Electric field cell for SANS

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Task2: “Kinetics and Dynamics”

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Bibliography

In the literature, the most commonly used configurations are:

- Range of electric field:

  From 0.04 to 4 kV/cm

- Range of temperature:

  From 10 to 60 °C

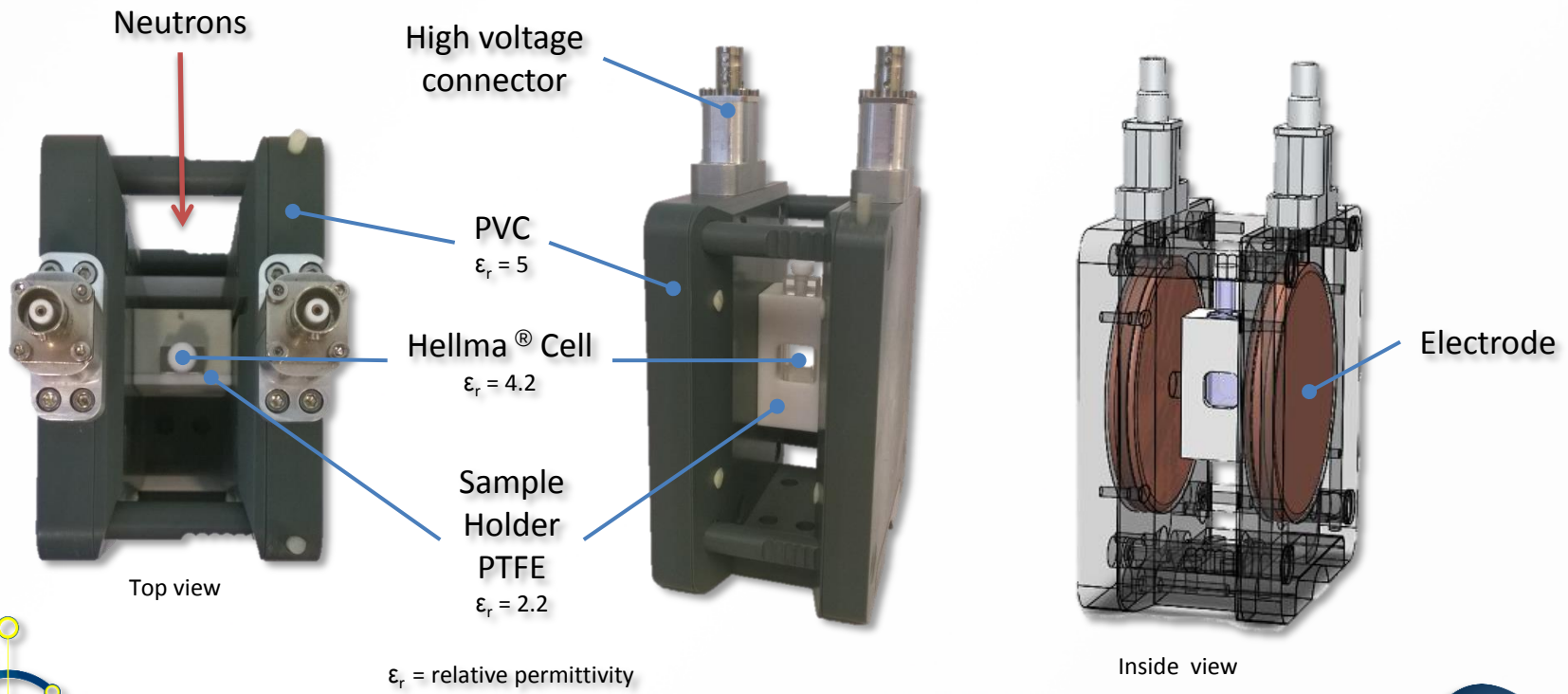
- Range of frequency:

