EVANESCENT WAVE DYNAMIC LIGHT SCATTERING AT A LIQUID-LIQUID-INTERFACE

Internship Report: from data evaluation to a new measurement setup

20. APRIL 2021 I SAMUEL MONTER

EVANESCENT WAVE DYNAMIC LIGHT SCATTERING

Measurement Setup

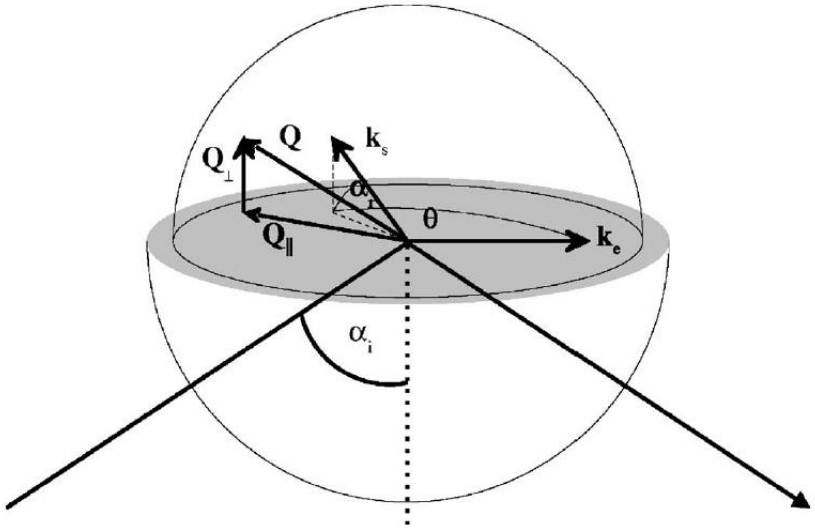
- Particles scatter light from evanescent wave

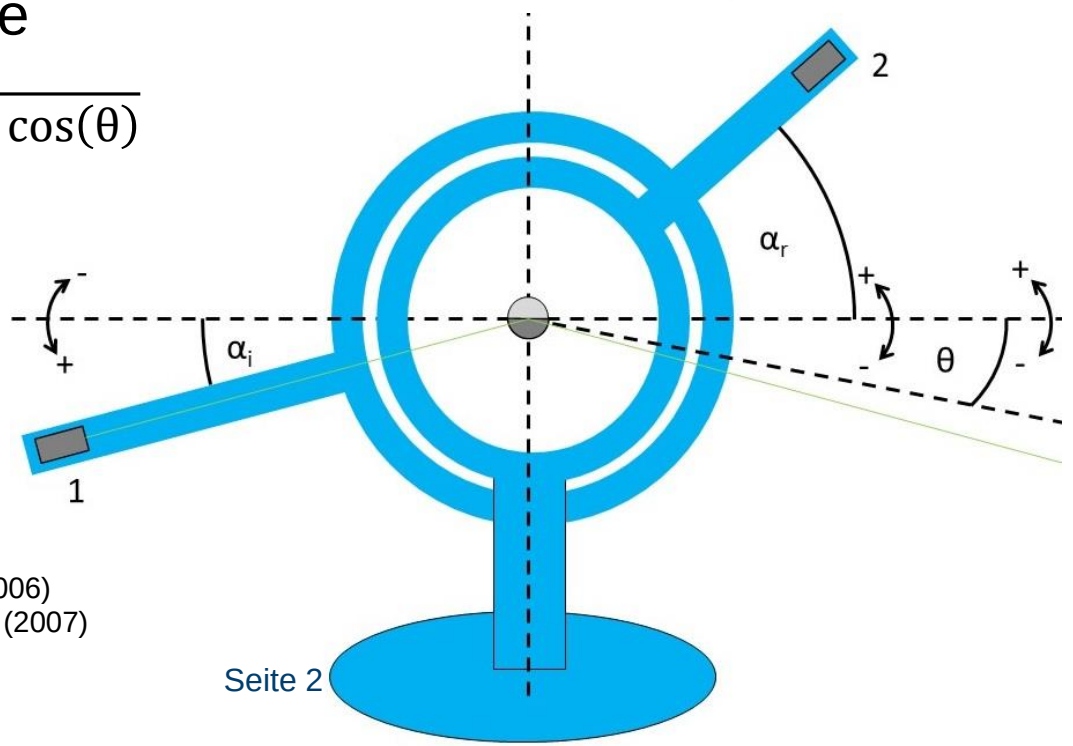
$$I = I_0 e^{-kz} \text{ with } \frac{\kappa}{2} = \frac{2\pi}{\lambda}\sqrt{\left(n_1 sin(\alpha_i)\right)^2 - n_2^2}$$

- 3 axis gonimeter enables resolution of diffusion normal and parallel to the interface

$$Q_{\parallel} = \frac{2\pi n_2}{\lambda}\sqrt{1 + \cos(\alpha_r^2) - 2\cos(\alpha_r)\cos(\theta)}$$

$$Q_{\perp} = \frac{2\pi n_2}{\lambda}\sin(\alpha_r)$$





P. Holmqvist, J. K. G. Dhont, P. R. Lang, Phys. Rev. E, **74**, 021402 (2006)
P. Holmqvist, J. K. G. Dhont, P. R. Lang, J. Chem. Phys. **126**, 044707 (2007)

EVANESCENT WAVE DYNAMIC LIGHT SCATTERING

Data Evaluation

- Measure: mixed homodyne and heterodyne detection

$$g_2 = 1 + 2C_1 g_1(t) + \left(C_2 g_1(t)\right)^2$$

$$\text{with } C_1 = C_2 - C_2^2 \quad C_2 = 1 - \sqrt{1 - A}$$

$$g_1 = (1 - B_1) exp(-\Gamma t) + B_1$$

- Extract: Γ from a fit to g_2
  - Model for short times for Γ

$$\Gamma = Q_{\parallel}^2 < D_{\parallel} > (\kappa) + \left(Q_{\perp}^2 + \frac{\kappa^2}{4}\right) < D_{\perp} > (\kappa)$$

  - Decay is single exponential for short times

P. Holmqvist, J. K. G. Dhont, P. R. Lang, J. Chem. Phys. **126**, 044707 (2007)

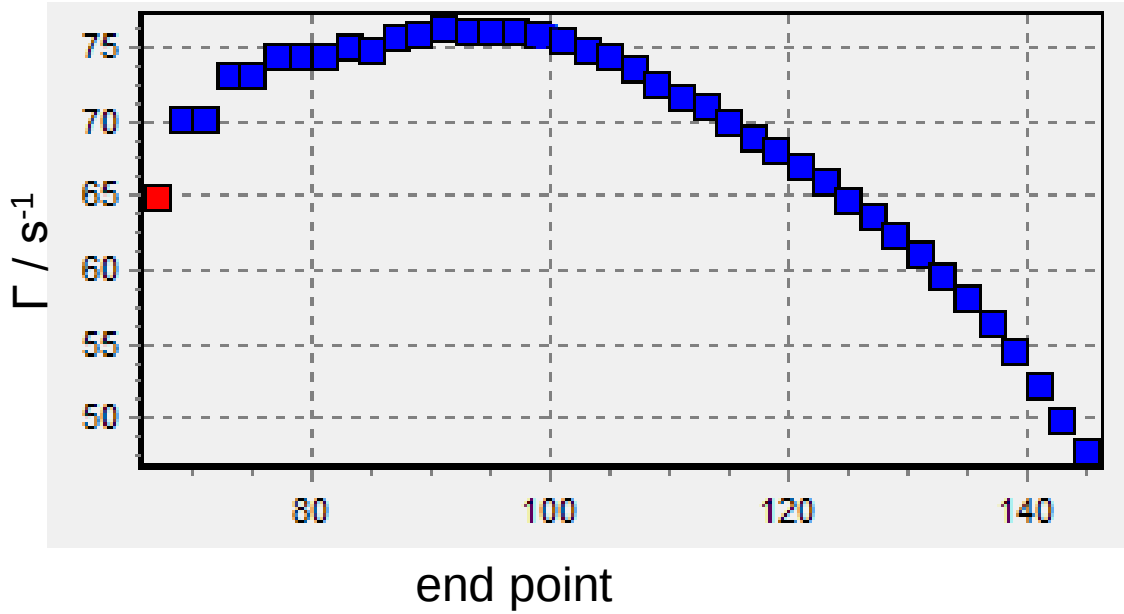
EVANESCENT WAVE DYNAMIC LIGHT SCATTERING

Data Evaluation – so far

- Choose start and end point for fit
- Perform fit → Γ
- Cut off data points for long times

