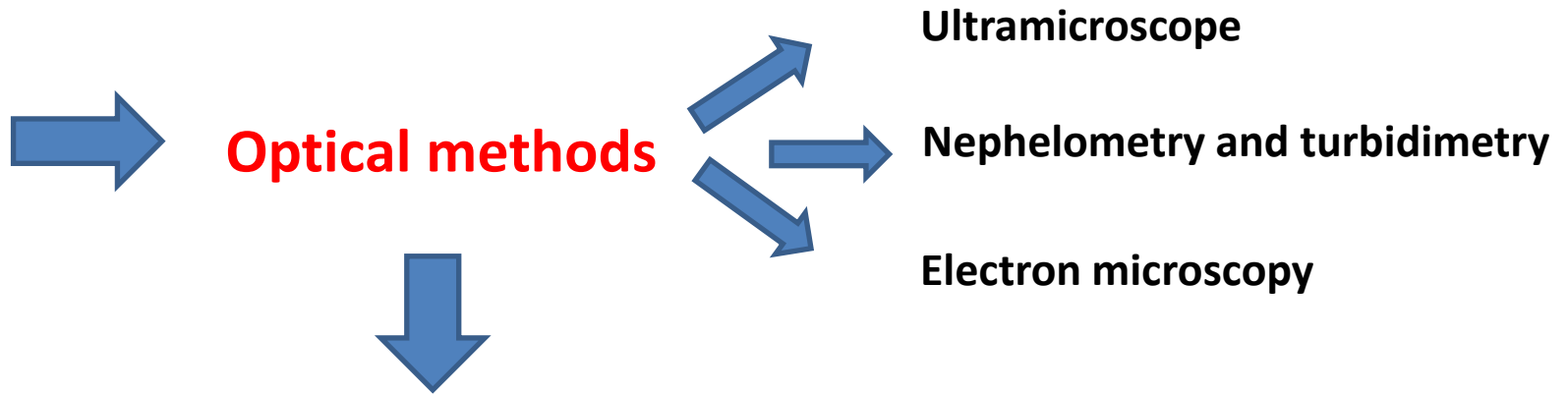


$$Q (\%) = f(t, d)$$





# Optical methods

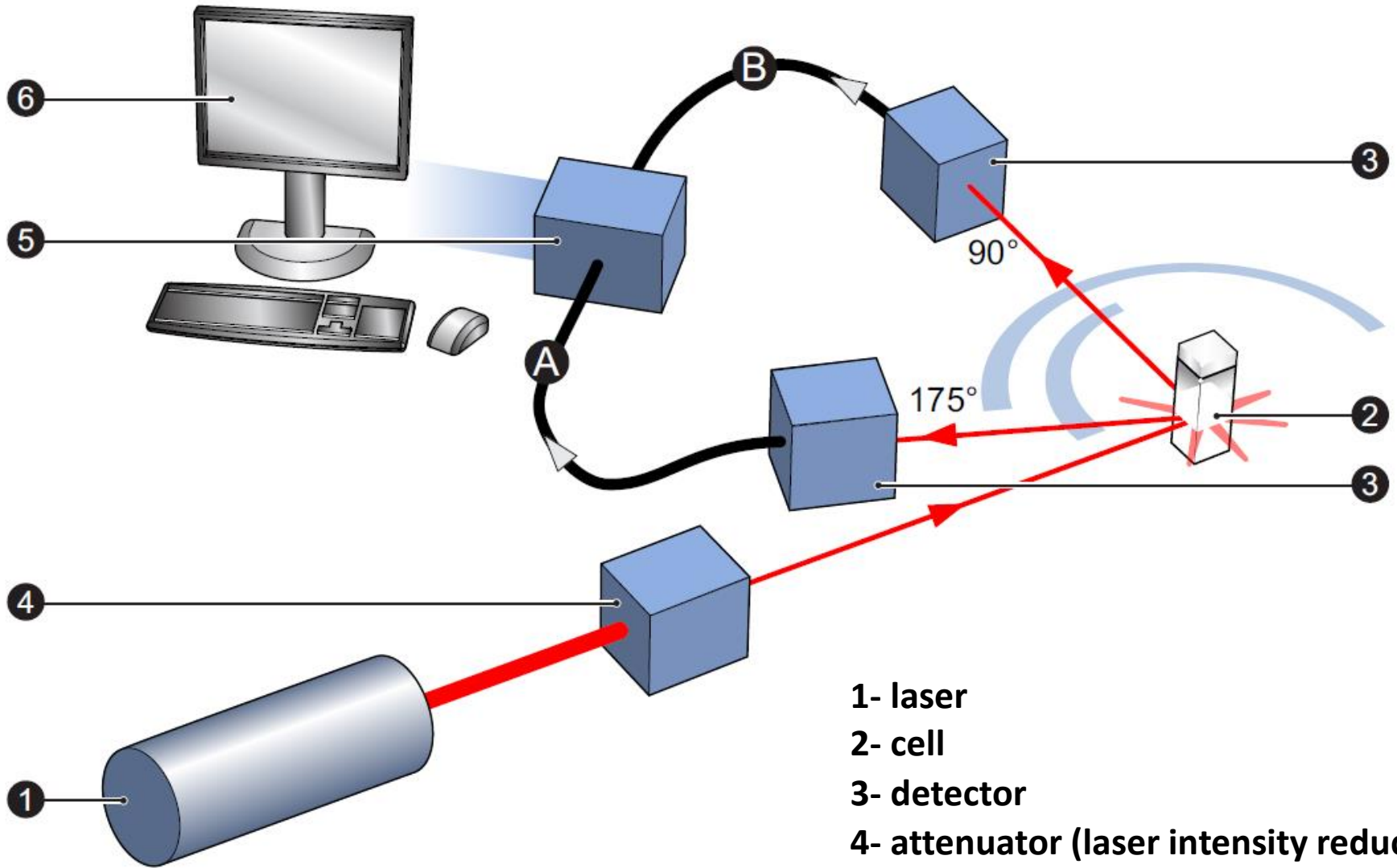


**Laser light scattering methods**

**Rayleigh equation**



## Particle size measurement at Malvern (scheme)



- 1- laser
- 2- cell
- 3- detector
- 4- attenuator (laser intensity reducer)
- 5- correlator (signal processing board)
- 6- computer

