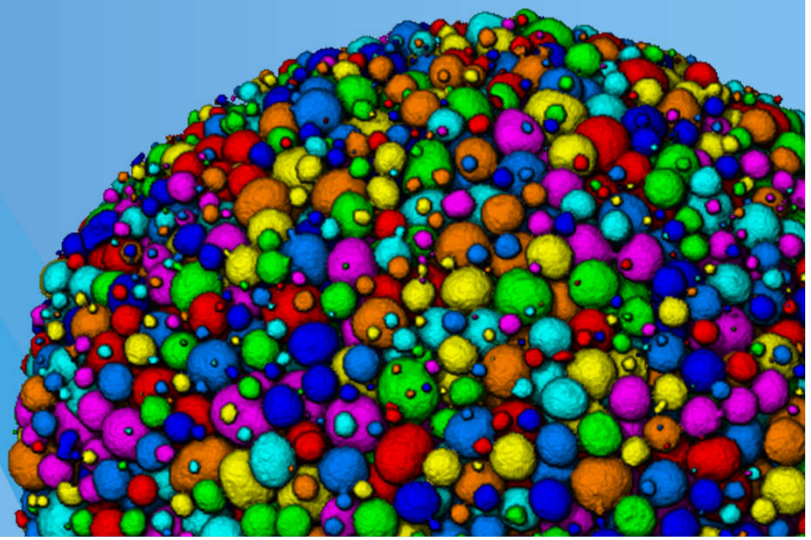
Dynamic processes in metal foams

Paul H. Kamm, John Banhart & Francisco García Moreno



25.03.2019, XFEL Workshop, Hamburg

Dynamic processes in metal foams

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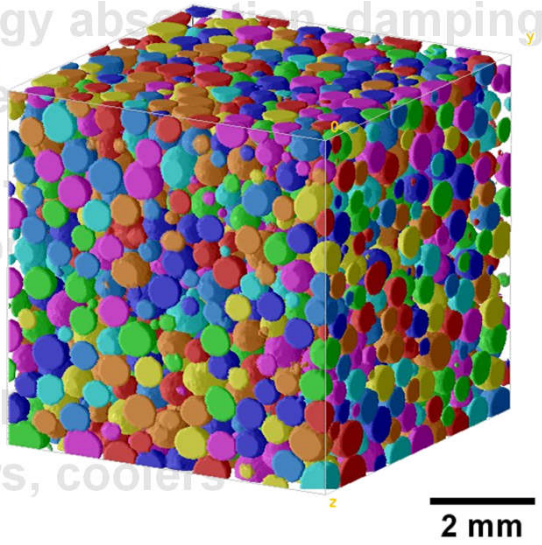
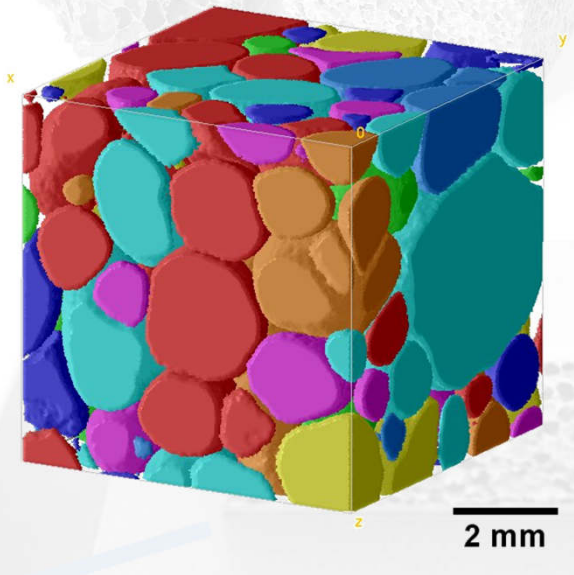
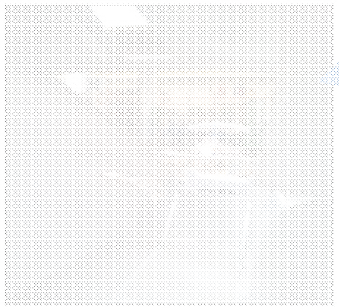
METALLIC FOAMS

- Preferable properties
  - weight specific mechanical properties
  - energy absorption, damping
  - large
  - etc...
- Applicatio
  - light
  - bum
  - filters, coolers





(a)



(b)

[courtesy of Thomas Hipke, IWU, Chemnitz, Germany]

[metalfoam.de]

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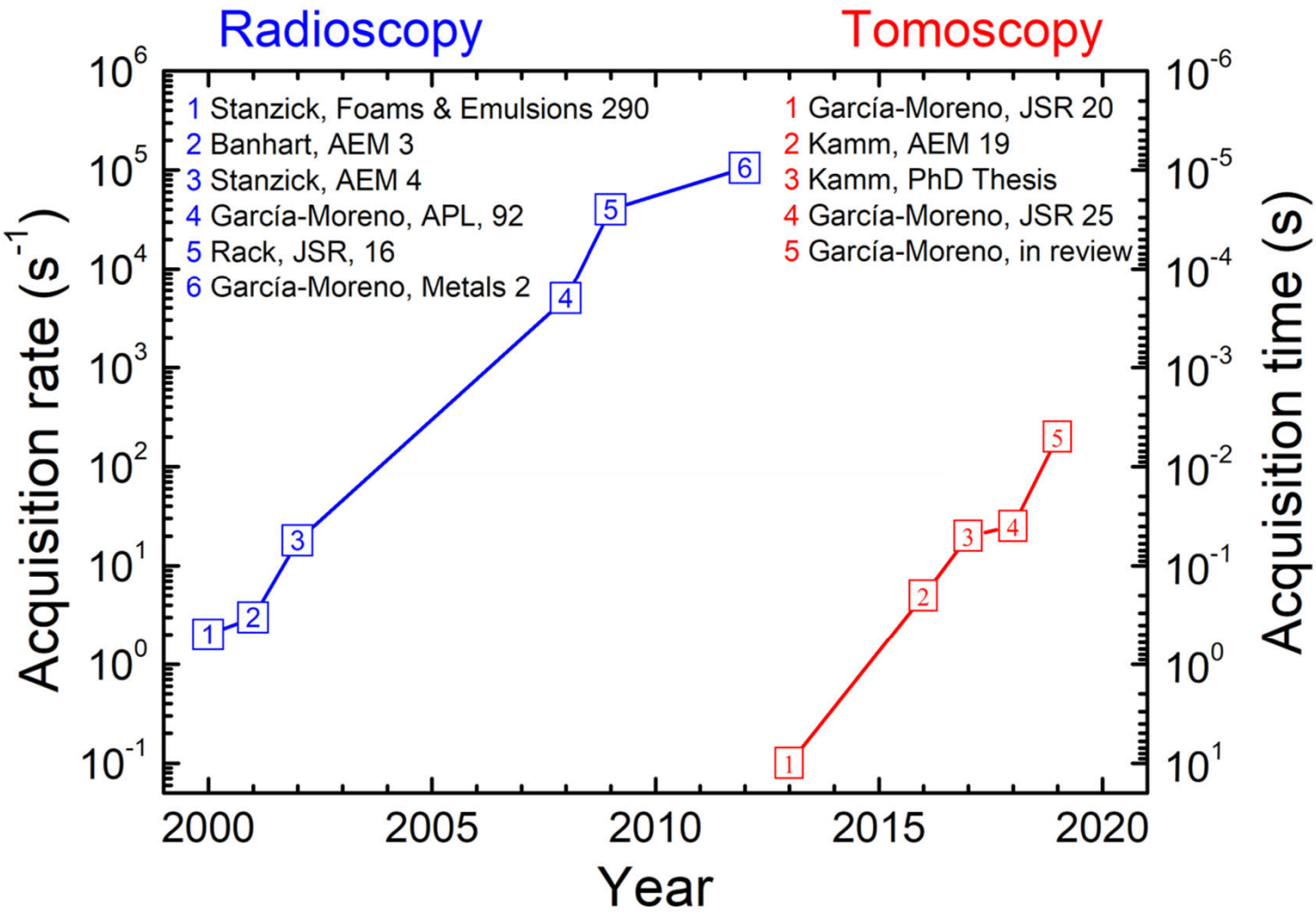
PHENOMENA IN METAL FOAMS



