Dielectrophoretic filtration for high-throughput particle enrichment

Georg R. Pesch

Dielectrophoresis 2018, University of Surrey

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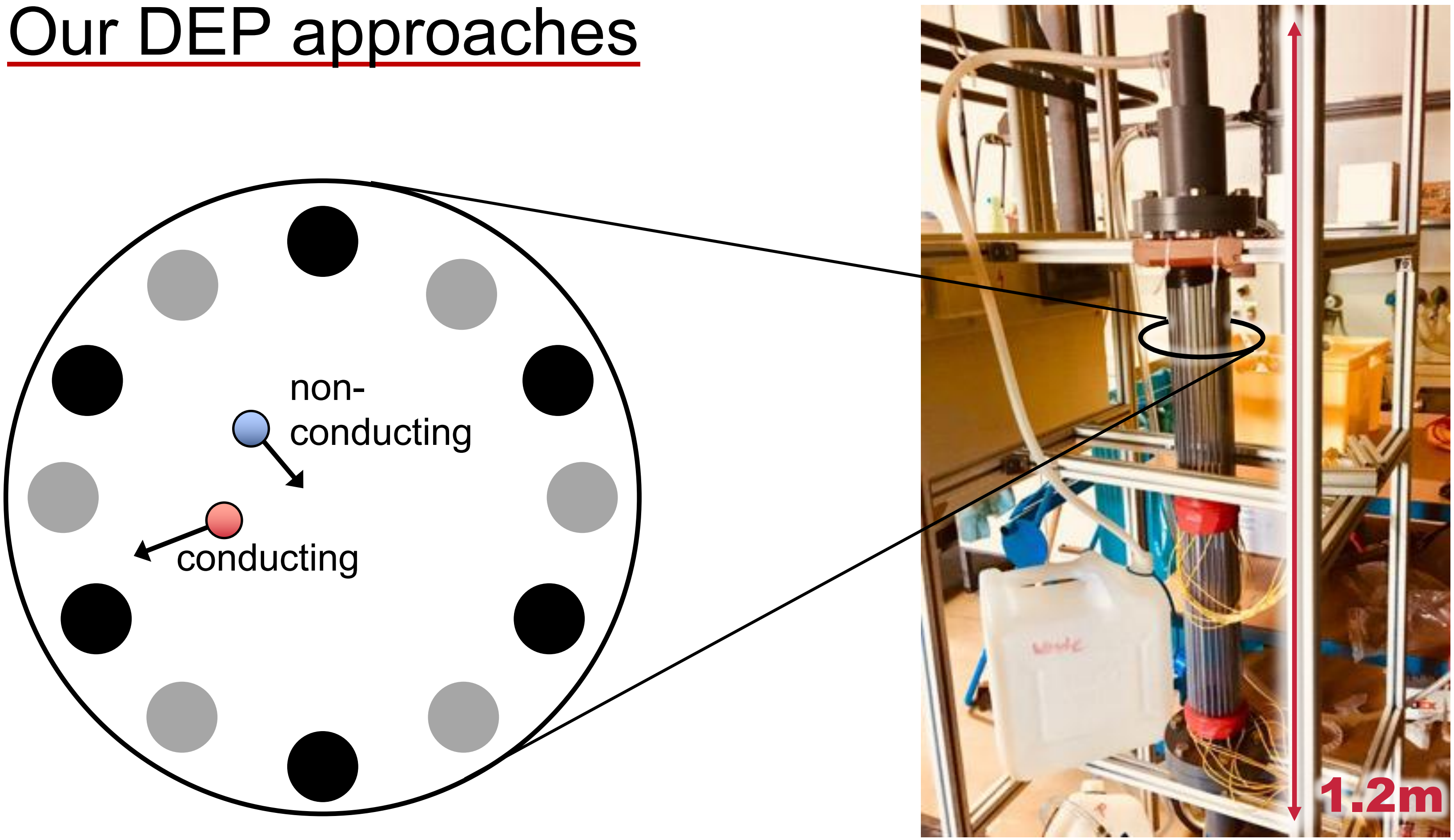
Universität Bremen
MZH

Our DEP approaches



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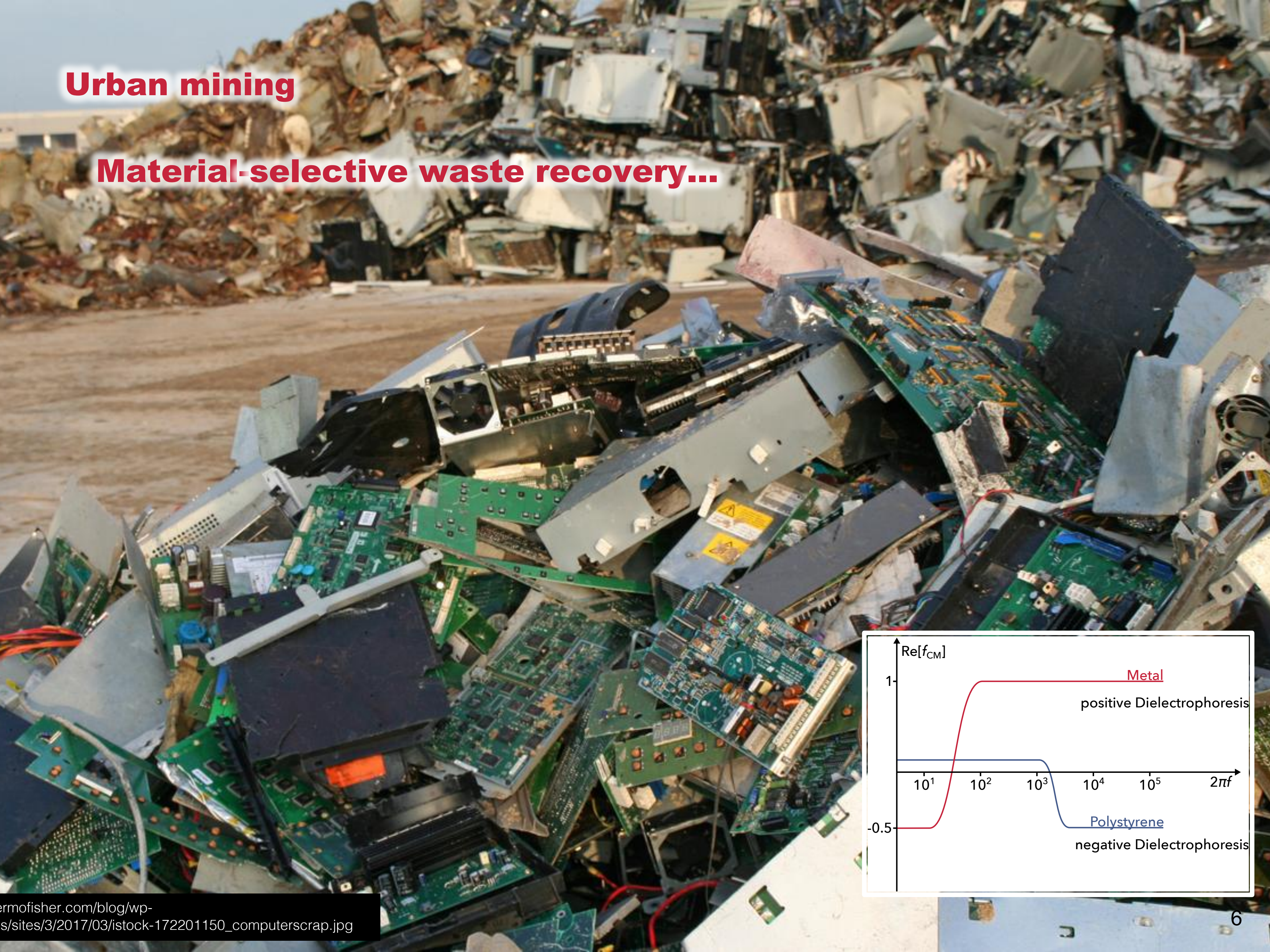

