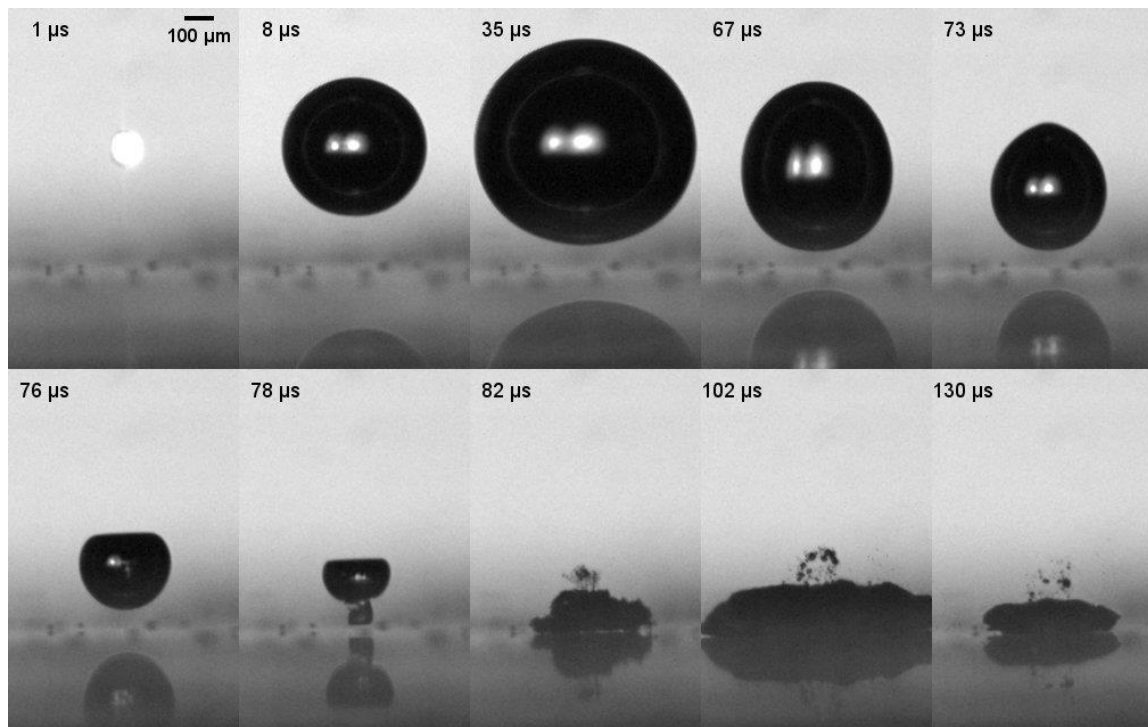


Precision Cleaning with Single Cavitation Bubbles seeded in a Jet

Dominik Mnich, Fabian Reuter, Claus-Dieter Ohl
Otto-von-Guericke-University Magdeburg

Cavitation Bubbles

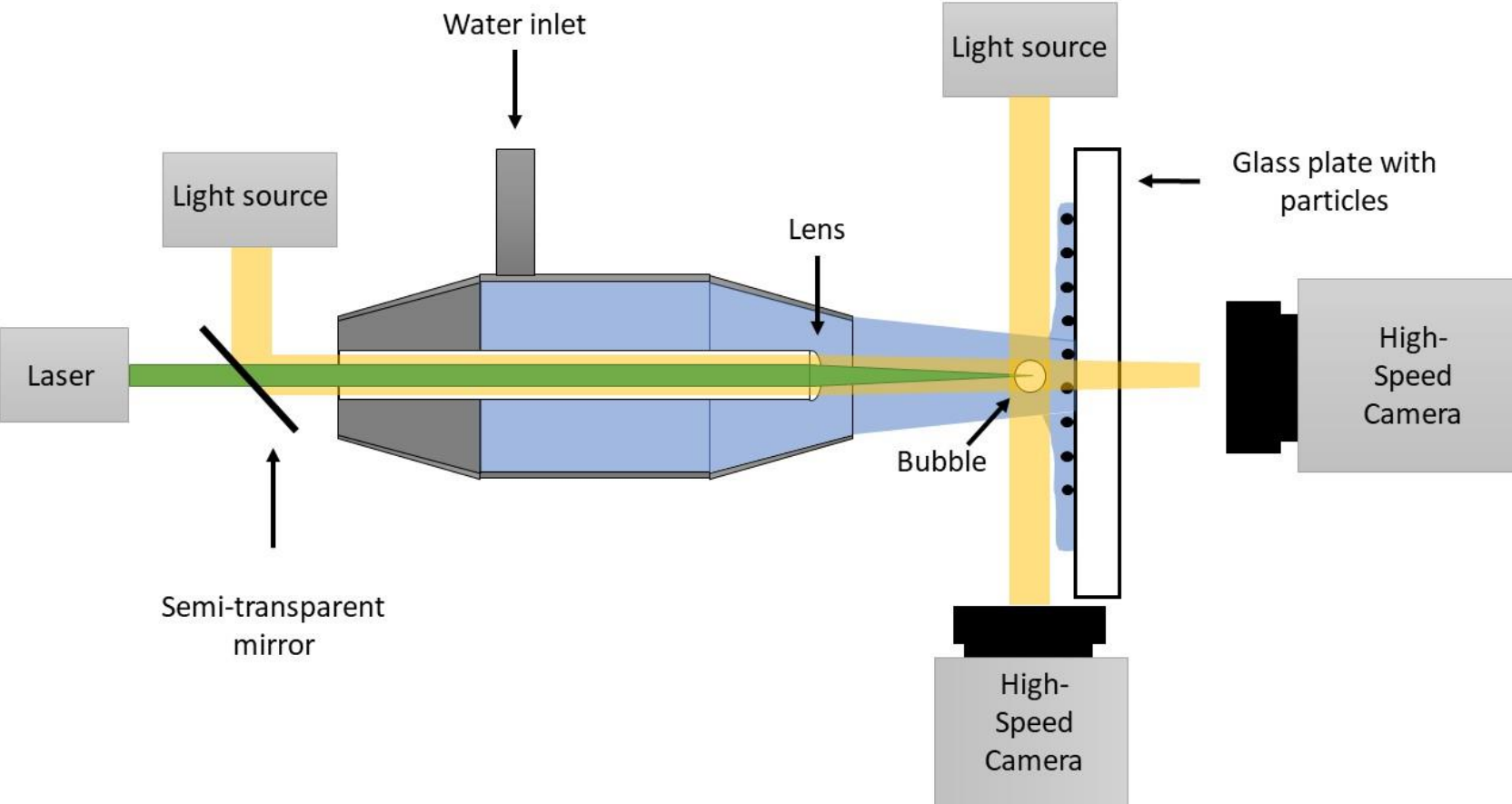
- can lead to erosion (near a surface)
- surface cleaning without damaging is possible
- now: bubbles seeded in a background flow



