A simple design to study the accuracy of household meters

MetroWaMet final meeting and dissemination workshop

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

Content

-Shortly VTT MIKES and project background

-Development of the calibration rig

-Measurement results of the household meter

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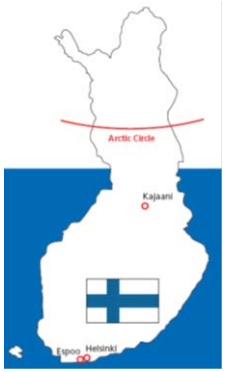
National Metrology Institute VTT MIKES



- Part of VTT Technical Research Centre of Finland Ltd
- National Metrology Institute VTT MIKES has two departments located in Espoo and Kajaani

VTT MIKES Kajaani

- World’s northernmost national standard laboratory
- National standard for force, torque, heavy mass and water flow

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MetroWaMet

- The work is done under EMPIR project called “Metrology for real-world domestic water metering”
- Work Package 1, Infrastructure to assess domestic water meters under dynamic load changes
- The aim was to develop/modify an existing test rig to meat the needs to measure the water meters under dynamic load changes
- Comparison measurement between partners
- In Finland we used the scale of the gravimetric calibration rig as the base for the new dynamic rig

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Simple dynamic water meter calibration rig

Liquid flow

- We use the flow from local water supply network
  - Pressure ca. 7 barg
    - ➢ Regulated to 4 barg
  - Pressure regulator at the inlet to balance the fluctuations
  - Temperature of the water is colder (ca. 7 - 8 °C) compared to normal 20 °C

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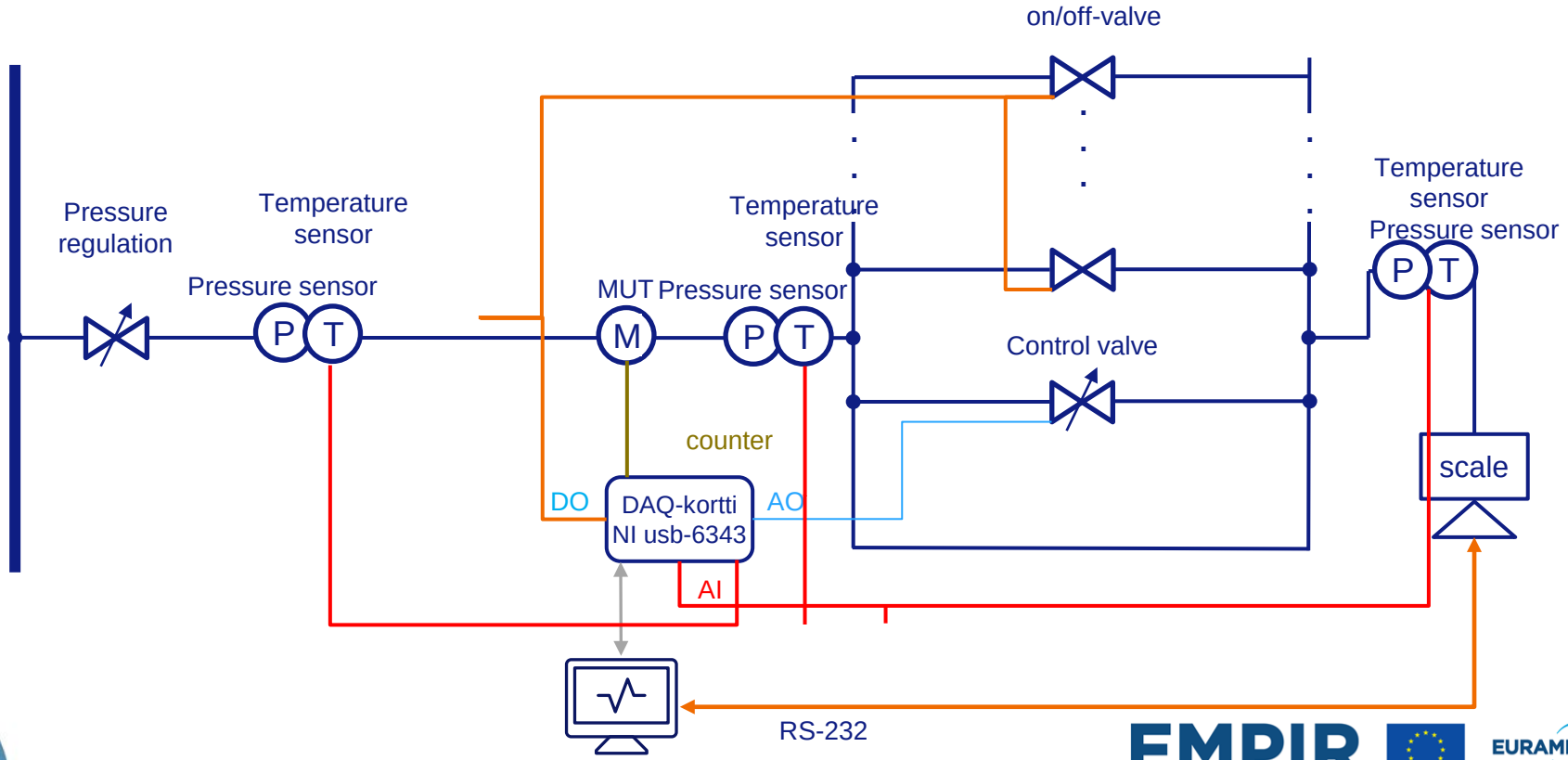
Hardware