## Sample holders (cuvettes)

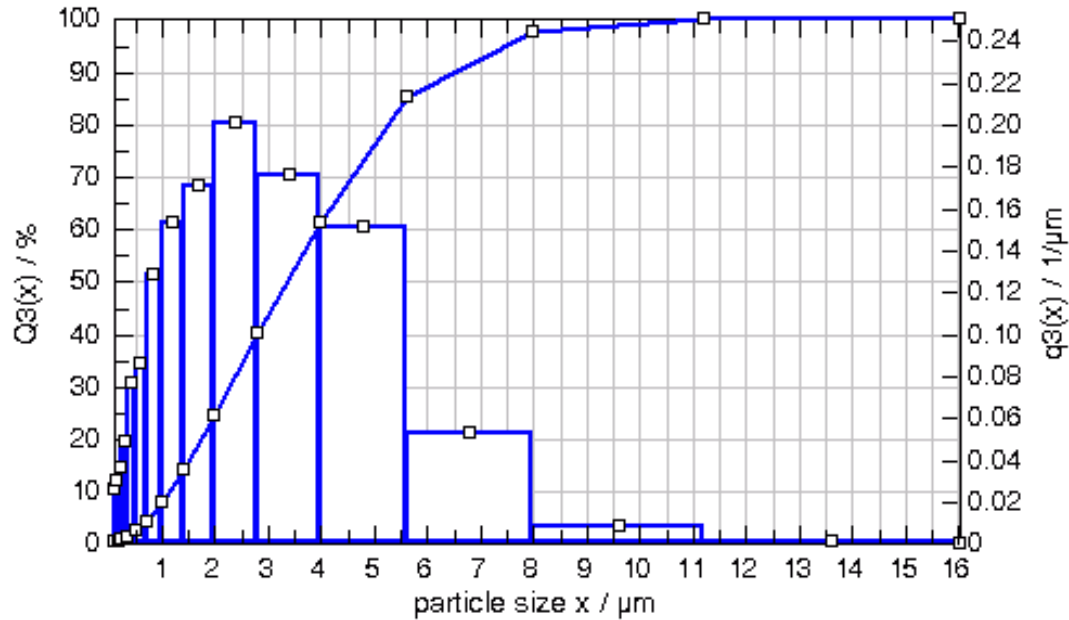


Disposable cuvettes

Non disposable  
cuvette

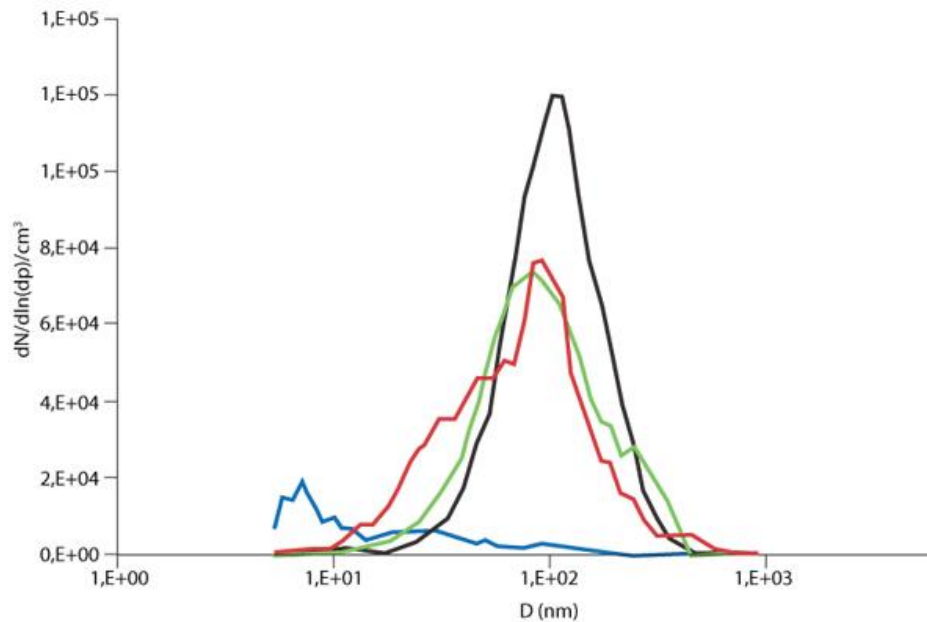
**Expression of results obtained  
by  
particle size determination**

