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Experimental and numerical study of a fuel cell anode channel model

Outline

- Motivation
- Main idea
- Problem
- Results
- Future work

Motivation

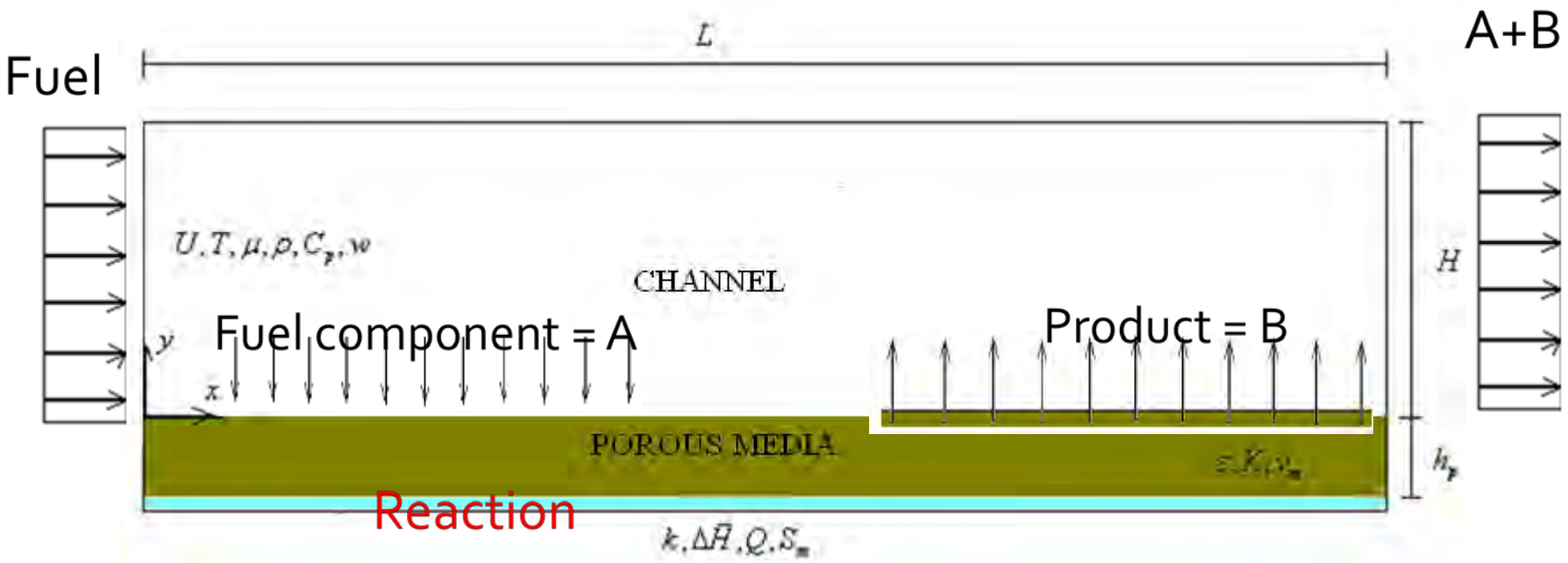
- Lack of experimental data
- Lack of Heat Transfer studies
- Lack of Fluid Mech studies
- Use of optical techniques for field measurements

Main idea

Can we…

- …model FC channels by scaling-up geometry?
- …use acid-base colorimetry for C?
- …use IR thermography for T?
- …simultaneously measure C, T and V?

What's the problem?



Problem characteristics

- Experimental

- Low Re
- Porous medium
- Mass, Heat , Momentum & Charge transfer
- Electrochemical reaction
- Multicomponent