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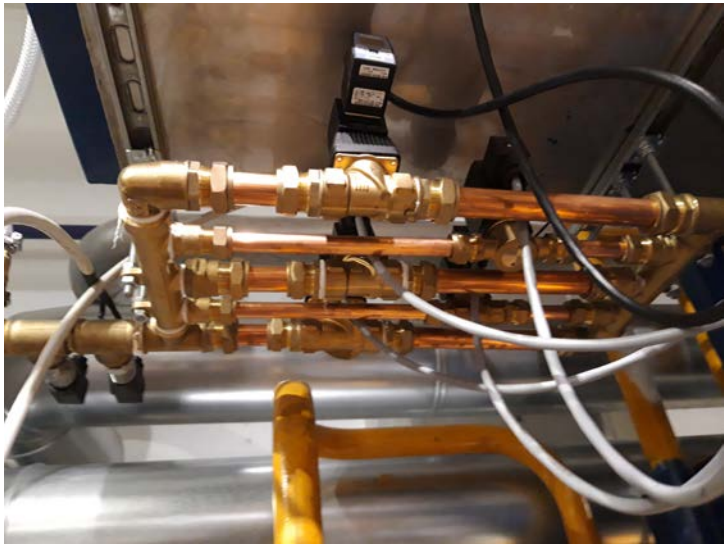
Flow rig

