Annual Report

2023

J.M. Burgerscentrum

Research School for Fluid Mechanics

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TUD, TU/e, UT, RUG, WUR, UU, UvA

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Preface

It is a great pleasure to present the annual report of the J.M. Burgerscentrum, which provides an overview of the activities of our research school during the year 2023. The core of the report consists of a pointwise summary of the 2023 research initiatives and achievements within each of the participating JMBC groups. In addition, also six research highlights are provided in the form of short articles, as prepared by junior JMBC members who received their PhD degree in 2023 (all six Cum Laude). The Annual Report also provides general information about the research school, such as its goals, its organization, and its connection with industries and technological institutes.

The Burgerscentrum covers the fluid flow (related) research as carried in groups in seven universities in the Netherlands. In 2023, the following 6 groups became member: Flight Performance and Propulsion (Aerospace Engineering, Delft), Breathe Lab & SenseLab (Architecture and the Built Environment, Delft), Engineering Thermodynamics (Mechanical Engineering, Delft), Salutary Engineering (Civil Engineering, Delft), The Processing and Performance of Materials Group (Mechanical Engineering, Eindhoven), and Biomedical and Environmental Sensorsystems (Twente). In 2023 the number of registered PhD students in the Burgerscentrum has increased to over 400, and the number of postdocs is about 50. The number of registered scientific staff (professors) has increased to close to 300. In 2023, two new board members were welcomed: prof. Jennifer Herek (Twente) and prof. Patrick Anderson (Eindhoven).

A main achievement in 2023 within the Burgerscentrum is the delivery of 127 PhD Theses, among which a few with honours. A full list is given in this report. In the year 2023, eight courses were organised. Some new courses are being developed, which will start in 2024/2025. Among these, a course on “Fluid Dynamics in Sustainable Energy” and a course on “Wake Flows”. Such courses for the PhD students and postdocs will remain an important task for the Burgerscentrum, and the staff is encouraged to nominate their students for participation.

A recurrent highlight in a Burgerscentrum year is the two-day gathering in Hotel De Werelt in Lunteren. Also, in 2023 the Burgers Symposium was a great success with 230 participants. The programme included the Burgers Lecture by prof. Peko Hosoi of MIT, talks and posters by the PhD students and postdocs, new staff introductions, and awards for the best presentations. The symposium was closed with the Award Ceremony of the 2022 Hoogendoorn KIVI Award to Willian Hogendoorn.

In 2023, some of the scientific staff in the Burgerscentrum received prestigious grants. Among them are ERC grants for: Lorenzo Botto (Delft), Ivan Langella (Delft), Phillip de Goey (Eindhoven), Yoeri van de Burgt (Eindhoven), Detlef Lohse (Twente), Richard Stevens (Twente), Alvaro Marin (Twente), and Maziyar Jalaal (Amsterdam). Congratulations to all for this major achievement. Such awards also underpin the international recognition of the worldwide leading role of fluid mechanics and physics in the Netherlands.

Collaboration between JMBC groups and teams in the industry and in the technological, as represented in the JMBC Advisory Board, is also of great importance to demonstrate the societal and economic impact of the fundamental and applied research efforts. In 2023 the Burgerscentrum has asked an external agency to quantify the impact of fluid flow research on the society and economy in the Netherlands. The results are published in the report “Flow to the Future; Fluid Dynamics in the Netherlands” (*Alles stroomt in Nederland; met stromingsleer op naar de toekomst*). It appears that more than 19,000 people work on fluid dynamics in Dutch industry and that fluid dynamics contributes 11.5 billion euros to the Dutch economy every year. Fluid dynamics is therefore of crucial importance

for solving future societal challenges. The report was presented to the Higher Education & Science spokespersons in the House of Parliament on 6th June 2023. This will help to get complete recognition of the importance of fluid flow in the Netherlands. Fluid dynamics should be seen an enabling key technology with world-wide leadership through its scientific research.

We are looking back at an excellent fluid flow year 2023. Thanks are due to all who are contributing to the success.

Prof. dr. ir. Hans van Duijn
Chairman of the JMBC Board

Prof. dr. ir. Ruud Henkes
Scientific Director JMBC

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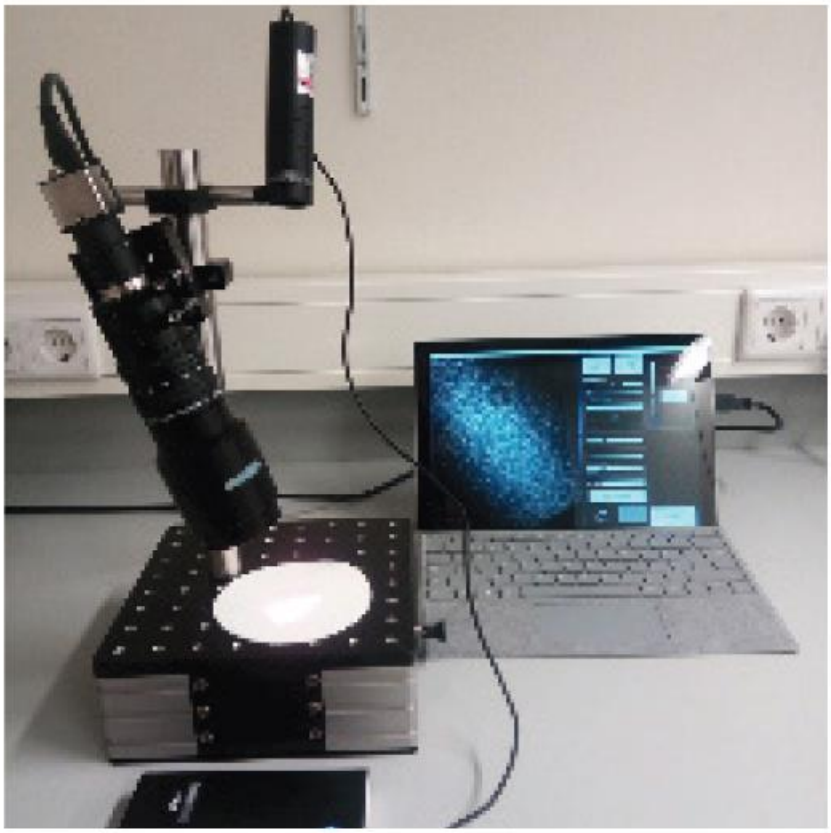


Process & Energy - Fluid Mechanics

Process & Energy - Multiphase Systems

Process & Energy - Complex Fluid Processing

Process & Energy - Engineering Thermodynamics

Maritime and Transport Technology – Ship Hydromechanics

Maritime and Transport Technology – Dredging Engineering

Chemical Engineering - Transport Phenomena

Chemical Engineering - Product and Process Engineering

Applied Mathematics - Numerical Analysis

Applied Mathematics - Mathematical Physics

Aerospace Engineering - Aerodynamics

Aerospace Engineering - Wind Energy

Aerospace Engineering – Flight Performance and Propulsion

Civil Engineering and Geosciences – Environmental Fluid Mechanics

Civil Engineering and Geosciences – Reservoir Engineering

Civil Engineering and Geosciences – Salutary Engineering

Faculty of Architecture and the Built Environment – Breathe Lab and SenseLab

Eindhoven University of Technology (TU/e) (page 100)

Applied Physics - Fluids & Flows

Applied Physics - Transport in Permeable Media

Applied Physics - Elementary Processes in Gas Discharges

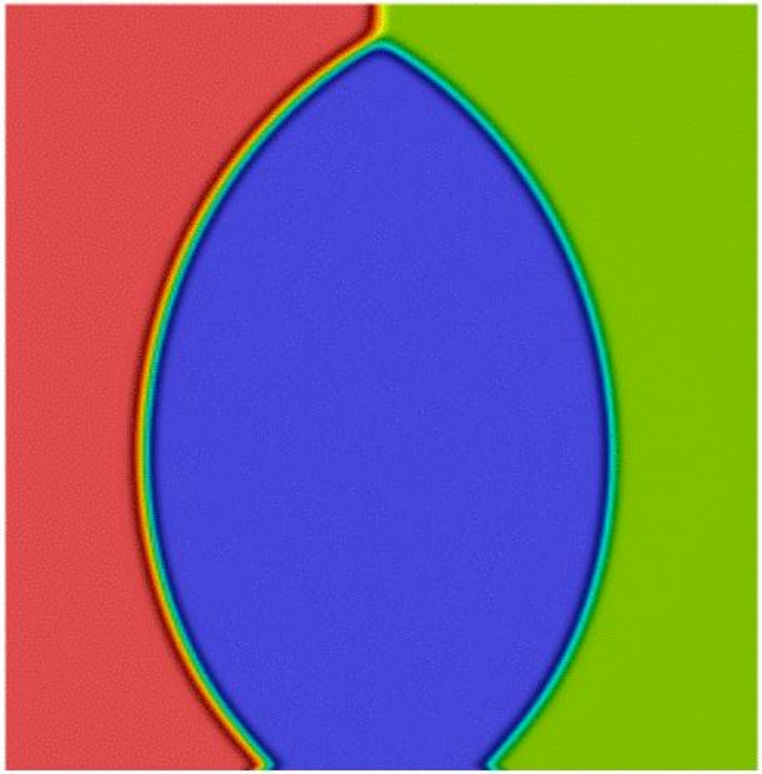
Mechanical Engineering - Energy Technology

Mechanical Engineering - Power & Flow

Mechanical Engineering - Microsystems

Mechanical Engineering - The Processing and Performance of Materials Group

GENERAL



Introduction

The JM Burgerscentrum (JMBC) is the national research school for fluid mechanics in The Netherlands. Its main goals are:

- Stimulation of collaboration of the participating groups with respect to their research efforts. The JMBC aims at being one of the leading institutes for fluid mechanics in the world.
- Organization of advanced courses for PhD-students. These courses are also attended by postdocs and by researchers from industries and technological institutes.
- Co-operation with industries and technological institutes. The aim is to promote the use of up-to-date knowledge on fluid mechanics for solving practical problems.
- Strengthen the contacts between fluid mechanics research groups at Dutch universities and the international fluid mechanics community.

In total about 300 senior scientific staff members participate in the JMBC. The groups are located at the seven universities in the Netherlands, namely: Delft, Eindhoven, Twente, Groningen, Wageningen, Utrecht, and Amsterdam. The various fluid mechanics groups are based in different departments, and in different disciplines: in Civil Engineering; Mechanical Engineering, Maritime Technology, (Applied) Physics, Aerospace Engineering, Applied Mathematics, Chemical Technology, Biology, and in Physical Oceanography. The professors with their senior staff form the Council of Project leaders, which meets regularly. At the end of 2023, about 400 PhD-students and 50 postdocs were registered as participants of the JMBC.

The scientific director of the JMBC is assisted by the Management Team, consisting of the local directors in Delft, Eindhoven, and Twente (who are also representing the groups in Groningen, Wageningen, Utrecht, and Amsterdam). The running of the JMBC takes place under final responsibility of the Board of the JMBC.

A number of contact groups in different topical areas are active, in the sense that they strengthen the network between researchers at different groups, promoting the exchange of expertise and experience between the participating groups. The various JMBC groups have intensive, active contacts and close links with industries and technological institutes in The Netherlands. This connection is formally facilitated by the Industrial Advisory Board, with members representing a large number of companies and technological institutes.

The JMBC research groups have various scientific contacts with research groups in other countries, often in the form of individual collaboration projects, but also in the form of organised networks. This international setting implies joint publications with other researchers from all over the world, and also exchange of staff: external visitors to the JMBC groups and JMBC staff visiting foreign fluid-mechanics groups.

As common practice in the scientific community, the research groups present their work at international conferences and in the form of journal publications. The number of publications from JMBC staff in well-known scientific journals is considerable.

An important activity of the JMBC is the organisation of the Burgers Symposium, which is the annual two-day meeting of the research school. This annual meeting is attended by more than 200 participants (both staff, PhD students, and postdocs). In addition to the plenary Burgers Lecture and the Evening Lecture the Symposium programme includes oral and poster presentations by the JMBC PhD students.

Each academic year the JMBC organises a number of special courses, meant primarily as advanced fluid-dynamical education of the PhD students and postdocs of the JMBC. The topics of these courses varies from one year to another, although some courses are given every other year. These courses are also open to participants from other research schools and from industry.

Impact of Fluid Mechanics

Fluid dynamics forms a vital part of understanding and providing solutions to all major future societal challenges as covered by the following 6 areas:

1. **Climate change**. Predicting warming and impacts of greenhouse gas emissions on the oceans, sea levels and weather.
2. **Environment.** From water, river and flood management including pollution and water treatment. To the cooling, heating and air management in buildings.
3. **Energy transition and energy security**. Whether through tidal and wind energy, the hydrogen economy and biofuels, through to next generation batteries and high efficiency transport. Also, fluid dynamics in aircraft.
4. **High-tech manufacturing and high-tech materials**, from semiconductor to additive manufacturing, 3D printing and bio-compatible production.
5. **Healthcare.** From aerosol distribution of viruses, advanced micro-fluidic based diagnostics to personalised treatment and drug production. Also, fluid dynamics in sports.
6. **Agriculture and food production**. Such as next generation indoor vertical farming, food production and processing ideal for exploitation in the Netherlands.

Research in all those 6 application areas in carried by the groups in the Burgerscentrum. The industry is represented in the Burgerscentrum through an Industrial Advisory Committee, chaired by Tim Peeters of TataSteel.

On request of the Burgerscentrum, in 2023 Harlin Ltd has investigated the role of fluid dynamics in the Netherlands. The objective was to highlight the importance of fluid dynamics on Dutch society and the economy, now and in the future. This led to an estimate of the size of the fluid dynamics sector in the Netherlands and a quantification of its current economic impact. Expert input identified the societal challenges most dependent on developments in fluid dynamics. The analysis is based on a proven process used internationally to quantify the impact of enabling technologies embedded deep within large, diversified companies.

The investigation confirms that fluid dynamics technology has the potential to transform societal challenges, but its complexity and hidden presence makes it relatively unknown to the general public and policy makers. It is essential to create more visibility and have national recognition of fluid dynamics as a key enabling technology to solve important societal problems. It appears that more than 19,000 people work on fluid dynamics in Dutch industry and that fluid dynamics contributes 11.5 billion euros to the Dutch economy every year. Fluid dynamics is therefore of crucial importance for solving future societal challenges. In the report 'Flow to the Future; Fluid Dynamics in the Netherlands' (*Alles stroomt in Nederland; met stromingsleer op naar de toekomst*), which was commissioned by the J.M. Burgerscentrum, the national research school for fluid mechanics, the gross added value is calculated at 130,000 euros per employee. More than 75% of the fluid mechanics industry exports its products and services.

The report 'Flow to the Future in the Netherlands' was presented to the Higher Education & Science spokespersons in the House of Parliament on 6th June 2023. This will help to get complete recognition

of the importance of fluid flow in the Netherlands. Fluid dynamics should be seen an enabling key technology with world-wide leadership through its scientific research.

Alles stroomt in Nederland.pdf (tudelft.nl)
Flow to the Future in the Netherlands.pdf (tudelft.nl)

On 6th June 2023, a delegation of the J.M. Burgerscentrum visited the 'Tweede Kamer' in The Hague.

Research Program

The research program of the JMBC has been grouped into three main research themes. The reason for this structure is to present a combination of projects which have coherence, either in terms of physical models or in terms of mathematical methods.

The three themes are:
1. Complex dynamics of fluids
2. Complex structures of fluids
3. Mathematical and computational methods for fluid flow analysis

Fluid flows in the environment or in industrial applications are almost always characterised by some complexity. Frequently, it is this complexity that makes the flow an interesting topic of research. The first form of complex dynamics that comes to mind is turbulence, in contrast to laminar flow. In particular, aspects like laminar-turbulence transition, effects of thermal buoyancy, compressibility and rotation, density stratification and the interaction with chemical reactions are topics that are actively being studied by a number of the JMBC groups.

Also, the presence of different phases, e.g. in the form of particles, bubbles or drops, may add to the complexity of flows. This class of flows, generally denoted as 'dispersed multi-phase flow', forms a strong focal point of research within the JMBC. Non-Newtonian and granular flows form a special class of complex flows that is being studied by several groups. Also, micro- and is an important topic, not in the least because of its important industrial and biomedical applications.

Advanced mathematical and computational techniques have become indispensable instruments for the description and understanding of complicated flow phenomena. The rapid increase of computational power has significantly stimulated the use of simulation techniques. In areas such as turbulent flow simulation, important progress has been made through refined modelling via Large-Eddy Simulation (LES), Direct Numerical Simulation (DNS) and stochastic methods. In other areas similar trends have become feasible, such as PDF modelling in combustion, and particle-based methods, like the Lattice-Boltzmann method.

Experimental techniques also play a crucial role in modern fluid-dynamics research. Many experimental methods are based on various forms of laser diagnostics, like e.g. PIV and PTV for flow measurements and CARS and LIF for measurements of temperatures and concentrations. Also, recording of ultrafast flow phenomena via high-speed camera techniques is playing an essential role in present-day fluid mechanics.

Within the JMBC, the various groups have built up extensive expertise on these aspects of experimental, theoretical and computational fluid dynamics. Within the framework of the network provided by the research school, stimulated by the contact groups, all groups benefit from this common pool of knowledge and expertise.

As usual in the scientific community, progress in the research projects is reported in the form of PhD theses, journal publications, contributions to conference proceedings, (chapters of) books, and in the form of presentations at conferences. In various industry-funded projects, the JMBC groups produce output in the form of special reports for industries and technological institutes.

Burgers Program for Fluid Dynamics at the University of Maryland

Inspired by the intellectual heritage of Johannes M. Burgers, who had a second career in the period 1955 to 1981 at the University of Maryland (after his retirement at Delft University of Technology), the mission of the Burgers Program for Fluid Dynamics is to enhance the quality and international visibility of the research and educational programs in fluid dynamics and related areas at the University of Maryland, in partnership with the J.M. Burgerscentrum. Fluid dynamics in this context is viewed to include a broad range of dynamics, from nanoscales to geophysical scales, in simple and complex fluids.

The establishment of the Burgers Program was celebrated with an inaugural symposium at the University of Maryland in November 2004. Prof. Gijs Ooms, the Scientific Director of the JMBC at that time, gave a lecture on the life and legacy of Burgers on that occasion. The interdisciplinary Burgers Program encompasses almost 80 faculty members spread over 22 different units in the College of Computer, Mathematical and Natural Sciences and the A. James Clark School of Engineering. The program is currently led by Prof. James Duncan, Keystone Professor at the Department of Mechanical Engineering, University of Maryland.

In the fall of 2024, Prof. Ruud Henkes of Delft University of Technology (and the current scientific director of the Burgerscentrum) gave the Burgers Lecture at the 20th Annual Burgers Symposium. His presentation was entitled: “Multiphase Flow in Pipelines”.

2023 Participation

The table shows the number of participants in the Burgerscentrum as per end 2023.

	TUD	TU/e	UT	RUG	WUR	UU	UvA	Total
Scientific staff	**109**	**81**	**79**	**7**	**6**	**2**	**8**	**292**
PhD students	**172**	**109**	**119**	**9**	**14**	**0**	**7**	**430**
Postdocs	**15**	**13**	**20**	**0**	**3**	**0**	**2**	**53**

2023 PhD Courses

30 January – 3 February 2023, CFD 2, Delft University of Technology, 20 participants.

27 February – 3 March 2023, Multiphase Flow and Phase Transitions, University of Twente, 35 participants.

3 – 5 April 2023, Shallow Flows, VKI Brussels, Organized by the Von Karman Institute (VKI) in collaboration with the Burgerscentrum.

12 – 14 April 2023, Computational Multiphase Flow, Delft University of Technology, 22 participants.

22 – 26 May 2023, Machine Learning, Eindhoven University of Technology, 31 participants.

25 – 29 September 2023, Rheology, Wageningen University & Research, Course organzized by the VLAG research school in collaboration with the Burgerscentrum.

6 – 9 November 2023, Turbulence, Delft University of Technology, 46 participants.

13 – 14 December 2023, Solution Methods in Computational Mechanics, Eindhoven University of Technology, Organized by Engineering Mechanics Research School in collaboration with the Burgerscentrum.

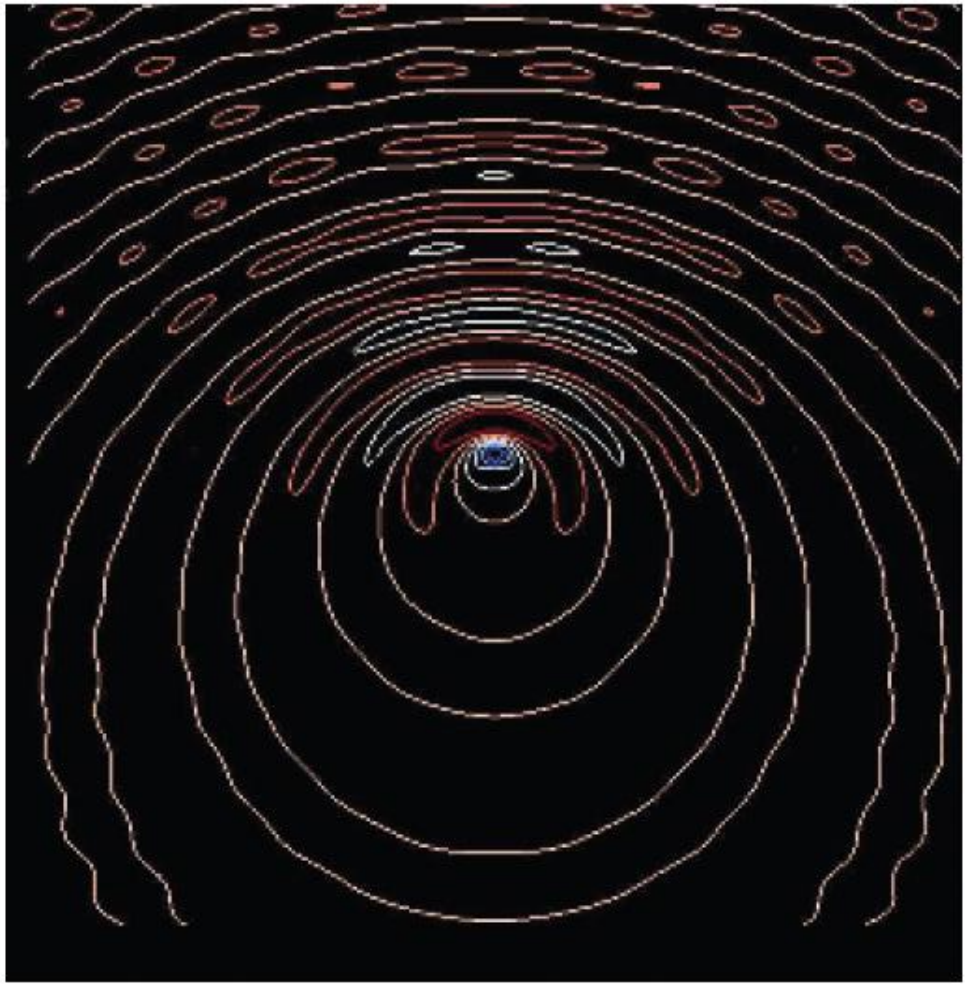
2023 Burgers Symposium

The yearly Burgers Symposium was held on 31 May 1 June 2023 in Hotel De Werelt in Lunteren. There was a large attendance (230 persons) from PhD students, postdocs, professors in the Burgerscentrum, as well as delegates from industries and technology organisations. The programme included the following:

- Burgers Lecture by Prof. Peko Hosoi (MIT, USA), "Filtration and fundamental fluid mechanics inspired by the manta ray".
- Evening Lecture by Prof. Erik van Sebille (Utrecht University), “Tackling the plastic soup: How physicists, mathematicians and computer scientists can support a clean and sustainable ocean”.
- 46 oral presentations by PhD students and postdocs
- 6 oral presentations by new staff in the Burgerscentrum

- 3 oral presentations in the session “Fluid Flow in Industry”.
- 65 posters and 3 movies in the Burgers Gallery
- 2022 KIVI Hoogendoorn Fluid Mechanics Award (Laudatio and prestation) for dr. ir. Willian Hogendoorn (Delft University of Technology)
- Burgers Symposium Awards for the 2 best oral best presentations (to Yuri Sinzato and Sanne van Essen), for the best poster with pitch (to Sowmya Kumar), and for the best movie (to Timo van Overveld).

HIGHLIGHTS



This highlight refers to the PhD by Martin van der Eijk (2023, cum laude)

Slamming of structures on aerated water

Martin van der Eijk and Peter Wellens
Delft University of Technology, Mechanical Engineering, Ship Hydromechanics

Background

Maritime structures in heavy seas can experience wave impact events with high loads. Impact events can be influenced by the presence of air in water through compressibility (Bredmose et al., 2009; Za et al., 2016; Plumerault et al., 2012). Compressibility leads to lower impact pressures and the generation of high-frequency load variations due to density waves. Quantification of the influence of aeration on impact pressures through numerical methods was challenging before.

A new cartesian grid method, an extension of our work (van der Eijk & Wellens, 2019, 2023, 2024) for compressible multiphase flow, is introduced to account for water, air and homogeneous mixtures of air and water. The method is designed to predict the hydrodynamic loads on moving bodies engaging with interfaces between fluids having large density ratios. An equation for conservation of energy is omitted by enforcing pressure-density relations.

New experimental data of 2D wedge impacts with aerated water, made available as open data, are presented to demonstrate the validity of the numerical method.

Method

Computing the position of the fluid-fluid and the fluid-body interfaces accurately is relevant for determining the moment of impact. A colour function $f(x,t)$ is used to capture the position of the interface. Transport of the interface is described by

$$\frac{Df}{Dt} = \frac{\partial f}{\partial t} + (\mathbf{u} \,.\, \boldsymbol{\nabla}) f = 0, \tag{1}$$

in which $f(x,t) = 0$ gives the position of the interface and $\mathbf{u}$ the interface velocity. Eq. (1) is implemented as a Volume-of-Fluid algorithm.

The positions of the interfaces lead to volume fractions. The definition of the volume fractions is given in Figure 1. Volume fraction C_b indicates the part of a volume that is open to fluid. Fraction (1−C_b) then represents the part of a volume that is occupied by a (moving) body. Volume fraction C_a indicates the part of a volume that is occupied with gas (air), where C_f gives the part of the volume occupied with liquid, either water or aerated water, a homogeneous mixture of air and water.

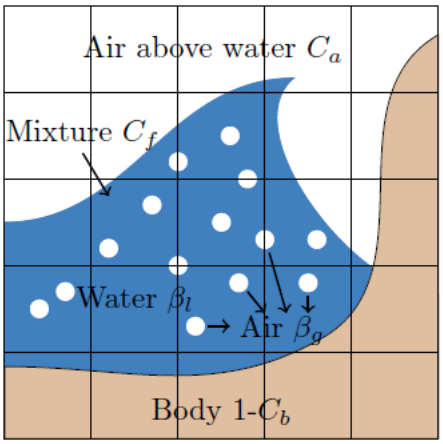


Figure 1: Illustration of the phases of matter in the solver and how they are represented discretely in the cartesian grid. Volume fraction C_f is used for representing aerated water, C_a for air above the water, β_l for the water part of the homogeneous air-water mixture, β_g for the air part. C_b gives the part of a volume not occupied by the body and open to fluid.

Following Plumerault et al. (2012), additional volume fraction fields are introduced to indicate the part by volume of the homogeneous mixture that is gas, β_g, and the part that is water, β_l. These volume fractions are necessary for the formulation of the mathematical model. The governing equations are formulated for a multiphase flow of immiscible Newtonian fluids. An equation for the conservation of mass, using a single velocity field $\mathbf{u}$, is formulated for each phase

$$\frac{\partial \alpha_k \rho_k}{\partial t} + \boldsymbol{\nabla} . (\alpha_k \rho_k \, \mathbf{u}) = 0, \quad k = a, l, g \tag{2}$$

in which subscript a stands for air above water, l for the liquid part of the phase with aerated water, and g for the air part of the aerated water phase. Fractions α_k are defined as

$$\alpha_a = \frac{C_a}{C_b}, \quad \alpha_l = \frac{\beta_l C_f}{C_b}, \quad \alpha_g = \frac{\beta_g C_f}{C_b} \tag{3}$$

Using ρ as the density of the aggregate fluid, the equations for the conservation of momentum read

$$\frac{\partial \rho \mathbf{u}}{\partial t} + \boldsymbol{\nabla} . (\rho \mathbf{u} \otimes \mathbf{u}) + \boldsymbol{\nabla} p + \rho \mathbf{g} = 0. \tag{4}$$

Here, p is the pressure in the aggregate fluid and $\mathbf{g}$ the vector of the acceleration of gravity. Note that the viscous term has been omitted from the momentum equation as mainly short-duration events will be considered, in which viscous effects such as the formation of boundary layers can be ignored.

The governing equations require closure that for reasons of efficiency is not obtained through solving an energy relation, but by means of a formulation for the speed of sound of the mixture. For the air-water mixture we define a mixture density (ρ_f) as follows

$$\rho_f = (1 - \beta_g)\rho_l + \beta_g \rho_a, \qquad \rho = \frac{C_f}{C_b}\rho_f + \frac{C_b - C_f}{C_b}\rho_a. \tag{5}$$

According to the equation of Wood (1941), rewritten by making use of the volume fractions of the different phases, the speed of sound formulation for homogeneous mixtures becomes

$$\frac{1}{\rho c^2} = \frac{\frac{c_{b-}\, c_f}{c_b}}{\rho_a c_a^2} + \frac{\frac{c_f}{c_b}}{\rho_f c_f^2} \tag{6}$$

This mixture speed of sound c_f (Wood, 1941) is illustrated in Figure 2; it shows a large decrease in speed of sound for a small fraction of β_g, even up to values lower than the speed of sound of air c_a and water c_l at atmospheric conditions. The low speed of sound explains the relevance of compressibility (Mach number) for aerated impacts.

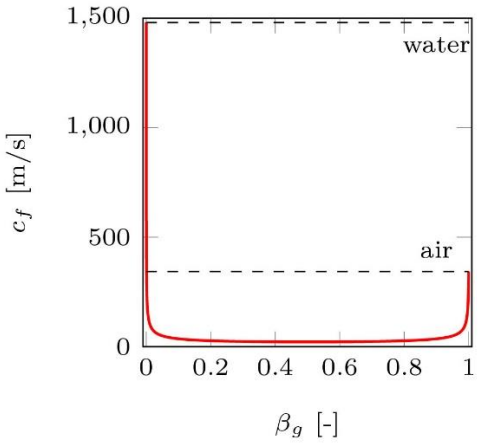


Figure 2: Woods' formulation in Eq. (6) for mixture sound of speed c_f Plotted for air volume fraction β_g assuming C_f = 1.

Results

The test case with a shock bubble is performed to investigate how density waves change direction and how they are transmitted between fluids in simulations with a compressible multiphase method. Helium shock-bubble experiments were performed by Haas and Sturtevant (1987) and the results serve as a benchmark.

The simulation setup for the 2D helium shock bubble case is illustrated in Figure 3. Air, initially, is in two states on either side of the domain. A cylindrical helium bubble is placed in the air at one of these states, approximately in the middle of the domain. The domain boundaries are closed with atmospheric pressure prescribed on the left horizontal end of the domain.

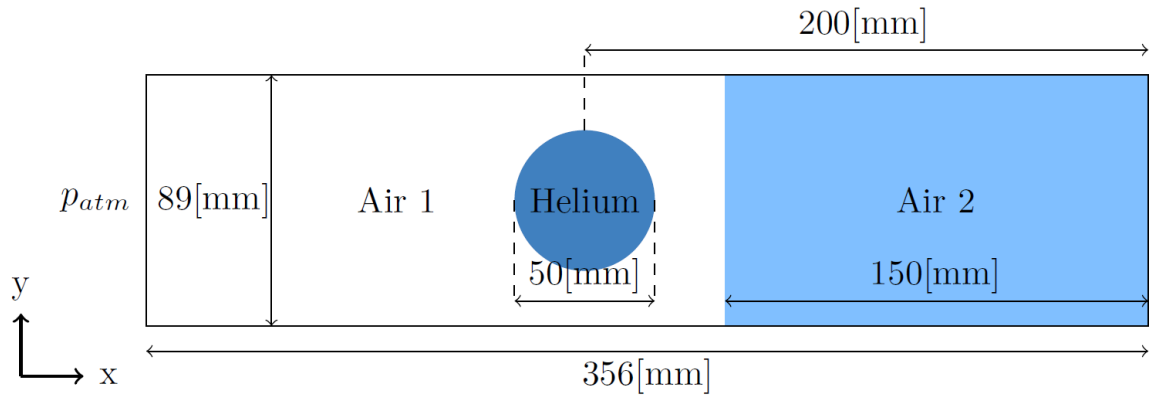
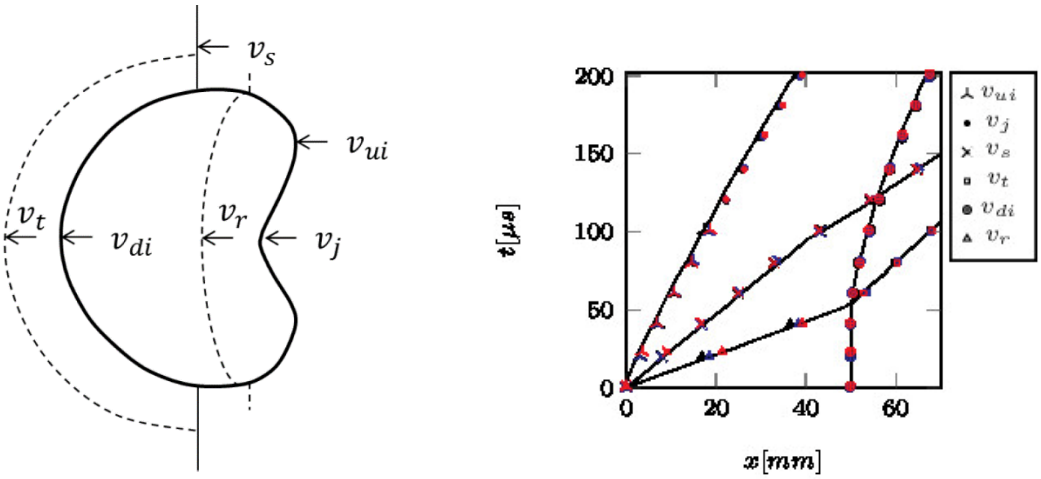


Figure 3: Shock bubble: simulation setup with air at two states of pressure, and helium bubble in the air at one of these states.

Quirk and Karni (1996) conducted a detailed numerical study of the helium shock bubble. Kreeft and Koren (2010) also simulated the shock bubble, but with different fluid properties using a density-based model solving Kapila's five-equation model for inviscid, non-heat-conducting, compressible two-fluid flows.

In our simulations, the front of the density wave before interacting with the helium bubble at t =0 [s], is smeared out over ten grid cells. We chose the position in the middle of these 10 cells as the position of the density wave front to compare with the results from literature. The results of the simulations are given in terms of the positions and the velocities of the interfaces and the density wave fronts. The definition of all interfaces and shock fronts is given in Figure 4a. Interfaces and shock fronts are identified by their velocities v. Figure 4b features a space-time plot of the interfaces, in which the results of the numerical method at three grid resolutions is compared with the results of Quirk and Karni [6]. The positions of the interfaces over time are in good agreement with Quirk and Karni (1996).



(a) Definition of interfaces and density wave fronts. *(b) Space-time plot of interface positions.*

Figure 4. Shock bubble: definition of interfaces and density wave fronts together with a space time plot of the position of the interfaces and wave fronts. Numerical results (markers) at three grid resolutions: 400x50 (black symbols), 800x100 (blue symbols) and 1200x150 (red symbols), compared with Quirk and Karni (1996) (solid lines).

Experiments for impacts with aeration are rare. Trying to avoid the effect of cavitation, encountered by Ma et al. (2016), because our numerical method would not be able to deal with it, we chose to conduct an experiment with falling wedges.

The setup of the experiment consists of three parts: a box containing aerated water, a fall tower and a wedge attached to a guiding mechanism within the fall tower. The fall height from the tip of the wedge to the initial free surface of the water is at most 2.83 [m] so that, with friction, a maximum impact speed V_i up to 7.0 [m/s] can be achieved. The box and wedge are illustrated in Figure 5, in which α is the deadrise angle.

