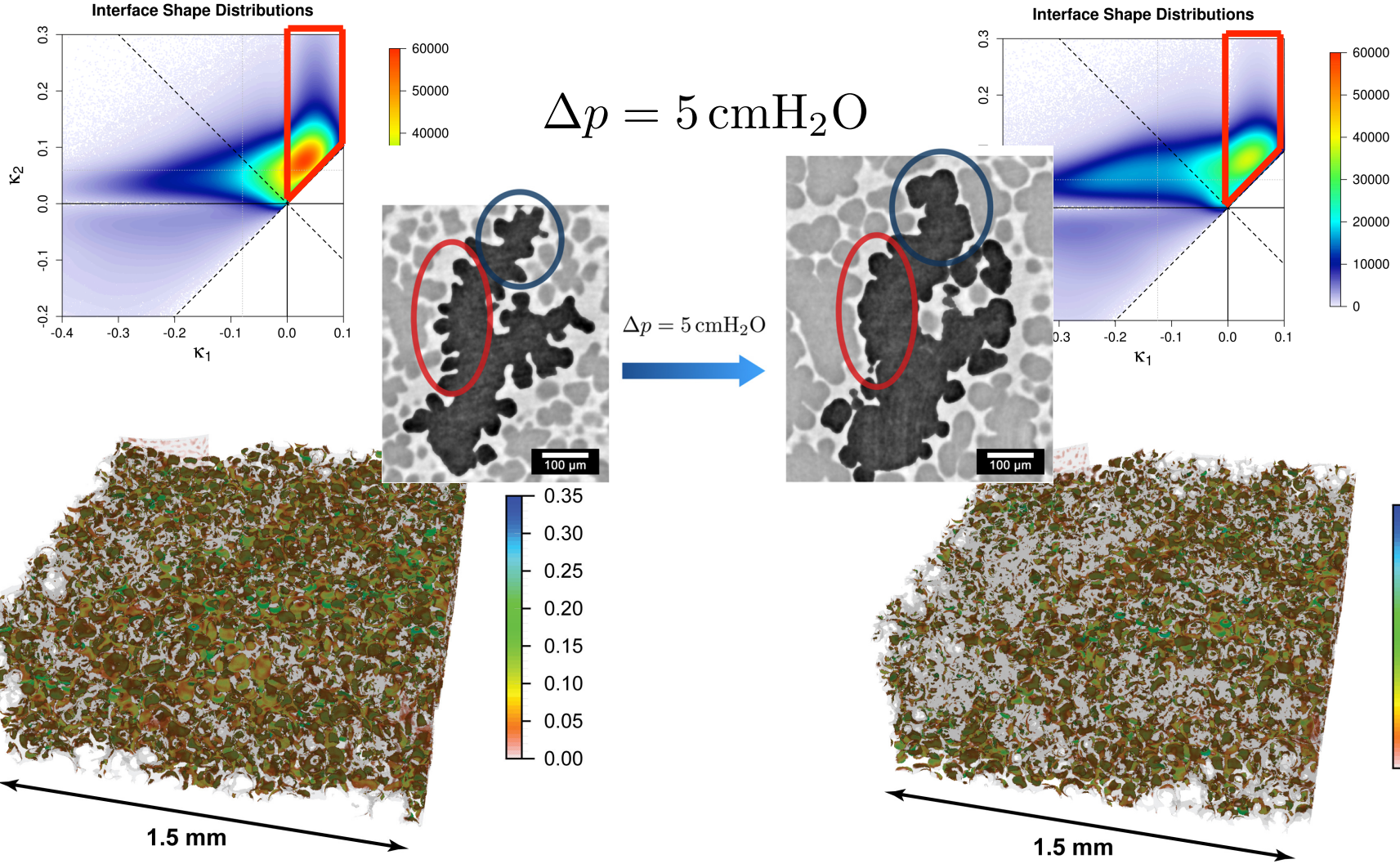
Dynamic imaging of the lungs: quantification

Curvature analysis to automatize alveoli shape analysis (recruitment?)