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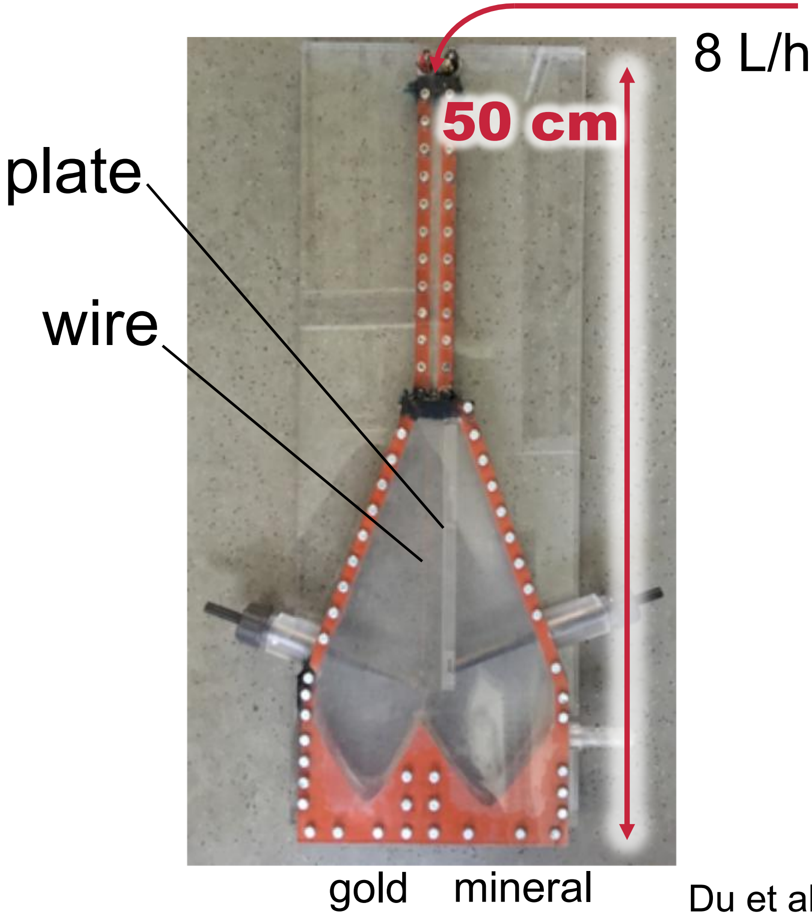
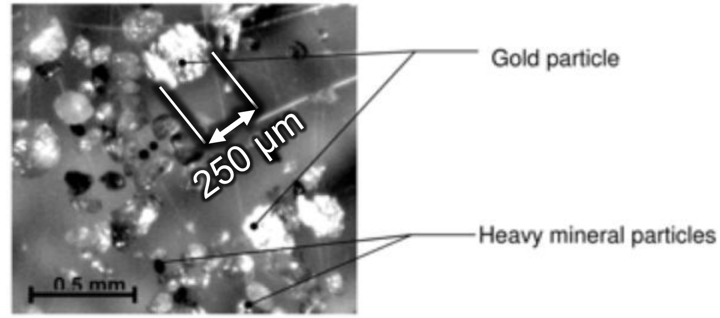
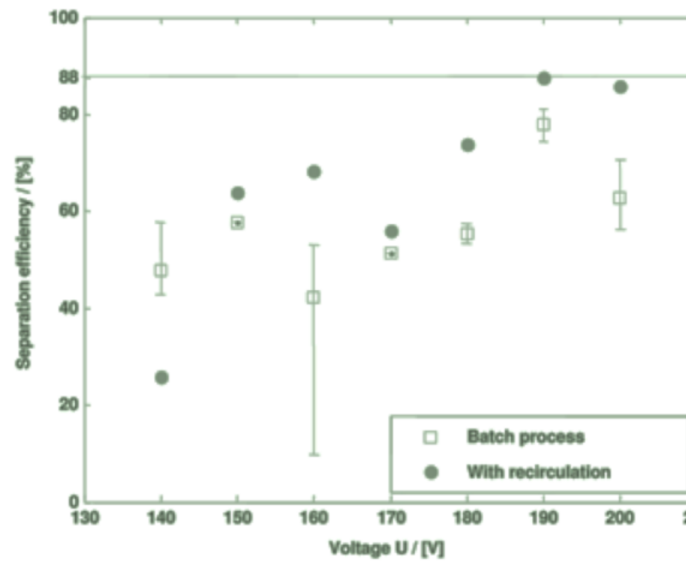
Our DEP approaches







Du et al. (2008), Separation Science and Technology 43(15)

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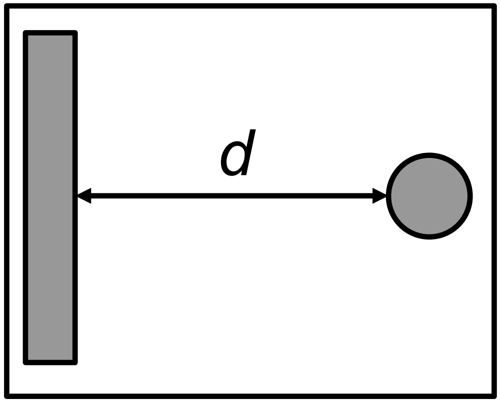
DEP motion and electrode design

$$\boldsymbol{F}_{\mathrm{DEP}} = 2\pi r^3 \varepsilon_{\mathrm{m}} \mathrm{Re}\left[\tilde{f}_{\mathrm{CM}}\right] \nabla \left|\boldsymbol{E}_{\mathrm{RMS}}\right|^2$$

electrode-based designs



$\nabla\mathbf{E}^2 \sim U^2/d^3$

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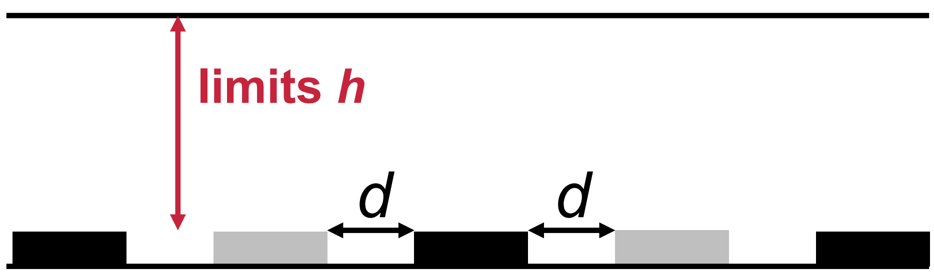

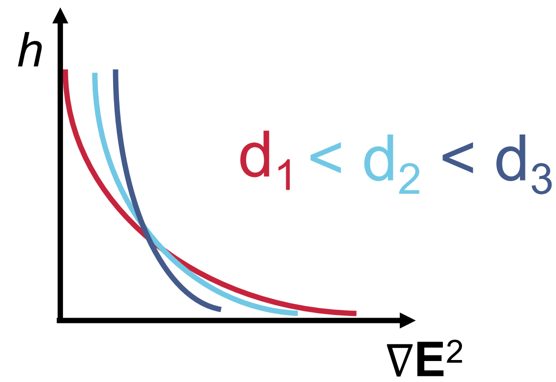

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DEP motion and electrode design

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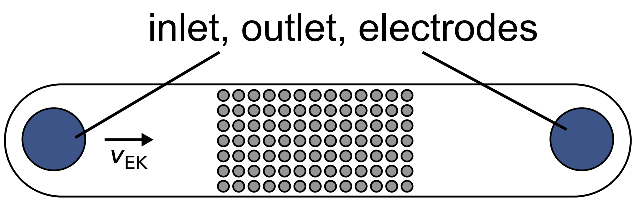
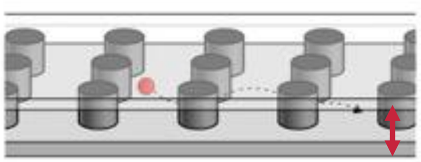
electrodeless designs