➢ end point vs. Γ plot

- Choose a Γ from constant region



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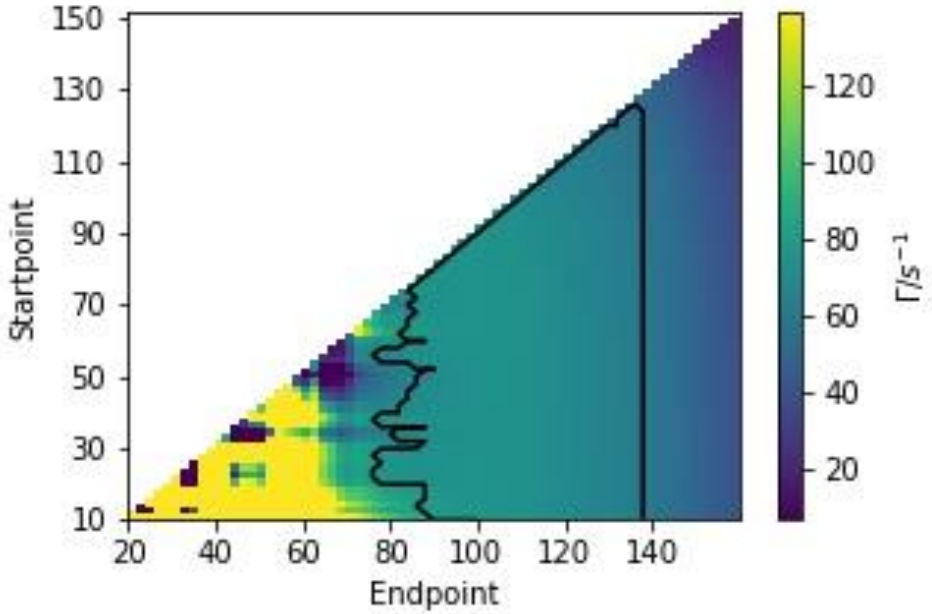
EVANESCENT WAVE DYNAMIC LIGHT SCATTERING

Data Evaluation – Extension

- Choose start and end point for fit
- Perform fit → Γ
- Cut off data points for long times
- Cut off data points for long times

➢ End point vs start point vs Γ contour plot

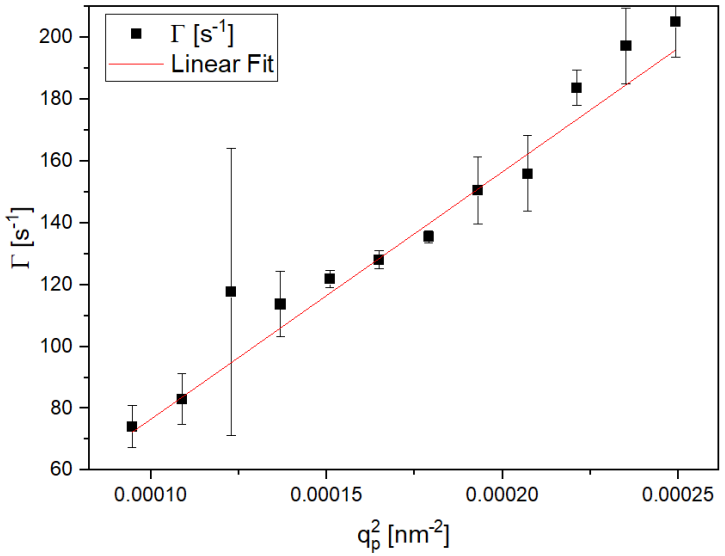
- Choose a Γ from constant region
- Benefits:
  - Less human bias
  - Automated stack excecution



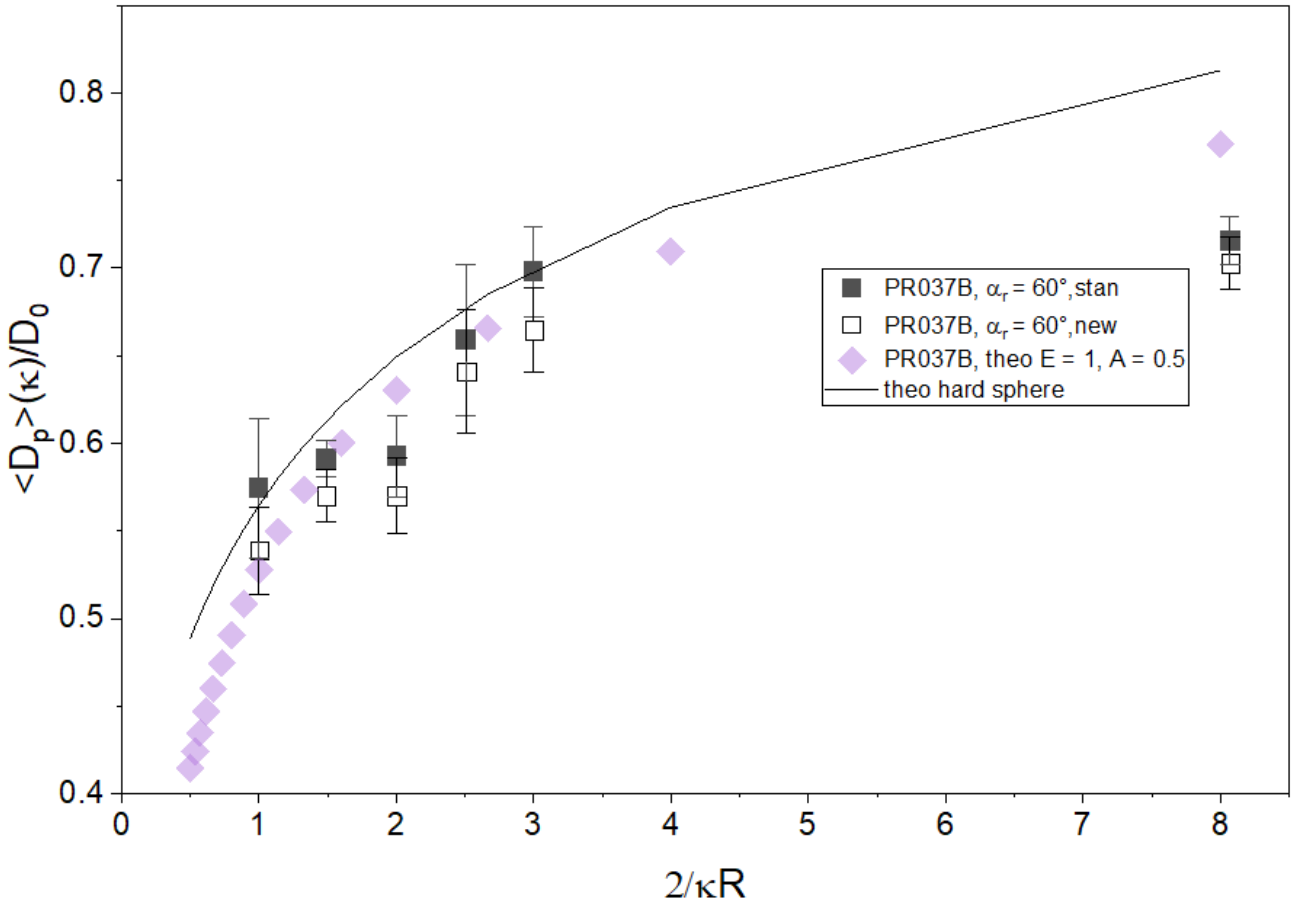
EVANESCENT WAVE DYNAMIC LIGHT SCATTERING

Measurements on hollow sphere

- Determine $< D_{\|} >$ from the slope of a linear fit of $Q_{\|}^2$ vs Γ



$$\Gamma = Q_{\|}^2 < D_{\|} > (\kappa) + \left(Q_{\perp}^2 + \frac{\kappa^2}{4} \right) < D_{\perp} > (\kappa)$$