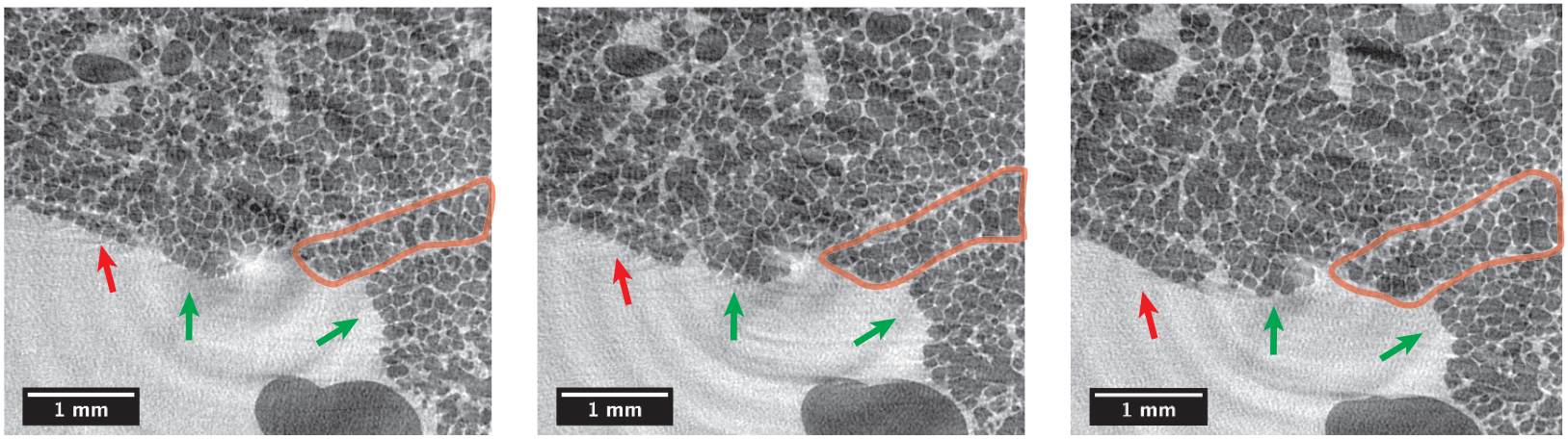


Time resolved alveoli structure in vivo

Ventilation and ECG

- Heterogeneous distention or homogeneous cyclic opening-collapse of alveoli?

G. Lovric , PhD thesis



(a) (b) (c)

Figure 7.7. Tomographic slices of rats lungs at different breath-hold peak-inspiratory pressures: **(a)** 5 cmH_2O; **(b)** 10 cmH_2O; **(c)** 15 cmH_2O. The marked area indicates the region of biggest stretching (approximate change in diameter from 350 μm to 450 μm, the green arrows indicate regions that are very little changed upon intubation, while the red arrows show a region where new alveolar structures appear, which however originate from "deeper" slices.

The Fly

Daniel Schwyn
Imperial College London

Rajmund Mokso
TOMCAT

Simon Walker
UNIVERSITY OF OXFORD

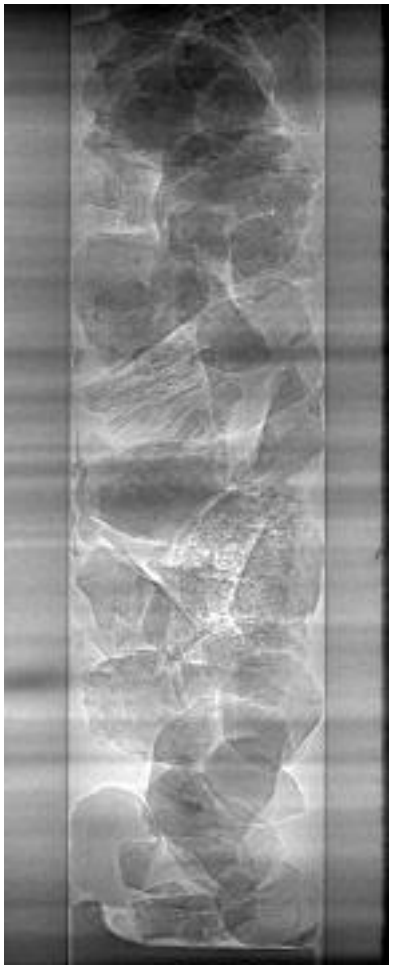
Rajmund.Mokso@maxiv.lu.se

The classical approach to time-resolved tomography

Dynamic studies in 3D are possible if the rate of structural changes in the sample $\{V_{EVOL}\}$ < spatial resolution $\{\delta R\}$/scan time $\{t_{SCAN}\}$)

