Establishing metrology standards in microfluidic devices, MFMET EMPIR project

Elsa Batista, Portuguese Institute for Quality, Portugal

MFMET project Coordinator

The EMPIR initiative is co-funded by the European Union's Horizon 2020 research and innovation programme and the EMPIR Participating States

EMPIR MFMET Overview

Call: 2020 Normative

JRP name: Establishing metrology standards in microfluidic devices

JRP refeence: 20NRM02 MFMET

Total budget: ~ 1 M€

Total labour: ~120 MM

Duration: 36 months

Start date: June 2021

Coordinating Organisation: IPQ

Partners - 9 NMIs/DIs, 4 research institutions/university, 4 companies (17). 12 countries

Collaborators: 27

Chief stakeholder: The Microfluidic association

https://mfmet.eu, more than 1300 viewers per month
https://zenodo.org/communities/mfmet

MFMET Consortium

MFMET
Establishing Metrology Standards in Microfluidic Devices

RI. SE
Research Institutes of Sweden

DANISH TECHNOLOGICAL INSTITUTE

Hahn Schickard

enabling MNT
micro nano technology

Bronkhorst®
Flow Technology

University of Glasgow

TÜV SÜD
National Engineering Laboratory

microfluidic ChipShop

CZECH METROLOGY INSTITUTE

leti
cea tech

CETIAT
ensemble, innover et valider

LABORATOIRE NATIONAL DE MÉTROLOGIE ET D'ESSAIS
LNE

IMT
PRECISION ON GLASS

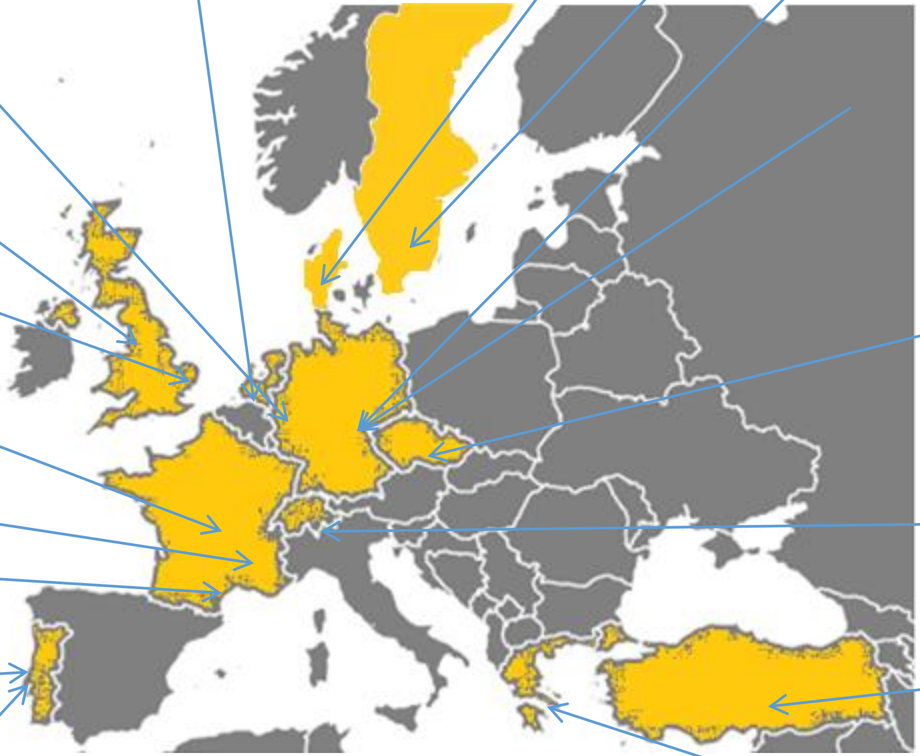
IPQ

TÜBİTAK

INESC MN
Microsystems and Nanotechnologies

ESYP

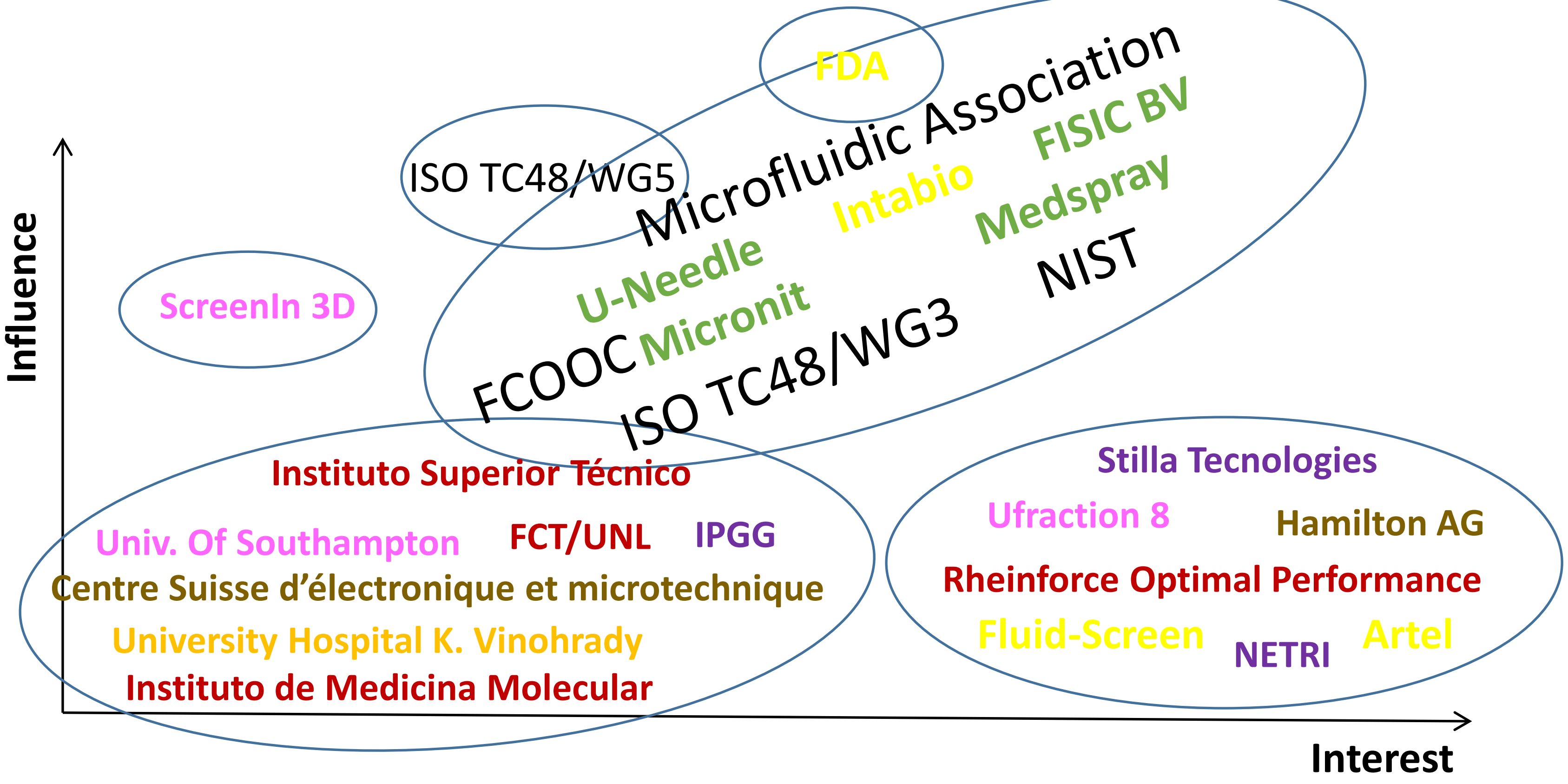
EIM



Stakeholder map 20NRM02 MFMET

Netherlands
Portugal
Switzerland
France
US
UK
Czech Republic
International

KEEP SATISFIED	CO-CREATE
MONITOR	INFORM



Overview