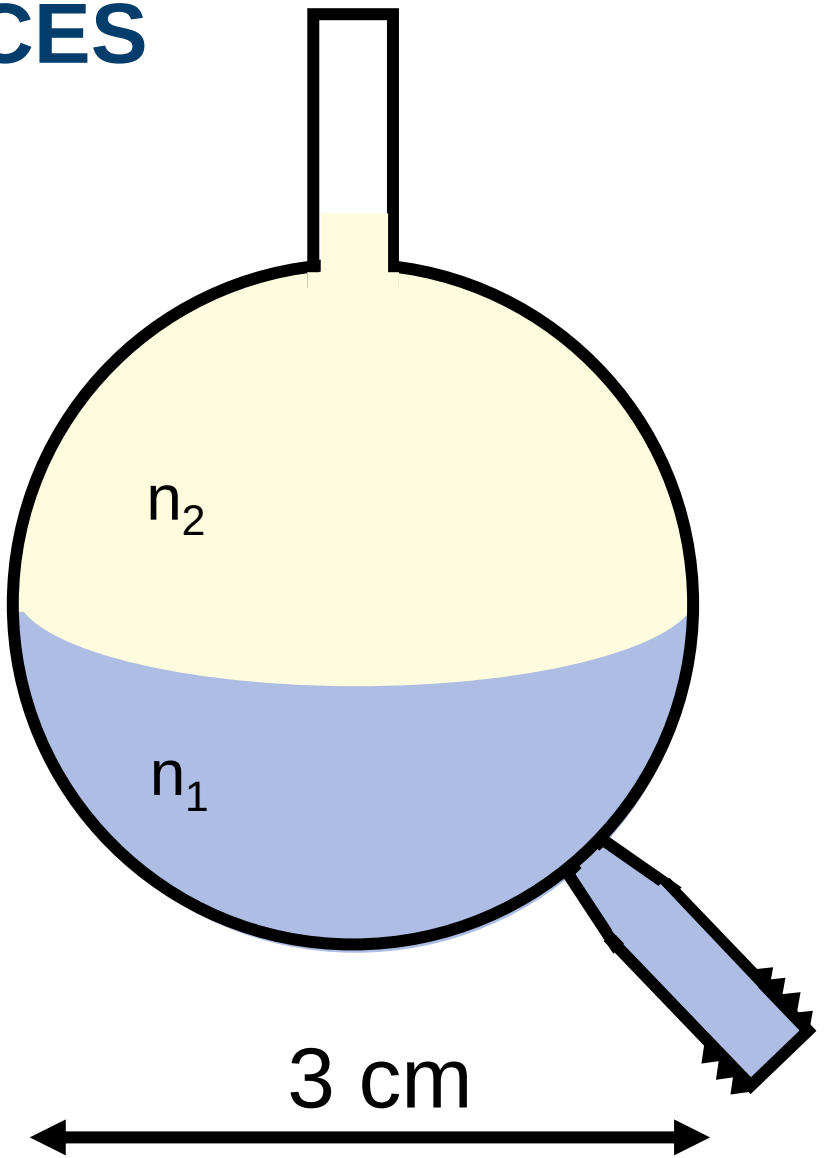


NEW SETUP: LIQUID-LIQUID-INTERFACES

New challenges

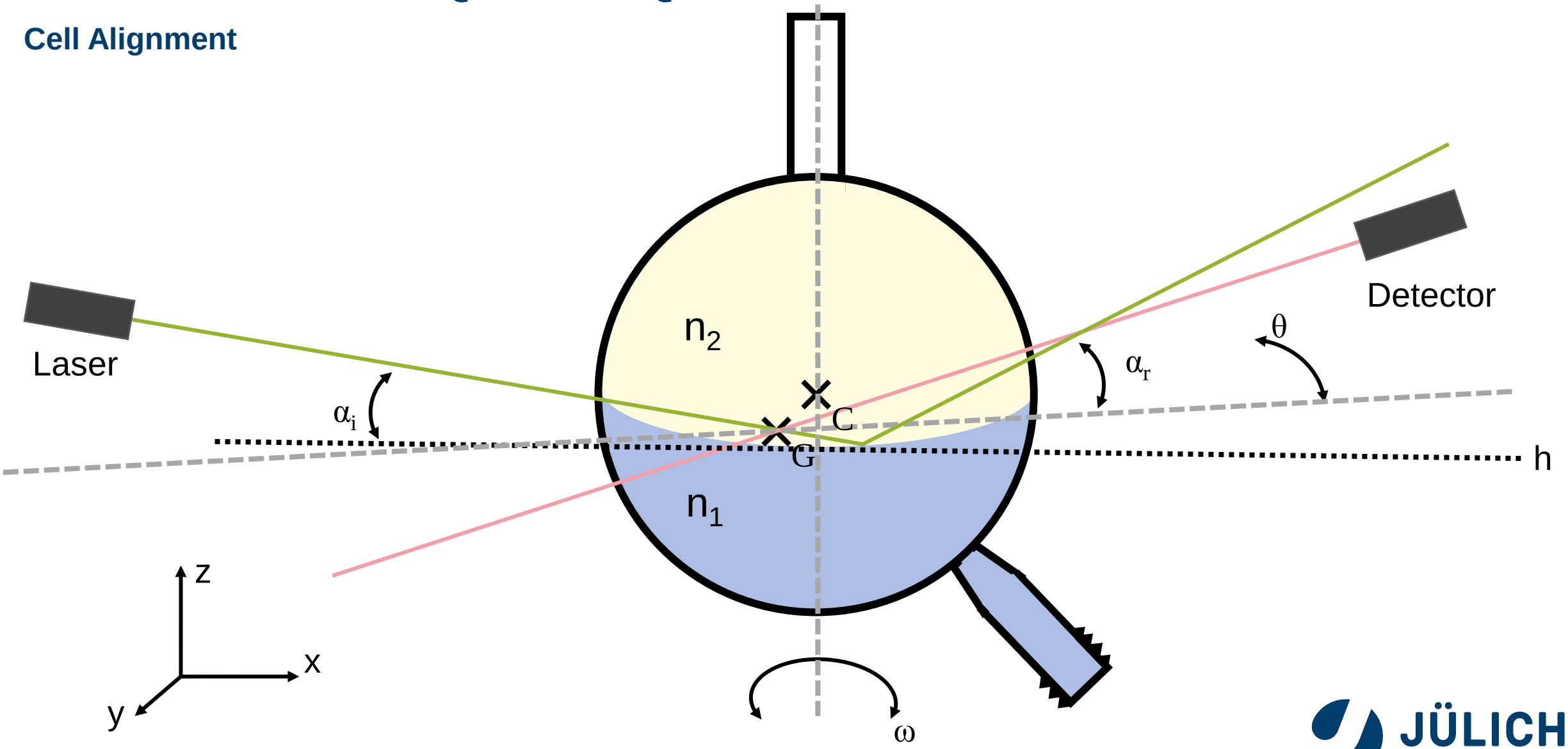
- Choice of the system
  - Immiscible liquids
  - $n_1 < n_2$
  - Stability against irreversible adsorption at the interface

  ➢ Negatively charged PTFE particles in H_20 + toluene
- Setup alignment
  - Alignment of empty cell
  - Precise filling of the cell