# Distribution curves



**Integral PSD**

$$Q(g, kg) = f(d)$$



**Differential PSD**

$$\frac{dQ}{dD} = f(d_{mean})$$

# Type of differential curves obtained by Malvern zeta-sizer

Sample Name: MAN\_123 2

SOP Name: mansettings.nano

File Name: Vedran measurement.dts

Record Number: 3559

Material RI: 3,00

Material Absorbtion: 0,001

Dispersant Name: Water

Dispersant RI: 1,330

Viscosity (cP): 0,8872

Measurement Date and Time: 18. srpna 2015 16:06:49

Temperature (°C): 25,0

Duration Used (s): 80

Count Rate (kcps): 206,0

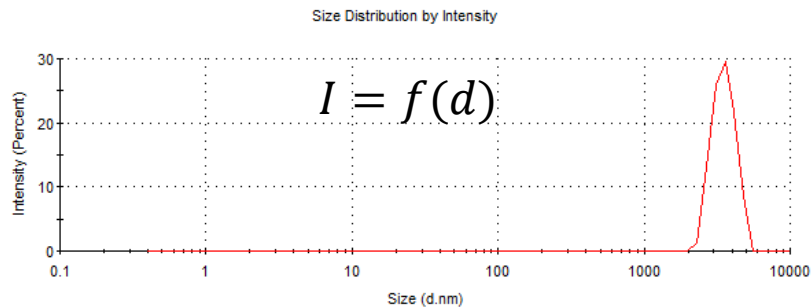
Measurement Position (mm): 3,00

Cell Description: Disposable micro cuvette (40µl)

Attenuator: 7

	Size (d.nm):	% Intensity:	St Dev (d.nm):
<b>Z-Average (d.nm):</b> 3409	<b>Peak 1:</b> 3543	100,0	620,8
<b>Pd:</b> 0,033	<b>Peak 2:</b> 0,000	0,0	0,000
<b>Intercept:</b> 0,845	<b>Peak 3:</b> 0,000	0,0	0,000

Result quality : **Good**



Sample Name: MAN\_123 2

SOP Name: mansettings.nano

File Name: Vedran measurement.dts

Record Number: 3559

Material RI: 3,00

Material Absorbtion: 0,001

Dispersant Name: Water

Dispersant RI: 1,330

Viscosity (cP): 0,8872

Measurement Date and Time: 18. srpna 2015 16:06:49

Temperature (°C): 25,0

Duration Used (s): 80

Count Rate (kcps): 206,0

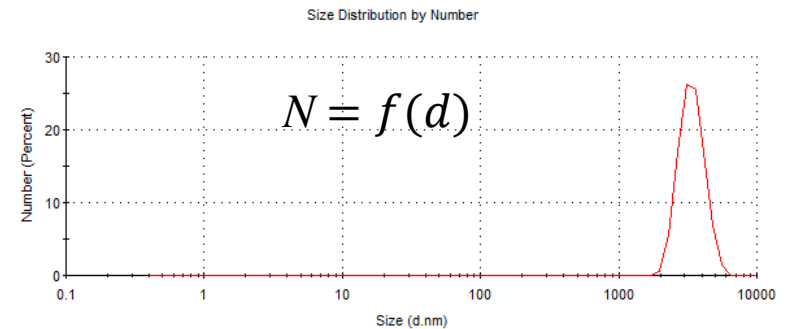
Measurement Position (mm): 3,00

Cell Description: Disposable micro cuvette (40µl)

Attenuator: 7

	Size (d.nm):	% Number:	St Dev (d.nm):
<b>Z-Average (d.nm):</b> 3409	<b>Peak 1:</b> 3426	100,0	704,6
<b>Pd:</b> 0,033	<b>Peak 2:</b> 0,000	0,0	0,000
<b>Intercept:</b> 0,845	<b>Peak 3:</b> 0,000	0,0	0,000