***h* limited by production**

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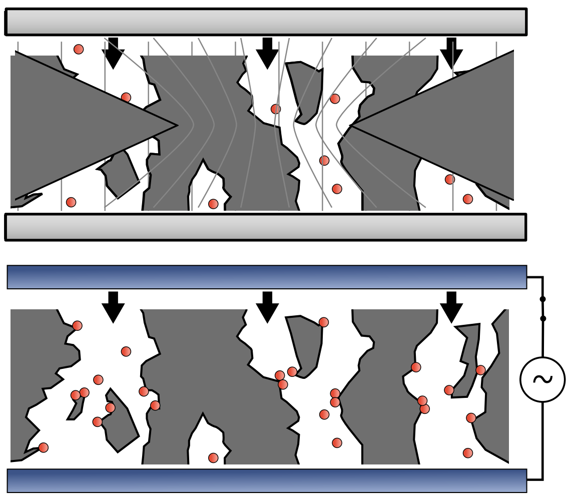
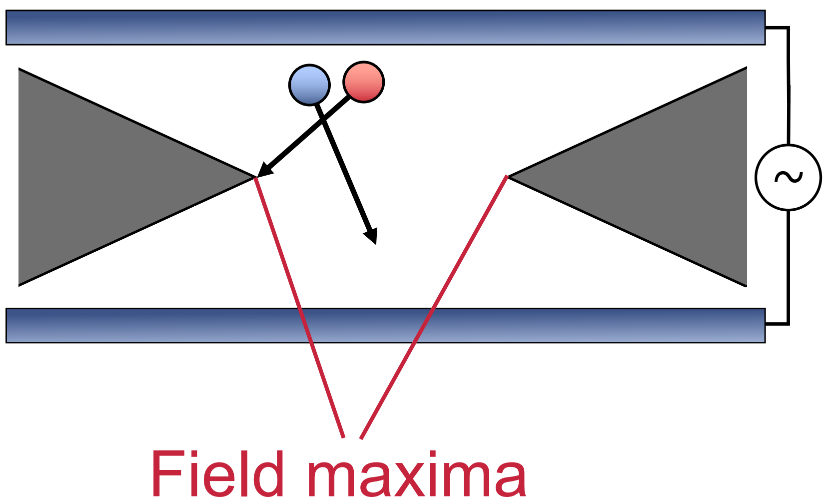
DEP filtration





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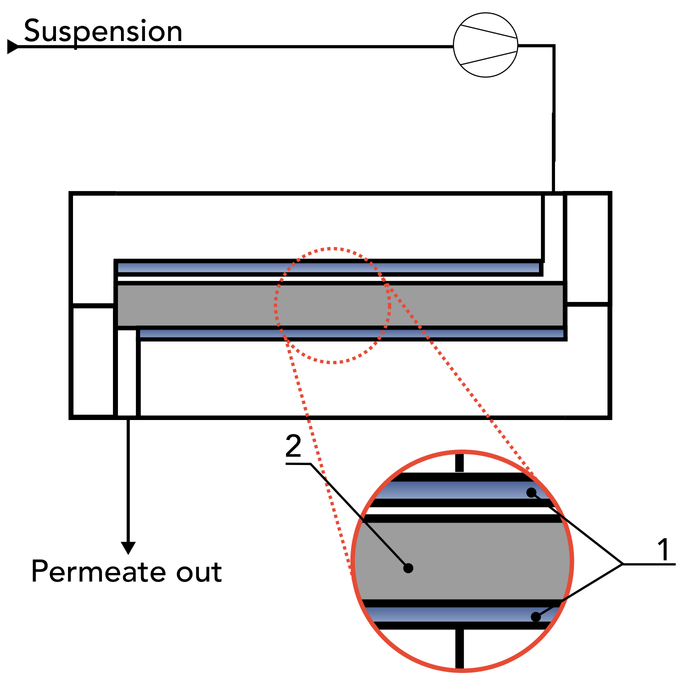
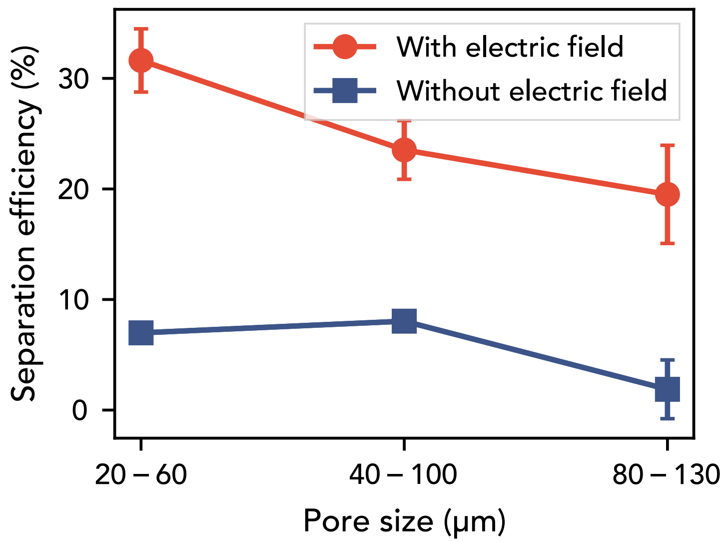
DEP Filtration



1–electrodes, 2–filter

Separation of 340 nm LbL particles
200V over 2 mm
1 mL min^{-1}



Pesch et al. (2014), Separation and Purification Technology 132

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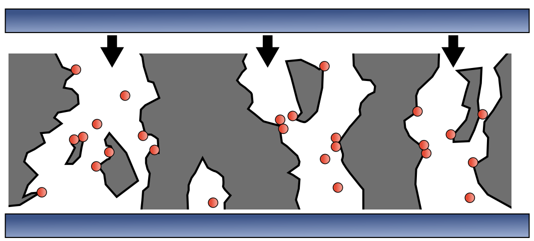
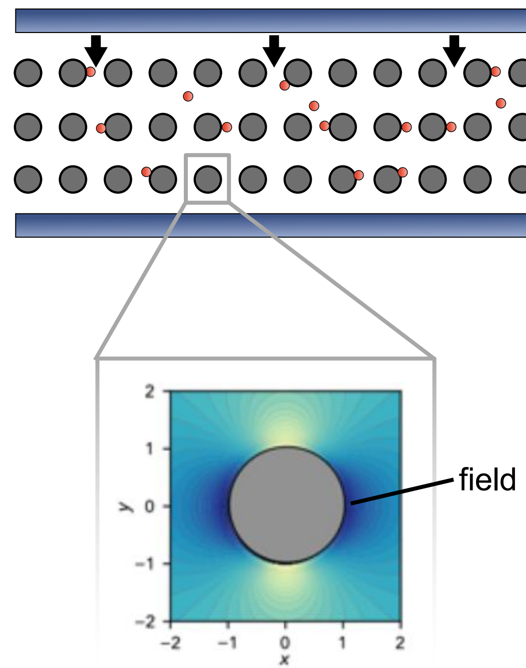
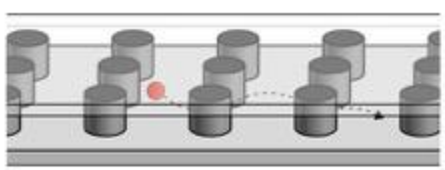
Model filter







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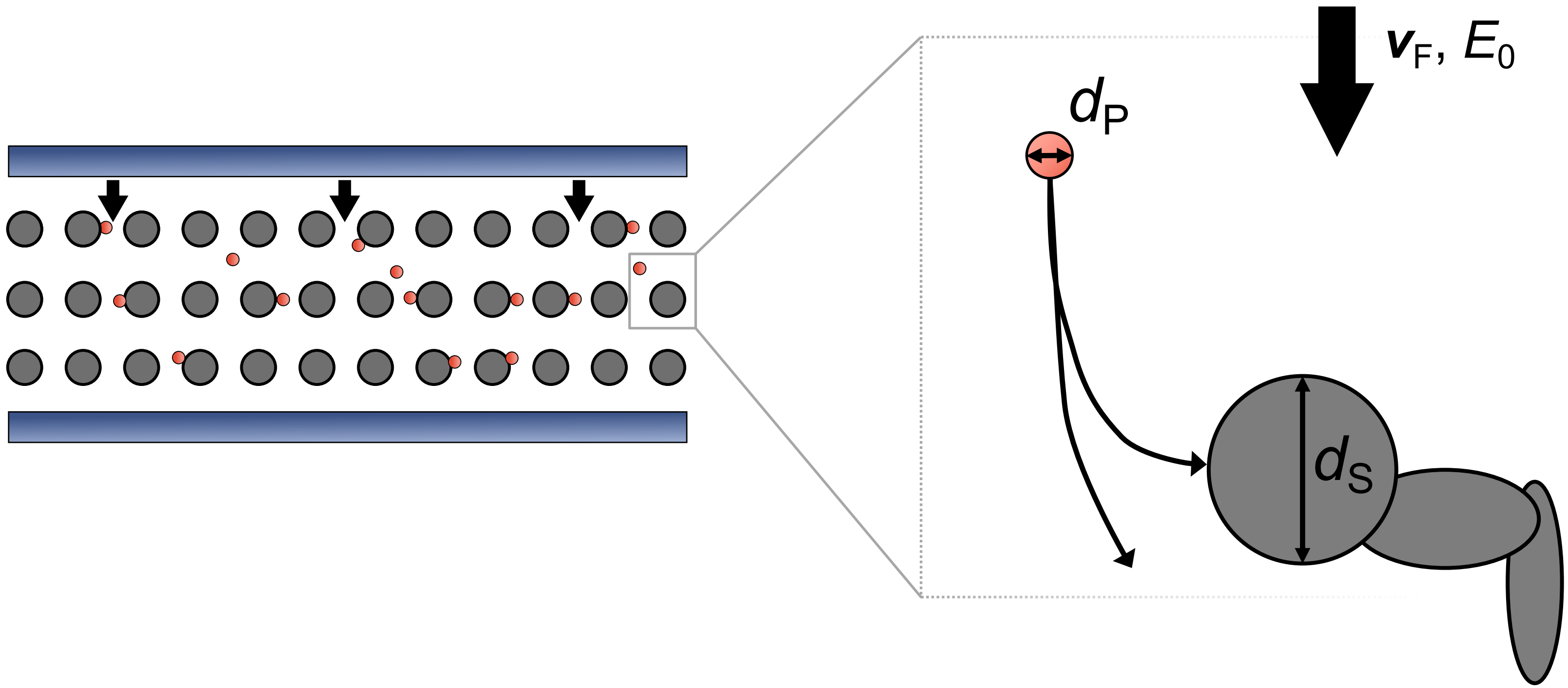
How do we design this?



