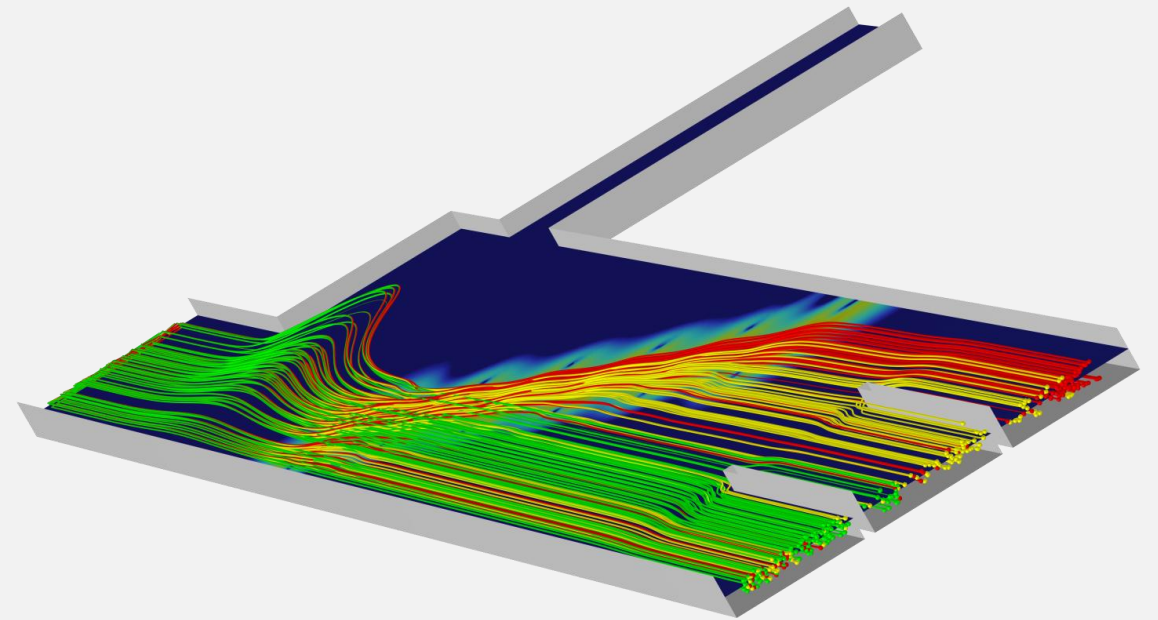


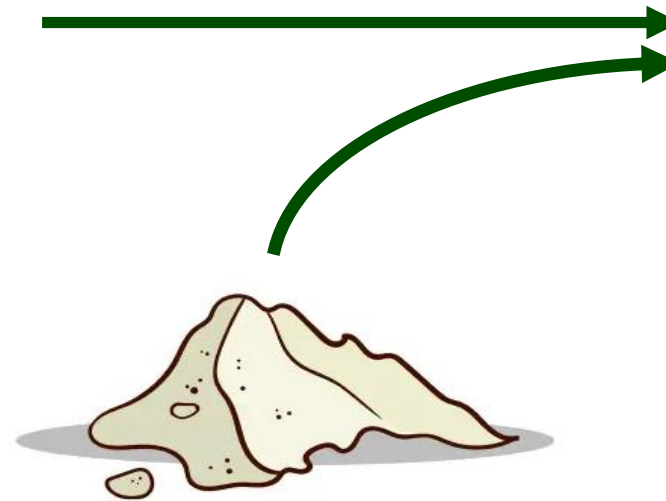
Developing novel food fractionation techniques: The Electrophoresis Case

Kickstarting the design process of an electrophoretic fractionation device: Optimization using particle trajectories.

