Universität Siegen

Zukunft menschlich gestalten

TRACKOPT - KICKOFF

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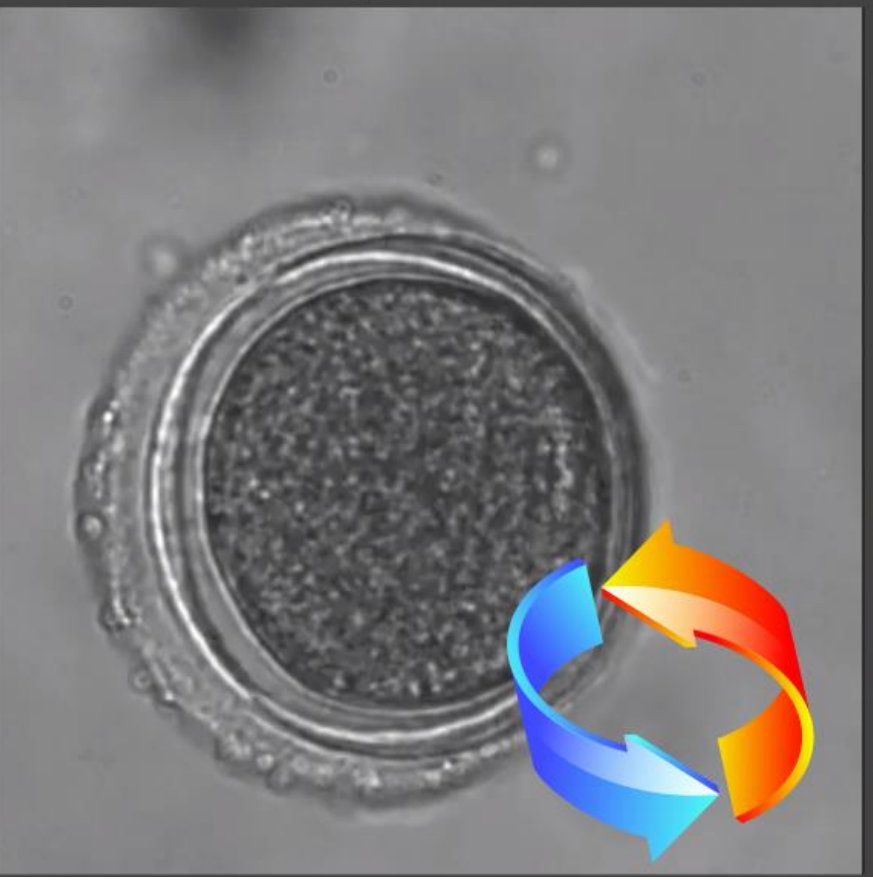
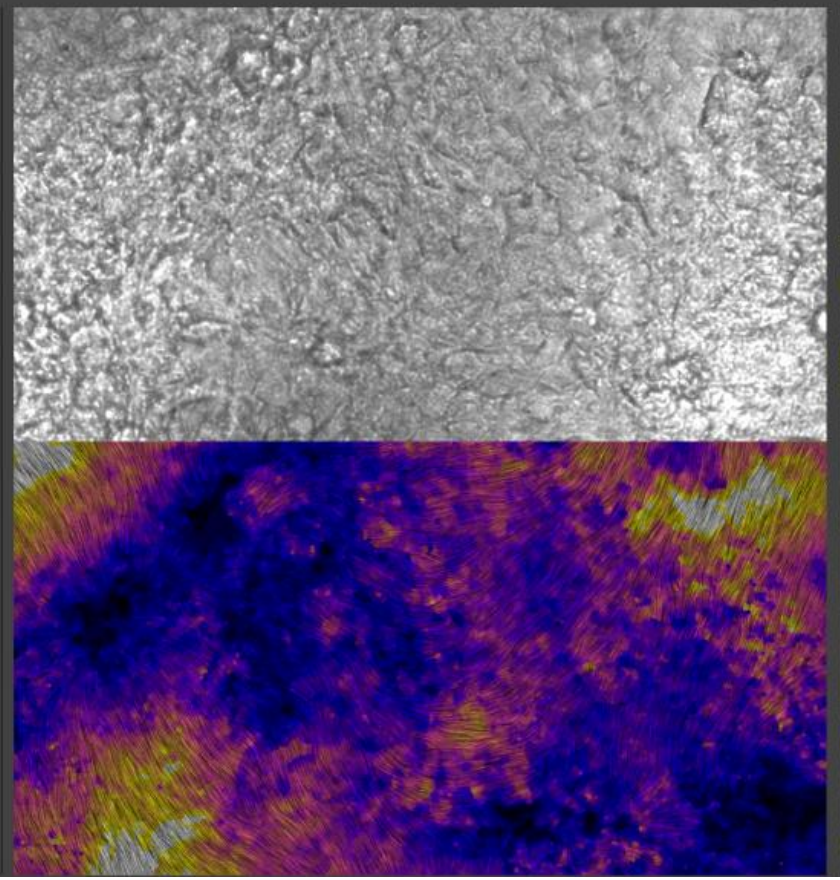
COMMUNICATIONS ENGINEERING
SIEGEN UNIVERSITY