$$t_{SCAN} < \delta R / V_{EVOL}$$

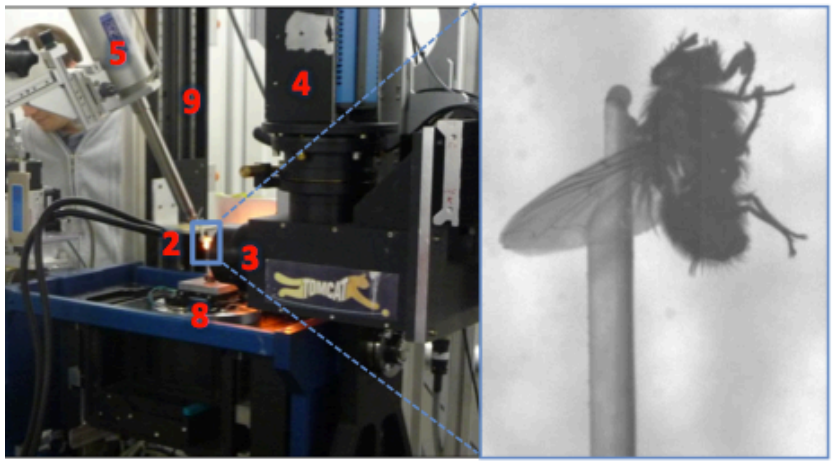
0.5 s 5 µm 10µm/s



Mokso et al, J/ Phys. D. 2013

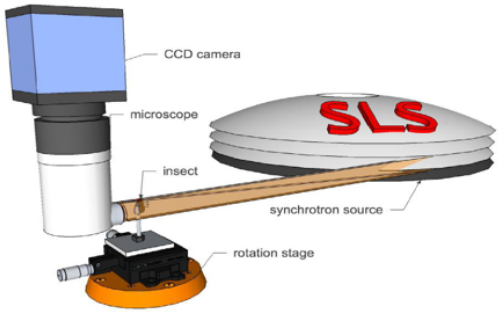
Rajmund.Mokso@maxiv.lu.se

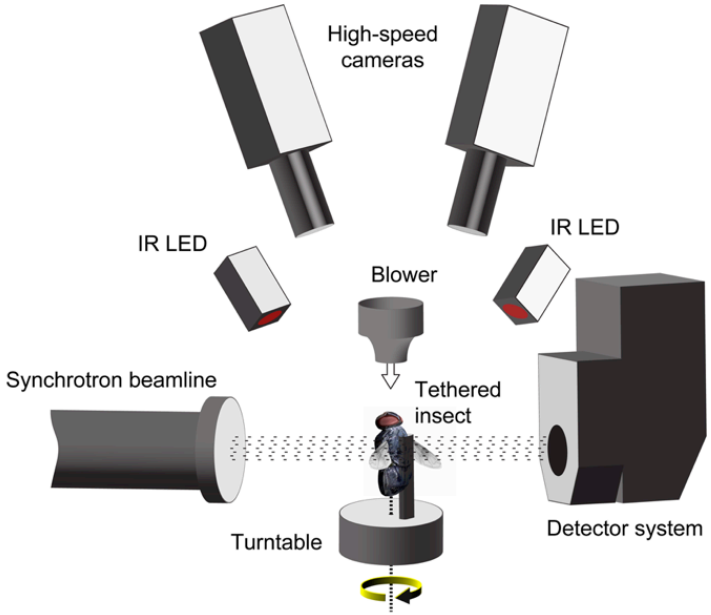
In vivo fly imaging setup



Experimental setup.