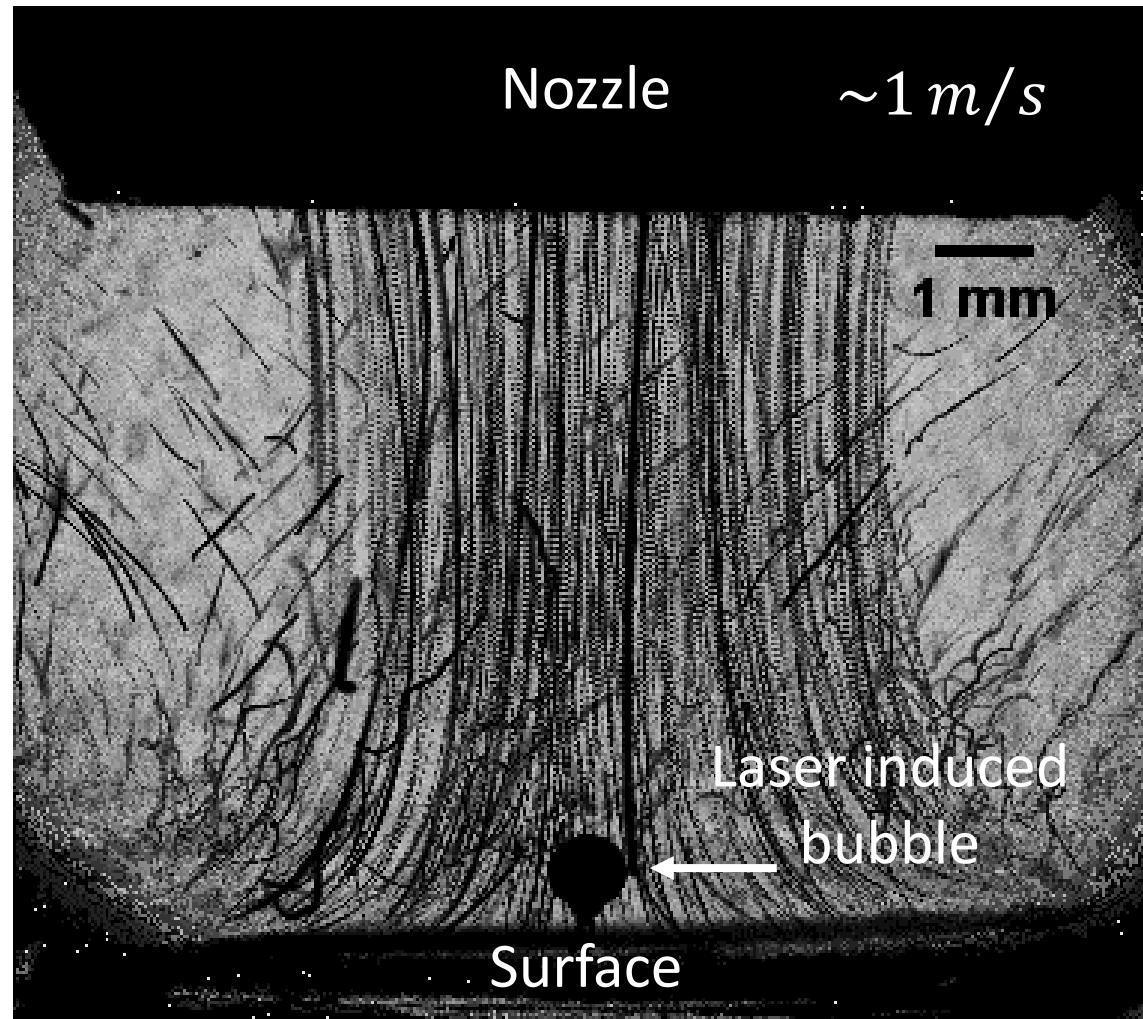
Advantages:

- Precise control of bubble location and radius
- No chemicals for cleaning
- Potential applications: industry (semi conductor) and medicine