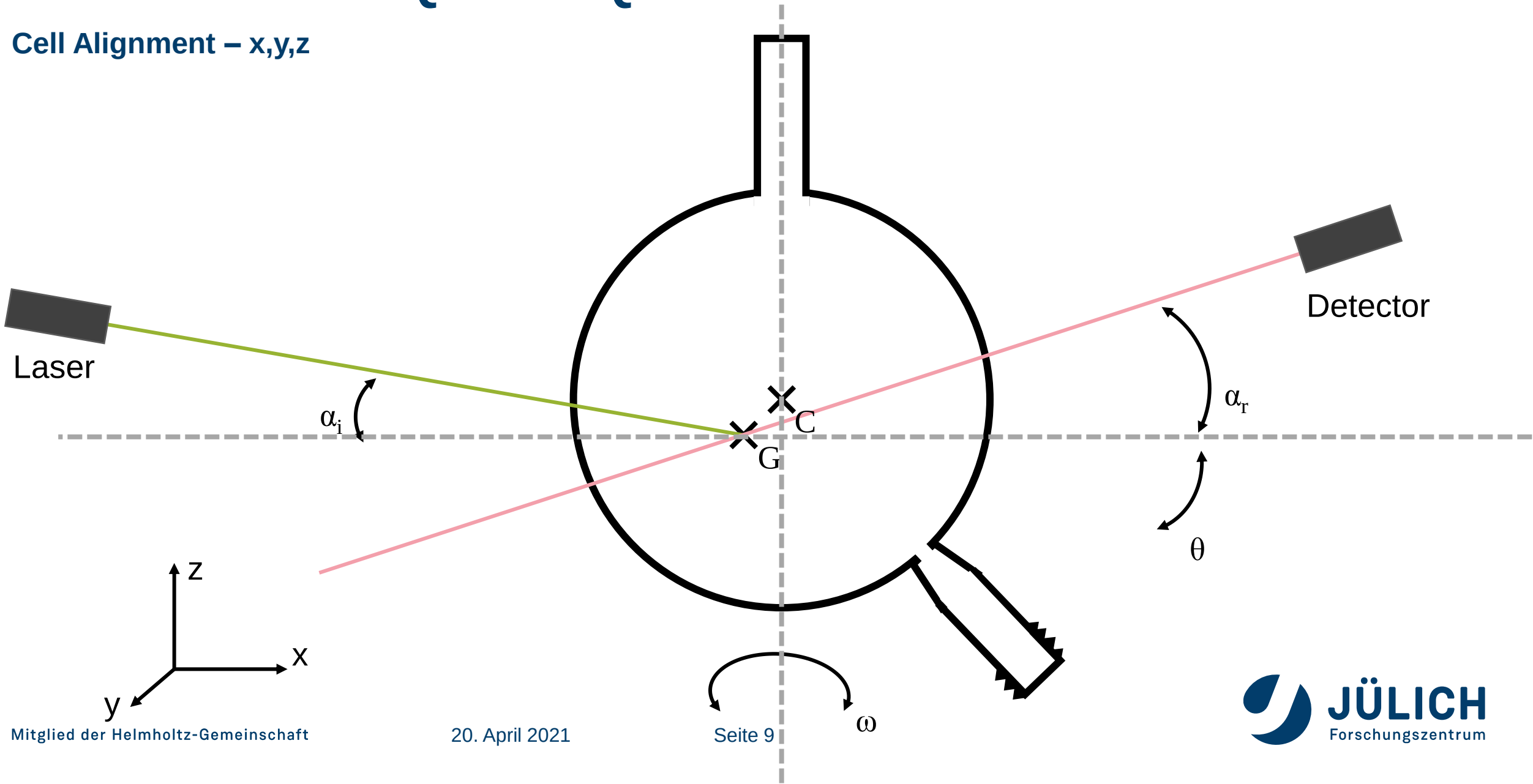
NEW SETUP: LIQUID-LIQUID-INTERFACES

Cell Alignment



NEW SETUP: LIQUID-LIQUID-INTERFACES

Cell Alignment – x,y,z



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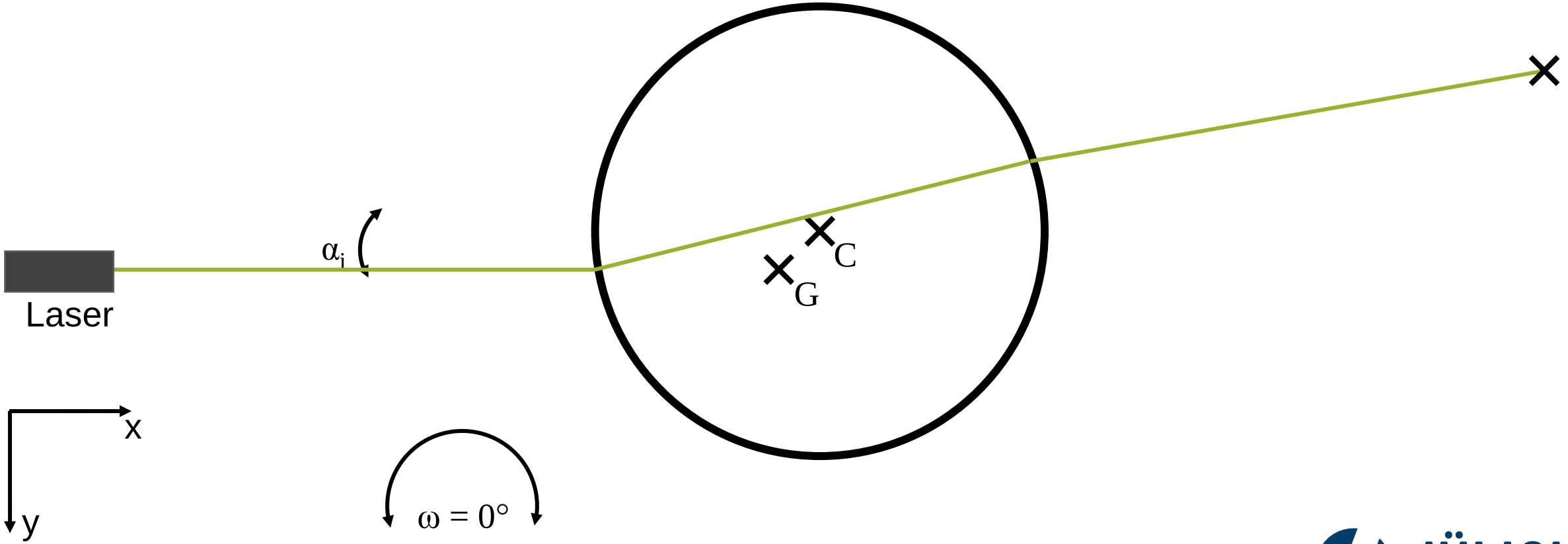

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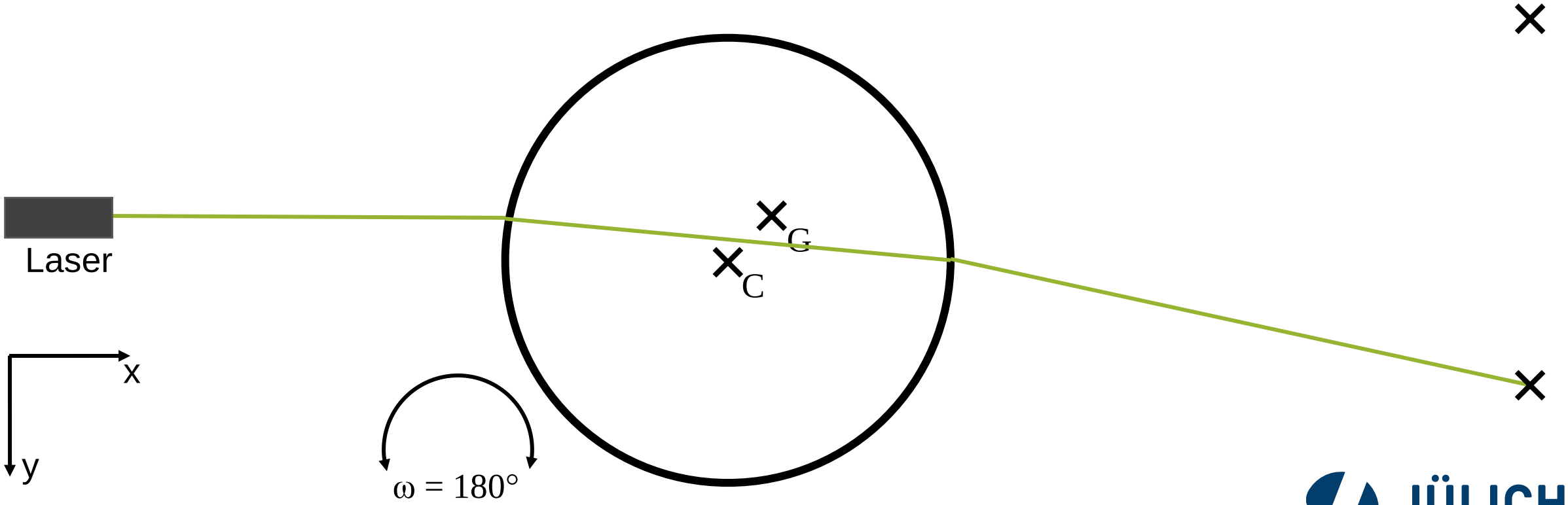
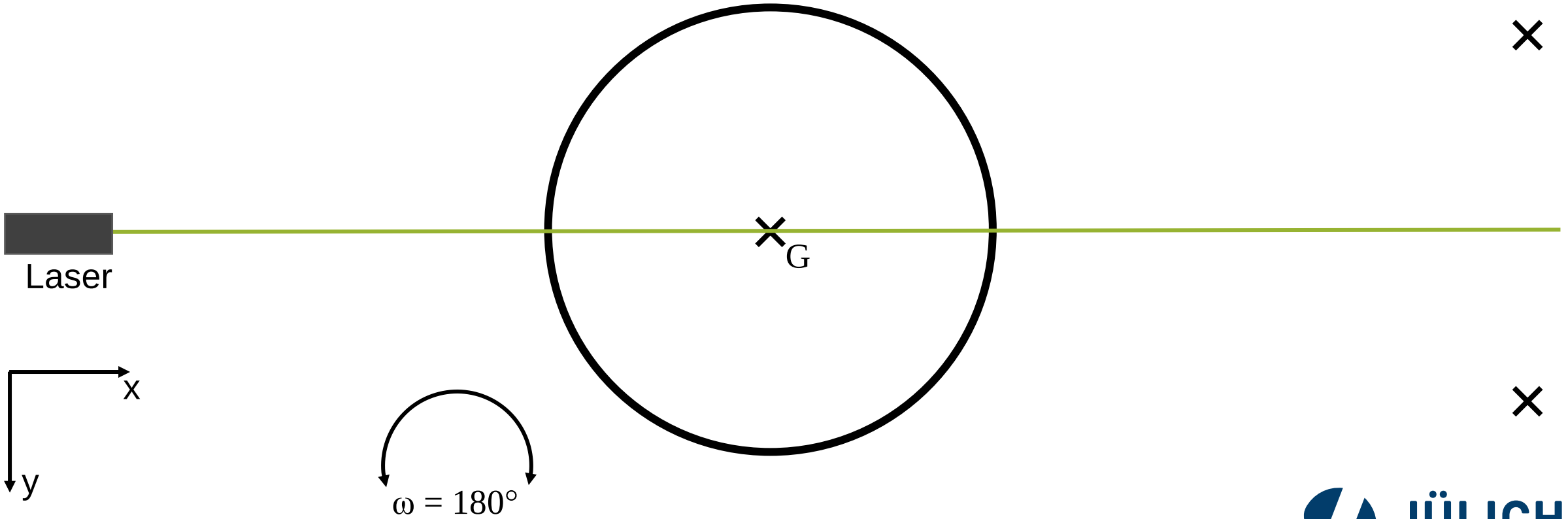