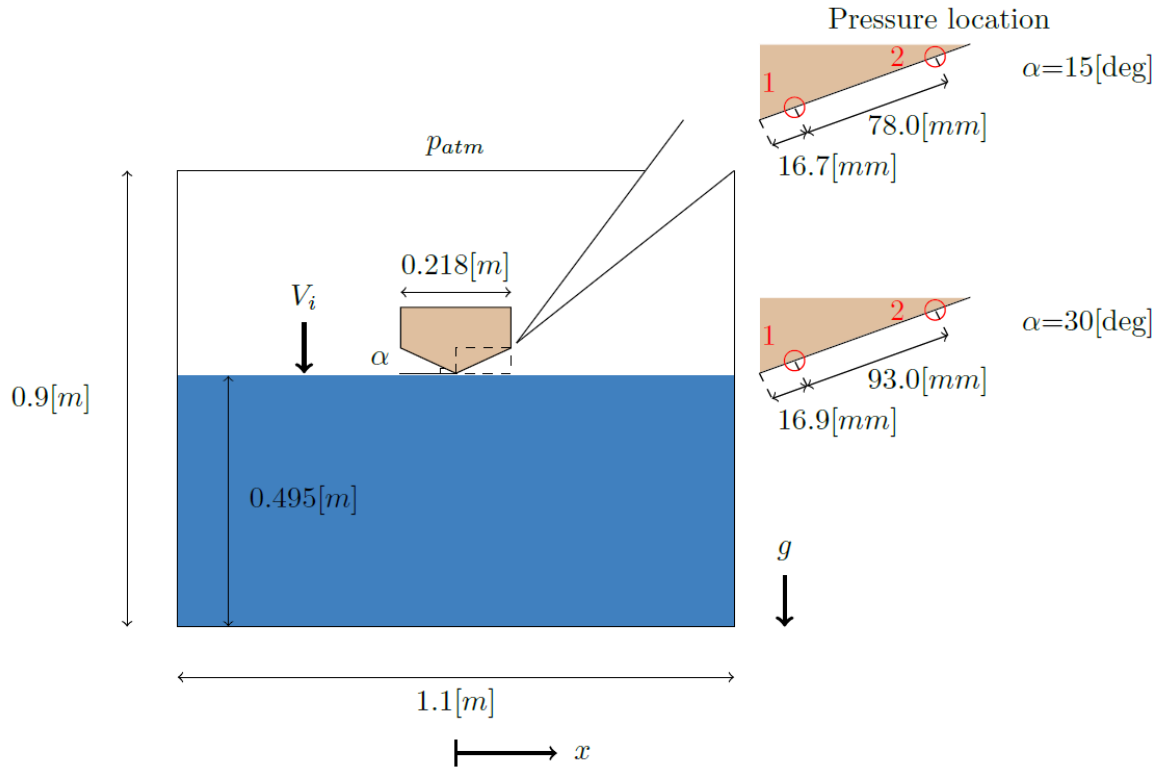
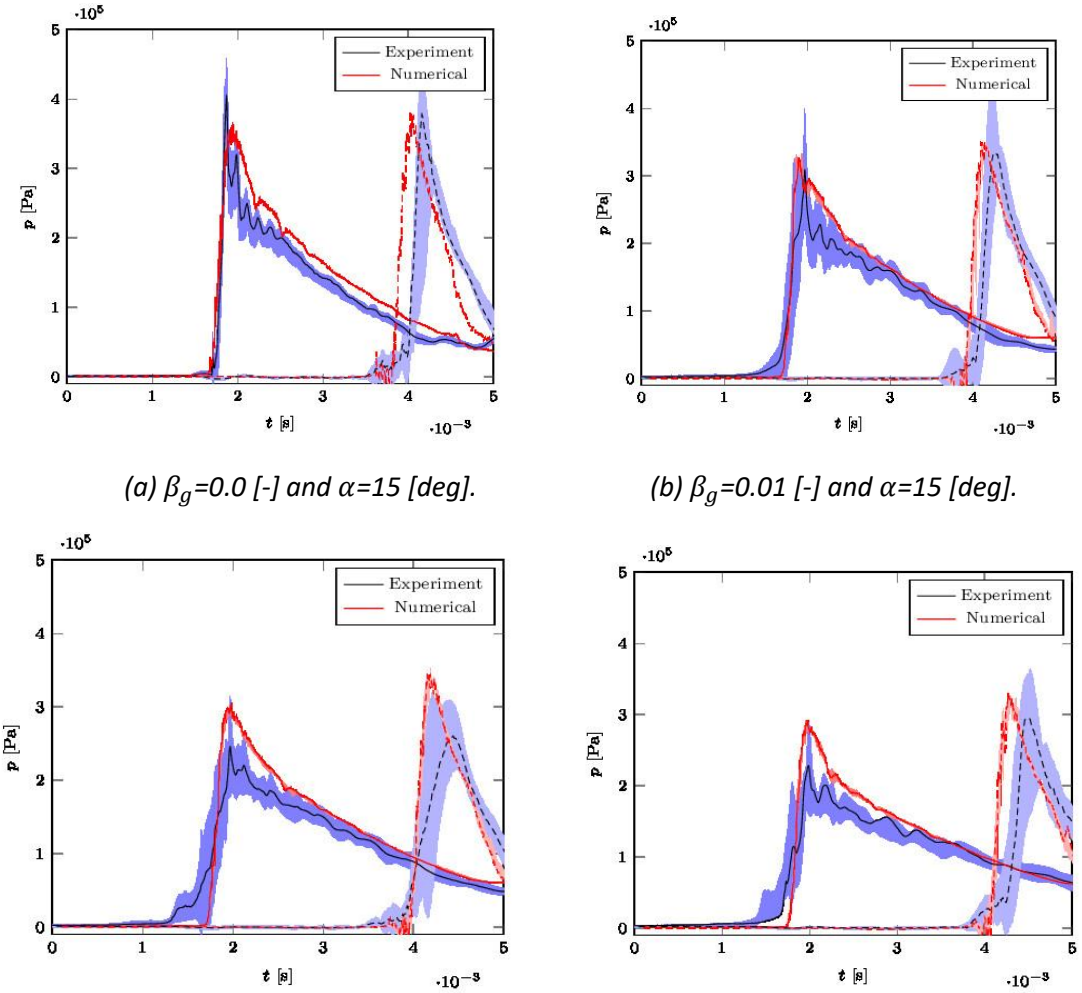


Figure 5: Setup of wedge impact experiment with aerated water. Dimensions of the experiment are also the dimensions of the numerical domain.

Two wedges are used, each with a mass of 31.78 [kg/m], having different deadrise angles (α). One has a deadrise angle of 15 [deg]; the other with 30 [deg] deadrise angle is not discussed further. Pressure sensors were used at two different locations along the bottom of the wedge to measure the impact.

Air bubbles in water are created at the bottom of the box. The experiment is conducted for four aeration levels (β_g = 0.0, 0.01, 0.02, 0.04 [-]). Figure 6 shows the pressures obtained from the numerical simulations with grid 109x29 together with the pressures obtained from the tests in the experiment. The atmospheric pressure was subtracted from all results. Solid blue lines are for pressure sensor 1 and dashed blue lines are for pressure sensor 2. The blue lines for the pressure from the experiment are the average of ten signals. A band is formed along the lines representing one standard deviation above and below the average. Red lines in Figure 6 represent the pressures from the simulations, solid lines for pressure sensor 1 and dashed lines for pressure sensor 2. The lines are the

average pressures obtained from two simulations- at each aeration level β_g with the minimum and maximum value measured at that level on either side of the wedge.



(a) β_g=0.0 [-] and α=15 [deg].

(b) β_g=0.01 [-] and α=15 [deg].

c) β_g=0.02 [-] and α=15 [deg].

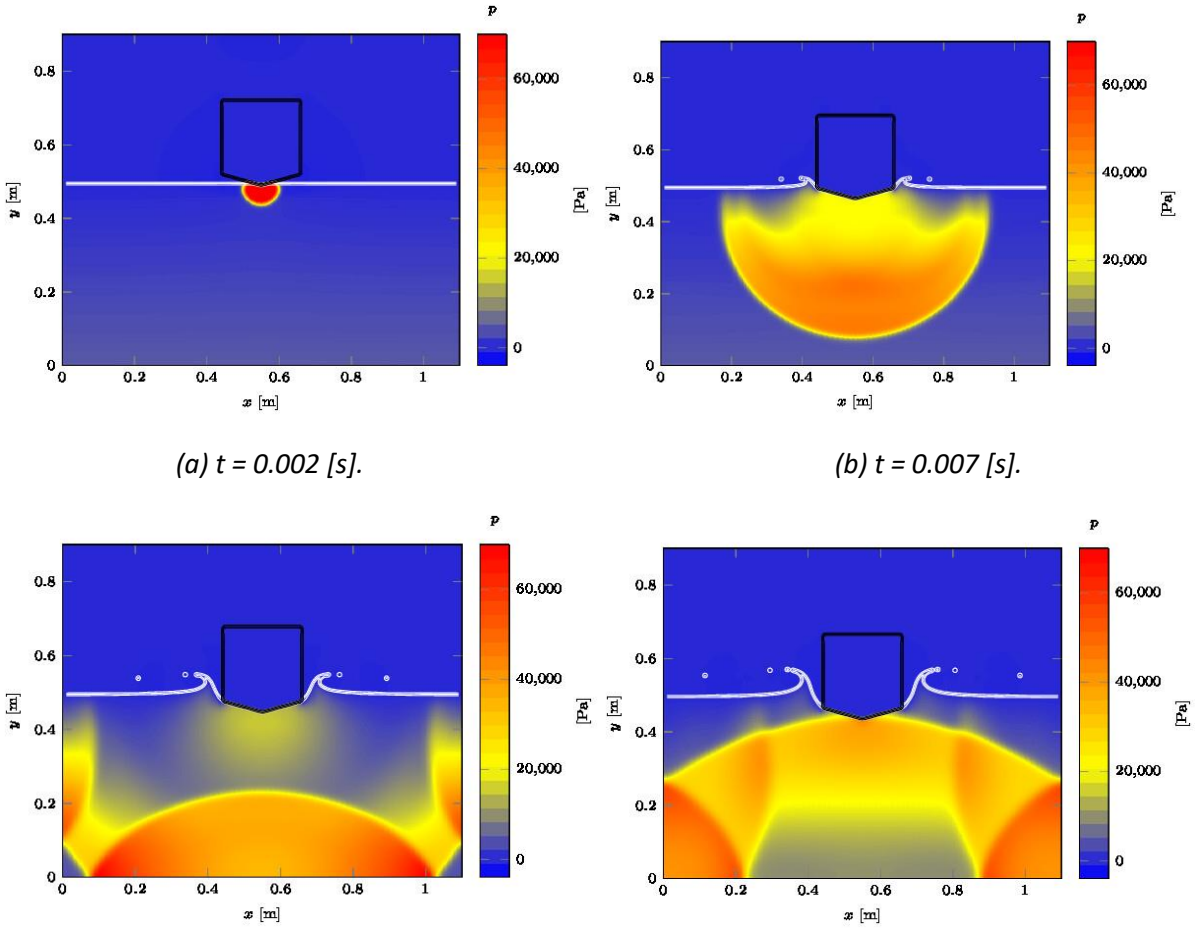
(d) β_g=0.04 [-] and α=15 [deg].

Figure 6. Impact pressures: simulation results (red) with experimental results (blue) for two pressure positions. Pressure sensor 1 is represented by solid lines (__). Pressure sensor 2 is represented by dashed lines (- - -). Band for the experiments composed of one standard deviation below and one above average pressure. Grid 109×29 was used for the simulations. Simulated pressures are the average of two simulations with the minimum and maximum value for aeration at that level. Band around numerical results formed by minimum and maximum. Uncertainty of grid convergence not included in graphs.

The simulated pressures show good agreement with the measured pressures for all aeration levels. The lower aeration levels are represented better than the higher aeration levels; this is thought to be caused by inhomogeneity of the air-water mixture at higher air content, and 3D interaction effects of air bubbles.

The wedge impacting with the aerated water generates density waves due to the compressibility of the air-water mixture. The density waves reflect off of domain boundaries and propagate back to the

wedge. The back-and-forth propagation of the density waves causes high-frequency pressure oscillations on the wedge. A time sequence of the simulated pressure after impact for the wedge with α = 15 [deg] and for aerated water with β_g = 0.04 [-] is shown in Figure 7. The density waves become apparent by their front, which shows as a barrier between regions with higher and lower pressure that propagates through the domain.



(a) t = 0.002 [s].

(b) t = 0.007 [s].

(c) t = 0.011 [s].

(d) t = 0.014 [s].

Figure 7. Time sequence of simulated pressure fields for wedge impact α = 15 [deg] and β_g = 0.04 [-] at different time instances. From the sequence it becomes apparent that density waves are formed that propagate through the domain.

Conclusion and future outlook

A new compressible pressure-based multiphase model is presented for modeling the interaction of homogeneous aerated water with moving bodies. The formulation was designed with efficiency in mind: it solves a system of equations that is no larger than the number of cells in the domain and it does not require iteration within a time step. The model can deal with high-density ratio compressible flows using a non-conservative formulation for transport of the interface together with a new formulation for the speed of sound in multiphase mixtures.

The numerical results are in good agreement with solutions for traditional compressible multiphase flow cases, such as a cylindrical helium shock bubble. The test cases demonstrate the method's ability to handle contact discontinuities and rarefactions. The pressure levels in propagating density waves were predicted well, but the discontinuity between pressure levels was diffused over a couple of grid cells.

A 2D experimental setup for wedge impacts with water was converted specifically for this study to validate the numerical method for the interaction between aerated water and moving bodies in terms of the impact pressure. A level of 1% aeration by volume reduces the impact pressure by 14%. The numerical and experimental results are in good agreement for lower aeration levels, both showing a similar maximum pressure and development of the pressure over time. The differences at higher aeration levels are larger. We believe this to be due to three dimensional effects of the bubbles in the mixture in the experiment at higher aeration levels. These are not yet accounted for by the numerical method.

Future work will focus on representing the effects at higher aeration levels, both by means of numerical method development and new experiments to measure the distribution of gas bubbles in water.

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This highlight refers to the PhD Thesis by Timo van Overveld (2023, Cum laude)

Spherical particles in oscillating flows

From a single particle to pattern dynamics

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Background

Granular systems are widely present in nature and often exhibit self-organization into patterns. The understanding of these patterns is also essential for many industrial processes, such as the separation of mixtures with multiple granular components. Additionally, a rich range of pattern-forming phenomena can be attributed to the interactions between the grains and the fluid in which they are immersed. Such fluid-immersed patterns are relevant in systems containing colloids, magnetic particles, active matter, or sediment.

One example is the self-organization of spherical particles submerged in a fluid and subjected to horizontal oscillations. When two spherical particles are in each other's vicinity, they align themselves perpendicular to the direction of the flow. This phenomenon is the basis of complex patterns in denser systems, such as one-particle-thick chains oriented perpendicular to the oscillation direction with a regular spacing between them, as shown in Figure 1. The formation of these structures is driven by the nonzero residual flow that remains when averaging over a full oscillation period. This residual flow, known as *steady streaming*, is a nonlinear effect that emerges at intermediate values of the particle Reynolds number, when both viscous and inertial effects govern the system. Our research aims to improve the understanding of the behaviour of spherical particles in oscillating flows, from the fundamental dynamics at the particle level to pattern characteristics in many-particle systems.

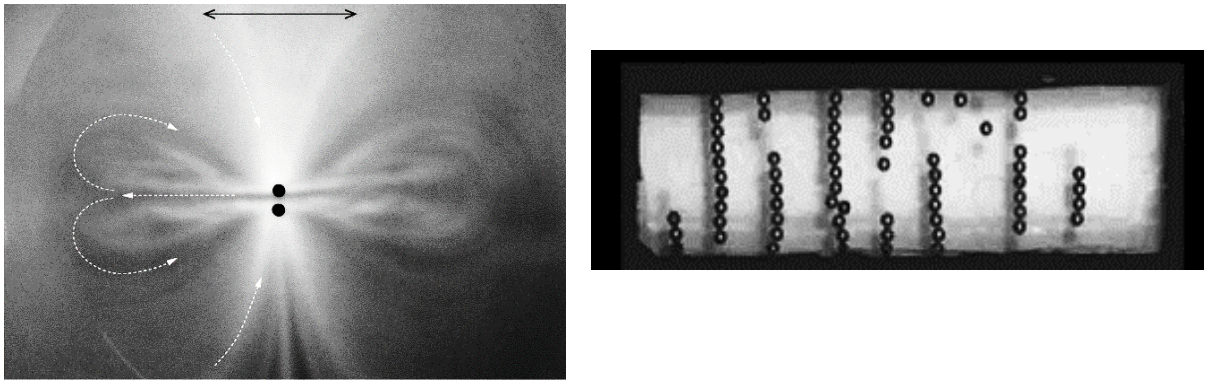

Figure 1. (Left) Two dense spherical particles in an oscillating flow form a stable pair aligned perpendicular to the oscillation direction (Klotsa et al., 2007). (Right) When more particles are present, one-particle-thick chains form, with a regular spacing between them (Klotsa et al., 2009).

Dynamics of a single particle

First, we consider the results of the motion of a single spherical particle in an oscillating flow. The analytical solutions of the Basset-Boussinesq-Oseen equation are derived to describe the particle motion over a smooth wall. The particle motion parallel to the oscillatory forcing is characterized by a single dimensionless quantity: A_r/D, which is the relative particle excursion length with respect to the ambient flow, normalized by the particle diameter. This quantity is directly proportional to the normalized excursion length of the flow, A/D, and further depends on the particle-fluid density ratio $s = \rho_s/\rho_f$ and the viscous length scale normalized by the particle diameter $\delta/D = \sqrt{(2\nu/\omega)}/D$.

Particle pair dynamics

In a next step, we study the dynamics of a pair of spheres in an oscillating box filled with viscous fluid using direct numerical simulations (DNS) of a fully resolved flow, where the particles are modeled using an immersed boundary method (Breugem, 2012) (IBM). Due to the steady streaming flow, the particles align perpendicular to the oscillation direction, moving in elongated *figure-8*-shaped trajectories, with a gap between them, as shown in Figure 2. The pairs and steady streaming flow around them are characterized by two regimes, where either viscous or advective effects dominate. For $A_r/D \leq 1$, the mean particle separation only depends on δ/D, which controls the viscous dissipation of the vorticity within the steady streaming flow. For larger A_r/D values, the mean particle separation increases with A_r/D, which determines the production of vorticity close to the particles and the advection of vorticity away from them. The two regimes are also found in the magnitude of the oscillations of the gap perpendicular to the flow, which increases in the viscous regime and decreases in the advective regime.

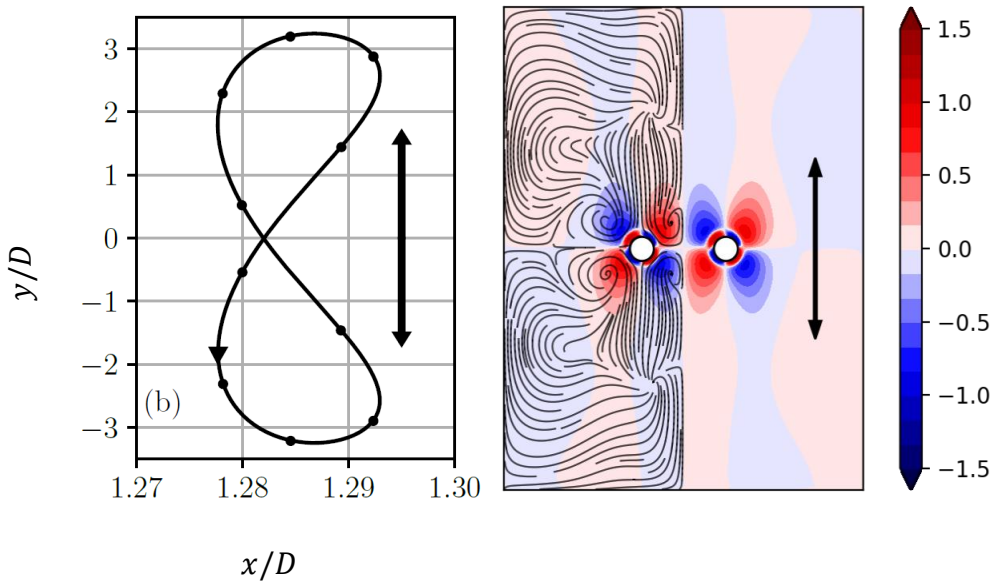

Figure 2. (Left) 'Figure-8-shaped' trajectory of one particle that is part of a stable pair. (Right) The period-averaged out-of-plane vorticity in the horizontal plane through a particle pair, with superimposed streamlines (black curves) and (right), revealing two 'inner' vortices close to each particle and two 'outer' vortices. Vorticity is advected in the oscillation direction in long wakes away from the pair.

Effect of the Stokes boundary layer

Next, the particle pair dynamics in the oscillating box (with bulk fluid and bottom moving in unison) are compared to those in an oscillating channel flow (with bulk fluid moving relative to a stationary bottom). The presence of a Stokes boundary layer above the bottom in the oscillating channel flow leads to fundamental differences in the steady streaming flow, and consequently, in the particle pair dynamics, see Figure 3. The velocity shear within the Stokes boundary layer directly enhances particle rotation through hydrodynamic torque and introduces shear to the spatial structure of the steady streaming flow. Furthermore, the relative motion of the bottom introduces an additional degree of freedom, which controls the particle rotation and the distribution of the period-averaged vorticity over the horizontal plane. The two systems are only equivalent in a limited region of the parameter space. Overall, the particle dynamics in the oscillating channel flow, compared to the oscillating box, are governed by an additional dimensionless parameter, i.e., the particle-fluid density ratio s.

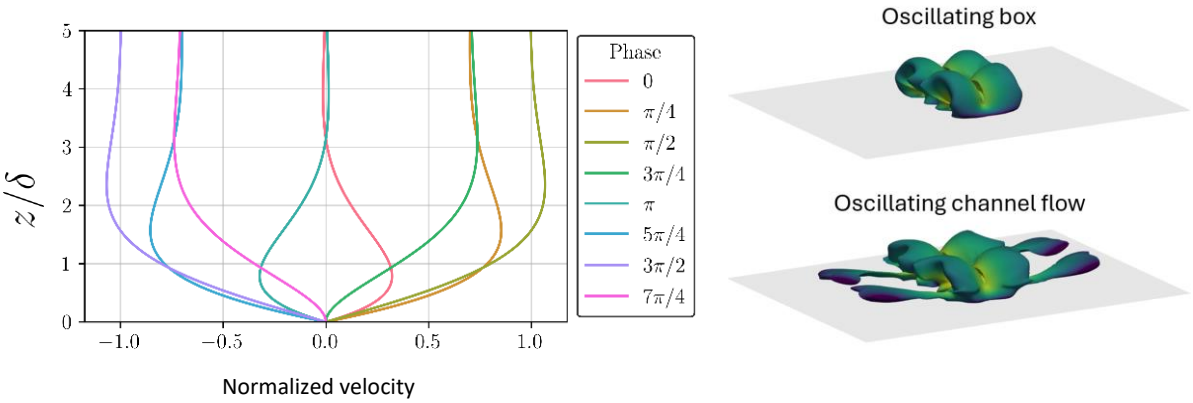

Figure 3. (Left) The Stokes boundary layer profile due to the stationary bottom with respect to the fluid, shown at different times of the oscillation period. (Right) The vortices in the steady streaming flow, visualized using the λ_2-criterion (Jeong & Hussain, 1995), are significantly affected due to the sheared velocity above the bottom in the oscillating channel flow.

Pattern formation in denser systems

The number of particles is substantially increased to study the self-organization into patterns using laboratory experiments in an oscillating box. The interactions between the particles and the steady streaming flow lead to the formation of either one-particle-thick chains or multiple-particle-wide bands, oriented perpendicular to the direction of oscillation, as shown in Figure 4. The normalized spacing between these structures is only a function of A_r/D, implying that it is an intrinsic quantity established by the hydrodynamics. Contrarily, the width of the bands depends on both A_r/D and the confinement, characterized by the particle coverage fraction ϕ. Using the relation for the chain spacing, the transition from one-particle-thick chains to wider bands is given as a function of both A_r/D and ϕ. Complementary numerical simulations show that the regular chain spacing arises from the balance between long-range attractive and short-range repulsive hydrodynamic interactions caused by the vortices in the steady streaming flow, as shown in Figure 5. These vortices induce an additional attractive interaction at very short range when $A_r/D \geq 0.7$, which stabilizes the multiple-particle-wide bands.

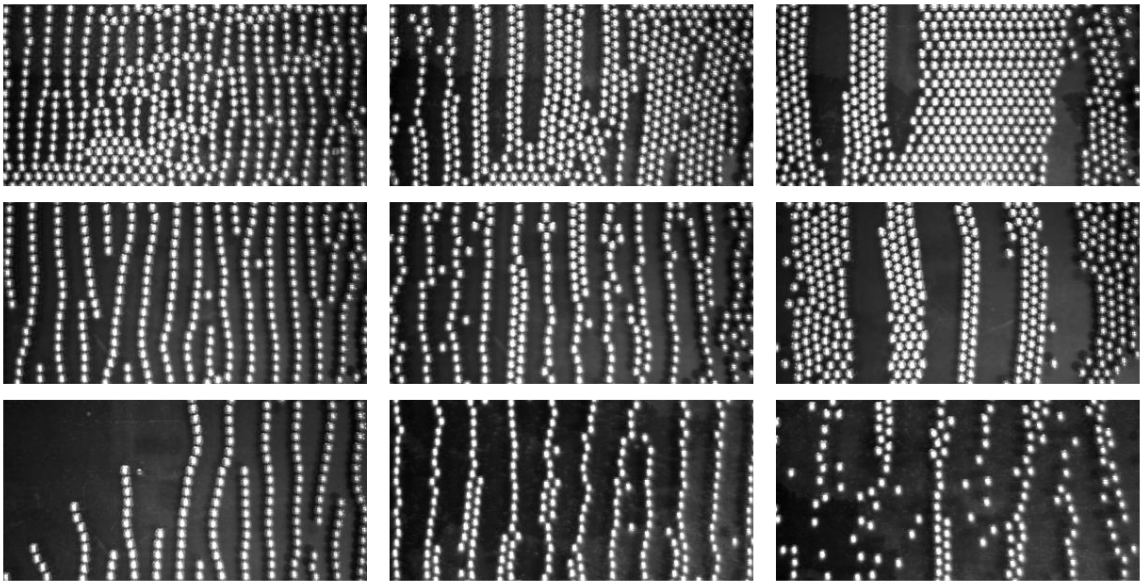

Figure 4. Different patterns are found in the experiments, ranging from one-particle-thick chains to multiple-particle-wide bands, depending on the normalized relative particle-fluid excursion length A_r/D (increasing horizontally) and the particle number density ϕ (increasing vertically).

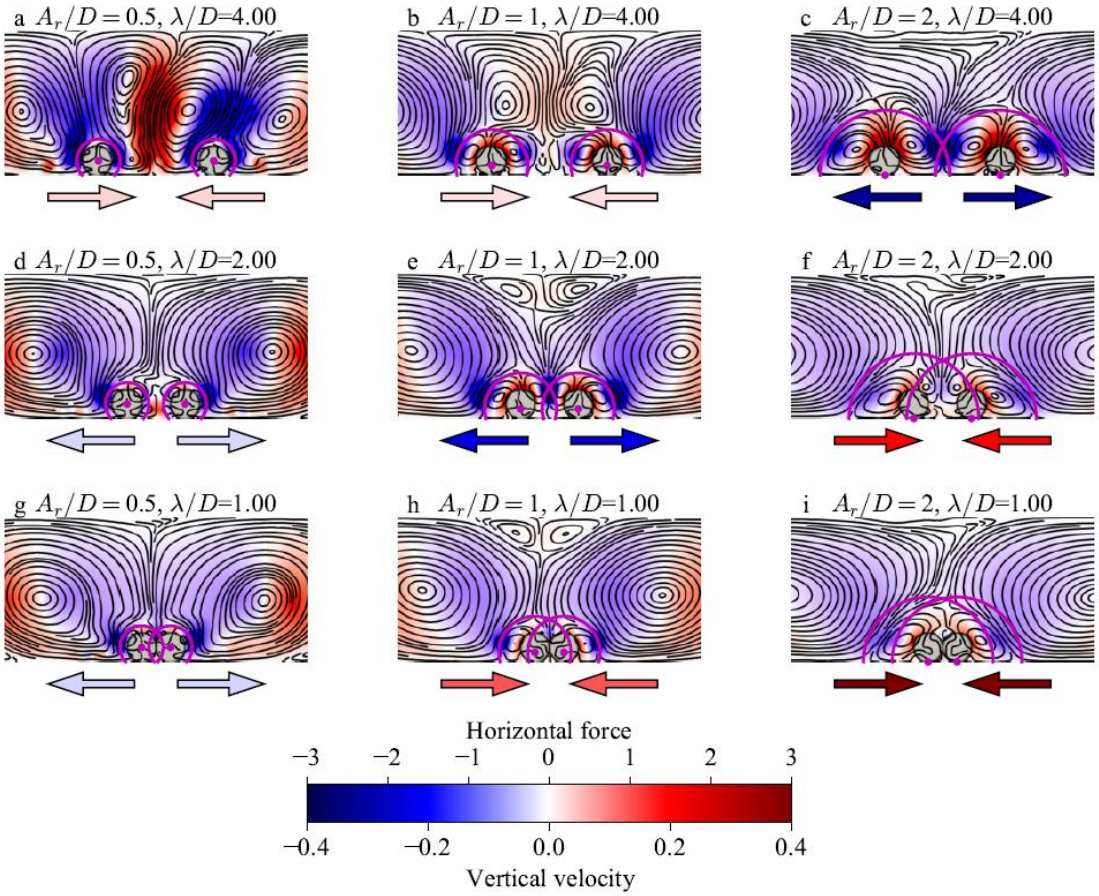

Figure 5. The side-view of the average flow field around two parallel particle chains from our numerical simulations. The chain spacing λ and the relative excursion length A_r are varied. The arrows indicate the direction and magnitude of the horizontal hydrodynamic forces on the particles.

Modeling and control of pattern characteristics

In the remaining parts of the thesis, the pattern characteristics are explored from different perspectives. Using simplified model potentials, the dynamical behaviour of the particles due to the complex hydrodynamic interactions is further clarified. The characteristic patterns observed in hydrodynamic experiments are successfully replicated using Monte Carlo simulations. Additional experiments show that the patterns can be controlled through boundary shape effects, e.g., by using serrated sidewalls. These results underscore the potential for pattern control within hydrodynamic systems, not only by changing the hydrodynamic interactions driving the self-organization but also by changing the properties of the confinement.

All in all, our research offers a comprehensive overview of the behaviour of spherical particles in oscillating flows, ranging from fundamental dynamics at the particle level to pattern characteristics in dense systems.

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This highlight refers to the PhD Thesis by Rui Yang (2023, cum laude)

Turbulent flows with phase changes

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Phase-change transitions are well-established phenomena in the scientific community, representing the transformation of matter between its various states: solid, liquid, gaseous, and plasma. Melting, the process of changing matter from a solid to a liquid state, and solidification, the reverse process, are familiar examples. Consider, for instance, making ice cubes from water (solidification) or converting ice cubes back to water (melting). Similarly, matter can transition from its liquid state to the gaseous state, known as evaporation, and the reverse process is termed condensation. Daily examples of evaporation include the boiling of water, leading to water vapour, and the aerosol droplets generated from coughing and sneezing, while condensation occurs when water vapour forms water droplets on a mirror after a hot bath. The study focuses on two classes of phase-change transitions: melting and freezing (Part I) and evaporation and condensation (Part II). These transitions have diverse applications, ranging from industrial to environmental scenarios. Throughout the study, we emphasize the interaction between phase-change and turbulent flows, and how this interaction influences the overall phase-change process.

Part I. Melting and Freezing (Ice melting)

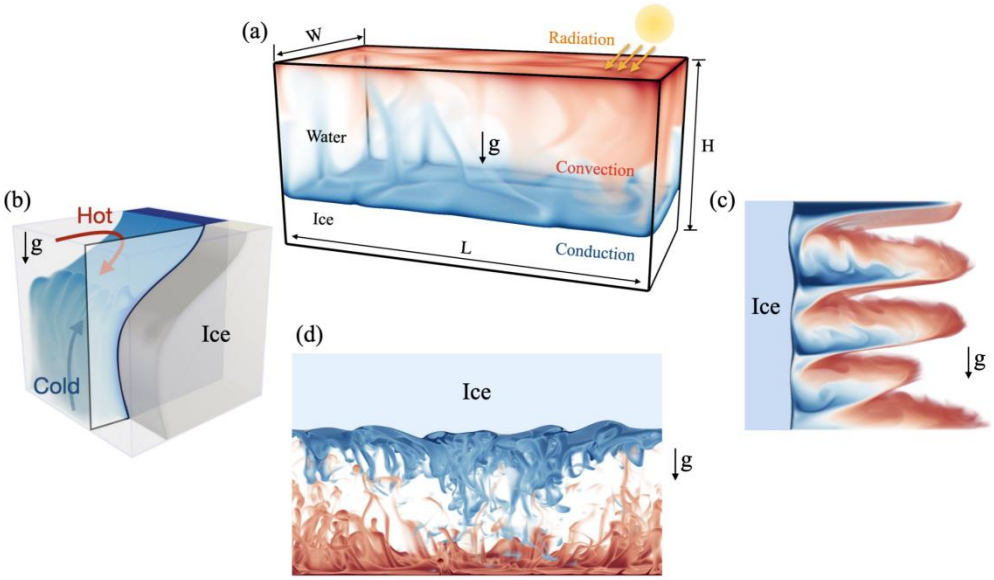

Figure 1: Summary of the melting geometries we studied in our numerical melting studies: (a) Melt pond dynamics under solar radiation (Yang et al. 2023b); (b) Sidewall melting in fresh water (Yang et al., 2022a); (c) Sidewall melting in saline water (Yang et al. 2023a); (d) Basal melting under turbulent thermal convection (Yang et al., 2023c).

The quantitative understanding of glacial ice melting into the ocean is one of the most outstanding challenges in environmental fluid dynamics. The lack of knowledge is on a fundamental level, due to the highly complex multi-scale, multi-physics nature of the problem. The process involves intricate multi-way coupling effects including thermal convection, salinity, ocean current, and radiation, etc. As ice melts into the surrounding salty water, a decrease in local salt concentration leads to reduced water density, inducing upward buoyant forces and consequently upward flow. This flow dynamically interacts with the ice, resulting in a feedback loop of further melting (Stefan problem).

Our investigation employs direct numerical simulations with the phase field method. To capture the intricacies of melting dynamics within turbulent flows, we implement a multiple-resolution strategy for salinity and phase field simulations 0. The versatility of our method is demonstrated through successful applications to diverse melting scenarios, including the formation of melt ponds 0, melting in Rayleigh-Bénard (RB) convection (Yang et al., 2023c), vertical convection with fresh water (Yang et al., 2022a), and vertical convection with salty water 0. We showcase results obtained across these various geometries, see Figure 1. This work contributes to advancing our understanding of the complex dynamics involved in glacial ice melting within oceanic environments.

More specifically, we examined basal melting through heating from below (RB convection) and observed the emergence of topographical structures evolving from initially smooth surfaces due to the underlying convective flow. We further quantified the roughness scaling with the strength of the thermal driving and determined the horizontal length scale using theoretical upper and lower bounds. Our proposed theory successfully predicts the trends in numerical results (Yang et al., 2023c). Moving forward, we delved into the temperature oscillation effect on heat transfer and melt rate in RB convection, which relates to diurnal and seasonal cycles in natural systems. Our findings indicated a significant enhancement in heat transfer depending on the frequency due to boundary layer perturbations caused by modulation. We further proposed frequency-dependent Stokes thermal boundary. Based on its interplay with the thermal and velocity boundary layer in RB convection, we derived theoretical scalings for the onset and optimal frequency for heat transfer enhancement (Yang et al., 2020). Continuing our exploration, we investigated surface melting by solar radiative heating from above and analyzed the evolution of melt ponds. This study revealed the bistability of melt pond formation, which means under the same parameters, the melt pond can either form or disappear, depending on the initial condition. This bistability was explained through the balance of interface heat flux (Yang et al., 2023b). Additionally, we focused on ice sidewall melting in freshwater (Yang et al., 2022a) and saline water 0. In freshwater, we observed an abrupt increase in the melt rate with rising ambient temperature, attributed to changes in flow structure due to the density anomaly effect in freshwater. In saline water, we studied the evolution of the layered structure of melting ice, which is quantitatively consistent to the previous experiments. We further observed a non-monotonic dependence of the melt rate on salinity, understanding it as a result of the competition among salinity-driven buoyancy, temperature-driven buoyancy, and salinity-induced stratification.