Date: 23-09-2026

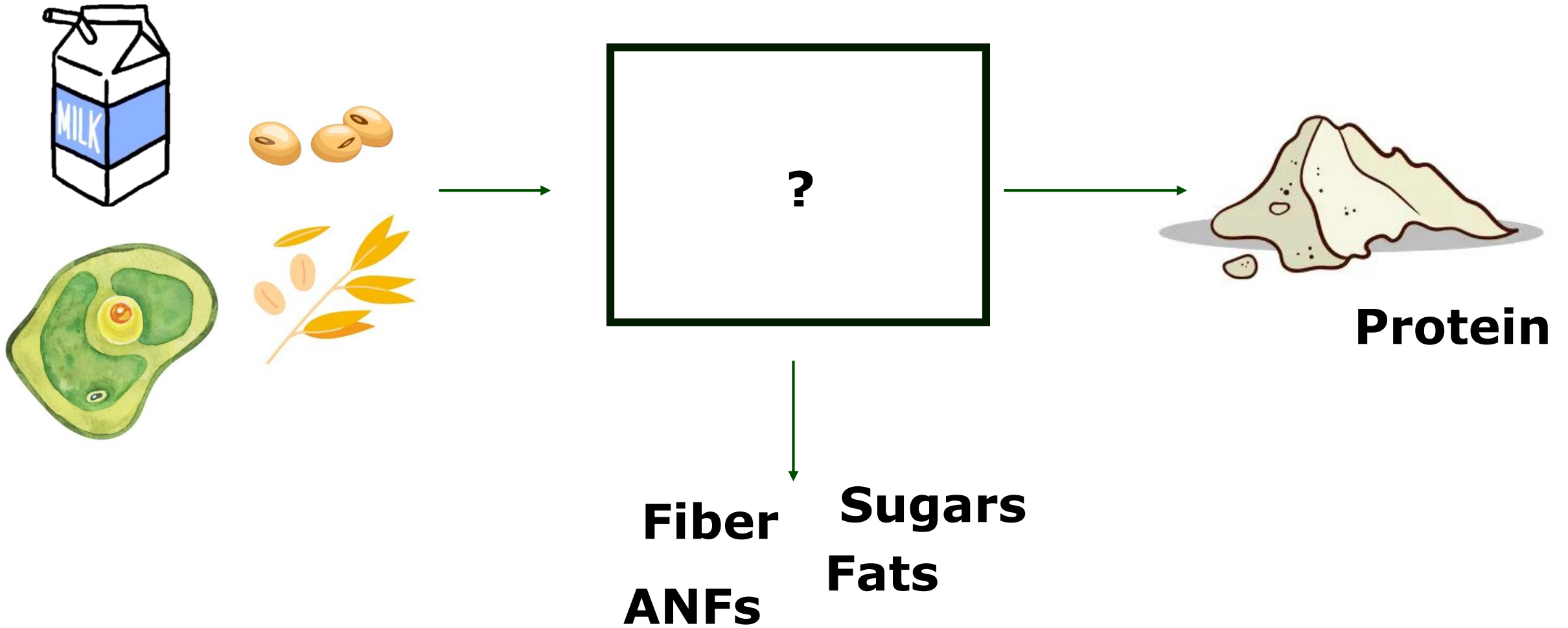
Author: Tjeerd Wijtzes, MSc





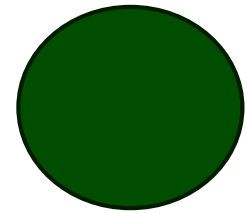
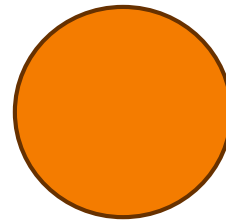
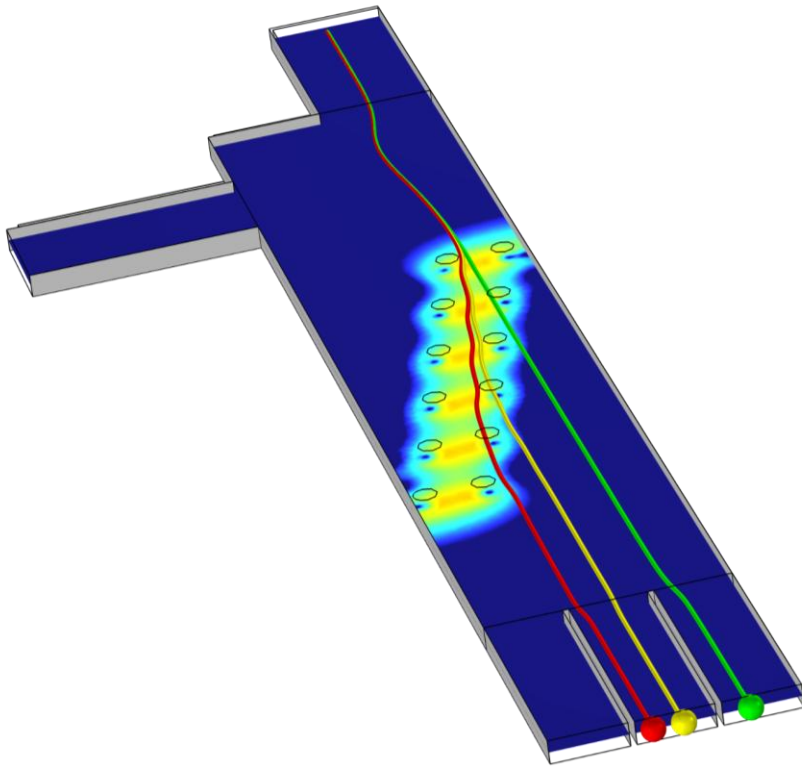
Protein