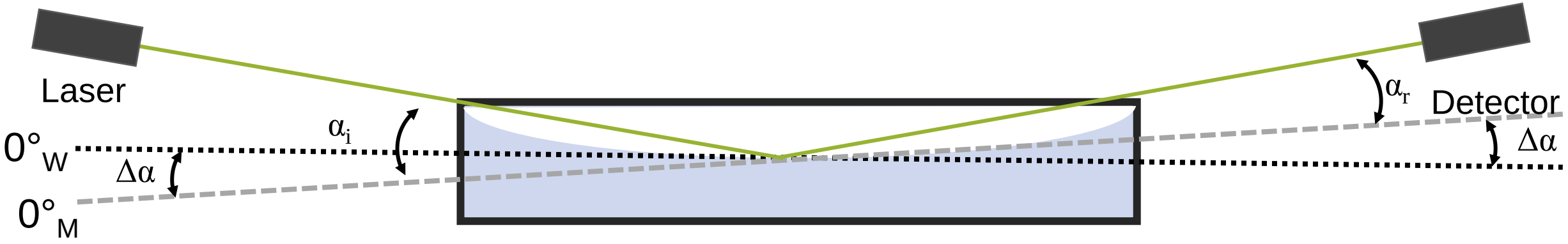
NEW SETUP: LIQUID-LIQUID-INTERFACES

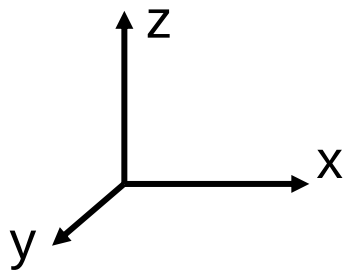
Cell Alignment – x,y,z



NEW SETUP: LIQUID-LIQUID-INTERFACES

Cell Alignment – α_i,α_r

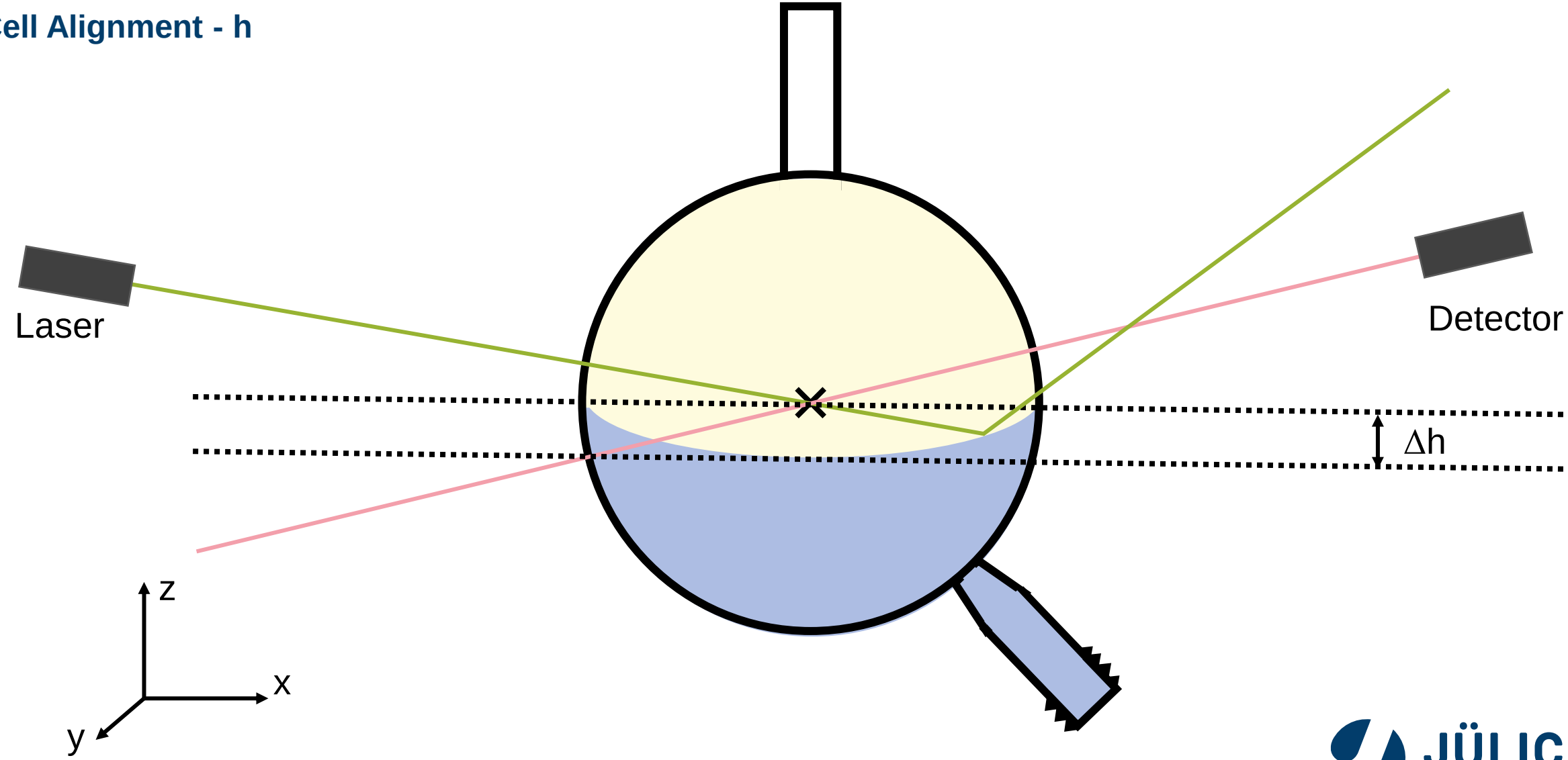




$$\Delta\alpha = \frac{1}{2}(\alpha_i - \alpha_r)$$

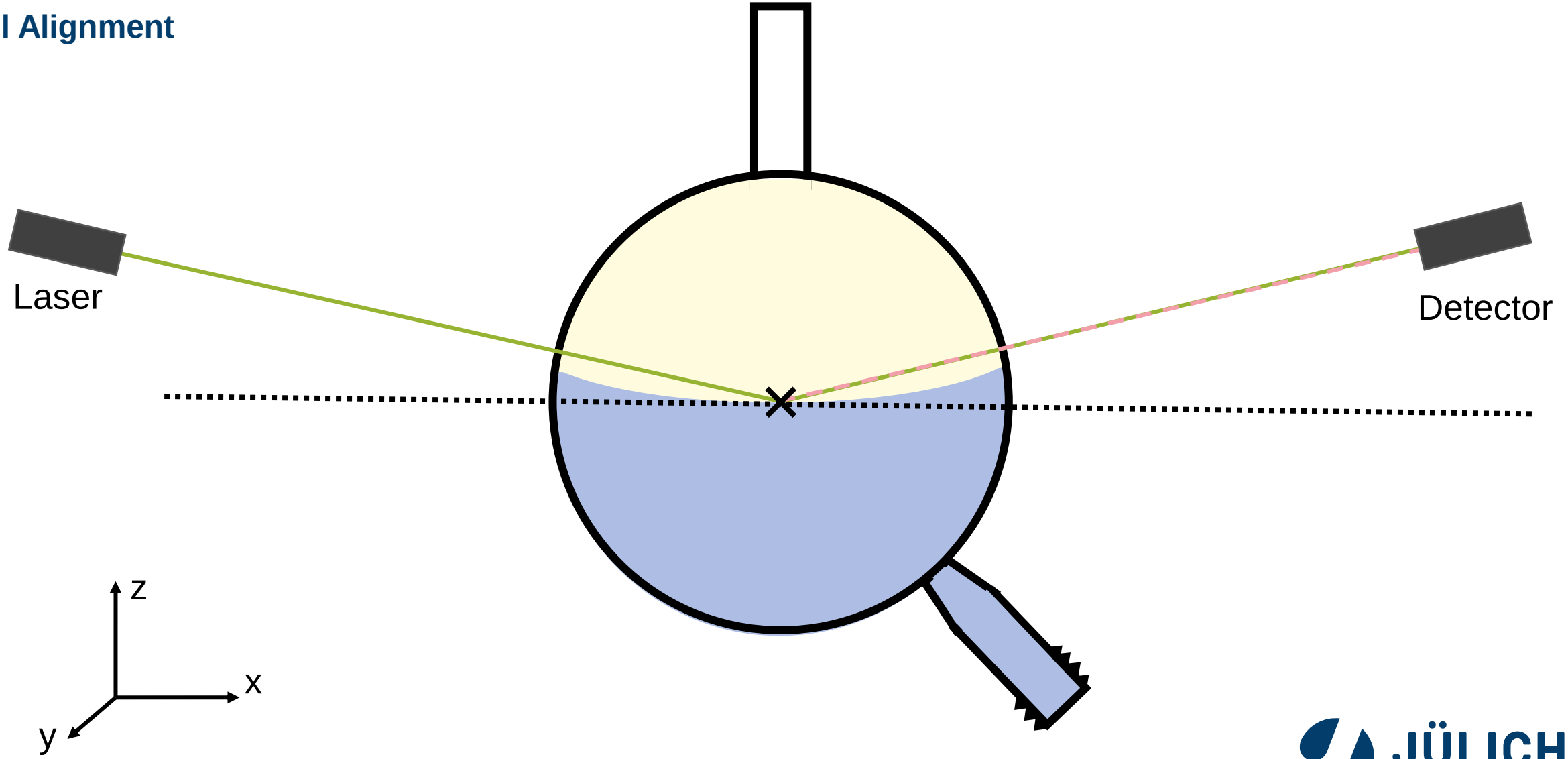
NEW SETUP: LIQUID-LIQUID-INTERFACES

Cell Alignment - h