Part II. Evaporation and Condensation (Respiratory droplet spreading)

This part primarily focuses on the evaporation and condensation processes concerning respiratory droplets, particularly in scenarios like coughing flows with microdroplets and indoor ventilation, which significantly contributes to the spread of infectious diseases. Understanding the interaction between

droplets and ambient turbulent flows is essential in this context. Droplets or particles suspended in the air can act as carriers for respiratory viruses, making it scientifically vital to study their motion and evaporation processes to comprehend virus transmission. The dispersion of droplets/particles in the air is a complex multiphase and multiscale fluid dynamics problem, influenced by various factors, including environmental flow, human movements, convective heat generated by the human body, and the jets produced during coughing and sneezing.

We employ direct numerical simulations to investigate a turbulent respiratory event and study the evolution of microdroplets in turbulent flow using the point particle approach. Numerical simulations offer real-time tracking of droplets or particles and provide detailed physical parameters, offering a more effective way to understand their dispersion compared to experimental measurements. The effects of ambient temperature and RH are investigated (Chong et al, 2020; Ng et al., 2021), which can be applied for large-scale parameterizations. Additionally, we utilize DNS, fully coupled with temperature, CO_2, and water vapour concentration fields, to examine indoor mechanical displacement ventilation across a wide range of ventilation rates and its impact on CO_2 removal and air quality, as well as its interaction with the flow pattern (Yang et al., 2022b).

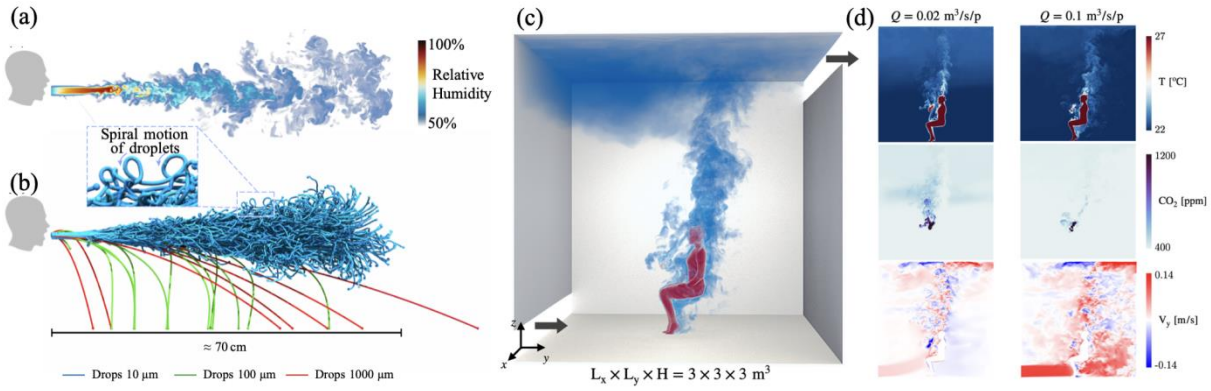

Figure 2: (a) Contour snapshot and (b) droplet trajectories of the droplet-laden cough simulation. (c) Illustration of the simulation setup with the body plume, breathing flow, and arrows indicates the inlet and outlet flows and (d) Temperature, CO_2 field and horizontal velocity of ventilated flows for different flow rates.

Firstly, we delved into the dynamics of microdroplet evaporation in a coughing flow, including quantifying the lifetime of the droplets in the turbulent and humid coughing puff (Chong et al., 2020) and analyzing the impact of ambient temperature and humidity on the droplet lifetime (Ng et al, 2021). We made a significant discovery that small droplets (with an initial diameter of 10 μm) are entrained by turbulent eddies in the expelled humid puff, see Figure 2(a-b), resulting in an extension of their lifetime by a factor of more than 30 compared to scenarios without the puff. We further conducted a detailed investigation of various ambient temperature and humidity conditions, and proposed a model for the axial relative humidity (RH) based on the assumption of a quasistationary jet, which accurately predicted super-saturated RH conditions in our simulations. Shifting our focus to a larger scale, we explored the effect of indoor displacement ventilation rate Q on the clean zone height h with a human present, sitting, and breathing inside the room, see Figure 2(c-d). We found that for weak ventilation, the interface height follows a scaling relation $h \sim Q^{3/5}$. However, for excessively strong ventilation, the interface height h becomes insensitive to Q. In summary, our study provided valuable insights into the evaporation and condensation processes in different pandemic-

related scenarios, contributing to a better understanding of the dynamics of microdroplets and the impact of ventilation rates on clean zone heights (Yang et al. 2022b).

Conclusion

The study has demonstrated that multiphase flow, with multiple components and phase transitions, is extremely rich, with a huge phase space and many, often counterintuitive phenomena. These flows are of utmost relevance in nature & technology, and our analysis only scratches on this field, or speak in the language of our research field, is only the tip of an iceberg. Many new phenomena remain be discovered and explained, and we expect a boost of activity on this subject in the upcoming decade.

Acknowledgement

This work was part of the ERC Advanced Grant under project "MultiMelt" with No. 101094492 and also the German Science Foundation DFG through the Priority Programme SPP 1881 "Turbulent Superstructures".

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This highlight refers to the PhD Thesis by Fernanda Leticia dos Santos (2023, Cum Laude)

Broadband flow-induced noise for airfoils: inflow turbulence distortion effect on leading-edge noise generation and prediction

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Background

Many marine animals have developed an excellent sensory perception of sound, strongly relying on acoustic communication to navigate, locate prey, avoid predators, and reproduce. Unwanted sound, i.e., noise, dramatically affects these animals. The propeller of marine vessels significantly contributes to underwater noise. When propeller cavitation occurs, cavitation noise is the dominant noise source; thus, avoiding cavitation inception is important, as reflected in the guidelines of the International Maritime Organization. In addition, cavitation must be avoided due to strict noise requirements for certain vessels, such as fishery research ships, oceanography research ships, and naval vessels. In the PhD thesis, noise sources for noncavitating propellers, specifically flow-induced broadband noise sources, are studied.

The primary sources of broadband noise for a propeller blade section are leading- and trailing-edge noise. Leading-edge (LE) noise is generated by the impingement of the hull wake in the propeller LE. This noise is usually dominant in the low- and mid-frequency ranges, whereas trailing edge noise is dominant for high frequencies. Low-frequency sound waves are of great interest for marine applications because the noise generated by vessels is dominant in this frequency range and these waves propagate for long distances due to the high speed of sound in water and the low dissipation. Therefore, LE noise is one of the most relevant broadband sources for noncavitating marine vessels. Accurate LE noise prediction is paramount to designing silent propellers. One of the most used prediction methods is Amiet's theory. This theory neglects the blade section geometrical effect on the near-field and radiated noise. This results in inaccurate noise predictions for foils in the mid- and high-frequency ranges. This inaccuracy is attributed to the distortion of the turbulent inflow as it approaches the foil LE. Hence, to improve LE noise prediction, the turbulence distortion phenomenon should be understood and quantified so that it can be accounted for in Amiet's LE noise prediction model. This project aims to investigate the turbulence distortion phenomenon with the objective of enhancing LE noise predictions.

Trailing-edge (TE) noise is generated by the interaction of the TE region of the blade with the boundary layer and the near wake flow and strongly depends on the boundary layer at the foil TE. In scaled tests, tripping devices are installed on the model surface to hasten the laminar-turbulent transition due to the relatively low Reynolds numbers in these tests. As these devices affect the boundary layer development and, thereby, the source of TE noise, a better understanding of the influence of tripping devices on the TE noise source and radiated noise is needed.

Method

Experiments were performed in the Aeroacoustic Wind Tunnel at the University of Twente, where a turbulent inflow was generated by a grid and a rod, and it interacted with different airfoil geometries, named NACA 0008 (N08), NACA 0012 (N12), NACA 0018 (N18), and NACA 63018 (N63018). The turbulence distortion phenomenon was investigated based on hot-wire anemometry measurements performed at the stagnation line of the airfoils and on wall-pressure fluctuation (WPF) measurements at the surface of the airfoils. The noise generated by the interaction of the turbulent inflow with the airfoils was measured by a microphone array located in the far field. Based on the hot-wire and WPF measurements, it was possible to analyze the turbulent inflow behavior near the airfoil LE, which is the noise source for the LE noise, giving insights into the physics of how the turbulence distorts (changes) in the near field, i.e., near the airfoil surface. The far-field noise measurements were used to investigate the noise generated by different airfoils when submitted to the same turbulent inflow, giving insights into the effect of the turbulence distortion on the far-field radiated noise. These measurements also allowed us to analyze the capability of Amiet's LE noise prediction method to estimate this noise source. Furthermore, numerical simulations were performed and validated with the experimental results, which resulted in new insights regarding the distortion of the turbulent inflow.

Boundary layer measurements using hot-wire anemometry, WPF measurements, and radiated far-field noise were also performed for a NACA 0012 airfoil subjected to a non-turbulent, uniform inflow. These measurements were conducted using different tripping devices to trigger an earlier boundary layer transition. Two tripping device geometries were tested: a zigzag strip and grits distributed randomly along the span.

Results

Based on the experimental results, we observed that the turbulence distortion affects the near field of the LE noise, i.e., the turbulent inflow near the LE (see Figure 1), the spanwise correlation length, and the WPFs in the LE region, consequently also impacting the far-field radiated LE noise (see Figure 2). Lower LE noise levels are observed for mid and high frequencies at most directivity angles for thicker airfoils.

Empirical formulations were proposed to model the integral length scale and the streamwise velocity fluctuations at the stagnation line of an airfoil as a function of the relevant airfoil geometrical parameter for the turbulence distortion, i.e., airfoil maximum thickness. These formulations are essential because more accurate LE noise predictions are obtained when the turbulence parameters used as input to Amiet's model are extracted near the airfoil LE, as shown in this research. Furthermore, the turbulence spectrum near the LE has a high-frequency decay different from the prediction of the rapid distortion theory (RDT). Based on the experiments, a new formulation is developed for the turbulence spectrum. A much better agreement between experimental and predicted LE noise is observed when this new turbulence spectrum formulation is used with as input the turbulence parameters obtained near the airfoil LE (see Figure 3). This leads to a new approach to account for turbulence distortion in Amiet's LE noise model.

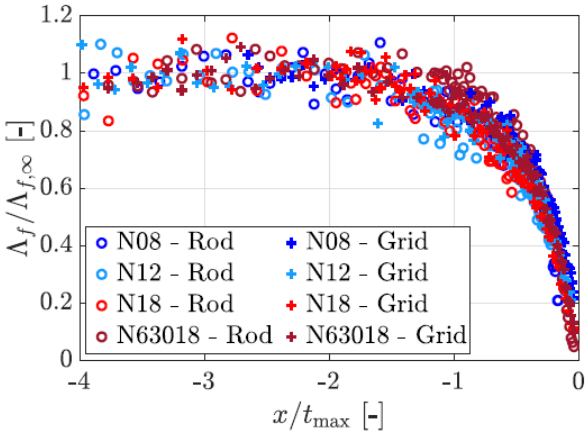

Figure 1: Integral length scale (Λ_f) of the turbulent inflow normalized by its free-stream value ($\Lambda_{f,\infty}$) along the streamwise direction (x) normalized by the airfoil maximum thickness (t_{max}) at the airfoil stagnation line. Turbulent inflow generated by the grid and rod for the different airfoil geometries.

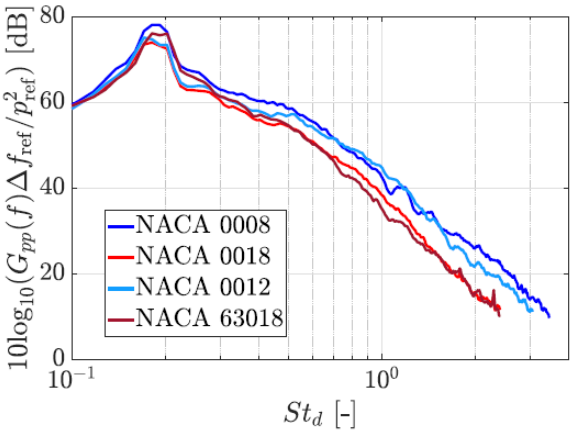

Figure 2: Power-spectral density of the measured radiated far-field noise for the different airfoils tested.

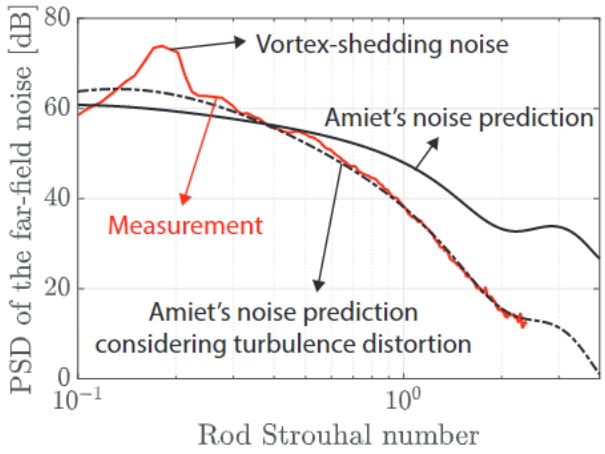

Figure 3: Power-spectral density (PSD) of the radiated far-field noise measured compared with Amiet's prediction and with Amiet's prediction considering the turbulence distortion effect.

As the turbulence distortion also impacts the WPFs in the airfoil LE region, poor estimations of the WPF spectrum using Amiet's model are observed. Also here, a better agreement between experimental and predicted WPF spectra is observed when the turbulence parameters used as input to Amiet's model are extracted near the airfoil LE. This shows the importance of accounting for the turbulence distortion in Amiet's model for LE noise and WPF spectrum in order to obtain accurate predictions.

The implications of incorporating the turbulence distortion in Amiet's LE noise prediction were also analyzed for propeller blade sections (see Figure 4). The predicted LE noise levels for the propeller blade sections are lower when turbulence distortion is accounted for (see Figure 5). However, this noise mechanism is dominant in the low- and mid-frequency ranges. The frequency at which the dominant noise source shifts from the LE to the TE reduces when turbulence distortion is considered (see Figure 5. The analysis also shows that the observed frequency range in which the turbulence distortion affects the LE noise is within the range where noise generated by a noncavitating marine application is relevant. This demonstrates the relevance of the results for the design of silent noncavitating propellers.

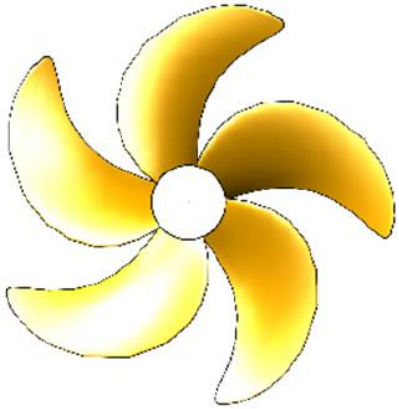

Figure 4: Propeller geometry used to estimate the LE and TE noise for blade sections located at 70% and 90% of the propeller radius.

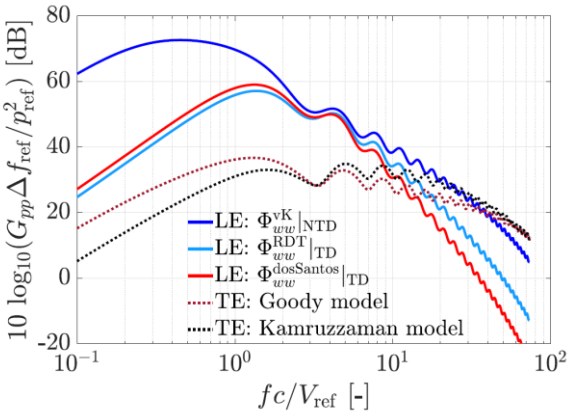

Figure 5: Power-spectral density of the predicted LE and TE noise using Amiet's theory. Different cases are considered for LE noise: NTD – no turbulence distortion effect considered, TD – turbulence distortion effect considered with different formulations for the turbulence spectrum (Φ_{ww}). TE noise is predicted for different WPF models.

In the thesis, it is also shown that tripping devices affect the transition process from a laminar to a turbulent boundary layer and the characteristics of the boundary layer developed at the TE, such as the WPFs (see Figure 6). When the trip height increases, the spectral level of the WPFs increases in the low-frequency range, resulting in an increase of TE far-field noise, reaching up to 4 dB (see Figure 7).

Conclusion

The results contribute to a better understanding of the turbulence distortion mechanism for airfoils and its effect on LE noise. The proposed approach to account for the turbulence distortion effect on Amiet's LE noise prediction can be used to obtain more accurate noise estimations for airfoils and to consider the airfoil shape effect on LE noise during the design phase of a propeller blade, for example. This improves the ability to design more silent, noncavitating propellers and other lift-generating surfaces, thus positively contributing to the well-being of both humans and animals affected by noise pollution. In addition, the discussion on the influence of tripping devices on the turbulent boundary

layer developed at the TE and on the radiated TE noise can be used as a first guideline to determine the appropriate trip height for aeroacoustic measurements and to understand the uncertainty introduced by the tripping device on the determination of the boundary layer parameters and on the measured noise.

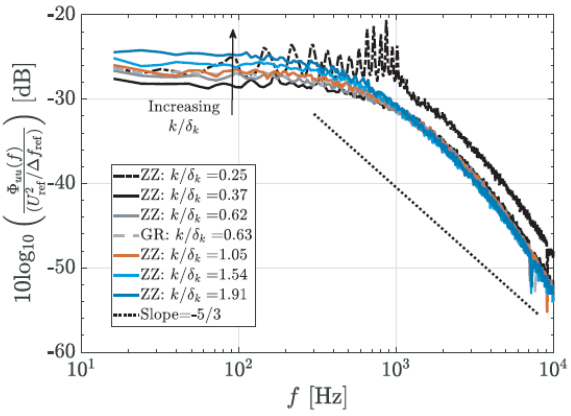

Figure 6: Power-spectral density of the velocity for different tripping devices height (k). Velocity measured in the boundary layer at 30% of the boundary layer thickness and at 95% of the chord length of a NACA 0012 airfoil at a Reynolds number of 270,000. ZZ – zigzag strip geometry, and GR – grit type of tripping device.

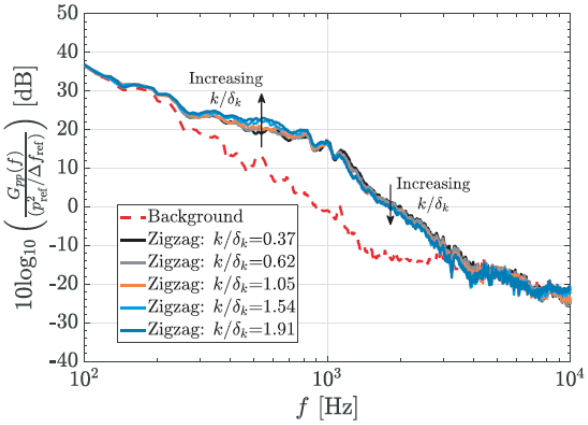

Figure 7: Power-spectral density of the TE radiated far-field noise for different tripping devices height (k). Velocity measured in the boundary layer at 30% of the boundary layer thickness and at 95% of the chord length of a NACA 0012 airfoil at Reynolds number of 270,000.

Acknowledgement

This work was part of the PANPA project, which was in collaboration with TNO and MARIN.

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This highlight refers to the PhD by Ivanna Lins Colijn (2023, cum laude)

Multiscale investigation and characterization of nano-particle reinforced bioplastics: Toward a circular economy

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Background

The discovery of plastics has revolutionized the world we live in due to their astonishing properties including mouldability, durability, price, and strength in combination with light weight. However, our consumption pattern in combination with the (often) non-biodegradable/compostable nature of plastics is no longer compatible. A circular bio-economy offers an escape from our current reality where fossil fuels have adverse effects on the environment, and plastic pollution negatively impacts life on the planet. There is a clear demand for plastics as well as a desire to reduce the impact on the planet. We therefore need to ask ourselves what these novel materials should look like and what their role is within a circular economy.

At present, much can be gained by recycling, reusing, or reducing traditional fossil-based plastics. In a polluted world where fossil sources are scarce and oil prices are heavily fluctuating, it is advisable to focus on biobased materials for the long(er) term. Bio-based (biodegradable/compostable) plastics are particularly relevant because of their lower footprint compared to their fossil-based counterparts. Today, the use of bioplastics is still a niche, mainly because their functionality does not compare favourably to their intended use.

The addition of nanoparticles to biobased polymers led to nanocomposites with enhanced mechanical, thermal, and barrier properties, and has the potential to make the use of bioplastics mainstream (Yanat & Schroën, 2021, 2023).

Method

Within the thesis, we investigated and characterized the multiscale physical and chemical properties of nanoparticle reinforced plastics through multidisciplinary research that is divided into three parts:

- Part I: Model systems
- Part II: Biobased systems
- Part III: Plastic products and society

Improved material properties are observed when nanoparticles are homogeneously dispersed in the polymer matrix. In practice however, nanoparticles tend to aggregate. The first part of this thesis is dedicated to model systems to investigate the effect of various design parameters on nanoparticle dispersion, and how the resultant nanocomposite structure affects material properties. In the second

part of the thesis, we focussed on the development of fully biobased and compostable nanocomposites consisting of PLA and chitin nanocrystals. The last part of this thesis was dedicated to plastic materials in society (Colijn, 2023).

Results

In practice, nanocomposite design often relies on trial-and-error approaches, despite the various theoretical frameworks available. We reviewed these frameworks and summarized experimental techniques to measure fundamental properties. Nanoparticle dispersion is predominantly affected by thermodynamic factors; for optimal nanoparticle dispersion, the nanoparticle – polymer interaction forces need to be higher than the interaction forces between the nanoparticles themselves. This clearly illustrates we should look beyond the famous 'like-dissolves-like theory'. Kinetic effects – such as shear forces – can bring nanoparticles to a new 'equilibrium', but these effects are of lesser importance in nanocomposite design (Colijn et al., 2023; Colijn & Schroën, 2021).

Molecular dynamics simulations highlight that nanoparticle – polymer interactions affect nanoparticle dispersion, which is key to the creation of enhanced materials properties. Favourable interactions increased the polymer density at the nanoparticle interface, thus resulting in an increased interphasial layer thickness; this leads to the formation of nanoparticle bridges and increased glass transition temperature, correlating to more stable materials (Colijn, 2023).

We showed that interphasial relaxation times were 10^2 – 10^3 times longer in nanocomposites than in neat polylactic acid (PLA). As such, nanoparticles essentially play the role of long-lived physical crosslinks. Nanoparticle dispersion highly affected nano- and bulk scale dynamics inside polymers (Colijn et al., 2024). The nano- and bulk scale dynamics were practically independent of the enthalpic component. We hypothesized that individual interphasial regions can affect each other, an effect that is enhanced by improved dispersion and higher nanoparticle loading. That leads to thought-provoking indications that dispersion is more important than nanoparticle – polymer interactions, whereas the latter is generally considered most important (Colijn et al., 2024).

In practise, nanoparticle aggregates can potentially be broken up during industrial processes. Ultrasound can easily deliver the critical energy input needed to break up chitin nanocrystal aggregates, whereas the energy input generated during polymer extrusion is expected to be too low (Colijn et al., 2021). Thus, other methods than those classically applied in industry should be considered to achieve chitin nanocrystal dispersion. Modifying chitin nanocrystals with fatty acids differing in carbon chain length was used to achieve this; particles modified with the longest fatty acid showed highest hydrophobicity, and dispersibility (Colijn et al., 2022a).

Generally, particle addition to the base polylactic acid polymer resulted in brown colour formation, which was reduced when the particles were modified (Colijn et al., 2023). This was likely the result of better dispersibility of modified chitin nanocrystals, and reduced reactivity. Overall, the addition of chitin nanocrystals improved barrier properties and provided high UV protection without this being at the expense of mechanical strength (Colijn, 2023).

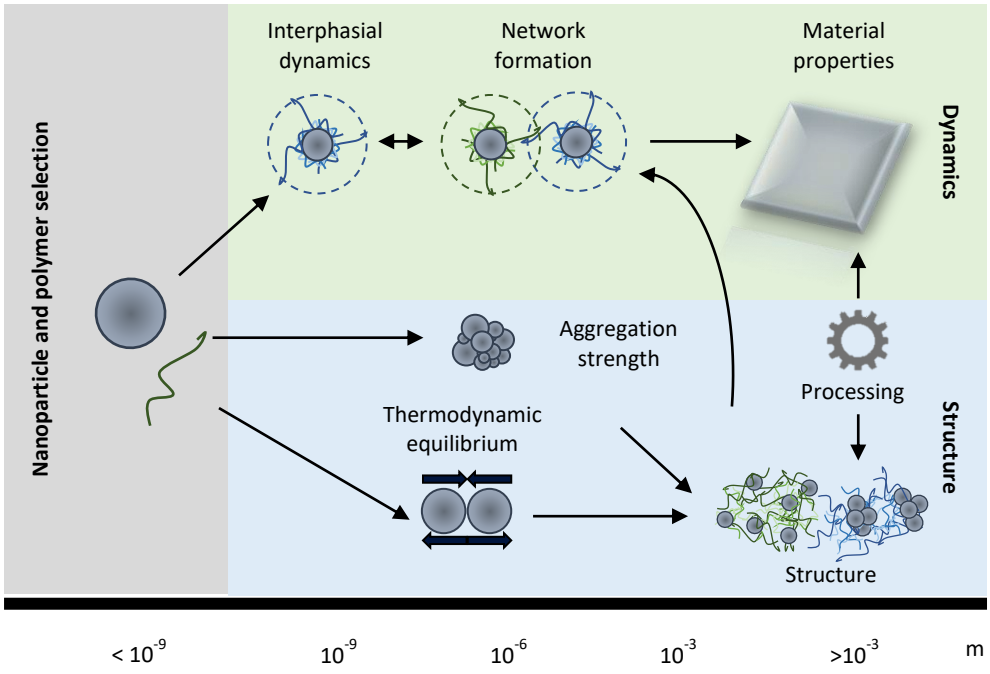
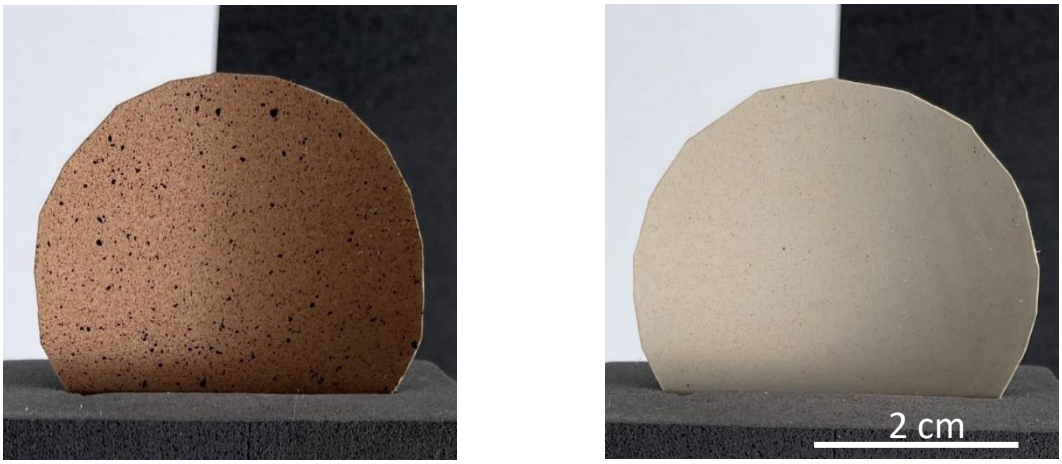


Figure 1: Overview of the various scales and driving forces affecting the formation of nano-composite plastic materials (Colijn, 2023).



(a) (b)

Figure 2: (a) Large chitin nanocrystal aggregates visible at 5 wt.%; (b) fatty acid surface modification (C18:0) improves dispersibility and film transparency (Colijn et al., 2023).

Plastics play an important role in the transition from a linear economy toward a circular one, but ideas about this role differ among actors. We studied these ideas as a form of futurity framing of traditional media and international academic papers. The futurity frame of a linear economy focussed on today's issues with plastics such as their non-biodegradability. Within the vision of a transition toward a circular economy, actors focus on the processes and steps required for change including consumer behaviour, social structures, and waste management systems. In both visions, actors envision plastics as part of our future circular economy. Academic papers focus mainly on alternatives forms of plastics, whereas newspapers mainly report on closing the loop for traditional forms of plastic. We observe a

missed opportunity to combine both visions to develop alternative biobased and biodegradable forms of plastics that can be recycled. The further development of this future vision of recyclable bioplastics and biodegradable plastics by industry, academics, governments, and NGOs, including citizens, may contribute to a more fully circular biobased plastic economy (Colijn et al., 2022b).

Outlook

Fundamental insights can be used to rationally design nanocomposite materials. On the smallest scale enthalpic and entropic factors are important for interphasial and overall nanocomposite architecture, and collectively affect material dynamics; it seems important to maximize the polymer density near the nanoparticle surface to reduce interphasial dynamics.

In order to get improved materials, interphasial properties need to be translated to the bulk, and we illustrate that the overall nanocomposite dispersion state plays a crucial role in this. In well-dispersed systems interphasial layers interact with each other, potentially via overlapping interphasial zones, polymer bridges, or communicate via entanglements (if applicable). Eventually, a pseudo-percolation network is formed which reduces the dynamics of most of the material. From this, we concluded that nanoparticle dispersion is the key factor for nanocomposite design, and various thermodynamic and kinetic routes are available to facilitate that. This leads to altered mechanical, barrier, and thermal properties. Additionally, nanoparticles can give optical, antioxidant, and/or antimicrobial features if the nanoparticle possess such functionality.

Before novel materials - such as bio nanocomposites - can successfully be introduced into society, other factors should be investigated as well including scalability, accessibility, end-of-life possibilities, sustainability, toxicology, and consumer acceptance and handling. We conclude that the rational design of nanocomposites needs to be approached in a truly multifaceted way that combines various fields of science to be successful.

Acknowledgement

This research was carried out under project number A17020 in the framework of the research program of the Materials Innovation Institute (M2i) (http://www.m2i.nl) supported by the Dutch government.

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This highlight refers to the PhD Thesis by Ronald Remmerswaal (2023, Cum laude)

Numerical modelling of variability in liquid impacts

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Introduction

Transport of liquefied natural gas (LNG) in LNG carriers yields a flexible delivery method for NG. The LNG is contained in large membrane tanks with a capacity of up to 40 000 m^3 as shown in Figure 1, where each LNG carrier may have up to four such tanks. There is ample opportunity for sloshing during transport, which means that the design of LNG tanks requires the prediction of pressures resulting from breaking wave impacts. Such impact pressures are often obtained using Froude scaled impact pressures from small-scale experiments (typically at scale 1 : 40), which unfortunately result in scaling biases, as we will now discuss.

When considering a breaking wave, the heavy liquid pushes the much lighter gas out of the way, resulting in a shear layer at the interface between the two fluids. Depending on the value of the nondimensional Weber number, which is a measure of the relative importance of inertia over surface tension, this may result in a Kelvin–Helmholtz (KH) instability: in this case the destabilizing influence of inertia dominates over the stabilizing capillary force. This instability leads to fragmentation of the interface, as is shown in Figure 2, and thus yields a high variability of impact pressures. The use of Froude scaling, however, implies that the Weber number is underestimated in the small-scale experiments.

This results in the aforementioned scaling bias: a smaller value of the Weber number implies that fewer KH instabilities are present, thereby resulting in less fragmentation of the interface. In the ‘sloshing of liquefied natural gas’ (SLING) project, the aim is to improve our understanding of the physical phenomena that are responsible for scaling biases in breaking wave impacts. Numerical simulation methods are used in this thesis to study breaking wave impacts in 3D, including the effects of KH instabilities. Due to the vast range of length and time scales, this is a challenging task which requires the development of novel numerical methods.

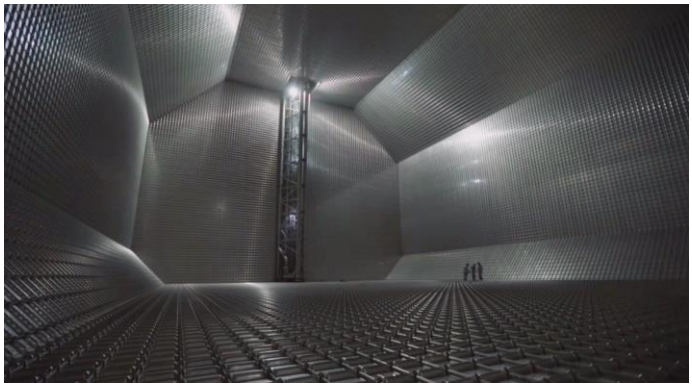


Figure 1. The interior of a Mark III LNG membrane tank.

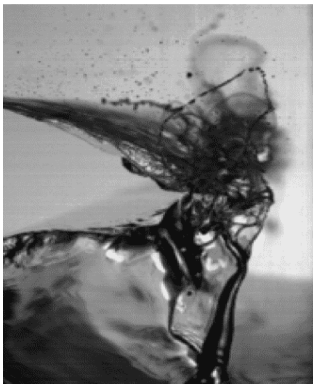
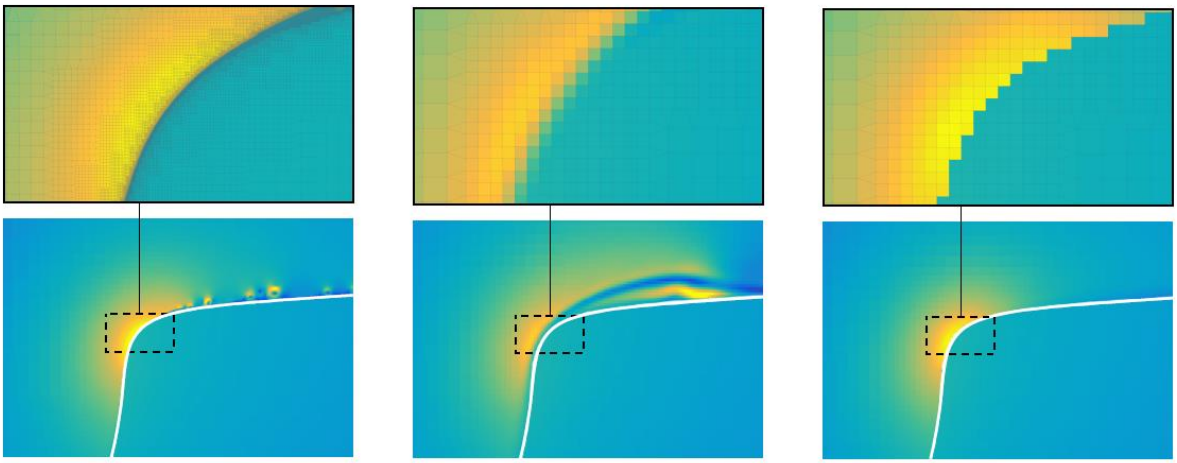


Figure 2. Experiment at scale 1 : 6.



a. Fine mesh & one-velocity. *b. Coarse mesh & one-velocity.* *c. Coarse mesh & two-velocity.*

Figure 3. The velocity magnitude at the wave crest of a 4 m long breaking wave. The 'fine' mesh yields a resolved shear layer with h ≈ 0.1 mm whereas the 'coarse' mesh corresponds to h ≈ 3.1 mm (32 times larger).

Methodology

The fluids are modelled as immiscible, incompressible and Newtonian. As we deem conservation properties of importance, we use the finite volume method on an adaptive mesh for the discretization of the resulting two-phase Navier–Stokes equations. The methods are implemented in our in-house ComFLOW code.