(1) Beam
(2) Sample
(3) Scintillator
(4) Detector / CMOS camera
(5) Cryojet
(6) Fan (for airflow)
(7) High-speed Camera
(8) Rotation stage
(9) Robotic stage (to release fly)





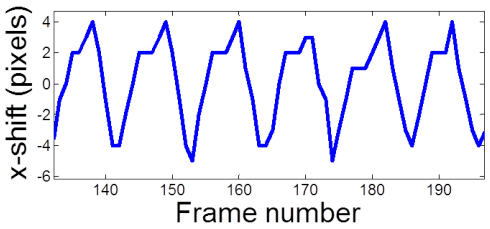
Exposure + Readout	300 + 100 [µs]
Number of projections	a) 1x 8051 (3.3s) **SSS** b) 1x 1251 (0.5s) **SFS** c) 6x 1251 (3s) **MFS**
Voxel size	$(3\ \mu m)^3$
X-ray energy spectra	Polychromatic (~ 30 keV see slice data) Monochromatic (18 keV, see renderings)

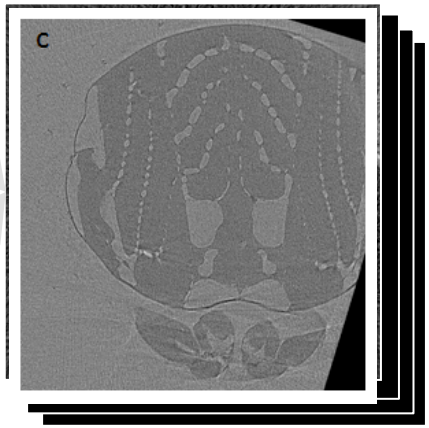
Schwyn et al. Synch. Rad. News 2012

Optical flow guided retrospective gating

Image-based grouping of radiographs

- The usual way of gated tomography is to use a gating signal to trigger acquisition
- In our case: no external gating signal; Group radiographs according to wing beat phase (e.g. upstroke /) using cross correlation.





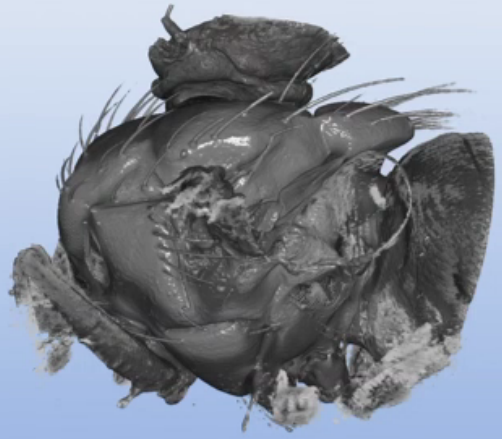
3 kHz effective temporal resolution

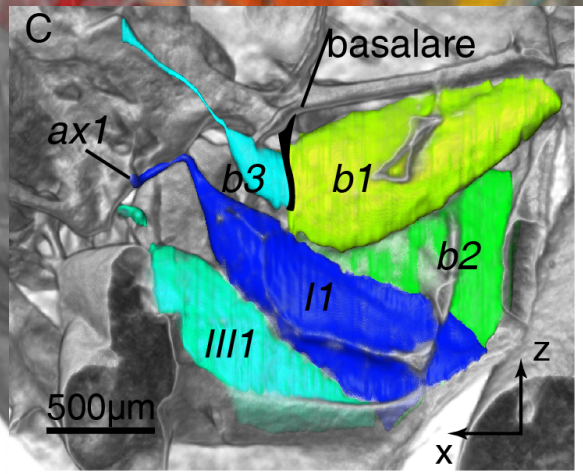
in 3D with 3 um voxel size

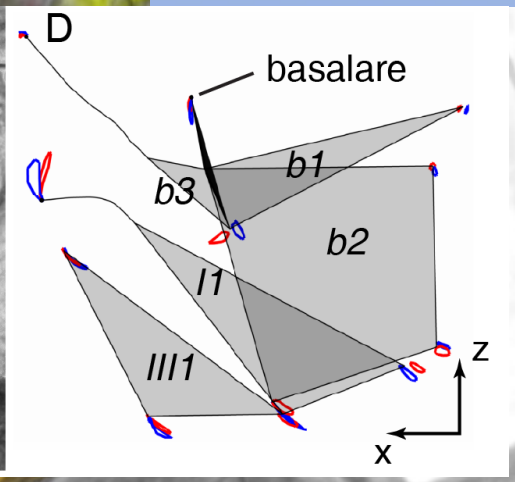
Mokso, Schwyn et al. Scientific Reports (2014)