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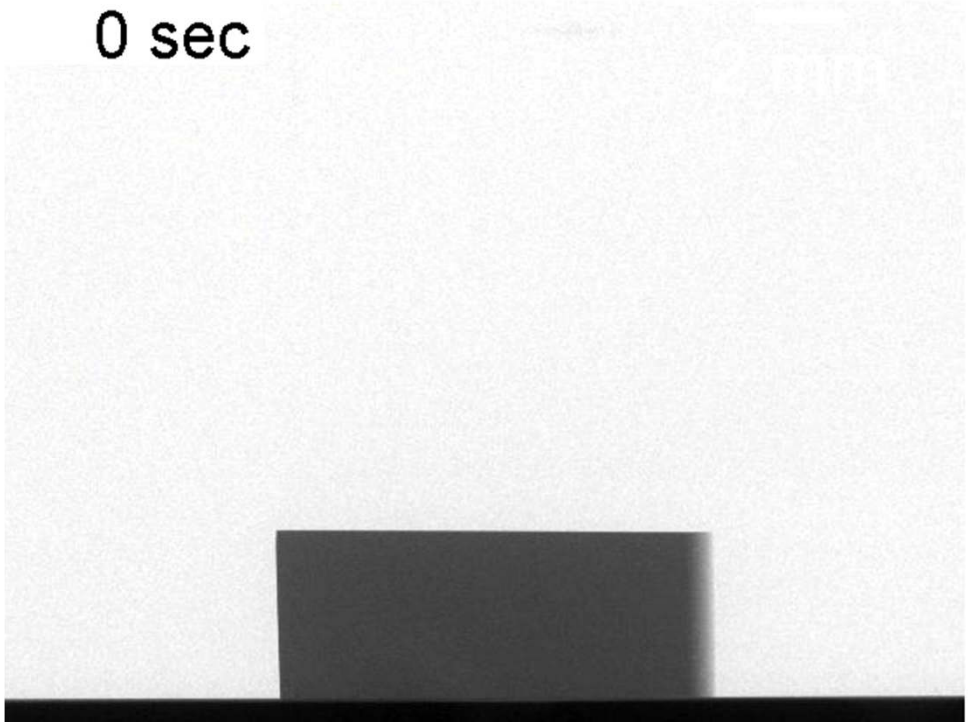
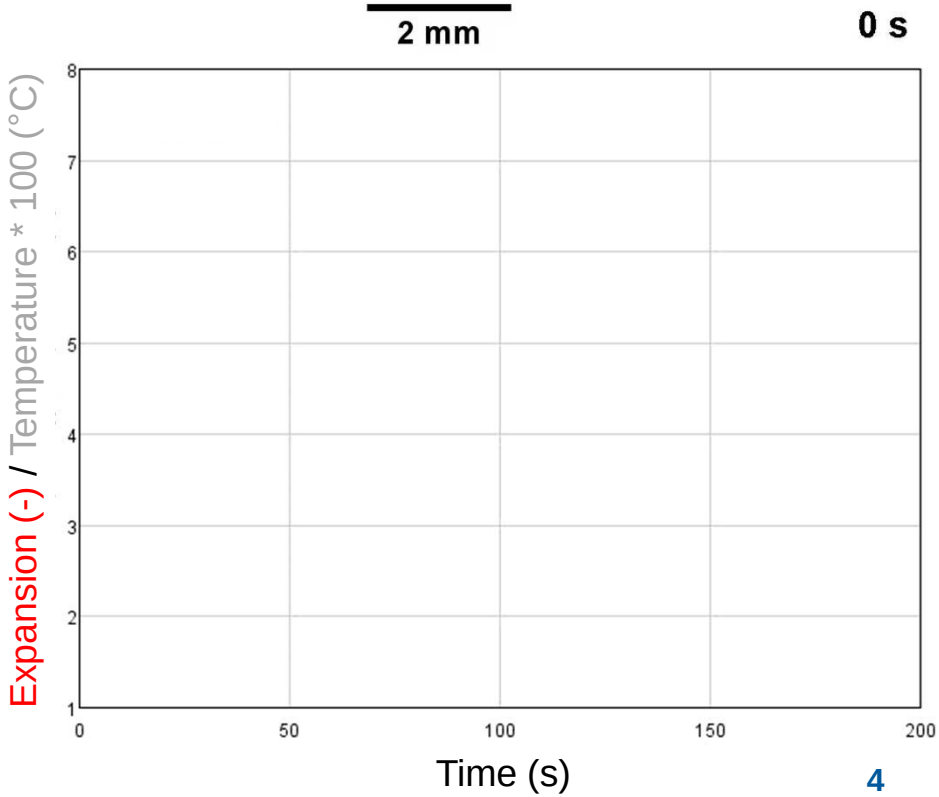
FOAM EVOLUTION

- Expansion
- Structure evolution
  - Coarsening
  - Coalescence
- Microscopic evolution
  - Solidification
  - Chemical composition