Sketch – top view



Background flow



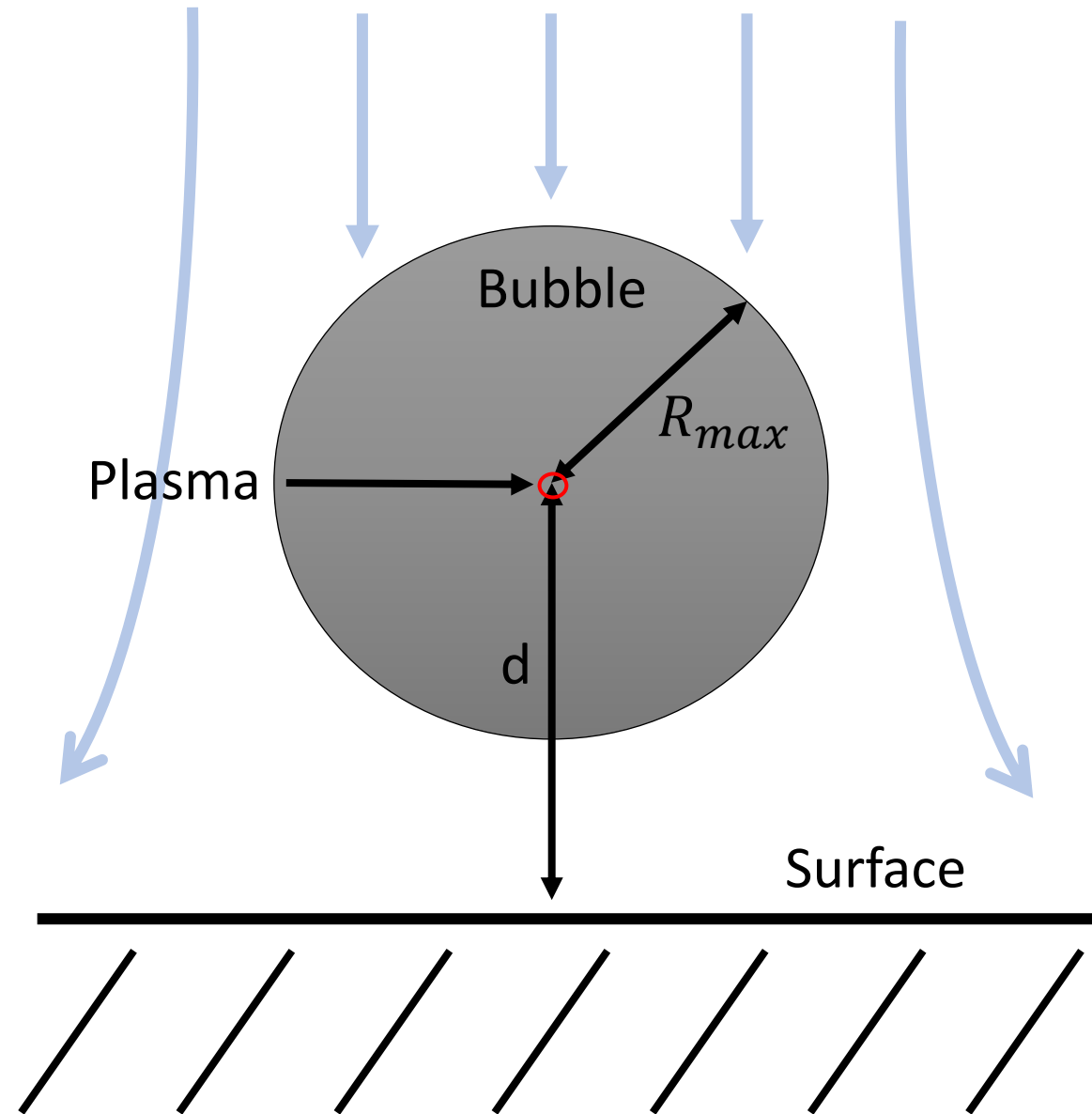
Side view of the flow profile

Important parameter

- R_{max} – maximal bubble radius (measured for undisturbed bubble)
- d – distance to the surface