Transport of mass and momentum. We utilize the dimensionally unsplit geometric volume of fluid (VOF) method to advect the interface, wherein the interface is implicitly represented using the liquid volume fractions. This results in a sharp representation of the interface. Computation of the volume fluxes requires so called donating regions, for which we have derived simple conditions that guarantee boundedness of the volume fraction field, thereby no longer needing a fluid redistribution scheme. The transport of momentum is done using the same volume fluxes used for mass transport. Our approach differs from the literature in the way the staggered momentum field is transported: we

introduce an efficient algebraic interpolation of the fluxes, resulting in exact mass and momentum conservation, while obtaining semi-discrete convective conservation of kinetic energy.

Modelling of surface tension. As motivated in the introduction, we want to numerically model the KH instability, which means that the balance between inertia and surface tension must be accurately captured. We use a surface tension model based on sharply imposing the Young–Laplace equation, which is achieved using a well-balanced ghost fluid method (GFM) where the interface curvature is approximated using local height-functions. Our analysis of the geometric VOF method explains why the interface curvature does not converge under mesh refinement whenever a piecewise linear approximation (PLIC) of the interface is used, resulting in spurious currents despite using a well balanced method. We propose to use a piecewise parabolic interface approximation instead, for which we show that the interface curvature does converge under mesh refinement. This results in a complete mitigation of spurious currents, also for unsteady problems.

Modelling of the shear layer. Viscous effects play a role at the interface between the fluids, resulting in a shear layer which is thin compared to our length scales of interest, and therefore expensive to resolve. We propose to model this shear layer with a tangential velocity discontinuity, resulting in a novel and truly sharp two-velocity model. In Figure 3 we show the efficacy of this approach: the simulation of a breaking wave is considered, where we use the one-velocity model on either a fine or coarse grid (the mesh size is 32 times larger), and the two-velocity model on the coarse grid. These results show that whereas the one-velocity model results in an artificial thickening of the shear layer, the two-velocity model instead accurately approximates the unresolved shear layer with a velocity discontinuity.

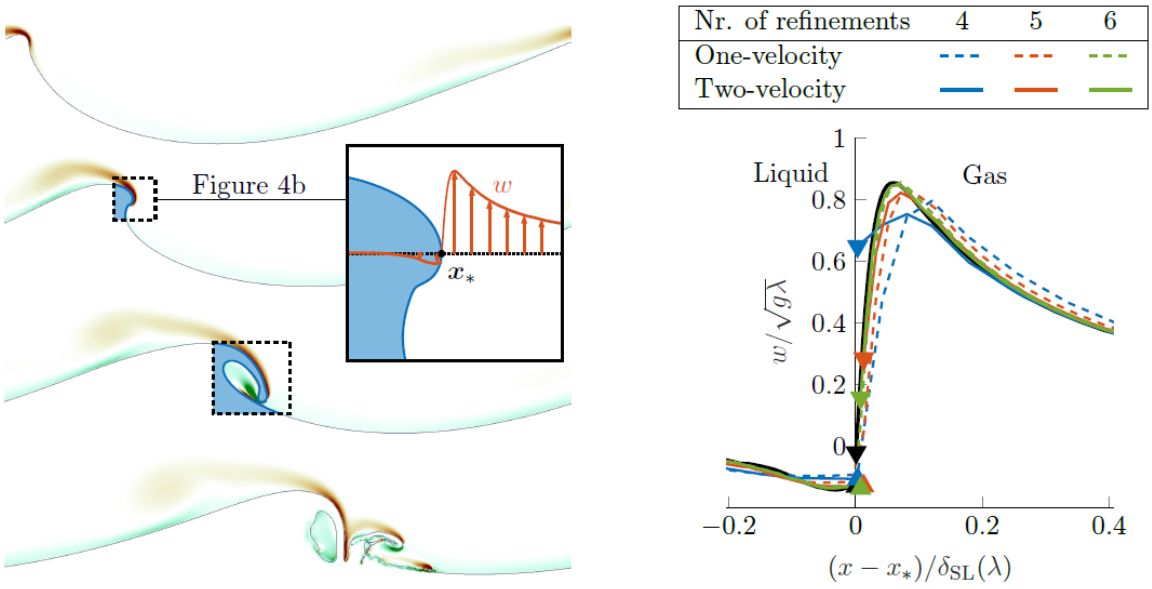


Figure 4. Two-dimensional simulations of a third-order Stokes wave.

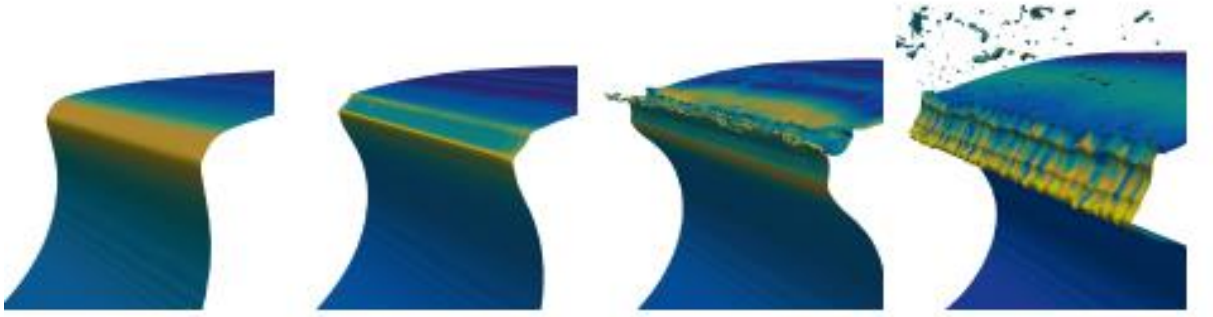
Results

The proposed numerical methods have been thoroughly validated using many academic test problems, one of which is the simulation of a low Reynolds number third-order Stokes wave as shown

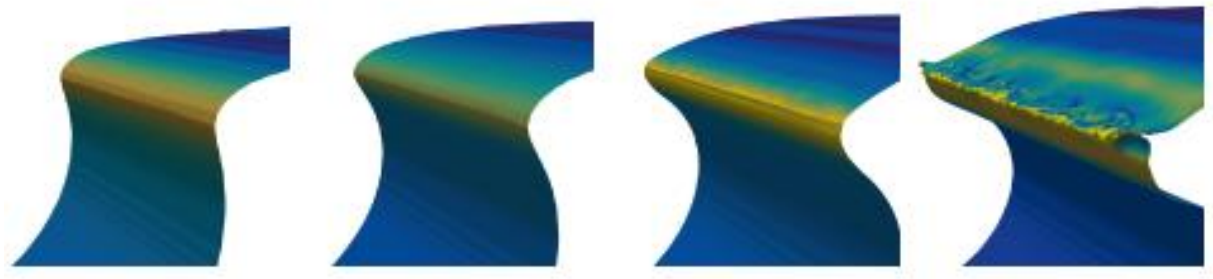
in Figure 4a. In Figure 4b we show the velocity tangential to the interface as a function of the interface normal distance, at the position indicated in the boxed inset of Figure 4a (which is inside the shear layer). This result shows that both the one- and two-velocity model converge to the same solution under mesh refinement, and moreover illustrates that the velocity in the gas phase converges faster when the two-velocity model is used. Note that the tangential velocity discontinuity present in the two-velocity model, as indicated by the triangular markers, vanishes under mesh refinement.

The two-velocity model was applied to several high Reynolds number wave impact problems. In particular, the scaling bias due to surface tension was investigated by simulating a 3D large gas pocket impact at two geometrical scales. The evolution of the crest shape is shown in Figure 5, where we compare simulations done at scale 1 : 10 and 1 : 20. As discussed in the introduction, such a comparison yields an underestimated Weber number at the smaller scale. Indeed, we see that instabilities arise later in time and a larger scale (after Froude scaling) when the smaller scale simulation is considered. Furthermore, we find that the wavelength of the spanwise instability at scale 1 : 10 compares very well to theoretical predictions. These results could only have been obtained using our proposed two-velocity model, as using a standard one-velocity model would have been computationally too expensive, especially in 3D.

In conclusion, we find that the proposed numerical methods are able to capture variability of wave impacts, and therefore yield a valuable tool in the design of LNG tanks.



a. At scale 1 : 10.



b. At scale 1 : 20.

Figure 5. The interface coloured by the magnitude of the gas velocity, resulting from the 3D wave impact problem at two scales, in the frame of reference of the wave tip.

Acknowledgements

This work is part of the research programme SLING, which is (partly) financed by the Netherlands Organisation for Scientific Research (NWO).

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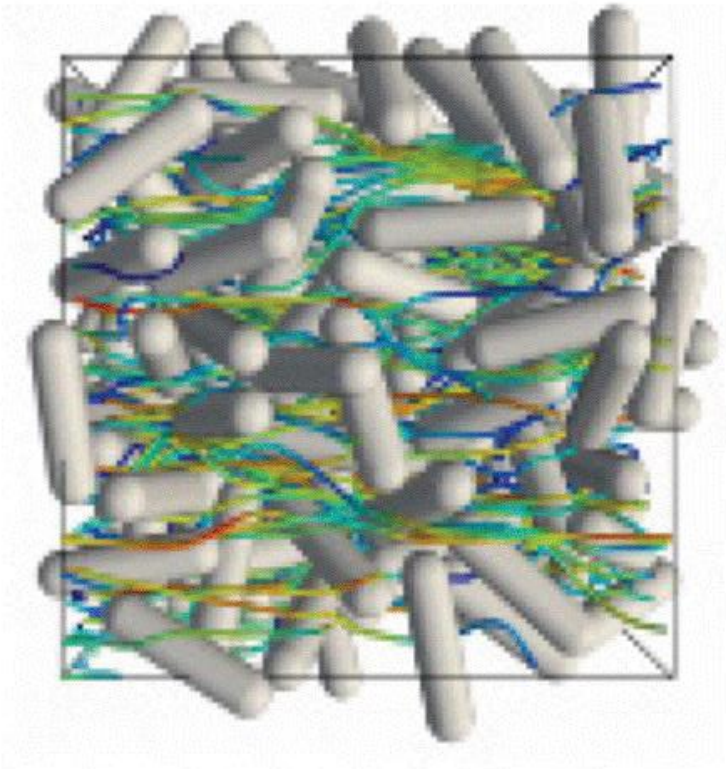
Remmerswaal, R. A. and Veldman, A. E. P. (2022c). Towards a sharp, structure preserving two-velocity model for two-phase flow: transport of mass and momentum. arXiv preprint arXiv:2209.14934.

PHD THESES



2023 PhD Theses

In 2023 a total of 127 PhD theses were delivered within the Burgerscentrum; Delft University of Technology (35), Eindhoven University of Technology (40), University of Twente 37), University of Groningen (2), WUR (7), Utrecht University (0), University of Amsterdam (6).

The thesis defenses in chronological order in 2023 are listed below.

1. 12 January 2023 – Themistoklis Melissaris – *Simulation of cavitation and surface erosion on marine propellers*, PhD Thesis, Delft University of Technology, (van Terwisga, Poelma).
2. 12 January 2023 – Lijun Thayyil Raju – *Physicochemical hydrodynamics in confined multicomponent liquids*, PhD Thesis, Twente University, (Lohse, Zhang).
3. 20 January 2023 – Alessando D'Aguanno – *Physics and control of transonic buffet*, PhD Thesis, Delft University of Technology, (van Oudheusden, Schrijer).
4. 20 January 2023 – Ivanna Lins Colijn – *Multiscale investigation and characterization of nano-particle reinforced bioplastics: Toward a circular economy*, PhD Thesis "Cum Laude", Wageningen University & Research, (Schroën).
5. 20 January 2023 – Jiajing Yang – *Real-time monitoring of low-concentration pollen in the air*, PhD Thesis, Eindhoven University of Technology, (Wyss, den Toonder).
6. 24 January 2023 – Natalia Mazur – *Boosting power of salt hydrates for heat storage*, PhD Thesis, Eindhoven University of Technology, (Adan, Huinink).
7. 24 January 2023 - Ronald Remmerswaal – *Numerical modelling of variability in liquid impacts*, PhD Thesis ("Cum Laude"), University of Groningen, (Verstappen, Veldman).
8. 26 January 2023 – Max Döpke – *Adsorption and electrokinetics at silica-electrolyte interfaces*, PhD Thesis, Delft University of Technology, (Padding, Hartkamp).
9. 26 January 2023 – Kun Xin – *CO_2 capture with hydrophobic deep eutectic solvents: Experiments and modelling*, PhD Thesis, Eindhoven University of Technology, (van Sint Annaland, Gallucci).
10. 26 January 2023 – Antoni Brentjes – *Investigating charged water sprays through simulations and experiments*, PhD Thesis, University of Twente, (Brem, Pozarlik).
11. 27 January 2023 – José Rivera Arbeláez – *Following the dots: Versatile and modular approach for engineering and analyzing three-dimensional cardiac tissues*, PhD Thesis, University of Twente, (Segerink, Passier, van den Berg, Catarino Ribeiro).
12. 31 January 2023 – S. Wang – *Modelling urban automated mobility on-demand systems: an agent-based approach*, PhD Thesis, Delft University of Technology, (Lin, Correia).
13. 1 February 2023 – Duy Ahn Le – *Microfluidic chips for oil recovery from carbonate reservoirs at elevated temperatures*, PhD Thesis, University of Twente, (Mugele, Gardeniers, Duits).
14. 3 February 2023 – Jasper Hoeksema – *Mean-field limits and beyond: Large deviations for singular interacting diffusions and variational convergence for population dynamics*, PhD Thesis, Eindhoven University of Technology, (Peletier, Tse).
15. 7 February 2023 – Xin Liu – *Regeneration of iron fuel in fluidized beds*, PhD Thesis, Eindhoven University of Technology, (Deen, Tang).
16. 9 February 2023 – Wendy Olsder – *Optimization models for faster and affordable access to rare disease treatments*, PhD Thesis, Eindhoven University of Technology, (Adan, Martagan).
17. 15 February 2023 – Patrick Meijaard – *Hyper-gravity controlled microparticles probing the plasma sheath*, PhD Thesis, Eindhoven University of Technology, (Beckers, Kroesen).
18. 23 February 2023 – Stefano Lovato – *Sailing through fluid mud*, PhD Thesis, Delft University of Technology, (van Rhee, Keetels).

19. 6 March 2023 – Xiao Deng – *Morphodynamic equilibria in double-inlet systems; their existence, multiplicity and stability*, PhD Thesis, Delft University of Technology, (Schuttelaars, De Mulder).
20. 8 March 2023 – Heleen Middelkamp – *Microfluidic vessels-on-chips for vascular disease modelling*, PhD Thesis, University of Twente, (van den Berg, van der Meer).
21. 9 March 2023 – Jelle Houben – *Accelerating thermochemical energy storage by doping*, PhD Thesis, Eindhoven University of Technology, (Adan, Kato, Huinink).
22. 10 March 2023 – Shuyana Heredia Deba – *Radical filtration: The functionality of photocatalic membranes in water treatment*, PhD Thesis, University of Twente, (Lammertink, Wols).
23. 14 March 2023 – Robin Doddema – Spectroscopy on the verge of soot formation, PhD Thesis, Eindhoven University of Technology, (Dam, Deen).
24. 14 March 2023 – Hesheng Bao – *Detailed description of igniting high-pressure sprays using efficient models*, PhD Thesis, Eindhoven University of Technology, (Somers, Roekaerts).
25. 15 March 2023 – Ming Huang – *Wake and wind farm aerodynamics of vertical axis wind turbines*, PhD Thesis, Delft University of Technology, (Simão Ferreira, Sciacchitano).
26. 23 March 2023 – Anastasiia Hraivoronska – *Discrete-to-continuum limits of evolutionary equations via generalized gradient flows*, PhD Thesis, Eindhoven University of Technology, (Peletier, Tse).
27. 6 April 2023 – Shahin Mohammad Nejad, *Scattering dynamics of rarefied gases: A hybrid atomistic/machine learning approach*, PhD Thesis, Eindhoven University of Technology, (Smeulders, Frijns, Gaastra-Nedea).
28. 13 April 2023 – Ruther Hebbink – *Pressure recordings for monitoring tidal breathing and optimizing settings for nasal high-flow therapy*, PhD Thesis, University of Twente, (Hagmeijer, Wijkstra, Duiverman).
29. 14 Apil 2023 – Heleen Kibbelaar – *Emulsions: Stability, rheology and sensory perception*, PhD Thesis, University of Amsterdam, (Bonn, Velikov).
30. 19 April 2023 – Cosimo Livi – *A study of particles-flow interactions based on the numerical solution of the Boltzmann equation*, PhD Thesis, Eindhoven University of Technology, (Toschi, Clercx).
31. 21 April 2023 – Lorenz Baumgartner – *Mass transfer and flooding phenomena in carbon dioxide electrolyzers*, PhD Thesis, Delft University of Technology, (Vermaas, Kleijn).
32. 21 April 2023 – Inger Bij de Vaate – *Spatiotemporal variability in global storm surge and tidal water levels from satellite radar altimetry*, PhD Thesis, Delft University of Technology, (Klees, Verlaan, Slobbe).
33. 26 April 2023 – Marvin Wilhelm Detert – *Plasmonic bubbles in binary liquids*, PhD Thesis, Twente University, (Lohse, Prosperetti).
34. 15 May 2023 – Gal Akrish – *Spectral modelling of coastal waves over spatial inhomogeneity*, PhD Thesis, Delft University of Technology, (Reniers, Zijlema, Smit).
35. 15 May 2023 – Conrad Hessels – *Reduction of combusted iron using hydrogen*, PhD Thesis, Eindhoven University of Technology, (Deen, van Oijen, Tang).
36. 16 May 2023 – Bernard Weninger – *Bridging intermittency: with iron electrodes*, PhD Thesis, Delft University of Technology, (Mulder, Van Ommen).
37. 17 May 2023 – Dirk Jonker – *Advanced nanofabrication techniques for electron emission devices*, PhD Thesis, University of Twente, (Gardeniers, Zandvliet, van Houselt, Tiggelaar).
38. 24 May 2023 – David Dykstra – *Viscoelastic metamaterials*, PhD Thesis, University of Amsterdam, (Bonn, Coulais).

39. 25 May 2023 – Eveline van Doremaele – *Organic neuromorphic computing: at the interface with bioelectronics*, PhD Thesis, Eindhoven University of Technology, (van de Burgt, den Toonder).
40. 26 May 2023 – Olga Palusci – *Urban ventilation and the compact mediterranean City: Numerical analysis of the dynamic relationship between density, morphology, and wind flow*, PhD Thesis, Eindhoven University of Technology, (Blocken, Monti, Montazeri).
41. 26 May 2023 – Paran Pourteimouri – *Modelling the influence of characteristics, orientation and positioning of beach buildings on airflow and aeolian sediment transport patterns in the surrounding area*, PhD Thesis, University of Twente, (Hulscher, Wijnberg, Campmans).
42. 31 May 2023 – Rafael Rodríguez-Mosqueda – *CO2 capture from ambient air by alkaline carbonates with application to CO2 enrichment for greenhouses*, PhD Thesis, University of Twente, (Brem, Shahi).
43. 1 June 2023 – Arash Rashimalimamaghani – *Development of carbon molecular sieve membranes (SMSMs) for membrane reactors*, PhD Thesis, Eindhoven University of Technology, (Gallucci, van Sint Annaland, Neiro d'Angelo).
44. 2 June 2023 – Youssef Saade – *Drops & bubbles: From fundamentals to applications*, PhD Thesis, Twente University, (Lohse, Prosperetti).
45. 8 June 2023 – Elles Raaijmakers – *Nudging neurons: Characterizing the behaviour of single neurons and small networks in the presence of weak electric fields*, PhD Thesis, Eindhoven University of Technology, (van Beurden, Lüttge, Mestrom).
46. 9 June 2023 – Sten ten Klooster – *Inside, at the edge, and on the run: dynamics of lipid oxidation in emulsions across length scales*, PhD Thesis, Wageningen University & Research, (Schroën, Berton-Carabin).
47. 13 June 2023 – Romana Perinajová – *Modelling of blood flow in aorta: MRI-based computational fluid dynamics of aortic hemodynamics*, PhD Thesis, Delft University of Technology, (Kenjereš, Lamb).
48. 13 June 2023 – Mohammad Hasani – *Towards plasma charging visualization*, PhD Thesis, Eindhoven University of Technology, (Beckers, Kroesen).
49. 14 June 2023 – Aviral Rajora – *Multiphase flow modelling of electrochemical systems*, PhD Thesis, Delft University of Technology, (Padding, Haverkort).
50. 14 June 2023 – Edoardo Saredi – *Advancements in large-scale volumetric PIV and PTV*, PhD Thesis, Delft University of Technology, (Scarano, Sciacchitano).
51. 14 June 2023 – Setareh Kazemzadeh – *Organic neuromorphic systems with biologically relevant functionalities*, PhD Thesis, Eindhoven University of Technology, (van de Burgt, den Toonder).
52. 15 June 2023 – Yibo Chen – *Dynamics of chemotactic microswimmers: from individual motions to interactions*, PhD Thesis, Twente University, (Lohse, Verzicco).
53. 22 June 2023 – Merel Verbeek – *Optimizing the configuration of tidal turbines in storm surge barriers*, PhD Thesis, Delft University of Technology, (Uijttewaal, Labeur).
54. 22 June 2023 – Christa van IJzerdoorn – *From loose grains to resilient dunes*, PhD Thesis, Delft University of Technology, (de Vries, Reniers, Hallin).
55. 22 June 2023 – Bastiaan Veltkamp – *Lubrication in sliding and squeezing*, PhD Thesis, University of Amsterdam, (Bonn, Velikov).
56. 28 June 2023 – Muxi Lei – *Assessment of improvement of indoor thermal comfort and energy demand of Chinese heritage apartment buildings under climate change*, PhD Thesis, Eindhoven University of Technology, (Roders, Blocken, van Hooff).

57. 29 June 2023 – Shaoqiang Su – *Atomic force microscopy resolved semiconductor-electrolyte interface for photocatalytic water splitting*, PhD Thesis, University of Twente, (Mugele, Mul, Sîretano, Mei).
58. 29 June 2023 – Joost Kranenborg – *Vertical dependences in swash-zone flows and sand transport*, PhD Thesis, University of Twente, (Hulscher, Reniers, van der Werf, Campmans).
59. 30 June 2023 – Christoph Mertens – *Experimental aeroelastic characterization based on integrated optical measurements*, PhD Thesis, Delft University of Technology, (Van Oudheusden, Sciacchitano, Sodja).
60. 30 June 2023 – Sietse van der Linden – *Underwater ablation using short and ultrashort laser pulses*, PhD Thesis, University of Twente, (Römer, Hagmeijer).
61. 3 July 2023 – Stan Looijmans – *Adhesion-modified polypropylene composites: a sticky situation*, PhD Thesis, Eindhoven University of Technology, (Anderson, van Breemen, Cavallo).
62. 3 July 2023 – Valesca Harezlak – *Filters and plant strategies: What steers vegetarian dynamics in floodplains of regulated lowland rivers?*, PhD Thesis, University of Twente, (Hulscher, Augustijn, Geerling).
63. 5 July 2023 – You-An Lee – *Mixing and solvent exchange in turbulent jet flows*, Twente University, (Lohse, Huisman, Sun).
64. 5 July 2023 – Farzan Sepahi – *Mass transport in multiphase electrochemical systems*, PhD Thesis, Twente University, (Lohse, Verzicco, Krug).
65. 5 July 2023 – Inês Figueiredo Pereira, *Minimally invasive smart glaucoma implants*, PhD Thesis, Eindhoven University of Technology, (den Toonder, Beckers, Wyss).
66. 7 July 2023 – Abhijit Kalbhor – *Model development and numerical investigation of soot formation in combustion*, PhD Thesis, Eindhoven University of Technology, (van Oijen, Somers).
67. 7 July 2023 – Moritz Junker – *Transport through polyelectrolyte multilayer based membranes for nanofiltration*, PhD Thesis, University of Twente, (Lammertink, de Vos, de Grooth).
68. 5 September 2023 – Koen Muller – *Tracking schooling fish in three dimensions*, PhD Thesis, Delft University of Technology, (Tam, Westerweel, Hemelrijk).
69. 5 September 2023 – Mohamed Elerian – *Numerical investigation of turbidity flows generated by polymetallic nodules mining*, PhD Thesis, Delft University of Technology, (van Rhee, Helmons).
70. 6 September 2023 – Sarah Schyck – *Anisotropic and magnetic microparticles: Preparation and out-of-equilibrium assembly*, PhD Thesis, Delft University of Technology, (Rossi, Boukany).
71. 7 September 2023 –Giullia Zoppini – *Receptivity of swept wing boundary layers to surface roughness: Diagnostics and extension to flow control*, PhD Thesis, Delft University of Technology, (Kotsonis, Ragni).
72. 7 September 2023 – Raninisha Sitlapersad – *Molecular simulations of supercapacitors*, PhD Thesis, University of Twente, (Thornton, den Otter).
73. 11 September 2023 – Swaraj Nanda – *Gas transport into vortex cavities*, PhD Thesis, Delft University of Technology, (Van Terwisga, Westerweel, Elsinga).
74. 11 September 2023 – Sagi Ephrati – *Data-driven stochastic modeling for coarsened computational geophysical fluid dynamics*, PhD Thesis, University of Twente, (Geurts, Cifani).
75. 12 September 2023 – Sjoerd Knippenberg, Designing a product platform for ship locks, PhD Thesis, Eindhoven University of Technology, (Etman, Adan).
76. 13 September 2023 – Bedassa Cheneka – *Wind power ramps: Characterisation, forecasting, and future projection*, PhD Thesis, Delft University of Technology, (Watson, Basu).
77. 15 September 2023 – Eva van Aalen – *Glow-in-the-dark diagnostics: using bioluminescent sensor proteins*, PhD Thesis, Eindhoven University of Technology, (Merkx, den Toonder).

78. 18 September 2023 – Ginger Egberts – *In silico exploration of post-burn contraction using uncertainty quantification*, PhD Thesis, Delft University of Technology, (Vuik, Vermolen, van Zuijlen).
79. 18 September 2023 – Furkat Yunus – *Methodologies and algorithms for sound propagation in complex environments with application to urban air mobility: A ray acoustics approach*, PhD Thesis, Delft University of Technology, (Casalino, Ragni, Avallone).
80. 19 September 2023 – Chih-Chia Huang, *Modelling of injection zone in blast furnaces*, PhD Thesis, Eindhoven University of Technology, (Deen, van Oijen, Tang).
81. 20 September 2023 – Lourenco Tercio Lima Pereira – *Physics of broadband noise reduction by serrated trailing edges*, PhD Thesis, Delft University of Technology, (Scarano, Ragni, Avallone).
82. 20 September 2023 – Vahid Alghalandi – *Soft by design: turnable elastomers and plastomers with bottlebrush topology*, PhD Thesis, Wageningen University & Research, (van der Gucht, Kodger).
83. 22 September 2023 – Donato Pinto – *CH_4 and CO_2 utilization by unsteady-state operation*, PhD Thesis, Delft University of Technology, (Urakawa, Van Ommen).
84. 22 September 2023 – Patrick Deenen, *Data-driven modelling and optimization of semiconductor manufacturing*, PhD Thesis, Eindhoven University of Technology, (Adan, Nuijten, Akcay).
85. 22 September 2023 – Fernanda Leticia Dos Santos – *Broadband flow-induced noise for airfoils: Inflow turbulence distortion effect on leading-edge noise generation and prediction*, PhD Thesis “Cum Laude”, University of Twente, (Venner, da Santana).
86. 22 September 2023 – Arputha Paul – *Blending the boundaries: Enhancing ion transport with electrokinetics*, PhD Thesis, University of Twente, (Lammertink, Wood).
87. 25 September 2023 – Timm Swoboda – *On the heat dissipation in micro-electronics and advanced thermal control devices*, PhD Thesis, University of Twente, (Brem, Muñoz Rojo).
88. 28 September 2023 – Shubham Dalvi – *Towards a magnetocaloric cooling system: Using interactions of magnetic fields & magnetic fluids*, PhD Thesis, University of Twente, (Brem, van der Meer, Shahi).
89. 29 September 2023 – Jedrzej Winczewski – *Additive manufacturing of zirconia-based 3D microstructures*, PhD Thesis, University of Twente, (Gardeniers, Susarrey Arce).
90. 6 October 2023 – Robert Hartmann – *Rotation and confinement in turbulent Rayleigh-Bénard convection*, PhD Thesis, Twente University, (Lohse, Verzicco, Stevens).
91. 6 October 2023 – Yogesh Jethani – *Dynamics of flow, particles and bubbles in a piezo-acoustic inkjet channel*, PhD Thesis, Twente University, (Lohse, Versluis, Segers).
92. 6 October 2023 –Feng-Chun Hsia– *Nanoscale topography and wear of ceramic interfaces and their effect on macroscale friction*, PhD Thesis, University of Amsterdam, (Bonn, Frenken).
93. 9 October 2023 – Seyyed Sherwin Safavi Nic – *Capturing the dynamics of direct contact condensation: A numerical and experimental study*, PhD Thesis, Eindhoven University of Technology, (Kuipers, Buist).
94. 11 October 2023 – Mark Sassenburg – *Electrical Intensification of CO2 Reduction Electrolysis*, PhD Thesis, Delft University of Technology, (Smith, Burdyny, Padding).
95. 13 October 2023 – Roeland Wildemans – *Nonlinear dynamics of intrinsic thermos-acoustics modes*, PhD Thesis, Eindhoven University of Technology, (Lopez Arteaga, de Goey, Kornilov).
96. 16 October 2023 – Efrat Gomeh – *See what I mean? Meaning-making by visualizations in policy controversies over energy and food technologies*, PhD Thesis, Wageningen University & Research, (Metze, Schroën, Dijstelbloem).

97. 17 October 2023 – Monteza Hadian – *Thermocatalytic decomposition of methane in a gas fluidized bed reactor: Numerical modeling and experimental study*, PhD Thesis, Eindhoven University of Technology, (Kuipers, Buist).
98. 18 October 2023 – Cedric Devriese – *The CFD design and optimization of a compressor, combustor and turbine system towards 100 kWe hydrogen fuelled micro gas turbine*, PhD Thesis, Eindhoven University of Technology, (Bastiaans, Deen, De Paepe).
99. 18 October 2023 – Ravi Patel – *Towards plasma-assisted ignition-stabilized combustion*, PhD Thesis, Eindhoven University of Technology, (Nijdam, Dam).
100. 23 October 2023 – Samy Iousef – *Computational modeling of convective heat transfer at building surfaces*, PhD Thesis, Eindhoven University of Technology, (van Wesemael, Blocken, Montazeri).
101. 23 October 2023 – Prasansha Rastogi – *3D printing of foams for acoustics applications*, PhD Thesis, University of Twente, (Venner, Visser, Wijnant).
102. 25 October 2023 – Katarína Košútová – *Indoor airflow and heat transfer in a cross-ventilated generic building: Wind tunnel experiments and computational fluid dynamics analyses*, PhD Thesis, Eindhoven University of Technology, (Blocken, Hensen, van Hooff).
103. 26 October 2023 – Martin van der Eijk – *Extreme aerated water-wave impacts on floating bodies*, PhD Thesis "Cum Laude", Delft University of Technology, (Boersma, Wellens).
104. 26 October 2023 – Edgar Ortega Roano – *Impact phenomena in multiphase flows*, PhD Thesis "Cum Laude", Twente University, (van der Meer, Marin).
105. 27 October 2023 – Juan Alvarez Naranjo – *Multi-scale sintering model of visco-elastic powders*, PhD Thesis, University of Twente, (Luding, Weinhart).
106. 30 October 2023 – Xiadong Li – *Towards efficient adjoint-based mesh optimization for predictive Large Eddy Simulation*, PhD Thesis, Delft University of Technology, (Hickel, Hulshoff).
107. 2 November 2023 – Karina González López – *Quantifying mechanical disorder in computer glasses*, , PhD Thesis, University of Amsterdam, (Lerner, Jalaal).
108. 10 November 2023 – Alessia Broccoli – *Microdevices for high-throughput screening of single catalyst particles*, PhD Thesis, University of Twente, (Odijk, van den Berg, Meirer, Mul).
109. 14 November 2023 – Kushal Ujjaini Kempaiah – *Active control of turbulent skin-friction: An experimental study*, PhD Thesis, Delft University of Technology, (Scarano, Baars).
110. 14 November 2023 – Jigar Parekh – *Development of methods for uncertainty quantification in CFD applied to wind turbine wake prediction*, PhD Thesis, University of Groningen, (Verstappen, Bertoglio).
111. 14 November 2023 – Bo Fan – *Granular flows: effects of grain shape, surface friction and grain elasticity*, PhD Thesis, Wageningen University & Research, (van der Gucht, Börzcönyi, Dijksman).
112. 24 November 2023 – Feiyu Geng – *Lifetime prediction of vertical-axis wind turbines based on CFD simulations with high-cycle fatigue modeling*, PhD Thesis, Eindhoven University of Technology, (Suiker, Blocken, van Wesemael, Montazeri).
113. 24 November 2023 – Almohanad Abusultan - *A hybrid ion exchange resin - bipolar membrane electrodialysis process for reverse osmosis permeate remineralization*, PhD Thesis, University of Twente, (Van der Meer, Kemperman, Wood)
114. 29 November 2023 – Santiago Velandia Rodriguez – *Pickering emulsions with proteins; Stabilization and rheological behavior*, PhD Thesis, University of Amsterdam, (Bonn, Roques-Carmes).
115. 29 November 2023 – Alexander Louwes – *On the fast pyrolysis of torrefied woody biomass*, PhD Thesis, University of Twente, (Brem, Pozarlik).

116. 30 November 2023 – Rui Yang – *Turbulent flows with phase changes*, PhD Thesis “Cum Laude”, Twente University, (Lohse, Verzicco).
117. 1 December 2023 – Stella Kruit – *Microfluidic impedance cytometry for single sperm analysis: Towards morphology characterization*, PhD Thesis, University of Twente, (Segerink, Olthuis, Broekhuijse).
118. 5 December 2023 – Alime Cengiz – *Iron encapsulation strategies to mitigate lipid oxidation in food emulsions*, PhD Thesis, Wageningen University & Research, (Schroën, Berton-Carabin).
119. 5 December 2023 – Katharina Münch – *Lipid oxidation in emulsions stabilized with plant protein ingredients: the relevance of non-protein components*, PhD Thesis, Wageningen University & Research, (Schroën, Berton-Carabin, Stoyanov).
120. 6 December 2023 – Gabriel González Saiz – *Advancements in optical diagnostics for experimental aeroelasticity: Benchmarking the cylinder-foil system*, PhD Thesis, Delft University of Technology, (Scarano, Sciacchitano).
121. 11 December 2023 – Sagar Adatrao – *Advances in PIV Uncertainty Quantification: Towards a comprehensive framework*, PhD Thesis, Delft University of Technology, (Scarano, Sciacchitano).
122. 12 December 2023 – Timo van Overveld – *Spherical particles in oscillating flows: From a single particle to pattern dynamics,* PhD Thesis “Cum Laude”, Eindhoven University of Technology, (Clercx, Duran Matute).
123. 14 December 2023 – Haoyu Li – *Waves and turbulence and waves in core-annular pipe flow*, PhD Thesis, Delft University of Technology, (Henkes, Pourquié).
124. 14 December 2023 – Julia Steiner – *Towards data-driven turbulence modelling for wind turbine wakes*, PhD Thesis, Delft University of Technology, (Viré, Watson, Dwight).
125. 20 December 2023 – Mohammad Khorsand Ahmadi – *Experimental study of the interplay between electrokinetic effects for electronic paper displays*, PhD Thesis, Eindhoven University of Technology, (Wyss, den Toonder, Henzen).
126. 20 December 2023 – Raffaele Vasaturo – *Numerical simulation of the atmospheric boundary layer with application to natural ventilation*, PhD Thesis, Eindhoven University of Technology, (Blocken, van Wesemael, van Hooff).
127. 21 December 2023 – Svetlana Obydenkova – *Sustainability assessment of emerging multi-product lignocellulosic value chains using residual biomass: lessons learned and perspectives of development*, PhD Thesis, Eindhoven University of Technology, (Smeulders, van der Meer, Boot).