- Numerical

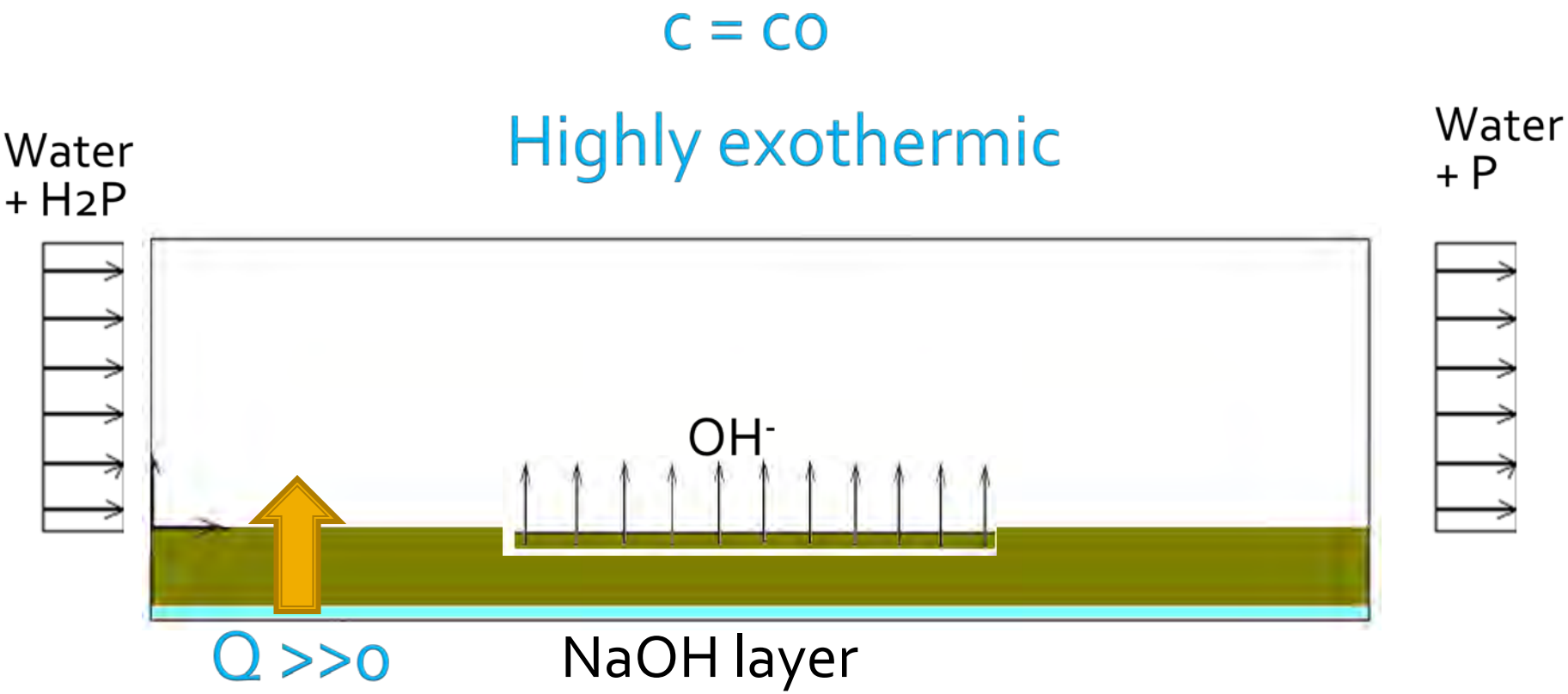
- Simple geometry
- Multiphysics
- Highly non-linear
- Coupled effects
- Convergence issues

How can we model this?