Non dimensional stand-off parameter

$$D^* = \frac{d}{R_{max}}$$



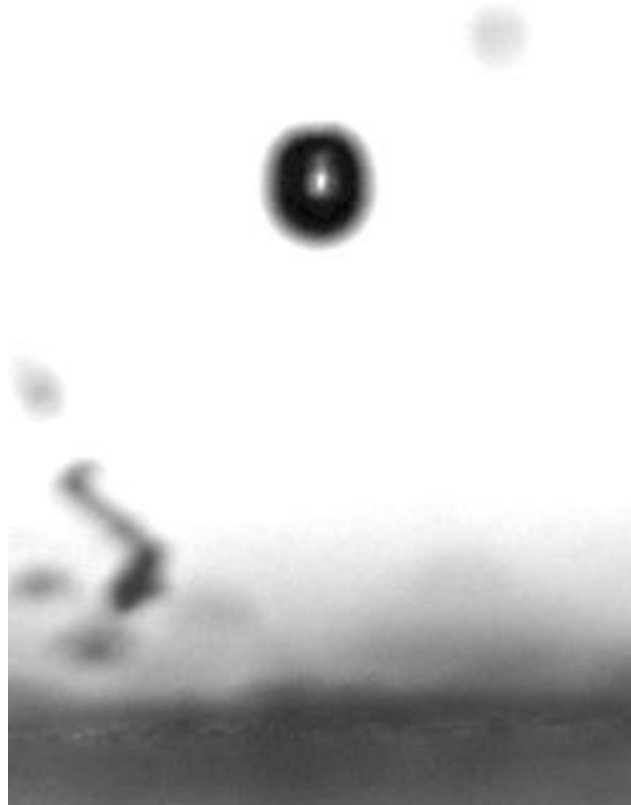
Results - Bubble dynamic

Bubble dynamic in background flow

No background flow

1 μ s

100 μ m



$D^* = 2.08$

Background flow

1 μ s

100 μ m



$D^* = 2.09$



Bubble dynamic in background flow

No background flow

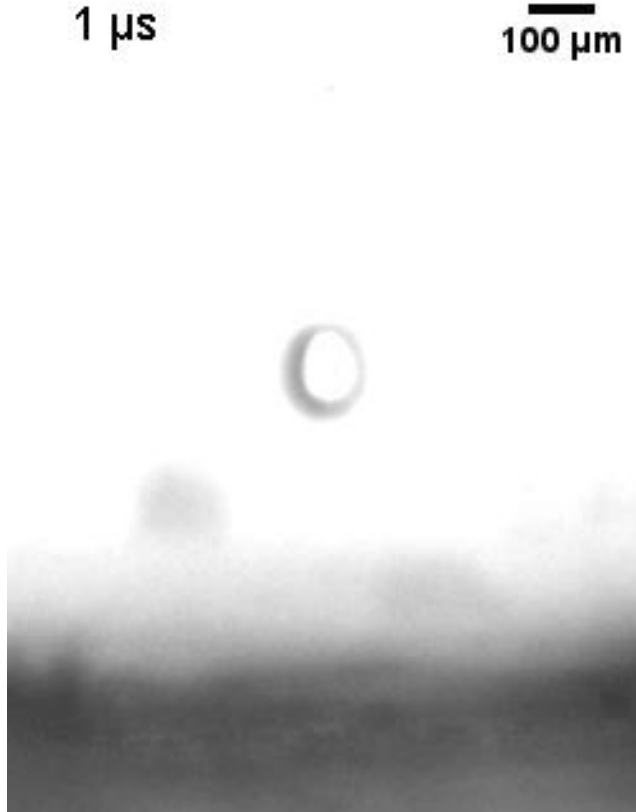
Background flow

1 μ s

100 μ m

1 μ s

100 μ m

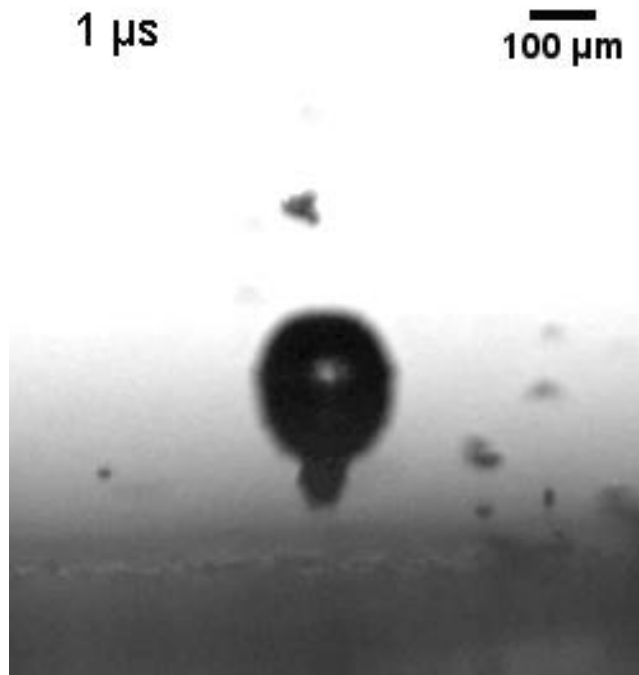


$$D^* = 1.38$$

$$D^* = 1.43$$

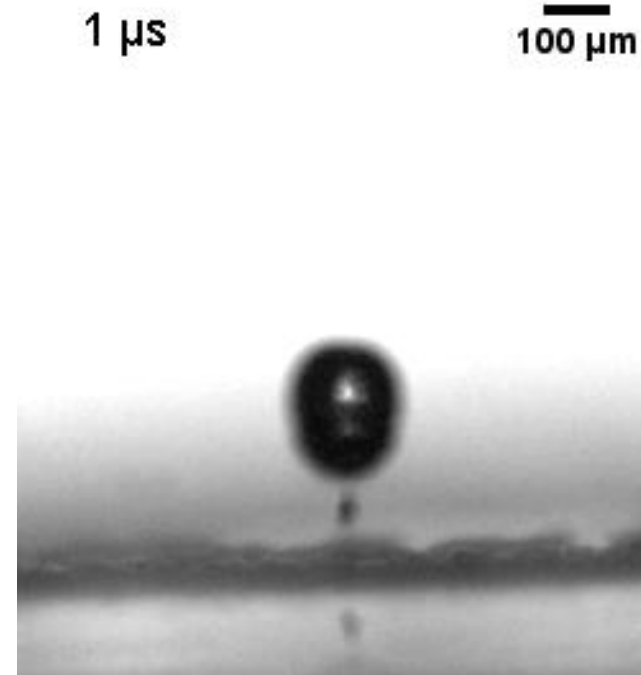
Bubble dynamic in background flow

No background flow

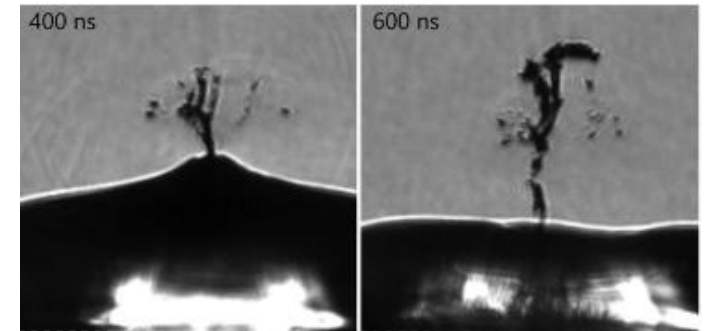


$$D^* = 0.67$$

Background flow

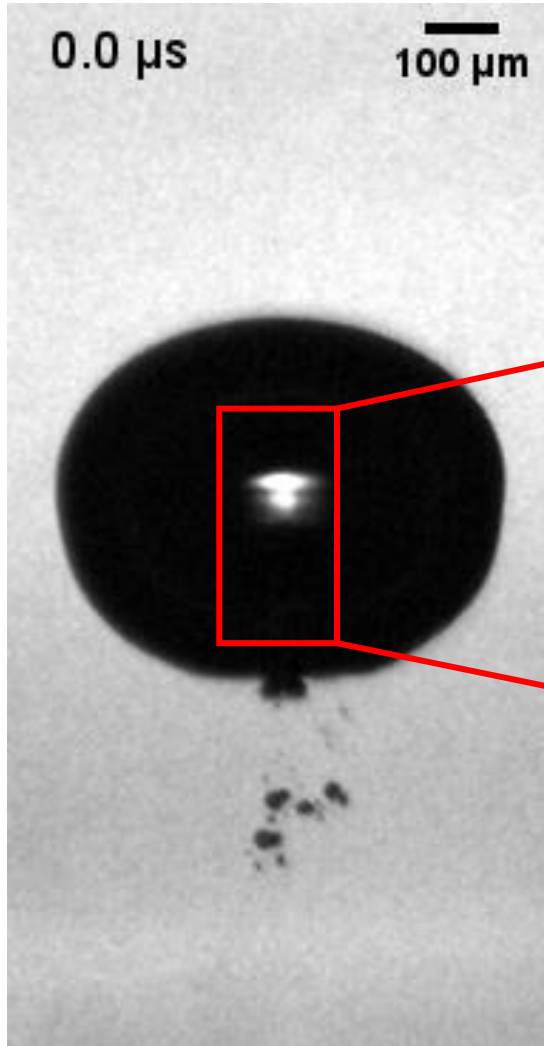


$$D^* = 0.64$$



Reuter, F. & Ohl, C-D. (2021), Supersonic needle-jet generation with single cavitation bubbles, 118, 134103