REPORTS OF INDIVIDUAL RESEARCH GROUPS

Delft University of Technology

Faculty of Mechanical Engineering (ME)

Department Process & Energy

Energy Technology, Heat Transformation Technology, and Thermal Fluids Engineering (TUD-ME-ET)

Prof. dr. René Pecnik	Full prof.
Prof. dr. Kamel Hooman	Full prof.
Dr. ir. Jurriaan Peeters	Associate prof.
Dr. ir. Willem Haverkort	Assistant prof.
Dr. eng. Pedro Costa	Assistant prof.
Dr. Emanuele Zanetti	Assistant prof.
Dr. Nicolas Valle	Assistant prof.

Group's research areas

- Turbulent heat and mass transfer
- Non-ideal fluid dynamics (supercritical fluids)
- Turbomachinery and rotating equipment
- Extreme-scale numerical simulations (GPGPU)
- Fluid mechanics for electrochemical applications
- Turbulent multiphase flows
- Urban flows and climate

Collaboration with other groups (inside or outside Burgerscentrum)

- Kawai, Tohoku University, Japan
- Larsson, University Maryland, US
- Pirozzoli, University Rome, Italy
- Woisetschlaeger, Graz University of Technology, Austria
- Fuchs, Wetsus, NL
- Neil Sandham, Southampton University, UK
- Boersma, TU Delft
- Hickel, TU Delft
- Rohde, TU Delft
- Halldór Pállson & Ásdís Helgadóttir, U. Iceland (Iceland)
- Francesco Picano, U. of Padova (Italy)
- Luca Brandt, KTH Mechanics (Sweden)
- Massimiliano Fatica, Josh Romero & Thorsten Kurth, NVIDIA Corporation (CA, USA)
- Soledad le Clainche, UP Madrid (Spain)
- Davide Modesti, TU Delft
- Nuclear Research and Consultancy Group
- McPhy
- HyET E-Trol
- Veco B.V.
- Magneto special anodes B.V.

- Shell
- Zero Emission Fuels B.V.
- RWTH-Aachen, group of Matthias Wessling
- Eden Tech Microfluidics

PhD thesis delivered in 2023

- 14 June 2023 – Aviral Rajora – *Multiphase flow modelling of electrochemical systems*, PhD Thesis, Delft University of Technology, (Padding, Haverkort).

Grants obtained in 2023

- McPhy, XL Stack Modelling, with postdoctoral researcher Sofen Kumar Jena
- HyET E-trol, Pulsed and Magnetic Field Electrolysis, with postdoctoral researcher Anamika Ghosh

Delft University of Technology

Faculty of Mechanical Engineering (ME)

Department Process & Energy

Fluid Mechanics (TUD-ME-FM)

Prof. dr. ir. Jerry Westerweel	Full prof.
Prof. dr. ir. Ruud Henkes	Full prof. (part time)
Dr. ir. Gerrit Elsinga	Associate prof.
Dr. Daniel Tam	Associate prof.
Dr. ir. Mark Tummers	Assistant prof.
Dr. Abel-John Buchner	Assistant prof.

Group's research areas

- Turbulence
- Dispersed multiphase flow
- Biological flows
- Unsteady hydrodynamics
- Combustion
- Hydrodynamics in Sports

Collaboration with other groups (inside or outside Burgerscentrum)

- Prof. Tom van Terwisga / prof. Detlef Lohse in the AQUA project (NWO)
- Dr. Sebastian Schreier in FlexFloat (NWO)
- Dr. Ido Akkerman in Lift control for hydrofoil craft (NWO)
- Dr. Dimitris Boskos (DCSC/ME/TUD)
- Prof. Florian Muijres (WUR)
- Prof. Sikke Klein (P&E/ME/TUD)
- dr.ir. A. Sciacchitano (L&R)
- dr.ir. G. Oldenziel (Deltares)
- dr. C. Muthanna (SINTEF)
- Dr. Daniele Fiscaletti (MTT/ME/TUD)
- Dr. Gunnar Jacobi (MTT/ME/TUD)
- Dr. Manu Goudar (SRON)
- Dr. A. Seth (BME/ME/TUD)
- Prof. Gijsje Koenderink (BN/TNW/TUD)
- Dr. Kristina Ganzinger (AMOLF)

PhD theses delivered in 2023

- 5 September 2023 – Koen Muller – *Tracking schooling fish in three dimensions*, PhD Thesis, Delft University of Technology, (Tam, Westerweel, Hemelrijk).
- 11 September 2023 – Swaraj Nanda – *Gas transport into vortex cavities*, PhD Thesis, Delft University of Technology, (Van Terwisga, Westerweel, Elsinga).

- 14 December 2023 – Haoyu Li – *Waves and turbulence and waves in core-annular pipe flow*, PhD Thesis, Delft University of Technology, (Henkes, Pourquié).

Grant obtained in 2023

- NWO-TTW "Flow for Gold" (20421)
- Bio-inspired flow control of hydrokinetic turbine blades under unsteady loading (3mE Cohesion grant): with Dr. D. Fiscaletti (MTT/ME/TUD) and Dr. G. Jacobi (MTT/ME/TUD)
- BioToHydRow (3mE Cohesion grant): with Dr.ir A.J. Greidanus (FM/ME/TUD) and Dr. A. Seth (BME/ME/TUD)

Projects started in 2023

- NWO-TTW "Flow for Gold" (20421)
- Bio-inspired flow control of hydrokinetic turbine blades under unsteady loading (3mE Cohesion grant): with Dr. D. Fiscaletti (MTT/ME/TUD) and Dr. G. Jacobi (MTT/ME/TUD)
- TANGO: Velocity from stereo imaging using two temporally spaced emission plume observations: with Dr. M. Goudar (SRON)
- Ventilation inception of surface-piercing hydrofoils in waves (TU Delft/NOC-NSF)
- HELIOS (EU Horizon CLEANH2)

Other 2023 highlights

- Reijtenbagh J, Tummers, MJ & Westerweel, J "Drag force on a starting plate scales with the square root of acceleration" *Phys. Rev. Lett.* 130 (2023) 174001

Delft University of Technology

Faculty of Mechanical Engineering (ME)

Department Process & Energy

Multiphase Systems (TUD-ME-MS)

Prof. dr. ir. Christian Poelma	Full prof.
Dr. ir. Wim-Paul Breugem	Associate prof.
Dr. Brian Tighe	Associate prof.
Dr. Angeliki Laskari	Assistant prof.
Dr. ir. Emma Hinderink	Assistant prof.

Group's research areas

- Flow of dense suspensions
- Flow measurement techniques for multiphase systems
- Turbulence and boundary layers near open surfaces
- Rheology
- Emulsions and food processing

Collaboration with other groups (inside or outside Burgerscentrum)

- Flow measurements using Magnetic Resonance Imaging (with University of Rostock)
- Fluid dynamics of flexible, floating structures (with MT&T, TU Delft)
- Ventilated cavities (with University of Michigan)

PhD thesis delivered in 2023

- 12 January 2023 – Themistoklis Melissaris – *Simulation of cavitation and surface erosion on marine propellers*, PhD Thesis, Delft University of Technology, (van Terwisga, Poelma).

Project started in 2023

- Flow of Concentrated Food Emulsions: Droplet deformation in relation to interfacial and macroscopic rheological properties (Tighe/Hinderink/Poelma)

Delft University of Technology

Faculty of Mechanical Engineering (ME)

Department Process & Energy

Complex Fluid Processing (TUD-ME-CFP)

Prof. dr. ir. Johan Padding	Full prof.
Dr. Lorenzo Botto	Associate prof.
Dr. Burak Eral	Assistant prof.
Dr. Remco Hartkamp	Assistant prof.
Dr. ir. Willian Hogendoorn	Assistant prof.

Group's research areas

- Electrochemical processes
- Electrokinetic transport
- Mesoscale transport phenomena
- Multiphase flows
- Viscoelastic flows
- Crystallization
- Solids processing
- Electrochemical separation processes
- Fluid dynamics of centrifugation of complex fluids
- Spray drying of 2D materials and rheology of complex fluid interfaces

Collaboration with other groups (inside or outside Burgerscentrum)

- Lipid membrane structural properties, with prof. Mark van Loosdrecht and dr. Duncan McMillan (TUD)
- Electrochemical Conversion of CO2 to Synthetic Fuel Using 2D Electrode Materials, with dr. Peyman Taheri (TUD)
- Design of suspension electrodes for CO2 electroconversion, with dr. David Vermaas (TUD)
- Bubble Dynamics in Electrolysis, with dr. Cor van Kruijsdijk (Shell), dr. James McClure (Virginia Tech) and dr. Zhe Li (Canberra National University)
- Hydrodynamic Drag, Lift and Torque Correlations for Ellipsoidal Particles, with dr. Yousef el Hasadi (TUD) and dr. Sathish Sanjeevi (National Energy Technology Laboratory, Morgantown, USA)
- Critical comparison of gas-solid fluidization modelling methods, with prof. Olivier Simonin, prof. Renaud Ansart (IMFT/LGC Toulouse), dr. Simon Schneiderbauer (JKU Linz) and dr. Baptiste Hardy (TUD)
- Processing of Solid Borohydride Hydrogen Carriers, with prof. Dingena Schott, ir. Klaas Visser (TUD) and dr. Chris Slootweg (UvA)
- Transport phenomena in novel electric drying techniques, with prof. Maarten Schutyser (WUR) and prof. Valeria Garbin (TUD)
- Fluidized bed gasification of biomass and plastic waste, with prof. Wiebren de Jong (TUD) and dr. Elyas Moghaddam (GI Dynamics)

- Fundamentals of non-photochemical laser induced nucleation, with dr. Allan Myerson (MIT) and dr. Andrew Alexander (University of Edinburgh)
- Recovery of rare earth elements with light induced crystallization, with dr. Kerstin Forsberg (KTH, Sweden)
- Battery recycling with eutectic freeze crystallization, with dr. Pieter Verhees (Umicore)
- Light induced seed generation for industrial crystallization, with dr. Clemens Bothe (Bayer)
- Morphology control in antisolvent crystallization, with dr. Rob Geertman (J&J)
- Separations in e-refinery, with dr. Ruud Kortlever, dr. David Vermaas and dr. Monique van der Veen (TUD)
- Rheology of suspensions of graphene nanoplatelets, with Prof. Hong Liang (Texas AM, USA)
- Buckling of elastic sheets in shear flow: comparison experiments/simulation, with dr. Michael Graham (U. of Wisconsin at Madison, USA)
- Buckling of particle-laden droplets, with Dr. Alvaro Marin (UTwente)
- Trans-stenotic pressure gradient estimation using LES and MRI, with Dr. Selene Pirola (TUD)

PhD theses delivered in 2023

- 26 January 2023 – Max Döpke – *Adsorption and electrokinetics at silica-electrolyte interfaces*, PhD Thesis, Delft University of Technology, (Padding, Hartkamp).
- 14 June 2023 – Aviral Rajora – *Multiphase flow modelling of electrochemical systems*, PhD Thesis, Delft University of Technology, (Padding, Haverkort).
- 11 October 2023 – Mark Sassenburg – *Electrical Intensification of CO2 Reduction Electrolysis*, PhD Thesis, Delft University of Technology, (Smith, Burdyny, Padding).

Grants obtained in 2023

- NWO-VIDI grant for Remco Hartkamp: *Toward ideally wetted porous electrodes for CO2 reduction*
- NWO-TTW OTP grant for Burak Eral: *MicroWash: Reducing plastic microfibre pollutant release at the source by rational flow design*
- ERC-POC grant for Lorenzo Botto: *Sludge Cam "A smart centrifuge camera for testing dewatering ability of waste-water sludges in hyper-gravity"*

Projects started in 2023

- NWO-TTW OTP project of Johan Padding and Remco Hartkamp started: *CO2 into hexanoic acid using microbial electrosynthesis (C1to6)*
- LTPPT-TREPS with direct industrial funding of Burak Eral started: *Trace separations with external fields*
- Gas-liquid flows in LOHC dehydrogenation reactors: Johan Padding started new project with improved LOHC
- Hydrodynamics and crystallization phenomena in dehydrogenation reactors based on borohydrides: Johan Padding started new project on crystallization of spent fuel mixtures
- Understanding mechanochemistry in high energy ball mills: new project started focusing on bulk powder behaviour

- NWO-VIDI grant of Remco Hartkamp started: *Toward ideally wetted porous electrodes for CO2 reduction*
- TUD Cohesion project of Willian Hogendoorn started: *Trans-stenotic pressure gradient estimation using LES and MRI*

Other 2023 highlights

- *2022 KIVI Hoogendoorn Fluid Mechanics Award* awarded to Willian Hogendoorn at the Burgers Symposium 31 May & 1 June 2023
- Media impact: research of Lorenzo Botto on visualisation of centrifugation at 3000G covered by the US journal *New Scientist* (video attracted 43K views)

Delft University of Technology

Faculty of Mechanical Engineering (ME)

Department Process & Energy

Engineering Thermodynamics (TUD-ME-ETH)

Prof. dr. ir. Thijs Vlugt	Full prof.
Dr. Othon Moultos	Assistant prof.
Dr. ir. Tim Nijssen	Assistant prof.
Dr. ir. Mahinder Ramdin	Assistant prof.

Group's research areas

- Molecular thermodynamics and simulation for the energy transition; modelling of phase equilibria, transport phenomena, and hydrocracking; development of adsorption processes for nitrogen/oxygen separation from air
- Application of molecular thermodynamics to sustainable Process & Energy Engineering: (i) I hydrogen storage, purification and transportation, and (ii) design of sustainable adsorbents for the removal of contaminants from water
- Process design and techno-economics of renewable systems including CO2 capture and conversion to value-added products, and hydrogen production from water electrolysis
- Physics-based modelling to develop processes and devices for carbon capture

Grants obtained in 2023

- Intelligent design of sustainable Sugar(cYclodextrin)-based adsorbents for the Removal of PFAS and other Organic microPollutants from water (SYROP, NWO-OTP)
- Fuel cell propulsion system for Aircraft Megawatt Engine (FAME, Clean Aviation)
- Green ammonia production with Lithium chemistry (GAPLiC, NWO-XS)
- T.M.J. Nijssen and M. Khosravi; Understanding and controlling direct air capture under dynamic conditions,TU Delft ME Cohesion grant 60k€
- ARC-CBBC project on Thermocatalytic Decomposition of Methane, 1 PhD student (400k), Vlugt
- NWO XS grant on Closed-loop recycling of Li-ion batteries (Vlugt)
- ENCASE eu project on CO2 flow and thermodynamics (1 PhD student)

Projects started in 2023

- Sebastiaan Kuipers. Fluid dynamics, heat and mass transfer in air contactor devices for Direct Air Capture. Promotor: T.J.H. Vlugt, Co-promotor: T.M.J. Nijssen.

Other 2023 highlights

- Dr. O. Moultos received the prestigious "Young Researcher Award" during the 16th International Conference on Properties and Phase Equilibria for Product and Process Design (PPEPPD2023) in Tarragona, Spain
- Publication in collaboration with CiTG/TU Delft which includes important and extensive new data sets for (a) interfacial tensions of H_2 gas in contact with aqueous NaCl solutions, (b) self-diffusivities of H_2 in aqueous NaCl solutions, and (c) solubilities of H_2 in aqueous NaCl solutions. Van Rooijen, Moultos, Vlugt et al. J. Chem. Eng. Data. 2024, 69, 307-319
- Publication of a review article on the carbonation problem in CO_2 electrolyzers. Ramdin et al. Carbonation in low-temperature CO2 electrolyzers: Causes, consequences, and solutions. Ind. Chem. Chem. Res. 2023, 62, 6843-6864
- Development of a new software tool for the computation of adsorption and reaction equilibria from quantum mechanical calculations and free energy computations: Solving Chemical Absorption Equilibria Using Free Energy and Quantum Chemistry Calculations: Methodology, Limitations, and New Open-Source Software, H.M. Polat, F. de Meyer, C. Houriez, O.A. Moultos, T.J.H. Vlugt, Journal of Chemical Theory and Computation, 2023, 19, 2616-2929
- Development of a new software tool for the computation of breakthrough curves for adsorption: RUPTURA: Simulation Code for Breakthrough, Ideal Adsorption Solution Theory Computations, and Fitting of Isotherm Models, S. Sharma, S.R.G. Balestra, R. Baur, U. Agarwal, E. Zuidema, M.S. Rigutto, S. Calero, T.J.H. Vlugt, D. Dubbeldam, Molecular Simulation, 2023, 49, 893-953. (www.iraspa.org)

Delft University of Technology

Faculty of Mechanical Engineering (ME)

Department Maritime and Transport Technology

Ship Hydromechanics (TUD-ME-SH)

Prof. dr. ir. Bendiks Jan Boersma	Full. prof.
Prof. dr. ir. Gabe Weymouth	Full. prof.
Prof. dr. ir. T.C.J. van Terwisga	Full prof. (part time)
Dr. ir. Ido Akkerman	Assistant prof.
Dr. ing. Sebastian Schreier	Assistant prof.
Dr. ir. Peter Wellens	Assistant prof.
Dr. Harleigh Seyffert	Assistant prof.
Dr. Daniele Fiscaletti	Assistant prof.
Dr. Bernat Font	Assistant prof.
Dr. Nicolás Valle Marchante	Assistant prof.

Group's research areas

- Ship hydromechanics
- Multiphase flow: Cavitation, phase transition
- Multiphase flow: free surface waves and entrainment
- Turbulence: separating turbulent boundary layers and wakes
- Fluid-structure-interaction: Large amplitude deformations
- Data-driven modelling

Collaboration with other groups inside and outside the Burgerscentrum

- In almost all projects we collaborate with the groups of Westerweel/Poelma/Henkes

PhD theses delivered in 2023

- 12 January 2023 – Themistoklis Melissaris – *Simulation of cavitation and surface erosion on marine propellers*, PhD Thesis, Delft University of Technology, (van Terwisga, Poelma).
- 11 September 2023 – Swaraj Nanda – *Gas transport into vortex cavities*, PhD Thesis, Delft University of Technology, (Van Terwisga, Westerweel, Elsinga).
- 26 October 2023 – Martin van der Eijk – *Extreme aerated water-wave impacts on floating bodies*, PhD Thesis "Cum Laude", Delft University of Technology, (Boersma, Wellens).

Projects started in 2023

- Floating Future
- FlexFloat
- SCALE: Multiphase simulations using Artificial intelligence and Statistical methods at Scale

Other 2023 highlights

- Hired Bernat Font as Assistant Professor of Data Driven Ship Hydrodynamics

Delft University of Technology

Faculty of Mechanical Engineering (ME)

Department Maritime and Transport Technology

Dredging Engineering (TUD-ME-DE)

Dr. ir. Rudy Helmons	Associate prof.
Dr. ir. Geert Keetels	Assistant prof.
Dr. ir. Arno Talmon	Assistant prof.
Dr. ir. Said Alhaddad	Assistant prof.
Dr. ir. Antonio Jarquin Laguna	Assistant prof.

Group's research areas

- Dredging Processes, including trenching of cables and pipelines
- Deep Sea Mining
- CFD of (multiphase) flows
- Turbidity currents, hyper concentrated sediment water flows
- Sedimentation and erosion of sediments
- Hydraulic and mechanical excavation
- Seabed interaction with fishing gear
- Wave energy
- Low head energy storage

Collaboration with other groups (inside or outside Burgerscentrum)

- Blue Harvesting: collaboration with RWTH Aachen University, ICM Institute of Marine Sciences, Aarhus University, NIOZ, Jacobs University, University Politechnica of Catalunya , Royal IHC
- PlumeFloc: NIOZ, IHC Mining, Allseas, Boskalis, Deltares
- Onderzoek Duurzame visserij: Marin, NIOZ, Wageningen Research
- SailFM : Marin, Port of Rotterdam
- StimTech: WUR, VisNED, Vissersbond, Visserij Innovatie Centrum
- ALPHEUS: collaboration with UGhent, Technische Universität Braunschweig, University of Stuttgart, Chalmers University of Technology, NTNU

PhD theses delivered in 2023

- 23 February 2023 – Stefano Lovato – *Sailing through fluid mud*, PhD Thesis, Delft University of Technology, (van Rhee, Keetels).
- 5 September 2023 – Mohamed Elerian – *Numerical investigation of turbidity flows generated by polymetallic nodules mining*, PhD Thesis, Delft University of Technology, (van Rhee, Helmons).

Delft University of Technology

Faculty of Applied Sciences

Department Chemical Engineering

Transport Phenomena (TUD-CE-TP)

Prof. dr. Valeria Garbin	Full prof.
Prof. dr. ir. Chris Kleijn	Full prof.
Prof. dr. Saša Kenjereš	Full prof.
Prof. dr. ir. Harrie van den Akker	Full prof. (part time)
Dr. ir. David Vermaas	Associate prof.
Dr. Luis Portela	Assistant prof.
Dr. Bijoy Bera	Assistant prof.
Dr. Hanieh Bazyar	Assistant prof.

Group's research areas

- Multiphase flow and turbulence
- Electrochemical flow systems
- Interfacial phenomena and soft matter
- Biomedical fluid dynamics and transport phenomena
- Magnetohydrodynamics

Collaboration with other groups (inside or outside Burgerscentrum)

- Department of Mechanical Engineering, The Hong Kong Polytechnic University, Hong Kong, China
- Chemical Engineering Department, University Salamanca, Spain
- ELECTRIFIED: collaboration with FPE group at WUR (JMBC), CFP group at TUD (JMBC) and RUG, TU/e, UT
- Smart Tomographic Sensors for Advanced Industrial Process Control: collaboration with Helmholtz-Zentrum Dresden-Rossendorf (HZDR), Germany, Lodz University of Technology (LUT), Poland, and Institut de Mécanique des Fluides de Toulouse (IMFT), France
- Computation for Rational Design of Bioreactors: collaboration with Department of Biotechnology, Delft University of Technology (TU Delft)
- Two-Phase Gas-Liquid Flows in Pipelines: collaboration with University of Campinas (UNICAMP), Brazil
- CO2 Cooling for Particle Detectors: collaboration with European Organization for Nuclear Research (CERN), Switzerland.
- X-Ray Tomography: collaboration with Centrum Wiskunde & Informatica (CWI).
- LUMC - Leiden University Medical Centre: Department of Radiology; Department of Pediatric Surgery; Department of Cardiology and Anatomy and Embryology; Department of Cardiothoracic Surgery
- MUMC+ - Maastricht University Medical Centre: Department of Radiology & Nuclear Medicine; Cardiovascular Research Institute
- AMC - Amsterdam University Medical Centre: Department of Radiology and Nuclear Medicine
- EMC - Erasmus Medical Centre Rotterdam: Department of Cardiology; Department of Biomedical Engineering
- University of Ghent, Belgium - Institute of Biomedical Technology

- AGH Krakow University of Science and Technology, Poland - Faculty of Energy and Fuels, Department of Fundamental Research in Energy Engineering
- SCK-CEN - Belgian Nuclear Research Centre, Mol, Belgium
- Vinca Institute of Nuclear Sciences, University of Belgrade, Serbia
- Tata Steel, IJmuiden, The Netherlands
- Philips, Department of MR R&D Clinical Science, Best, The Netherlands
- Pie Medical Imaging, Maastricht, The Netherlands

PhD theses delivered in 2023

- 21 April 2023 – Lorenz Baumgartner – *Mass transfer and flooding phenomena in carbon dioxide electrolyzers*, PhD Thesis, Delft University of Technology, (Vermaas, Kleijn).
- 13 June 2023 – Romana Perinajová – *Modelling of blood flow in aorta: MRI-based computational fluid dynamics of aortic hemodynamics*, PhD Thesis, Delft University of Technology, (Kenjereš, Lamb).

Grants obtained in 2023

- NWO-TTW Vidi grant "Towards green fuels with nano-sized thin layers" (PI: D. Vermaas)
- NWO-TTW Vici grant "Flow physics of Pickering emulsion reactors for sustainable chemical conversion" (PI: V. Garbin)
- EU-MSCA Industrial Doctoral Network "CoCoGel: Controlling Colloidal Gels for Novel Sustainable Materials" (TUD participant: V. Garbin)
- Initiative on Innovation in Delft Engineering Education (IDEE) grant for investigating "Retention in Engineering Education" (consortium with 5 PIs from TUD; TP PI: B. Bera)

Projects started in 2023

- Transport of charged species in artificial kidney.Collaboration with Utrecht Medical Center, Department of Nephrology (B. Bera)
- Microrheology of coacervated polymer mixtures for medical glue. Collaboration with Department of Chemistry, RUG (B. Bera)
- NWO-TTW Vidi project "Towards green fuels with nano-sized thin layers" (PI: D. Vermaas)
- NWO-TTW Vici project "Flow physics of Pickering emulsion reactors for sustainable chemical conversion" (PI: V. Garbin)

Delft University of Technology

Faculty of Applied Sciences

Department Chemical Engineering

Product and Process Engineering (TUD-CE-PPE)

Prof. dr. ir. Ruud van Ommen	Full prof.
Dr. ir. Volkert van Steijn	Associate prof.
Dr. Pouyan Boukany	Associate prof.

Group's research areas

- Droplet microfluidics
- Interfaces, bubbles, droplets, emulsions and interfaces
- Granular matter, (nano)particle processing, fluidization
- Application of fluid mechanics in health technology

Collaboration with other groups (inside or outside Burgerscentrum)

- Collaboration with a wide range of groups, including Kuipers (TU/e), Luding (UT), Padding (TUD), Quax & Kruyt (LUMC), Van Beusekom (EMC), Ten Dijke (LUMC)

PhD theses delivered in 2023

- 16 May 2023 – Bernard Weninger – *Bridging intermittency: with iron electrodes*, PhD Thesis, Delft University of Technology, (Mulder, Van Ommen).
- 6 September 2023 – Sarah Schyck – *Anisotropic and magnetic microparticles: Preparation and out-of-equilibrium assembly*, PhD Thesis, Delft University of Technology, (Rossi, Boukany).
- 22 September 2023 – Donato Pinto – *CH_4 and CO_2 utilization by unsteady-state operation*, PhD Thesis, Delft University of Technology, (Urakawa, Van Ommen).

Grants obtained in 2023

- Marie Curie grant: "HydrOdynamics & biomechanics of canceR cell mIgration in heterOgeNeous media (ORION)" by dr. Ankur Bordoloi in Boukany's group
- NWO-XS grant: "3d-Printing meets T-cells (T-PRINT)" by dr. Mahiyeh Nouiri in Boukany's group

Projects started in 2023

- NXTGEN HIGHTECH grant: "Thin film technology for 3rd generation electrolysers", 2 PhD position by prof. Ruud van Ommen

Other 2023 highlights

- ARC CBBC's presentation award by PhD student Rens Kamphorst

Delft University of Technology

Faculty of Electrical Engineering, Mathematics and Computer Science (EEMCS)

Delft Institute of Applied Mathematics (DIAM)

Numerical Analysis (TUD-EEMC-NA)

Prof. dr. ir. Kees Vuik	Full prof.
Prof. dr. Martin van Gijzen	Full prof.
Dr. ir. Matthias Möller	Associate prof.
Dr. ir. Deepesh Toshniwal	Assistant prof.
Dr. Alexander Heinlein	Assistant prof.

Group's research areas

- Discretization methods for Partial Differential Equations: Isogeometric analysis (IgA), Boundary Element Method (BEM), Multiscale methods for porous media flow.
- Fast and Robust solvers: Domain Decomposition methods, Preconditioned and Deflated Krylov methods, Multigrid methods, Scalable methods
- High Performance computing: methods for GPU and Quantumcomputing, parallel iterative methods
- Machine Learning methods combined with Partial Differential Equations

Collaboration with other groups (inside or outside Burgerscentrum)

- Group of Prof. J. Westerweel
- Group of Dr. H. Hajibeygi

PhD thesis delivered in 2023

- 18 September 2023 – Ginger Egberts – *In silico exploration of post-burn contraction using uncertainty quantification*, PhD Thesis, Delft University of Technology, (Vuik, Vermolen, van Zuijlen).

Grants obtained in 2023

- Novel quantum algorithms for computational fluid dynamics: TU Delft and Fujitsu join forces Dr. Matthias Moller
  https://www.tudelft.nl/en/2023/eemcs/novel-quantum-algorithms-for-computational-fluid-dynamics-tu-delft-and-fujitsu-join-forces

Projects started in 2023

- Quantum Computational Fluid Dynamics, Dr. Matthias Moller

Delft University of Technology

Faculty of Electrical Engineering, Mathematics and Computer Science (EEMCS)

Delft Institute of Applied Mathematics (DIAM)

Mathematical Physics (TUD-EEMC-MP)

Prof. dr. ir. Henk Schuttelaars	Full prof.
Prof. dr. ir. Arnold Heemink	Full prof. (em.)
Prof. dr. ir. Martin Verlaan	Full prof. (part time)
Prof. dr. ir. Hai Xiang Lin	Full prof.
Dr. ir. Wim van Horssen	Associate prof.
Dr. Johan Dubbeldam	Associate prof.
Dr. Bernard Meulenbroek	Assistant prof.
Dr. Domenico Lahaye	Assistant prof.
Dr. Yoeri Dijkstra	Assistant prof.
Dr. ir. Ramses van der Toorn	Assistant prof.
Ir. Marieke Kootte	Assistant prof.

Group's research areas

- Modelling and analysis of partial differential equations, with applications in coastal sea dynamics, vibrating structures, and petroleum reservoirs
- Data assimilation and Inverse modelling, with application in tidal model calibration, reservoir history matching, emission estimation in atmospheric-chemistry transport models, and closed-loop degaussing for ships
- Complex networks, Dynamics on/of complex networks
- Development of mathematical methods in perturbation theory, difference equations, differential-delay equations, and fractional differential equations, with applications in mechanical engineering

Collaboration with other groups (inside or outside Burgerscentrum)

- Forecast Arctic Surges and Tides for the Netherlands: collaboration with dr. Slobbe, department of geosciences and remote sensing
- Versatile Hydrodynamics - A synergistic development of tomorrow's marine navigation products: collaboration with dr. Slobbe, Geosciences and remote sensing, CiTG, and with prof. J. Pietrzak, Environmental Fluid Mechanics, CiTG
- SaltiSolutions: collaboration with Prof. Dr. T. Hoitink, Environmental Fluid Mechanics, WUR
- Morphodynamic evolution of tidal basins: collaboration with Prof. dr. ir. T. De Mulder, Faculty of Engineering and Architecture, Ghent University
- IFlow, three-dimensional modeling of sediment trapping in estuaries: collaboration with Dr. G.P. Schramkowski and Dr. S. Kaptein, Flanders Hydraulics Research
- Collaboration with Katerina Stankova (TPM at TU Delft)
- Collaboration with NAS group of Piet van Mieghem (EEMCS at TU Delft)
- Towards Exascale Computing for Large Scale Groundwater Simulation, collaboration with Prof. dr. M. Bierkens, Utrecht University, and Dr. G.H.P. Oude Essink, Deltares

- Air quality forecast by integrating learning with data assimilation, collaboration with Dr.ir. A. Segers and Dr. A.M. Manders-Groot, TNO Climate, Air and Sustainability
- ML and DA for improving air quality forecast of chemical transport models, collaboration with Dr. J. Jin, Nanjing University of Information Science & Technology
- Collaboration with the Departments of Mathematics at ITB and at UGM (Indonesia)

PhD theses delivered in 2023

- 31 January 2023 – S. Wang – *Modelling urban automated mobility on-demand systems: an agent-based approach*, PhD Thesis, Delft University of Technology, (Lin, Correia).
- 6 March 2023 – Xiao Deng – *Morphodynamic equilibria in double-inlet systems; their existence, multiplicity and stability*, PhD Thesis, Delft University of Technology, (Schuttelaars, De Mulder).
- 21 April 2023 – Inger Bij de Vaate – *Spatiotemporal variability in global storm surge and tidal water levels from satellite radar altimetry*, PhD Thesis, Delft University of Technology, (Klees, Verlaan, Slobbe).

Grants obtained in 2023

- Dr. Yoeri Dijkstra (VENI). Understanding three-dimensional salt intrusion under climate change and human interventions

Delft University of Technology

Faculty of Aerospace Engineering

Department Flow Physics and Technology

Aerodynamics (TUD-AE-AD)

Prof. dr. Stefan Hickel	Full prof.
Prof. dr. Fulvio Scarano	Full prof.
Prof. dr. Marios Kotsonis	Full prof.
Dr. ir. Bas van Oudheusden	Associate prof.
Dr .ir. Marc Gerritsma	Associate prof.
Dr. Richard Dwight	Associate prof.
Dr. Andrea Sciacchitano	Associate prof.
Dr. ir. Sander van Zuijlen	Assistant prof.
Dr. ir. Ferry Schrijer	Assistant prof.
Dr. Ahn Khoa Doan	Assistant prof.
Dr. Steven Hulshoff	Assistant prof.
Dr. Davide Modesti	Assistant prof.
Dr. ir. Woutijn Baars	Assistant prof.
Dr. Mogeng (Morgan) Li	Assistant prof.
Dr. Theo Michelis	Assistant prof.

Group's research areas

- Aircraft aerodynamics, flapping-wing and animal flight aerodynamics, wind turbine aerodynamics, sports aerodynamics
- High-speed aerodynamics, compressible flows, shock-turbulence interactions, hypersonic flows
- Unsteady aerodynamics and aeroelasticity
- Bluff body aerodynamics and wakes
- Boundary layers: flow stability and laminar-turbulent transition, flow separation, turbulence, wall roughness, heat transfer
- Active and passive flow control, actuators for flow control
- Flow measurement and flow visualization techniques, Particle Image Velocimetry (PIV)
- Computational Fluid Dynamics (CFD), Fluid-Structure Interaction (FSI)
- Direct Numerical Simulation (DNS), Large Eddy Simulation (LES), Variational Multiscale Methods
- High performance computing, quantum computing
- Machine learning and data assimilation
- High-order methods for continuum mechanics
- Turbulence modelling for RANS and LES
- Thermodynamics modelling: reactive flows, multiphase flows
- Climate effects: aircraft emissions, control by aerosols

Collaboration with other groups (inside or outside Burgerscentrum)

- Sports aerodynamics: TU Delft/ME/Fluid Mechanics; Monash U.; F1 teams
- Wall bounded turbulence: U. of Bologna; La Sapienza U.; U. of Melbourne; KTH; U. of Houston; U. of Waterloo
- Aeroacoustics: von Karman Institute; NLR

- Combustion: U. of Twente; Tokyo Institute of Technology; IICs Bangalore
- Hypersonics: von Karman Institute; U. of Maryland
- Shock-wave/boundary-layer interaction: U. of Cambridge; RWTH Aachen; Rolls-Royce Deutschland
- Multiphase flows: TU Delft/ME; MARIN; TU Munich; U. Napoli; CITY University; Wärtsilä
- Dynamic control of wind turbine wakes: TU Delft/ME
- Bluff-body aerodynamics: Norwegian U. of S&T; U. of Sheffield; U. of Calgary; Univ. of Durham
- Uncertainty Quantification: TU Delft/ME/Systems and Control; DLR; Sorbonne Univ.
- Machine learning: Imperial College London; The Alan Turing Institute; Siemens Mobility Austria GmbH; TU Munich; TU Berlin; Sorbonne Université; Tokyo Institute of Technology
- Data assimilation: TU Berlin
- Numerical methods: TU Delft/Mathematics; U. of Twente; U. Carlos III de Madrid; Lilium GmbH
- Measurement techniques: NLR; DLR; ESA-ESTEC; U. Carlos III de Madrid; U. of Houston; U. of Hokkaido; U. BW München; Volkswagen; LaVision; F1 teams
- Flow control: CERTH, Greece; Leonardo SPA; U. of Twente; ETH Zürich

PhD theses delivered in 2023

- 20 January 2023 – Alessando D'Aguanno – *Physics and control of transonic buffet*, PhD Thesis, Delft University of Technology, (van Oudheusden, Schrijer).
- 15 March 2023 – Ming Huang – *Wake and wind farm aerodynamics of vertical axis wind turbines*, PhD Thesis, Delft University of Technology, (Simão Ferreira, Sciacchitano).
- 14 June 2023 – Edoardo Saredi – *Advancements in large-scale volumetric PIV and PTV*, PhD Thesis, Delft University of Technology, (Scarano, Sciacchitano).
- 30 June 2023 – Christoph Mertens – *Experimental aeroelastic characterization based on integrated optical measurements*, PhD Thesis, Delft University of Technology, (Van Oudheusden, Sciacchitano, Sodja).
- 7 September 2023 –Giullia Zoppini – *Receptivity of swept wing boundary layers to surface roughness: Diagnostics and extension to flow control*, PhD Thesis, Delft University of Technology, (Kotsonis, Ragni).
- 20 September 2023 – Lourenco Tercio Lima Pereira – *Physics of broadband noise reduction by serrated trailing edges*, PhD Thesis, Delft University of Technology, (Scarano, Ragni, Avallone).
- 30 October 2023 – Xiadong Li – *Towards efficient adjoint-based mesh optimization for predictive Large Eddy Simulation*, PhD Thesis, Delft University of Technology, (Hickel, Hulshoff).
- 14 November 2023 – Kushal Ujjaini Kempaiah – *Active control of turbulent skin-friction: An experimental study*, PhD Thesis, Delft University of Technology, (Scarano, Baars).
- 6 December 2023 – Gabriel González Saiz – *Advancements in optical diagnostics for experimental aeroelasticity: Benchmarking the cylinder-foil system*, PhD Thesis, Delft University of Technology, (Scarano, Sciacchitano).
- 11 December 2023 – Sagar Adatrao – *Advances in PIV Uncertainty Quantification: Towards a comprehensive framework*, PhD Thesis, Delft University of Technology, (Scarano, Sciacchitano).
- 14 December 2023 – Julia Steiner – *Towards data-driven turbulence modelling for wind turbine wakes*, PhD Thesis, Delft University of Technology, (Viré, Watson, Dwight).