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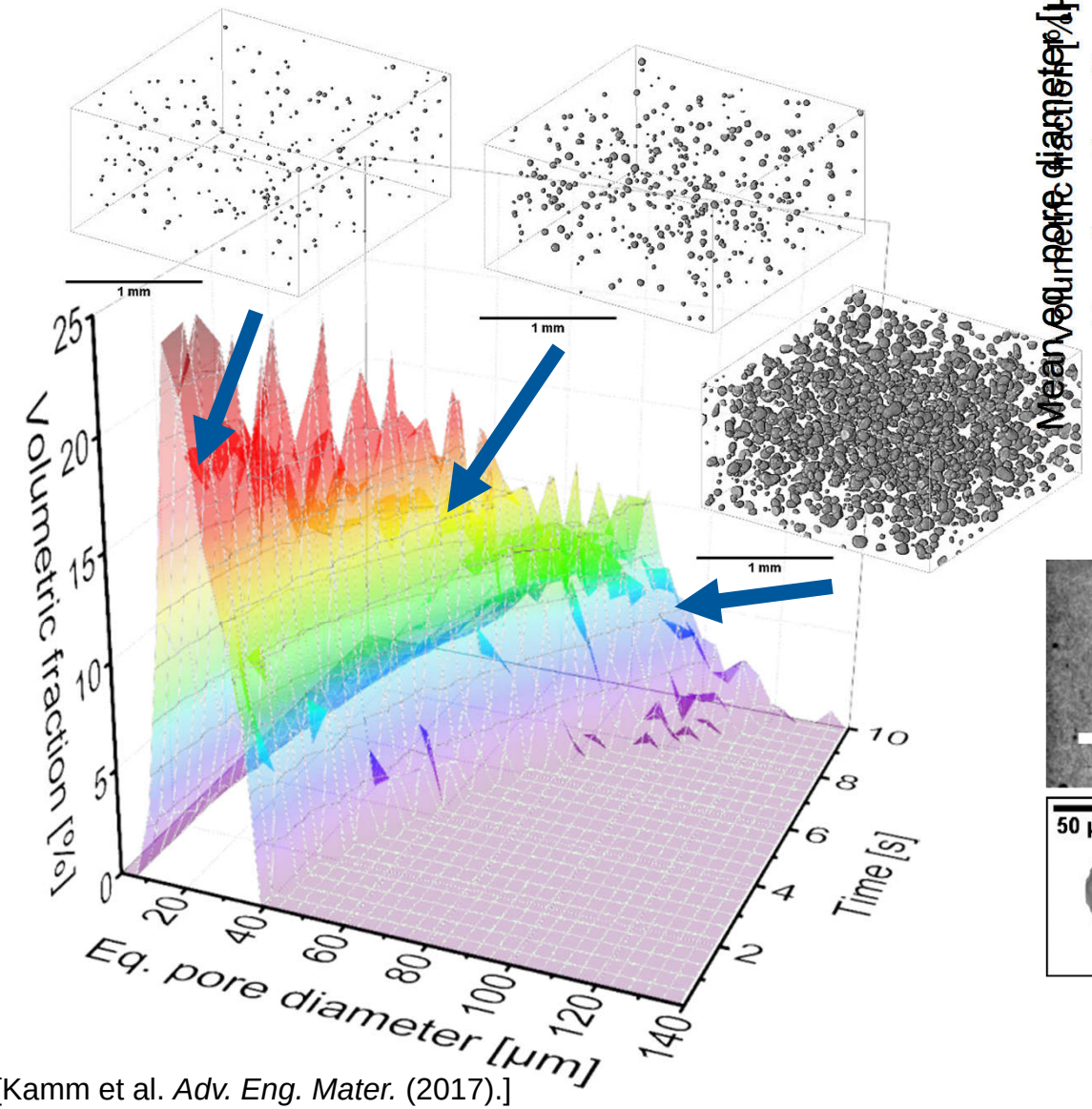
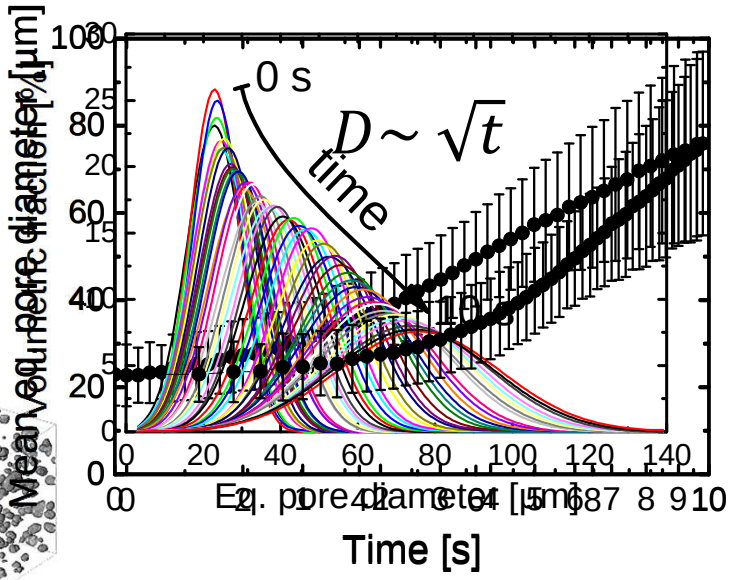
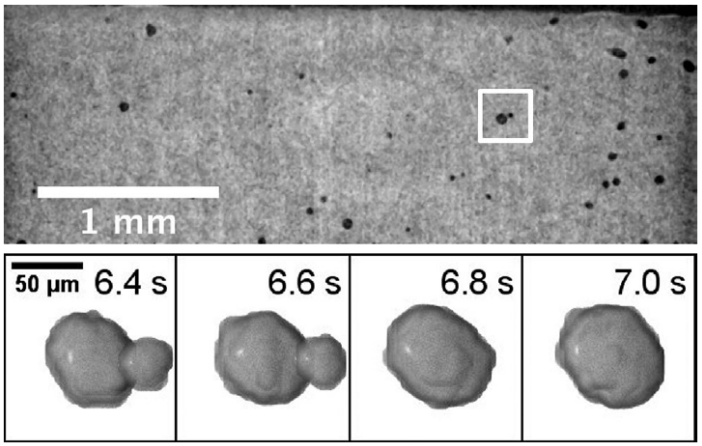
BUBBLE NUCLEATION AND GROWTH



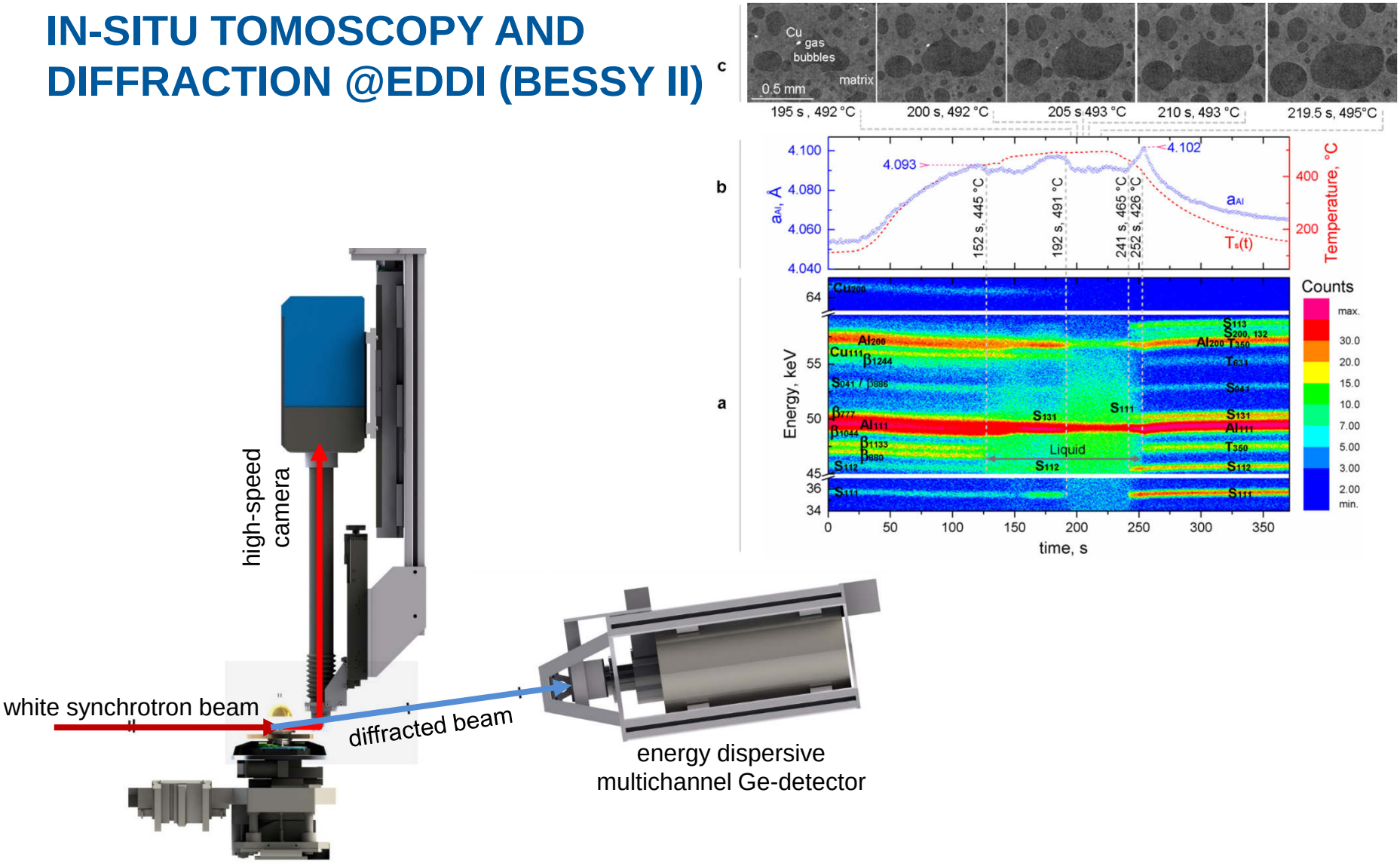




[Kamm et al. *Adv. Eng. Mater.* (2017).]