Inlet and pressure vessel

Control valves



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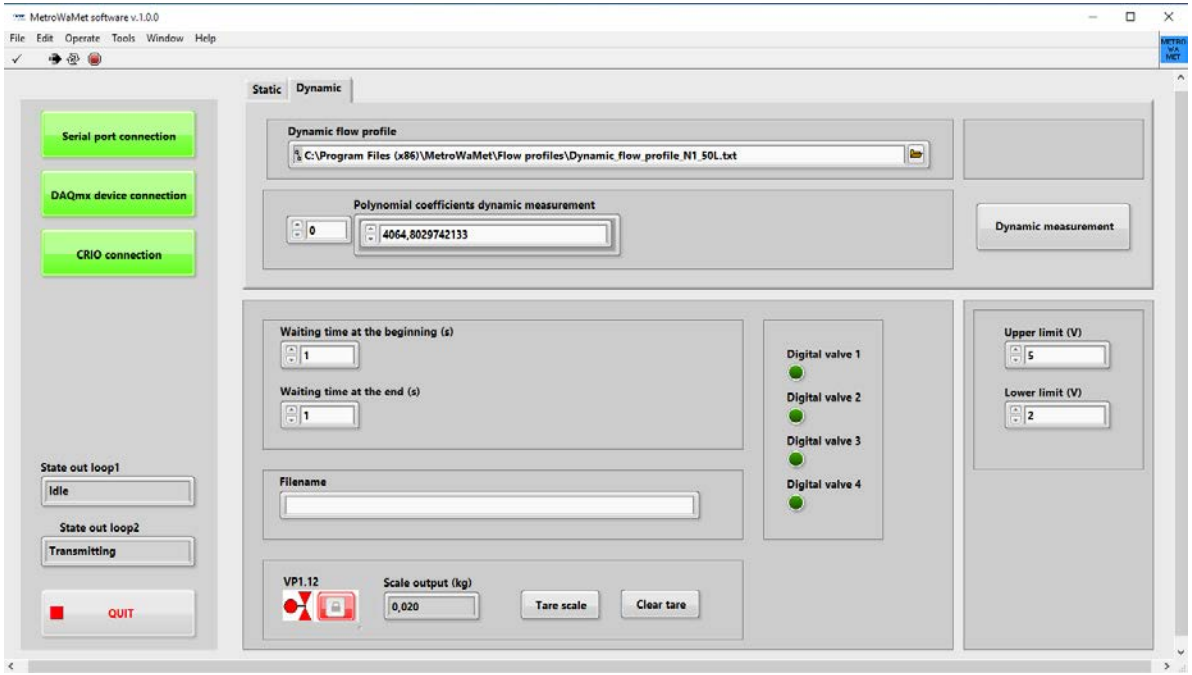
User interface of the software



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Simple design

- The rig imitates the operating system of normal house
  - There are needs for very specific rigs, but we tried to get this closer to normal use
  - Primary standard -> secondary standard -> … -> bucket

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Performance of household water meter

Measurements with typical meter

- Tested meter is ultrasonic design, size of the meter is DN20, Q_3=2,5 m^3/h and R250
- Meter has normal operation mode (resolution 1 L) and test mode (resolution 0.001 L)
- Normal end-user cannot use test operation mode
- Tests were done with VTT's test rig, where the scale is the reference, with dynamic and static profiles

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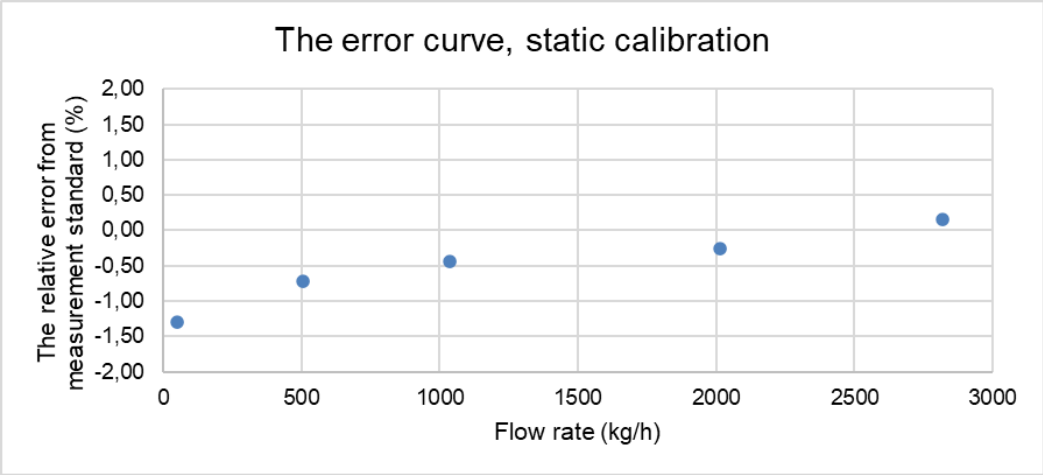
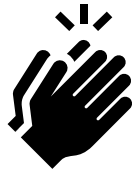
Measurements with typical meter

