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# Organ-on-a-Chip Focused Strategic Partnership (OrChESTRA)

## Deliverable D1.3

Report on mobility and training/education activities - 2

## Work Package 1

Enhancing S&T excellence capacity of ODTÜ MEMS

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# 1 INTRODUCTION

This report presents the second report on mobility and training/education activities delivered under WP1: "Enhancing S&T excellence capacity of ODTÜ MEMS." It covers the period up to project closure and documents (i) staff-exchange missions and (ii) a focused programme of training and education comprising technical seminars, an organ-on-chip masterclass, and two summer schools hosted at the coordinator's premises. Within the reporting period, three outgoing missions from ODTÜ MEMS and two incoming visits from TU/e were completed. Training and education activities centred on core microfluidics and organ-on-chip topics—sample and fluid handling, device fabrication, imaging/flow analysis, and sensor systems for real-time cell monitoring—and were delivered by partner and invited experts. The following sections provide information regarding these activities and the value achieved.

# 2 MOBILITY ACTIVITIES

During this period, staff exchanges progressed but remained below the level foreseen in the Grant Agreement. Of the sixteen visits initially planned (eight exchanges), five were completed in total: three outgoing missions from ODTÜ MEMS to partner institutions and two incoming visits from TU/e. Although the overall number was lower than anticipated, the exchanges that took place were closely aligned with the task topics—microfluidics, organ-on-chip, and cleanroom practice—and, where possible, were coupled with in-person technical seminars to maximise knowledge transfer within the project timeframe.

Several practical constraints reduced mobility, including overlapping academic timetables, facility scheduling, visa procedures, and administrative lead times. To mitigate these effects, each visit was focused on well-defined laboratory tasks and accompanied by seminar or training sessions, while preparatory discussions and follow-up activities were conducted online.

Discussions on potential exchanges were also held with IMEC and UFR. However, given the partners' concurrent project commitments and the limited thematic overlap of available staff during the reporting period, these opportunities could not be realised. The dialogue nevertheless helped align expectations and maintain collaboration continuity through virtual meetings and shared documentation.

The completed missions produced tangible outputs—harmonised notes on chip handling, imaging and measurement parameter sheets, and seminar slide decks—that are now available for internal reuse and have strengthened day-to-day collaboration between ODTÜ MEMS and TU/e groups.

All mobility reports for the three outgoing and two incoming visits have been received and archived together with agendas and photos.

## 2.1 Outgoing visits

### 2.1.1 Outgoing visit – 1: Mehmet Oğulcan Güngör's visit to TU/e

**Visitor:** Mehmet Oğulcan Güngör (MSc, Mechanical Engineering / Micro-&-Nanotechnology, ODTÜ MEMS)

**Host:** Microsystems Research Section, Department of Mechanical Engineering, TU/e

**Date:** 07–18 July 2025

**Mehmet Oğulcan Güngör** is a mechanical engineer and MSc student in Micro and Nanotechnology at Middle East Technical University (METU). A graduate of METU's Department of Mechanical Engineering, he conducts his research at the Micromanufacturing Laboratory within that department and works as a researcher at

ODTÜ MEMS Center. His work focuses on rapid tooling and microfabrication of polymer-based microfluidic devices and MEMS packaging, integrating traditional fabrication methods with 3D printing, injection molding, and thermoforming to enable scalable lab-on-a-chip production. He contributes to both EU-funded and TÜBİTAK-supported projects, including OrChESTRA and MAESTRO, with research interests in additive manufacturing and microfluidic system integration for biomedical applications.

**Motivation of the visit:** The visit to the Microsystems Research Section at TU/e aimed to strengthen technical collaboration within the OrChESTRA project, particularly in the field of microfabrication and bonding techniques for organ-on-a-chip systems. The exchange allowed knowledge transfer between the ODTÜ MEMS and TU/e researchers on advanced fabrication technologies, including femtosecond laser machining and microwave-assisted bonding. These topics are directly aligned with the OrChESTRA's WP3 "Development of organ-on-a-chip platform" focusing on microfabrication techniques for polymer-based organ-on-chip platforms. The visit also aimed to identify possible complementary fabrication methods that can be transferred to the partner institutions and integrated into the overall project workflow.

**Activities performed during the visit:**

During the visit Mr. Güngör:

- Visited the Microfabrication Laboratory and explored various fabrication techniques available at TU/e, including additive manufacturing, laser cutting, and micromachining.
- Received introductory training on **femtosecond laser machining** using the *FEMTOprinter f200 aHead* system and its associated *Alphacam* software.
- Collaborated on the **microwave-assisted bonding project**, focusing on localized thermal bonding methods using inkjet-printed heating patterns.
- Participated in group meetings and project discussions, contributing to planning activities and sharing insights from his ongoing work at ODTÜ MEMS.
- Delivered a **presentation** on his current research on polymer rapid tooling, injection molding of microfluidic chips, and sensor packaging approaches developed at ODTÜ MEMS and METU.
- These activities were conducted under the supervision of **Assoc. Prof. Dr. Hans M. Wyss** and the Microsystems Research Section team.

**Expected Results, Next Steps to be Taken:** The visit facilitated direct knowledge transfer on advanced microfabrication and bonding methods that will contribute to potential improvement of OrChESTRA prototypes and collaborative studies. The experience gained in femtosecond laser machining and localized microwave bonding will be used to enhance ongoing work on polymer microfluidic device packaging at ODTÜ MEMS Center. Next steps include:

- Evaluating the implementation of similar fabrication methods such as femtosecond laser machining, FDM 3D printing, laser cutting, and microwave-assisted bonding setups within ODTÜ MEMS Center laboratories.
- Continuing technical discussions and data sharing with TU/e for future joint publications or joint proposal submission.
- Exploring possibilities for long-term collaboration between ODTÜ MEMS and TU/e on hybrid microfabrication and bonding techniques for polymer-based organ-on-chip systems.