Result quality : **Good**



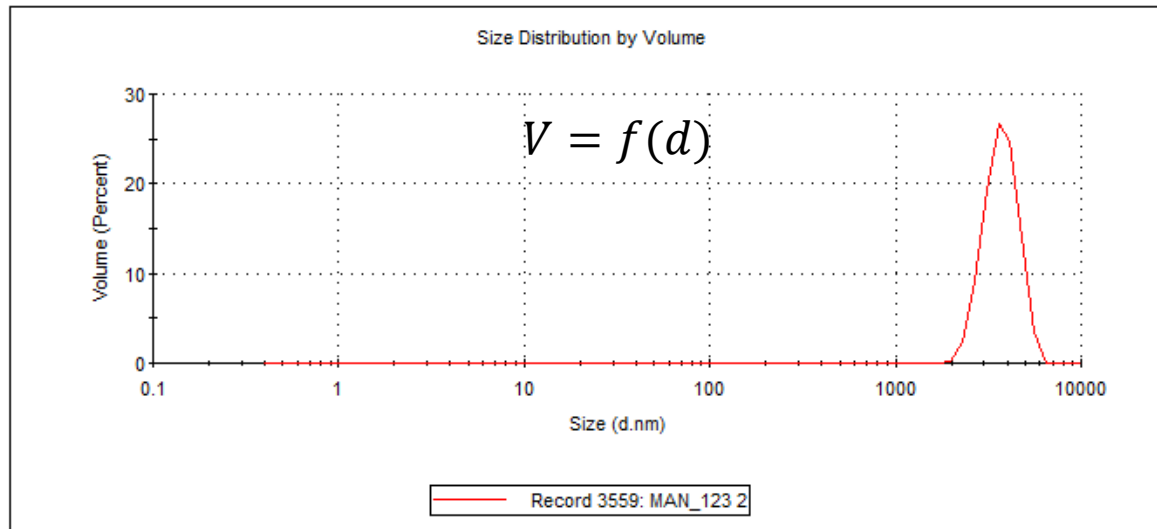
# Type of differential curves obtained by zeta-sizer

Sample Name: MAN\_123 2  
SOP Name: mansettings.nano  
File Name: Vedran measurement.dts  
Record Number: 3559  
Material RI: 3,00  
Material Absorbtion: 0,001  
Dispersant Name: Water  
Dispersant RI: 1,330  
Viscosity (cP): 0,8872  
Measurement Date and Time: 18. srpna 2015 16:06:49

Temperature (°C): 25,0  
Count Rate (kcps): 206,0  
Cell Description: Disposable micro cuvette (40µl)  
Duration Used (s): 80  
Measurement Position (mm): 3,00  
Attenuator: 7

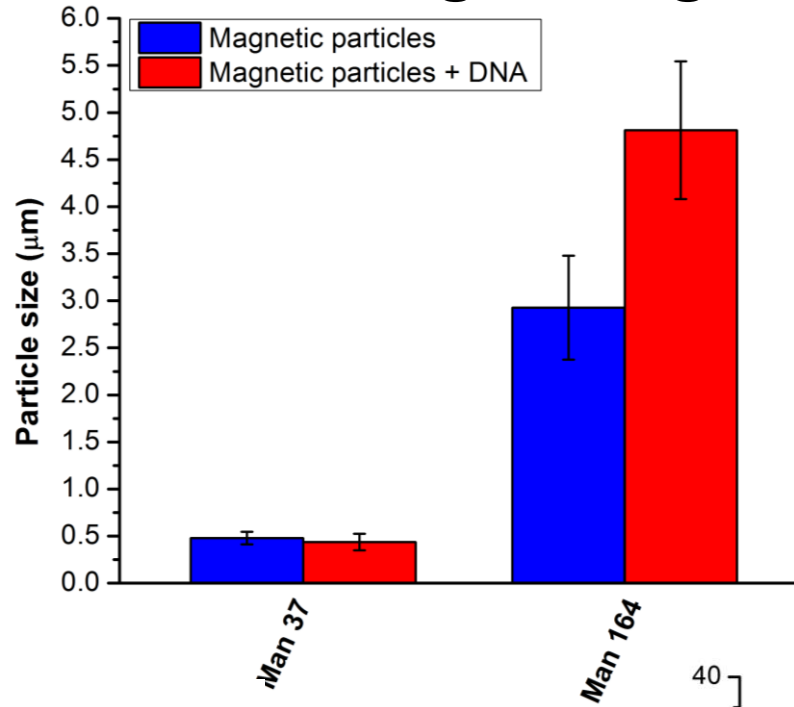
	Size (d.nm):	% Volume:	St Dev (d.nm):
<b>Z-Average (d.nm):</b> 3409	Peak 1: 3753	100,0	749,6
<b>Pdl:</b> 0,033	Peak 2: 0,000	0,0	0,000
<b>Intercept:</b> 0,845	Peak 3: 0,000	0,0	0,000