  From 0 to 60 kHz

Actual design

Prototype of the electric field cell

- External electrodes
- Rectangular and circular Hellma ® cells
- Easy to use



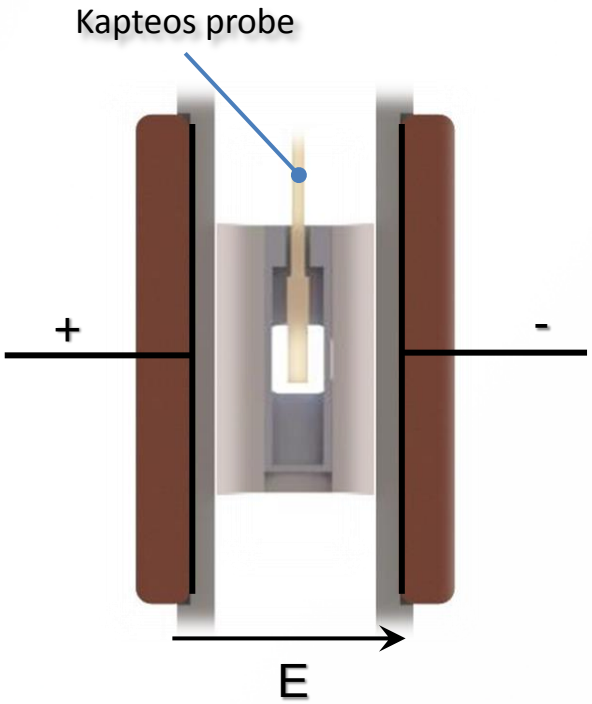
ε_r = relative permittivity

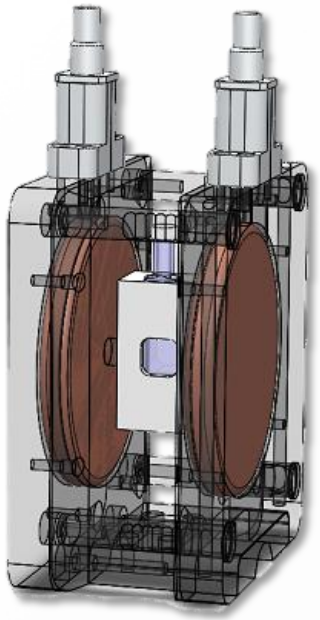
Actual design

How to measure the high electric field inside the sample?

Difficulty due to dielectric materials

- External electrodes
- Rectangular and circular Hellma ® cells
- Easy to use





Actual design

Measurements

kapteos probe's to measure high electric field inside a fluid

Measurements performed in different solvents:

Fluid	Permittivity ε_r	Electric field (kV/cm)
Air	1.0	3.07E-1
Toluene	2.3	2.45E-1
Ethanol	24.3	2.36E-2
DMSO (Dimethyl sulfoxide)	46.7	5.32E-3
Distilled water	78.6	2.72E-3

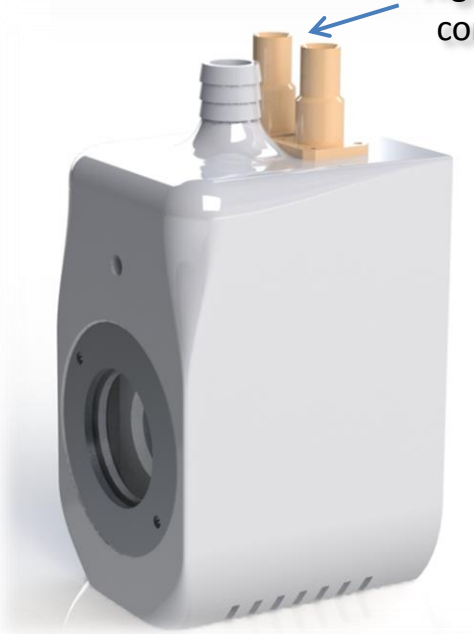
Electric field in different fluids with an applied voltage of 2kV at 10kHz at 20°C

Due to a large amount of dielectric materials, the electric field is actually too weak.