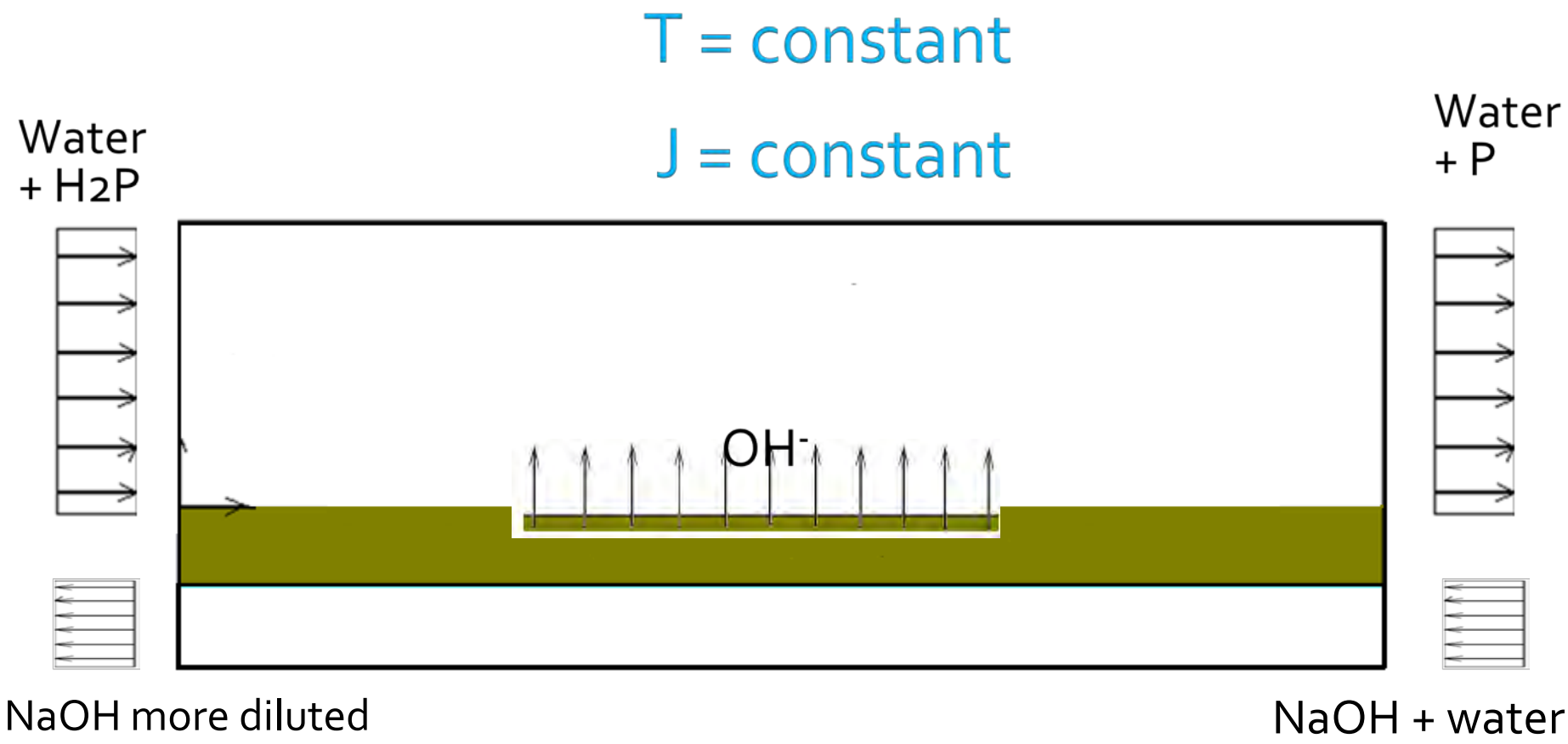
Assumptions

- Scaling-up: *No effect is left behind*
- Low Reynolds
- No charge transfer
- Chemical Reaction
- Liquids, no gases

What's the model problem?: single channel



What's the model problem?: two channels

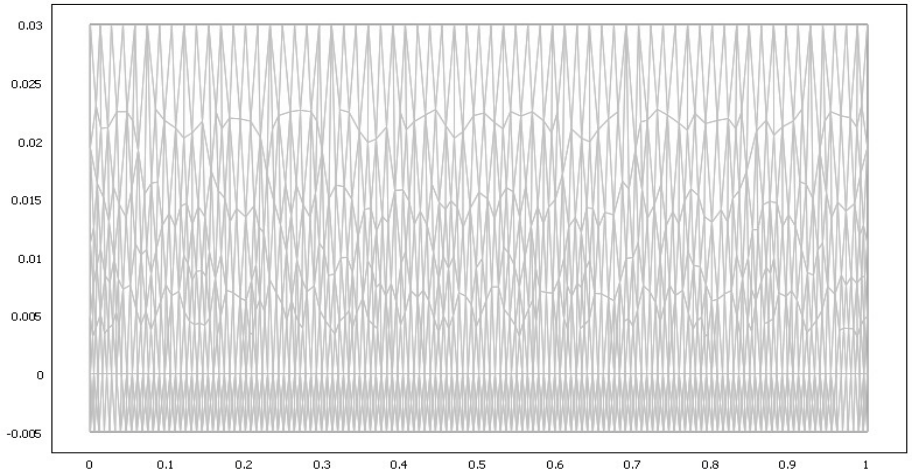


What does COMSOL do?

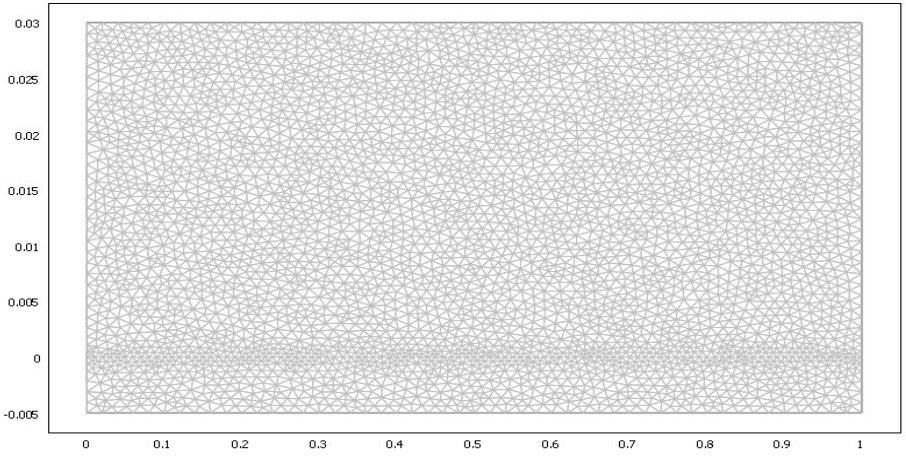
- Flexible modeling
- Experimental time-saving
- First glimpse of coupled effects
- Multiphysics phenomena
- Multi-scale phenomena