### 2.1.2 Outgoing visit – 2: Dr. Ezgi Salmanlı's visit to TU/e

**Visitor:** Dr. Ezgi Salmanlı (Postdoctoral Researcher, ODTÜ MEMS)

**Host:** Department of Mechanical Engineering, TU/e

**Date:** 07–23 July 2025

**Dr. Ezgi Salmanlı:** Ezgi Salmanli graduated from Ankara University Faculty of Veterinary Medicine in 2015. During her study, she experienced working abroad as a Research Intern at Laboklin GmbH in Bad Kissingen, Germany and carried out test to validate newly developed peptide-based ELISA for the detection of EHV-1/4 disease and performed Virus Neutralization Tests for this purpose. After her graduation she started PhD at Ankara University Faculty of Veterinary Medicine Department of Virology. During her doctoral studies, as a TÜBİTAK (The Scientific and Research Council of Türkiye) 1003 scholar, had the chance to gain experience in the project of "Development of a DNA-Based Vaccine Against Crimean Congo Hemorrhagic Fever". Her thesis project aimed to develop peptide-based ELISA system for the detection of maternal antibodies. In order to develop this ELISA system, she recombinantly synthesised the CPV-2 VP-2 capsid protein obtained from a local isolate and conducted studies on its use as a diagnostic antigen. Later, she worked as a R&D specialist and conducted studies on production of *E. coli* produced recombinant biomaterials in 5L benchtop bioreactor along with development of Colloidal Gold Lateral Flow Immunoassays to detect various analytes from different biological and nonbiological matrices by using different bioconjugation methods. Three products have been developed and are on the market from these studies. In 2023 she joined the ODTÜ MEMS Center and had the opportunity to participate as a researcher in two projects. She is conducting cell culture studies within the scope of the Gut-on-a-Chip system designed for the OrChESTRA. Additionally, she is a researcher in the project supported by TÜSEB (Health Institutes of Turkey), which focuses on the Development of a LAMP PCR-based microfluidic chip integrated with micro/nanoparticles for the isolation and rapid detection of pathogenic bacteria from biological fluids.

**Motivation of the visit:** The main motivation behind this visit was to gain hands-on experience and advanced technical training in microfabrication and organ-on-a-chip technologies, which constitute the core focus areas of the OrChESTRA project. As a postdoctoral researcher working on the development of microfluidic and biosensing platforms at ODTÜ MEMS, this research stay at TU/e provided a valuable opportunity to enhanced Dr. Salmanlı's practical knowledge and technical competence in soft lithography, femtosecond laser micromachining, and microfluidic device fabrication.

The training and laboratory observations conducted at TU/e—particularly in the areas of soft lithography-based mold and electrode production, and cell culture applications involving astrocytes and neurons for Brain-on-a-Chip systems—contributed to the mutual exchange of knowledge and harmonization of experimental protocols across partner laboratories.

Furthermore, this visit strengthened collaborative ties between ODTÜ MEMS and TU/e by fostering discussions on microfluidic integration, material selection, and fabrication optimisation for organ-on-a-chip models. The experience gained during this visit was inline with the research component of OrChESTRA as it facilitated the transfer of expertise particularly in cell culture and development of functional organ-mimicking microphysiological systems.

**Activities performed during the visit:**

During her visit, Dr. Salmanlı:

- Actively participated in soft lithography-based fabrication of electrodes and molds, observing all key steps including spin coating of photoresist, UV exposure, and development.
- Attended introductory training on femtosecond laser machining, including hands-on sessions with the FEMTOprinter f200 aHead system and its associated Alphacam software.
- Visited the Cell Culture Lab and observed the culturing of astrocytes and neurons for Brain-on-a-Chip models, while engaging in scientific discussions on their application and integration with microfluidic platforms.
- Participated in group meetings, contributing to project planning and technical discussions.
- Gave a presentation about her current work and scientific background to the Microsystems research section at TU/e.

**Expected Results, Next Steps to be Taken:** The visit is expected to enhance technical expertise in soft lithography, femtosecond laser machining, and cell culture integration for organ-on-a-chip applications. The knowledge gained will support the standardisation of microfabrication protocols and the development of microfluidic molds and electrodes at ODTÜ MEMS.

### 2.1.3 Outgoing visit – 3: Dr. Vildan Şanko's visit to UFR

**Visitor:** Dr. Vildan Şanko (Senior Researcher, ODTÜ MEMS)

**Host:** Department of Microsystems Engineering, UFR

**Date:** 14–18 July 2025

**Dr. Vildan Şanko:** Dr. Vildan Şanko is a senior researcher at ODTÜ MEMS Center. She obtained her PhD in chemistry and has research experience in the development of electrochemical biosensors and functional biomaterials for medical and environmental diagnostics. Her current work focuses on integrating nanostructured materials, hydrogels, and polymer composites into sensing platforms to achieve enhanced sensitivity, selectivity, and biocompatibility. Dr. Şanko has been actively involved in several national and EU-supported research projects in the fields of sensor technologies, biomaterials, and analytical chemistry, contributing to multidisciplinary collaborations between academia and research centers. She is also expanding her expertise in microfabrication and organ-on-a-chip systems, aiming to combine material innovation with miniaturized sensing approaches. She has authored more than 30 peer-reviewed articles, reviews, and book chapters published in high-impact journals such as TrAC Trends in Analytical Chemistry, Sensors & Actuators, B: Chemical, and ACS Sensors, ACS Applied Nano Materials. She is also a co-inventor on two EU patents related to advanced biomaterials and material technologies.