Bubble jet velocity

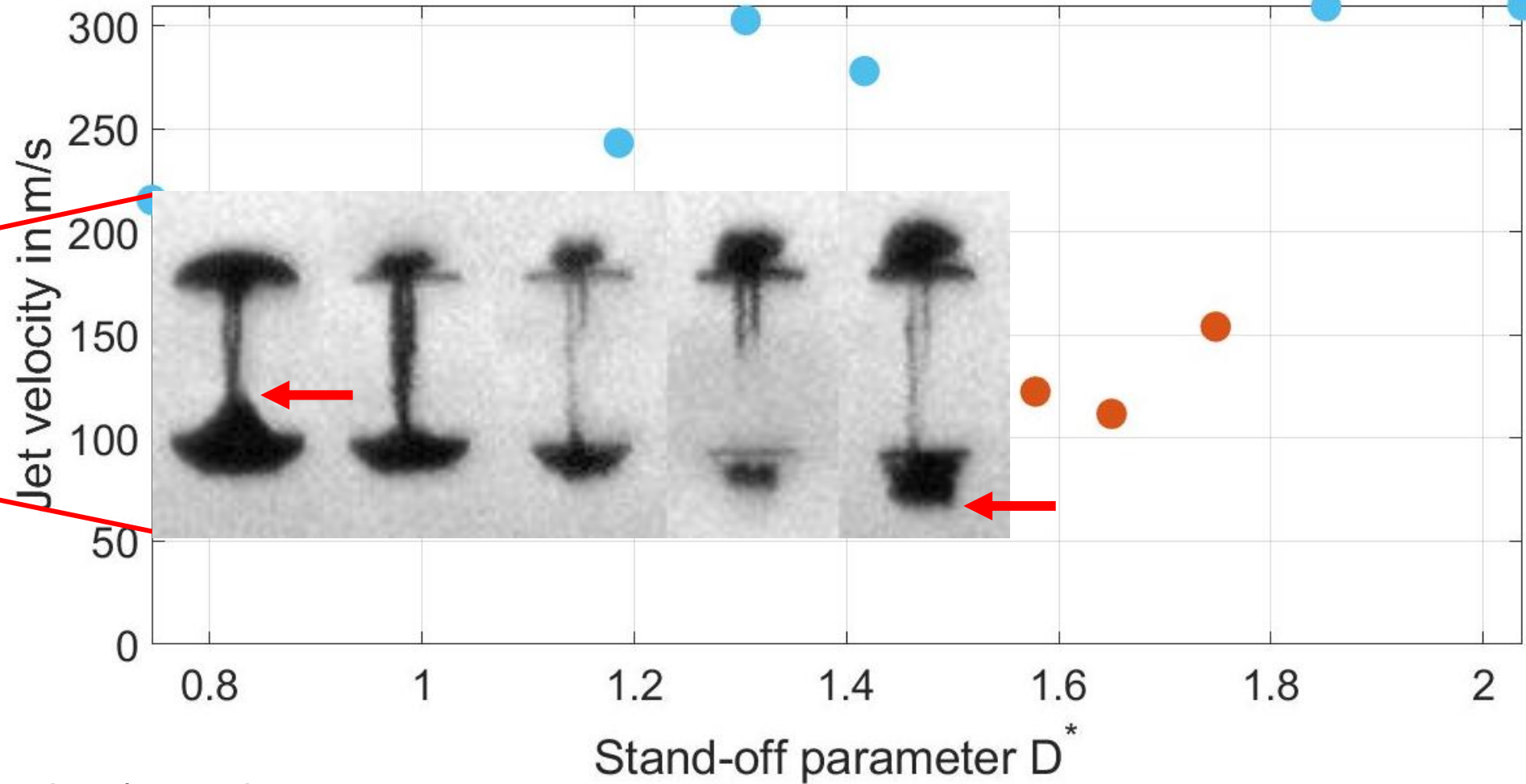


$D^* = 2.04$

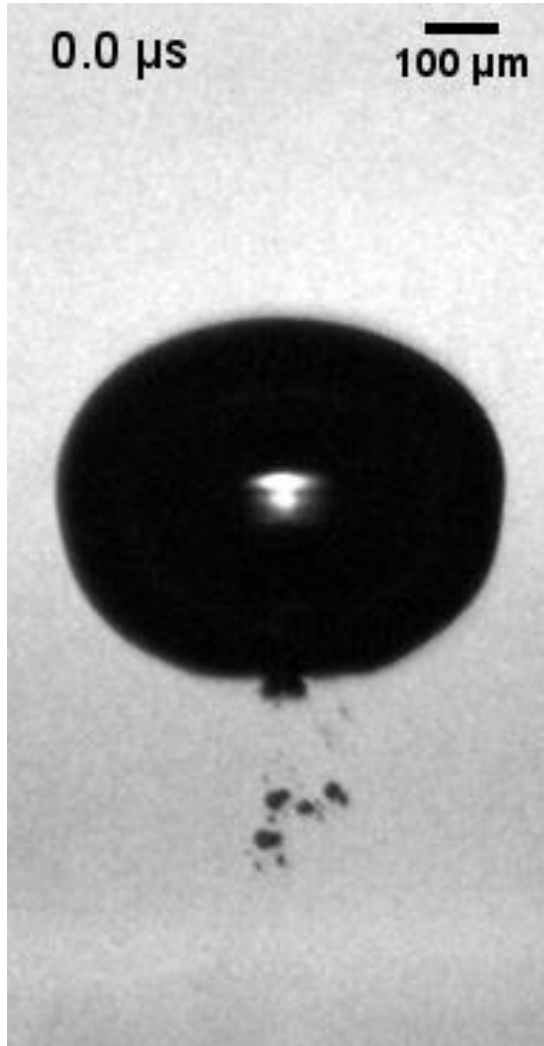
10 Mio. FPS

No background flow

3 m/s background flow



Bubble jet velocity

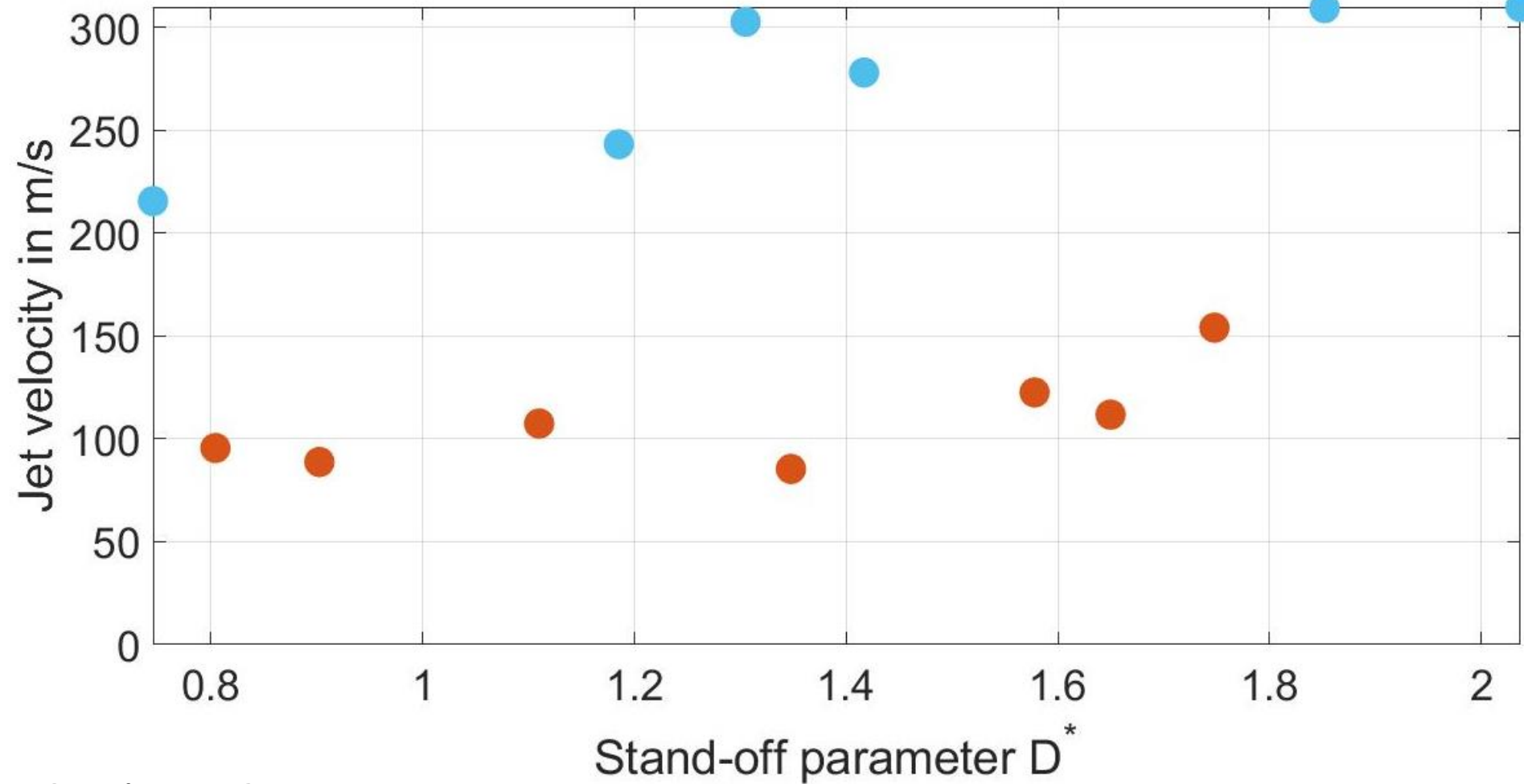


$$D^* = 2.04$$