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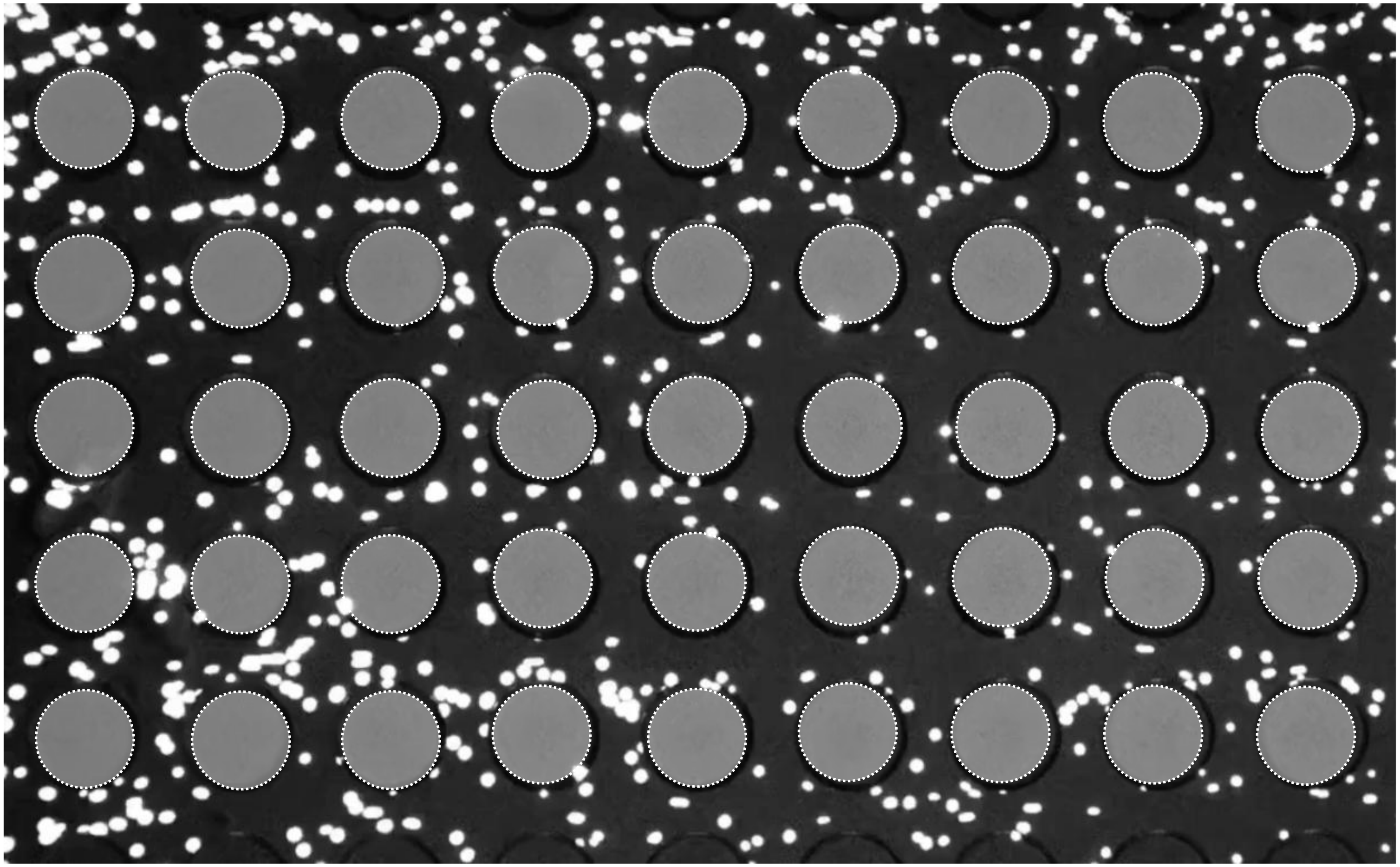

$\boldsymbol{v}_{\mathrm{F}}$, E_0

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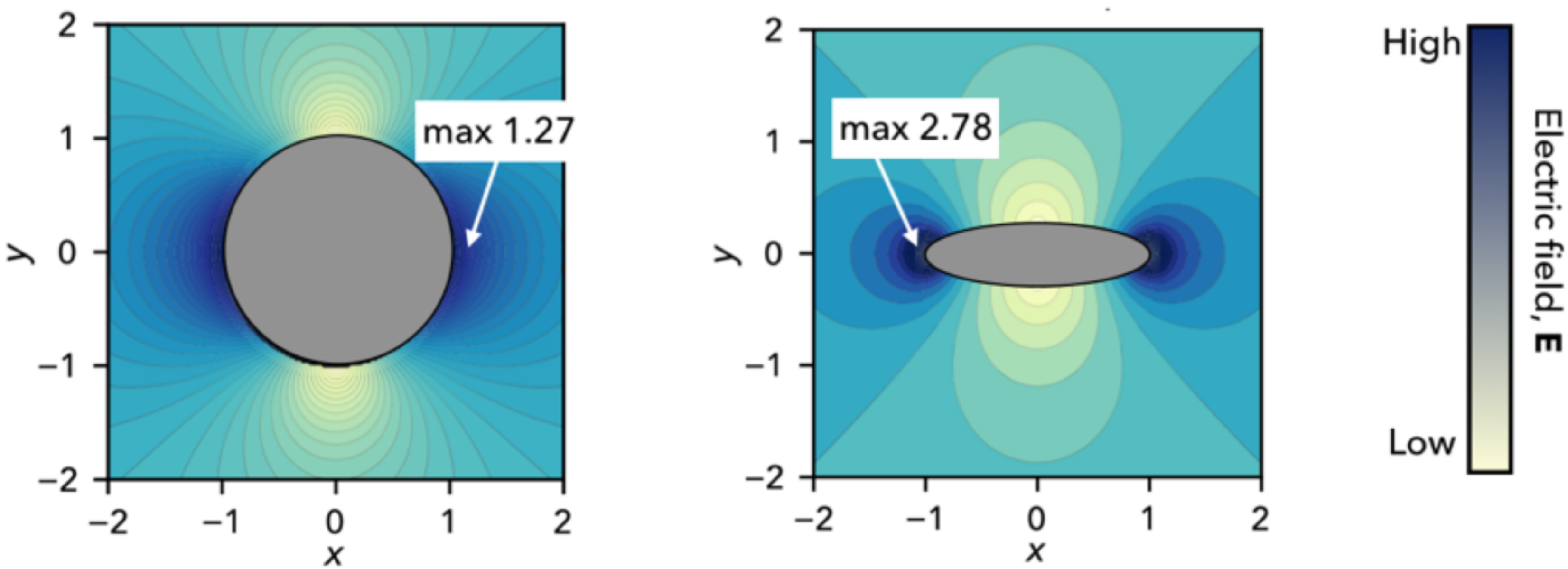
Polarization of a single post



Pesch et al. (2016), ELECTROPHORESIS 37(2)

