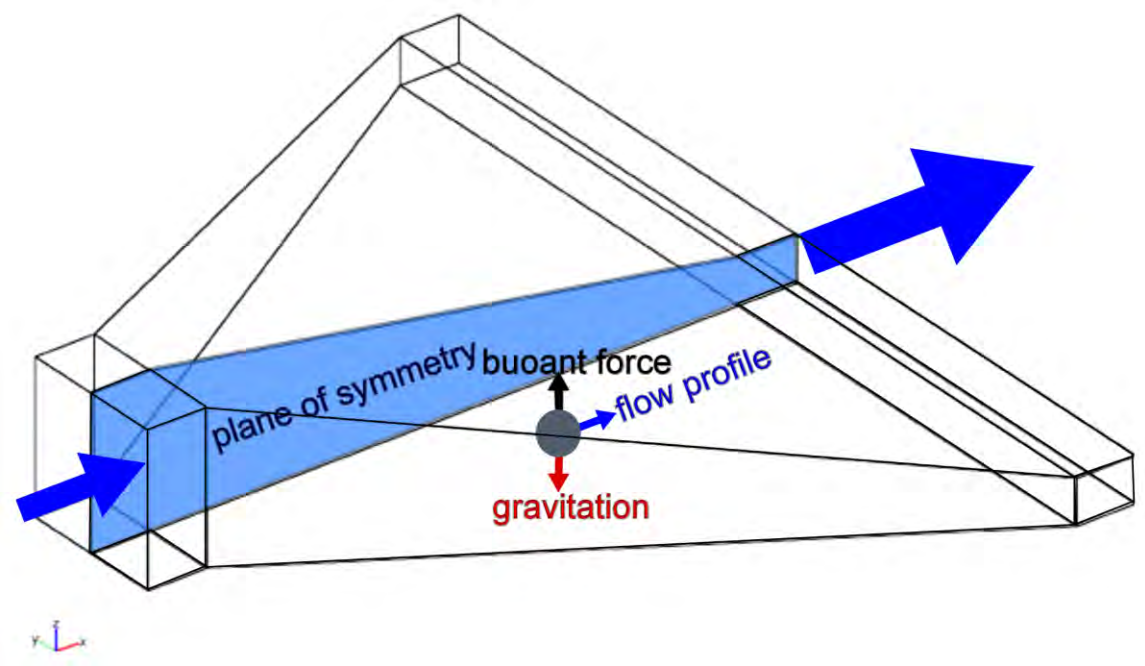
Positioning System for Particles in Microfluidic Structures