TRACKOPT – APPLICATION CELL TRACKING

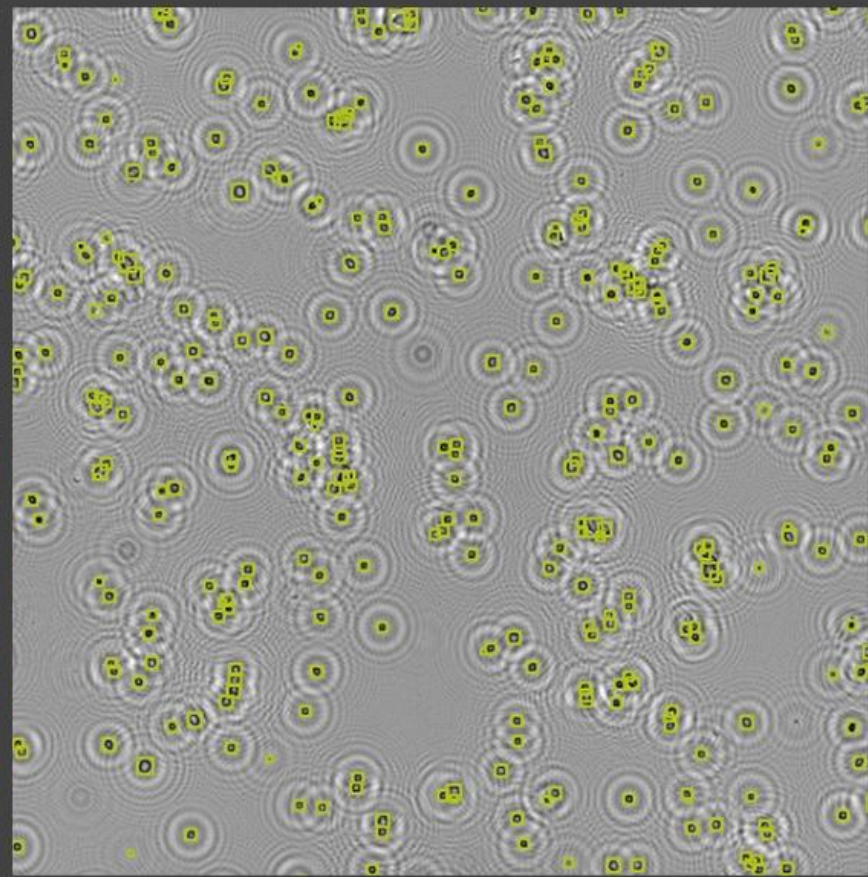
Fall I: Festkorpertransformation



Fall II: elastische Verformung



Fall III: holografische Partikel

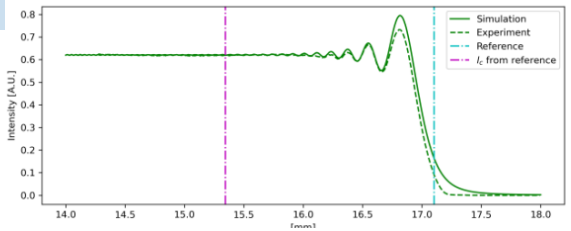


CASE I: RIGID BODY MOTION

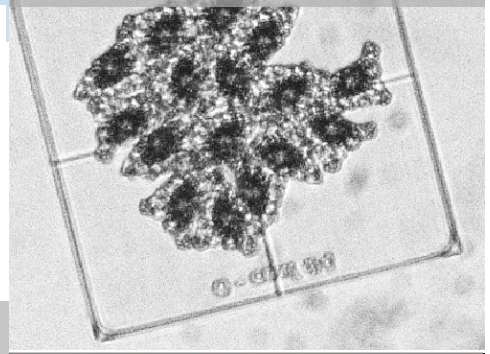
Data has been/will be acquired in a concurrent project (L2S 3D Microscopy)

- **Goal:** pose estimation of single cells / cell clusters
  - tracking to enable structure from-motion
- Challenge: image formation - PDE
- Properties:
  - Periodic motion
  - 3D constraints