Meshing

Elements non-scaled

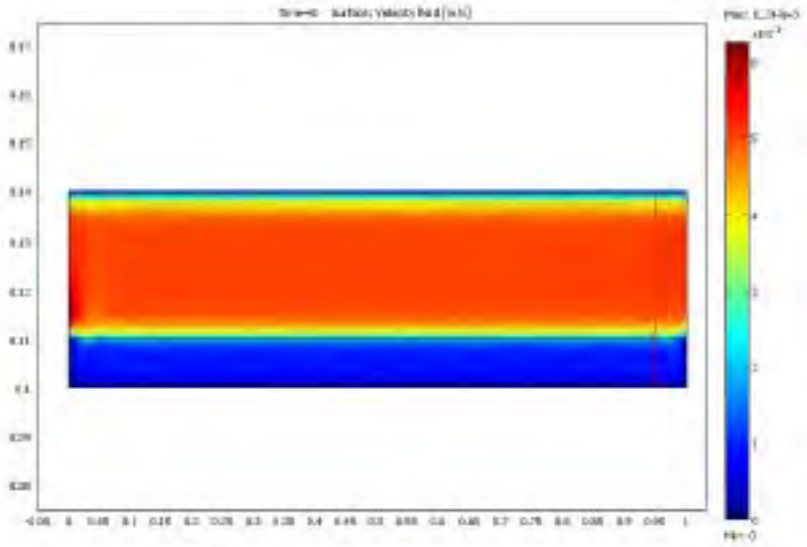


Elements scaled

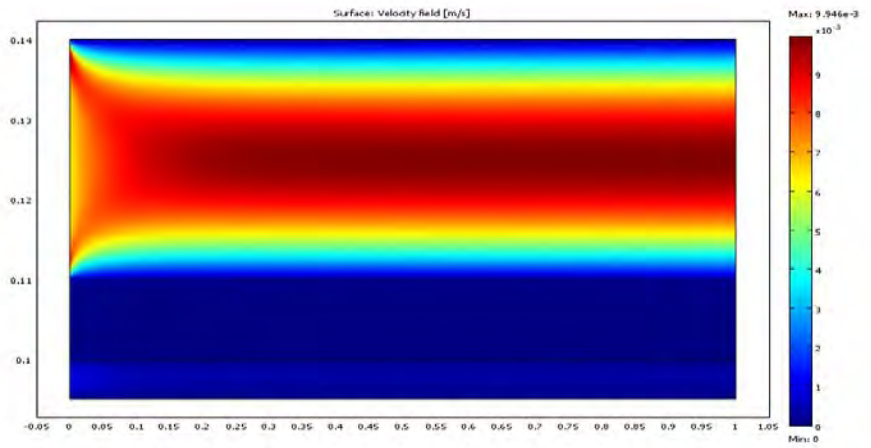


Flow: Pressure driven

- Single channel

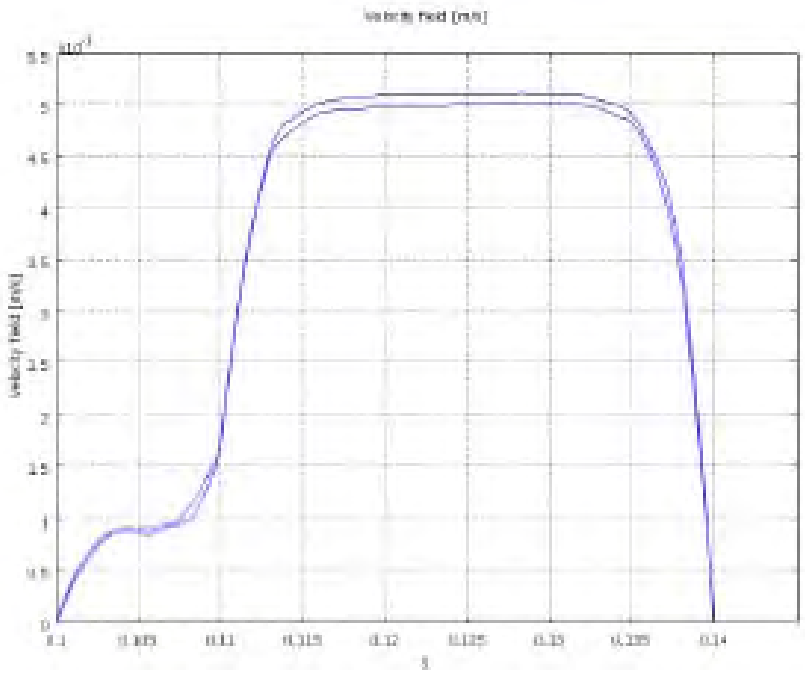


- Bi-channel

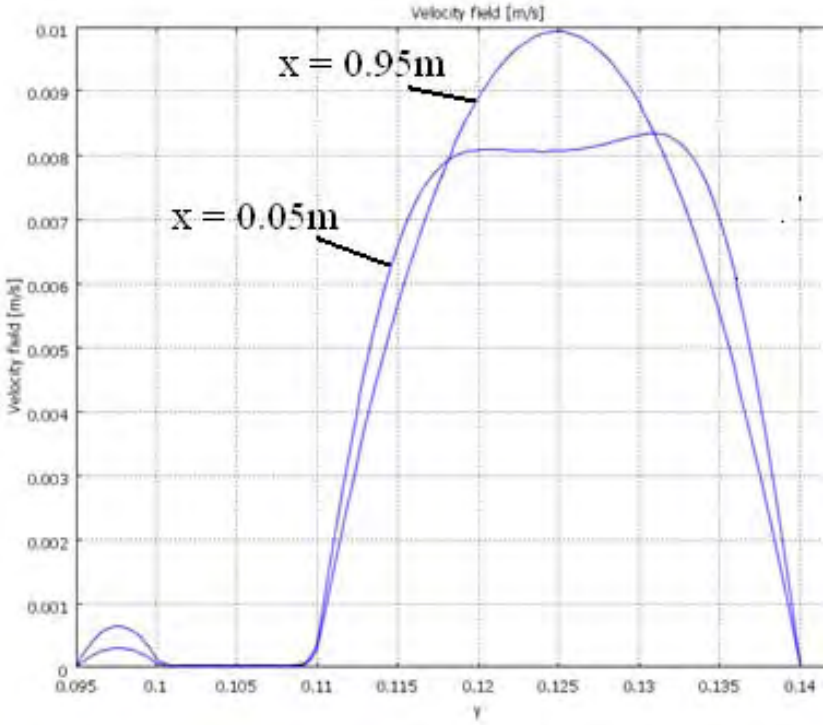