10 Mio. FPS

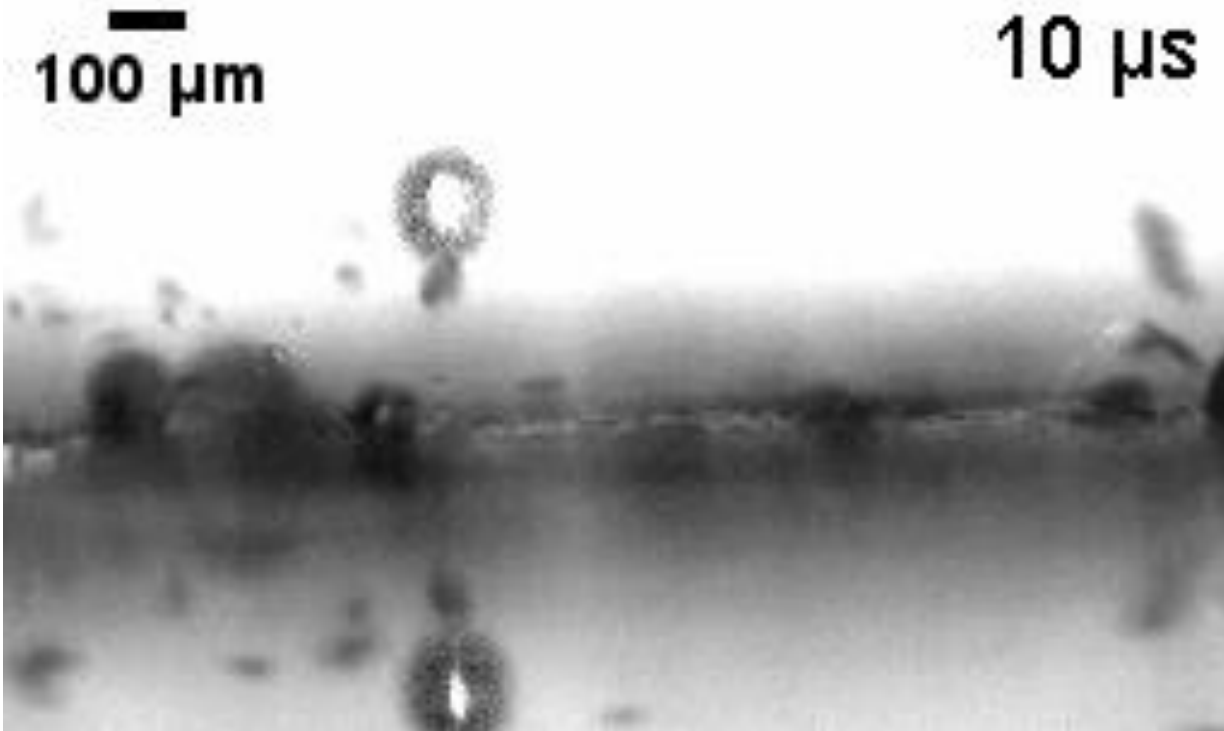
No background flow

3 m/s background flow

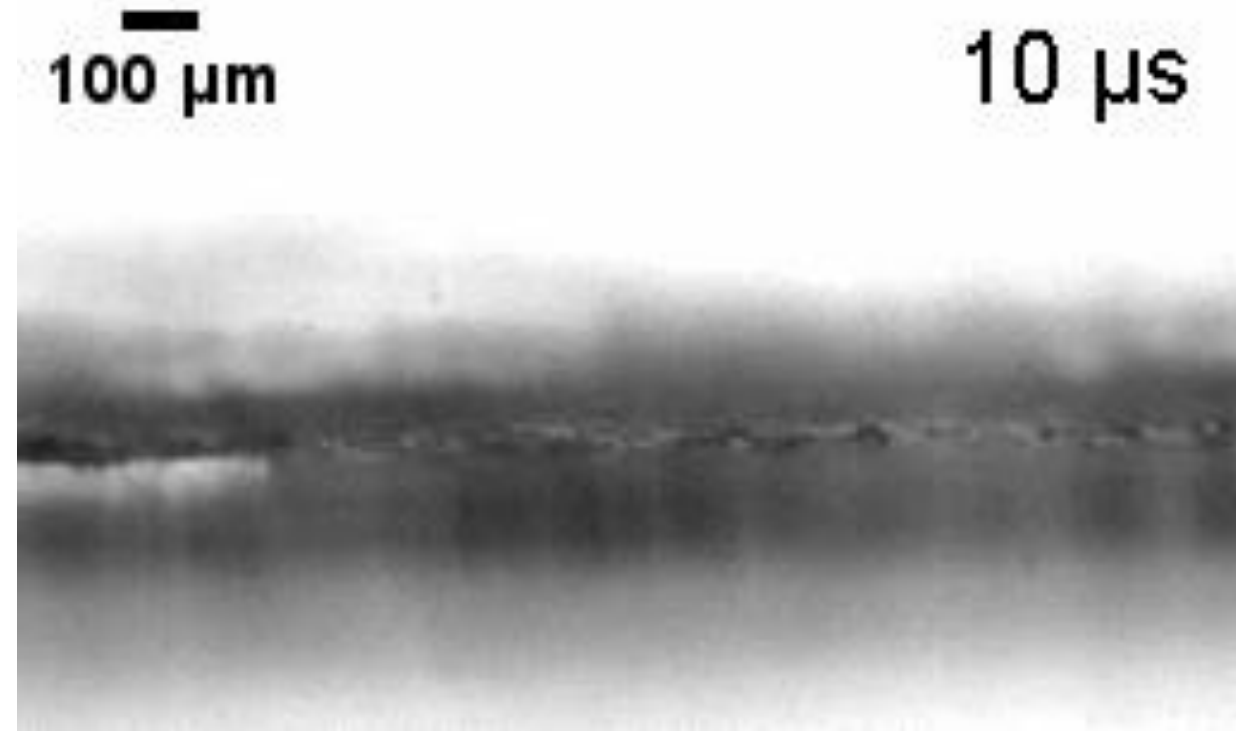


Results – Cleaning of surfaces

Influence of the background flow

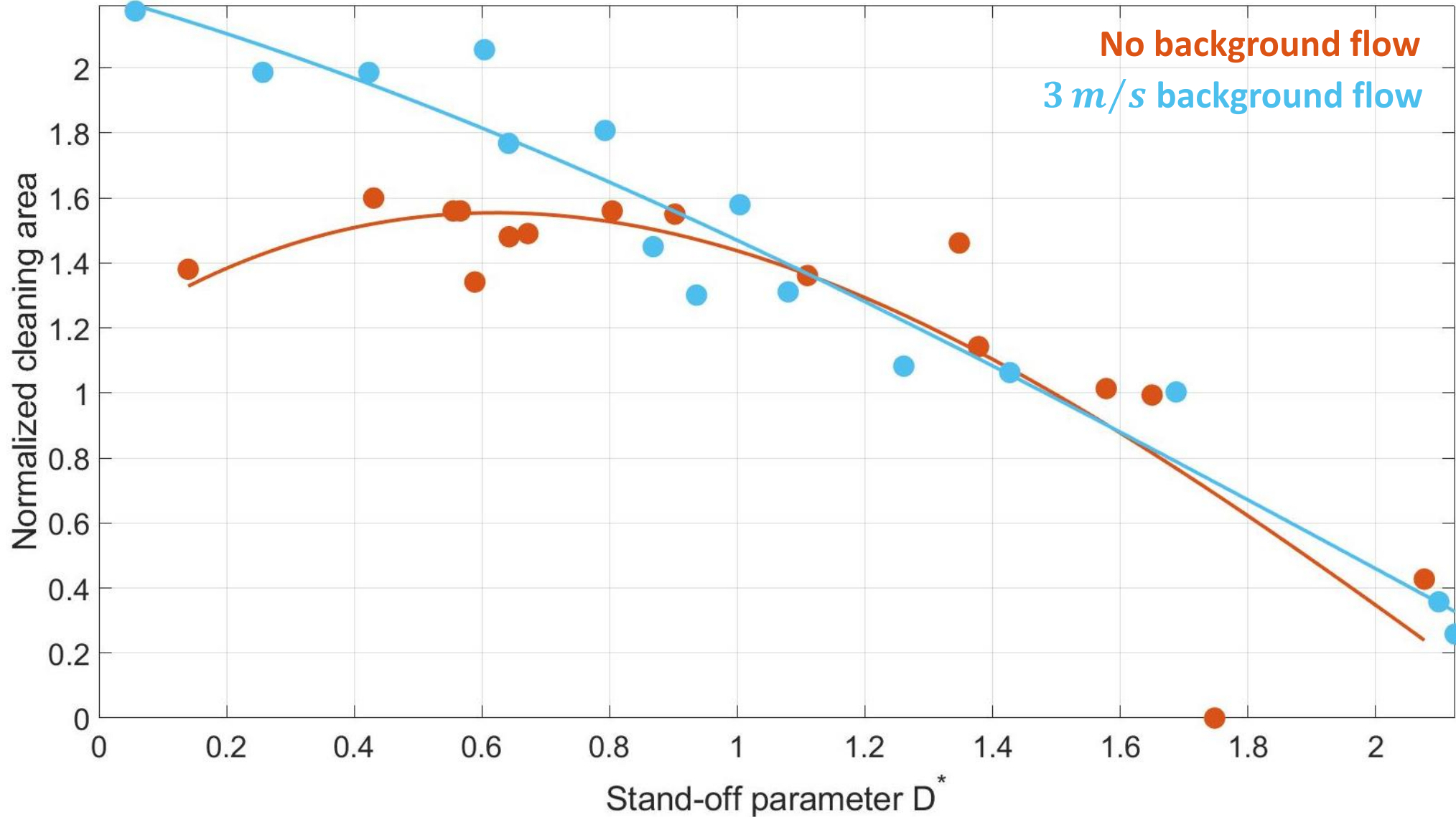