**Motivation of the visit:** The primary motivation behind this visit was to strengthen scientific collaboration between ODTÜ MEMS and UFR, focusing on the development and integration of advanced materials and electrochemical sensor technologies. The visit provided an opportunity to exchange knowledge on microfabrication approaches, thin-film processing, and interfaces, which are essential for next-generation biosensing platforms. This mobility activity is directly relevant to the objectives of the ongoing project, which aims to establish a multidisciplinary framework combining materials science, electrochemistry, and microengineering for diagnostic and environmental applications. Through joint experiments, technical

discussions, and training sessions, the visit contributed to enhancing mutual expertise, promoting technology transfer, and identifying potential pathways for future collaborative research and EU funding applications. Overall, the staff exchange helped improve skills in sensor fabrication and characterization and strengthened collaboration between the institutions, creating a basis for future joint research on innovative biosensing technologies.

**Activities performed during the visit:**

During her visit, Dr. Şanko:

- Discussed immunoassay development and microfluidic platform design.
- Explored microfluidic platform development strategies and design considerations.
- Engaged in discussions on prototyping approaches for microfluidic devices.
- Examined integration methods for microfluidics and organ-on-a-chip systems.
- Learned about open microfluidic systems and 3D printing techniques, including lab demonstrations.
- Explored bioprinting methodologies and organ-on-a-chip applications.
- Discussed bioprinting strategies, organ-on-a-chip platforms, and potential collaborative research directions.
- Observed Clean Room facilities and reviewed the microfabrication workflow for microfluidic chip production.

**Expected Results, Next Steps to be Taken:** The staff exchange is expected to contribute to enhanced technical knowledge and experimental skills in sensor fabrication, surface modification, and biomaterial characterisation. The visit allowed for mutual learning through laboratory training and discussions on fabrication strategies, analytical optimisation, and data evaluation approaches. These activities supported the exchange of know-how and the establishment of shared protocols between the participating institutions. As the next steps, both teams plan to continue collaboration through joint experimental studies, manuscript preparation, and follow-up project proposals under EU research programs.

## 2.2 Incoming visits

### 2.2.1 Incoming visit – 1: Dr. Hans Wyss' visit to ODTÜ MEMS

**Visitor:** Dr. Hans Wyss (Associate Prof., TU Eindhoven)

**Host:** ODTÜ MEMS

**Date:** 11-15 August 2025

**Dr. Hans Wyss**: is an associate professor (UHD) at TU Eindhoven, the Netherlands. He studied Experimental Physics at ETH Zurich, Switzerland, where he also obtained his PhD in the Department of Materials Science. His PhD work was on ceramic suspensions and processing of ceramic materials. For his post-doctoral studies he spent 6 years (2003-2008) at Harvard University, where he worked in the group of prof. David Weitz on Experimental Soft Matter. Since 2009, Hans Wyss has been a scientific staff member (starting as an assistant prof.) at the Department of Mechanical Engineering at Eindhoven University of Technology (TU/e), with a research focus on microfluidics and soft matter. Hans' research group studies materials that are structured at the meso-scale - larger than molecules but smaller than macroscopic objects. The group develops and uses

simple tools, often based on microfluidics technology, for studying the mechanics, dynamics and structure of complex soft materials. Examples of materials studied include colloidal suspensions and gels, emulsions, foams, biological systems, and polymers. Their rich phase behavior is one reason why they can be encountered in a wide range of applications; at the same time they hold a tremendous potential for studying fundamental scientific questions that are relevant to the behavior of all materials. A key expertise of the group is the measurement of mechanical properties of soft materials at small length scales. Further focus points are the mechanics and dynamics of microgel particles, the study of phoretic forces acting on colloidal particles, and microfluidic technologies for organ-on-chip technologies.

**Motivation of the visit:** After seminars given in previous visits had focused more on scientific content, in this visit, the goal was to share dr. Wyss' experience in science communication and publication of research results to a broader audience.

**Activities performed during the visit:**

During his visit, Dr. Wyss:

- Delivered **two presentations on the dissemination/publication of scientific research**, one on how to write an effective scientific paper, and one on designing a good scientific paper.
    - Presentation on writing a good scientific paper "**Short Introduction to Writing a Scientific Paper":** This presentation is based on advice and guides from dr. Wyss' previous PhD and post-doc advisors, Prof. Gauckler at ETH Zurich, and Prof. Weitz at Harvard, as well as Prof. Whitesides, another renowned professor at Harvard. The presentation focused on practical tips and recommendations for writing a good scientific paper and a recommended workflow for efficiently doing so. Emphasis on starting with a clear main point of the paper, then build the whole structure of the manuscript around most effectively making this point. Start with an outline instead of whole paragraphs of text. The whole function of the introduction is to point out the importance of the main point of the paper (the thing that is missing from previous research that is needed to move forward in the research field).
    - Presentation on designing a good science poster "**How to design a poster - A very opiniated presentation**". This presentation is based on a presentation of Bob Huisman, PhD student in the Microsystems section at TU Eindhoven. The presentation focused on different ways to make your poster stand out from others, how to grab the attention and how to most effectively convey the main message while keeping the reader's attention.
- Held meetings with mentees for the career development programme.
- Attended brainstorming sessions focused on ongoing ODTÜ MEMS projects and explored potential future collaborations and project directions beyond the OrChESTRA framework.

### 2.2.2 Incoming visit – 2: Dr. Rahman Sabahi Kaviani's visit to ODTÜ MEMS

**Visitor:** Dr. Rahman Sabahi Kaviani (post-doc researcher, TU/e)

**Host:** ODTÜ MEMS

**Date:** 11-15 August 2025

**Dr. Rahman Sabahi Kaviani:** Rahman Sabahi Kaviani is a postdoctoral researcher in the Microsystems section of the Department of Mechanical Engineering at Eindhoven University of Technology (TU/e), working on the design and fabrication of microfluidic devices and microsystems for Organ-on-Chip applications. He earned his Ph.D. in the same group at TU/e with a thesis on the development of Nervous System-on-Chip technology. Rahman holds a B.Sc. in Mechanical Engineering from Sharif University of Technology, Iran, and an M.Sc. from the University of Michigan, Ann Arbor, where he was a member of the BioMEMS Laboratory and the Lurie Nanofabrication Facility.