Flow: Velocity profiles

- Single channel



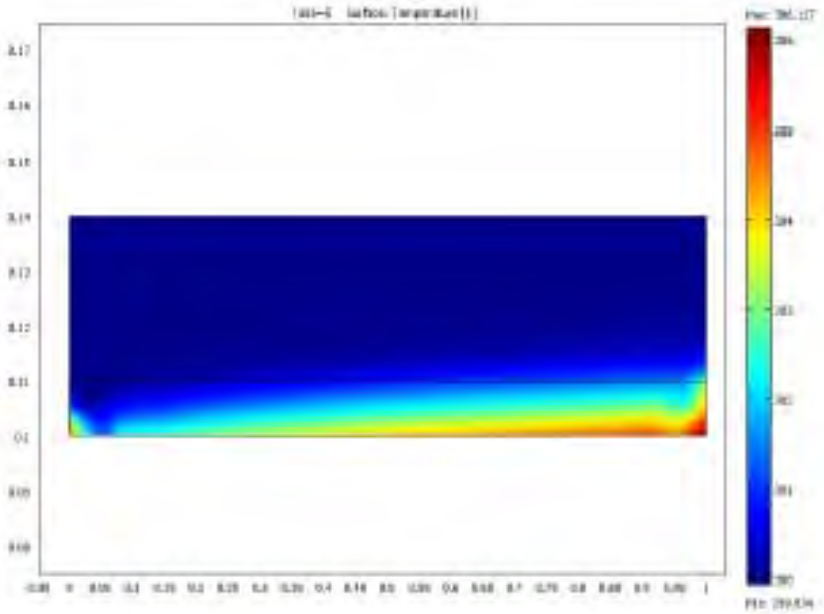
- Bi-channel



Temperature

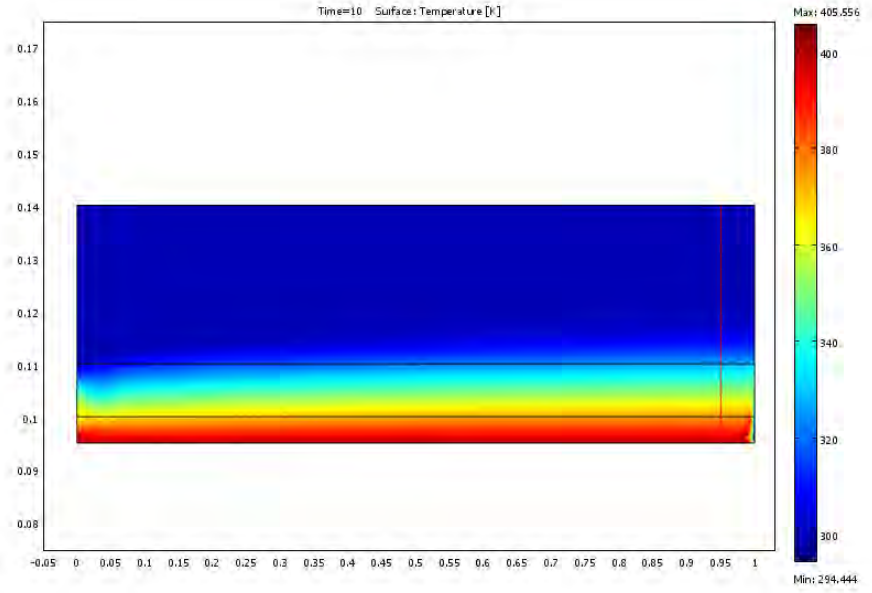
- Single channel

Q = constant



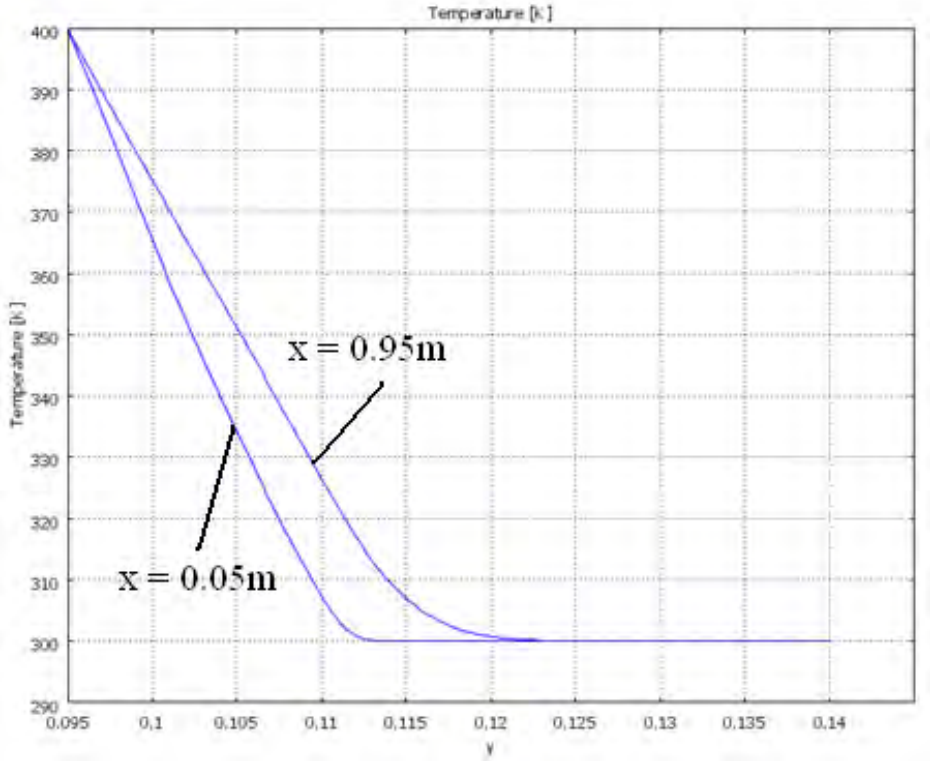
- Bi-channel

T = constant