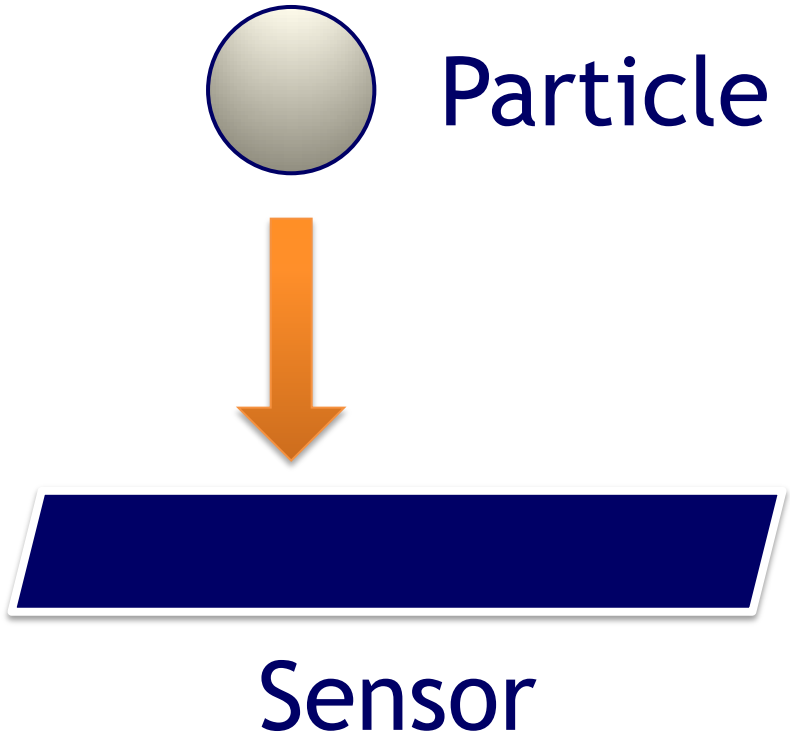
D. Kappe
A. Hütten

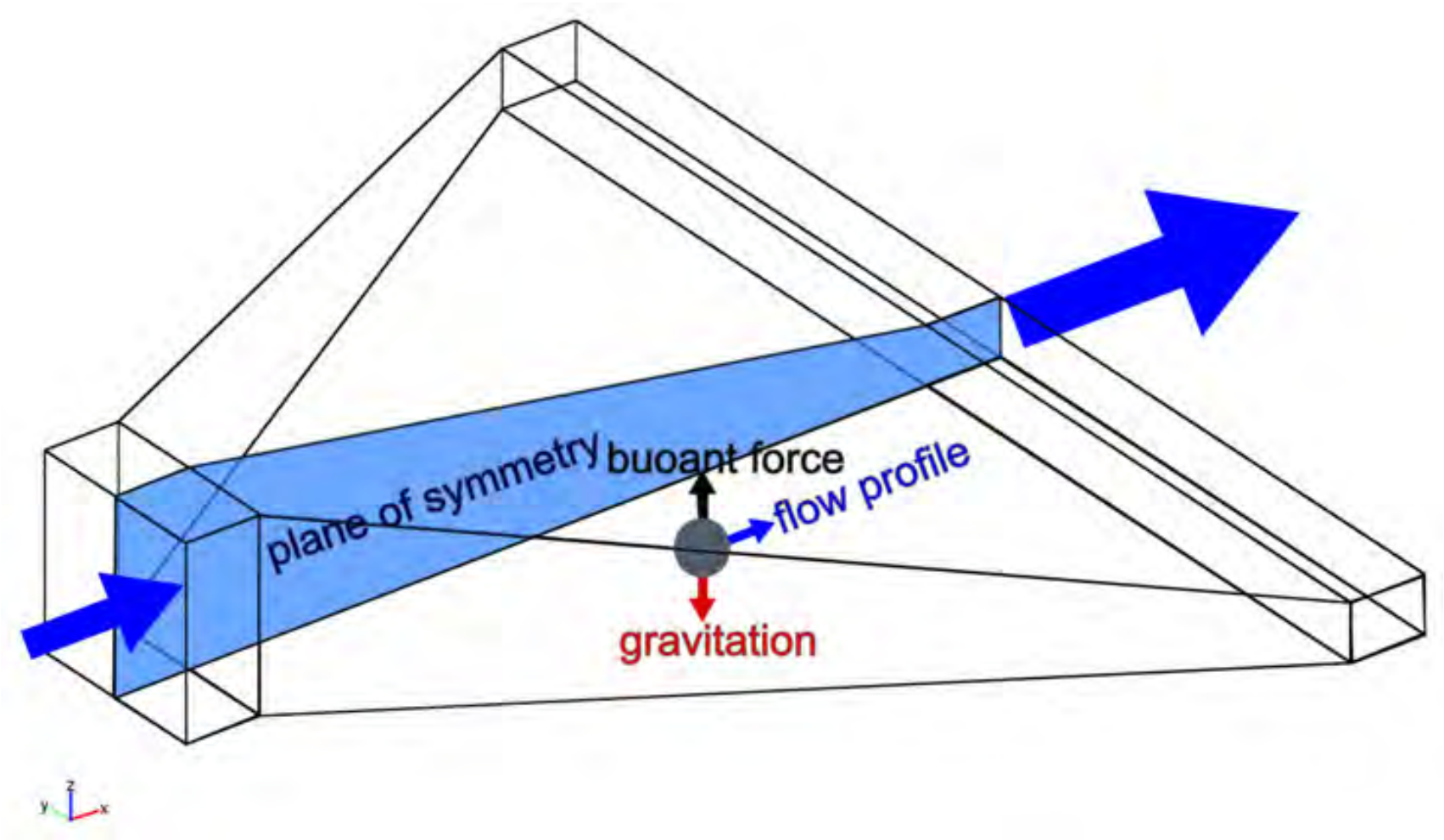
Excerpt from the Proceedings of the 2012 COMSOL Conference in Milan

Motivation

Probing Particles

- Proximity to sensor is needed
- Achieved by magnetic fields
  - ➢ Increased complexity
- Achieved by gravitation
  - Applicable for slow flow profiles
  - Application for higher velocities
  - ➢ Discussed here




plane of symmetry
buoant force
flow profile
gravitation
z
y
x

Microfluidics

Flow Profile

1. Navier-Stokes equation for Incompressible fluids
2. Equation of continuity
   - ➢ Stokes equation
3. No-Slip boundary conditions
   - except for inlet, outlet and symmetry

Concentration

- Advection-Diffusion equation
- Additional gravitation force
- No particle-particle interaction
- Level-Set equation for initial height mapping