**Motivation of the visit:** The visit aimed to facilitate knowledge transfer and exchange experiences and results in microfluidic chip design and fabrication, strengthening collaboration and advancing OrChESTRA's goals in Organ-on-Chip technologies.

**Activities performed during the visit:**

During his visit, Dr. Kaviani:

- Delivered two presentations on different Organ-on-Chip topics, including Cartilage-on-Chip and Nervous System-on-Chip technologies, followed by technical discussions with ODTÜ MEMS researchers.
- Participated in lab visits and in-depth discussions about the facilities and fabrication capabilities of the ODTÜ MEMS Center, exchanging experiences and methodologies related to microfluidic chip design and fabrication.
- Attended brainstorming sessions focused on ongoing ODTÜ MEMS projects and explored potential future collaborations and project directions beyond the OrChESTRA framework.

**Expected Results, Next Steps to be Taken:** Strengthened collaboration and mutual understanding between TU/e and ODTÜ MEMS in Organ-on-Chip research; Identified joint research opportunities and potential collaborative experiments building on shared expertise.

Representative photos from the staff exchange visits, including activities conducted at partner institutions, are presented in Figure 1 and Figure 2.


(a) (b)

(c) (d)

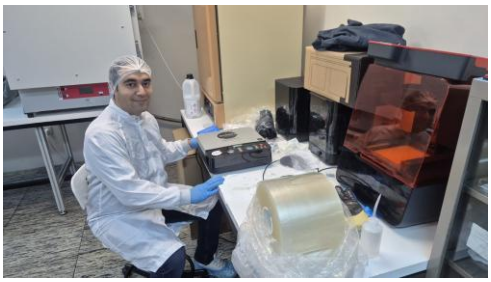
(e) (f)

**Figure 1:** Photos from outgoing staff-exchange activities: (a) presentation by M. Oğulcan Güngör at TU/e; (b) view of the microfabrication laboratory at the Mechanical Engineering Dept., TU/e; (c) Dr. Salmanlı's presentation at TU/e; (d) slide from Dr. Salmanlı's presentation; (e) exterior view of the Faculty of Engineering, UFR; (f) examples of microfluidic cartridge prototypes during Dr. Vildan Şanko's visit to UFR.


(a)

(b)

(c)



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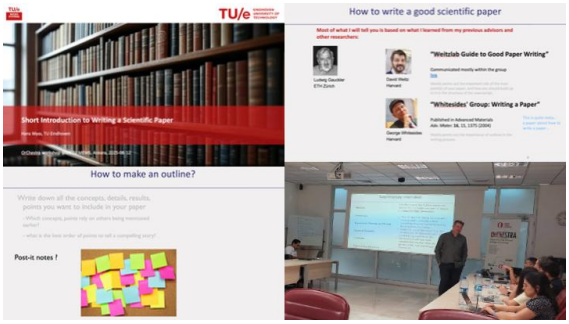


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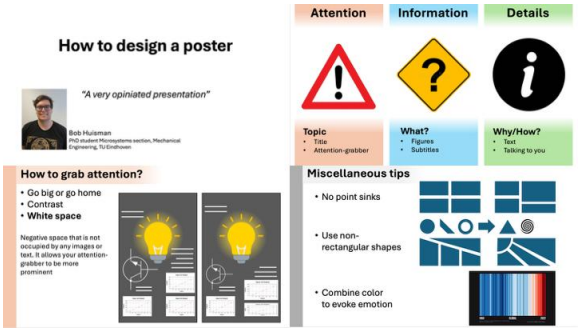



(f)

**Figure 2:** Photos from incoming staff-exchange activities: (a) Dr. Yıldırım with Dr. Wyss and Dr. Kaviani; (b) presentation by Dr. Wyss; (c) presentation by Dr. Kaviani; (d) Dr. Kaviani at the ODTÜ MEMS Centre cleanroom, during an introduction to SLA 3D printing and thermoforming facilities, including the fabrication of an organ-on-chip prototype using thermoforming; (e) Dr. Wyss' presentation titled *"A Short Introduction to Writing a Scientific Paper"*; (f) Dr. Wyss' presentation titled *"How to Design a Poster"*.

# 3 TRAINING AND EDUCATION ACTIVITIES

In this reporting period, training and education activities were delivered to support skills development at ODTÜ MEMS and across partner institutions. The programme comprised six technical seminars, one master class, and two summer schools hosted at ODTÜ MEMS. Content focused on core microfluidics and organ-on-chip topics. Sessions were open to ODTÜ MEMS researchers as well as students and researchers from partner institutions and other organisations. The combination of summer-school lectures/workshops and seminar sessions provided structured learning opportunities and exposure to current methods in the field.

## 3.1 Seminars

Six technical seminars were delivered by partner and invited experts. Sessions focused on practical methods and recent advances in microfluidics and organ-on-chip, linking techniques to ongoing research lines. Attendance included ODTÜ MEMS researchers and students alongside colleagues from partner organisations. The details of the accomplishments achieved are given below:

### Seminar 1: Niche Based Cellular Therapeutic Platforms

A focused technical seminar on "Niche Based Cellular Therapeutic Platforms" was delivered in person by Prof. Korkusuz at TU/e on 28 May 2024 during her visit. The talk provided an overview of translational research on stem cell–based and nanoscale therapeutic systems targeting infertility, bone regeneration, and cancer treatment.