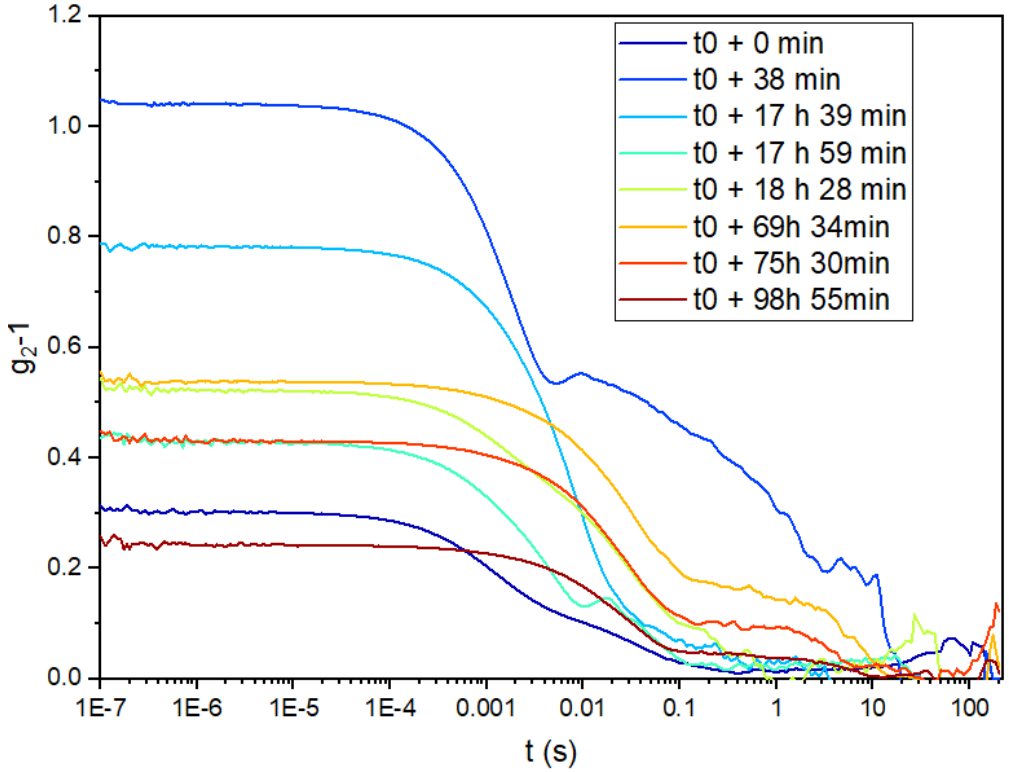
NEW SETUP: LIQUID-LIQUID-INTERFACES

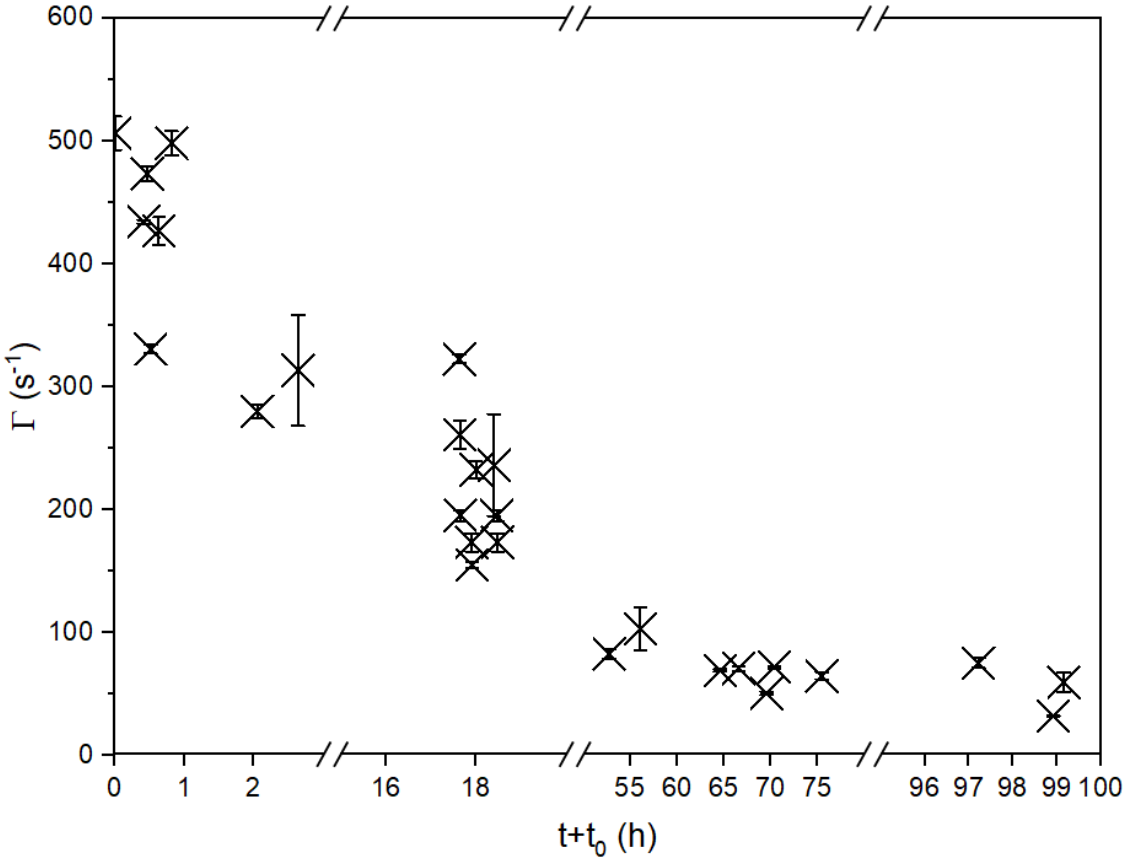
Cell Alignment



NEW SETUP: LIQUID-LIQUID-INTERFACES

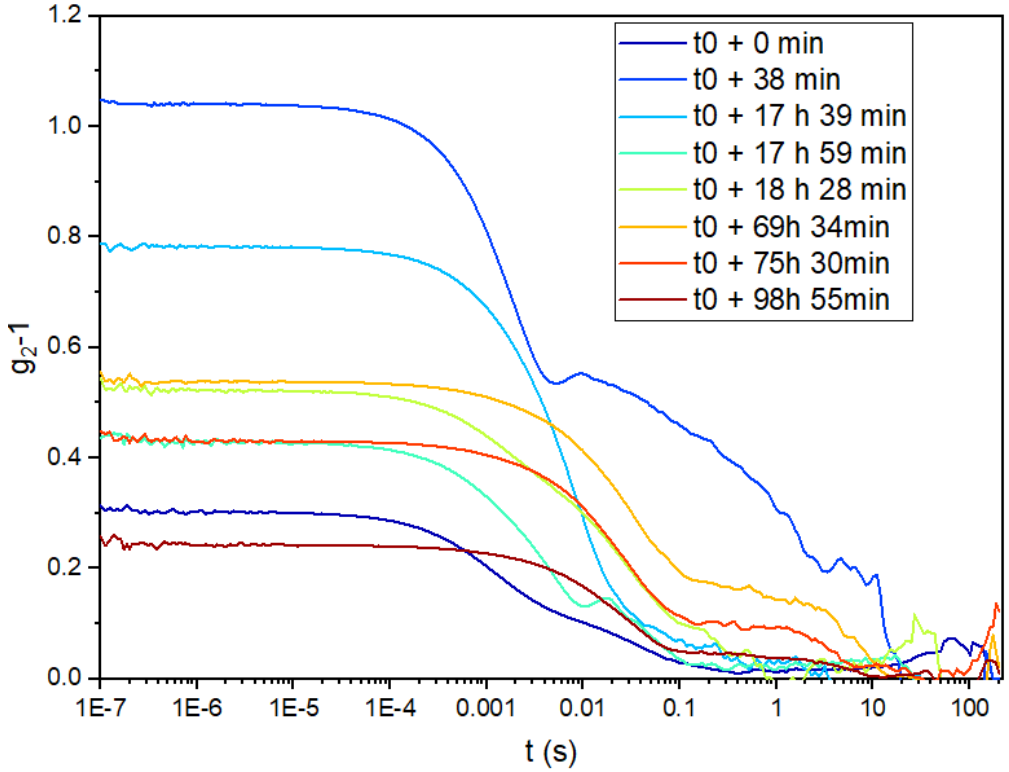
First results

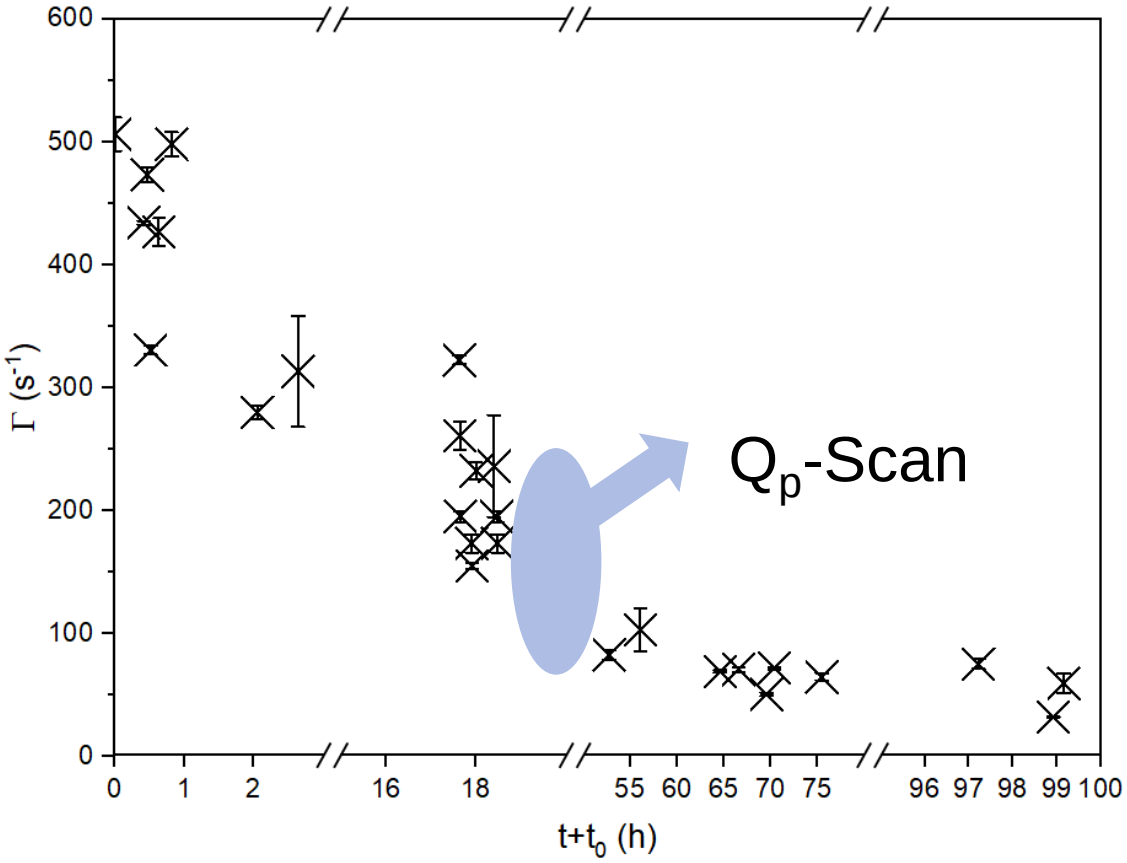




NEW SETUP: LIQUID-LIQUID-INTERFACES

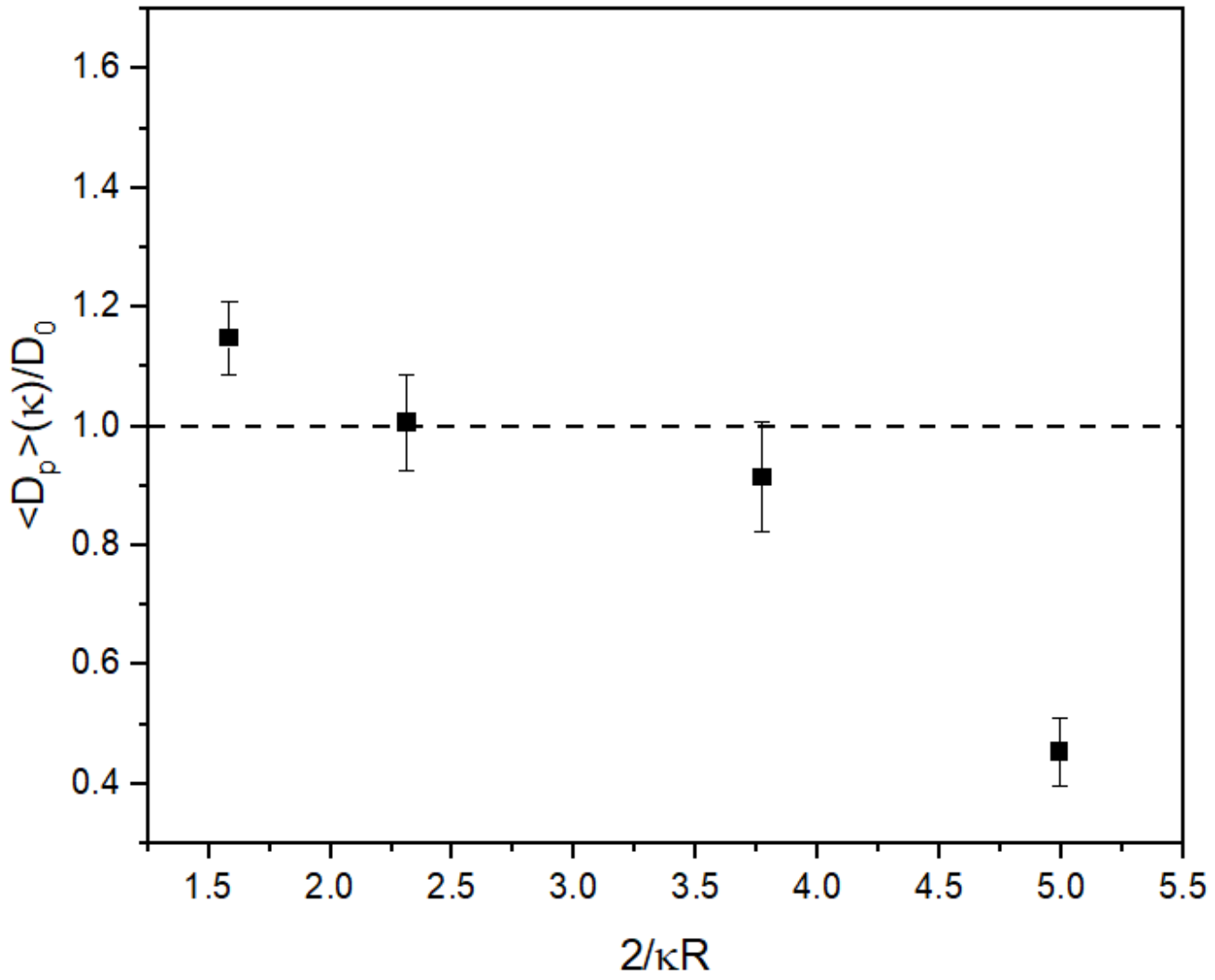
First results





NEW SETUP: LIQUID-LIQUID-INTERFACES