Dynamic processes in metal foams

IN-SITU TOMOSCOPY AND DIFFRACTION @EDDI (BESSY II)



[Jiménez et al. *J. Synchrotron Rad.* (2018).]

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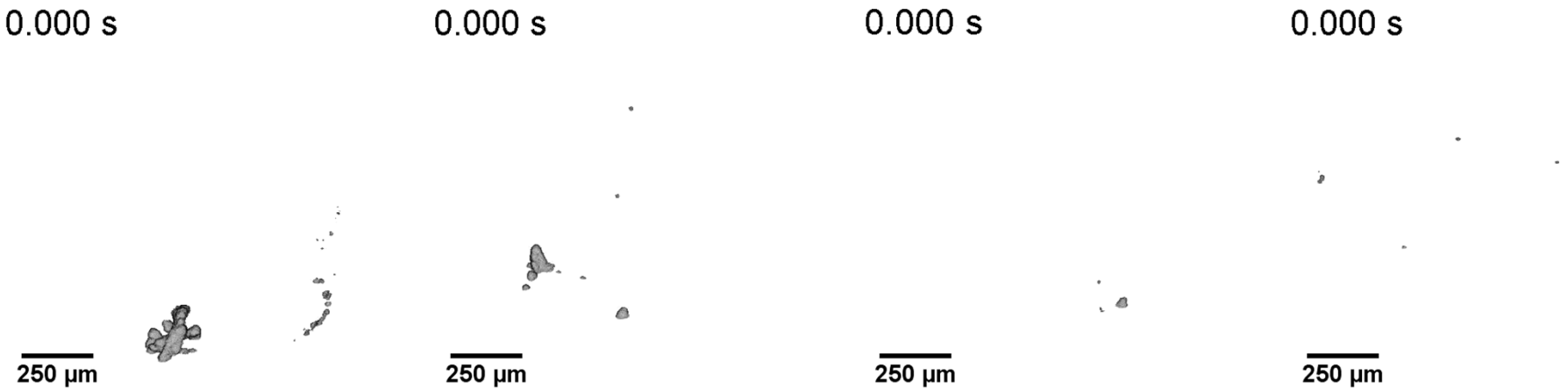
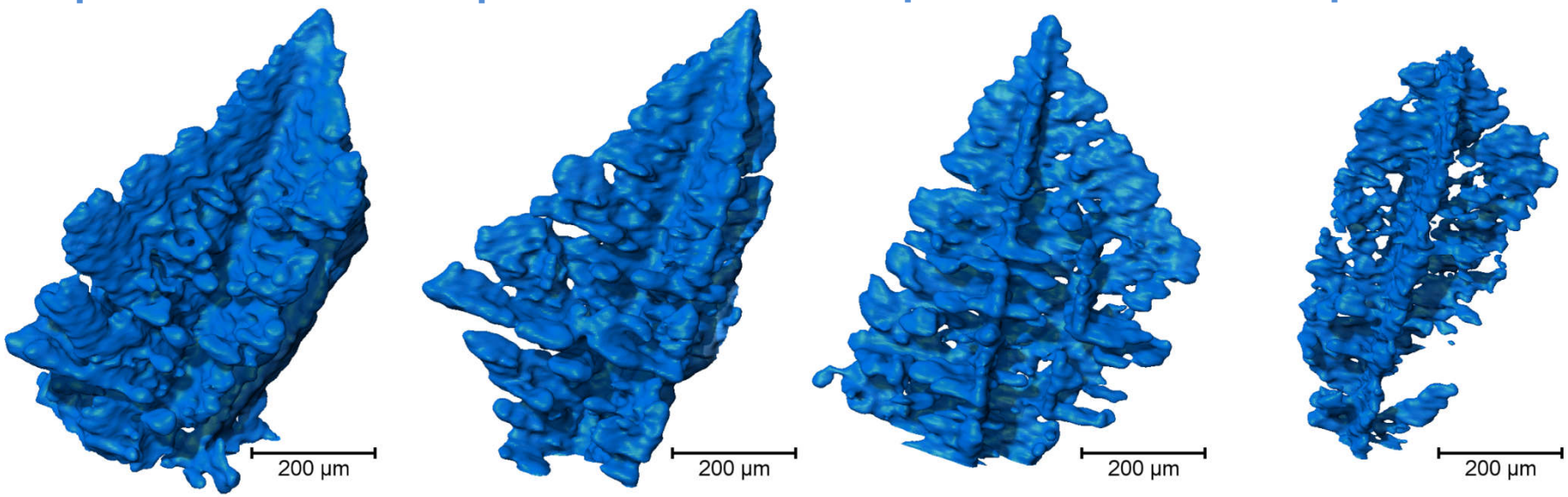
1 Ks^{-1} **2 Ks^{-1}** **6 Ks^{-1}** **~15 Ks^{-1}**



188 µms^{-1} **274 µms^{-1}** **558 µms^{-1}** **815 µms^{-1}**



[Kamm et al. *in preparation*.]

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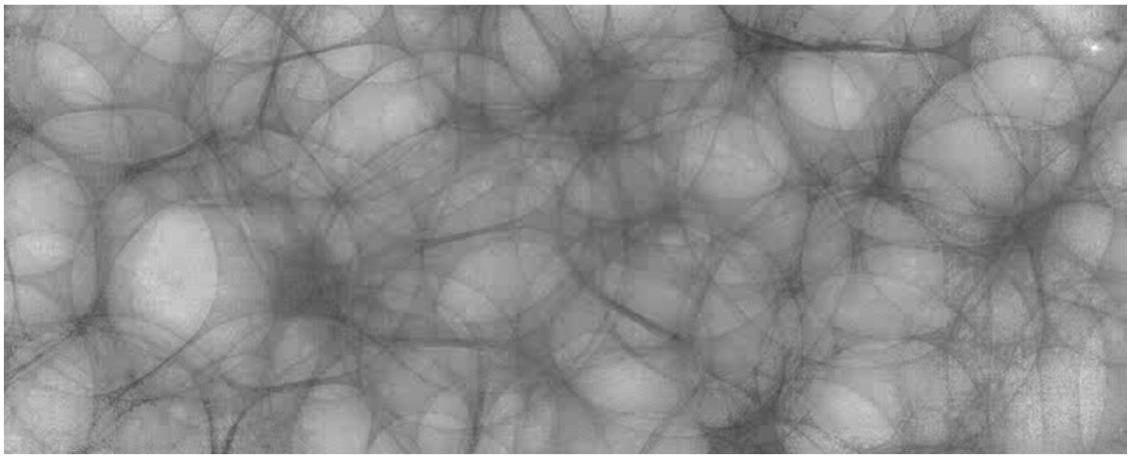
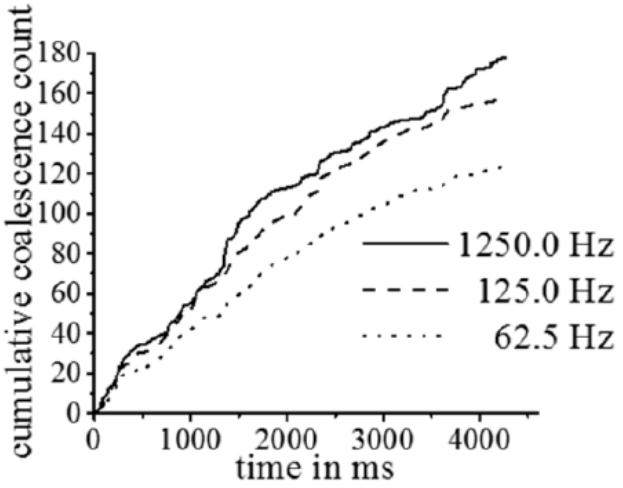
TOPOLOGICAL REARRANGEMENTS