$v = 0 \text{ m/s}$



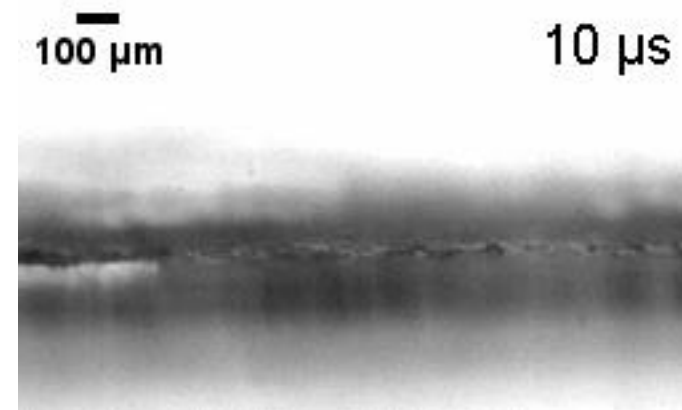
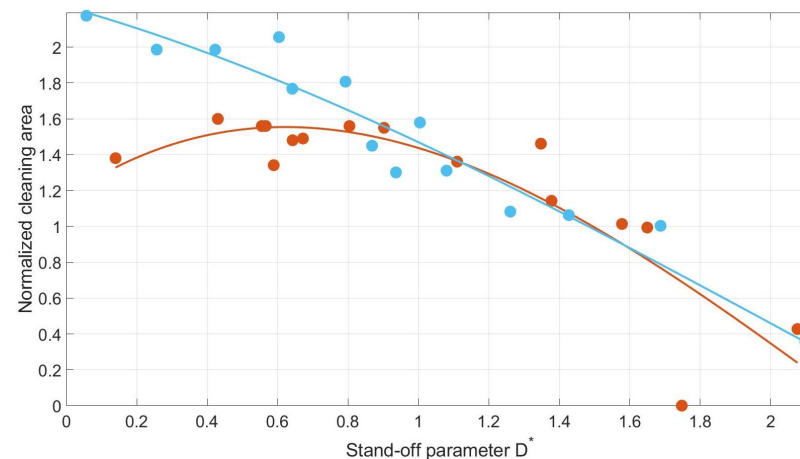
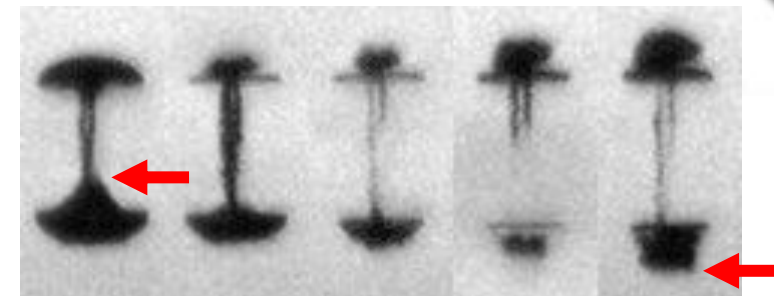
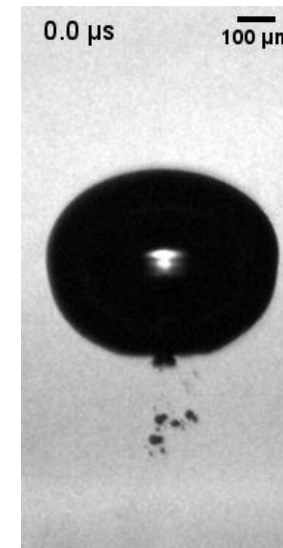
$v = 1 \text{ m/s}$

Cleaning of the surface



Conclusion

- Bubble dynamic changes with background flow
- Pinch-off and splitting of the bubble
- Fast bubble jets after the pinch-off
- Avoid reattachment of particles
- Increased cleaning effect with background flow



**Thank you for
your attention**

ALFRED KÄRCHER | FÖRDERSTIFTUNG