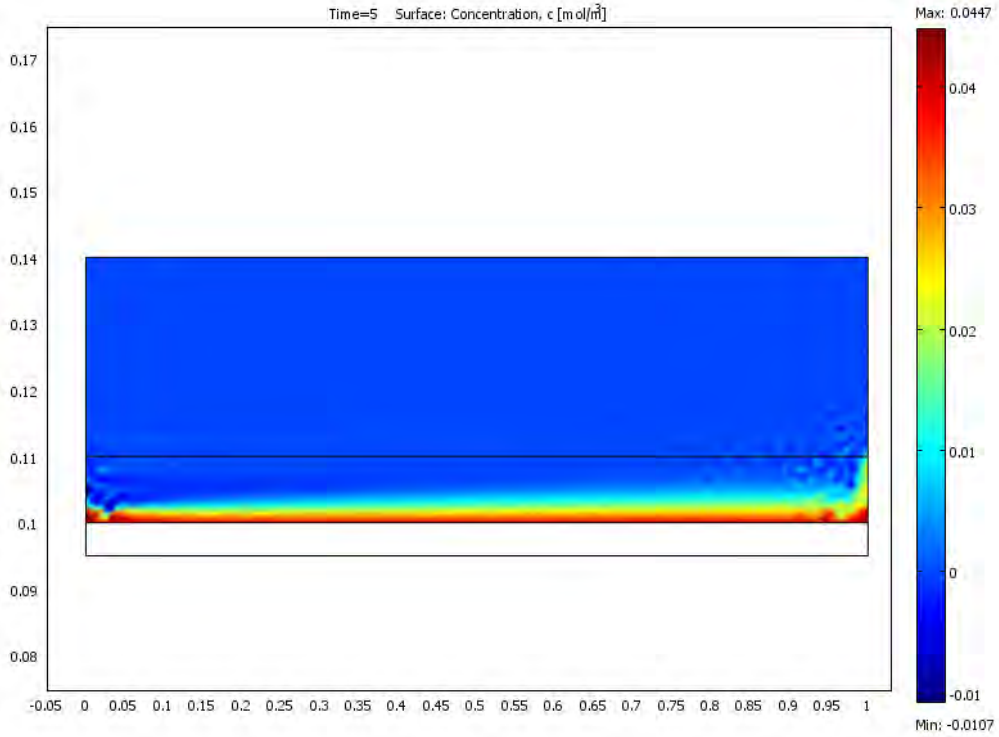


Two channel configuration: Temperature

- Boundary condition: T = constant



Concentration



Experimental set-up

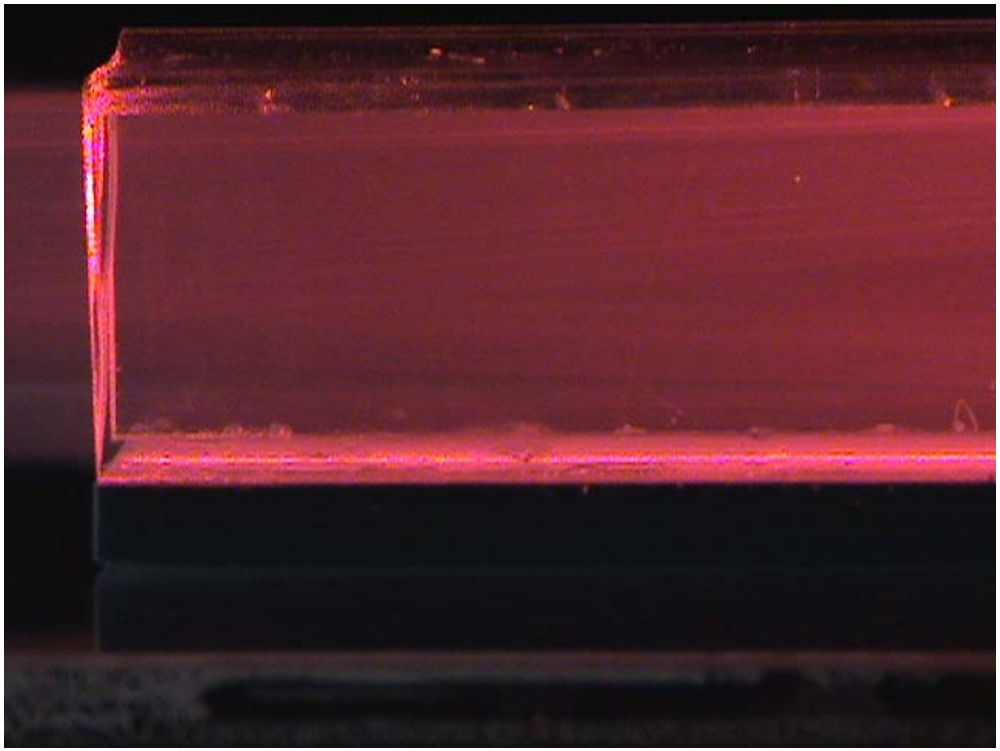
- Acrylic walls
- Porous media = brick
- Water = solvent