Prof. Korkusuz presented her group's recent work on niche-based germ and somatic stem cell therapeutic strategies, including in vitro spermatogenesis-on-chip platforms for male infertility and microfluidic culture systems (MFD, HD, ALI) designed to mimic testicular niches. The session also highlighted advances in nanoparticle-based endocannabinoid systems with anticancer potential and allogeneic MSC exosome–nanocomposite therapeutics for bone regeneration.

The seminar underlined the need for high-quality preclinical and clinical data to support next-generation personalised therapies and demonstrated how dynamic lab-on-chip and nanomedicine approaches can converge to address regenerative and oncologic challenges.

The talk stimulated discussions between ODTÜ MEMS and TU/e on possible joint experimental directions and microfluidic integration for future organ-on-chip applications.

**Short bio of Prof. Dr. Petek Korkusuz:** Prof. Korkusuz received her MD from Gazi University (1991), completed residency in Histology & Embryology at Hacettepe University (1997) and earned a PhD in Medical Pharmacology at Gazi University (2000). She was appointed Assistant Professor in 1998, Associate Professor (tenured) in 2003 and Full Professor in 2010 at Hacettepe University Faculty of Medicine, where she currently chairs the Department of Histology & Embryology. Her secondary appointments span Nanomedicine & Nanotechnology, Bioengineering, Stem Cell Sciences and Oral Biology. She held research/training positions at Bordeaux University INSERM (cell culture), Osaka University (hybridoma technology; lymphocyte homing), Erasmus University (phage display; EM screening; NATO-B1), and was a visiting professor at Harvard and Yale iPSC centres (2015). Prof. Korkusuz has over 140 SCI-indexed publications, multiple patents and book chapters. Her research focuses on regenerative medicine; pluripotent/multipotent stem cells; somatic and germ cell niches; biomaterials immunobiology; musculoskeletal repair; and cannabinoid system biology. She is an active member of international societies including ISSCR and ESGCT.

## Seminar 2: Microfluidic Dead-End Chamber Devices for Studying the Effects of Extracellular Viscosity on Cell Viability

On 5 May 2025, Dr Hans Wyss delivered an in-person seminar at ODTÜ MEMS entitled “Microfluidic Dead-End Chamber Devices for Studying the Effects of Extracellular Viscosity on Cell Viability.”

While microfluidics has become an essential tool for manipulating small volumes with high precision, its potential for uncovering fundamental biological mechanisms is still unfolding. In this talk, he presented how custom-designed microfluidic dead-end chamber devices, combined with aqueous two-phase systems (ATPSs), are used to investigate the effect of extracellular fluid viscosity on the cell cycle of yeast. The team finds that increasing viscosity beyond a critical threshold leads to a reversible delay in cell division, linked to impaired nutrient uptake and a membrane-tension imbalance. These results reveal a novel, reversible physical regulation of the cell cycle, highlighting how microfluidic platforms can help isolate and probe physical parameters that shape cellular behaviour.

**Short bio of Dr. Hans Wyss:** Hans Wyss received his PhD from the Materials Department at ETH Zurich, Switzerland, where he worked on ceramic suspensions and gels. In his undergraduate education, he studied experimental physics at the Physics Department of ETH Zurich. Before joining TU/e in 2009, Hans worked as a postdoctoral researcher in the Experimental Soft Matter group at Harvard University. He is currently employed as an associate professor in the Microsystems section in the Department of Mechanical Engineering at Eindhoven University of Technology; his research group "Microfluidics and Soft Matter" focuses on the use of microfluidic technologies for experimentally studying and controlling the behavior of soft and biological materials. He has developed several new experimental tools for the study of such materials, including the methods "Capillary Micromechanics" and "Strain-Rate Frequency Superposition," which are used to probe the viscoelastic behavior of soft and biological materials. Hans regularly collaborates with a range of international groups from countries including the United Kingdom, Switzerland, Hong Kong, China, Korea, and the United States.

## Seminar 3: Time-dependent Capillary Micromechanics of Cancer Spheroids

On 6 May 2025, Dr Hans Wyss delivered an in-person seminar at ODTÜ MEMS entitled "Time-dependent Capillary Micromechanics of Cancer Spheroids."

This presentation introduced Capillary Micromechanics as a method for measuring the mechanical properties of microscopic soft objects, such as hydrogel particles or biological cells/tissues. It extended the standard Capillary Micromechanics method to time-dependent measurements, where the viscoelastic—rather than purely elastic—response of the material can be probed by recording time-dependent deformations in response to an applied load. The presentation then showed applications of this time-dependent Capillary Micromechanics in the study of cell spheroids. The first example was a comparative study of the viscoelastic properties of cell spheroids obtained via different processing methods (grown in a bioreactor vs. a well plate). The results indicate distinct differences, highlighting the importance of process conditions on the mechanical behaviour of cells and tissues. In the second example, the study employed Capillary Micromechanics and atomic force microscopy to assess the mechanical properties of normal and cancer spheroids as well as their surrounding matrix. The findings reveal that normal and cancer spheroids exhibit different stiffness, and that extracellular matrix stiffness influences cancer cell dissemination. Additionally, the role of netrin-4, a basement-membrane protein associated with cancer patient survival and known to reduce basement-membrane stiffness, was explored. The study finds that while netrin-4 is associated with a decrease in Matrigel stiffness, it has only a minimal impact on the mechanical properties of the spheroids themselves.

## Seminar 4: Microtechnology for Subcellular-Resolution Electrophysiology and Organ-on-Chip Systems

On 8 May 2025, Prof. Dr Andreas Hierlemann (ETH Zurich) delivered an in-person seminar at ODTÜ MEMS entitled “Microtechnology for Subcellular-Resolution Electrophysiology and Organ-on-Chip Systems.”

