Note this is an updated ReadMe (date 14.02.2026)

Changes:

- Some supplementary information added in file Suppl_information_TORE.pdf
- Two movies oft he bubbles rising as seen from the four cameras fort he lower field of view
- Addition of affiliation
- Addition of published script as .pdf

Project Title:

Mixing structures in bubble wakes of single bubbles and bubble swarms and their influence on gas-liquid mass transfer and chemical reactions

Applicants: Professorin Dr. Alexandra von Kameke; Professor Dr.-Ing. Michael Schlüter

Deutsche Forschungsgemeinschaft (DFG) - Project number 517064495

Related Publication:

"Experimental analysis of time resolved three-dimensional velocity and vorticity fields behind single rising bubbles using Lagrangian particle tracking velocimetry" in Chemical Engineering Science (CES) in 2026 (https://doi.org/10.1016/j.ces.2026.123403, Received 21 October 2025; Received in revised form 23 December 2025; Accepted 19 January 2026)

Principal Investigators / Authors:

A. v. Kameke (https://orcid.org/0000-0002-1913-774X), corresp. Author, Alexandra.vonkameke@haw-hamburg.de, HAW Hamburg

R. Uphoff, HAW Hamburg

E. Steuwe (https://orcid.org/0009-0001-7213-7159), HAW Hamburg

J. H. Nissen (https://orcid.org/0009-0004-2915-6890), HAW Hamburg

M. Hoffmann, TUHH Hamburg

M. Schlüter (https://orcid.org/0000-0001-5969-2150), TUHH Hamburg

F. Kexel (https://orcid.org/0000-0003-4268-2348), TUHH Hamburg

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1. General Information

Data set Title:

WakeMix – Lagrangian particle tracking data and bubble shapes for rising bubble experiments (data paper1)

Short Description:

This is the data and some MATLAB scripts for the analysis of the wake fluid motion of rising, wobbling bubbles generated using 4D-PTV with 4 high-speed cameras, fluorescent particles, a high-speed laser and specialized software DaVis 11.0 (LaVision GmbH, Germany) – module flowmaster. The data provided here was exported from the DAVIS software and then further processed with MATLAB.

The data can be used to retrieve the velocity field in the wake oft he rising bubbles at different bubble rising heights and two different bubble sizes (deq = 2.45mm and deq = 2.62mm)

Date of Data Collection:

[10-04-2024]

Geographical Coverage (if applicable):

[Berliner Tor 21, 20099 Hamburg, Germany]

Keywords:

[Bubble wake dynamics, 3D particle tracking, Bubble induced fluid flow, Bubble wobbling, 3D-Vorticity]

2. Methodological Information

Data Collection and Processing:

A) There is data for the bubble rising (in passive fluorescent particles but particles do not fluoresce bc ill. is with white LED) for each bubble size

- data :
  - Outline of the bubble from each camera:
    - N05_low_smoothed_bubble_centroidnboundary_00.mat

        - N05_High_smoothed_bubble_centroidnboundary_01.mat
        - N06_Low_smoothed_bubble_centroidnboundary_01.mat
        - N06_High_smoothed_bubble_centroidnboundary_00.mat

    - Calibration data from DAVIS: N05_Low_Calibration.xml

- scripts to plot particle tracks and bubble reconstruction together:

  Using .m MATLAB scripts:

  1. scripts: figures_wakemix_particle_tracks_low_raw.m (needs .mat file for particle tracks., produced by track_mat_from_dat_steps_N05_low_commented.m)

  2. functions:

     reconstruct_bubble_3d.m, velocities_from_particle_tracks.m

  3. classes: laVisionImage2WorldMapper.m

B) And there is data for the particle tracks illuminated with the high-speed laser and reconstructed by the LAVISION software for four cases:

- data:

  1. Bubble generated with needle N05 with FOV starting right at needle (WM_N05_Low_240410_bubble01_uncertainties.dat.zip)

  2. Bubble generated with needle N05 with FOV starting approximately at 40 mm above the needle (WM_N05_High_240410_bubble00_uncertainties.dat.zip)

  3. Bubble generated with needle N06 with FOV starting right at needle (WM_N06_240410_bubble04_uncertainties.dat.zip)

  4. Bubble generated with needle N06 with FOV starting approximately at 40 mm above the needle (WM_N06_High_240410_bubble00_uncertainties.dat.zip)