This project aims <u>to contribute to the development of globally accepted standards for microfluidics</u> and disseminate them to end users in industry (health and pharmaceutical sectors) and academia.

- ✓ by the development of **consensus-based measurement protocols & guidelines**

- ✓ By the **dissemination of metrology standards** towards normative committees (ISO TC48/WG3), industry and end users

Work Packages Summary

Establishing Metrology Standards in Microfluidic Devices

Project Coordinator – Elsa Batista

WP no.	WORK PACKAGE TITLE	WP LEADER	
WP1	Establishment of consensus-based flow control specifications for microfluidics	INESC MN	Vania Silverio
WP2	Development of measurement protocols for microfluidics	CETIAT	Florestan Ogheard
WP3	Development of general standards and guidelines for interfaces and connectivity	IMT	Christina Pecnik
WP4	Development of guidelines for the standardisation of dimensions for modularity and sensor integration	microfluidics ChipShop	Elena Müller
WP5	Creating impact	DTI	Henrik Kjeldsen
WP6	Management and coordination	IPQ	Elsa Batista

Major achievements for each WP

WP1 - Consensus-based flow control specifications for microfluidics

- **Definitions, Symbols and Vocabulary of Flow Control**.
- Generic Specification List for **comparison of flow control components**.
- Work on ISO/FDIS 10991 - Microfluidics — Vocabulary and ISO CD TS 6417 - Microfluidic pumps – Symbols and performance communication within **ISO TC 48/WG3**
- Work on **Database** of microfluidics components

Major achievements for each WP

Establishing Metrology Standards in Microfluidic Devices

WP1 - Consensus-based flow control specifications for microfluidics

- **Whitepaper on Leakage Testing** – collaboration with The Microfluidics Association.