Grants obtained in 2023

- OTP "*Flow for Gold: Quantitative flow visualisations to enhance sports performance"*

- MSCA *"Industry empowerment to Multiphase fluid dynamics simulations using Artificial intelligence and Statistical methods on modern hardware architectures at Scale"* (SCALE)
- COST action CYPHER

Projects started in 2023

- Multi-objective optimization of flexible propellers for low noise and high efficiency
- Turbulent inflow data generation using goal-oriented reduced-order models
- Deployable vortex generators using shape memory materials
- Laminar & turbulent boundary layer flows over non-adiabatic walls
- Hydrogen Aircraft Powertrain and Storage System (HAPSS)
- Hydrogen combustion at high strain rate conditions
- Aerodynamics of pitching airfoils with tubercles leading edge
- Advanced numerical modeling for Vortex in Cell data assimilation of 3D PTV
- Streamline and timeline visualization with a HFSB probe
- A universal approach to light reflections elimination in 3D PIV
- Object registration techniques in 3D PTV and near wall flow visualization for generalized surfaces
- Track detection for 3D PTV multi-exposure recordings with time sequence encoding
- Aerodynamics analysis of a swirled combustor with PIV
- Augmentation of PTV diagnostic with physics-informed machine learning
- Data-driven identification of precursor of flashback
- Machine learning techniques for generative aircraft design
- Non-intrusive unsteady pressure loads measurement techniques in wind tunnels for launchers

Other 2023 highlights

- Marios Kotsonis promoted to Professor of Flow Control
- 20th International Symposium on Flow Visualization, TU Delft, July 2023
- Masters of Flow Visualization, 1st edition
- AIAA Best Paper Award for "*GPU-accelerated simulations for eVTOL aerodynamic analysis*"

Delft University of Technology

Faculty of Aerospace Engineering

Department Flow Physics and Technology

Wind Energy (TUD-AE-WE)

Prof. dr. Damiano Casalino	Full prof.
Prof. dr. Simon Watson	Full prof.
Prof. dr. Dominic von Terzi	Full. prof.
Prof. dr. ir. Carlos Simao Ferreira	Full prof.
Prof. dr. ir. Axelle Viré	Full prof.
Dr. Daniele Ragni	Associate prof.
Dr. ir. Delphine de Tavernier	Assistant prof.
Dr. Tercio Lima Pereira	Assistant prof.
Dr. ir. Frits de Prenter	Assistant prof.
Dr. ir. Dries Allaerts	Assistant prof.
Dr. Wei Yu	Assistant prof.

Group's research areas

- Aerodynamics of wind turbines, farms and clusters
- Aeroacoustics of wind energy and aviation applications
- Aeroelasticity of wind energy devices

Collaboration with other groups (inside or outside Burgerscentrum)

- European Academy of Aeroacoustics EA2: Professional School with Von Karman Institute of Fluid Dynamics and University of Bristol https://www.tudelft.nl/lr/european-academy-of-aeroacoustics
- TU Delft Advanced Air-Mobility and Turbo Air, https://www.tudelft.nl/lr/tu-delft-advanced-air-mobility-ta2m with benchmarking activities across institutes (e.g. VKI, Achen, Ecole Centrale de Lyon, Onera, DLR, NLR)
- European Academy of Wind Energy
- US National Renewable Energy Lab (NREL), Wind Energy section
- TNO, Wind Energy section

PhD theses delivered in 2023

- 15 March 2023 – Ming Huang – *Wake and wind farm aerodynamics of vertical axis wind turbines*, PhD Thesis, Delft University of Technology, (Simão Ferreira, Sciacchitano).
- 7 September 2023 –Giullia Zoppini – *Receptivity of swept wing boundary layers to surface roughness: Diagnostics and extension to flow control*, PhD Thesis, Delft University of Technology, (Kotsonis, Ragni).
- 13 September 2023 – Bedassa Cheneka – *Wind power ramps: Characterisation, forecasting, and future projection*, PhD Thesis, Delft University of Technology, (Watson, Basu).

- 18 September 2023 – Furkat Yunus – *Methodologies and algorithms for sound propagation in complex environments with application to urban air mobility: A ray acoustics approach*, PhD Thesis, Delft University of Technology, (Casalino, Ragni, Avallone).
- 20 September 2023 – Lourenco Tercio Lima Pereira – *Physics of broadband noise reduction by serrated trailing edges*, PhD Thesis, Delft University of Technology, (Scarano, Ragni, Avallone).
- 14 December 2023 – Julia Steiner – *Towards data-driven turbulence modelling for wind turbine wakes*, PhD Thesis, Delft University of Technology, (Viré, Watson, Dwight).

Grants obtained in 2023

- eVTOLUTION: eVTOL multi-fidelity hybrid design and optimization for low noise and high aerodynamic performance, Horizon Europe
- AMPERE: TTW- OTP Aeroacoustic Multi-path Permeable geometries for airfoil Edge-noise Reduction
- STABILIZE: NWO-Veni STable and Accurate Boundary conditions In the LattIce boltZmann mEthod
- MARTA: NWO-Veni Morphing wind turbine blAdes foR Turbulence Absorption
- HybridLabs: NWO NWA-ORC “Accelerating Dutch deployment of offshore renewables through data-driven hybrid labs”
- EU Horizon Europe DigiWind – Digital Skills for Wind Energy
- NWO OTP DIAMOND DynamIc yAw Models fOr wiND turbine/farm design

Projects started in 2023

- NWO VIDI Physics-informed modelling for floating wind turbines
- EU Horizon Europe MERIDIONAL: Multiscale modelling for wind farm design, performance assessment and loading

Delft University of Technology

Faculty of Aerospace Engineering

Department Flow Physics and Technology

Flight Performance and Propulsion (TUD-AE-FPP)

Prof. dr. Arvind Gangoli Rao	Full prof.
Prof. dr. ir. Leo Veldhuis	Full prof.
Dr. ir. Ivan Langella	Assistant prof.
Dr. ir. Francesca De Domenico	Assistant prof.

Group's research areas

- Novel Propulsion systems
- Aircraft Engine Integration
- Novel Combustion system

Grants obtained in 2023

- VENI: Francesca de Domenico, NWO
- ACHIEVE: Hydrogen Research Europe, EU
- HYLENA: Horizon Europe Collaborative, EU
- DEMOQUAS: Horizon Europe Collaborative, EU
- TRIATHALON: Horizon Europe Collaborative, EU
- Luchtvaart in Transitie: Groeifonds, RVO
- ICARUS: Marie Curie ITN, EU

Projects started in 2023

- HOPE: Horizon Europe Collaborative, EU
- ERC of Ivan Langella

Other 2023 highlights

- The faculty purchased an aircraft for research purposes, Cesna Sky Master.
- The combustion lab was equipped with a new LIF (Laser Induced Fluorescence) measuring system

Delft University of Technology

Faculty of Civil Engineering and Geosciences

Department Hydraulic Engineering

Environmental Fluid Mechanics (TUD-CEG-EFM)

Prof. dr. ir. Wim Uijttewaal	Full prof.
Prof. dr. Caroline Katsman	Full prof.
Prof. dr. Julie Pietrzak	Full prof.
Prof. dr. ir. Ad Reniers	Full prof.
Dr. ir. Claire Chassagne	Associate prof.
Dr. Ton van den Bremer	Associate prof.
Dr. ir. Bram van Prooijen	Associate prof.
Dr. ir. Marcel Zijlema	Assistant prof.
Dr. ir. Robert Jan Labeur	Assistant prof.
Dr. Marion Tissier	Assistant prof.

Group's research areas

- Physical Oceanography
- Coastal and Estuarine dynamics
- River dynamics
- Sediment dynamics
- Turbulence and transport in environmental flows

Collaboration with other groups (inside or outside Burgerscentrum)

- Hydrodynamical interaction with submerged floating tunnels: University of Michigan, USA
- Turbidity currents triggered by jets: Karlsruhe Institute of Technology, Germany
- The fluid mechanics of marine litter pollution in the coastal zone: TU Eindhoven.
- Plastic accumulation in water systems: Bandung Institute of Technology, Indonesia
- Mangrove restoration: University Diponegoro University Semarang, Indonesia
- Hydrodynamics and sediment transport in estuaries: NIOZ-Yerseke
- Characteristics of currents in the subpolar North Atlantic Ocean – NIOZ-Texel, UU and University of Oxford
- Hydrodynamics and sediment transport in estuaries: SKLEC Shanghai China
- Wave Breaking in Crossing Seas, Universities of Oxford, Edinburgh, Manchester and University College Dublin
- Near-dune hydrodynamics during wave attack, North Carolina State University, USA and University of North Carolina Wilmington, USA.
- Long wave dynamics along reef-lined coasts, University of Montpellier, Université de Bretagne Occidentale, and Université de Pau et des Pays de l'Adour, France
- Coral reef restoration and island flooding, Plymouth University and University of Bath, UK.
- Hydrodynamics of large-scale floating infrastructure, MARIN, Wageningen, The Netherlands
- Salinity intrusion into estuaries: Woods Hole Oceanographic Institution, MA, USA and University of Washington, WA, USA
- Circulation and Mixing in the Southern North Sea: NIOZ-Texel, NIOZ-Yerseke, WMR

PhD theses delivered in 2023

- 15 May 2023 – Gal Akrish – *Spectral modelling of coastal waves over spatial inhomogeneity*, PhD Thesis, Delft University of Technology, (Reniers, Zijlema, Smit).
- 22 June 2023 – Merel Verbeek – *Optimizing the configuration of tidal turbines in storm surge barriers*, PhD Thesis, Delft University of Technology, (Uijttewaal, Labeur).
- 22 June 2023 – Christa van IJzerdoorn – *From loose grains to resilient dunes*, PhD Thesis, Delft University of Technology, (de Vries, Reniers, Hallin).
- 29 June 2023 – Joost Kranenborg – *Vertical dependences in swash-zone flows and sand transport*, PhD Thesis, University of Twente, (Hulscher, Reniers, van der Werf, Campmans).

Grants obtained in 2023

- EU Horizon proposal: DuneFront: Demonstration of Dune-Dike hybrid blue-grey Natura Based Solutions. This project includes dedicated laboratory and numerical modeling of extreme runup and overtopping in the presence and absence of vegetation over dune-dike configurations to establish the corresponding safety levels during extreme storm conditions
- CREST: Coral reef restoration to reduce island flooding. In this project, large-scale laboratory experiments will be conducted to systematically investigate the effect of reef restoration on sea-swell and infragravity wave dynamics and wave-driven flooding
- StratiFEst-ival (TKI): Multiple former estuaries experience ecological issues related to hypoxia and stratification. This project investigates stratification, circulation and mixing dynamics in enclosed former estuaries using both innovative measurements and numerical models, to lay the groundwork for improved ecosystems

Projects started in 2023

- The NWO-XL project NoSE (The role of the North Sea in the Atlantic Ocean biogeochemical system: North Sea-Atlantic Exchange) started with TU Delft as co-applicant (van Prooijen, Pietrzak)
- The NWO-perspective program WADSED (**Wad**den **S**ea and **E**stuaries: system **D**ynamics and sediment management under climate change) started (Wang, van Prooijen, van Maren)
- The NWO-LSR (large scale research infrastructure) program Delta-Enigma (Observation and experimentation equipment to improve predictions of biogeomorphology in deltas) started (van Prooijen)
- The NWO-M1 project North Atlantic CLUEDO Controls on Light Upper ocean waters Entering the Deep Ocean started (Katsman, Gelderloos)
- NWA-ORC Floating Future (Scaling up floating structures as climate-proof space-creating solution enabling societal, industrial and ecological win-wins), work package 2.3-4: Technology (Hofland, Labeur)
- The NWO-ORC program OR-ELSE (Operational Recommendations for Ecosystem based Large scale Sand Extraction) started, including a project on Flow and Transport in the Southern North Sea (Pietrzak, Kranenburg)

Other 2023 highlights

- TU Delft organized the NCK days (Nederlands Centrum voor Kustonderzoek) in 2023. The J.M. Burgerscentrum was one of the contributors

Delft University of Technology

Faculty of Civil Engineering and Geosciences

Department Geoscience & Engineering

Reservoir Engineering (TUD-CEG-RE)

Prof. dr. Hadi Hajibeygi Full prof.
Dr. D.V. Denis Voskov Associate prof.

Group's research areas

- Geothermal energy
- Hydrogen storage
- CO2 storage

Delft University of Technology

Faculty of Civil Engineering and Geosciences

Department of Water Management

Sanitary Engineering (TUD-CEG-SE)

Dr. ing. Dhruv Mehta Assistant prof.

Group's research areas

- Drinking water supply and treatment
- Waste water supply and treatment
- Decentralised sanitation with concentrated slurry

Collaboration with other groups (inside or outside Burgerscentrum)

- Multiphase Systems (TUD-ME-MS)
- Dredging Engineering (TUD-ME-DE)
- Environmental Fluid Mechanics (TUD-CEG-EFM)

Grants obtained in 2023

- OTP SYROP: co-applicants Dr. R. Taormina, Dr. K. Lompe
- Marie Skłodowska-Curie Actions Individual Fellowship: Dr. S. Mohapatra

Other 2023 highlights

- Patent: gas recovery from wastewater US 11,554,332 (van Linden, N., van Lier, J.B. and Spanjers, H.)

Delft University of Technology

Faculty of Architecture and the Built Environment

Department of Urbanism - Breathe Lab TUD-ABE-BL) and

Department of Architectural Engineering and Technology – SenseLab (TUD-ABE-SL)

Dr. Clara García-Sánchez Assistant prof.
Prof. dr. ir. Philomena M. Bluyssen Full prof.

Group's research areas

- Indoor airflow, ventilation, air cleaning and air quality
- Indoor environmental quality assessments (air, thermal, light and sound qualities), both perceptual and physical/chemical
- Exposure studies in the SenseLab with subjects
- Design of heating, ventilating, and air conditioning systems
- Indoor furnishing materials: emissions, acoustics, light (dolour, reflection etc.) and thermal aspects
- Automatic reconstruction of the built environment tailored for CFD simulations.
- Large-scale urban flow CFD simulations (RANS/LES)
- Dispersion CFD simulations indoor and outdoor

Collaboration with other groups (inside or outside Burgerscentrum)

- National Center for Atmospheric Research (NCAR), USA (Domingo Muñoz-Esparza)
- Polytechnic University of Madrid (UPM), Spain (Soledad Le Clainche)
- Amsterdam University (Daniel Bohn)
- Utrecht University
- The University Medical Centre Utrecht
- Erasmus University
- Erasmus University Medical Centre
- University of Twente (Detlef Lohse)
- University of Maastricht
- Technical University of Eindhoven
- TNO

Grants obtained in 2023

- Pandemic & Disaster Preparedness Centre grant
- OCW mobile air cleaners
- Pandemische Paraatheid en Ventilatie (P3Venti)

Projects started in 2023

- Pandemic & Disaster Preparedness Centre – Frontrunner 2 (PhD A. Giri)
- P3Venti (Pandemische Paraatheid en Ventilatie) – Programmalijn III (Bluyssen advisor)
- OCW – Air cleaning in classrooms
- Horizon-CL5-2022-D5-01 – REFMAP (Reducing Environmental Footprint through transformative Multi-scale Aviation Planning)
- Horizon Marie Curie – MODELAIR (co-supervision PhD with UPM)

Other 2023 highlights

- Prof. dr. ir. Philomena M. Bluyssen is included in the list of 2% Top Scientist (Elsevier).

Eindhoven University of Technology

Department of Applied Physics

Fluids & Flows (TUE-AP-FF)

Prof. dr. Herman Clercx	Full prof.
Prof. dr. ir. GertJan van Heijst	Full prof. (em.)
Prof. dr. Federico Toschi	Full prof.
Prof. dr. Anton Darhuber	Full prof.
Dr. ir. Rudie Kunnen	Associate prof.
Dr. ir. Jos Zeegers	Associate prof.
Dr. Matias Duran Matute	Assistant prof.
Dr. Alessandro Corbetta	Assistant prof.
Dr. ir. Hanneke Gelderblom	Assistant prof.
Dr. ir. Jos Zeegers	Assistant prof.
Dr. Nicolae Tomozeiu	Assistant prof.

Group's research areas

- Turbulence
- Environmental Fluid Mechanics
- Multiphase and Complex Fluids
- Micro- and Nanohydrodynamics

Collaboration with other groups (inside or outside Burgerscentrum)

- "Shaping turbulence with small particles" NWO-Groot (Toschi, Clercx & Kunnen): Twente University (PoF-group), Università di Roma (Tor Vergata; Verzicco)
- "Fundamental fluid dynamics challenges in inkjet printing (FIP)" NWO-Canon-UT-TU/e program (Darhuber & Toschi): Canon Production Printing, Twente University (PoF-group), Utrecht University, TU/e (ET-group, Mech. Eng.)
- "SaltiSolutions: Data and CFD for solutions" NWO-TTW Perspectief (Clercx & Duran Matute): Delft University (Civil Eng.; Pietrzak), UCSB-USA (Meiburg), Flanders Hydraulics (Kaptein, Lopez Castaño), Hydro-Key (Uittenboogaard), Deltares (O'Mahoney)
- "UMO: Urban Mobility Observatory" NWO-Apparatuur Groot (Toschi). Delft University (Civil Eng.; Daamen)
- "Transport in rarefied gases in next generation phot-lithography machines (RARETRANS)" TTW-OTP (Toschi & Clercx): ASML (Arlemark), TU/e (ET-group, Mech. Eng.), Flow Matters (Di Staso)
- "Understanding and Controlling the Flow of Human Crowds" NWO-VENI (Corbetta): TU/e (MCS-SCI; Schilders & IE&IS-HTI group), RUG (de Jong), Univ. Tokyo (Feliciani), ITT Madras (Panachagnula, Thampi), Naturalis Leiden, Eindhoven municipality.
- "HTCrowd: a high-tech platform for human crowd flows monitoring, modeling and nudging" NWO-HTSM (Toschi & Corbetta). TU/e (IE&IS-HTI group), ProRail, Eindhoven municipality.
- "Active contamination control for equipment and substrates: Particle transport (ACCESS)" VDL-TU/e Impuls Program (Clercx, Kunnen & Toschi): VDL (Shestakov (VDL), Flow Matters (Di Staso), TU/e (AP-EPG; Beckers)
- "Active contamination control: Non-spherical particle dynamics in rarefied gases (ACCESS-2)" VDL-TU/e NGF Program (Clercx & Kunnen): VDL (Shestakov (VDL), TU/e (AP-EPG; Beckers)

- "Unravelling Neural Networks with Structure-Preserving Computing" NWO-Groot (Toschi & Corbetta). Sissa, Trieste (Rozza), Los Alamos (Gyria, Livescu)
- "Capillary shaping of structured surfaces for steering cell behavior" TU/e-AP (Gelderblom): TU/e (AP-SMB), TU/e (OBM-Biomed. Eng.; Foolen)
- "Plasma-induced flow in the liquid phase" TU/e-ICMS (Gelderblom): TU/e (AP-EPG; Sobota)
- "Self-organization of particles under an oscillating flow" TU/e-AP (Duran Matute & Clercx): Delft University (3ME-LAH; Breugem), Genova (Mazzuoli), TU/e (AP-SMB; Ellenbroek, Meijer)
- "The Dutch Wadden Sea as an event-driven system" NWO-ENW-Klein2 (Duran Matute): NIOZ (Gerkema, Donatelli), IOW-Germany (Gräwe)
- "Dispersion statistics in confined quasi-2D turbulence" CONACyT (Clercx & Duran Matute): Delft University (ME-MTT; Keetels)
- "Predicting, measuring and quantifying airborne virus transmission" Pandemic and Disaster Preparedness Center (PDPC) frontrunner program TUE-AP (Gelderblom), TUE-Me (Homan), Erasmus MC (Herfst, Fouchier)
- "SRCrowd: Individual and collective agency in Socially Responsible nudging of Crowds" NWO-HTSM-MVI (Toschi & Corbetta): TU/e (IE&IS-HTI group), ProRail
- "Predicting, measuring and quantifying airborne virus transmission", PDPC Frontrunner (Gelderblom): TU/e (P&F-group, Mech. Eng.; Homan), Erasmus MC (Herfst, Fouchier)
- "AICrowds: AI-Based Pedestrian Crowd Modelling and Management", EMDAIR - EAISI Exploratory Multidisciplinary AI Research Program (Corbetta): TU/e (CS-EE; Schoukens), TU/e (Stat-M&CS; Castro)
- "Fighting malaria mosquitoes using smart turbulence flow fields" (Zeegers): Wageningen University (Exp. Zoology group; Muijres)
- "Magnetic Density Separation" (Zeegers): Umincorp Rotterdam (Van Grootheest)
- "Mitigation Strategies for Airborne Infection Control – MIST" (Duran Matute): TU/e (BE; Van Hooff), Twente University (PoF; Lohse)
- "In-situ measurements of plasma-liquid interactions" (Darhuber): TU/e (AP-EPG; Sobota)

PhD theses delivered in 2023

- 19 April 2023 – Cosimo Livi – *A study of particles-flow interactions based on the numerical solution of the Boltzmann equation*, PhD Thesis, Eindhoven University of Technology, (Toschi, Clercx).
- 12 December 2023 – Timo van Overveld – *Spherical particles in oscillating flows: From a single particle to pattern dynamics,* PhD Thesis "Cum Laude", Eindhoven University of Technology, (Clercx, Duran Matute).

Grants obtained in 2023

- Open Competitie ENW - XS "A novel tensiometry device for in-situ measurements of plasma-liquid interactions" (Darhuber)
- EAISI-grant (TU/e) "Optimal pedestrian mobility in massive events" (Corbetta; 1 PhD)
- KIC – MISSION Emerging Key Enabling Technologies (NWO) "Accelerating Rarefied Gas Dynamics" (Toschi, Clercx, Corbetta; 2 PhD and 1 PD)
- DeepNL Call 2b (NWO) "A digital twin for modelling and forecasting induced seismicity" (Toschi; 2 PhD)

- NXTGEN Hightech Groeifonds program ACCESS-2 (with VDL and TU/e) “Non-spherical particle dynamics in rarefied gases” (Clercx, Kunnen; 1 PhD)

Projects started in 2023

- Droplets in turbulence (Kunnen; PhD: Chiel Koster)
- Optimal pedestrian mobility in massive events (Corbetta; PhD: Chiel van der Laan)

Other 2023 highlights

- Cum Laude distinction PhD thesis Timo van Overveld
- Organization of Pedestrian and Evacuation Dynamics 2023 in Eindhoven. Most prominent conference in the field (Corbetta, Toschi)
- Review paper: N.A.M. Araujo, L.M.C. Janssen, T. Barois, G. Bofetta, I. Cohen, A. Corbetta, O. Dauchot, M. Dijkstra, W.M. Durham, A. Dussutour, S. Garnier, H. Gelderblom, R. Golestanian, L. Isa, G.H. Koenderink, H. Lowen, R. Metzler, M. Polin, C.P. Royall, A. Sari, A. Sengupta, C. Sykes, V. Trianni, I. Tuval, N., Vogel, J.M. Yeomans, I. Zuriguel, A. Marin and G. Volpe, Steering self-organisation through confinement, Soft Matter 19, 1695 (2023)
- Review paper: A. Corbetta and F. Toschi, Physics of Human Crowds, Annu. Rev. Cond. Matt. 14, 311 (2023)
- Review paper: R. Benzi and F. Toschi, Lectures on Turbulence, Phys. Rep. 1021, 1 (2023)

Eindhoven University of Technology

Department of Applied Physics

Transport in Permeable Media (TUE-AP-TPM)

Prof. dr. ir. Olaf Adan (part-time)	Full prof. (part time)
Dr. ir. Leo Pel	Associate prof.
Dr. ir. Henk Huinink	Associate prof.

Group's research areas

- Transport and phase changes in permeable media (to support various technology domains, such as high-tech materials, petrophysics and thermal energy storage)
- Interaction between transport of fluids and solutes, phase changes and material response on different scale levels (micrometre to millimetre range)
- Thermo-Chemical Materials
- Experimental techniques (such as MRI)

PhD theses delivered in 2023

- 24 January 2023 – Natalia Mazur – *Boosting power of salt hydrates for heat storage*, PhD Thesis, Eindhoven University of Technology, (Adan, Huinink).
- 9 February 2023 – Wendy Olsder – *Optimization models for faster and affordable access to rare disease treatments*, PhD Thesis, Eindhoven University of Technology, (Adan, Martagan).
- 9 March 2023 – Jelle Houben – *Accelerating thermochemical energy storage by doping*, PhD Thesis, Eindhoven University of Technology, (Adan, Kato, Huinink).
- 12 September 2023 – Sjoerd Knippenberg, Designing a product platform for ship locks, PhD Thesis, Eindhoven University of Technology, (Etman, Adan).
- 22 September 2023 – Patrick Deenen, *Data-driven modelling and optimization of semiconductor manufacturing*, PhD Thesis, Eindhoven University of Technology, (Adan, Nuijten, Akcay).

Eindhoven University of Technology

Department of Applied Physics

Elementary Processes in Gas Discharges (TUE-AP-EPG)

Prof. dr. ir. Gerrit Kroesen	Full prof.
Dr. ir. Jan van Dijk	Associate prof.
Dr. Dipl.-Ing. Ana Sobota	Associate prof.

Group's research areas

- Non-thermal atmospheric pressure plasmas and their interaction with substrates

Collaboration with other groups (inside or outside Burgerscentrum)

- Plasma-induced flow in the liquid phase (Sobota (PI) and Gelderblom; PhD: Ryan)

PhD theses delivered in 2023

- 15 February 2023 – Patrick Meijaard – *Hyper-gravity controlled microparticles probing the plasma sheath*, PhD Thesis, Eindhoven University of Technology, (Beckers, Kroesen).
- 13 June 2023 – Mohammad Hasani – *Towards plasma charging visualization*, PhD Thesis, Eindhoven University of Technology, (Beckers, Kroesen).

Eindhoven University of Technology

Department of Mechanical Engineering

Energy Technology (TUE-ME-ET)

Prof. dr. ir. David Smeulders	Full prof.
Prof. dr. ir. Harald van Brummelen	Full prof.
Prof. dr. ir. Rick de Lange	Full prof.
Prof. dr. Herbert Zondag	Full prof. (part time)
Prof. dr. Angèle Reinders	Full prof. (part time)
Dr. ir. Camilo Rindt	Associate prof.
Dr. ir. Michel Speetjens	Associate prof.
Dr. ir. Clemens Verhoosel	Associate prof.
Dr. ir. Arjan Frijns	Assistant prof.
Dr. Silvia Gaastra-Nedea	Assistant prof.
Dr. Maja Rücker	Assistant prof.
Dr. ir. Michael Abdelmalik	Assistant prof.
Dr. Azahara Luna-Triguero	Assistant prof.

Group's research areas

- Thermal energy storage
- Thermo-mechanical fluid-structure interactions
- Micro-thermofluidics

Collaboration with other groups (inside or outside Burgerscentrum)

- "Fundamental fluid dynamics challenges in inkjet printing (FIP)" NWO-Canon-UT-TU/e program (TU/e-AP-FF group, Darhuber & Toschi): Canon Production Printing, Twente University (PoF-group), Utrecht University, TU/e (ET-group, Mech. Eng.)
- "Transport in rarefied gases in next generation phot-lithography machines (RARETRANS)" TTW-OTP (TU/e-AP-FF group, Toschi & Clercx): ASML (Arlemark), TU/e (ET-group, Mech. Eng.), Flow Matters (Di Staso)
- Mat4Heat NWO program: Radboud University (Vlieg), TU/e-AP-FF group (Huinink, Adan), TU/e (ET-group, Mech. Eng.)
- Dr. Roeland Diltz (TU/e-Electrical Engineering) on AI and solvers of Boltzmann equation
- Dr Yoeri van de Burgt and Dr Nick Jaensson (TU/e-Microsystems group, Mech. Eng.) on machine learning for multi-physics modelling and design
- Prof. Aldo Frezzotti, Politecnico di Milano on kinetic modelling for micro/nano fluidics
- Prof Luiza Cabeza, Lleida University on heat transfer and heat storage
- TUDelft, Dept. Civil Engineering and Geosciences (Bertotti, Barnhoorn, Vardon) on subsurface energy and storage.

PhD theses delivered in 2023

- 6 April 2023 – Shahin Mohammad Nejad, *Scattering dynamics of rarefied gases: A hybrid atomistic/machine learning approach*, PhD Thesis, Eindhoven University of Technology, (Smeulders, Frijns, Gaastra-Nedea).
- 21 December 2023 – Svetlana Obydenkova – *Sustainability assessment of emerging multi-product lignocellulosic value chains using residual biomass: lessons learned and perspectives of development*, PhD Thesis, Eindhoven University of Technology, (Smeulders, van der Meer, Boot).

Grants obtained in 2023

- DeepNL PhD project (collaboration with UTwente and TUDelft) https://www.nwo.nl/en/news/eight-new-deepnl-projects-investigate-the-dynamics-of-the-deep-subsurface-under-the-influence-of-human-interventions
- 18 M€ GroenvermogenNL HyTROS programme approved on hydrogen transport and storage https://groenvermogennl.org/rd/werkpakket-2/

Projects started in 2023

- 4TU 'Heritage' programme on resilient cities https://www.4tu.nl/heritage/

Other 2023 highlights

- Prof. Reinders appointed director of Solliance https://www.solliance.eu/nl/home-nl/

Eindhoven University of Technology

Department of Mechanical Engineering

Power & Flow (TUE-ME-PF)

Prof. dr. ir. Niels Deen	Full prof.
Prof. dr. Philip de Goey	Full prof.
Prof. dr. ir. Jeroen van Oijen	Full prof.
Prof. dr. Hans Kuerten	Full prof.
Prof. dr. ir. Bert Vreman	Full prof. (part time)
Prof. dr. Benedicte Cuenot	Full prof. (part time)
Prof. dr. ir. Frank Willems	Full prof. (part time)
Prof. dr. Michael Golombok	Full prof. (part time)
Dr. ir. Rob Bastiaans	Associate prof.
Dr. Nico Dam	Associate prof.
Dr. Bart van Esch	Associate prof.
Dr. ir. Bart Somers	Associate prof.
Dr. Marie-Aline van Ende	Associate prof. (part time)
Dr. Giulia Finotello	Assistant prof.
Dr. Tess Homan	Assistant prof.
Dr. ir. Noud Maes	Assistant prof.
Dr. Yali Tang	Assistant prof.
Dr. ir. Xander Seykens	Assistant prof. (part time)
Dr. Xiaocheng Mi	Assistant prof.
Dr. ir. Nijso Beishuizen	Assistant prof. (part time)

Group's research areas

- Complex Multiphase Flows
- Metal Fuels as dense CO2-free Energy Carriers
- Combustion Systems and their Fuels

Collaboration with other groups (inside or outside Burgerscentrum)

- Chemical Process Intensification (van Sint Annaland, TU/e)
- Multi-scale Modeling of Multiphase Flows (Kuipers, TU/e)
- Complex Fluid Processing (Padding, TUD)
- On the topic of recycling of plastic particles by magnetic density separation (Fluids and Flows, Applied Physics, TU/e)
- On the topic of evaporation of droplets on porous substrates (Smeulders, Energy Technology, Mechanical Engineering, TU/e)
- On the topic of evaporation of droplets on porous substrates (Lohse, Physics of Fluids, UT)
- On the topic of hydrogen bubbles in electrolysis (Lohse, Physics of Fluids, UT)
- Delft University (Klein)
- Delft University (de Vos)
- Delft University (Roekaerts, Gangoli Rao)
- Dutch Section of the Combustion Institute (DSCI) en Nederlandse Vereniging voor Vlamonderzoek (NVV)

PhD theses delivered in 2023

- 7 February 2023 – Xin Liu – *Regeneration of iron fuel in fluidized beds*, PhD Thesis, Eindhoven University of Technology, (Deen, Tang).
- 14 March 2023 – Robin Doddema – Spectroscopy on the verge of soot formation, PhD Thesis, Eindhoven University of Technology, (Dam, Deen).
- 14 March 2023 – Hesheng Bao – *Detailed description of igniting high-pressure sprays using efficient models*, PhD Thesis, Eindhoven University of Technology, (Somers, Roekaerts).
- 15 May 2023 – Conrad Hessels – *Reduction of combusted iron using hydrogen*, PhD Thesis, Eindhoven University of Technology, (Deen, van Oijen, Tang).
- 19 September 2023 – Chih-Chia Huang, *Modelling of injection zone in blast furnaces*, PhD Thesis, Eindhoven University of Technology, (Deen, van Oijen, Tang).
- 18 October 2023 – Cedric Devriese – *The CFD design and optimization of a compressor, combustor and turbine system towards 100 kWe hydrogen fuelled micro gas turbine*, PhD Thesis, Eindhoven University of Technology, (Bastiaans, Deen, De Paepe).
- 7 July 2023 – Abhijit Kalbhor – *Model development and numerical investigation of soot formation in combustion*, PhD Thesis, Eindhoven University of Technology, (van Oijen, Somers).
- 13 October 2023 – Roeland Wildemans – *Nonlinear dynamics of intrinsic thermos-acoustics modes*, PhD Thesis, Eindhoven University of Technology, (Lopez Arteaga, de Goey, Kornilov).
- 18 October 2023 – Ravi Patel – *Towards plasma-assisted ignition-stabilized combustion*, PhD Thesis, Eindhoven University of Technology, (Nijdam, Dam).

Grants obtained in 2023

- ICONIC, Horizon Europe, ERC Proof of Concept Grant for research into metal fuels, De Goey
- CIRCL, TTW OTP project, Deen, Finotello, Roghair, Van Sint Annaland: Iron and iron powder as circular and carbon free energy carriers: research into possible scale-up to industrial size applications of this metal energy storage and conversion system.

Projects started in 2023

- HELIOS (Stable high hydrogen low NOx combustion in full scale gas turbine combustor at high firing temperatures), Horizon Europe Research and Innovation Activity under the Clean Hydrogen Partnership, TU/e is coordinator
- AmmoniaDrive, NWO TTW Perspectief: the innovative AmmoniaDrive power plant concept uniquely combines solid oxide fuel cell (SOFC) and internal combustion engine (ICE) technology using renewably produced, i.e. “green”, ammonia as fuel
- ICONIC, Horizon Europe, ERC Proof of Concept grant. It is a commercially oriented extension of the previously awarded ERC Advanced Grant of Philip de Goey
- ATAmute (Innovative Anechoic Broadband Compact Mufflers as solution for Acoustic and Thermo-Acoustic noise mutation), NWO TTW Take-off
- Internal TU/e call, Design and fabrication of apparatus for electrochemical iron powder production

Other 2023 highlights

- TU/e Team Science Award for Iron Power Consortium

Eindhoven University of Technology

Department of Mechanical Engineering

Microsystems (TUE-ME-MS)

Prof. dr. ir. Jaap den Toonder	Full prof.
Dr. Regina Lüttge	Associate prof.
Dr. ir. Yoeri van de Burgt	Associate prof.
Dr. Hans Wyss	Associate prof.
Dr. Ye Wang	Assistant prof.
Dr. Inês Pereira	Assistant prof.