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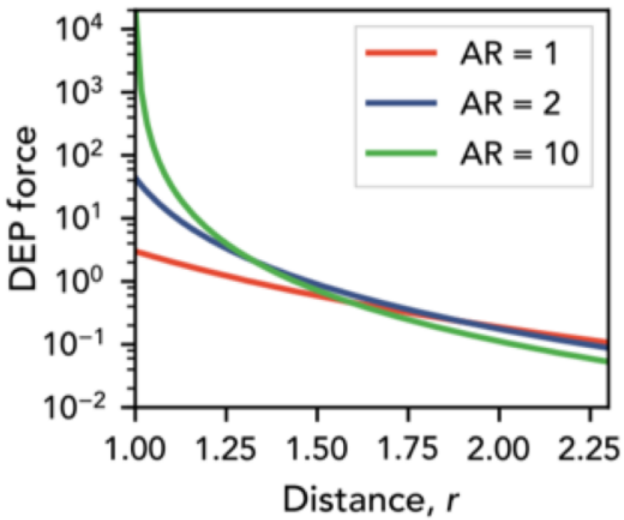
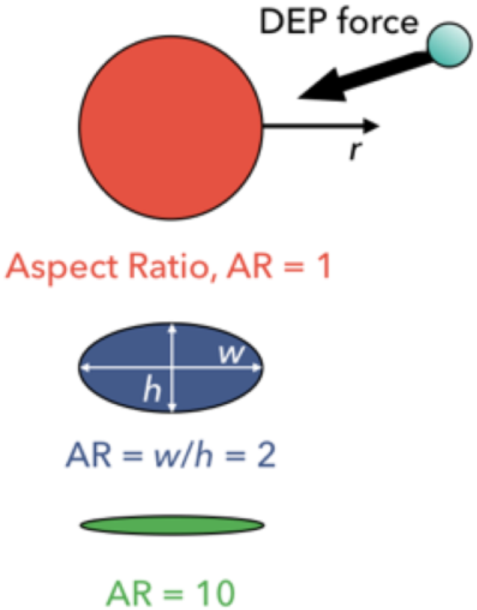
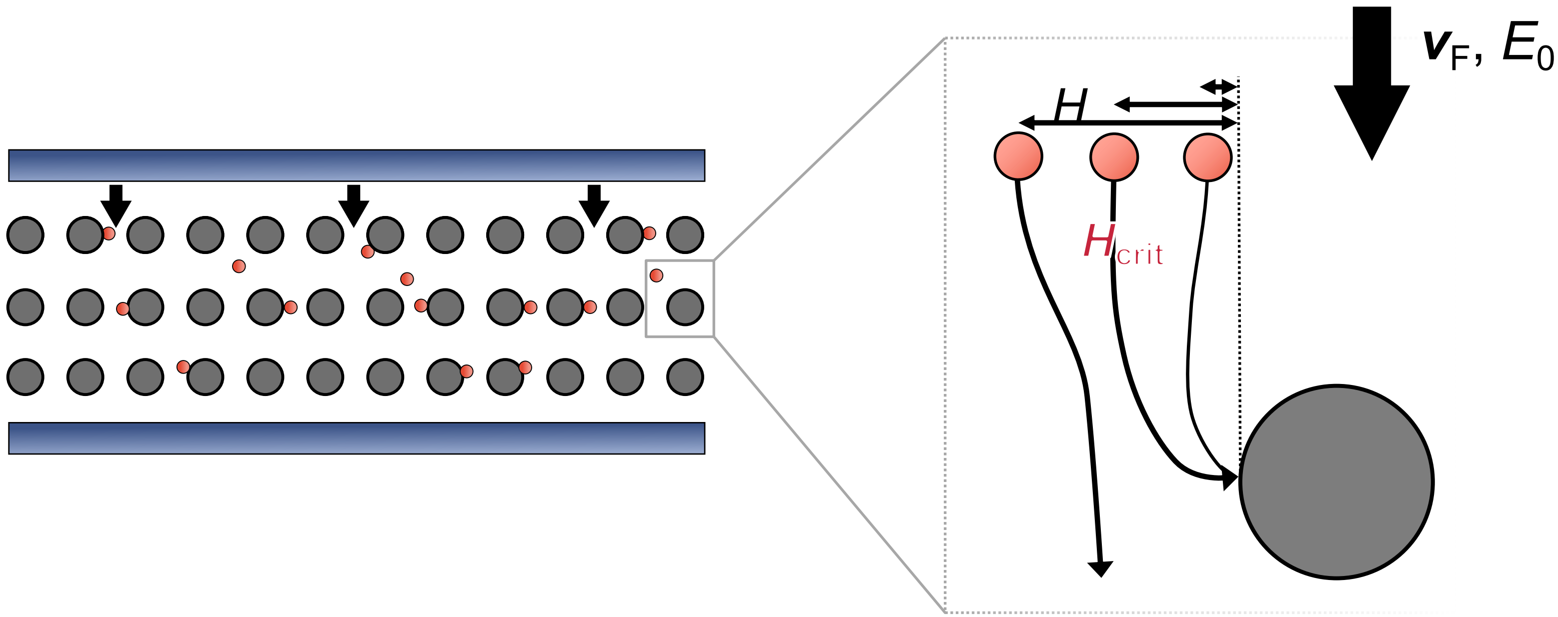




Pesch et al. (2016), ELECTROPHORESIS 37(2)

So… how do we design this now?



Pesch et al. (2017), Journal of Chromatography A 1483

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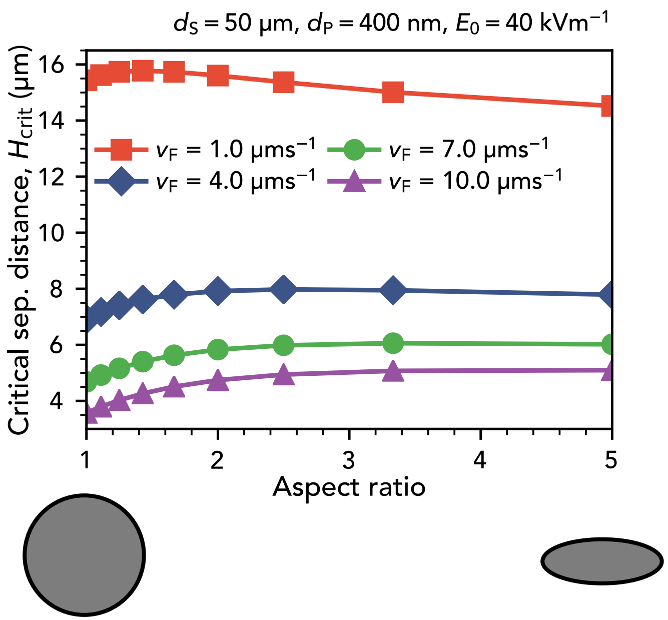
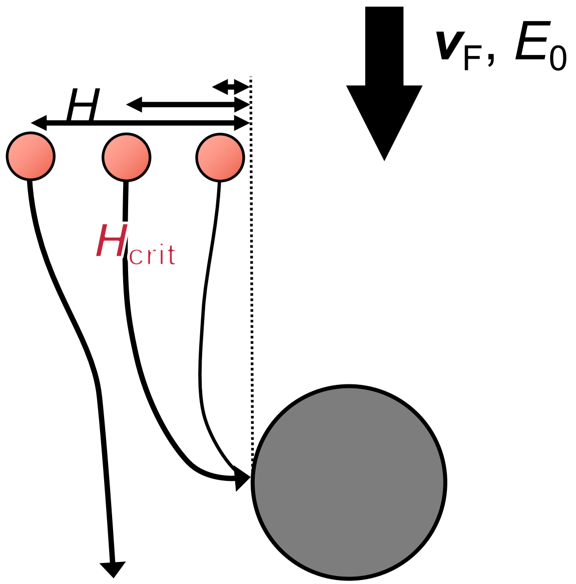
Trapping potential of a single post