Microfluidics Association

Version 1 June 1, 2022

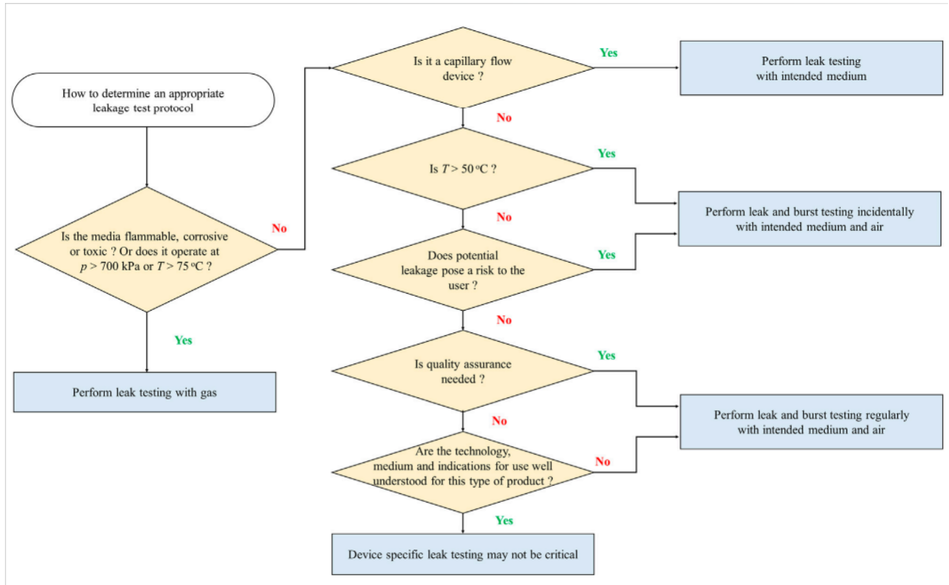
Protocols for leakage testing

A Microfluidics Association white paper.

Version 1, June 1, 2022

Henne van Heeren (enablingMNT, the Netherlands)[1], Matthew Davies (Flow Bio, UK), Armelle Keiser (CEA, France), Rudy Lagrauw (Micronit, the Netherlands), Darwin R. Reyes (NIST, USA), Vania Silvero (INESC MN, Portugal), Nicolas Verplanck (CEA, France)