Group's research areas

- Microfluidics & microactuation
- Organ-on-a-chip
- Biomedical microdevices
- Microfluidics & soft matter
- Neuromorphic engineering
- Wearable sensing

Collaboration with other groups (inside or outside Burgerscentrum)

- Nationaal Groeifonds Grant "NXTGEN HIGHTECH, Biomed 03: Organ-on-Chip"; collaboration with TUD, UT, DEMCON, Micronit, and other Ditch partners
- Horizon Europe Grant "LEARN: Development of novel assessments for indoor air quality monitoring and impact on children's health", grant No. 101057510; collaboration with INL, VUB, IMEC-NL, and other Euopean partners
- OrChESTRA "Organ-on-a-Chip Focused Strategic Partnership", Horizon Europe Twining action project, grant 101079473; collaboration with ODTÜ MEMS, IMEC and UFR
- NWO Gravitation Grant "Interactive Polymeric Materials (IPM) Research Center, Grant No. 024.005.020; collaboration with various TU/e research groups
- Eurostars/RVO Grant "AbET-UTI: Antibiotic Efficiency Testing (AbET) to enable evidence-based and personalized antibiotic administration for Urinary Tract Infections (UTI)", Grant No. ESTAR 22119. Collaboration with ShanX Medtech, Microfluidic Chipshop
- NWO-TTW-Perspectief Grant "SMART Organ-on-Chip" collaboration with TUD, UT, UMCU, WUR, MU, MUMC+, AMC, UL
- H2020-NMBP Grant "Tumor-LN-oC: Tumor and Lymph Node on Chip for cancer studies", collaboration with National Technical University of Athens, Abo Akademi University, ALPES, Rayfos, TU Wien, Alvesys, Phosprint, Asphalion, Amkres
- NWO-TTW-OTP Grant "SEDAS: Sweat sensing device and data analytics for semi-continuous sepsis monitoring", collaboration with Signal processing group at TU/e
- Penta-Aeneas Grant "Sentinel: A hybrid patch for early warning", collaboration with Signal processing group, TU/e, Philips Research, Micronit, Verhaert, Catharina ZH, Tegema
- NWO-OC-GROOT Grant "The Active Matter Physics of Collective Metastasis", collaboration with U Leiden, Radboud UMC, TUD, UMCU

- H2020-ECSEL Grant “Moore4Medical Accelerating Innovation in Microfabricated Medical Devices “, collaboration with TUD, Philips Research, INESC
- NWO-GDST Grant, “Electro-optical full colour display based on nano-particle dispersions”, collaboration with DIRM group at TU/e, TU/e, South China Normal University
- InSciTe - Trial for Smart, Easy and Accurate Minimally invasive Glaucoma Surgery, collaboration with DIRM group at TU/e, Biomedical Engineering at TU/e, MUMC+, Santen
- RAAK pro + ICMS Grant “Printing makes Sense”, collaboration with Fontys, Biomedical Engineering at TU/e

PhD theses delivered in 2023

- 20 January 2023 – Jiajing Yang – *Real-time monitoring of low-concentration pollen in the air*, PhD Thesis, Eindhoven University of Technology, (Wyss, den Toonder).
- 25 May 2023 – Eveline van Doremaele – *Organic neuromorphic computing: at the interface with bioelectronics*, PhD Thesis, Eindhoven University of Technology, (van de Burgt, den Toonder).
- 8 June 2023 – Elles Raaijmakers – *Nudging neurons: Characterizing the behaviour of single neurons and small networks in the presence of weak electric fields*, PhD Thesis, Eindhoven University of Technology, (van Beurden, Lüttge, Mestrom).
- 14 June 2023 – Setareh Kazemzadeh – *Organic neuromorphic systems with biologically relevant functionalities*, PhD Thesis, Eindhoven University of Technology, (van de Burgt, den Toonder).
- 5 July 2023 – Inês Figueiredo Pereira, *Minimally invasive smart glaucoma implants*, PhD Thesis, Eindhoven University of Technology, (den Toonder, Beckers, Wyss).
- 15 September 2023 – Eva van Aalen – *Glow-in-the-dark diagnostics: using bioluminescent sensor proteins*, PhD Thesis, Eindhoven University of Technology, (Merkx, den Toonder).
- 20 December 2023 – Mohammad Khorsand Ahmadi – *Experimental study of the interplay between electrokinetic effects for electronic paper displays*, PhD Thesis, Eindhoven University of Technology, (Wyss, den Toonder, Henzen).

Grants obtained in 2023

- ERC Consolidator Grant Yoeri van de Burgt, “Neuro-labs”
- Health Holland LSH-TKI Grant “OSCAR: Bone metastasis chip with microphysiological circulation for cancer profiling”, Grant No. LSHI22004
- Nationaal Groeifonds Grant “NXTGEN HIGHTECH, Biomed 03: Organ-on-Chip”; collaboration with TUD, UT, DEMCON, Micronit, and other Ditch partners.
- Horizon Europe Grant “LEARN: Development of novel assessments for indoor air quality monitoring and impact on children’s health”, grant No. 101057510; collaboration with INL, VUB, IMEC-NL, and other Euopean partners.

Projects started in 2023

- Health Holland LSH-TKI project “OSCAR: Bone metastasis chip with microphysiological circulation for cancer profiling”, Grant No. LSHI22004
- Nationaal Groeifonds project “NXTGEN HIGHTECH, Biomed 03: Organ-on-Chip”

Other 2023 highlights

- Jaap den Toonder and Regina Luttge elected as Fellows of the Netherlands Academy of Engineering (NAE)
- Yoeri van de Burgt received “Groundbreaking researcher” Award of TU/e
- Yoeri van de Burgt received an ERC Consolidator grant
- 24 peer-reviewed papers published, including in PNAS, Nature Communications, Nature Electronics, Advanced Functional Materials, Lab on aChip

Eindhoven University of Technology

Department of Mechanical Engineering

The Processing and Performance of Materials Group (TUE-ME-PPM)

Prof. dr. ir. Patrick Anderson	Full prof.
Dr. Markus Hütter	Associate prof.
Dr. ir. Martien Hulsen	Associate prof.
Dr. ir. Ruth Cardinaels	Associate prof.
Dr. ir. Nick Jaensson	Assistant prof.
Dr. Alexandra Alicke	Assistant prof.
Dr. Manolis Chatzigiannakis	Assistant prof.
Dr. Monica Zakhari	Assistant prof.

Group's research areas

- Computational and experimental soft matter
- Computational and experimental rheology
- Non-Newtonian fluid mechanics
- Material processing
- Multiscale modelling
- Interfacial rheology
- Thin film dynamics / droplet coalescence

Collaboration with other groups (inside or outside Burgerscentrum)

- Prof. Doros N. Theodorou, National Technical University of Athens, Greece
- Prof. Michal Pavelka, Charles University Prague, Czech Republic
- Prof. Jan Vermant, ETH Zürich Switzerland
- Prof. Theo Tervoort, ETH Zürich Switzerland
- Prof. Ruud van der Sman, WUR
- Soft Matter, Rheology and Technology Group, KU Leuven
- Dynamical Systems Design, Department of Mechanical Engineering, TU/e
- Thermo Fluids Engineering, Department of Mechanical Engineering, TU/e

PhD thesis delivered in 2023

- 3 July 2023 – Stan Looijmans – *Adhesion-modified polypropylene composites: a sticky situation*, PhD Thesis, Eindhoven University of Technology, (Anderson, van Breemen, Cavallo).

Grants obtained in 2023

- PhD project: Simulation-assisted design and control of microfluidic chips for highly deformable particles, TU/e ME internal grant
- PhD project: Dry fabrication, kneading and extrusion of electrolytes. NGF3 Circular Batteries grant

- Outreach project: RheoLit: Rheology in Literature and Art, together with Vivek Sharma University of Illinois Chicago. Society of Rheology grant

Project started in 2023

- PhD project: Unravelling the effects of solid particles on polymer laser sintering via in-situ characterizations
- PhD project: Experimental study of the impact dynamics of rheologically complex repeated droplets on different substrates
- PhD project: Leveraging morphology for design of complex materials for 4D printing

Other 2023 highlights

- NWO Take-off project: Melt-stretchable and tough polylactic acid (PLA)-based sustainable materials via in-situ nanocrystal formation (Hamid Ahmadi, Ruth Cardinaels and Patrick Anderson)
- Patent published about puff rheometer: WO2023249483A1 (C. van der Gracht, R. Cardinaels, N. Jaensson, “An apparatus arranged for measuring a rheological property and a method for measuring a rheological property”)
- Patent published about 3D printing with ultrasound: WO2023234771A1 (F. van Berlo, L. van Breemen, P. Anderson, “Apparatus and method for producing an object by means of additive manufacturing”)

Eindhoven University of Technology

Department Chemical Engineering and Chemistry

Multi-scale Modelling of Multi-phase Flows (TUE-CEC-MMM)

Prof. dr. ir. Hans Kuipers	Full prof.
Dr. ir. Maike Baltussen	Assistant prof.
Dr. ir. Kay Buist	Assistant prof.
Dr. ir. Frank Peters	Assistant prof.

Group's research areas

- Fundamentals of chemical reaction engineering
- Transport phenomena with fluid flow and with chemical transformations in multiphase chemical reactors and in porous media
- Multiphase Reactor Modelling
- Advanced Experimental Techniques for multiphase flow
- CFD with multifluid models and with discrete element models

Collaboration with other groups (inside or outside Burgerscentrum)

- Chemical Process Intensification, Sint Annaland, TUE-CEC-CPI
- Sustainable Process Engineering, Neira d'Angelo, TUE-CEC
- Power and Flow, Deen, TUE-ME-PF
- Physics of Fluids, Lohse, UT-TNW-POF
- Multi Scale Mechanics, Luding, Thornton, UT-ET-MSM
- Product and Process Engineering, van Ommen, TUD-CE-PPE
- Complex Fluid Processing, Padding, TUD-3mE-CFP
- Inorganic Materials and Catalysis, Hensen, TUE
- Transport Engineering and Logistics, Schott, TUD
- Inorganic Chemistry and Catalysis, Weckhuysen, UU
- Soft Condensed Matter, van Blaaderen, UU
- Chemical Technology, van Geem, Ghent University, Belgium
- Multiphase Flows, Schlüter, TUHH, Germany
- Solid Processing Engineering and Particle Technology, Heinrich, TUHH, Germany
- Particulate Flow Modelling, Pirker, JKU, Austria
- Chemical Engineering, Buwa, IIT Dehli, India
- Technical Chemistry, Hinrichsen, TUM, Germany
- Mechanical Engineering, Weiner, Braunschweig University of Technology, Germany

PhD theses delivered in 2023

- 9 October 2023 – Seyyed Sherwin Safavi Nic – *Capturing the dynamics of direct contact condensation: A numerical and experimental study*, PhD Thesis, Eindhoven University of Technology, (Kuipers, Buist).
- 17 October 2023 – Monteza Hadian – *Thermocatalytic decomposition of methane in a gas fluidized bed reactor: Numerical modeling and experimental study*, PhD Thesis, Eindhoven University of Technology, (Kuipers, Buist).

Eindhoven University of Technology

Department Chemical Engineering and Chemistry

Chemical Process Intensification (TUE-CEC-CPI)

Prof. dr. ir. Martin van Sint Annaland	Full prof.
Dr. ir. Ivo Roghair	Assistant prof.

Group's research areas

- Process intensification
- Reactive adsorption / Direct air capture and activation
- Electrification of industrial processes
- Catalyst structuring and heat integration using additive manufacturing
- Novel experimental techniques and numerical methods in reactive multiphase flows

Collaboration with other groups (inside or outside Burgerscentrum)

- THOR: collaboration with TNO, Ambrell, TotalEnergies, Hybrid Catalysis
- Zeocat: collaboration with VITO, Hybrid Catalysis, a.o.
- Totally nuts: collaboration with Avans
- Emissi0n: collaboration with TNO

PhD theses delivered in 2023

- 26 January 2023 – Kun Xin – *CO_2 capture with hydrophobic deep eutectic solvents: Experiments and modelling*, PhD Thesis, Eindhoven University of Technology, (van Sint Annaland, Gallucci).
- 1 June 2023 – Arash Rashimalimamaghani – *Development of carbon molecular sieve membranes (SMSMs) for membrane reactors*, PhD Thesis, Eindhoven University of Technology, (Gallucci, van Sint Annaland, Neiro d'Angelo).

Grants obtained in 2023

- Shell – KinDac: Adsorption kinetics for Direct Air Capture adsorption technologies (2 PhD's)
- TU/e-EIRES – Future Chemistry program – Systems integration: electrification of reverse water-gas shift reactors (1 PD for 2 yr)
- TU/e-EIRES – Future Chemistry program – Electrolyzers (1 PD for 2 yr)
- TU/e-EIRES – Future Chemistry program – Metal Fuels (1 PD for 2 yr)
- NXTGEN HIGHTECH, Modelling of electrolyzers (1 PhD)
- NWO - Open Technology Program: CIRCL: Closing the Iron Reduction-Combustion Loop (1 PhD + 2 EngDs)

Projects started in 2023

- Shell-KinDac, TU/e-EIRES projects

Eindhoven University of Technology

Department Mathematics and Computer Science

Centre for Analysis, Scientific Computing and Applications (TUE-MCS-CASA)

Prof. dr. ir. Barry Koren	Full prof.
Prof. dr. Mark Peletier	Full prof.
Prof. dr. Han Slot	Full prof. (part time)
Dr. ir. Jan ten Thije Boonkkamp	Associate prof.
Dr. ir. Arris Tijsseling	Associate prof.
Dr. ir. Benjamin Sanderse	Associate prof. (part time)
Dr. ir. Martijn Anthonissen	Assistant prof.
Dr. Koondanibha Mitra	Assistant prof.

Group's research area

- Computational Fluid Dynamics

Collaboration with other groups (inside or outside Burgerscentrum)

- Unravelling Neural Networks with Structure-Preserving Computing (NWO-XL project): Toschi Group, TUE (Giulio Ortali, Alessandro Corbetta and Federico Toschi); Data Mining Group, TU/e (Vlado Menkovski); Numerical Astrodynamics Group, Leiden University (Veronica Saz Ulibarrena and Simon Portegies Zwart); Scientific Computing Group, CWI, Amsterdam (Toby van Gastelen and Benjamin Sanderse)
- Enforcing Physical Behaviour in Neural Networks: Scientific Computing Group, CWI, Amsterdam (Benjamin Sanderse)
- Numerical Simulation of Internal Turbulent Flows with Heat Transfer: CFD Group, NRG, Petten (Ed Komen)
- Mechanistic Modelling of Slug Forces: Equinor, Oslo (Arnout Klinkenberg)
- Multistep Implicit Time Integration Methods: CFD Group, MARIN, Wageningen (Chris Klaij and Auke van der Ploeg)

PhD theses delivered in 2023

- 1 February 2023 – Chris Schoutrop – *Temperature plasma simulation: Stoichiometric transformations, Krylov methods and improved quadrature rules*, PhD Thesis, Eindhoven University of Technology, (van Dijk, ten Thije Boonkkamp).
- 23 March 2023 – Anastasiia Hraivoronska – *Discrete-to-continuum limits of evolutionary equations via generalized gradient flows*, PhD Thesis, Eindhoven University of Technology, (Peletier, Tse).

Other 2023 highlights

- 14th International Conference on Pressure Surges, Eindhoven University of Technology, 12-14 April 2023, organized by Arris Tijsseling

Eindhoven University of Technology

Department of the Built Environment

Building Physics (TUE-BE-BP)

Dr. ir. Twan van Hooff	Associate prof.
Dr. Hamid Montazeri	Assistant prof.
Dr. Stefanie Gillmeier	Assistant prof. and operational wind tunnel manager

Group's research areas

- Building aerodynamics
- Indoor/outdoor ventilation
- Pollutant/aerosol dispersion
- Wind comfort
- Automotive aerodynamics
- Maritime aerodynamics
- Wind energy
- Building-integrated photovoltaics
- Wind effects on PV panels
- Urban microclimate
- Sports aerodynamics

Collaboration with other groups (inside or outside Burgerscentrum)

- Fluids and Flows, Applied Physics, Eindhoven University of Technology
- Physics of Fluids, Faculty of Science and Technology, University of Twente
- Faculty of Architecture and the Built Environment, Delft University of Technology
- Faculty of Aerospace Engineering, Delft University of Technology
- Institute for Risk Assessment Sciences (IRAS), Utrecht University
- Faculty of Science, University of Amsterdam
- Department of Civil Engineering, KU Leuven, Belgium
- Energy and Materials in Infrastructure and Buildings, University of Antwerp, Belgium
- Department of Architecture and Urban Planning, Ghent University, Belgium
- Civil Engineering, National University of Ireland, Galway, Ireland
- Environmental and Hydraulic Engineering, Sapienza University Rome
- Department of Particulate Flow Modelling, Johannes Kepler University, Linz, Austria
- Department of Civil, Chemical and Environmental Engineering, University of Genoa, Italy
- IUSS School for Advanced Studies, Pavia, Italy
- School of Civil Engineering, University of Leeds, UK
- School of Civil Engineering, University of Birmingham, UK
- Meteorological Institute, Environmental Boundary Layer Wind Tunnel Laboratory, University of Hamburg, Germany
- Wind Engineering, Energy and Environment Research Facility, Western University, Canada
- Jules Verne climatic wind tunnels, The Scientific and Technical Centre for Building, CSTB, France
- Research Institute for Occupational Health and Safety (INRS), France

- Digital Twin Cities Centre, Chalmers University of Technology, Sweden
- Big Data for Smart Society (GATE) Institute, Sofia University, Bulgaria
- Mathematics and Computer Science, Intelligent Electrical Power Grids, Delft University of Technology
- Royal Meteorological Institute of Belgium
- The Electronics – ICT department, University of Antwerp, Belgium
- Izmir Institute of Technology, Turkey

PhD theses delivered in 2023

- 26 May 2023 – Olga Palusci – *Urban ventilation and the compact mediterranean City: Numerical analysis of the dynamic relationship between density, morphology, and wind flow*, PhD Thesis, Eindhoven University of Technology, (Blocken, Monti, Montazeri).
- 28 June 2023 – Muxi Lei – *Assessment of improvement of indoor thermal comfort and energy demand of Chinese heritage apartment buildings under climate change*, PhD Thesis, Eindhoven University of Technology, (Roders, Blocken, van Hooff).
- 23 October 2023 – Samy Iousef – *Computational modeling of convective heat transfer at building surfaces*, PhD Thesis, Eindhoven University of Technology, (van Wesemael, Blocken, Montazeri).
- 25 October 2023 – Katarína Košútová – *Indoor airflow and heat transfer in a cross-ventilated generic building: Wind tunnel experiments and computational fluid dynamics analyses*, PhD Thesis, Eindhoven University of Technology, (Blocken, Hensen, van Hooff).
- 24 November 2023 – Feiyu Geng – *Lifetime prediction of vertical-axis wind turbines based on CFD simulations with high-cycle fatigue modeling*, PhD Thesis, Eindhoven University of Technology, (Suiker, Blocken, van Wesemael, Montazeri).
- 20 December 2023 – Raffaele Vasaturo – *Numerical simulation of the atmospheric boundary layer with application to natural ventilation*, PhD Thesis, Eindhoven University of Technology, (Blocken, van Wesemael, van Hooff).

Grants obtained in 2023

- VLAIO/Flux 50 research grant: *NudgeFlow: The next generation of residential ventilation - tweaking the natural air flow with distributed components*. Breesch H, Laverge J, Verhaert I, De Geeteren L, van Hooff T.
- P3Venti “Program Pandemic Preparedness and Ventilation” part 3. Loomans MGLC, van Hooff T.
- NWA-ORC 2022: *HybridLabs – Accelerating Dutch innovations in offshore renewables through data-driven hybrid labs*. From TUE-BE-BP: Gillmeier S.

Projects started in 2023

- P3Venti “Program Pandemic Preparedness and Ventilation” part 2. Loomans MGLC, van Hooff T.
- NWO Perspectief program: MIST: MItigation STrategies for Airborne Infection Control (WP3, van Hooff T, Loomans MGLC, Duran Matute M (Applied Physics; TU/e))

University of Twente

Faculty of Science and Technology

Physics of Fluids (UT-ST-POF)

Prof. dr. Detlef Lohse	Full prof.
Prof. dr. Devaraj van der Meer	Full prof.
Prof. dr. Jacco Snoeijer	Full prof.
Prof. dr. Michel Versluis	Full prof.
Prof. dr. ir. Chris de Korte	Full prof. (part time)
Prof. dr. Andrea Prosperetti	Full prof. (part time)
Prof. dr. Chao Sun	Full prof. (part time)
Prof. dr. Roberto Verzicco	Full prof. (part time)
Prof. dr. Xuehua Zhang	Full prof. (part time)
Prof. dr. Marjolein van der Linden	Full prof. (part time)
Prof. dr. ir. Leen van Wijngaarden	Full prof. (em.)
Dr. Alvaro Marin	Adjunct prof.
Dr. ir. Richard Stevens	Associate prof.
Dr. Corinna Maaß	Associate prof.
Dr. Dominik Krug	Associate prof.
Dr. ir. Sander Huisman	Assistant prof.
Dr. ir. Martin van der Hoef	Associate prof. (part time)
Dr. Guillaume Lajoinie	Assistant prof.

Group's research areas

- Turbulence
- Wind Energy
- Computational Fluid Dynamics
- Multiphase flows with bubbles, drops, and particles
- Melting and dissolution
- Microbubble physics
- Ultrasound
- Blood flow characterization
- Heat and mass transfer
- Deep learning
- Fully developed turbulence and in particular thermally driven turbulence
- Micro- and nanofluidics
- Inkjet printing
- Surface nanobubbles and nanodroplets, colloidal science
- Bubble dynamics and cavitation
- Granular matter
- Acoustics

Collaboration with other groups (inside or outside Burgerscentrum)

- Max Planck Center Twente for Complex Fluid Dynamics: collaboration with MPI-DS in Göttingen and with MPI-Polymere in Mainz
- Tsinghua University, Group of Professor Chao Sun

- Collaboration with PIN group of Prof. Harold Zandvliet in Twente
- Collaboration with group of Prof. Daniel Bonn and Dr. Mazi Jalaal at UvA
- Collaboration with group of Prof. Federico Toschi & Prof. Herman Clercx & Dr. Rudi Kunnen, TUE.
- Collaboration with group of Prof. Albert van den Berg, UT
- Collaboration with groups of Profs. Rob Lammertink, Han Gardeniers, Guido Mul, UT
- Collaboration with groups of Prof. Stefan Luding, Cees Venner, CW Visser, Wilko Rohlfs, UT, CTW
- Collaboration with Canon, Venlo
- Thyrosonics project, collaboration with the INRIA institute in France
- HIFU-induced immunotherapy with the University of Ghent (Faculty of Pharmacy)
- Luminescent ultrasound detectors with the University of Ghent (Solid-state Physics)
- 4TU Precision Medicine, collaboration with the universities of Twente, Delft, Wageningen, and Eindhoven
- UCOM project, Ultrasound Cavitation in Soft Materials with City University of London, TU Munich, EPFL Lausanne, UPMC Sorbonne University, Institute of Cancer Research UK
- NWO OTP VORTECS on blood flow characterization with Radboud UMC
- NWO Perspective 3D ultrasound in vascular surgery (ultra-X-treme) with Radboud UMC
- TU/e, Rijnstate Hospital, CZ Eindhoven, Erasmus MC, and TU Delt
- Water and fire: A new intumescent coating based on heat-induced vaporization of water-filled microcapsules (NWO VENI Guillaume Lajoinie) - with PPG Coatings
- ADEAR - Aorta aneurysm dynamics and aortic endograft outcome. Top Technology Twente: University of Twente Connecting Industry program - with Terumo Aortic
- reMIND - Regenerative Medicine Innovative products as enabling technologies for the treatment of Alzheimer and other Neurological Diseases. REACT-EU European Commission - consortium with UT groups, Demcon, and local SMEs (Micronit, LocSense)
- NWO OTP ULTIMO – liver vascular flow: understanding liver treatment to improve microsphere optimal distribution – with UT, Radboud UMC, Terumo Querem.
- Microbubbles and ultrasound to guide radioembolization therapy: implementation of a patient-specific treatment strategy (NWO VENI Erik Groot Jebbink) – with Terumo Querem
- Mono-RAILS monodisperse microbubbles - Top Technology Twente: Connecting Industry - with Bracco Suisse S.A.
- NWO OTP SOUND-CHECK on bubble-mediated local drug delivery with Utrecht UMC, TU Delft, Bracco Suisse SA, Bruker, and FELIXrobotics BV

PhD theses delivered in 2023

- 12 January 2023 – Lijun Thayyil Raju – *Physicochemical hydrodynamics in confined multicomponent liquids*, PhD Thesis, Twente University, (Lohse, Zhang).
- 26 April 2023 – Marvin Wilhelm Detert – *Plasmonic bubbles in binary liquids*, PhD Thesis, Twente University, (Lohse, Prosperetti).
- 2 June 2023 – Youssef Saade – *Drops & bubbles: From fundamentals to applications*, PhD Thesis, Twente University, (Lohse, Prosperetti).
- 15 June 2023 – Yibo Chen – *Dynamics of chemotactic microswimmers: from individual motions to interactions*, PhD Thesis, Twente University, (Lohse, Verzicco).
- 5 July 2023 – You-An Lee – *Mixing and solvent exchange in turbulent jet flows*, Twente University, (Lohse, Huisman, Sun).
- 5 July 2023 – Farzan Sepahi – *Mass transport in multiphase electrochemical systems*, PhD Thesis, Twente University, (Lohse, Verzicco, Krug).

- 6 October 2023 – Robert Hartmann – *Rotation and confinement in turbulent Rayleigh-Bénard convection*, PhD Thesis, Twente University, (Lohse, Verzicco, Stevens).
- 6 October 2023 – Yogesh Jethani – *Dynamics of flow, particles and bubbles in a piezo-acoustic inkjet channel*, PhD Thesis, Twente University, (Lohse, Versluis, Segers).
- 26 October 2023 – Edgar Ortega Roano – *Impact phenomena in multiphase flows*, PhD Thesis "Cum Laude", Twente University, (van der Meer, Marin).
- 30 November 2023 – Rui Yang – *Turbulent flows with phase changes*, PhD Thesis "Cum Laude", Twente University, (Lohse, Verzicco).

Grants obtained in 2023

- "Melting and dissolution across scales in multicomponent liquid systems" (2023-2028), ERC-Advanced Grant of Detlef Lohse
- Windflow: Unlocking the complexities of windfarm-atmosphere interaction (2023-2028), ERC-Consolidator Grant Richard Stevens
- "High-speed immersion lithography" (2023-2027), EZK Connecting Industry Grant, with ASML and Demcon

Project started in 2023

- "Mitigation Strategies for Airborne Infection Control (MIST) (2023-2029), NWO-Perspective Program
- "Fundamental Fluid Dynamics Challenges in Inkjet Printing – Physicochemical Hydrodynamics" (2023-2029), NWO Connecting Industries Grant
- "Towards upscaling alkaline electrolysis: Pushing the limits of interfacial transport" (2022-2023), NWO-ECCM KICKstart DE-NL
- In addition, the grants obtained in 2023, as listed above

Other 2023 highlights

- Leen van Wijngaarden Prize 2023 for Dr. Sander Huisman
- KIVI Hoogendoorn Fluid Mechanics Award 2023 - for Dr. Vatsal Sanjay
- Wolfram Innovator Award - Sander Huisman
- ERC Proof of Concept grant for Alvaro Marin: Novel technology for detecting and identifying traces of micro and nano plastics in consumable water
- Detlef Lohse chosen as inauguration member of the NAE – Nederlandse Academy of Engineering
- Cover article in Physical Review Letters, Thin-Film-Mediated Deformation of Droplet during Cryopreservation, J.G. Meijer, P. Kant, D. van Buuren, and D. Lohse. Phys. Rev. Lett. 130, 214002 (2023), see cover of: Volume 130, Issue 21
- General audience article: Ultimate turbulent thermal convection, D. Lohse and O. Shishkina. Phys. Today 76, 26–32 (2023)

University of Twente

Faculty of Science and Technology

Physics of Complex Fluids (UT-ST-PCF)

Prof. dr. Frieder Mugele	Full prof.
Dr. Michael Duits	Associate prof.
Dr. Igor Siretanu	Assistant prof.

Group's research areas

- (Electro)wetting and droplet dynamics
- Microfluidic two-phase flow
- Interfacial physical chemistry
- (Interfacial) rheology
- CO2 fixation
- Photocatalysis

Collaboration with other groups (inside or outside Burgerscentrum)

- Ferrofluid-infused surfaces as microfluidic platform (Jun Gao, Chin. Academ. Sci. Qingdao; Xi Yao, City Univ. Hongkong)
- Polymer-based enhanced oil recovery (Julius Vancso, Univ. Twente)
- CO2 absorption in clays (Wim Brilman, Univ. Twente)
- Ultrasensitive graphene oxide-based Raman spectroscopy (Cees Otto, Univ. Twente)
- Facet-dependent surface properties of photocatalysts (Guido Mul, Univ. Twente)

PhD theses delivered in 2023

- 1 February 2023 – Duy Ahn Le – *Microfluidic chips for oil recovery from carbonate reservoirs at elevated temperatures*, PhD Thesis, University of Twente, (Mugele, Gardeniers, Duits).
- 29 June 2023 – Shaoqiang Su – *Atomic force microscopy resolved semiconductor-electrolyte interface for photocatalytic water splitting*, PhD Thesis, University of Twente, (Mugele, Mul, Sîretano, Mei).

Project started in 2023

- Chimay Shukla started as a PhD on the NWO-M Grant project
- Siddartha Mukherjee started as a Postdoc on photo-electro-catalysis
- Exchange Phd Enqing Liu from China working on Electro Wetting

Other 2023 highlights

- JACS paper: Nanometer-Resolved Operando Photo-Response of Faceted BiVO4 Semiconductor Nanoparticles. Shaoqiang Su, Igor Siretanu, Dirk van den Ende, Bastian Mei, Guido Mul, Frieder Mugele. https://doi.org/10.1021/jacs.3c12666

University of Twente

Faculty of Science and Technology

Cluster Membrane Science and Technology (MST)

Soft Matter, Fluidics and Interfaces (UT-ST-SFI)

Prof. dr. ir. Rob Lammertink	Full prof.
Prof. dr. ir. Karin Schroën	Full prof. (part time)
Dr. Jeff Wood	Associate prof.

Group's research areas

- Interfacial transport phenomena
- Membranes
- Ion transport
- Microfluidics

Collaboration with other groups (inside or outside Burgerscentrum)

- Combining Cake and Membrane Filtration for Removal of Micropollutants from Concentrate Streams in Reverse Osmosis Treated Drinking Water (Membrane Technology and Engineering for Water Treatment, UT)
- New membrane coatings and process designs for selective ion removal (WUR)
- Aerosol filtration (PoF, UT)
- Redox flow batteries (PCS, UT)

PhD theses delivered in 2023

- 10 March 2023 – Shuyana Heredia Deba – *Radical filtration: The functionality of photocatalic membranes in water treatment*, PhD Thesis, University of Twente, (Lammertink, Wols).
- 7 July 2023 – Moritz Junker – *Transport through polyelectrolyte multilayer based membranes for nanofiltration*, PhD Thesis, University of Twente, (Lammertink, de Vos, de Grooth).
- 22 September 2023 – Arputha Paul – *Blending the boundaries: Enhancing ion transport with electrokinetics*, PhD Thesis, University of Twente, (Lammertink, Wood).
- 24 November 2023 – Almohanad Abusultan - *A hybrid ion exchange resin - bipolar membrane electrodialysis process for reverse osmosis permeate remineralization*, PhD Thesis, University of Twente, (Van der Meer, Kemperman, Wood)

Grants obtained in 2023

- Bio-Gentle EU Doctoral Network (coordinating)

Projects started in 2023

- Mitigation Strategies for Airborne Infection Control (MIST), Perspectief program

University of Twente

Faculty of Science and Technology

Mesoscale Chemical Systems (UT-ST-MS)

Prof. dr. Han Gardeniers	Full prof.
Prof. dr. ir. David Fernandez Rivas	Full prof.
Prof. dr. Jimmy Faria Albanese	Associate prof.
Dr. ir. Niels Tas	Associate prof.
Dr. Arturo Susarrey Arce	Assistant prof.

Group's research areas

- Mass transport and reaction kinetics in systems with 3D nanostructured photo/electrolytic surfaces
- Inorganic nanostructures fabricated with additive manufacturing and their application in functional devices
- Microfluidic devices for chemical analysis & synthesis, molecule/particle separation, and liquid parameter measurement
- Bubble generation, growth, and collapse, and their interaction with soft and solid surfaces
- Microfabricated devices for liquid jetting and (electro)spinning, with applications in drug delivery and additive manufacturing
- Silicon-based 3D nanofabrication
- Microfluidic devices for catalytic conversions in liquid-liquid and gas-liquid interfaces.

Collaboration with other groups (inside or outside Burgerscentrum)

- Microflow magnetic resonance: collaboration with Makinwa (TUD)
- Continuous sensing and flow with bubbles: collaboration with Lohse / van der Meer (UT)
- CREAM4 - Chemical Reaction Engineering by Additive Manufacturing of Mesoscale MetaMaterials: collaboration with Sotthewes / Moralis-Masis (UT), Ruiz-Zepeda (Nat Inst Chem Ljubljana), Bartling (Leibniz Inst Catalysis Rostock), De Leon (Tec de Monterrey MX), Torres-Martinez (UA Nuevo León MX), Vandichel (U Limerick), Boscher (LIST Luxembourg), Aguirre (UNL Santa Fe Argentina), Cabriel / Izeddin (ESPCI Paris), Gabel / Merle (FAU Erlangen), Flox / Kallio (Aalto U), Takeuchi (UNAM MX)
- BuBble Gun - Penetrating microjets in soft substrates: towards controlled needle-free injections: towards controlled needle-free injections: collaboration with van der Meer / Lohse (UT), Hunter (MIT Cambridge MA, USA). Collaboration with prof. Mosser (EPFL).
- Development of a high P, high T microfluidic chip for water-flooding oil recovery: collaboration with Mugele / Duits (UT)
- PrintPack - Arranging the Particles: Step Changing Chemical Measurement Technology (ERC AdG Desmet): collaboration with Desmet (VU Brussels), Sotthewes / van der Meer (UT)
- Microfluidic approaches for particle generation and handling: collaboration with De Malsche (VU Brussel)
- Continuous retention-based enrichment of small molecules in liquid phase: collaboration with De Malsche (VU Brussel)
- Micro-GC - Chiral MS via micro-de Laval nozzle: collaboration with Horke (RU Nijmegen)

- Field electron emission in organic solvents for biomass conversion: collaboration with van Housselt / Zandvliet (UT)
- UCOM - Ultrasound cavitation in soft materials: collaboration with Versluis (UT) and 15 other research-oriented organisations in the EU, Switzerland, US, Japan, and China
- NeuroChip - Intracellular recording of human neurons on a chip: collaboration with le Gac (UT) and Cornelisse (VU Amsterdam)
- SERSing - Handheld device to detect chemical hazards anywhere: collaboration with Garcia Blanco (UT) and 8 other research-oriented organisations in Denmark, Czech Republic, Sweden and Spain
- Nanomachining of 3D race-track memories: collaboration with Parkin (MPI Halle)

PhD theses delivered in 2023

- 1 February 2023 – Duy Ahn Le – *Microfluidic chips for oil recovery from carbonate reservoirs at elevated temperatures*, PhD Thesis, University of Twente, (Mugele, Gardeniers, Duits).
- 17 May 2023 – Dirk Jonker – *Advanced nanofabrication techniques for electron emission devices*, PhD Thesis, University of Twente, (Gardeniers, Zandvliet, van Houselt, Tiggelaar).
- 29 September 2023 – Jedrzej Winczewski – *Additive manufacturing of zirconia-based 3D microstructures*, PhD Thesis, University of Twente, (Gardeniers, Susarrey Arce).