Result quality : **Good**

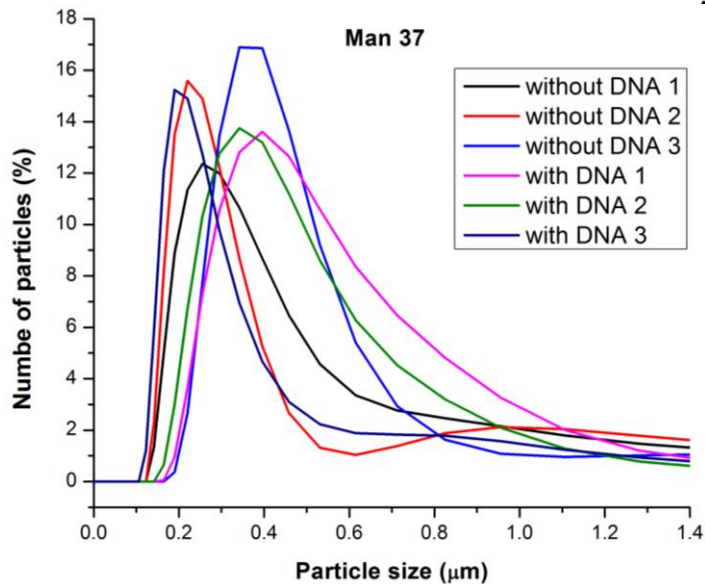




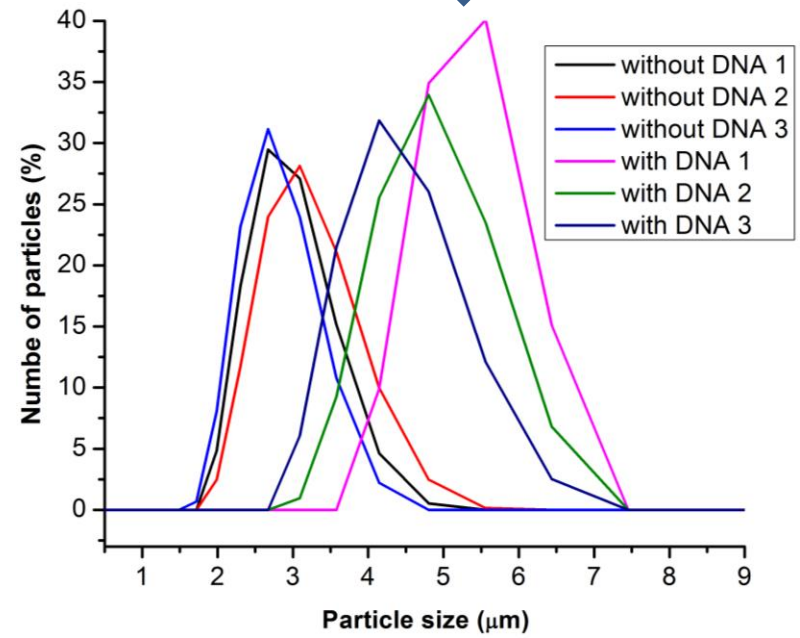
# Example: DNA binding to magnetic nanoparticles



Small particles  
(no visible change!)



Bigger particles  
(visible change!)



# Summary



The disciplines which need PSD



Methods which analyse particle sizes



Malvern zeta-sizer for particle size analysis



Types of expression of PSD



Examples of PSD obtained by Malvern zeta-sizer

Děkuji vám za vaši  
pozornost!

