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Nukleartechnik

Bubble identification and bubble parameters calculation via high-speed camera (HSC) and shadowgraph techniques

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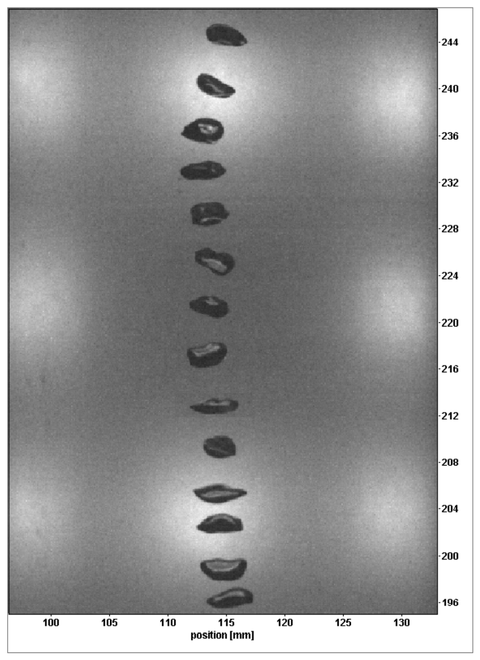
Data source: Raw images acquired by HSC (1279 frame/s @ 2016X2016 Pixel)

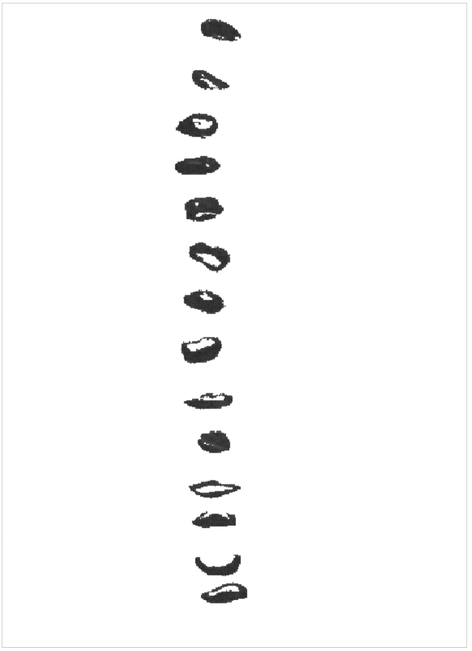
Step1

→Bubbles are extracted out of raw images depending on pixel-wise intensity filtering. All remaining noise is thrown away by applying different filtering techniques. This is done for all raw images sequences.

In adjacent image some snapshot out of 500 Images within 0.5 sec acquisition are shown in left part besides processed sequence at the right side. →



Raw image sequence



Processed results

Step 2

→ Bubbles entities are “identified” in each image . This means that a special procedure will assign pixels belonging to some bubbles with same identifier or number. This will prepare the calculation of bubbles parameters in step3 and is a main part of the technique.

Step 3

→Now knowing pixels belonging to each bubble in each time-step, various bubble parameters can be calculated, however these are mainly:

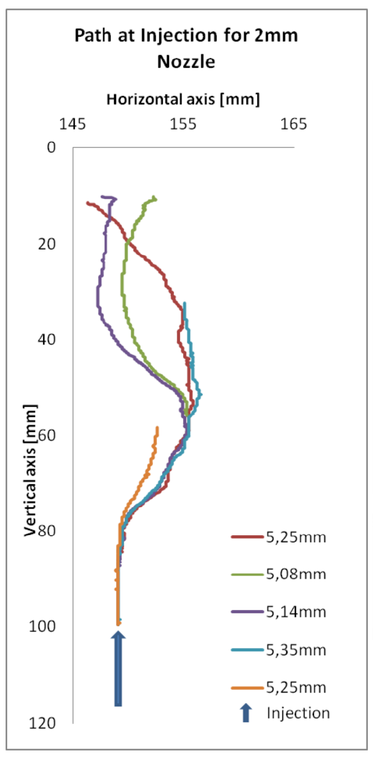
- Bubble 2D projected area.
- Two axes of ellipse-shaped bubbles.
- Bubble position.

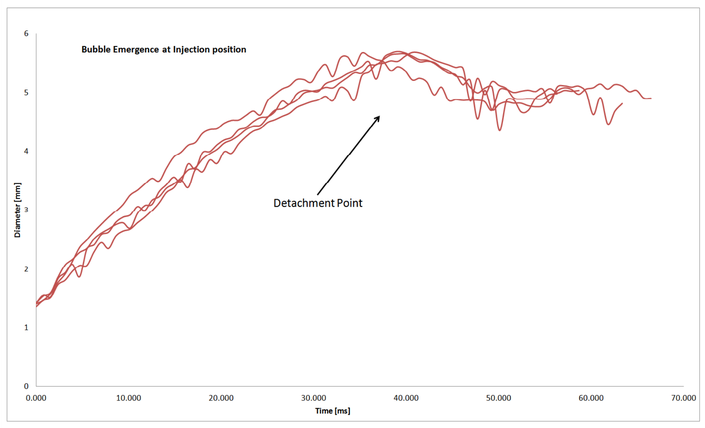
→*Out of these data **bubble equivalent diameter** and **bubble velocities** can be deduced <u>for each time step</u>*

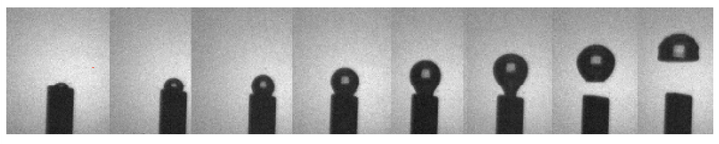
Step 4

→Bubbles are identified through time sequences and data can be calculated for each identified bubble along time

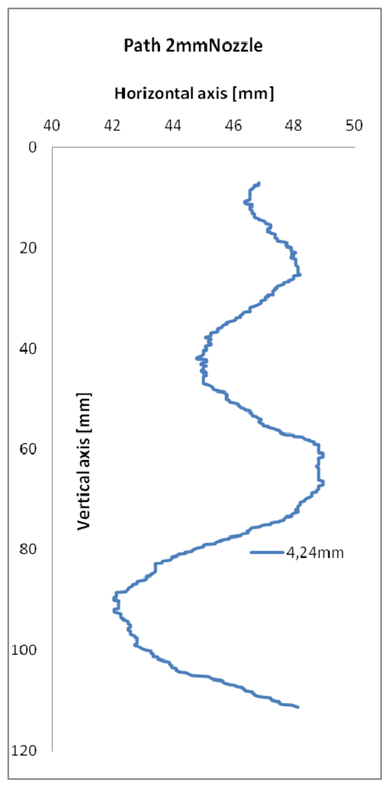
→*Now **Bubble path, bubble equivalent diameter** and **bubble velocities** can be deduced <u>along all time steps</u>*







Example for results in case of train of bubbles coming out a 2mm nozzle. All bubbles’ paths (left). Bubble diameter growth with time (right, top). Snapshots of bubble emergence (right, bottom)



Example for results in case of single bubble gentle injection. Bubble’s paths(left, 60 cm from injection). Bubble diameter, velocity, and aspect ratio with time (right, from top to bottom respectively)

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