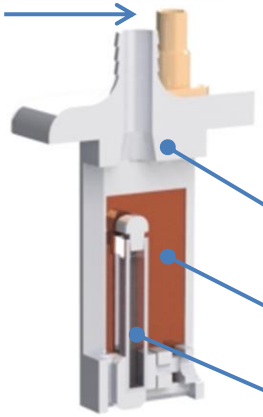
Kapteos probe inside an Hellma® cell

New design

Closed and thermalized



High voltage connector



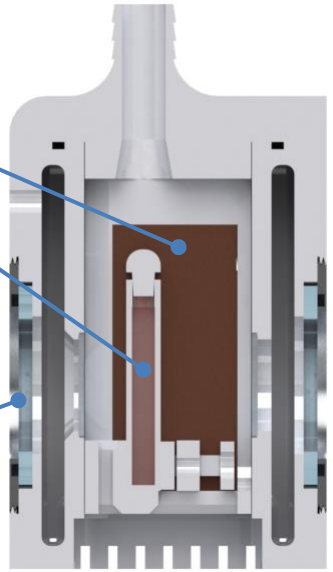
- Closed electric field cell
- **Less dielectric materials** between electrodes
- Spacing between electrodes is reduced
- Rectangular Hellma ® cell using
- Sample thermalization from 10 to 60 °C

Sample holder for Hellma ® cell (1, 2 or 5mm thickness)

Electrode

Hellma® cell

Neutron entry & Sample holder positioning



Quartz windows are not used at room temperature

New design

Closed and thermalized

- Closed electric field cell
- **Less dielectric materials** between electrodes
- Spacing between electrodes is reduced
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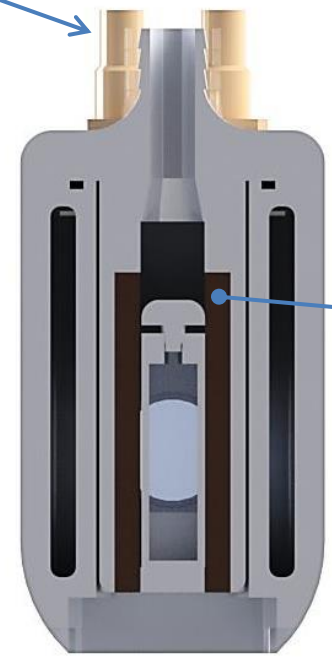
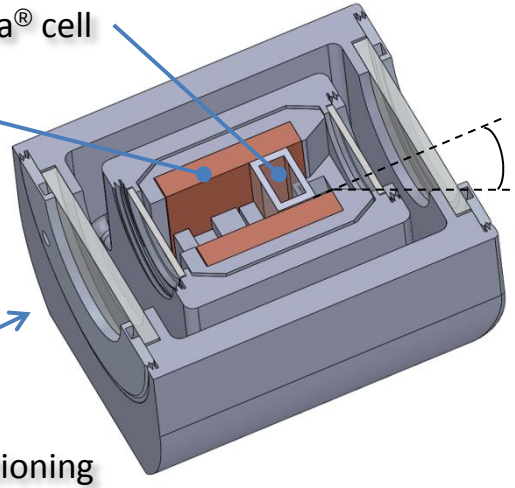
- Sample thermalization from 10 to 60 °C





Empty cell transmission : 0,91 (6Å – 2m)