Equations to solve

- Stokes equation $\nabla \mathrm{p} = \eta \Delta \mathrm{u} + \rho \mathrm{f}$
  - No-Slip condition $u = 0$
  - Symmetry $n \cdot \nabla u = 0$
- Advection-Diffusion equation

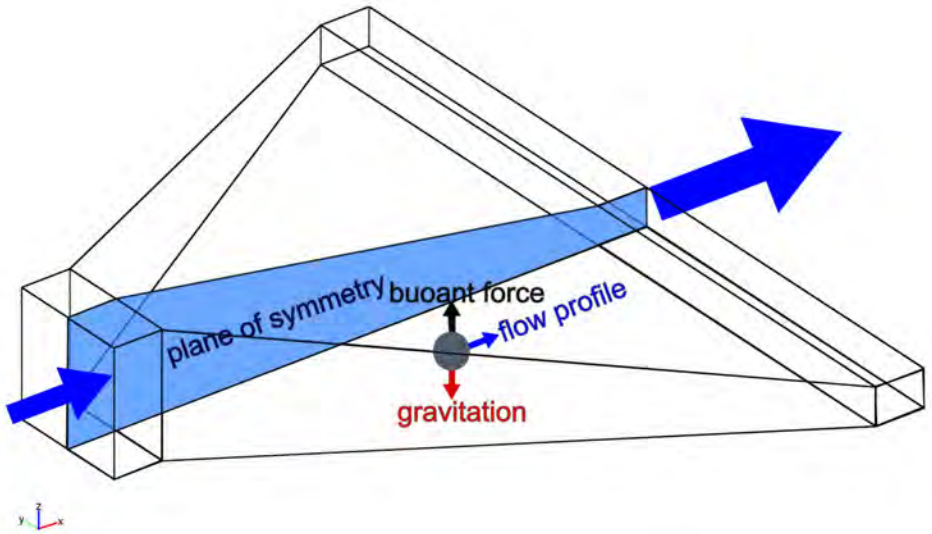
$$\frac{\partial c}{\partial t} + \nabla \cdot j = 0$$

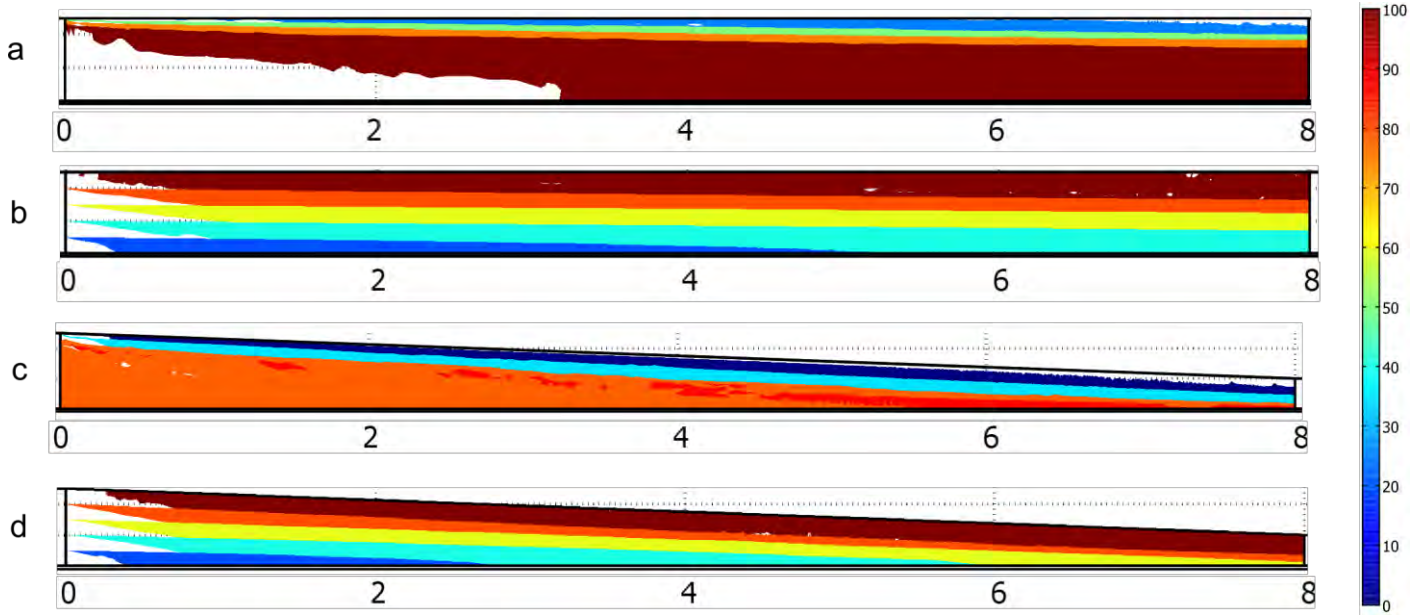
  - with $j = D\nabla c - (u - Gn_z)c$
- Level-Set equation
  - Like Advection-Diffusion equation without Diffusion and changed boundary condition