AlSi6Cu4 foam during pressure release



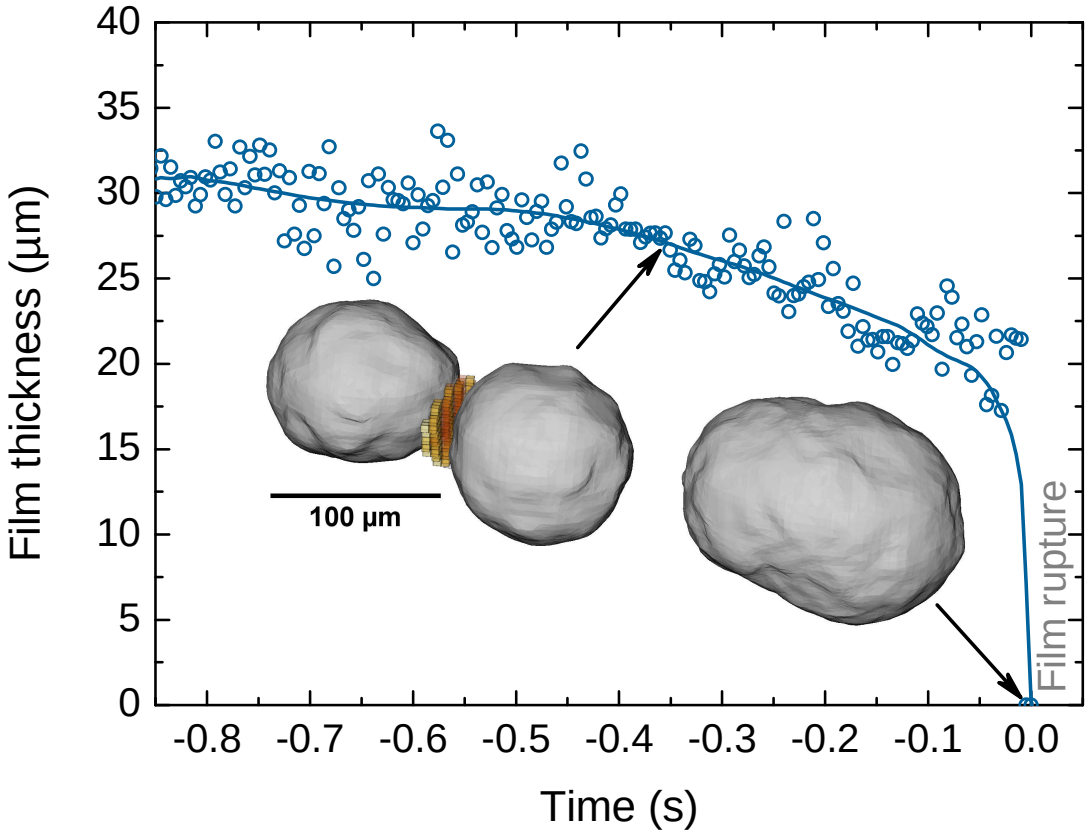
Time x1/50. Video = 1s.
Original 1250 fps

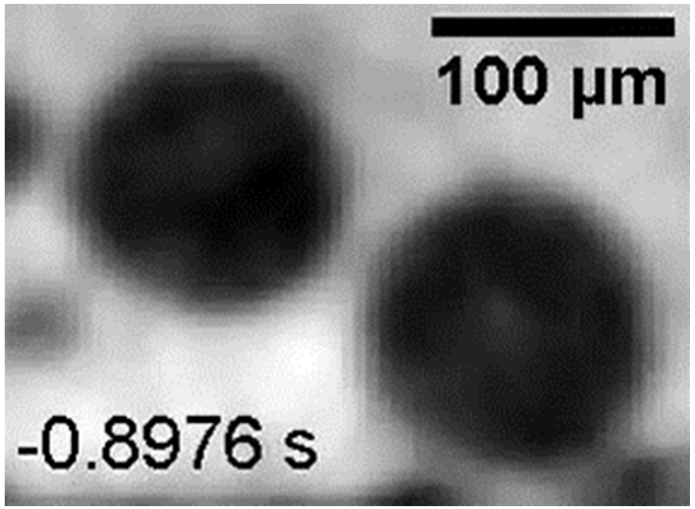
2 mm



[García-Moreno et al. *Appl. Phys. Lett.* (2008).]
[Paeplow et al. *Metals* (2017).]

FILM THINNING





[García-Moreno et al. *in review* (2019).]

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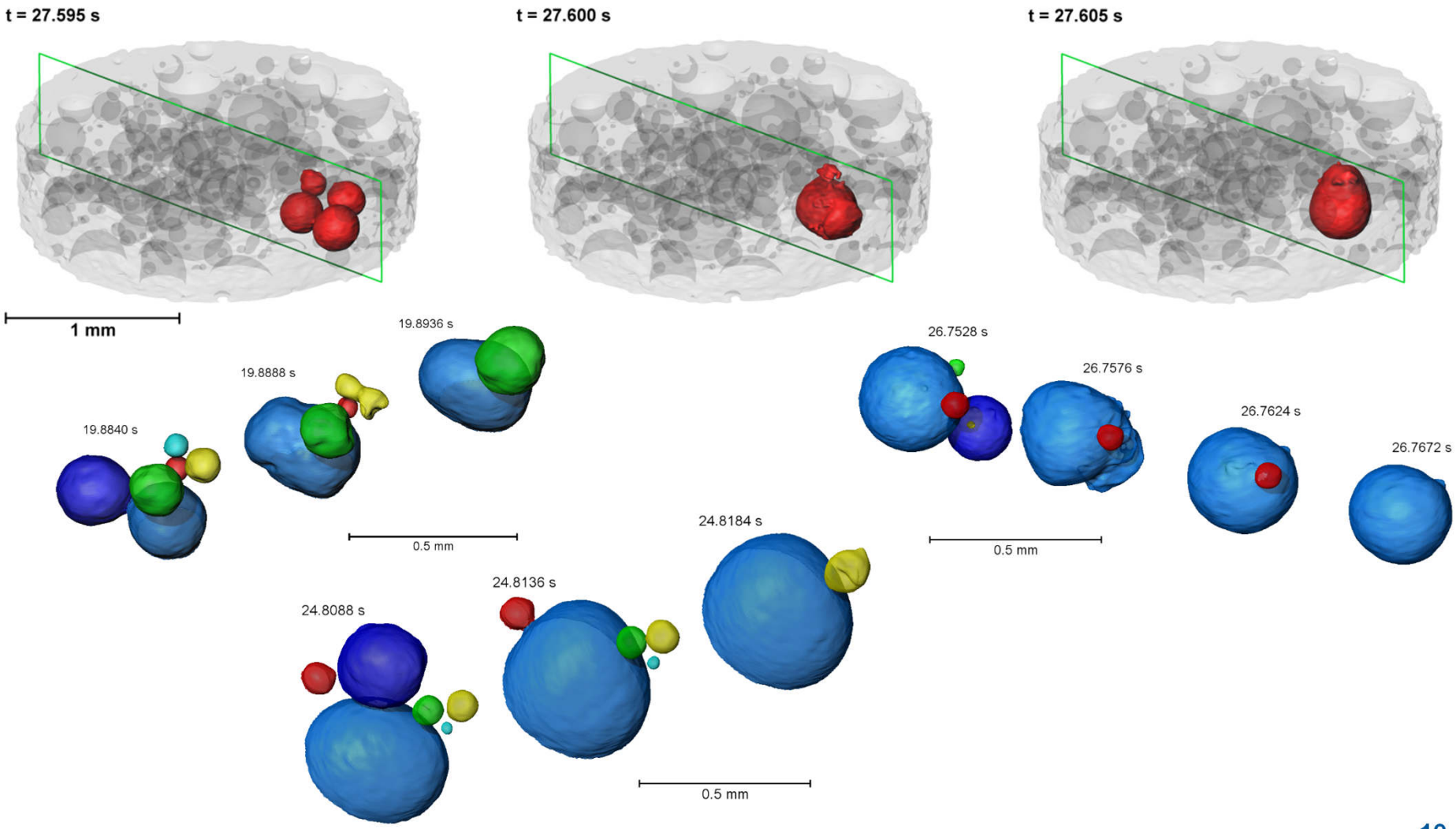
CASCADES



[García-Moreno et al. *in review* (2019).]