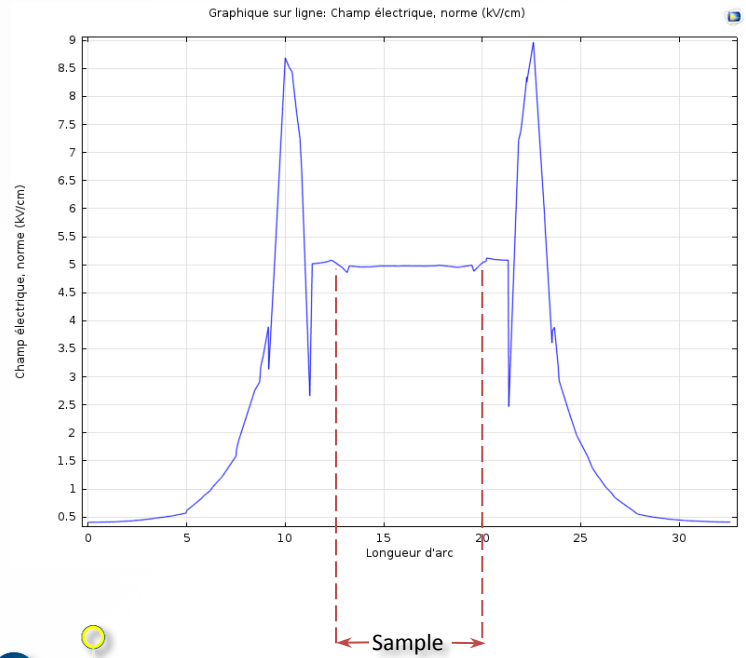
New design

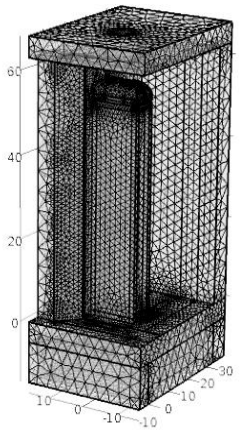
Simulation

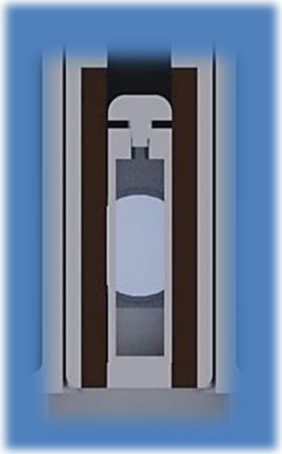
Electric Field Simulation

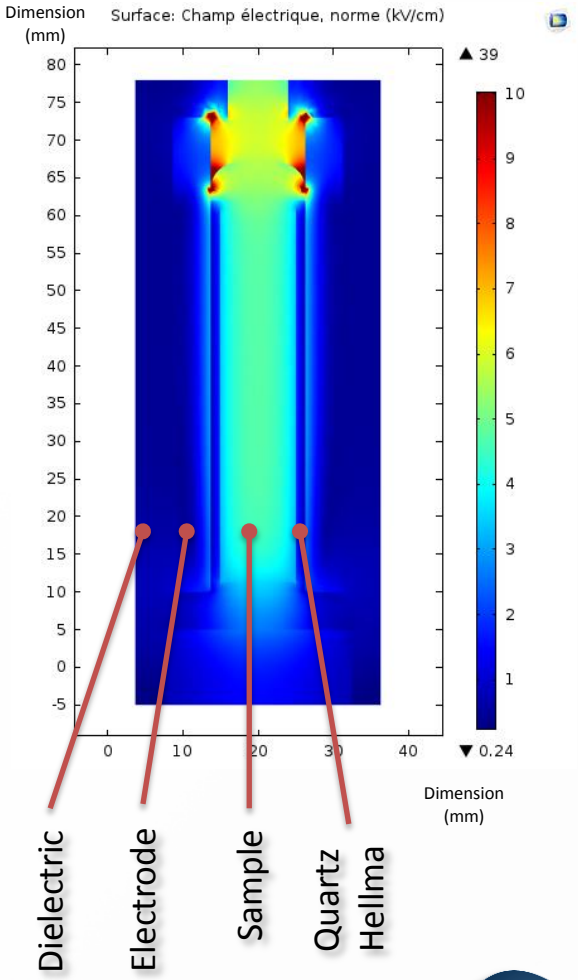
- Sample thickness 9.6mm

5 kV/cm on the sample (toluene ε_r = 2.3) with 8kV applied (1.6 kV/cm with 2kV)









New design

Thermalization

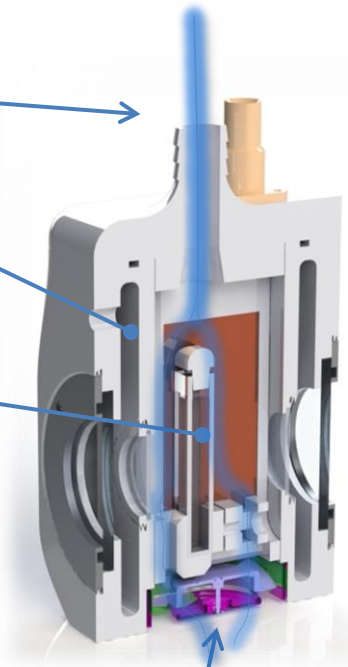
The sample is heated by using a stream of temperated gas.