Food fractionation



Electrophoretic fractionation

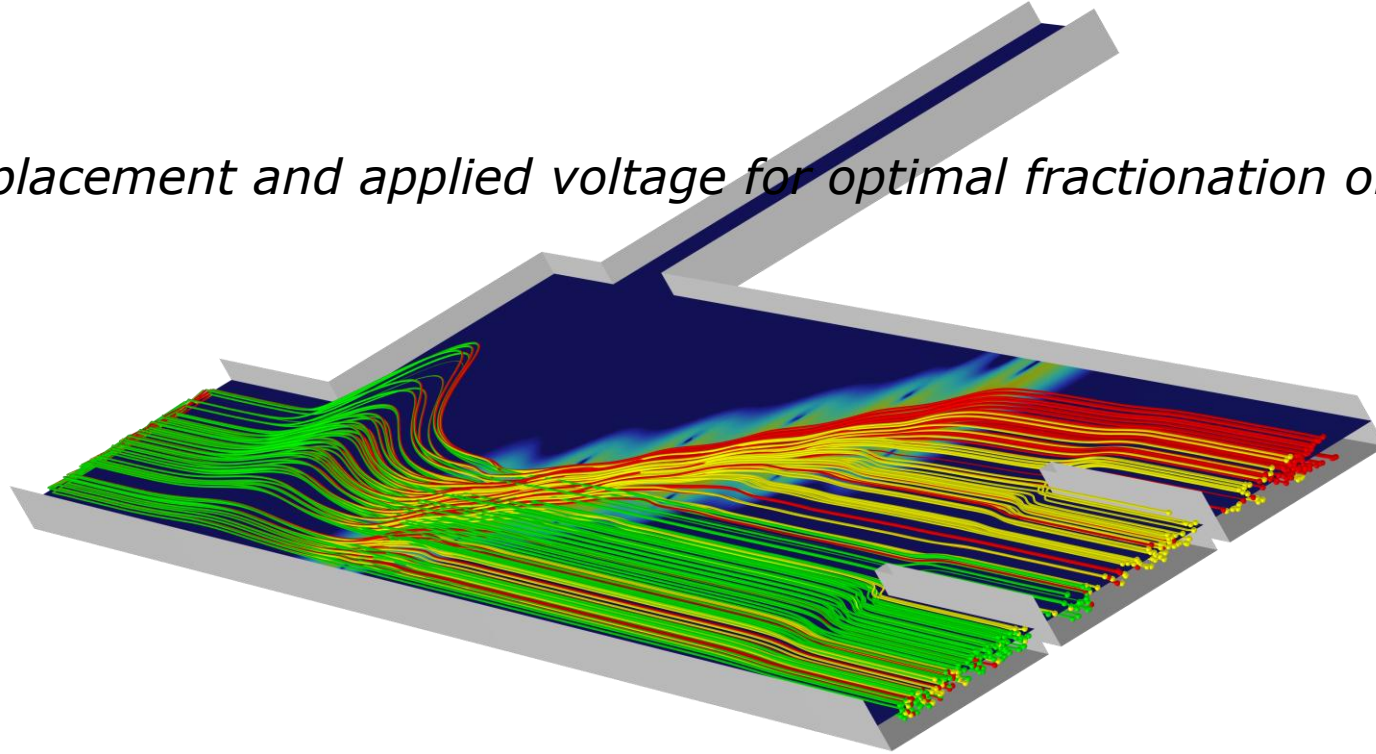
Separating based on charge and size



$$v_{el} = E * \mu_{el} \quad F_{drag} = 6\pi r \eta (v_{fluid} + v_{el})$$

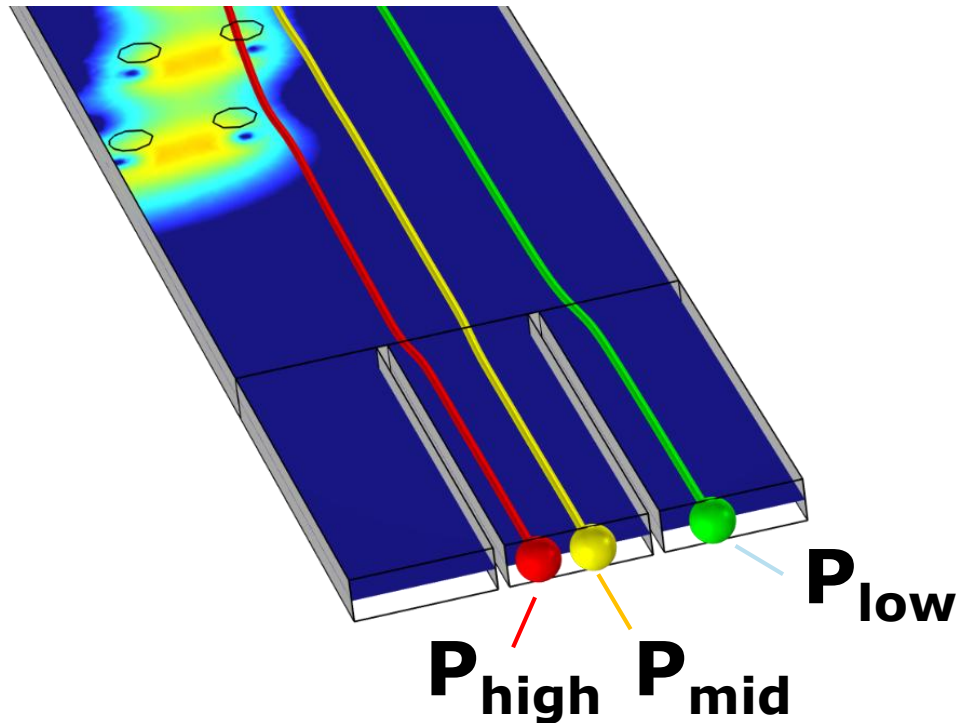
COMSOL Aim

Optimize electrode placement and applied voltage for optimal fractionation of food ingredients.