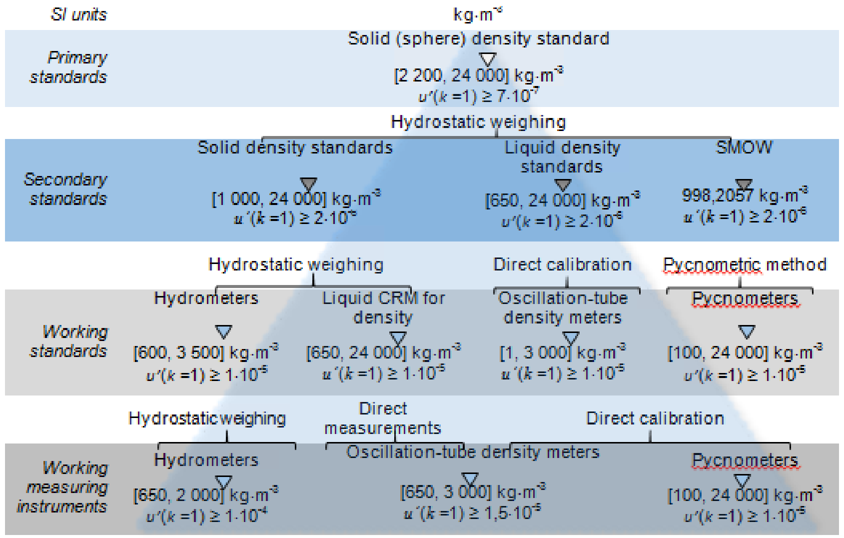
DOI: 10.5281/zenodo.6602162



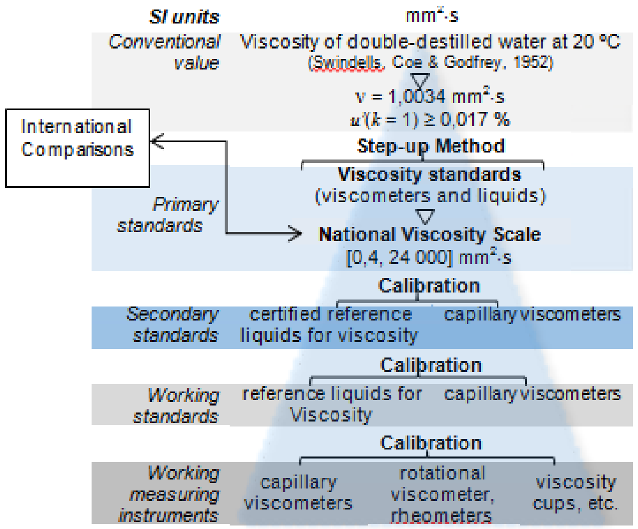
Major achievements for each WP

WP2 - Measurement protocols for different flow quantities and liquid properties

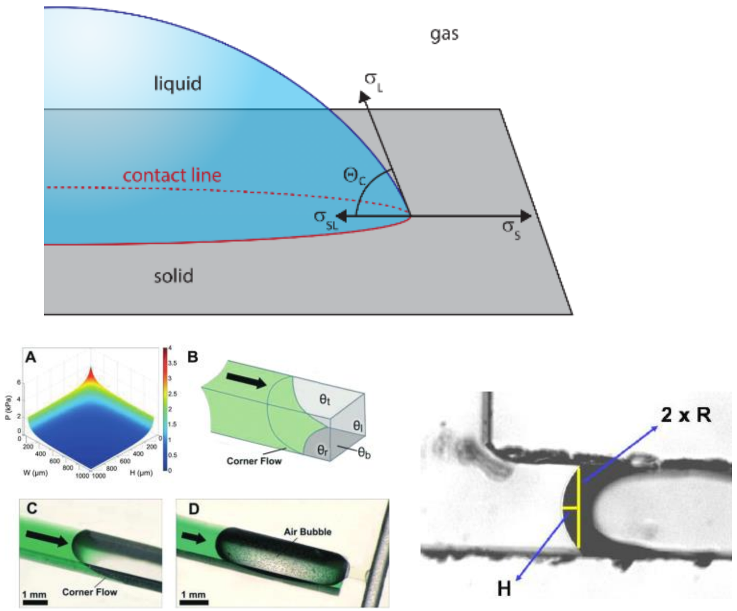
- Development of a test protocol for **liquid proprieties** measurements, Density, Contact angle, Viscosity and Refractive index