PLA (for 3D printer solution $\varepsilon_r = 3$)

Gas inlet

Double-walled and vacuum to prevent condensation

Hellma® cell



Gas outlet (Fan)

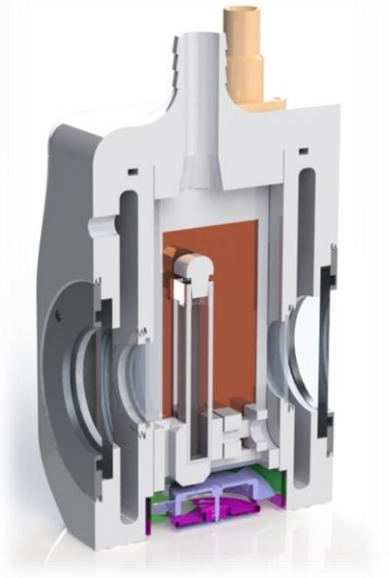
The range of temperature extends from 10 to 60 °C.

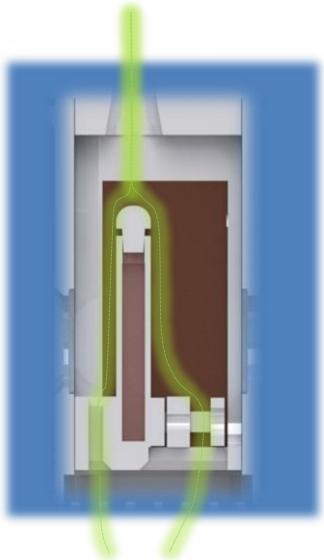
New design

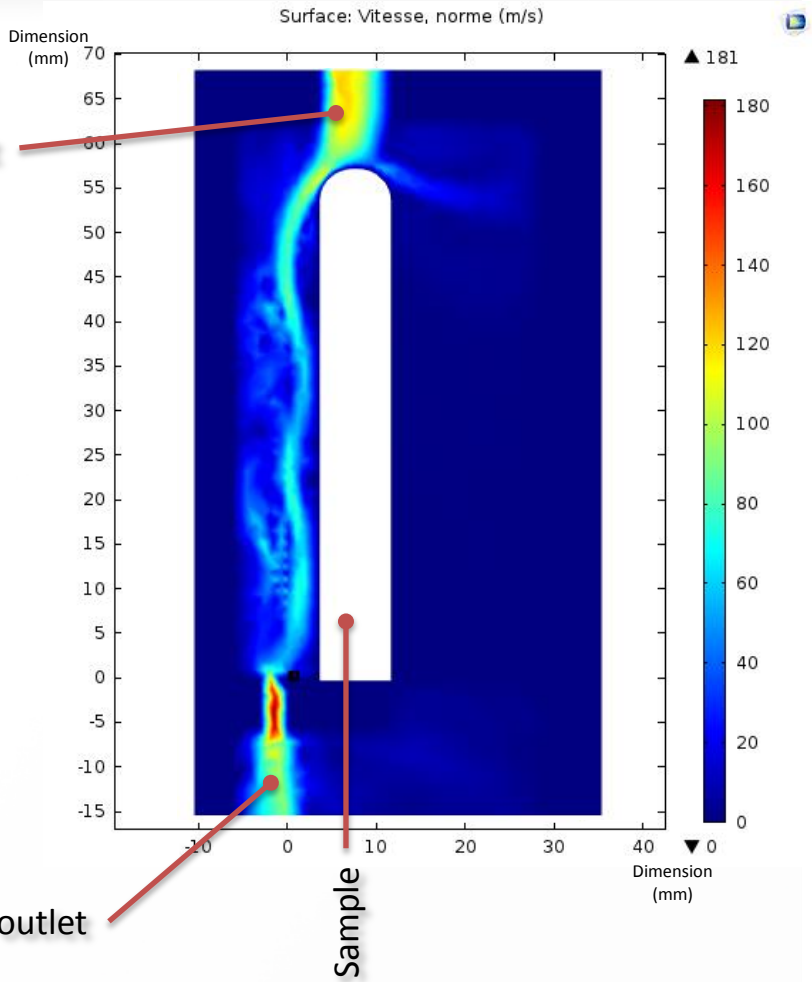
Simulation

Air flow Simulation

- Hellma® cell of 5mm with aerodynamic plug for a better contact







New design

Prototype

3D Printing from PLA material

PLA : Polylactic Acid

- Heat resistant PLA can withstand temperature of 110°C but is here porous due to the fabrication process

- Final design in resin (ε_r = 3.6 for 3D printer) to prevent air leak

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