Optimization

Objective function and control variables



Objective function

$$(P_{high} - P_{low}) - \left| \frac{P_{high}}{2} - P_{mid} \right|$$

Control variables

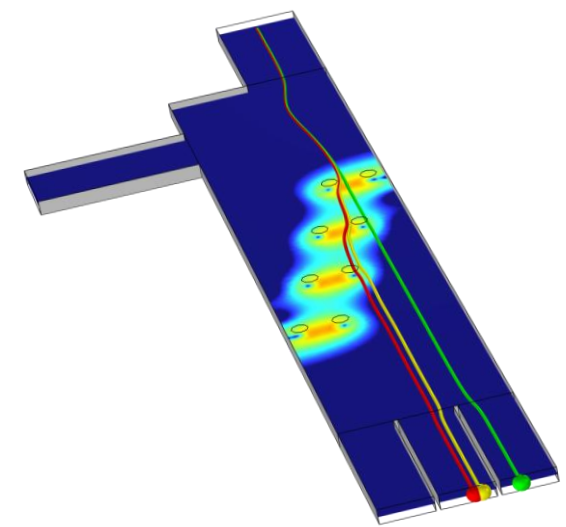
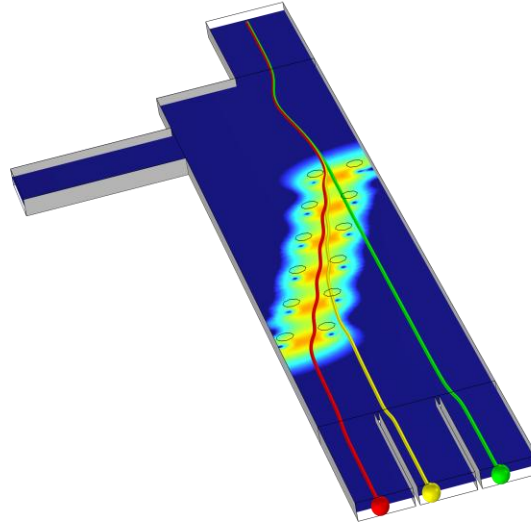
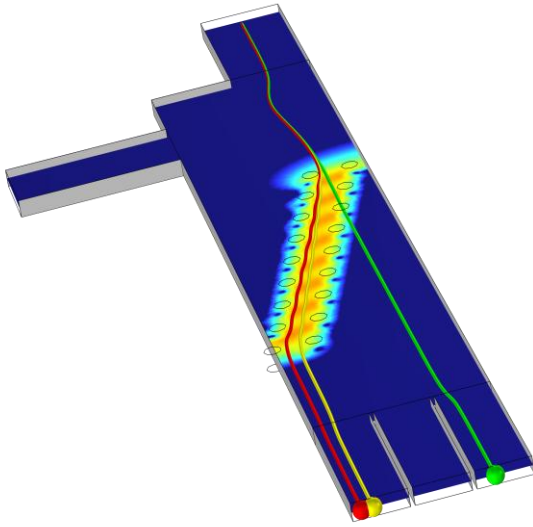
$$0.3 \text{ mm} \leq \text{Electrode distance} \leq 1 \text{ mm}$$