Density traceability chain



Viscosity traceability chain

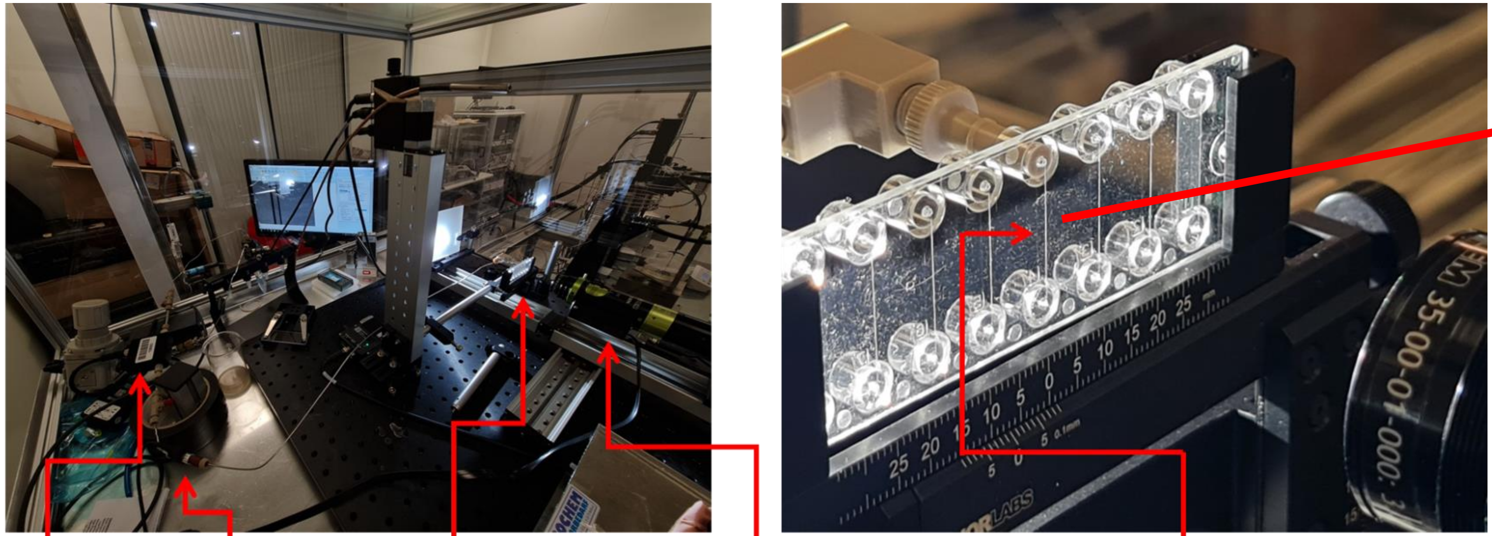


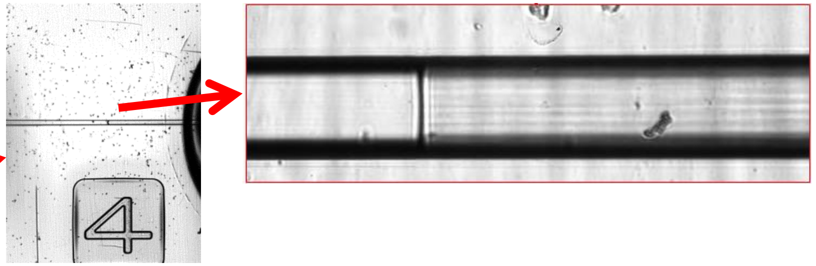
Contact angle on a surface and in a channel

Major achievements for each WP

WP2 - Measurement protocols for different flow quantities and liquid properties

- Development and application of test protocol for **flow proprieties** measurements, flow, flow resistivity, and volume:





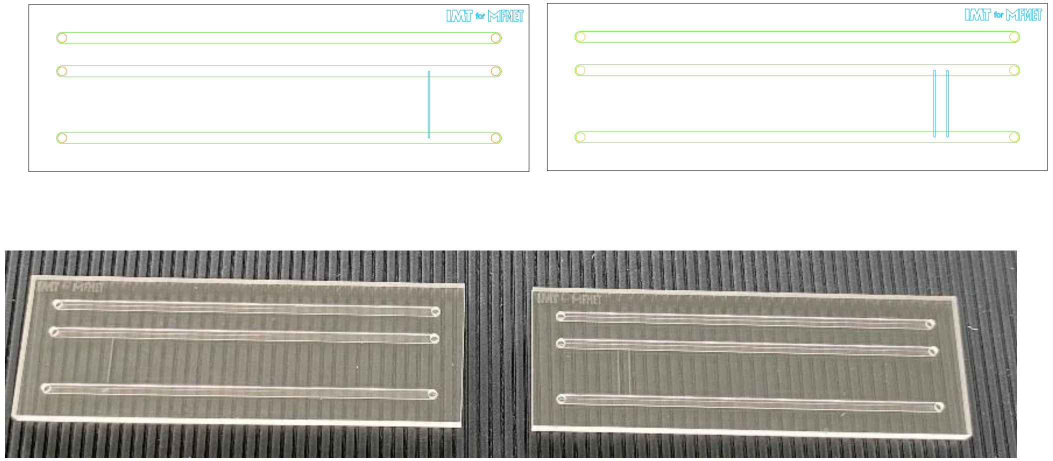
Flow resistivity

Flow rate

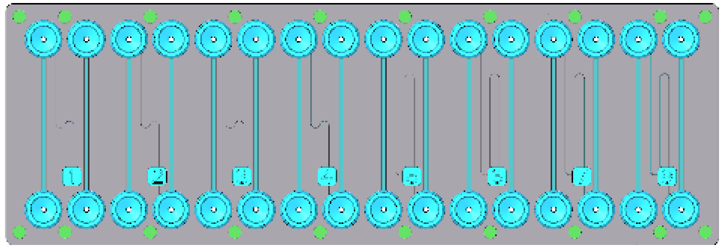
Major achievements for each WP

WP2 – Glass & polymer transfer standards (microfluidic chips)

Transfer standard designs to be used **to disseminate traceability** on flow, flow resistivity, volume, channels dimensions, roughness to microfluidics manufacturers and end-users, and **will be characterized by NMIs** for those quantities.