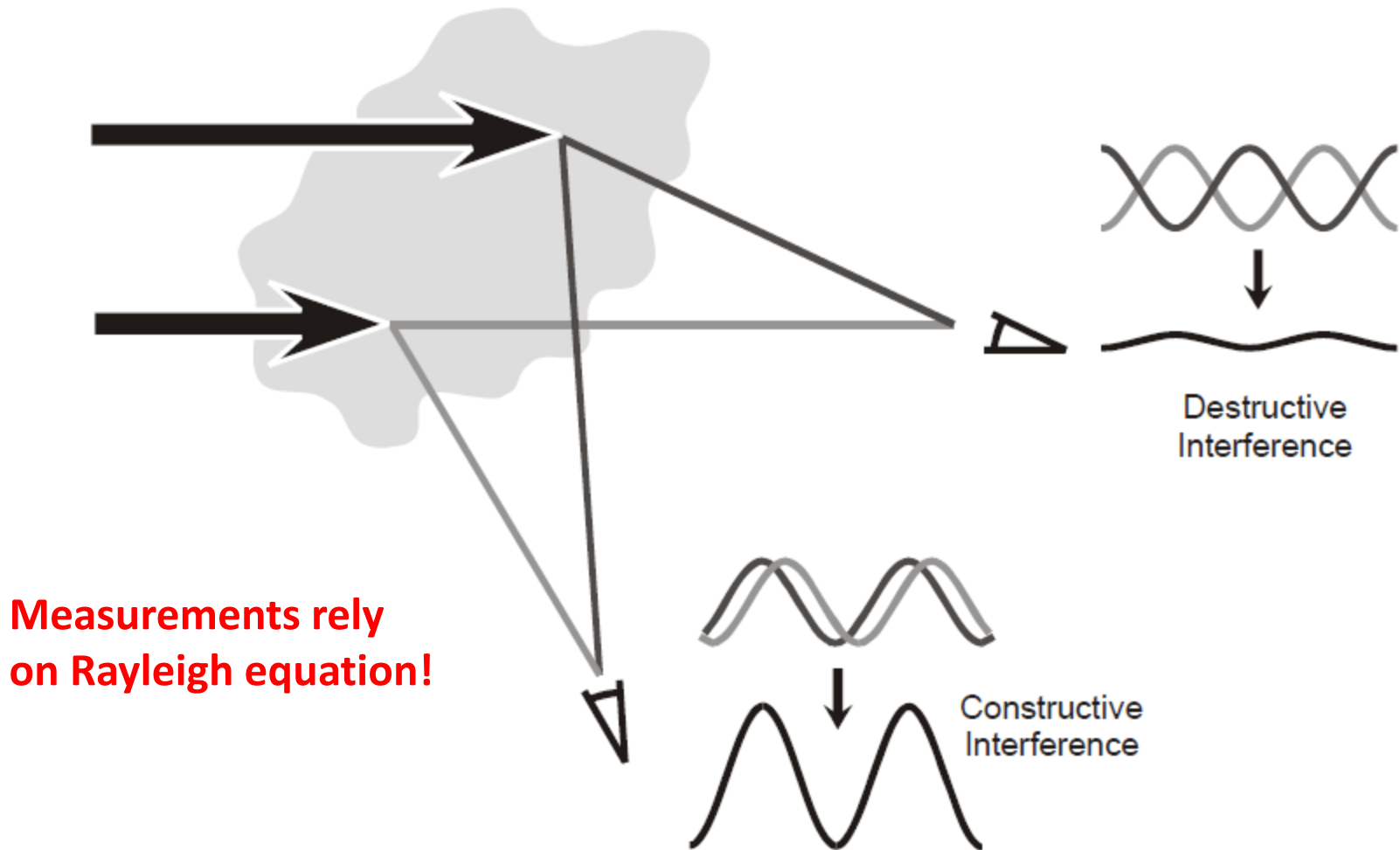
Thank you for your  
attention!

The project is supported by International Visegrad Fund,  
[www.visegradfund.org](http://www.visegradfund.org)





## Rayleigh scattering (for particles smaller than the light wavelength)



For particles smaller than the wavelength of light, Mie scattering (angular dependent on scattering intensity) reduces to Rayleigh scattering.