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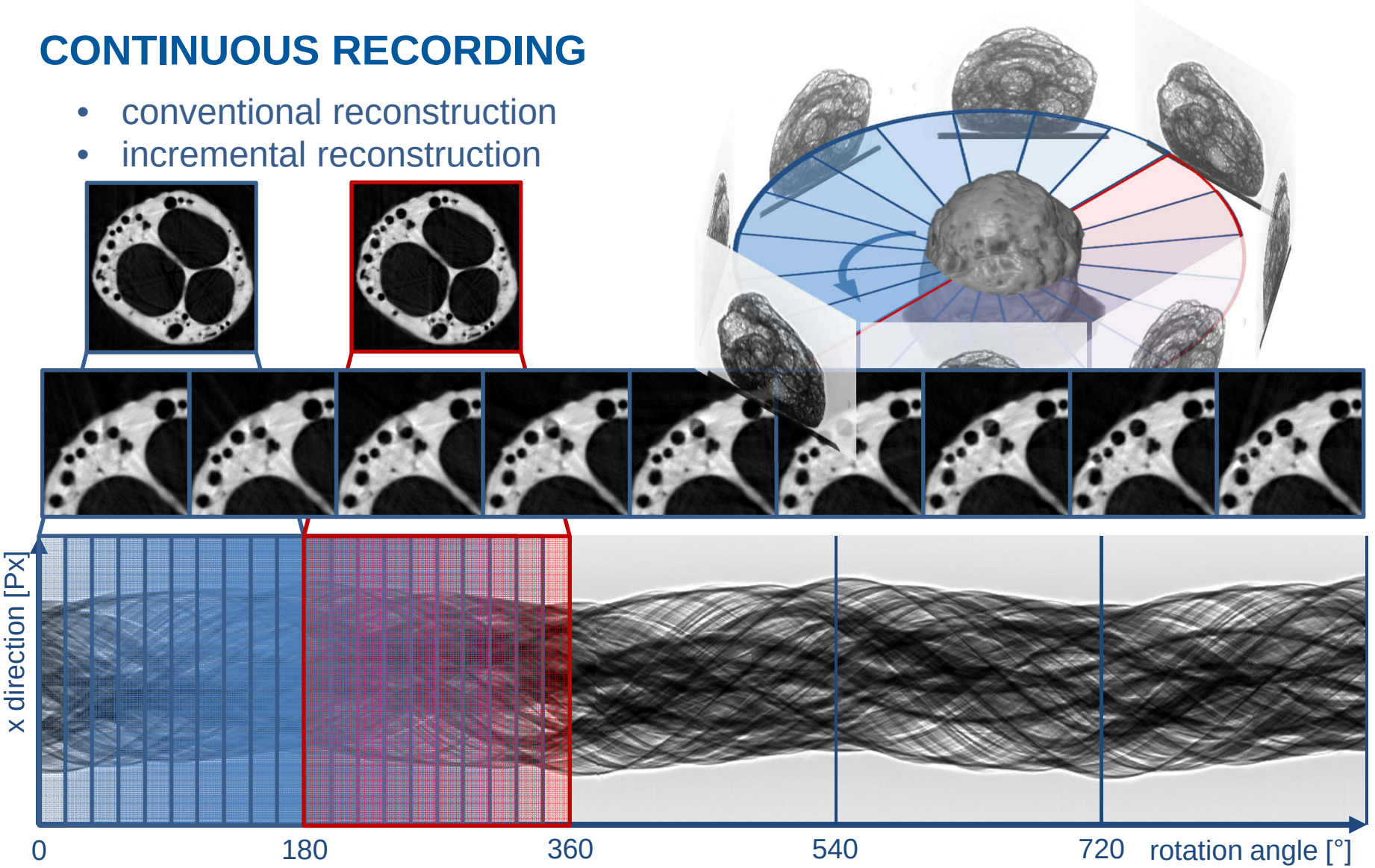
CONTINUOUS RECORDING