Recent advances in microfabrication and the emergence of new biological model systems now enable microphysiological platforms that faithfully recapitulate aspects of human physiology in vitro. Yet obtaining real-time information from, or performing manipulation of, the samples remains a major challenge. The talk outlined how microfluidic, microtechnological and microsensor structures, combined with representative 3D in vitro models of human organs or tissue barriers, can be used to devise robust microphysiological systems compatible with high-resolution microscopy and complementary read-outs. The group has developed versatile microfluidic platforms for the formation, cultivation and analysis of organotypic spherical 3D microtissues (e.g., cardiac tissue, liver, pancreas) and barrier systems (e.g., lung, placenta, blood–brain barrier) derived from various cell types. Sensor modules allow convenient functionalisation and calibration of sensors and do not interfere with microfluidic functions.

**Short bio of Andreas Hierlemann:** Andreas Hierlemann completed his college education in chemistry at the University of Tübingen, Germany, and was awarded a Ph.D. degree in 1996. He then held Postdoctoral positions at Texas A & M University, College Station, TX, USA, in 1997, and at Sandia National Laboratories, Albuquerque, NM, USA, in 1998. In 1999, he joined the Department of Physics, ETH Zurich, Switzerland, where he was appointed Associate Professor in June 2004. In April 2008, he became a Full Professor in the Department of Biosystems Science and Engineering (BSSE), ETH Zurich, Basel. His research interests include the development and application of microsensor, microfluidic, and microelectronic technologies to address questions in biology and medicine with applications in the fields of systems biology, drug testing, personalized medicine, and neuroscience. For details, seehttps://www.bsse.ethz.ch/bel/.

## Seminar 5: Development of Nervous System-on-Chip Technology

On 12 August 2025, Dr Rahman Sabahi Kaviani delivered an in-person seminar at ODTÜ MEMS entitled "Development of Nervous System-on-Chip Technology."

Neurodegenerative diseases such as Parkinson's and Alzheimer's pose major challenges due to their complex origins and lack of effective treatments. To address this, the Nervous System-on-Chip (NoC) technology has been developed through the integration of microfluidic systems and microscale chip design to create advanced in vitro models that mimic neural tissue function. This work introduces a modular toolbox of NoC components, such as microtunnels, nanogrooves, and microsieves, fabricated from materials like PDMS and NOA81 using micro- and nanofabrication techniques. The microfluidic chip design enables controlled nutrient and signal exchange, while the integration with microelectrode arrays allows real-time electrophysiological assessment of human stem cell-derived neurons, offering deeper insights into neural network formation and communication. The successful incorporation of thin-film electrodes on polymer-based microsieves further enhances functionality and supports rapid prototyping. Overall, this research advances microfluidic and chip-based platforms for studying neurophysiology and supports the development of physiologically relevant models for neurodegenerative disease research and drug discovery.

**Short bio of Rahman Sabahi Kaviani:** Rahman Sabahi Kaviani is a postdoctoral researcher in the Microsystems section of the Department of Mechanical Engineering at Eindhoven University of Technology (TU/e), working on the design and fabrication of microfluidic devices and microsystems for Organ-on-Chip applications. He earned his Ph.D. in the same group at TU/e with a thesis on the development of Nervous System-on-Chip technology. Rahman holds a B.Sc. in Mechanical Engineering from Sharif University of Technology, Iran, and an M.Sc. from the University of Michigan, Ann Arbor, where he was a member of the BioMEMS Laboratory and the Lurie Nanofabrication Facility.

## Seminar 6: A Microfluidic Cartilage-on-Chip Platform for Transplant Compatibility Screening

On 14 August 2025, Dr Rahman Sabahi Kaviani delivered an in-person seminar at ODTÜ MEMS entitled “A Microfluidic Cartilage-on-Chip Platform for Transplant Compatibility Screening”.

Osteoarthritis (OA) often leads to joint replacement, but iPSC-derived cartilage offers a regenerative alternative. However, success depends on patient-specific compatibility and immune responses. Current Cartilage-on-Chip models lack the ability to assess allograft rejection risks. We present a microfluidic Cartilage-on-Chip platform integrating patient chondrocytes, immune cells, and synovial fluid to simulate co-culture conditions and study immune-cartilage interactions. The system supports high-throughput screening and real-time imaging, with modular design for experimental flexibility. The integration of electrochemical sensors has also been explored to enable on-chip biomarker detection. This tool facilitates personalized pre-transplant assessments, bridging bioengineering and medicine to improve osteoarthritis treatment outcomes.

## 3.2 Organ-on-a-Chip Masterclass by AZAR Innovations


In collaboration with AZAR Innovations (facilitated via TU/e), ODTÜ MEMS hosted a four-day, practice-oriented masterclass on organ-on-chip technologies on 9–12 July 2024, open to ODTÜ MEMS researchers and participants from partner institutions and external organisations. To align the content with needs, registration captured each participant's target organ model(s), disease interests and prior experience; cohorts were capped at roughly twenty per track to preserve a focused, hands-on format. Facility was prepared with the required pumps, chips, microscopes and consumables, enabling participants to work through complete workflows rather than demonstrations only.

The programme was delivered in two tracks—biology (9–10 July) and engineering/integration (11–12 July)—combining short lectures with guided bench exercises. A structured "Organ-on-Chip Challenge" ran across both tracks: small teams designed an experiment for a specified chip/platform, implemented the setup, presented results and received feedback. Expert contributors (Dr Oscar Stassen, Dr Hans Wyss, Dr Vania Silvério, Dr Pelin Çandarlıoğlu) covered platform selection, chip handling and priming, assay design and read-outs; a dedicated session by Microfluidic ChipShop GmbH introduced current market options and good experimental practice.