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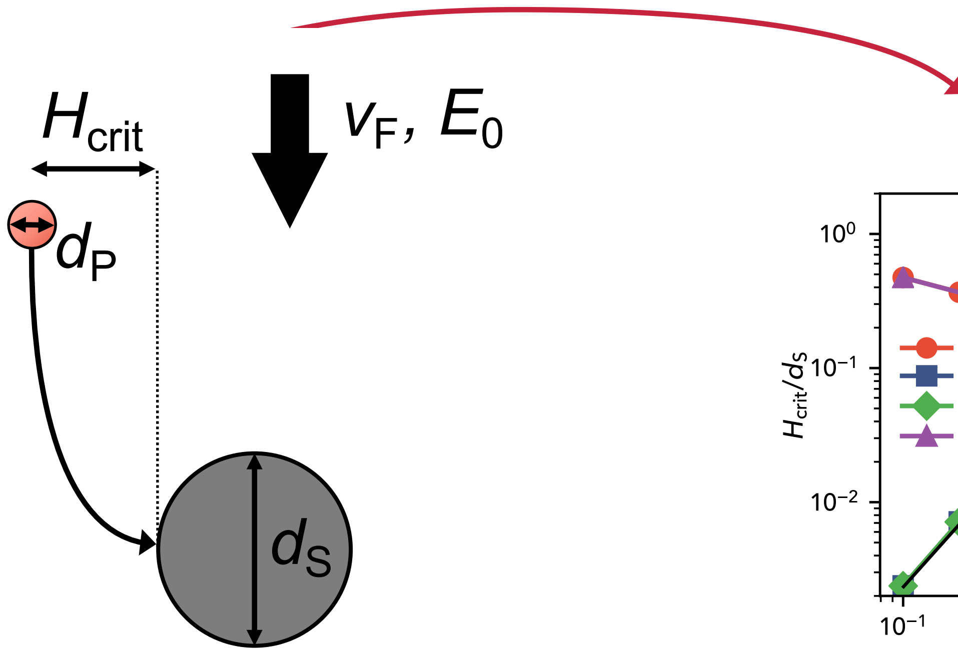

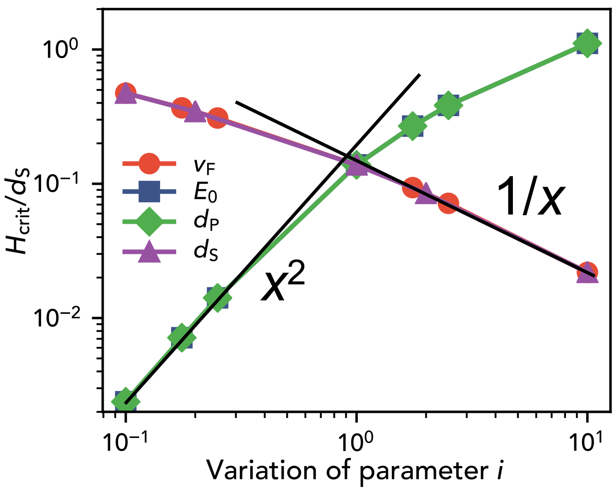

Pesch et al. (2017), Journal of Chromatography A 1483

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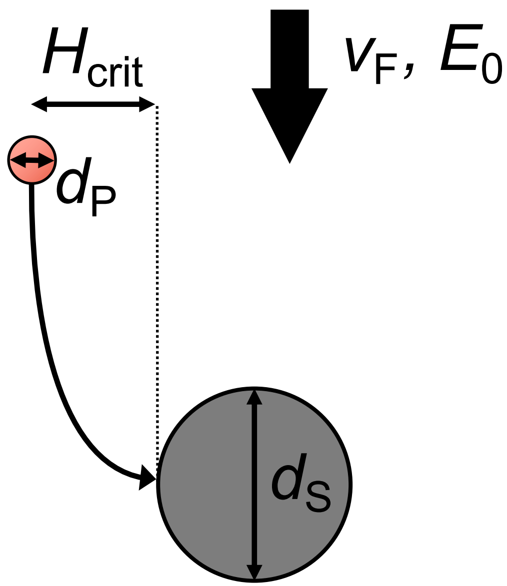

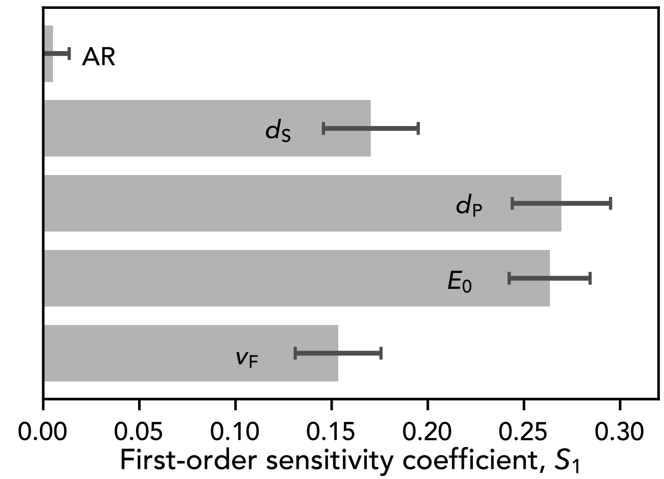

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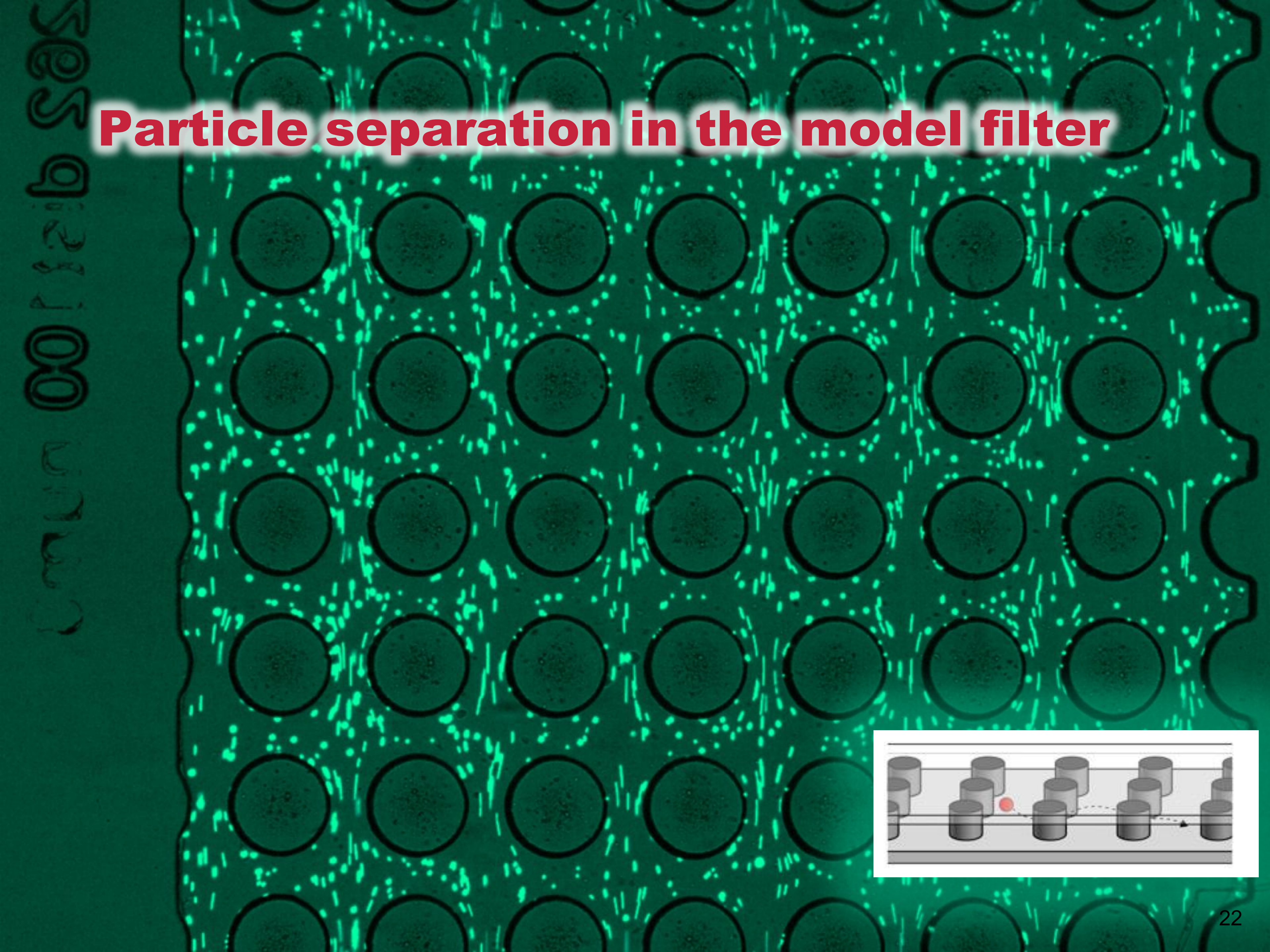
Particle separation in the model filter