- Phenolphthaleine = solute
- Sodium hydroxide = solute

How do we measure?

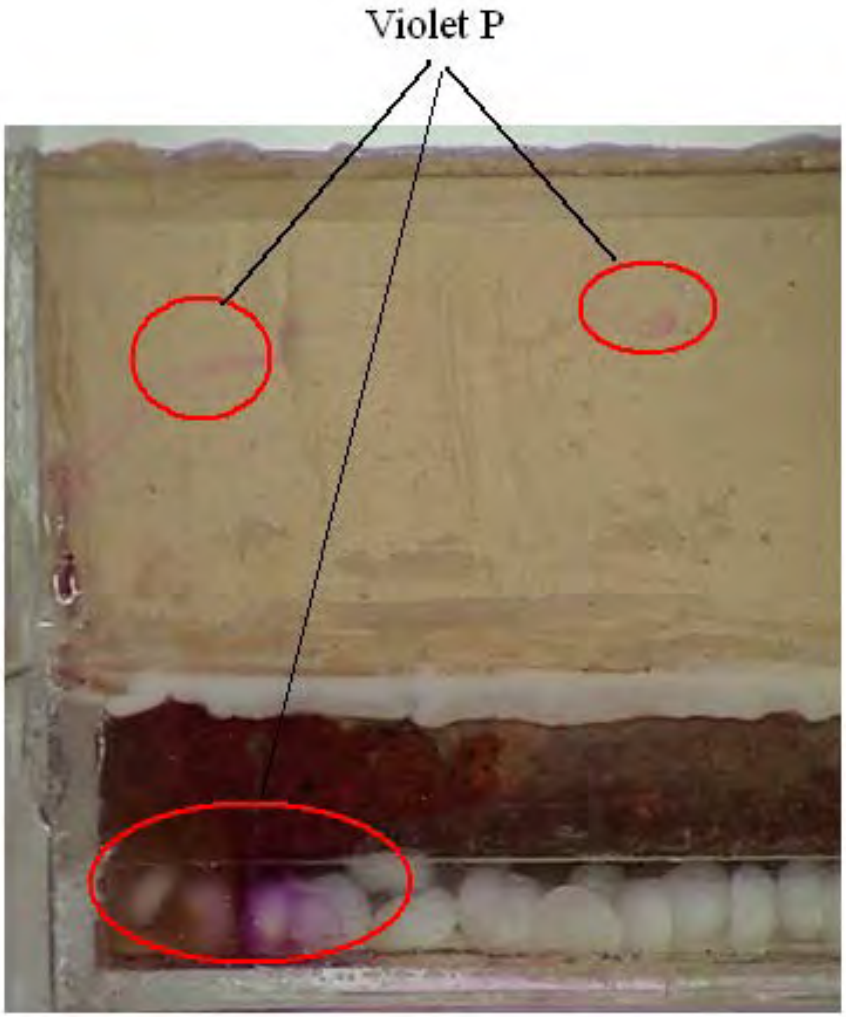
- Flow: seeding of reflecting particles, two snapshots, image processing (PIV)
- Concentration: Intensity = f(pH) (Colorimetric)
- Temperature: IR thermography