Outputs included step-by-step mini-SOPs and checklists for chip preparation and hygiene, ready-to-use templates for experiment planning and data capture, and a short list of concrete follow-up use cases to guide next steps in attendees' projects. Participant feedback pointed to clear gains in practical confidence and a better understanding of how to integrate OoC platforms with existing imaging/sensing infrastructure. The event also provided useful networking time for matching teams with complementary expertise and resources. Further details are provided in D4.5. This activity also supported direct interaction between industrial and academic participants, expanding ODTÜ MEMS's professional training capacity.

## 3.3 Summer schools

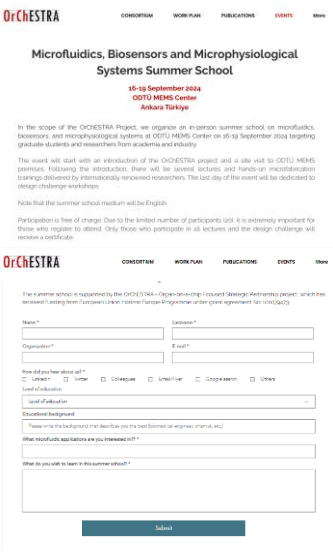
Two summer schools were delivered at the coordinator's premises, combining short lectures with guided practicals to build hands-on competence in microfluidics and organ-on-chip. Participants included ODTÜ MEMS researchers and students alongside participants from partner institutions and external organisations, with group sizes kept moderate to support lab-based work. Each school concluded with problem-solving sessions where teams translated methods into mini-use-cases relevant to their projects.

### 3.3.1 Summer School – 1

**Preparation Phase:** Planning for the **OrChESTRA Summer School 2024** was coordinated at **ODTÜ MEMS** to deliver a focused, training-oriented programme on microfluidics, biosensors and microphysiological systems. The internal coordination team comprised **Prof. Dr. Haluk Külah**, **Dr. Ender Yıldırım**, **Dr. Hüseyin Cumhur Tekin**, **Gamze Kozanoğlu**, **Pınar Burat**, and **Gizem Özdemir**. Working sessions defined the learning objectives (fundamentals plus application-focused blocks), the balance of lectures and hands-on elements, and a two-stage **design challenge** culminating in group presentations.

Speaker invitations were issued with support from **OrChESTRA partners and Advisory Board members**, securing contributions from **Dr. Vania Silvério (INESC MN)** and **Dr. Dries Braeken (IMEC)**, alongside additional expert contributors. The agenda centred on microfabrication fundamentals, flow control, electrical/optical sensing, imaging, and an introduction to microphysiological systems, and included a **cleanroom visit** and a practical microfabrication session.

To facilitate participation and visibility, a dedicated event page was prepared on the project website (https://www.orchestra-project.eu/summer-school-24), with registrations handled online. The Summer School was announced via the OrChESTRA website, LinkedIn, and e-mail lists, and standard event materials (programme, banner, name badges, promotional materials, etc.) were prepared for dissemination.




**Participants and selection:** A total of 44 candidates registered for the Summer School. During registration, applicants were asked “how did you hear about us?”, “what microfluidic applications are you interested in?”, “what do you wish to lear in this summer school?”, and “level of education”. Given the hands-on component, 28 participants were selected based on this information and lab-capacity constraints, and were formed into five project teams for the design challenge.

Participants were predominantly postgraduate (MSc/PhD) students, postdocs and other early-career researchers (including PhD holders) working in microfluidics, biosensing, organ-on-chip, biomedical engineering and related areas. The selected participants represented **18 institutions/organisations** across multiple cities, with **international participation** from **Tunisia** and **Iran**. Examples include:

- **Universities and research organisations:** Ankara University; Gazi University; Hacettepe University; Middle East Technical University; Bilkent University – UNAM; Fenerbahçe University; Gebze Technical University; Dokuz Eylül University; Karamanoğlu Mehmetbey University; TOBB ETÜ; Faculty of Science – Monastir (Tunisia); University of Tehran (Iran); ODTÜ MEMS.
- **Companies/SMEs:** Initio Cell; Mikro Biyosistemler; Validos Biomedical R&D Ltd. Co.

This mix supported cross-disciplinary teamwork and a balanced academic–applied perspective within the five groups.

**Event:** The **OrChESTRA Summer School 2024**, held **16–19 September 2024** at **ODTÜ MEMS (Ankara)**, delivered a four-day, in-person training programme on microfluidics, biosensors and microphysiological systems. The school combined lectures, a hands-on microfabrication session, and a two-stage design challenge. Contributions included talks by **Dr. Vania Silvério (INESC MN)** and **Dr. Dries Braeken (IMEC)** alongside other invited experts, offering participants a structured blend of fundamentals and application-focused content.

**Day 1 — Foundations and facilities:** Opening session introducing the Summer School aims and structure, followed by an orientation to ODTÜ MEMS facilities with a guided cleanroom visit. The academic block covered Fundamentals of Microfluidics (flow regimes, scaling, basic components) and Fundamentals of

Microfabrication for microfluidic devices (materials, patterning and fabrication routes), setting a common baseline for subsequent days.

**Day 2 — Sensing and systems:** The programme moved to system-level topics with lectures on flow generation and control (pumps, regulators, integration aspects), electrical sensing methods (impedimetric/amperometric readouts and interface considerations), and optical sensing methods (imaging and spectroscopic approaches). Two company presentations by Glakolens and Eden Microfluidics complemented the lectures with practical perspectives on device design and implementation.

**Day 3 — Hands-on and Microphysiological Systems:** Participants took part in a hands-on microfabrication session to reinforce core methods. The lecture track introduced microphysiological systems (MPS) and their design logic, followed by imaging techniques for OoC readouts and engineering the microenvironment (materials, mechanics and cues relevant to tissue models).