The needles are Sterican hypodermic needles from B. Braun Melsungen AG (Melsungen, Germany) with outer diameters of 0.5 mm (N05) and 0.6 mm (N06) and corresponding inner diameters of 0.26 mm and 0.41 mm. The gas flow rate is controlled using a syringe pump (Legato 200, kdScientific, Massachusetts, USA). The bubbles are generated at a frequency of 0.58 Hz for the smaller needle diameter and 0.50 Hz for the larger one. The resulting measurement volume is Lx × Ly × Lz ≈ (35 × 47 × 11) mm^3 for each measurement

- scripts:
    - track_mat_from_dat_steps_N05_low_commented.m (produces the .mat trajectory files, _nosmoothed.mat, _smoothed_*.mat, _reconn_nMissingPoints_*.mat, _reconn_filteredstd_*.mat)
        - uses functions:

        - recontracks_paper.m
        - import_dat.m
        - calculate_std_factor.m
        - velocities_from_particle_tracks.m
    - create_smoothing_spline_tracks_N05_low.m (loads *_reconn_filteredstd_5.mat' and produces _smoothingspl_veltracks_*.mat)

C) There is also the DAVIS Shake-the-Box processing list for the case of N05_High, but was identical for all cases: DAVIS_Processing_List_STB_N05_High.xml

Experimental Design / Study Context:

The applied reactor consists of glass panes and has a squared base of 150 x 150mm2 and a height of 250 mm. It is filled with 2.5 L of bidistilled water containing fluorescent, monodisperse polystyrene (PS) particles with a diameter of dtracer = 19.02µm (microParticles GmbH, Germany).The particles have minimized dye leaching behavior and are suspended in DI-water, thus an influence on the surface tension can be neglected, which has been confirmed by tensiometric measurements using a BP50 bubble pressure tensiometer (Kruess, Germany). The water temperature is approximately constant during the measurement at 22 +/- 1 °C, at an ambient pressure of p = 1024 mbar. The 4D-PTV measurements are performed and analyzed using the DaVis 11.0 software with the STB module. MATLAB (Matlab, r2024 a) is used for further image processing, graphical representation, and evaluation of the data. With a slight modifcation of the experimental set up, it used to record a bubble without particles. Instead of the laser light, two white LED panels serve as illumination from above and from the side (same direction as the laser) in order to be able to record the bubble only.

Data Validation and Quality Assurance:

Summarize how data accuracy, completeness, or consistency were checked.

Particle trajectories are recorded at a frame rate of 800 Hz within a processed volume of 1685x2159x 470 voxels. For each bubble rise, approximately 1000 time steps after bubble detachment are stored. The accuracy of reconstructed 3D particle positions in Lagrangian particle tracking methods such as STB is closely related to the quality of camera calibration and the consistency of particle image projections across all views. The DaVis software estimates a position uncertainty for each particle position at each timestep. The uncertainties lie well below the particle sizes of 19micrometer. Each bubble trial measurement (e.g. small bubble + low FOV) was performed 4-5 times. The measurements gave the same results and thus only one dataset is uploaded for each trial.

3. Data and File Overview

List of Files and Structure:

Raw image data from which the particle trajectories and the bubble boundaries were retrieved using four high-speed cameras (Phantom VEO 640L) is available on a hard-drive upon request to Alexandra.vonkameke@haw-hamburg.de

There are six folders and a README file:

File / Folder	Description	Format	Size
data_N05_Low.zip	The data of the tracks as .dat and the bubble outline as .mat files and calibration files (.xml) from Davis for the case	.xml, .mat, .dat	5.96 GB zipped
data_N05_High.zip	The data of the tracks as .dat and the bubble outline as .mat files and calibration files (.xml) from Davis for the case	.xml, .mat, .dat	5.6 GB zipped
data_N06_Low.zip	The data of the tracks as .dat and the bubble outline as .mat files and calibration files (.xml) from Davis for the case	.xml, .mat, .dat	4.78 GB zipped
data_N06_High.zip	The data of the tracks as .dat and the bubble outline as .mat files and calibration files (.xml) from Davis for the case	.xml, .mat, .dat	5.87 GB zipped
scripts /	Analysis MATLAB scripts and functions (the path and some initial values need to be adjusted to the case -> N05_Low, N05_High, N06_Low, N06_High :::: needle tip position to (x,y,z)=(0,0,0) :::: bubble and particle tilmestep difference <-- all in the comments of the corresponding script)	.m	28 KB
davis/	The example processing list from MATLAB: DAVIS_Processing_List_STB_N05_High.xml	.xml	6 MB
largebubb_N06_low.gif	A .gif movie showing the bubbles rise with LED illumination from Camera 1-4 (left to right) from the lower FOV and the large bubble	.gif	842 MB
smallbubb_N05_low.gif	A .gif movie showing the bubbles rise with LED illumination from Camera 1-4 (left to right) from the lower FOV and the smaller bubble	.gif	864 MB
Suppl_information_TORE.pdf	Some suppl. Information on the data and analysis and comparison to other data	.pdf	1.1 MB
Kameke_etal_2026.pdf	Published article	.pdf	14.7 MB
README	This readme, an updated version of the former	.pdf and .rtf	5 KB