Specification for the meter is class 2



- Static measurements
- Test mode
- Average results of 5 repeats, 300 s each

Meter is working fine in class 2, even close to class 1 (Q_2=16 m^3/h)



Metrology for Real-World Domestic Water Metering

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Measurements with typical meter

Static measurements, test mode, average results of 5 repeats, 300 s each

Nominal flow rate (kg/h)	Mass flow rate of the reference (kg/h)	Time of meas. (s)	Average upstream Pressure (bar)	Average water temp. (°C)	Average reference mass (kg)	Density of water (kg/m^3)	Indicated mass by MUT (kg)	Average relative error (%)	Standard deviation (%)	Relative expanded uncertainty (k=2)
50	51,98	300,0	4,05	10,20	4,331	999,685	4,275	-1,301	0,34	0,73
500	505,34	300,0	3,93	6,94	42,112	999,907	41,808	-0,720	0,06	0,31
1000	1035,49	300,0	3,84	6,96	86,291	999,906	85,910	-0,442	0,07	0,31
2000	2014,96	300,0	3,56	7,22	167,913	999,894	167,478	-0,259	0,07	0,31
2800	2819,78	300,0	3,17	6,87	234,982	999,910	235,366	0,164	0,03	0,29

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Measurements with typical meter

Dynamic measurements, test mode, average results of 5 repeats

Profile N°	Time of meas. (s)	Average upstream Pressure (bar)	Average water temp. (°C)	Average MUT Flow Rate (kg/h)	Average Reference Flow Rate (kg/h)	Water density (kg/m^3)	Average Reference Totalized Mass (kg)	Average relative error (%)	Standard deviation	Relative expanded uncertainty (k=2) (%)
1 - 50 L	443,0	3,99	7,51	445,429	449,343	999,874	55,294	-0,87	0,21	0,50
2 - 100 L	748,0	3,99	8,04	491,727	495,641	999,848	103,019	-0,79	0,11	0,35
3 - 80 L	560,0	4,01	7,72	555,959	559,171	999,868	86,908	-0,57	0,06	0,30

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Measurements with typical meter

- Previous measurements were made with more specific test mode
- How about with normal mode

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Comparison of test mode and normal mode

Static measurements, average results of 5 repeats

Nominal flow rate (kg/h)	Time of meas. (s)	TEST MODE: Average relative error (%)	TEST MODE: Standard deviation (%)	TEST MODE: Relative expanded uncertainty (*k*=2)		NORMAL MODE: Average relative error (%)	NORMAL MODE: Standard deviation (%)	
50	300,0	**-1,301**	*0,34*	0,73		**-0,659**	*0,899*	
500	300,0	**-0,720**	*0,06*	0,31		**-0,028**	*3,615*	
1000	300,0	**-0,442**	*0,07*	0,31		**0,927**	*3,562*	
2000	300,0	**-0,259**	*0,07*	0,31		**-1,341**	*1,533*	

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Comparison of test mode and normal mode

Dynamic measurements, average results of 5 repeats

Profile N°	Time of meas. (s)	TEST MODE Average relative error (%)	TEST MODE Standard deviation	TEST MODE Relative expanded uncertainty (*k*=2) (%)		NORMAL MODE Average relative error (%)	NORMAL MODE Standard deviation	
1 - 50 L	443,0	**-0,87**	*0,21*	0,50		**-2,16**	*3,06*	
2 - 100 L	748,0	**-0,79**	*0,11*	0,35		**-1,98**	*1,12*	
3 - 80 L	560,0	**-0,57**	*0,06*	0,30		**1,34**	*3,78*	

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Conclusion

- Both modes gives good results
- End user point of view, meters are accurate
- Specific and accurate tests needs more special flow rigs, like the ones developed during MetroWaMet project

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