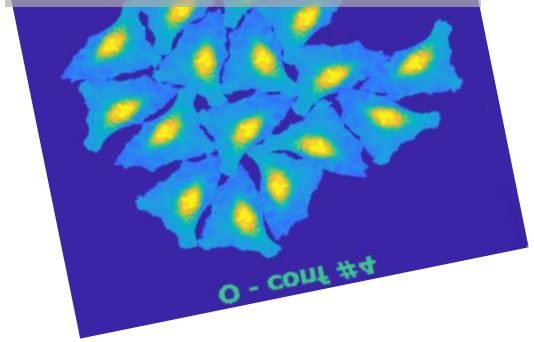
Validated GT simulation



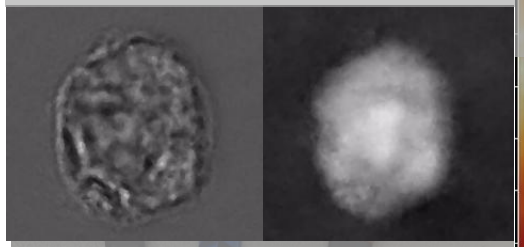
3D printed ground truth



ground truth phase map

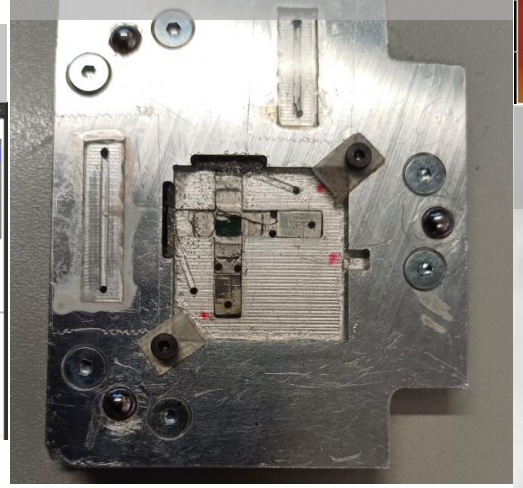


Phase Video

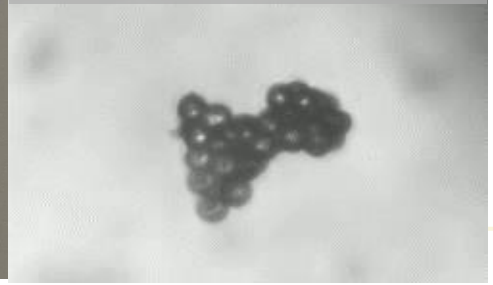


captured phase map

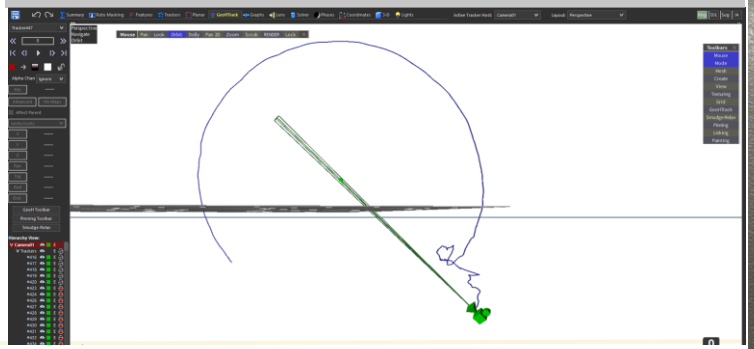