First results



NEW SETUP: LIQUID-LIQUID-INTERFACES

Outlook

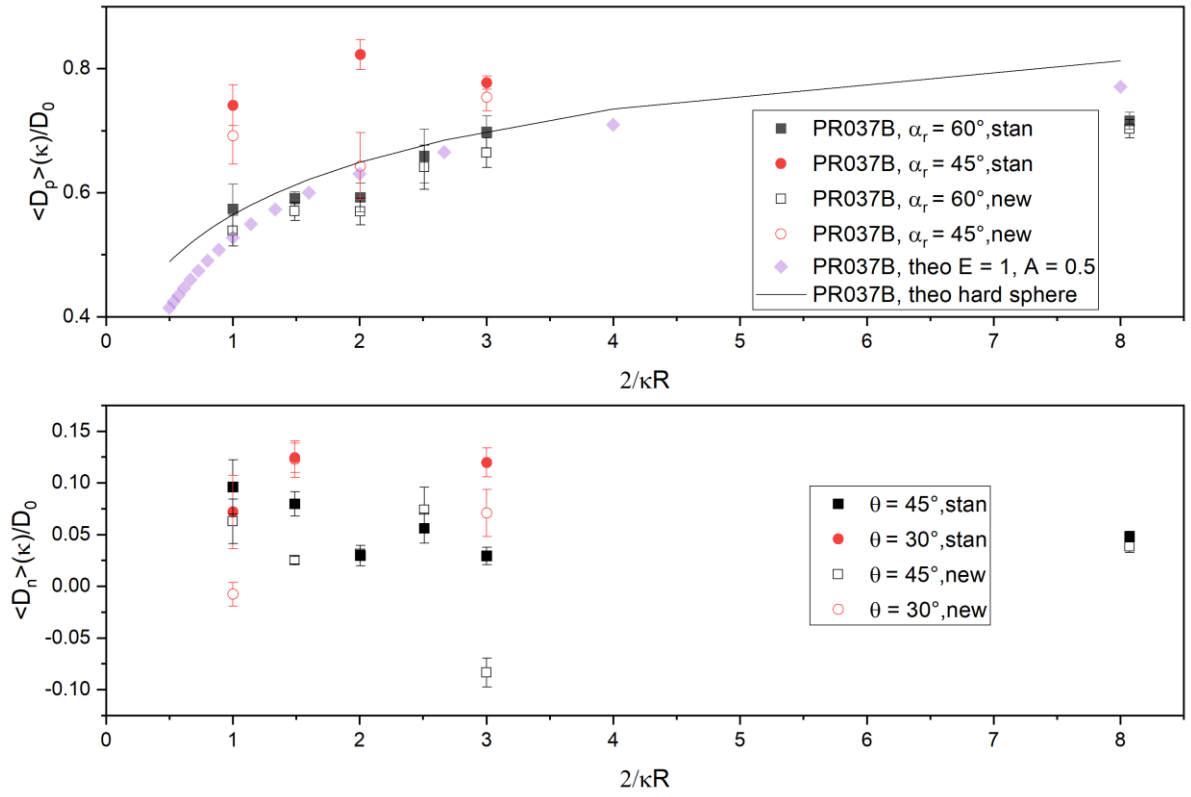
- Necessary improvements:
  - Cell with higher optical quality
  - Larger cell
- New available experiments:
  - EWDLS at liquid-liquid interfaces
  - Kinetics of nanoparticle interface adsorption
  - Diffusion of particles adsorbed in the interface

THANKS FOR YOUR KIND ATTENTION!

Lets have a nice discussion!