Glass standard designs, IMTAG



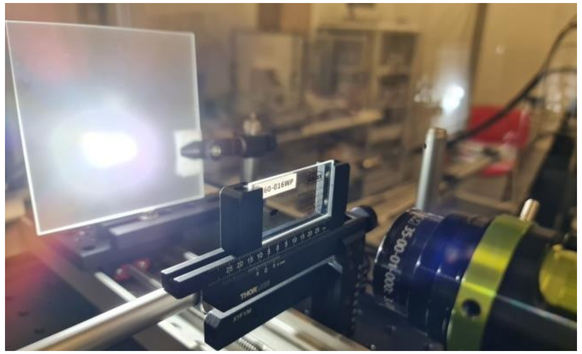
Polymer standard designs, Chipshop

Major achievements for each WP

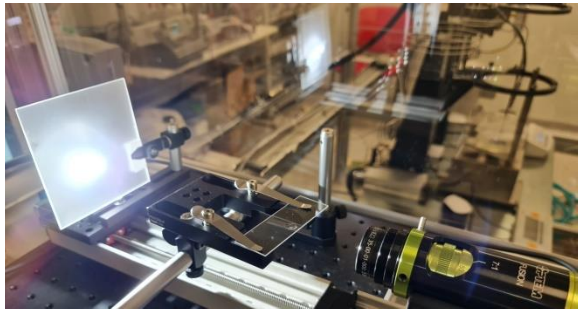
Establishing Metrology Standards in Microfluidic Devices

WP3 - General standards and guidelines for interfaces and connectivity

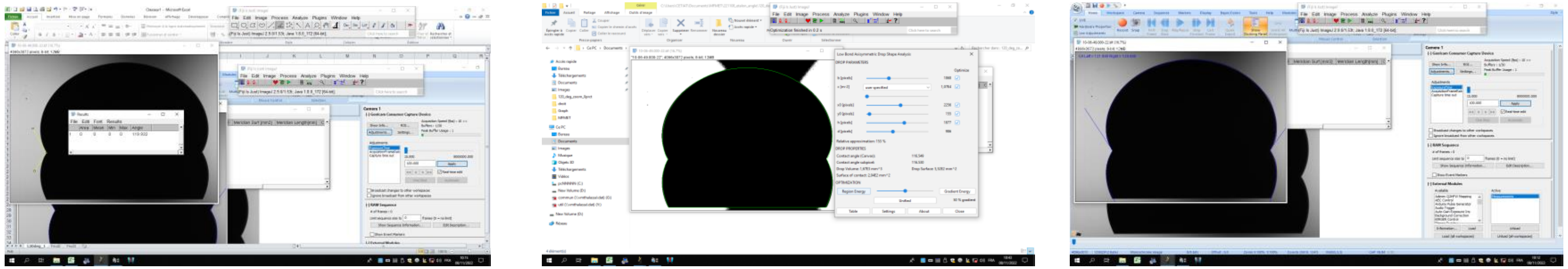
- Development and application of contact angle test protocol and calculation of surface energy (quantifying wettability)



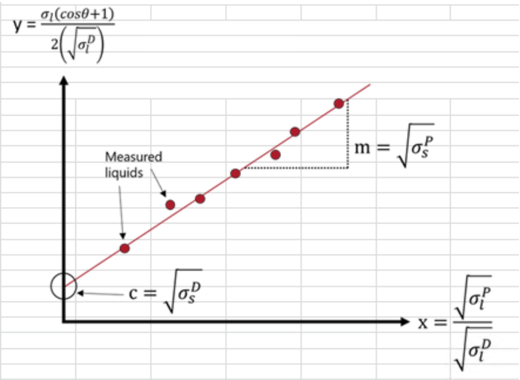
Calibration using an angle standard



Measurement of contact angle

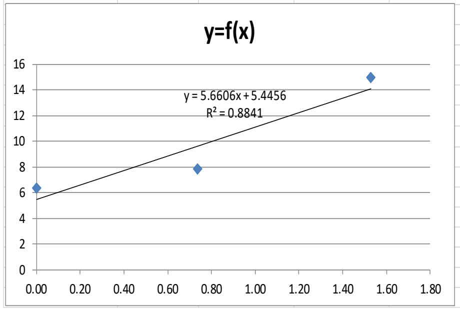


Comparison of 3 contact angle measurements algorithm using ImageJ software



Use of OWRK Model for the calculation of surface energy using 3 contact angle measurements Of ultrapure water, ethylene glycol and diiodomethane

test liquid	theta	cos(theta)	sig d l	sig p l	sig l	y	x
water	22.93	0.92	21.8	51	72.8	14.98	1.53
diiodomethane	37.71	0.79	50.8	0	50.8	6.38	0.00
ethylene glycol	34.89	0.82	30.9	16.8	47.7	7.81	0.74