acousto-fluidic device

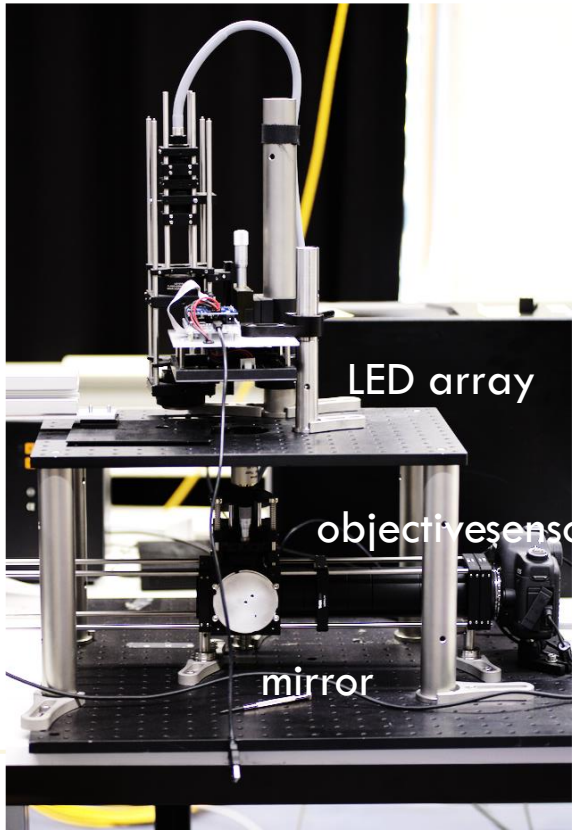


sustained sample rotation



Example SfM

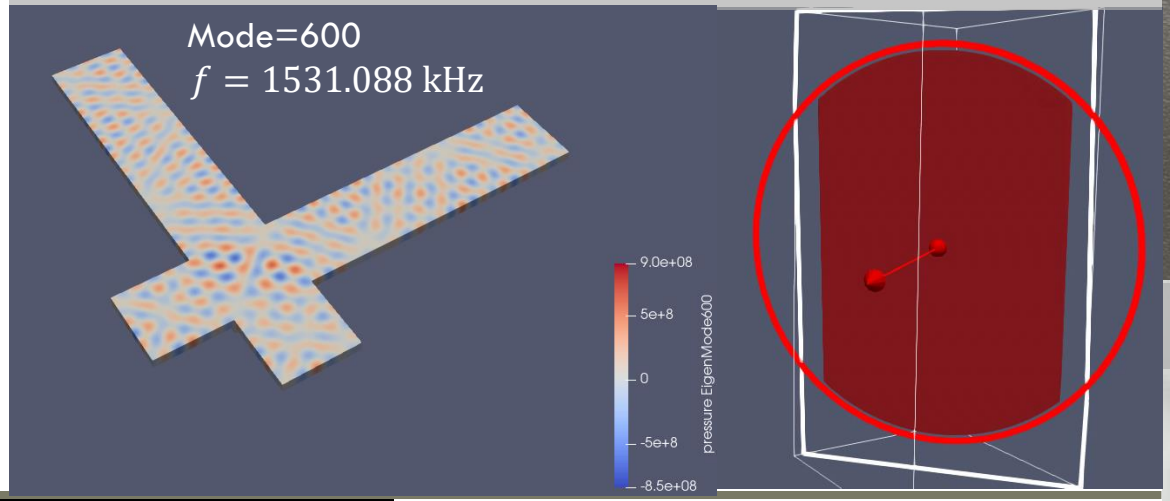




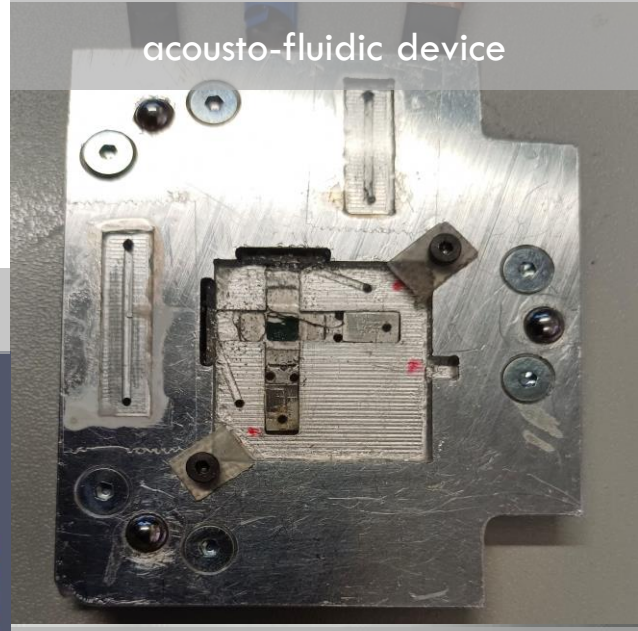
MICROFLUIDIC MANIPULATION DEVICE

- Enables touchless manipulation (translation, 2 rotation modes)
- To be used for 3D cell imaging via tomography