- conventional reconstruction
- incremental reconstruction



Sinograms at different rotation angles

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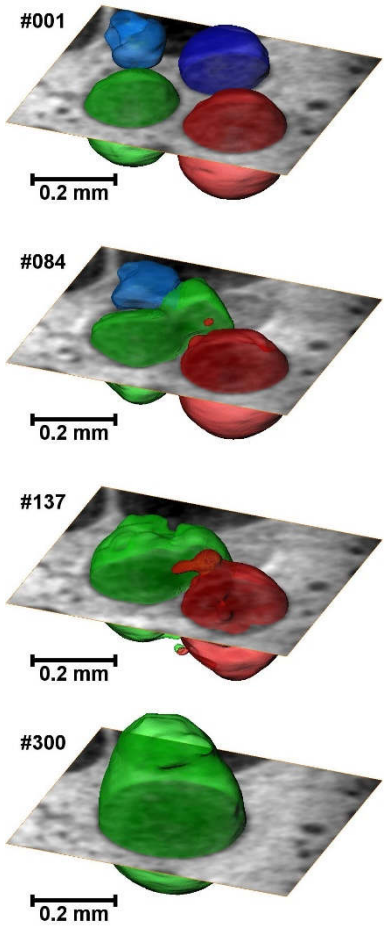
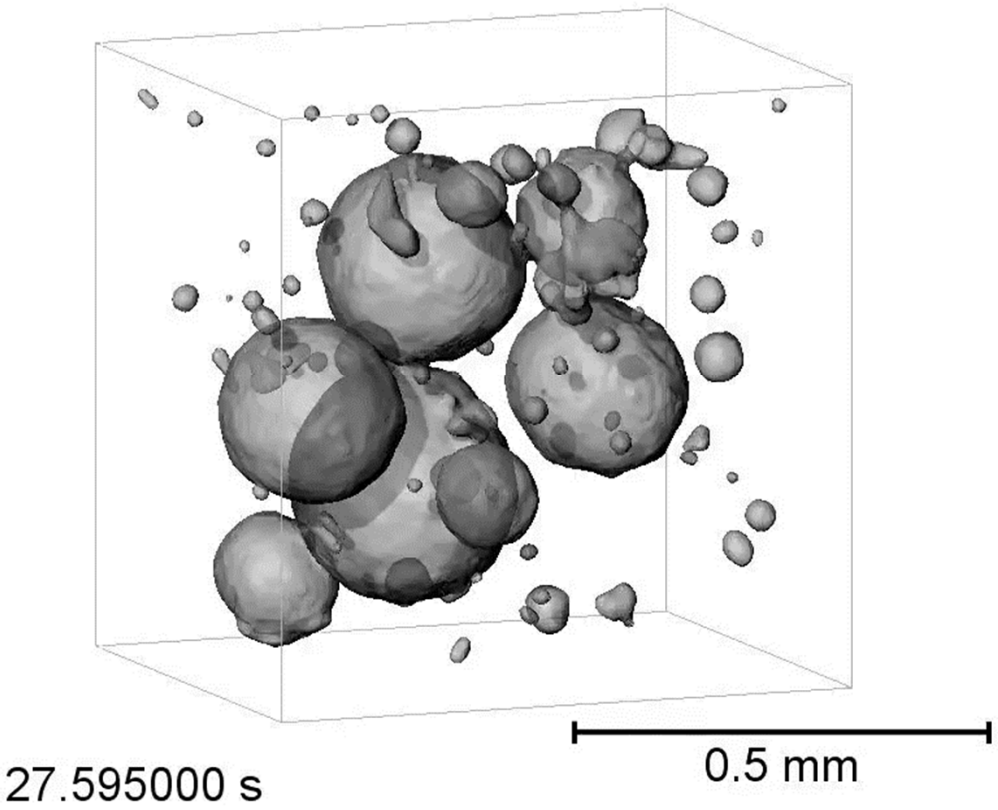
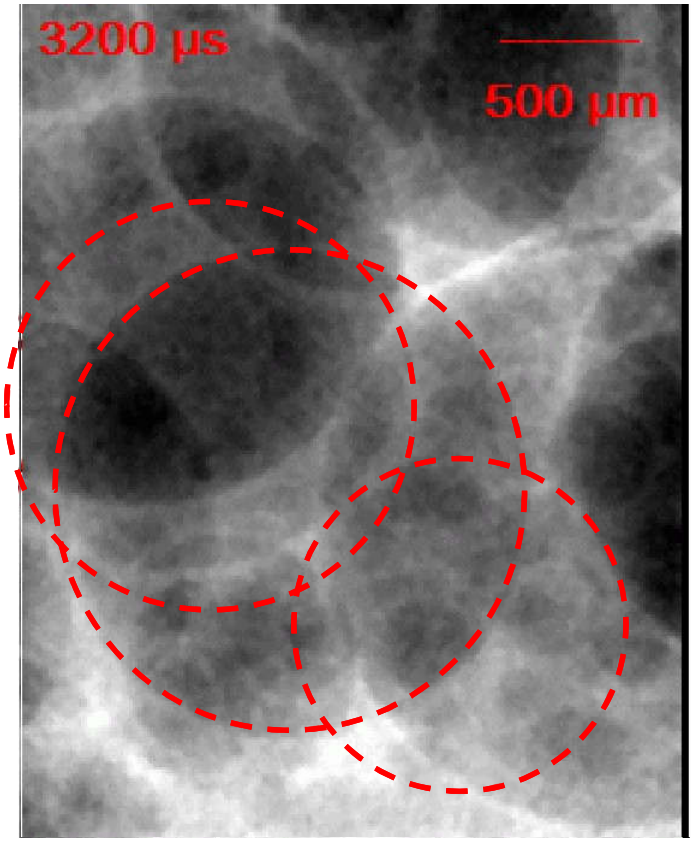
SLIDING WINDOW RECONSTRUCTION



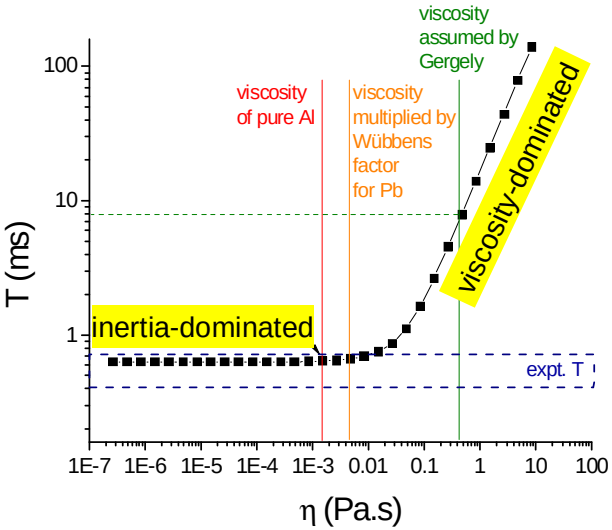


[García-Moreno et al. *in review* (2019).]

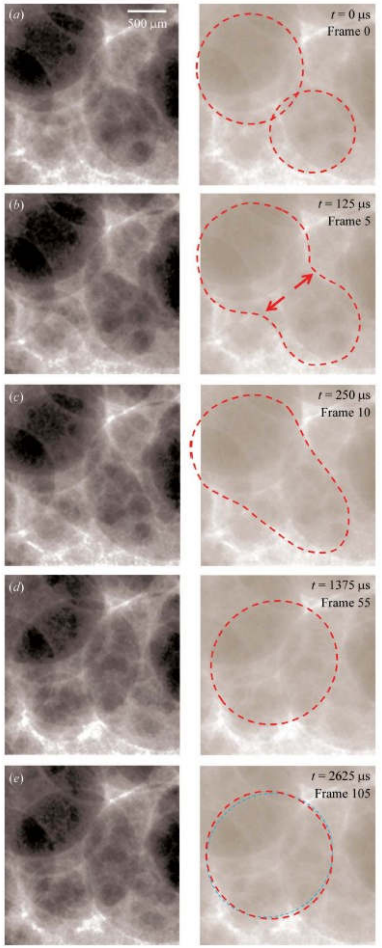
BUBBLE COALESCENCE



X-rays @ ID15a, ESRF
40000 fps
Time resolution: **25 µs**



not viscosity dominated



Coalescence of 2 bubbles in **~300 µs**

[Rack et al. *J. Synchrotron Rad.* (2009).]

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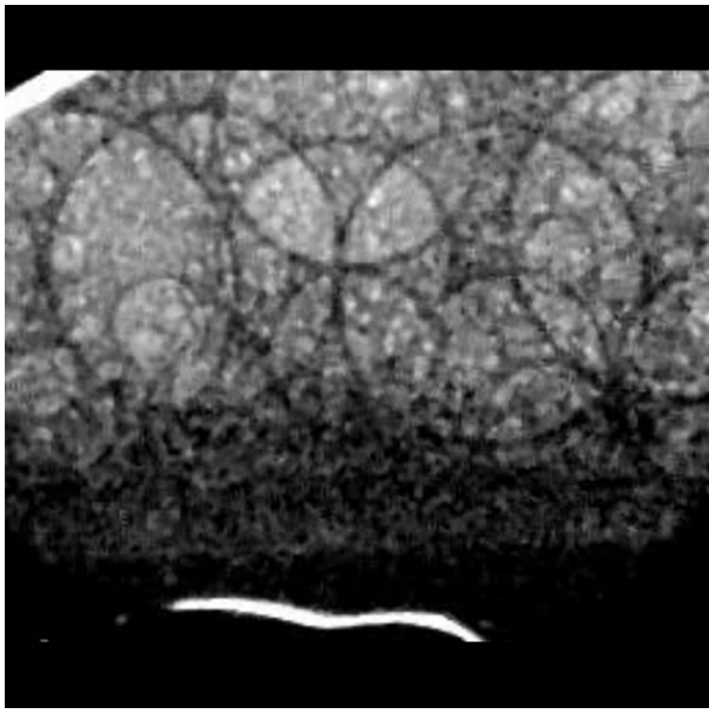
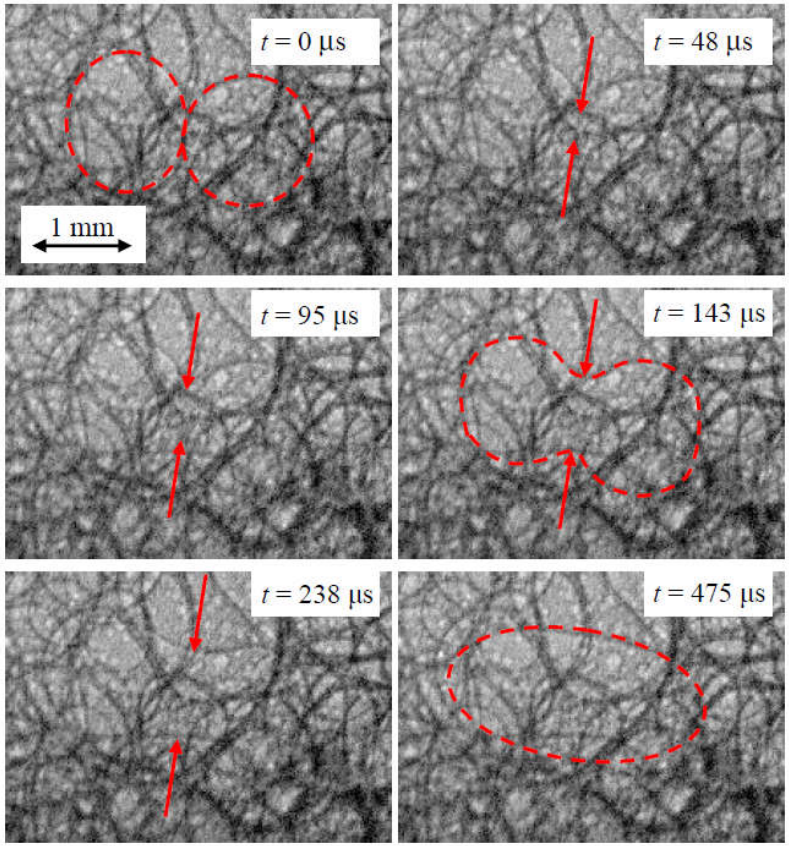
BUBBLE COALESCENCE