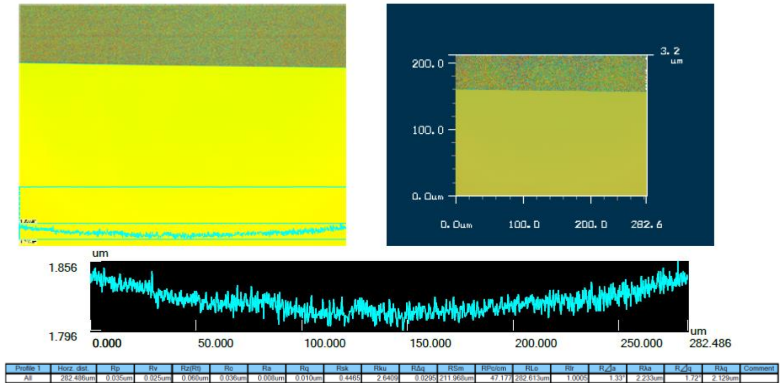


m	5.66		
m^2	32.04	mN/m	(sig P S)
c	5.45		
c^2	29.65	mN/m	(sig D S)
Surface energy (sig s) =	61.70	mN/m	

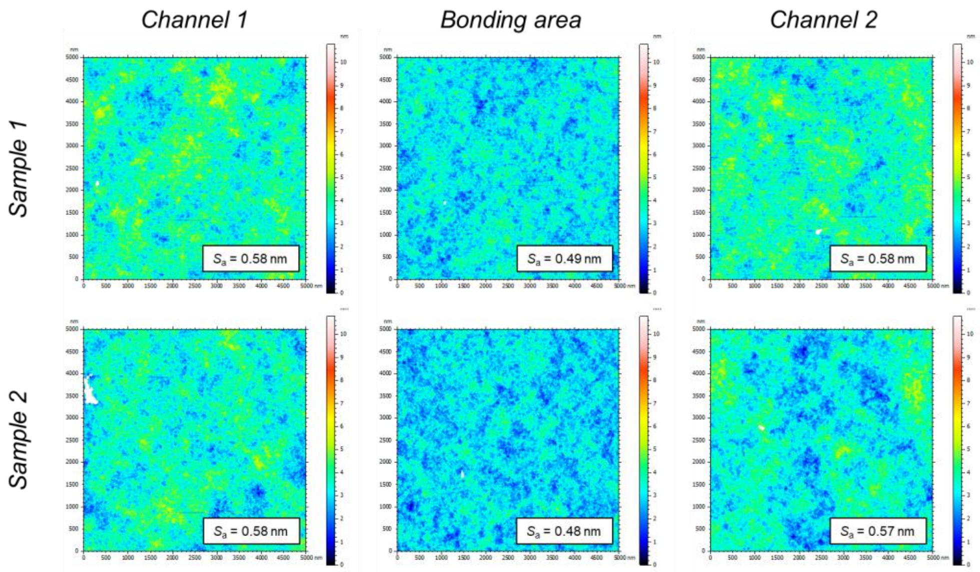
Major achievements for each WP

WP3 - General standards and guidelines for interfaces and connectivity

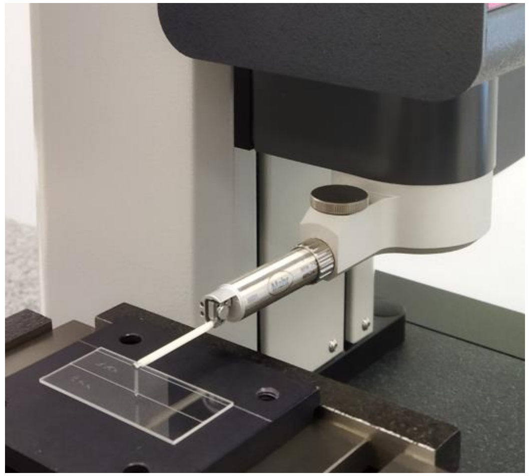
- Development and application of surface roughness measurements protocol



Confocal microscopy, LNE



Atomic Force Microscopy, IMTAG



Stylus instrument, IPQ

Major achievements for each WP

WP4 - Development of guidelines for the standardization of dimensions and accuracy for modularity and sensor integration

- Work on landscape document identifying standardization requirements for microfluidic component design and manufacturing with respect to modularity and heterogenous integration, has started.
- Work on current state of the art of modularity and heterogenous integration of microfluidic systems is almost completed.
- Report on material properties and methods to measure them, relevant for microfluidic components completed and a white paper developed.