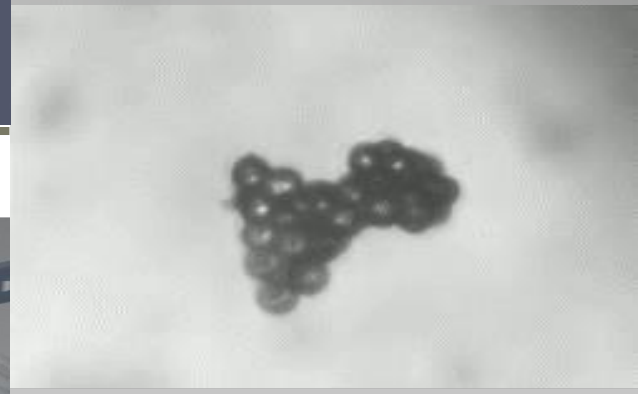
pressure distribution



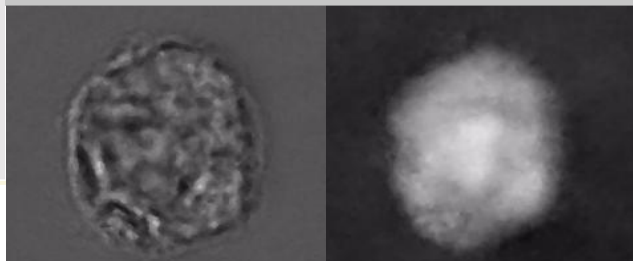
acousto-fluidic device

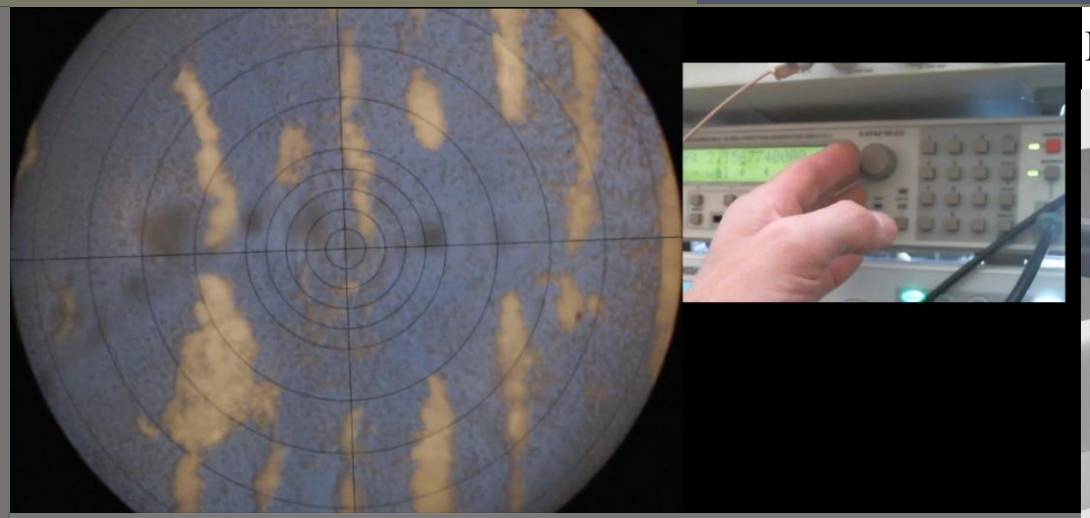


sustained sample rotation

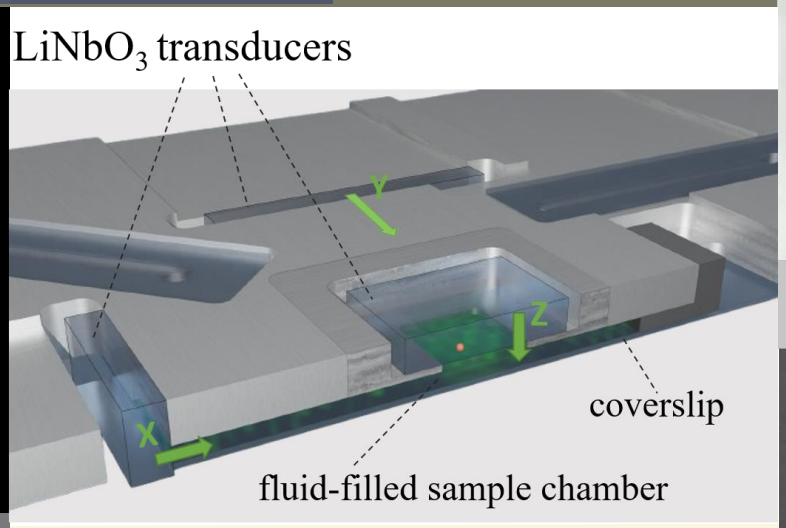


phase video



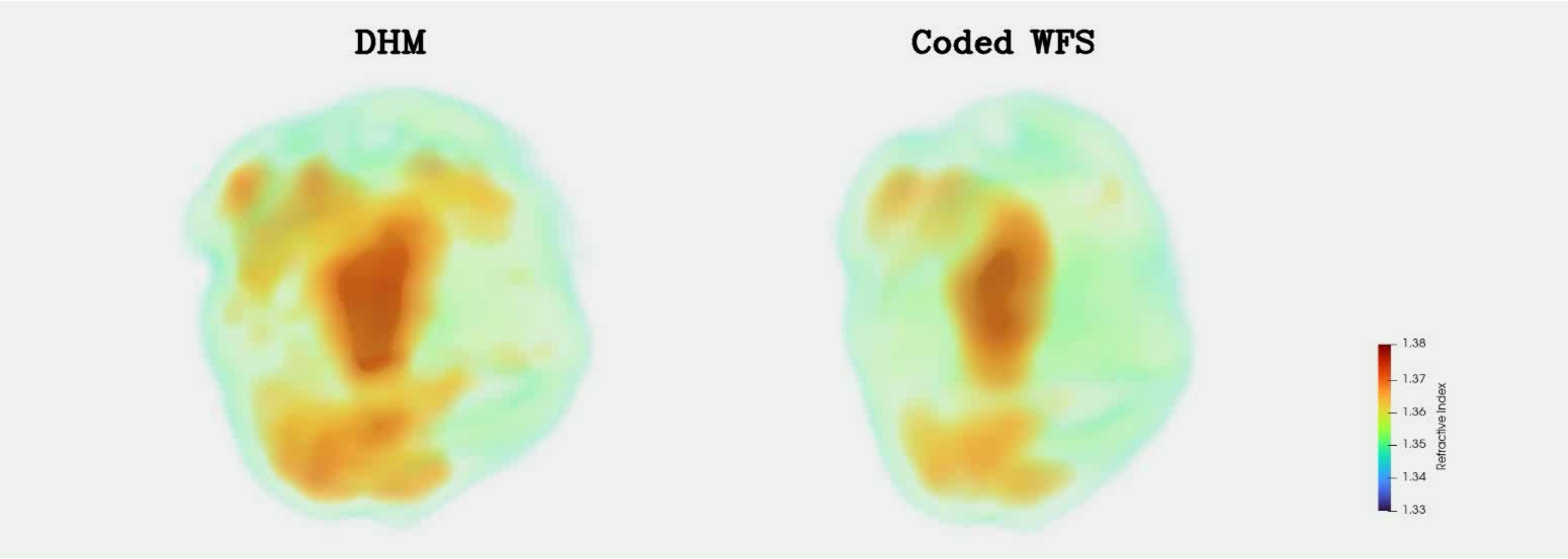


control via frequency tuning



acoustofluidic platform

FIRST TOMOGRAPHY RESULT



CASE II: ELASTIC DEFORMATION

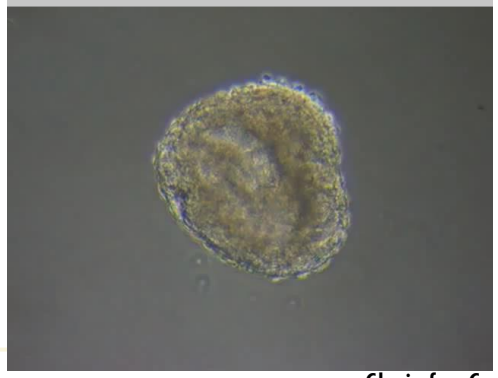
- Working with a biomedical group in Tampere / Finland

- Target: cardiomyocytes (cardiac muscle cells)
  - These cells show dynamic deformations
  - Different complexity levels:
    - Monolayers
    - Multi-layers
    - Organoids