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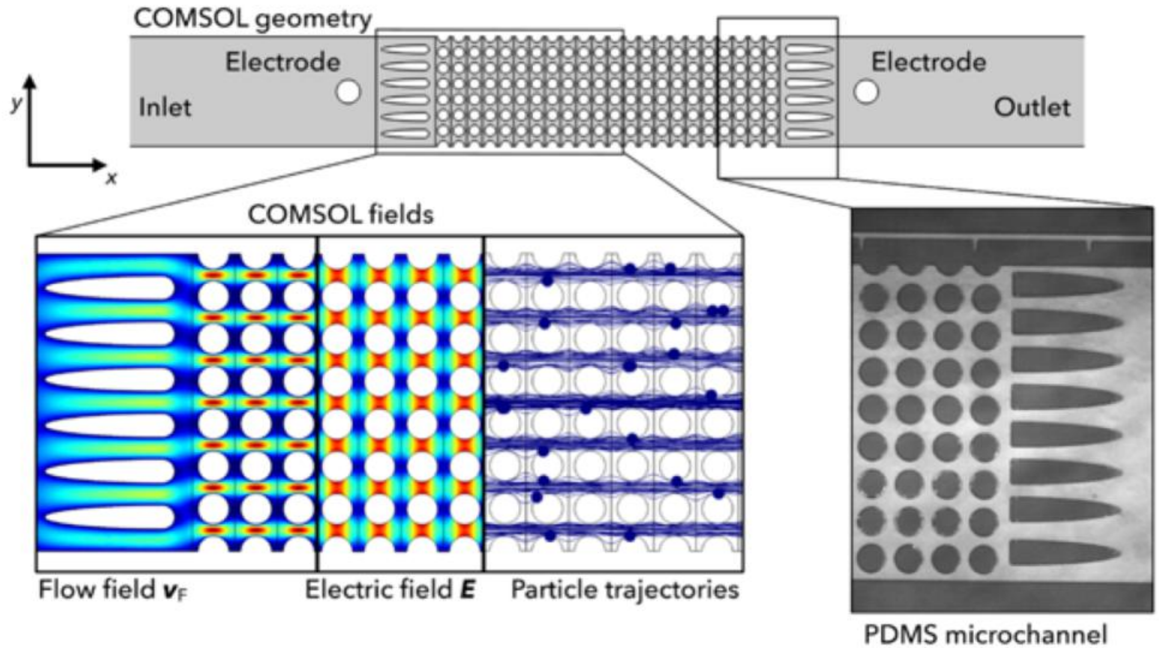

Pesch et al. (2018), Scientific Reports 8:10480

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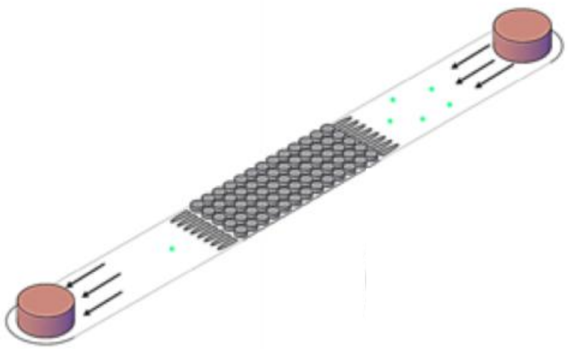
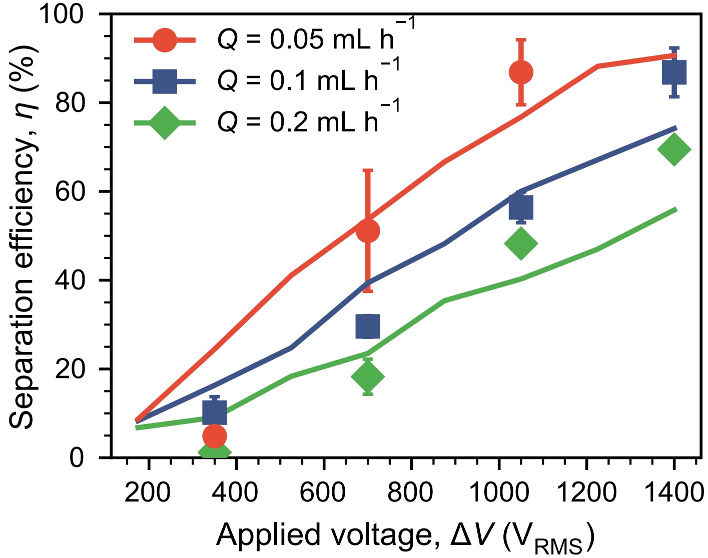


Post diameter d_S = 262 µm,
Post-to-post space d = 100 µm
Particle diameter d_P = 1 µm



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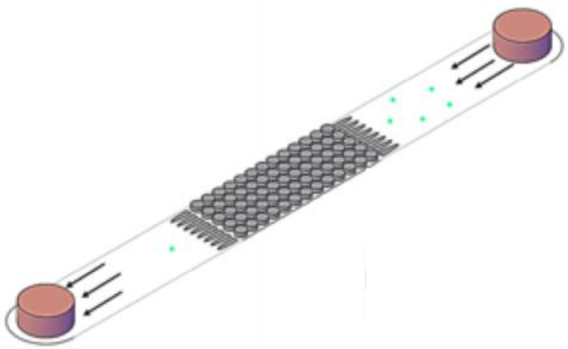
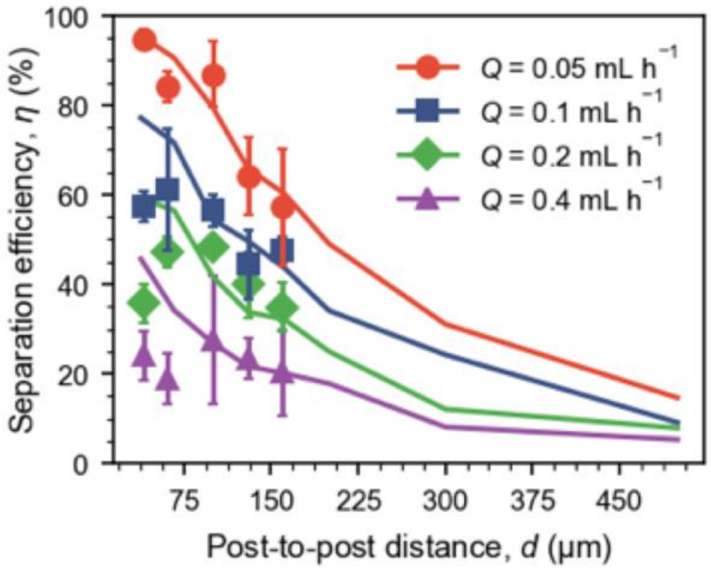
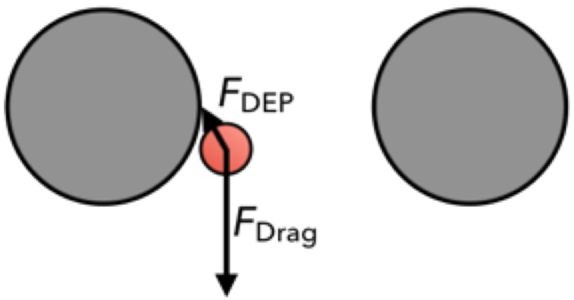




Post diameter	d_S = 262 μm,
Appl. voltage	ΔV = 1050 V_{RMS}
Particle diameter	d_P = 1 μm