File Naming Convention:

[WM_N05_Low_240410_bubble01_uncertainties.dat.zip]: N05 is the smaller bubble generated with outer needle diameter 0.5 mm, LOW defines the higher FOV measured, bubble01 the bubble trial (here first bubble measured with particle illumination)

[N05_low_smoothed_bubble_centroidnboundary_00.mat]: N05 is the smaller bubble generated with outer needle diameter 0.5 mm, _00 is the first bubble measured without laser illumination.

Number of Records / Observations:

published here: one record for each of the 4 cases. For each case 3-4 more measurements of the same variable set are available.

4. Access and Licensing Information

Repository and Persistent Identifier:

“Published via TORE, DOI: https://doi.org/10.15480/882.16589”

License for Use:

CC BY 4.0 (Attribution)

Access Restrictions:

Open

Text for Citation:

please cite this data/scripts wherever you use them and the corresponding article:
this data/scripts:
https://doi.org/10.15480/882.16589
the corresponding article:
https://doi.org/10.1016/j.ces.2026.123403
E.g.:
A.v. Kameke, R. Uphoff, E. Steuwe, J.H. Nissen, M. Hoffmann, M. Schlüter, F. Kexel, *Experimental analysis of time resolved three-dimensional velocity and vorticity fields behind single rising bubbles using Lagrangian particle tracking velocimetry*, Chemical Engineering Science, 2026,123403, https://doi.org/10.1016/j.ces.2026.123403.

5. Reproducibility and Software Dependencies

Software Required:

[Matlab (r2024a), 2024. https://www.mathworks.com/products/matlab.html, FlowMaster Module for DAVIS, LaVision GmbH, L., 2023. Product Manual for DaVis 11.0. LaVision GmbH, Anna-Vandenhoeck-Ring 19, D-37081 Göttingen Produced by LaVision GmbH, Göttingen]

Scripts and Workflow:

- download all zipped folders from the repository
- Unzip folders
- Run script **track_mat_from_dat_steps_N05_low_commented.m** as is using MATAB to create .mat trajectory files for experimental case N05_Low.
- Run script **create_smoothing_spline_tracks_N05_low.m** to produce final tracks with smoothed velocities that were used for further analysis in the publication (https://doi.org/10.1016/j.ces.2026.123403)
- Run script figures_wakemix_particle_tracks_low_raw.m to plot bubble and particle tracks together.
- Do all of the above again for the other .dat files of the other experimental trials (e.g. N05_High) adjusting the needle position (see comments in script) and the reference to the files.

Reproducibility Notes:

Please use the trajectory and bubble data for the generation of time resolved velocity-fields and the derivatives thereof. Also, the trajectory data can be used to analyze the mixing in the bubble wake.

6. Ethical and Legal Aspects

Data Protection:

Not applicable

Consent Statement:

[Indicate whether participants consented to data sharing.]

7. Versioning and Updates

Version Number:

v2.0.

Date of Release:

2026-02-05

Change Log:

2026-02-14, Added files: Publication, two .gif movies of the bubble rise, supplementary .pdf and this updated README

8. Contact Information

Corresponding Author:

Name: Alexandra von Kameke
Institution: Faculty of Sustainable Engineering, Heinrich-Blasius-Institute, Hamburg University of Applied Sciences
Email: Alexandra.vonkameke@haw-hamburg.de
ORCID: https://orcid.org/0000-0002-1913-774X
Project Website (if available): https://www.haw-hamburg.de/person/alexandra-kameke/