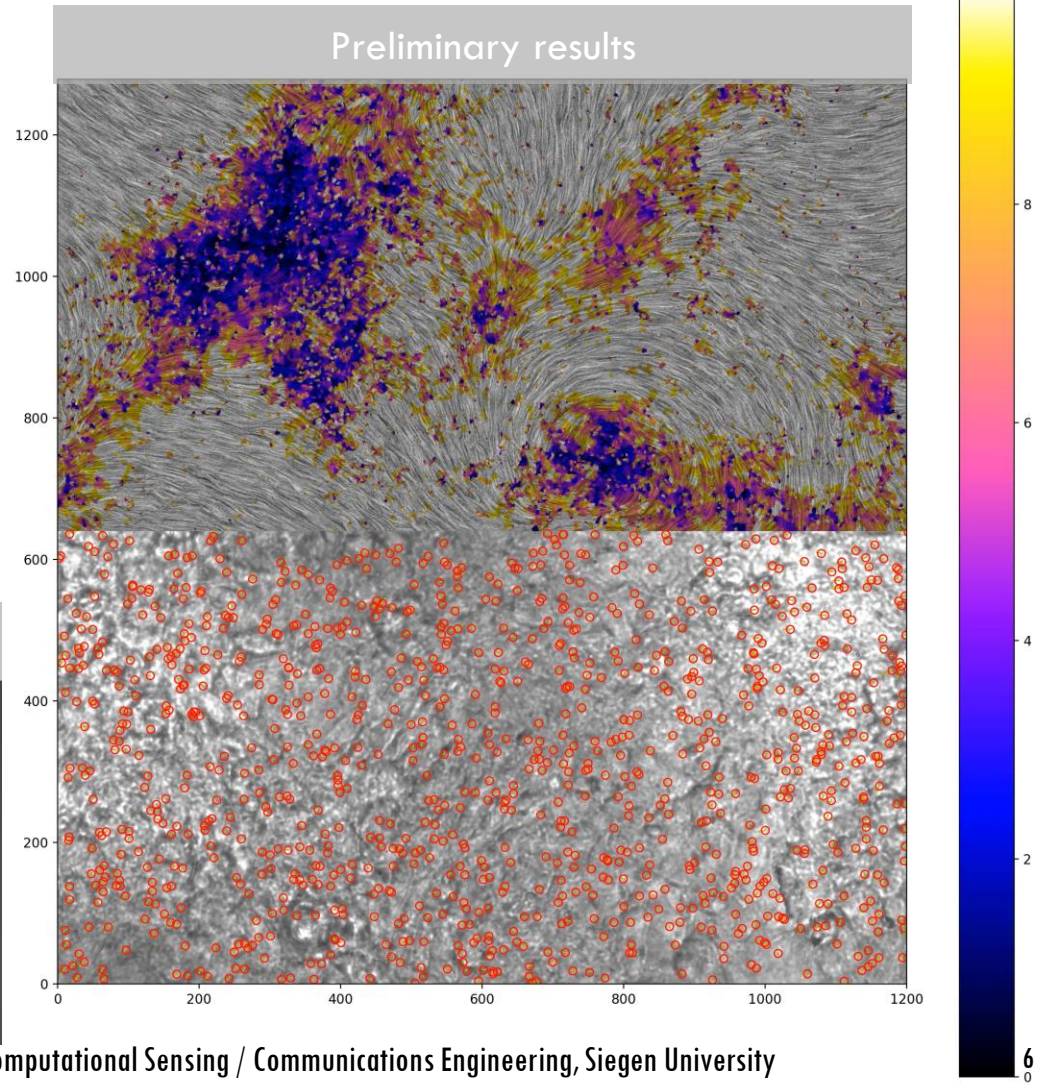
  - Cyclic motion

Show Tampere video

Cardiomyocyte Organoid



Preliminary results

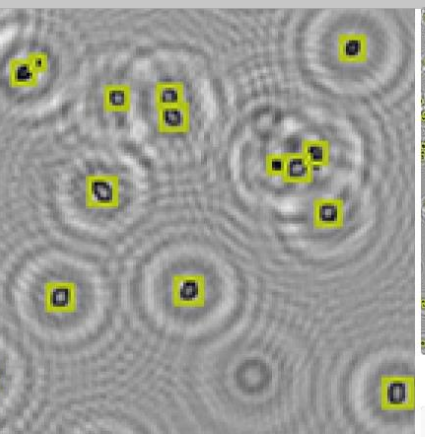


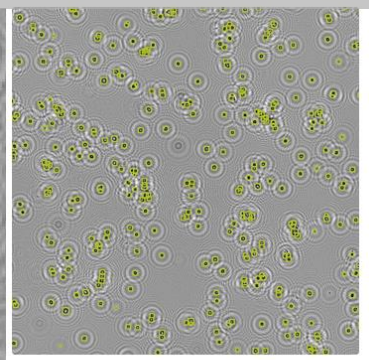
CASE III: HOLOGRAPHIC PARTICLES

- In cooperation with anvajo GmbH (Dresden)
  - Inline-holographic images of particles
  - Goal: 3D tracking (tumbling particles would yield 3D projections enabling improved classification)
  - Constraints: random walk, image formation: coherent imaging

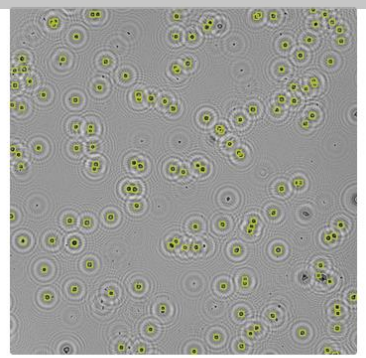
Point of care testing device for veterinarians