The flight of insec

Survival ~ 3 s







3 kHz effective temporal resolution
10-20 µm spatial resolution

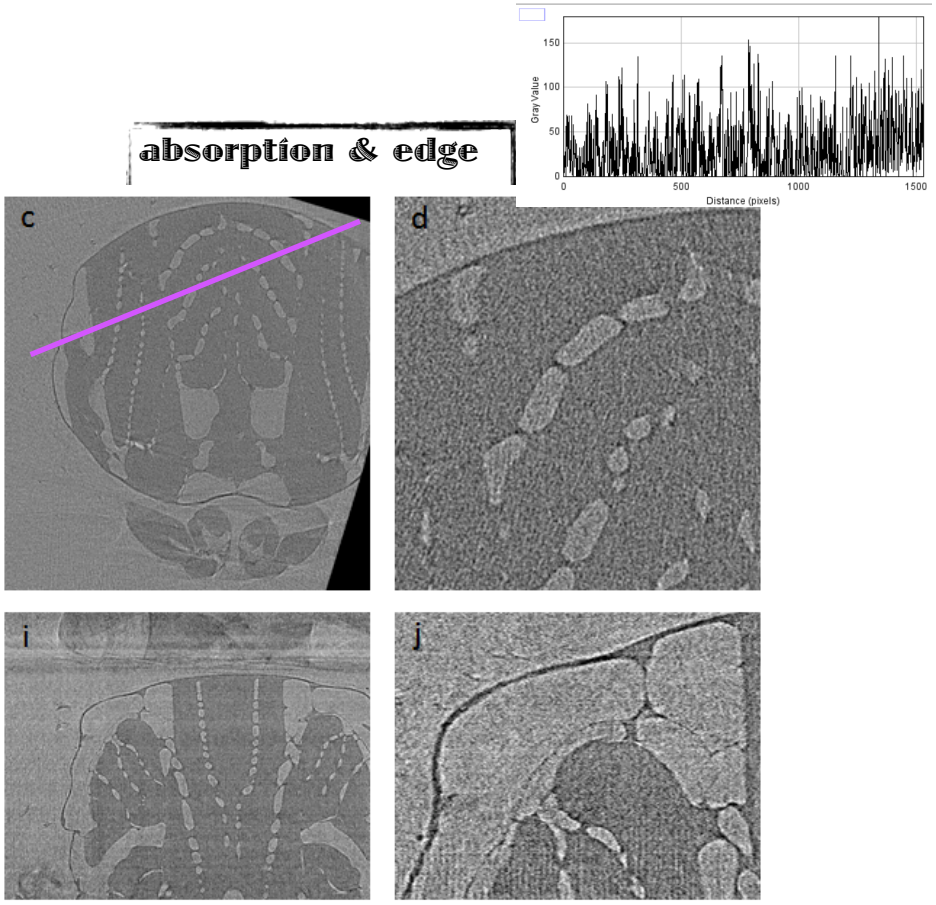
Daniel Schwyn
Imperial College London

Rajmund Mokso

Simon Walker
University of Oxford

Rajmund.Mokso@maxiv.lu.se

Phase tomography vs. edge enhancement



flight muscles of a fly

Phase tomography

Phase contrast tomography

Mokso et al., J. Phys. D, 2013

Liquid Foams

Christophe Raufaste

Benjamin Dollet

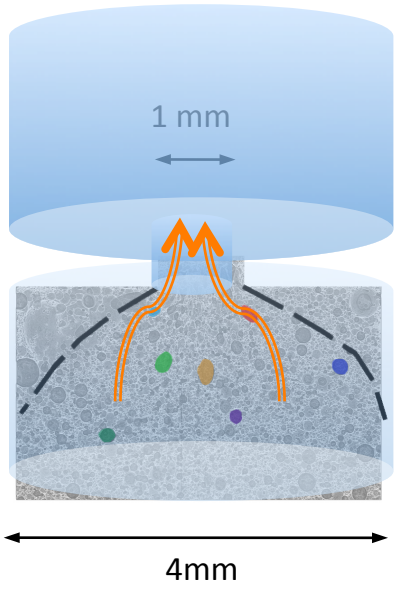
Stephan Santucci

Kevin Mader