$$1.5 \text{ V} \leq \text{Electrode voltage} \leq 3.5 \text{ V}$$

COMSOL Modules: Particle Tracing module, Optimization module & CFD module

Optimization results (1/2)

Optimal electrode placements for WPI feeds



Parameter $d = .3$

$d = .5$

$d = .8$

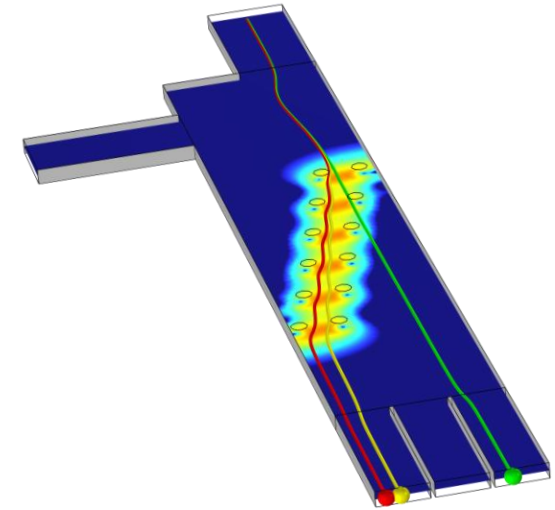
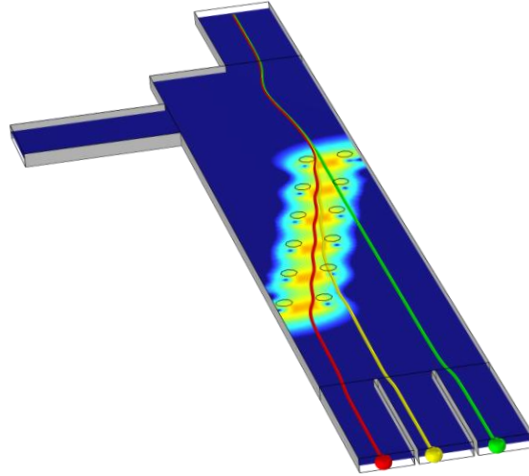
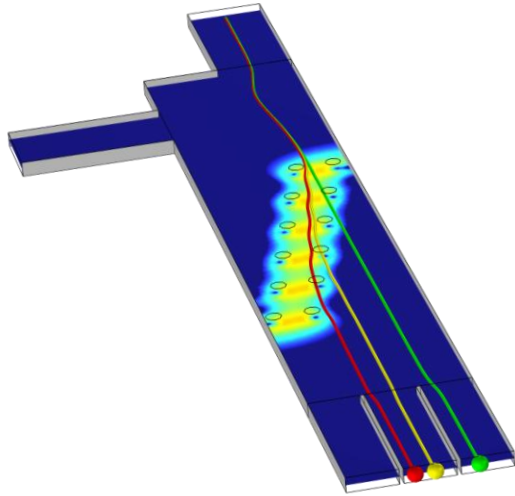
Objective Value: 2.7 mm

5.0 mm

1.3 mm

Optimization results (2/2)

Optimal electrode voltage for WPI feeds



Parameter $U = 2.5 \text{ V}$

$U = 2.95 \text{ V}$

$U = 3.5 \text{ V}$

Objective Value:

2.1 mm

5.13 mm

3.4 mm

Concluding remarks

For our WPI model feed, 2.95 volts on an electrode distance of 0.5 mm is optimal.

Electrode placement and applied voltage can be modified to fractionate a variety of feeds.

COMSOL® can be used effectively to streamline the design process of milli-fluidic unit operations.

COMSOL is a registered trademark of COMSOL AB.

Thank you!

Contact information:



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