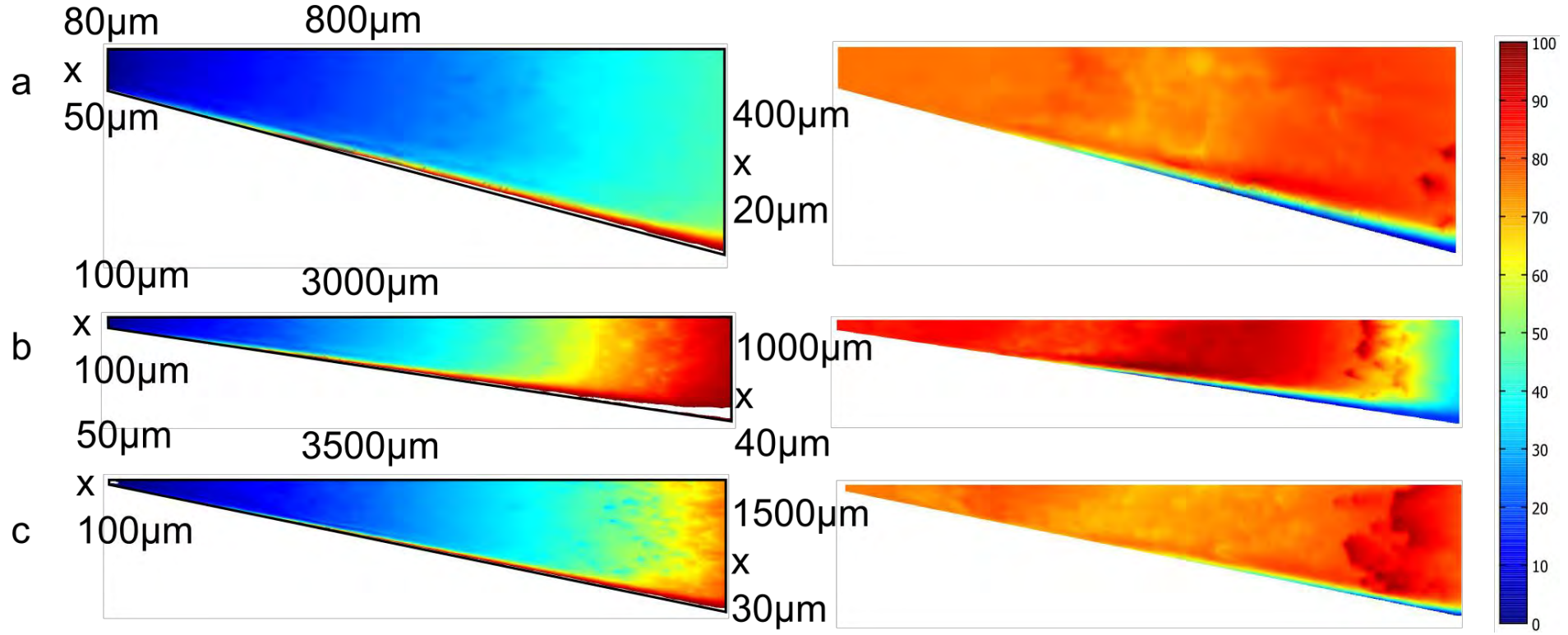
Implementation in COMSOL

Implementation for COMSOL 3.5
- Incompressible Navier-Sokes
  - Linear Solver
- Convection-Diffusion model
  - Compensated Petrov-Galerkin
- Convection-Diffusion model
  - without Diffusion (D=0)

To-Do
Implementation for COMSOL 4.x
+ Easier geometry creation
+ Particles-Tracing




a
b
c
d
0
2
4
6
8
100
90
80
70
60
50
40
30
20
10
0


a
80µm
x
50µm
800µm
400µm
x
20µm
b
100µm
x
100µm
3000µm
1000µm
x
40µm
c
50µm
x
100µm
3500µm
1500µm
x
30µm
100
90
80
70
60
50
40
30
20
10
0

Conclusion and Outlook

Observation

- Similar behavior for the initial height mapping
  1. Small area
  2. Large area
  3. Small area

Work to do

- Is it possible to derive an equation?
  - Which parameters?
  - Size and dimension