Grants obtained in 2023

- NWO/VIDI - Needle-Free Injections: Ultrafast Microjets for minimal skin damage: David Fernandez Rivas
- ERC Proof of Concept Grant from the ERC Plant-a-Jet
- Dutch Education Ministry Virtual International Cooperation € 15.000 (link)

Project started in 2023

- ERC Proof of Concept Grant from the ERC Plant-a-Jet
- EIC Pathfinder project "Chiralforce" - separation of enantiomeric molecules using optical forces.
- Horizon Europe project "ALCYONE" - Autonomous Living Cell analYsis ON-chip for Evaluation of space Environment Effects

Other 2023 highlights

- Course Entrepreneurial Toolbox for Engineers updated with Dutch Education Ministry Virtual International Cooperation grant (collaborating with Wits University, South Africa)

University of Twente

Faculty of Engineering Technology

Engineering Fluid Dynamics (UT-ET-EFD)

Prof. dr. ir. Kees Venner	Full prof.
Prof. dr. ir. Harry Hoeijmakers	Full prof. (em.)
Dr. ir. Rob Hagmeijer	Associate prof.
Dr. ir. Edwin van der Weide	Associate prof.
Dr. ir. Claas Willem Visser	Associate prof.
Dr. ir. Ysbrandt Wijnant	Assistant prof.
Dr. ir. Marijn Sanders	Assistant prof.
Dr. Kartik Jain	Assistant prof.
Dr. ir. Franciscus de Jongh	Assistant prof.
Dr. ir. Arne van Garrel	Assistant prof.
Dr. Huseyin Ozdemir	Assistant prof.
Dr. Jieke Jiang	Assistant prof.
Dr. ir. Lionel Hirschberg	Assistant prof.
Dr. ir. Philip Ströer	Assistant prof.

Group's research areas

- Aerodynamics & Aeroacoustics
- Computational Fluid Dynamics Algorithms and Design
- Thin Layer Flow and Lubrication
- Fluid Mechanics of Functional Materials
- Biomedical Fluid Mechanics

Collaboration with other groups (inside or outside Burgerscentrum)

- Thermal Engineering (UT-ET), Multi-Scale Mechanics (UT-ET), Physics of Fluids (UT-TNW), Robotics and Mechatronics (UT-EEMCS), Tribology and Surface Technology (UT-ET)
- Flow physics and technology, TUDelft
- LAMCOS INSA-Lyon, France
- Von Kármán Institute, Belgium
- Royal Dutch Aerospace Centre NLR
- SKF RTD
- Maritime Research Institute Netherlands MARIN
- DTU Denmark
- Technical University Muenich, Germany

PhD theses delivered in 2023

- 13 April 2023 – Ruther Hebbink – *Pressure recordings for monitoring tidal breathing and optimizing settings for nasal high-flow therapy*, PhD Thesis, University of Twente, (Hagmeijer, Wijkstra, Duiverman).
- 30 June 2023 – Sietse van der Linden – *Underwater ablation using short and ultrashort laser pulses*, PhD Thesis, University of Twente, (Römer, Hagmeijer).

- 22 September 2023 – Fernanda Leticia Dos Santos – *Broadband flow-induced noise for airfoils: Inflow turbulence distortion effect on leading-edge noise generation and prediction*, PhD Thesis "Cum Laude", University of Twente, (Venner, da Santana).
- 23 October 2023 – Prasansha Rastogi – *3D printing of foams for acoustics applications*, PhD Thesis, University of Twente, (Venner, Visser, Wijnant).

Grants obtained in 2023

- Micro-HS: Using Microfluidics to develop stable TCMs for Heat Storage, NWO-OTP
- MASS (ENGD, industrial)
- Solvent-free micro-encapsulation for better preservation of bio-active medicines, NWO Open Competition, ENW-XS

Projects started in 2023

- Roughness and starvation effects on film thickness and fatigue life in microdrop lubricated EHL contacts of rolling bearings, SKF M2i PhD project.
- Solvent-free micro-encapsulation for better preservation of bio-active medicines, NWO Open Competition, ENW-XS
- A Computational model to understand the Physiology of Type II Endoleaks, Health Holland PhD project.
- MASS (ENGD, Industrial)

Other 2023 highlights

- Jacob Wallenbergs Foundation prize 2023, for research and development in the field of Materials Materials Science, awarded to C.H. Venner

University of Twente

Faculty of Engineering Technology

Thermal Engineering (UT-ET-TE)

Prof. dr. ir. Gerrit Brem	Full prof.
Prof. dr. ir. Wilko Rohlfs	Full prof.
Prof. dr. ir. Theo van der Meer	Full prof. (em.)
Dr. ir. Jim Kok	Associate prof.
Dr. ir. Artur Pozarlik	Associate prof.
Dr. Mina Shahi	Associate prof.
Dr. ir. Amir Mahmoudi	Assistant prof.
Dr. Canan Acar	Assistant prof.
Dr. Yashar Hajimolana	Assistant prof.
Dr. Abhishek Singh	Assistant prof.
Dr. Mohammad Mehrali	Assistant prof.
Dr. Tingting Zhu	Assistant prof.
Dr. ir. Keerthivasan Rajamani	Assistant prof.

Group's research areas

- Energy efficient processes
- Thermal conversion and storage
- Heat pumps and district heating systems
- Hydrogen production, storage and end-use
- Material science for heat transfer applications
- Thermal management of electrical components
- Gaseous and liquid fuel combustion in gas turbine engines and furnaces
- Combustion dynamics and acoustics interaction
- Nitric oxide and soot emission in combustors
- Energy Systems Integration
- Biomass conversion
- CO2 capture from ambient air

Collaboration with other groups (inside or outside Burgerscentrum)

- ABraytCSPfuture: DLR Germany, CERTH Greece, Fraunhofer Germany, OPRA NL, CENER Spain, Techniker Spain, Landson, Kraftblock, COBRA Spain
- AGRICOOL: University of the Western Cape, Universita degli studi di Padova, Universidad de Lleida, Armengol & Ros Consultors i Associats, Genius Watter S.R.L., Institut International du Froid, Lib Pack LP, Flomack (Pty) Ltd, Genius Invest Puntland, Ecowas Centre for Renewable Energy and Energy Efficiency, Genius Agua e Energia CV, Blue Sky Renewable Energy BSE, Ministry of Agriculture and Rural Development
- Alliance International Catalyst Program: National Sciences and Engineering Research Council of Canada, University of Windsor
- Coca Cola Europacific Partners
- Dimeta B.V.

- DIVAC: ARES and Saxion
- DYNAF: TUE, Oxford university, Barcelona Supercomputing Centre, IFTA, Duiker Combustion Engineers, Danieli Corus, DNVGL, Bosch Nefit.
- EIGEN: alliander, SUNROCK, Ventolines, Elaadnl, TNO, Saxion University of Applied Sciences, SEMPERPOWER, PARKnCHARGE, OVERMORGEN, SEP, reco,
- Engender: ISPT, UCLouvain, Avebe, Corbion, Givaudan
- Heat Land: De Kleijn Energy Consulting, FPsim, Ennatuurlijk B.V., Twence holding B.V.
- HeatPie: Viridi PVT, Verhulst
- HeatQuiz: Digital Teaching, RWTH Aachen University
- HERCULES: DLR Germany, CERTH Greece, TATA Steel NL, Alucha NL, Kraftblock Germany, Landson Denmark, RISE Sweden, COBRA Spain, TMS Greece
- HERMES (National Technical University of Athens, Exergia, Tec4Fuels, OWI Science for Fuels, Imperial College, CERFACS, Paul Scherrer Institute, OPRA, Swiss Federal Institute of Technology Lausanne, Wroclaw University of Science and Technology
- HoSt, HVC, Bio-energie Andijk
- Hydrogen Systems and Enabling Technologies Joint Master's Program: Politechnico di Torino, Politechnico di Milano, SNAM S.P.A., Repsol SA, Universiti Teknologi Malaysia, The Norwegian Hydrogen Forum
- Kickstart- Industrial Heat Pump: TNO, TU Delft, TU Eindhoven, IBK, Smurtfit Kappa, Corbion, Reco, KWA Advisors, Farm Frites, De Kleijn Energy Consulting, Kiremko, Yeagar Energy
- MicroHS: Nobian, TNO, lamfluidics, ARES
- RECOWATDIG: WUST, AGH, KTH, HoSt, GAC
- ROGER: Rorer Renewable Energy B.V.
- Smart Energy Grid Regio Nijmegen: ARN BV, Modderkolk, ELESTOR, OSSTENDORP, if Technology Creating Energy, Gemeente of Nijmegen.
- SYPLAS: Paul Wurth
- TechUPGRADE: DTU Denmark, DLR Germany, TU Wein, COWI Denmark, IED Greece, Greenlab Denmark, Quanterall Ltd, TMEC Ukraine, MG Sustainable Sweden, Absolicon Sweden, RISE Sweden, University in Klaipėda, Lithuania, NTUA Greece
- Torwash B.V.
- Dimeta B.V.

PhD theses delivered in 2023

- 26 January 2023 – Antoni Brentjes – *Investigating charged water sprays through simulations and experiments*, PhD Thesis, University of Twente, (Brem, Pozarlik).
- 31 May 2023 – Rafael Rodríguez-Mosqueda – *CO2 capture from ambient air by alkaline carbonates with application to CO2 enrichment for greenhouses*, PhD Thesis, University of Twente, (Brem, Shahi).
- 25 September 2023 – Timm Swoboda – *On the heat dissipation in micro-electronics and advanced thermal control devices*, PhD Thesis, University of Twente, (Brem, Muñoz Rojo).
- 28 September 2023 – Shubham Dalvi – *Towards a magnetocaloric cooling system: Using interactions of magnetic fields & magnetic fluids*, PhD Thesis, University of Twente, (Brem, van der Meer, Shahi).
- 29 November 2023 – Alexander Louwes – *On the fast pyrolysis of torrefied woody biomass*, PhD Thesis, University of Twente, (Brem, Pozarlik).

Grant obtained in 2023

- AGRI-COOL Funded by EU Horizon Europe
- HeatPie funded by TKI HTMS
- HX-electrode: System integration of fuel cell and heat pump, in cooperation with TU Darmstadt (Germany), BDR Therma, and BAXI Innotech GmbH
- MICRO-HS funded by NWO, TTW-OPT
- MISD: Modular Integrated Sustainable Datacenter project (EU-IPCEI Program, UT – participating
- ROGER granted from RVO RegioDeal: UT contribution: € 96 K
- SYPLAS Funded by FNR

Project started in 2023

- Combustion of DME/LPG blends
- HX-electrode: System integration of fuel cell and heat pump, in cooperation with TU Darmstadt (Germany), BDR Therma, and BAXI Innotech GmbH
- HERCULES: High-temperature Thermochemical Heat Storage Powered by Renewable Electricity for Industrial Heating Applications (Funded by EU – Horizon Europe Program, UT – Coordinator)
- Schoon Gas
- TechUPGRADE: Thermochemical Heat Recovery and Upgrade for Industrial Processes (Funded by EU – Horizon Europe Program, UT – Participating)

Other 2023 highlights

- Keynote-Speech at the International Conference on Heat and Mass Transfer (Cape Town, South Africa) from W. Rohlfs

University of Twente

Faculty of Engineering Technology

Multi Scale Mechanics (UT-ET-MSM)

Prof. dr. Stefan Luding	Full prof.
Prof. dr. Anthony Thornton	Full prof.
Prof. dr. Harm Askes	Full prof.
Dr. Thomas Weinhart	Associate prof.
Dr. ir. Wouter den Otter	Associate prof.
Dr. Igor Ostanin	Assistant prof.

Group's research areas

- Multiscale Mechanics: Particle Systems
- Multiscale Methods: Bridging the gaps (from small to large, from discrete to continuum, from fast to slow, from fluid to solid (state transitions), etc.)
- Open-source software MercuryDPM: https://www.mercurydpm.org
- Open-source software oomph-lib https://oomph-lib.github.io/oomph-lib/doc/html/
- Molecular Modeling of Complex Fluids
- Virtual Prototyping of Particulate Processes
- Shaping segregation: Multiscale modelling of segregation in industrial processes
- Flow rheology for complex, non-Newtonian fluids (e.g. capillary suspensions)
- Mechanical wave propagation applied to non-invasive exploration/sensing
- Multiscale modelling of agglomeration: Applications tabletting, powder bed 3D-printing
- EU_ETN TUSAIL: Upscaling and Multiscale analysis of particle processes in industry
- Merging fluid AND solid mechanics for granular solid hydrodynamics
- Mathematical network analysis and advanced machine learning particle systems

Collaboration with other groups (inside or outside Burgerscentrum)

- Industrial Dense Granular Flows IDGF (with profs. Schott TUD, Kuipers TU/e, van Ommen, TUD)
- TUSAIL (EU-ETN with: University of Edinburgh, TU Hamburg Harburg, TU Braunschweig, University of Salerno + several industrial partners, e.g., JM, PG, BASF, SACMI, DCS, mercuryLAB)
- Modeling the dynamics of electrolyte in supercapacitors (with UU)
- Aeolian sand transport (sector plan PhD with K Wijnberg, UT)
- Segregation and non-spherical particles (with RC Hidalgo, Navarra)
- Segregation in industrial problems (with L. Orefice from RCPE, Graz)
- Dynamics of proteins in mitochondria (with Radboud University Medical Centre)
- Colloidal suspensions (with A. Jarray and E. Scholten, WuR)

PhD theses delivered in 2023

- 7 September 2023 – Raninisha Sitlapersad – *Molecular simulations of supercapacitors*, PhD Thesis, University of Twente, (Thornton, den Otter).
- 27 October 2023 – Juan Alvarez Naranjo – *Multi-scale sintering model of visco-elastic powders*, PhD Thesis, University of Twente, (Luding, Weinhart).

University of Twente

Faculty of Engineering Technology

Marine and Fluvial Systems (UT-ET-MFS)

Prof. dr. Suzanne Hulscher	Full prof.
Prof. dr. Kathelijne Wijnberg	Full prof.
Dr. Jord Warmink	Associate prof.
Dr. ir. Pieter Roos	Associate prof.
Dr. ir. Jebbe van der Werf	Associate prof.
Dr. ir. Bas Borsje	Associate prof.
Dr. ir. Anouk Bomers	Assistant prof.
Dr. ir. Geert Campmans	Assistant prof.
Dr. Trang Duong	Assistant prof.
Dr. Vasileios Kitsikoudis	Assistant prof.
Dr. ir. Erik Horstman	Assistant prof.

Group's research areas

- Environmental Fluid Mechanics
- Nature-based Flood Protection
- Vegetated flow dynamics
- Hydraulic river modelling
- River bed modelling
- Offshore seabed patterns
- Coastal sediment transport processes
- Aeolian sediment transport processes
- Bio-geomorphology of mangrove coasts
- Bio-geomorphology of saltmarshes
- Bio-geomorphology of beach-dune systems
- Morphodynamics of barrier coasts and tidal inlets
- Coastal hazards including erosion and flooding
- Climate change impacts on coasts and rivers
- Machine learning for flood prediction
- Estuarine salt intrusion

Collaboration with other groups (inside or outside Burgerscentrum)

- TUDelft Hydraulic Engineering
- Deltares (research areas
- NIOZ - Royal Institute for Sea Research
- WUR (research areas
- IHE Delft (research areas
- Leibniz University Hannover
- Technical University of Denmark
- Alfred Wegener Institute
- University of Copenhagen
- University of Liege
- NIWA New Zealand

- Royal Belgian Institute of Natural Sciences & Ghent University
- Van Hall Larenstein
- University of Nottingham
- University of Bonn
- Université de Toulouse
- UTwente, Multi Scale Mechanics group (UT-ET-MSM)

PhD theses delivered in 2023

- 26 May 2023 – Paran Pourteimouri – *Modelling the influence of characteristics, orientation and positioning of beach buildings on airflow and aeolian sediment transport patterns in the surrounding area*, PhD Thesis, University of Twente, (Hulscher, Wijnberg, Campmans).
- 29 June 2023 – Joost Kranenborg – *Vertical dependences in swash-zone flows and sand transport*, PhD Thesis, University of Twente, (Hulscher, Reniers, van der Werf, Campmans).
- 3 July 2023 – Valesca Harezlak – *Filters and plant strategies: What steers vegetarian dynamics in floodplains of regulated lowland rivers?*, PhD Thesis, University of Twente, (Hulscher, Augustijn, Geerling).

Grants obtained in 2023

- BANX – NWO_TTW Open Technology Programme
- Delta Enigma – NWO_GWI Large scale research infrastructure
- Future Flood Risk management Technologies – NWO Perspectief programme
- NL2120 – Groeifonds
- SOURCE – NWO – NWA_ORC programme
- AdaptCoast – NWO TTW Open Technology Programme
- MANABAS COAST– EU-project, Interreg North Sea

Projects started in 2023

- Delta Enigma – Large scale research infrastructure for observation of bio-geomorphological processes in fluvial, estuarine and coastal systems
- OR_ELSE - Operational Recommendations for Ecosystem-based Large-scale Sand Extraction
- SEDIMARE – Sediment transport and morphodynamics in marine and coastal waters with engineering solutions
- INREEF – Environmental fluid mechanics around small coral reef islands
- MANABAS COAST – Mainstreaming Nature Based Solutions through Coastal systems

Other 2023 highlights

- Initiated and hosting of NCR-summerschool on river dynamics

University of Twente

Faculty of Electrical Engineering, Mathematics and Computer Science (EEMCS)

System Analysis and Computational Science (SACS)

Multiscale Modelling and Simulation (UT-EEMCS-3MS)

Prof. dr. ir. Bernard Geurts Full prof.

Group's research areas

- Computational modeling of multiscale problems in multiphase flows, environmental flows and flows in complex domains
- Novel algorithms, with error quantification, immersed boundary methods and time-parallel integration
- Computational models for application in the fields of energy and biofluid mechanics

PhD thesis delivered in 2023

- 11 September 2023 – Sagi Ephrati – *Data-driven stochastic modeling for coarsened computational geophysical fluid dynamics*, PhD Thesis, University of Twente, (Geurts, Cifani).

University of Twente

Faculty of Electrical Engineering, Mathematics and Computer Science (EEMCS)

Biomedical and Environmental Sensorsystems (UT-EEMCS-BIOS)

Prof. dr. ir. Albert van den Berg	Full prof.
Prof. dr. ir. Loes Segerink	Full prof.
Prof. dr. ir. Mathieu Odijk	Full prof.
Dr. ir. Tim Segers	Assistant prof.
Dr. ir. Sergii Pud	Assistant prof.

Group's research areas

- Biomedical Microdevices
- Microdevices for Chemical Analysis
- Lab-on-a-chip tools for nanobiology
- Micro and nanobubbles on Chip

PhD theses delivered in 2023

- 27 January 2023 – José Rivera Arbeláez – *Following the dots: Versatile and modular approach for engineering and analyzing three-dimensional cardiac tissues*, PhD Thesis, University of Twente, (Segerink, Passier, van den Berg, Catarino Ribeiro).
- 8 March 2023 – Heleen Middelkamp – *Microfluidic vessels-on-chips for vascular disease modelling*, PhD Thesis, University of Twente, (van den Berg, van der Meer).
- 10 November 2023 – Alessia Broccoli – *Microdevices for high-throughput screening of single catalyst particles*, PhD Thesis, University of Twente, (Odijk, van den Berg, Meirer, Mul).
- 1 December 2023 – Stella Kruit – *Microfluidic impedance cytometry for single sperm analysis: Towards morphology characterization*, PhD Thesis, University of Twente, (Segerink, Olthuis, Broekhuijse).

University of Groningen

Faculty of Science and Engineering

Computational and Numerical Mathematics (RUG-SE-CNM)

Prof. dr. ir. Roel Verstappen	Full prof.
Prof. dr. Arthur Veldman	Full prof. (em.)
Prof. dr. Cristóbal Bertoglio	Associate and adjunct full prof.
Dr. ir. Fred Wubs	Associate prof.
Dr. Julian Koellermeier	Assistant prof.

Group's research areas

- CFD methods for numerical simulation (LES, DNS) of turbulent flows
- Inverse problems in (coupled) fluid and solid models
- Modeling, numerical analysis and simulation of blood flows
- Flow-motion encoding with Magnetic Resonance Imaging
- Numerical bifurcation analysis of fluid flows
- Structure-preserving discretization methods for fluid flows
- Numerical simulation methods for multi-phase flows
- Model reduction of rarefied gases and geophysical flows

Collaboration with other groups (inside or outside Burgerscentrum)

- Heat and Mass Technology Center, Universitat Politecnica de Catalunya
- Delft Institute of Applied Mathematics,TUD
- Netherlands eScience Center
- UMCG: Oral and Maxillofacial Surgery, BRIDGE, Pediatric Cardiology & Radiology
- Center for Mathematical Modeling, University of Chile
- Cardiovascular MRI group, Amsterdam AMC
- Center for Biomedical Imaging, Pontificia Universidad Católica de Chile
- Computational Biophysics, RUG
- Scientific Computing, CWI
- ComFLOW User Group: collaboration with MARIN, TUD + several shipyards/offshore companies
- Institute for Marine and Atmospheric Research (IMAU)
- CogniGron - Groningen Cognitive Systems and Materials Center
- Numerical Analysis and Applied Mathematics, KU Leuven
- Department of Energy and Power Engineering, Tsinghua University
- Differential Equations, Numerical Analysis and Applications group, University of Málaga
- Turbulence in Fusion Plasmas group, TU Eindhoven

PhD theses delivered in 2023

- 24 January 2023 - Ronald Remmerswaal – *Numerical modelling of variability in liquid impacts*, PhD Thesis ("Cum Laude"), University of Groningen, (Verstappen, Veldman).

- 14 November 2023 – Jigar Parekh – *Development of methods for uncertainty quantification in CFD applied to wind turbine wake prediction*, PhD Thesis, University of Groningen, (Verstappen, Bertoglio).

Grants obtained in 2023

- Unpuzzling cardiac damage by exercise imaging and biomechanical modeling" (Bertoglio, 250K). Health Technology Research and Innovation Cluster Groningen (HTRIC).

University of Groningen

Faculty of Science and Engineering

Computational Mechanical and Materials Engineering (RUG-SE-CMME)

Dr. Antonis Vakis Associate prof.
Dr. Pablo Druetta Assistant prof.

Group's research areas

- Tribology
- Advanced manufacturing
- Renewable energy
- Enhanced Oil Recovery
- CFD applications to engineering

Collaboration with other groups (inside or outside Burgerscentrum)

- Dynamics of a floating offshore platform for hybrid wind and wave energy conversion (D. Bernal, PhD project, Jan. 2022), with E. Mendoza (UNAM, Mexico): double doctorate with the student spending two years in Groningen (Jun. 2023-May 2025)
- Fluid flows through dense wave energy converter arrays (A.T. Asiikkis, PhD project, Sep. 2021-), with D.G.E. Grigoriadis (UCy, Cyprus): double doctorate with the student spending two years in Groningen (Sep. 2023-Aug 2025)
- CFD investigations of dense wave energy converter arrays (C. Wang, PhD project, Jan. 2021-), with A.E.P. Veldman (RUG-SE-CNM)
- Multi-phase CFD simulations for supercritical CO2-assisted extrusion (T.M. Kousemaker, PhD project, Jul. 2019-), with F. Picchioni (RUG-SE-PT)

Grants obtained in 2023

- Comenius Teaching Fellowship: Use of VR tools in CFD education (55 k€), P.D. Druetta
- Jantina Tammes School – Incentive Fund for Interdisciplinary Projects: Wind farms Integrated Network and information systems Defense for Generating Uniform and Adaptive Resilience for Digital twins (6 k€), A.I. Vakis with F.F.M. Mohsen and E.V. Moyakine
- DSSC XS grant – Use of ML to optimize dense WEC arrays (40 k€ total), A.I. Vakis with K. Bunte and B. Besselink

Wageningen University & Research (WUR)

Department of Animal Sciences

Experimental Zoology (WUR-ASG-EZO)

Prof. dr. ir. Florian Muijres	Full prof.
Prof. dr. ir. Johan van Leeuwen	Full prof. (em.)
Dr. Guillermo J. Amador	Assistant prof.

Group's research areas

- Bio-fluid mechanics of animal flight
- Bio-fluid mechanics of fish swimming
- Bio-inspired soft robotics
- Novel fishing methods

Collaboration with other groups (inside or outside Burgerscentrum)

- 4TU Soft Robotics: collaboration with TU Delft, TU/e, and U Twente
- NWO Vidi Aerodynamics and control of Diptera flight: collaboration with TU Delft.
- HFSP Swarming and in-flight mating of malaria mosquitoes: collaboration with TU Delft.
- Alliance EWUU Preventing malaria disease spreading by smart turbulence flow fields: collaboration with UU and TU/e.
- WU-WIAS PhD Talent Program Escape flights of moths as greenhouse pests: collaboration with TU Delft.
- NWO-TTW StimTech: Collaboration with Wageningen Marine Research (WMR), TU Delft, Visserij-Innovatiecentrum Zuidwest Nederland.
- NWO Vidi Functional morphology of cuttlefish suction cups: collaboration with Karlsruhe Institute of Technology (Germany), University of Kiel (Germany), TU Delft, U Twente, TU/e.
- WU-WIAS Postdoc Talent Programme Hydrodynamics and biomechanics of cuttlefish locomotion and prey capture: collaboration with University of Antwerp (Belgium), TU Delft.

Grants obtained in 2023

- Wageningen University – Wageningen Graduate School – Sandwich Doctorate Programme 2023; How microclimates affect malaria mosquitoes in Tanzania: behavioural adaptations and disease transmission risk

Projects started in 2023

- Wageningen University – Wageningen Graduate School – Sandwich Doctorate Programme 2023; How microclimates affect malaria mosquitoes in Tanzania: behavioural adaptations and disease transmission risk

Other 2023 highlights

- Burgerscentrum conference organized by the group: Biomechanics in Nature: Conference & Farewell Address of Professor Johan van Leeuwen Wageningen University/Wageningen International Conference Centre – 11-12 may 2023

Wageningen University & Research (WUR)

Department of Agrotechnology and Food Sciences

Food Process Engineering (WUR-AFS-FPE)

Prof. dr. ir. Karin Schroën Full prof.

Group's research areas

- Emulsions
- Foams
- Microfluidics
- Separation systems

Collaboration with other groups inside and outside the Burgerscentrum

- Within the ReCoVR project we work together with University of Twente, Delft University of technology, Eindhoven Technical University and various industrial partners.
- Within PICKFOOD we work together with the PCC group of Wageningen University, and various international partners that are all interested in Pickering emulsions.

PhD theses delivered in 2023

- 20 January 2023 – Ivanna Lins Colijn – *Multiscale investigation and characterization of nano-particle reinforced bioplastics: Toward a circular economy*, PhD Thesis "Cum Laude", Wageningen University & Research, (Schroën).
- 9 June 2023 – Sten ten Klooster – *Inside, at the edge, and on the run: dynamics of lipid oxidation in emulsions across length scales*, PhD Thesis, Wageningen University & Research, (Schroën, Berton-Carabin).
- 16 October 2023 – Efrat Gomeh – *See what I mean? Meaning-making by visualizations in policy controversies over energy and food technologies*, PhD Thesis, Wageningen University & Research, (Metze, Schroën, Dijstelbloem).
- 5 December 2023 – Alime Cengiz – *Iron encapsulation strategies to mitigate lipid oxidation in food emulsions*, PhD Thesis, Wageningen University & Research, (Schroën, Berton-Carabin).
- 5 December 2023 – Katharina Münch – *Lipid oxidation in emulsions stabilized with plant protein ingredients: the relevance of non-protein components*, PhD Thesis, Wageningen University & Research, (Schroën, Berton-Carabin, Stoyanov).

Grants obtained in 2023

- REACT EU: Large scale preparation of core shell capsules using in air technology.
- Joint project with IMEC One planet: Digestion investigation using micro-techniques

Projects started in 2023

- Part of the people for the ReCoVR project was hired, 2 more PDEngs to follow.

Other 2023 highlights

- Boxin Deng nominated for the Pieter Walstra Award (3rd prize)
- Highlight 2023 annual report JMBC: Multiscale investigation and characterization of nano-particle reinforced bioplastics: Toward a circular economy (Ivanna Lins Colijn, Karin Schroën)

Wageningen University & Research (WUR)

Department of Agrotechnology and Food Sciences

Physical Chemistry and Soft Matter (WUR-AFS-PCSM)

Prof. dr. ir. Jasper van der Gucht	Full prof.
Dr. Uddalok Sen	Assistant prof.

Group's research areas

- Polymer materials, gels, coacervates
- Rheology of complex fluids
- Film formation in colloidal systems
- Biophysics of living systems

Collaboration with other groups (inside or outside Burgerscentrum)

- Controlling multiphase flow (with TUD, UvA, Unilever, Shell, Evodos)
- Participation in two ITNs: Nanpaint (capillary suspensions), Pickfood (Pickering emulsions)
- Drying of waterborne polyelectrolyte-based coatings (ARC CBBC, with Twente Uniersity)
- Pelleting in the circular agriculture (with Animal nutrition (WUR) and Zetadec)

PhD theses delivered in 2023

- 20 September 2023 – Vahid Alghalandi – *Soft by design: turnable elastomers and plastomers with bottlebrush topology*, PhD Thesis, Wageningen University & Research, (van der Gucht, Kodger).
- 14 November 2023 – Bo Fan – *Granular flows: effects of grain shape, surface friction and grain elasticity*, PhD Thesis, Wageningen University & Research, (van der Gucht, Börzcönyi, Dijksman).

Grants obtained in 2023

- NWO-OTP Criminal InvestigationDX
- Marie Curie ITN Sigsyncel
- KIC Enabling Technologies, NanoFun
- NWO-M Self-healing under stress

Utrecht University

Institute for Meteorology and Oceanography (UU-IMAU)

Prof. dr. Henk Dijkstra	Full prof.
Dr. Anna von der Heydt	Associate prof.

Group's research areas

- Physical Oceanography
- Climate Dynamics

Collaboration with other groups (inside or outside Burgerscentrum)

- ERC-AdG, NWO-M1, NWO-NLeSC (Dijkstra)
- NWO-VICI (von der Heydt)

Grants obtained in 2023

- Horizon-Europe: ClimTip (von der Heydt + Dijkstra)
- NWO-M2 (Dijkstra)

Projects started in 2023

- eTAOC (NWO-NLeSC), Dijkstra
- NWO-VICI, von der Heydt

University of Amsterdam

Faculty of Science - Van der Waals-Zeeman Institute for Experimental Physics

Soft Matter Group (UVA-SMG)

Prof. dr. Daniel Bonn	Full prof.
Prof. dr. Noushine Shahidzadeh	Full prof.
Prof. dr. Peter Schall	Full prof.
Dr. Joshua Dijksman	Associate prof.
Dr. Corentin Coulais	Associate prof.
Dr. Maziyar Jalaal	Assistant prof.
Dr. Sara Jabbari-Farouji	Assistant prof.
Dr. Antoine Deblais	Assistant prof.

Group's research areas

- Flow behaviour of surfactant, polymer, granular and colloidal systems
- Wetting, complex fluids and hydrodynamics
- Crystallization and self-assembly
- Friction and interfaces
- Complex media and metamaterials
- Soft active matter
- Chaos and Dynamical Systems
- Biological Physics
- Environmental/ecological/geophysical fluid mechanics
- Computational continuum mechanics
- Light-matter interaction
- Active filaments in porous media
- Microswimmers in external fields
- Drying of gels in porous media
- Mechanics of glassy and semicrystalline polymers
- Properties with odd robotic matter

Collaboration with other groups (inside or outside Burgerscentrum)

- Industrial collaborations such as with Michelin, SKF and Unilever, Shell, DSM, Akzo Nobel, ASML, Tata steel, ATG Europe, BASF, SACMI, Zetadec, Ocean Cleanup, Ultimaker, Renolit, Chemtrix, Photanol
- AMOLF, Leiden, Utrecht, Delft, Eindhoven, UTwente, Wageningen,
- U Munster, DLR, esa, ETH, U Erlangen, INSA Lyon, University of Warsaw, University of Chicago, ENS Lyon, Georgia Tech, University of Milan, Osaka University, Can Tho University

PhD theses delivered in 2023

- 14 Apil 2023 – Heleen Kibbelaar – *Emulsions: Stability, rheology and sensory perception*, PhD Thesis, University of Amsterdam, (Bonn, Velikov).

- 24 May 2023 – David Dykstra – *Viscoelastic metamaterials*, PhD Thesis, University of Amsterdam, (Bonn, Coulais).
- 22 June 2023 – Bastiaan Veltkamp – *Lubrication in sliding and squeezing*, PhD Thesis, University of Amsterdam, (Bonn, Velikov).
- 6 October 2023 –Feng-Chun Hsia– *Nanoscale topography and wear of ceramic interfaces and their effect on macroscale friction*, PhD Thesis, University of Amsterdam, (Bonn, Frenken).
- 2 November 2023 – Karina González López – *Quantifying mechanical disorder in computer glasses*, , PhD Thesis, University of Amsterdam, (Lerner, Jalaal).
- 29 November 2023 – Santiago Velandia Rodriguez – *Pickering emulsions with proteins; Stabilization and rheological behavior*, PhD Thesis, University of Amsterdam, (Bonn, Roques-Carmes).

Grants obtained in 2023

- ERC Starting Grant M. Jalaal
- Marie Curie MSCA Fellowship J. Bynish
- ZonMW Hepapuff
- NWO KIEM G-Chem

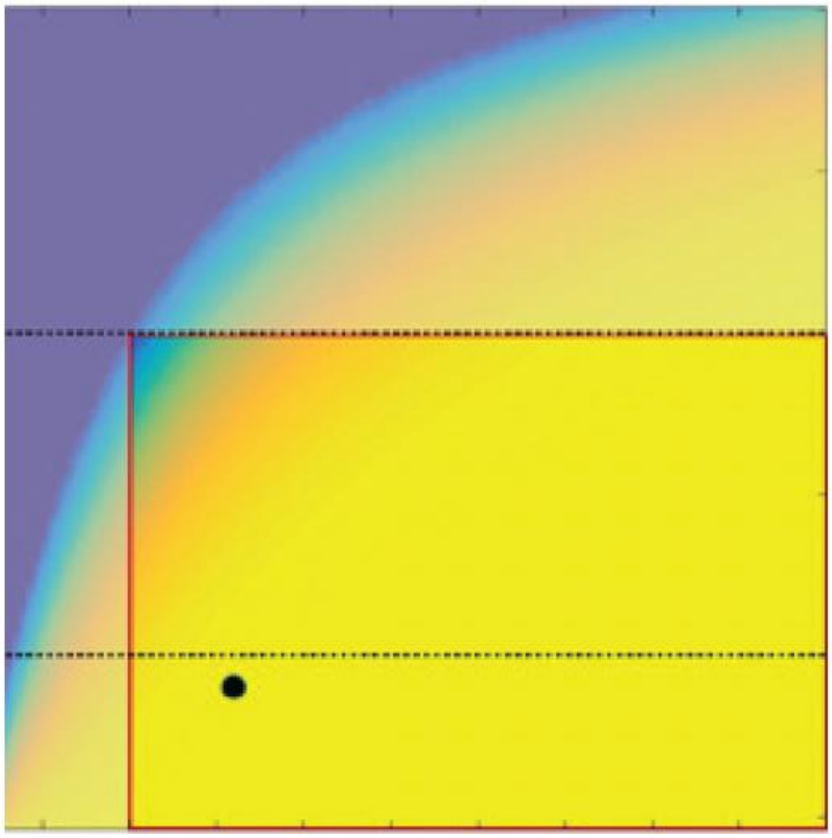
Project started in 2023

- NWO VIDI 2021 - C. Coulais
- HE MSCA PF 2022 ANIMODD
- NWO SIA KIEM G-Chem- P. Schall
- NWO ZonMW HepaPuff - D. Bonn
- Unilever MA2022-02071N - Bonn

Other 2023 highlights

- APS Soft Matter prize for Coulais
- Soft Matter Emerging Investigator award for Deblais

ORGANISATION



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Prof. dr. ir. Niels Deen	Eindhoven University of Technology
Prof. dr. Detlef Lohse	University of Twente

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Ir. Wouter Schiferli	EBN

Contact Groups

- Biological Fluid Mechanics
- Combustion
- Computational Fluid Dynamics (CFD)
- Experimental Techniques
- Lattice-Boltzmann Techniques
- Microfluidics
- Multiphase Flow
- Turbulence

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