Food foaming in 3D at 20 Hz

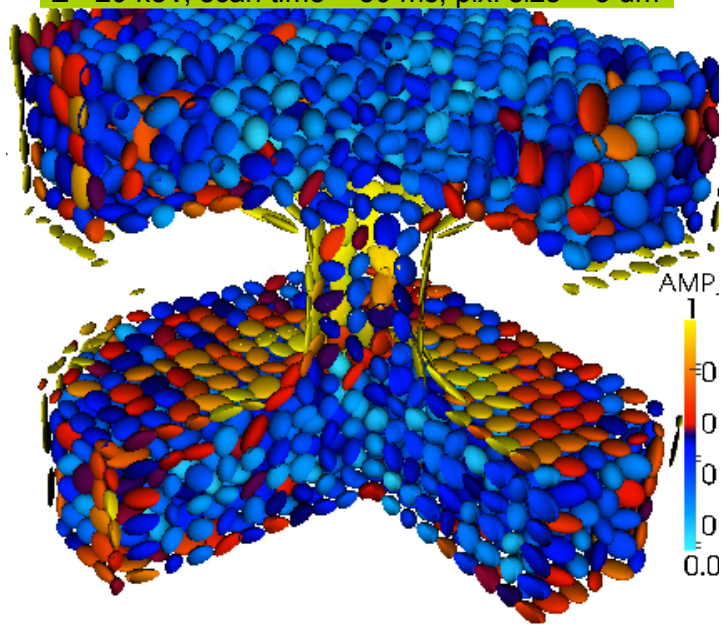
Concentrated glucose sirup

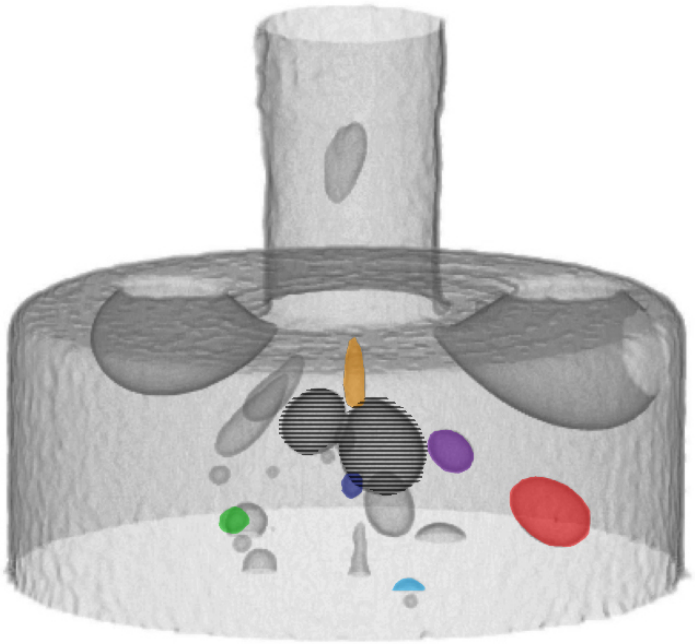
constriction (4:1:4)



20 HZ tomo

E= 20 keV, scan time = 50 ms, pix. size = 3 um





Images: Kevin Mader

- Optimize extrusion processing and extrudor design
- Quantify the stability of foam lamellae in food production
- Elongation contraction flow of non-Newtonian fluids

Birbaum et al. Experiments in Fluids 2016

Raufaste et al. COLSUA 2015

Rajmund.Mokso@maxlab.lu.se

MAX IV