Particle separation in the model filter



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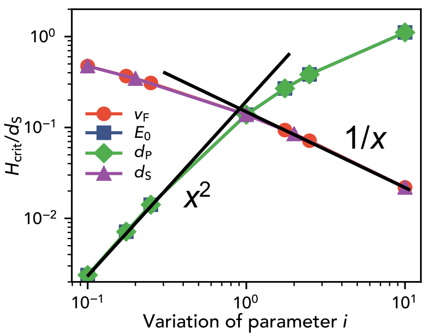
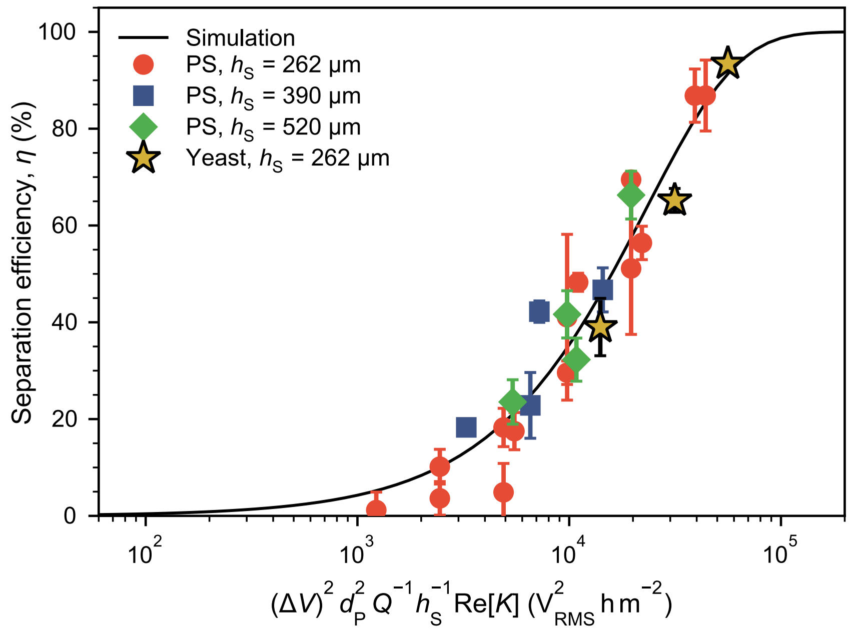
Particle separation in the model filter





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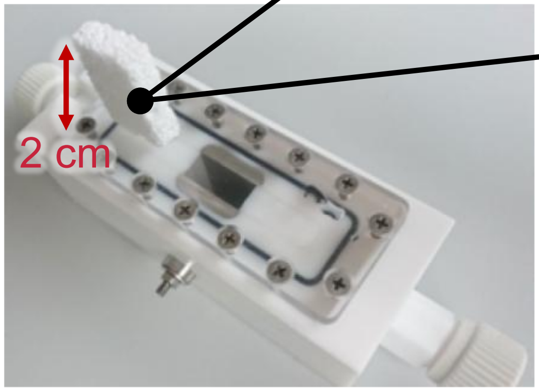
Particle separation in the *real* filter



pore size 130 µm
porosity 83%

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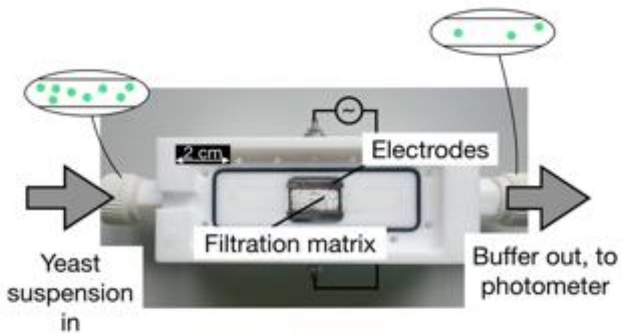
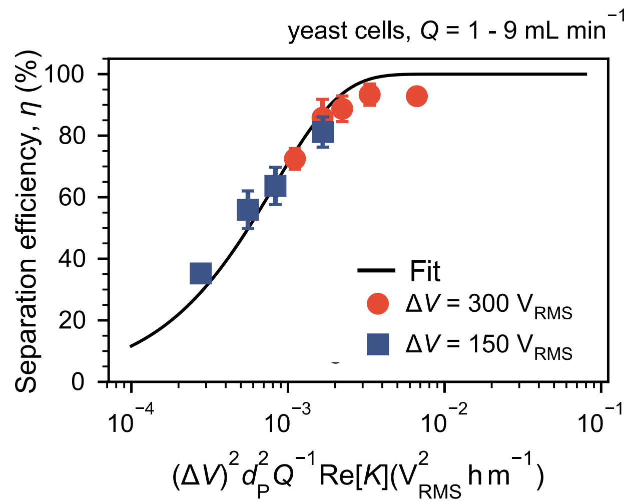
Particle separation in the real filter





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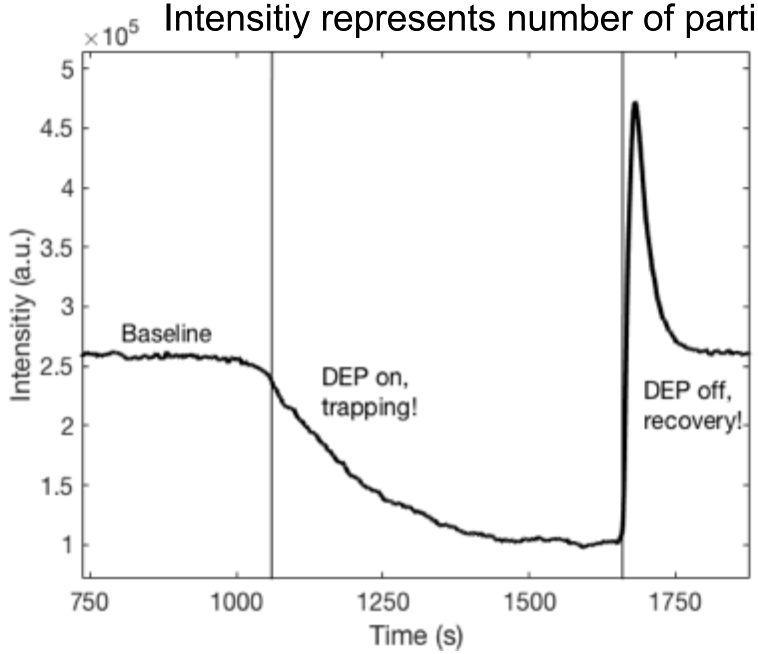
Recovery?

Intensitiy represents number of particles



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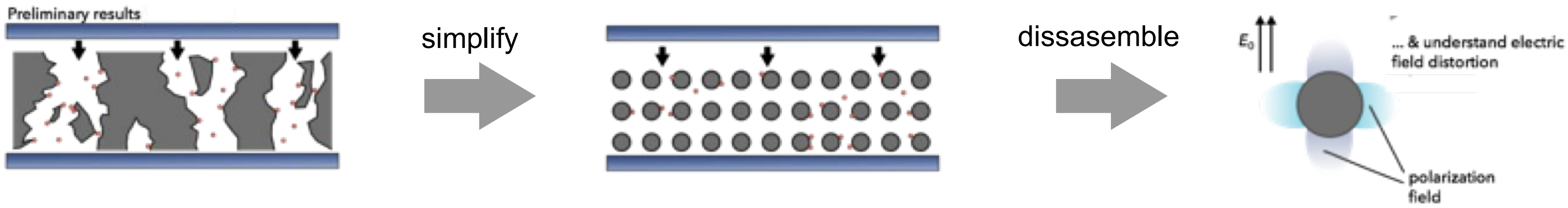
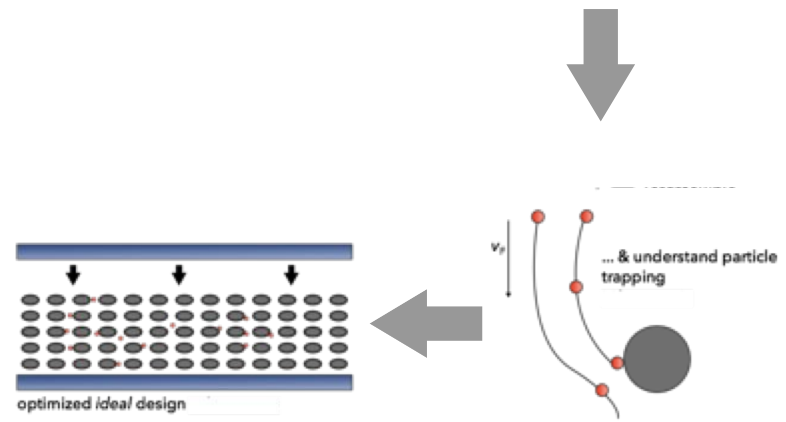
Conclusion and Outlook





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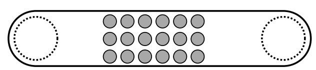

- Two devices, one for observation, one for high-throughput.

Next steps:

- Selectivity (real separation problems)
- Porous medium structure influence
- Enrichment!

Acknowledgement

DFG

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Graduiertenkolleg
GRK 1860

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Thank you for your attention!

Universität Bremen

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