Flow

- Particle Image Velocimetry

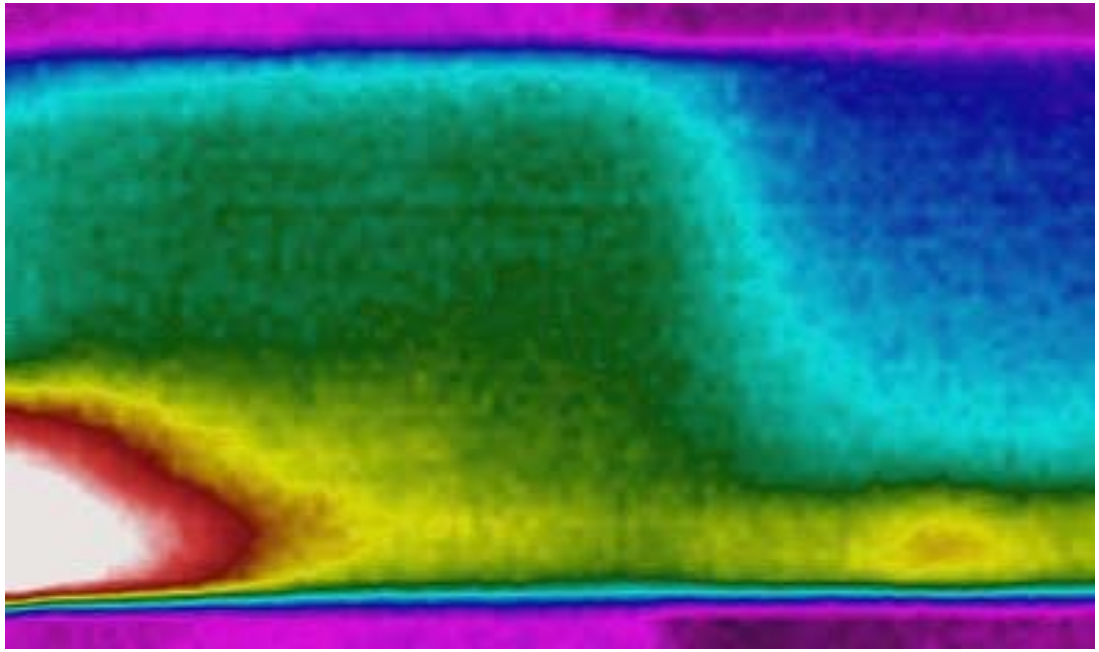


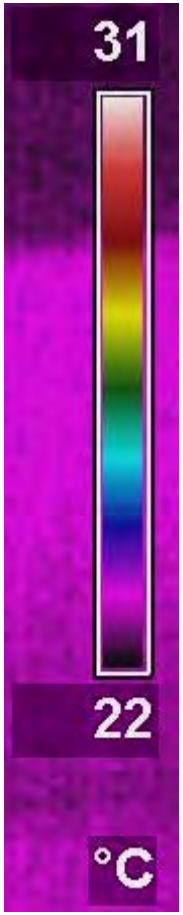
Concentration



Temperature

- IR Thermography





Future work

A lot!

Measure, measure, measure…

- Choose experimental configuration
- Experimental calibration
- Image processing

Run, run, run…

- Accurate & robust COMSOL simulations

THANK YOU!