WP5 - Impact

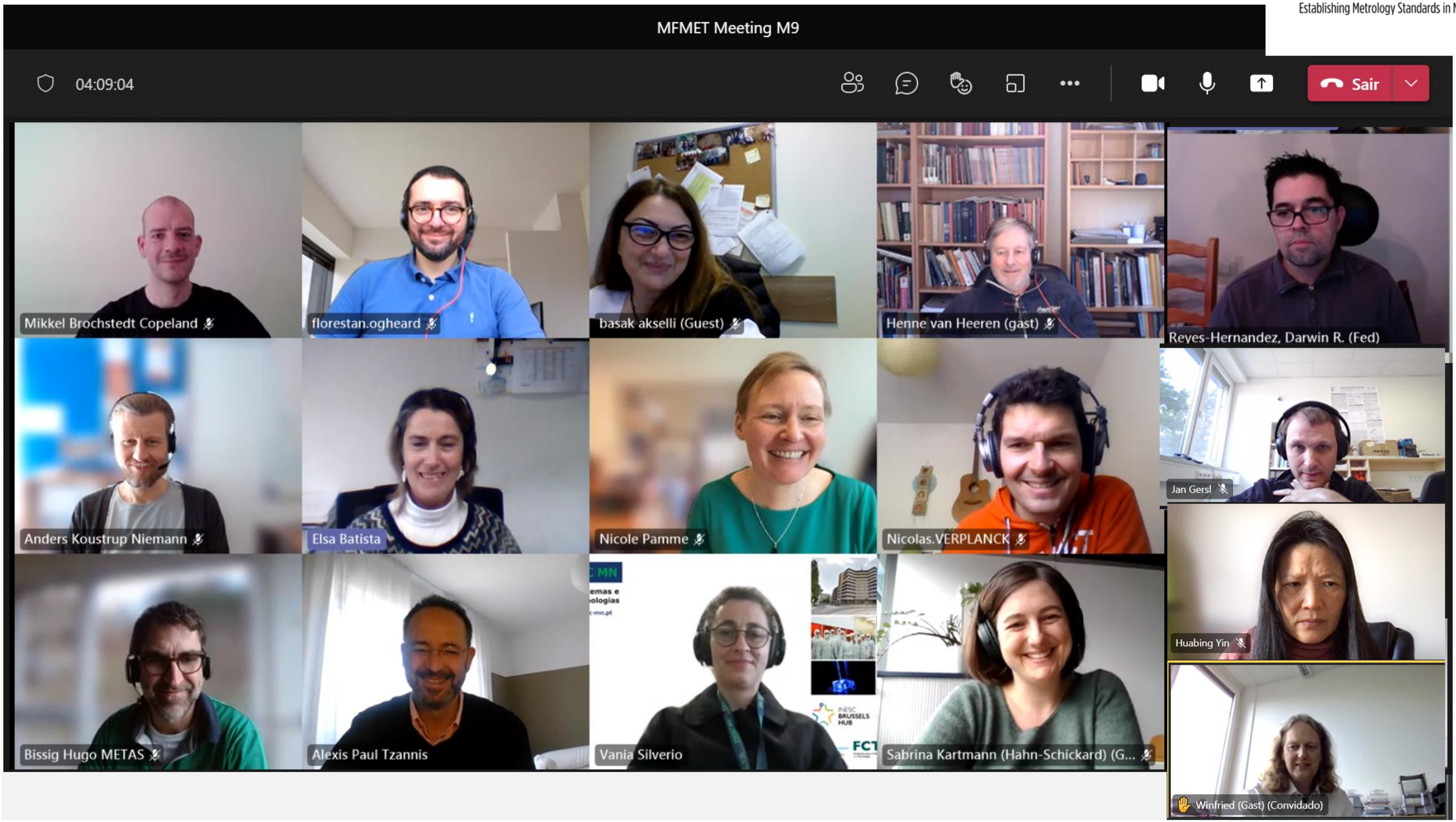
- 2 peer review **Paper** published
- 5 **Whitepapers** published in collaboration with The MFA
- 12 **presentations in conferences**
- 2 **Articles** published in trade/professional press
- 10 **technical reports/protocols**
- **Deliverable** 1 – Guidelines and a test protocol for flow control evaluating leakage and burst pressure in microfluidic devices
- Active participation in **ISO/TC48/WG3** - Microfluidic devices, **ISO/TC48/WG5**-Liquid handling devices- automatic

WP5 - Impact

- Active participation of MFMET participants in the development of the roadmap of the **CEN-CENELEC Focus Group Standards for Organ-on-Chip, specially in WG1 –terminology and WG3 - Engineering.**

The Team

Establishing Metrology Standards in Microfluidic Devices



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Save the date: MFMET workshop at CETIAT in Lyon, France on 14 of November 2023

THANK YOU

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