EVANESCENT DYNAMIC LIGHT SCATTERING

Measurements on hollow sphere



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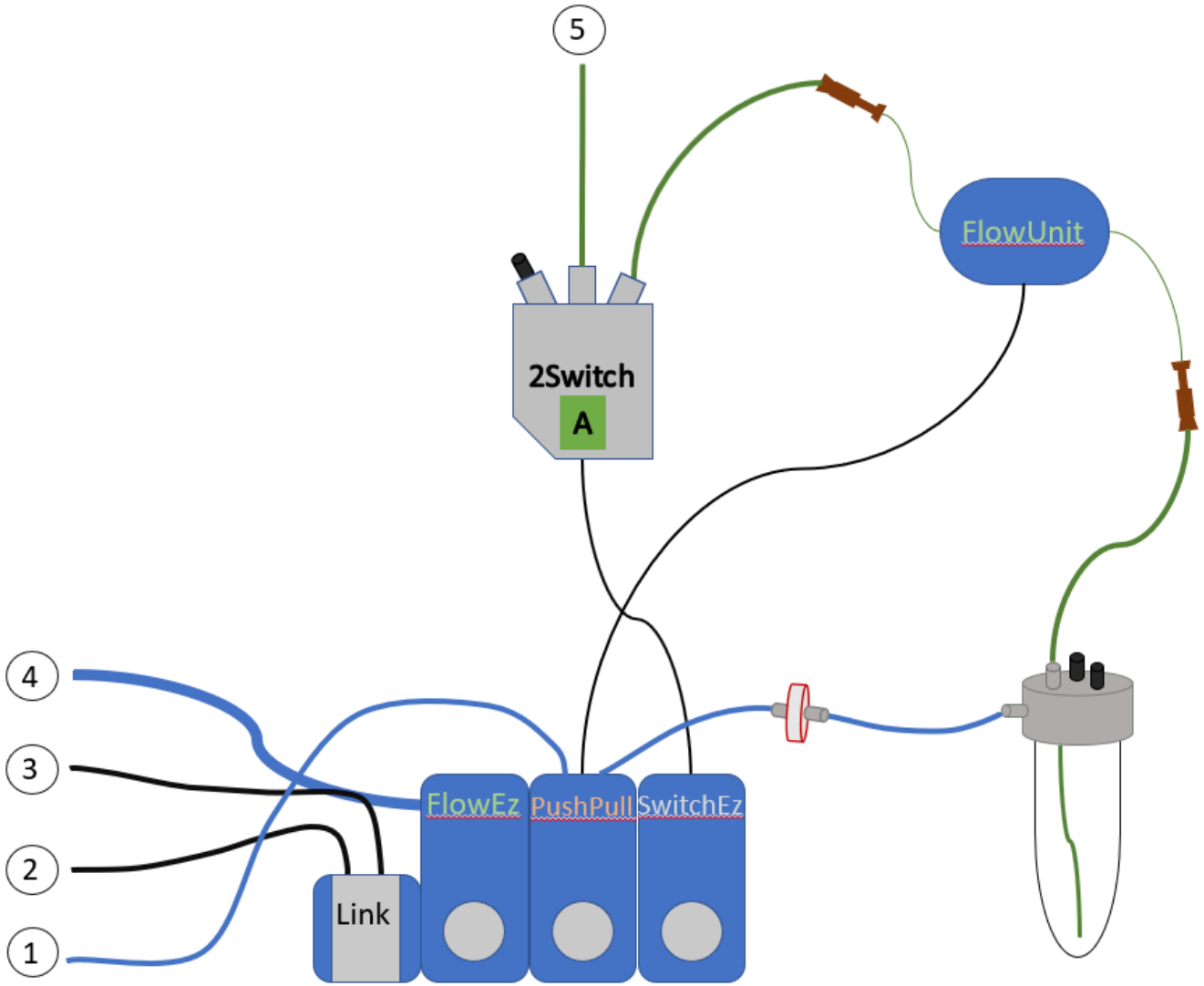
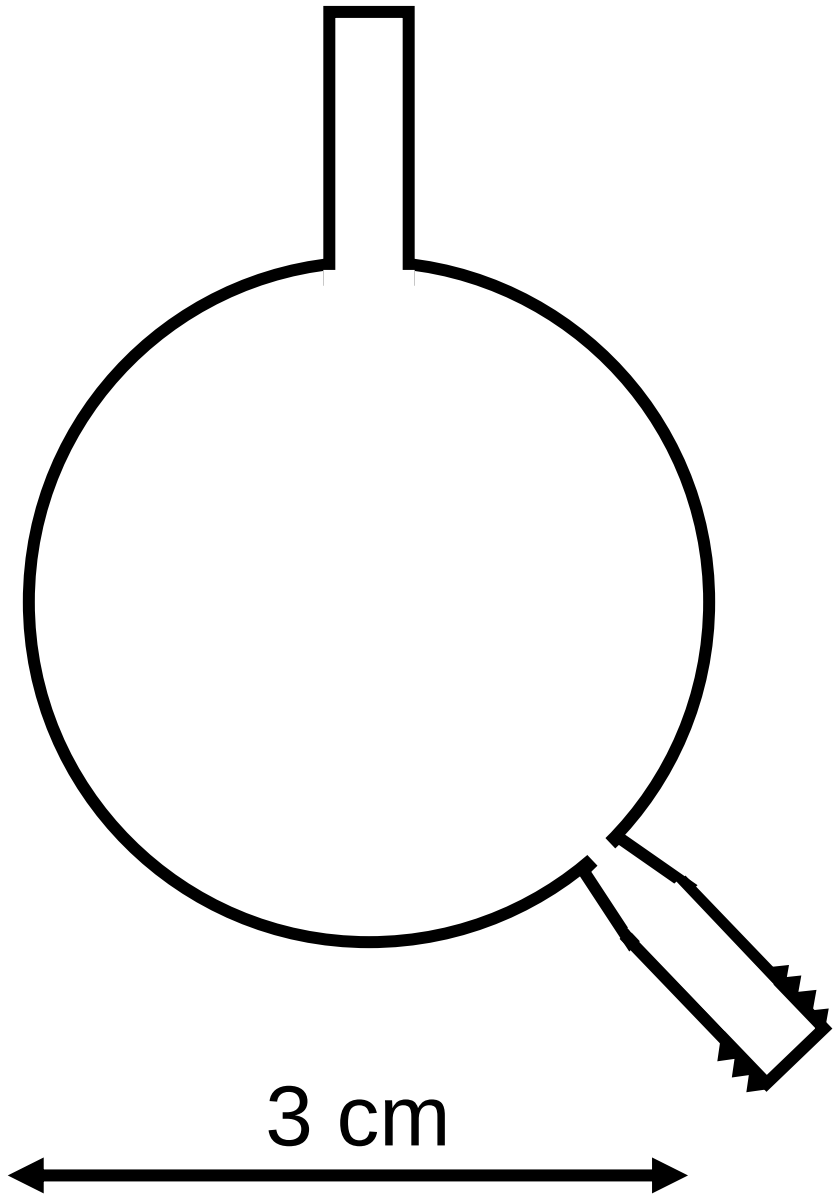
MICROFLUIDIC SETUP

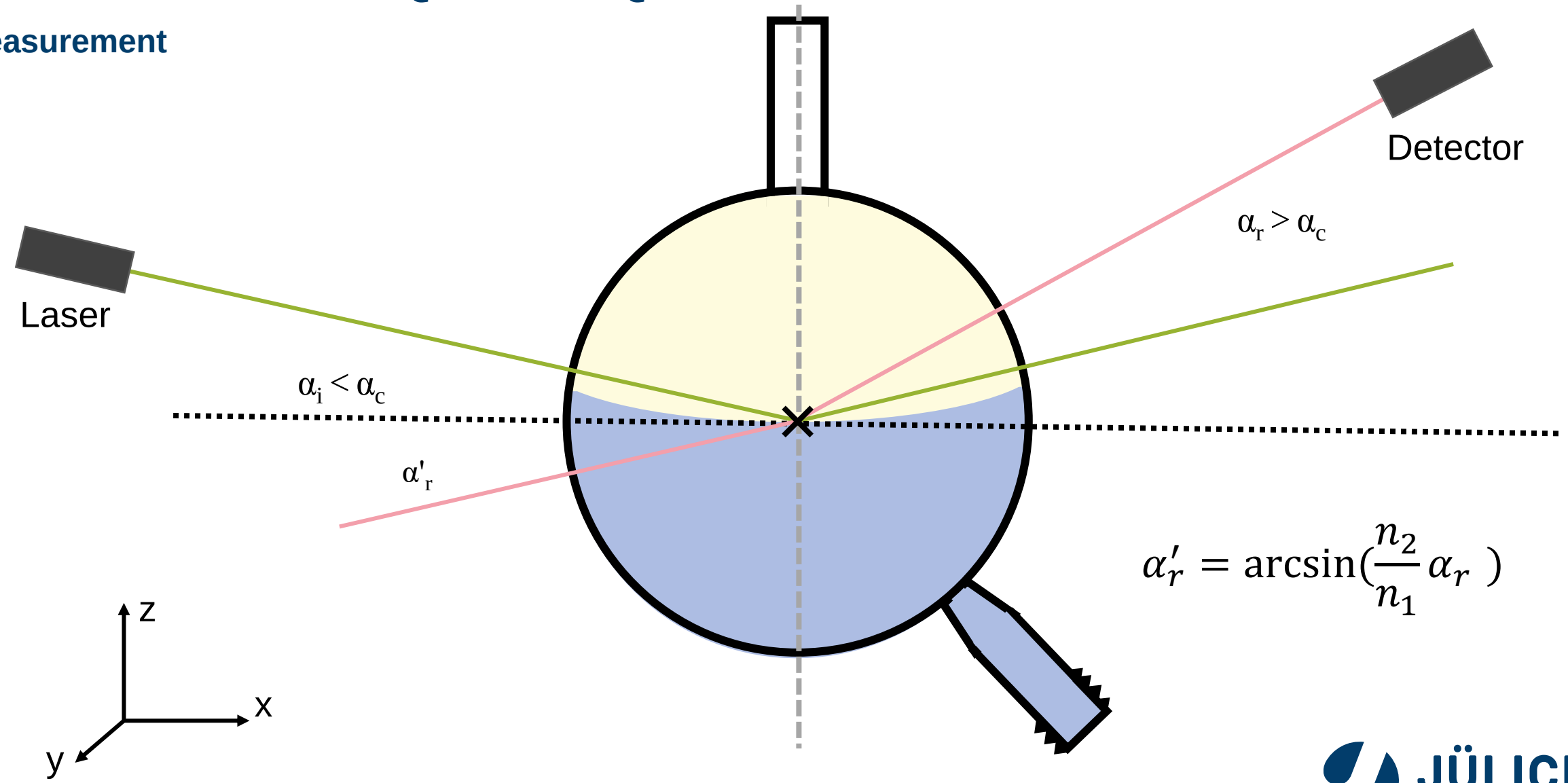
1. Vacuum supply
2. Power supply
3. USB
4. Pressure supply
5. Line to the sample cell




3 cm

NEW SETUP: LIQUID-LIQUID-INTERFACES

Measurement



$$\alpha'_r = \arcsin\left(\frac{n_2}{n_1}\alpha_r\right)$$

NEW SETUP: LIQUID-LIQUID-INTERFACES

First results