Coalescence of
2 bubbles **~380 µs**



dependence on bubble size

[García-Moreno et al. *Metals* (2012).]

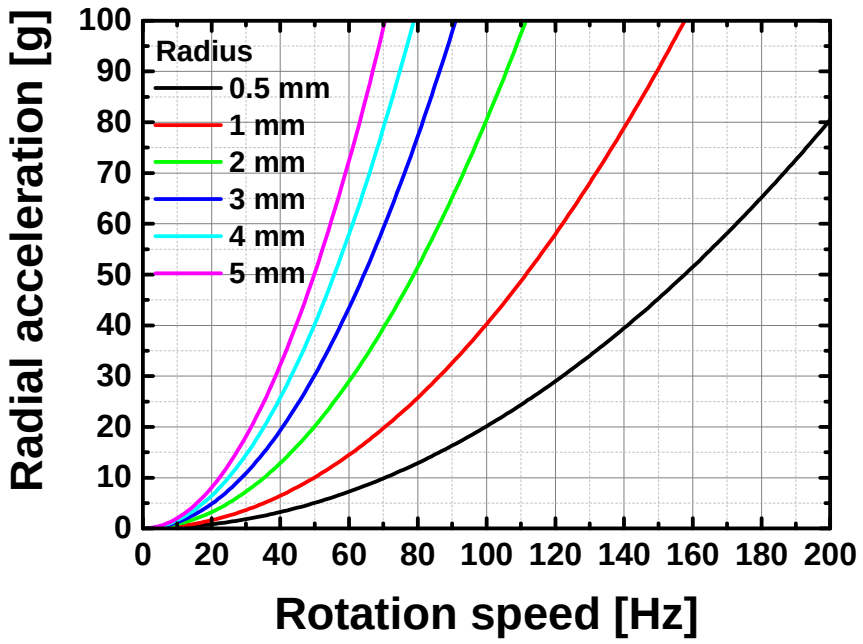
DESIRED CONDITIONS

sample size:
mm

spatial resolution:
µm

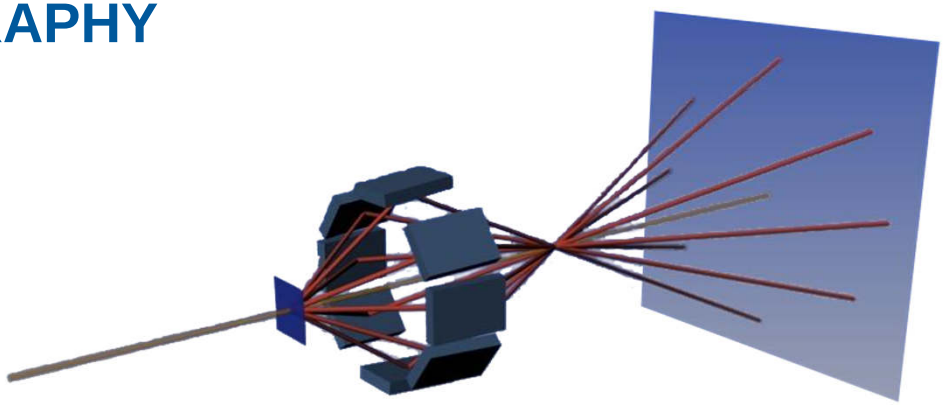
temporal resolution:
ns - µs

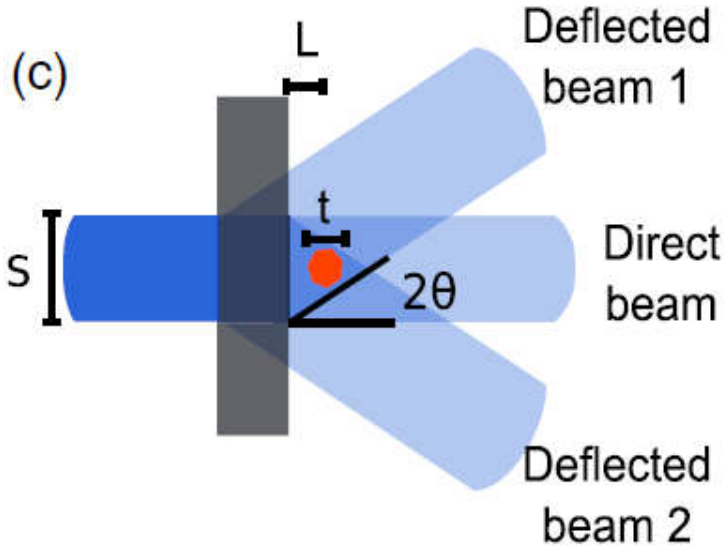
duration:
µs - ms

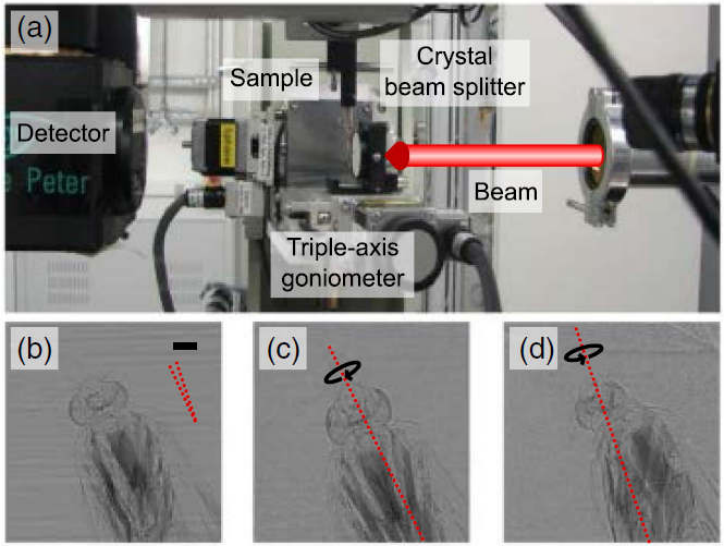


SINGLE SHOT TOMOGRAPHY

- Si crystal aligned in (001)
- [113] deflected beams







[Villanueva-Perez et al. *Optica* (2018).]