Example cells in urine

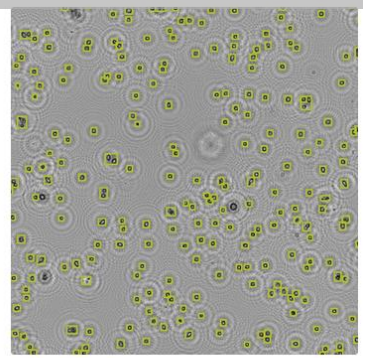




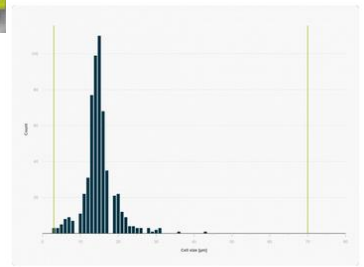
HEK293T - Human Embryonic Kidney Cells



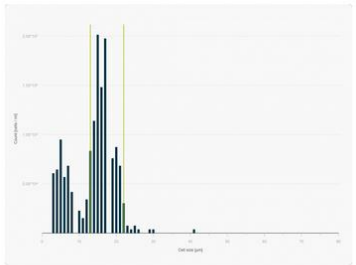
iPS cells - human induced pluripotent stem cells



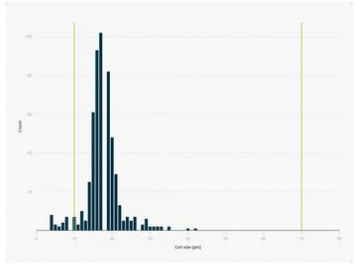
HeLa cells



HEK293T - Human Embryonic Kidney Cells



iPS cells - human induced pluripotent stem cells



HeLa cells

- Red Blood Cells/ White Blood Cells
- Squamous Epithelial Cells/ Non-Squamous Epithelial Cells
- Hyaline Casts/ Non-Hyaline Casts
- Calcium Oxalates Dihydrates/ Struvites/ Unclassified Crystals
- Bacteria (suspected presence)

WORK PLAN

Monat	1–3	4–6	7–9	10–12	13–15	16–18	19–21	22–24	25–27	28–30	31–33	34–36
AP 1	AP 1.1				AP 1.2				AP 1.3			
AP 2.1	Fall I				Fall II				Fall III			
AP 2.2	Fall I				Fall II				Fall III			
AP 2.3		Fall I				Fall II				Fall III		
AP 3	AP 3.1				AP 3.2							
AP 4	AP 4.1				AP 4.2				AP 4.3			
AP 5	AP 5.1								AP 5.2			

Simulation vs. capture

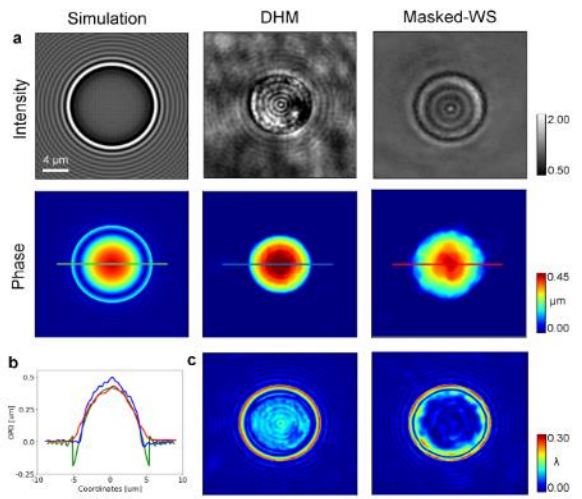


Fig. 1. Accuracy validation measurements using a 10 µm spherical silica bead. (a) The first and second rows show intensities and phases (in OPD) method-wise, respectively. (b) OPD of a cross-section profile of the bead relative to the immersion. (c) The RMSE of the DHM (left) and Masked-WS (right) OPDs from the phase of the simulated bead in (a), normalized by the wavelength λ_{III}.

- Current state:
  - Data availability: case I and case II, data available
  - Ground truth: simulation of transparent objects in microscopes is available
  - Classical methods: case I and case II have partial results
  -

AP2	Anwendung Mikroskopie, Koordination: USi2	Insgesamt 41PM
PM/Partner	36PM USi2, 5PM UMa	
AP2.1 Datenaufbereitung jeweils für Fall I),II) und III), AP2.1.(I-III) klassische Methoden und Annotation (6PM USi2) AP2.2 Datensimulation für Fall I),II) und III), Wellenoptische Simulationen mit entsprechenden Randbedingungen (6PM USi2) AP2.3 Constraintmodellierung für Fall I), II) und III), AP2.3.I: 3D Festkörpertransformation + TIE, AP2.3.II: Loop Closure + Schichtmodell, AP2.3.III Brownsche Bewegung + Holografie (24PM USi2, 5PM UMa)		

Thank you!

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