**Day 4 — Design challenge:** Teams worked through a two-block design challenge (Workshop 1 and Workshop 2), applying concepts from the previous days to propose an OoC solution and experimental plan. The event concluded with group presentations and closing remarks.

(a)

(b)

(c)

(d)

(e)

(f)

**Figure 3:** Various photos from the 1st Summer School: (a) presentation by ODTÜ MEMS; (b) presentation by IMEC; (c–d) images from the hands-on/workshop sessions; (e) winning team of the design challenge; (f) full group photo.

### 3.3.2 Summer School – 2: Engineering Summer School High School Student Program

**Preparation Phase:** Planning for the Engineering Summer School High School Student Program was coordinated at ODTÜ MEMS Center within the framework of the Middle East Technical University (METU) Engineering Summer School, with the support from METU in hardware provision and participant coordination. The ODTÜ MEMS organising team consisted of Prof. Dr. Haluk Külah, Dr. Zeynep Çağlayan Arslan, Akın Mert Yılmaz, Pelin Ormancı, Deniz Cenk Temel, Mustafa Berkay Kılıç, and Enes Ata Ünsal.

The primary goal of the program was to introduce MEMS technologies, inspire interest in engineering, and provide hands-on experience for high school students preparing for university entrance and field selection. The program was designed to combine short theoretical lectures with practical demonstrations, ensuring that participants could engage with both conceptual and applied aspects of microengineering.

During the planning phase, various electronics experiments were evaluated, and a pulse monitoring system was selected as the main hands-on activity. A presentation by Prof. Dr. Haluk Külah was scheduled to introduce the field of MEMS, while a microfluidics demonstration was coordinated with METU faculty Assoc. Prof. Emre Büküşoğlu. A generic informative presentation about cleanroom facilities were prepared by Dr. Zeynep Çağlayan Arslan. The cleanroom tour is planed with ODTÜ MEMS staff. The organising team prepared supporting materials such as an experimental guide and a quiz assessment to enhance student engagement and understanding.

Participant applications were collected through the METU Summer School online platform (https://metusummerschool.org/). For the electronics experiment, Analog Devices ADALM1000 modules were provided by METU, while basic electronic components (diodes, transistors, op-amps, and breadboards) were purchased by ODTÜ MEMS Center specifically for the event. The microfluidics session setup—including microscopes, flow controllers, and microfluidic chips—was assembled in advance to ensure a smooth demonstration experience. Additionally, souvenirs were prepared for participants.

**Event:** The OrChESTRA Project hosted a two-day educational program for high school students on 3–4 July 2025 at the ODTÜ MEMS Center, as part of the Middle East Technical University Engineering Summer School. The program aimed to introduce participants to Microelectromechanical Systems (MEMS) technologies through a combination of introductory lectures, guided facility tours, and hands-on experiments, fostering early engagement with engineering research environments. In that scope, participants divided into 3 groups to attend 3 sessions interchangeably.

Although primarily designed as an outreach activity, the summer school also contributed to strengthening the scientific and technological excellence capacity of ODTÜ MEMS. By introducing young participants to concepts in microfabrication, microfluidics, and sensors through hands-on modules delivered by ODTÜ MEMS researchers, the program fostered early interest in advanced engineering fields and expanded the future talent pipeline of the Centre. Moreover, the involvement of ODTÜ MEMS researchers and graduate students as mentors enhanced their pedagogical and communication skills, reinforcing the Centre's human capital base. The visibility gained through this initiative also strengthened ODTÜ MEMS's recognition as a national reference point for micro- and nanotechnology education.

**Session 1 — Cleanroom Introduction and Tour:** Students were introduced to the fundamental stages of MEMS device fabrication and gained first-hand experience through a guided visit to the cleanroom, where they observed the equipment and processes used in microfabrication.

**Session 2 — Electronics Experiment:** Using the ADALM1000 experimental platform, participants conducted basic circuit-building and electronic measurements, assembling their own pulse monitoring circuits and analysing signal behavior through hands-on experimentation. Experiment was performed in the order defined in the experimental guide, which was delivered before the event date. In this session a quiz exam was held about the experimental guide, and participants were awarded with souvenirs as a motivational support.

**Session 3 — Microfluidics Session:** The session provided an introductory overview of microfluidic principles. A live demonstration was conducted by Assoc. Prof. Emre Büküşoğlu, illustrating the flow behavior in microfluidics and reinforcing the theoretical concepts presented.

This program with 3 sessions was repeated for the 2 days of the event.

(a)

(b)

(c)


(d)

**Figure 4:** Various photos from the 2nd Summer School: (a, c) presentations by ODTÜ MEMS researchers; (b) team activity; (d) group photo.

# 4 CONCLUSIONS AND OVERALL IMPACT

OrChESTRA's mobility, training and education activities have significantly strengthened the scientific and technological capacity of ODTÜ MEMS and deepened collaboration with partner institutions. Over the full implementation period (M1–M36), the programme comprised 12 technical seminars reaching over 190 participants, five staff exchanges, an organ-on-a-chip masterclass, and two summer schools with a combined participation of around 90 students.

Although the number of staff exchanges was lower than originally foreseen, each was targeted and high-impact, focusing on laboratory practices, method transfer, and protocol harmonisation across research teams. The technical seminars, masterclass and summer schools collectively provided hands-on and application-oriented training, supporting knowledge exchange in microfluidics, organ-on-a-chip, and related microsystem technologies.

These activities have strengthened working links between ODTÜ MEMS and partner groups, creating shared understanding and paving the way for joint experimental work. The resulting interaction has improved coordination on microfabrication and organ-on-a-chip tasks, while providing a practical foundation for future collaboration beyond the project timeframe.

Overall, the activities have consolidated ODTÜ MEMS's position as a regional reference point in microfluidics and organ-on-a-chip research, while reinforcing its human capital through targeted training, mentoring, and sustained international engagement.