

WATEF 2018 – Aveiro (Portugal)

Development of a noise-sensing device for water end-uses monitoring

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3. The prototype
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7. Future aims

INTRODUCTION

Urban water efficiency has been our research area for nearly 20 years

We have worked on:

- Hydraulic modelling
- Water losses management
- Meter management
- Demand characterization and management

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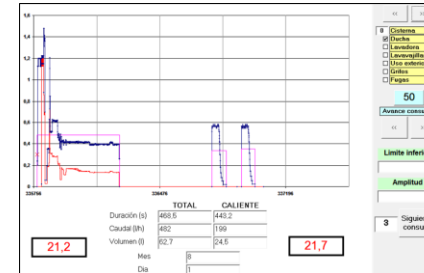


Topic of this
presentation

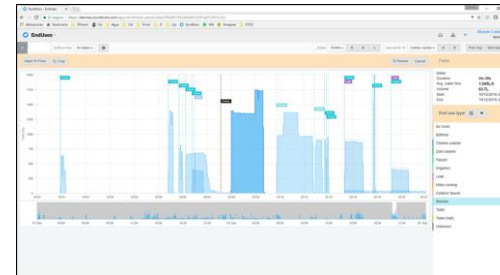
INTRODUCTION

Complementary approaches to learn how water is consumed at home

- Water diaries fulfilled by consumers
- Surveys on consumers' habits
- Audits in households
- Pilot studies
- End-uses monitoring:



(2003)



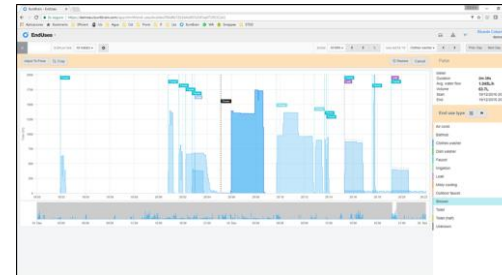
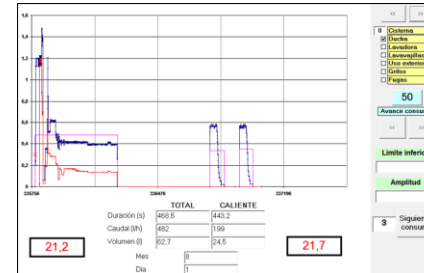
(2016)

INTRODUCTION

Complementary approaches to learn how water is consumed at home

- End-uses monitoring:

Why don't we learn which is the water device being used by listening to it?



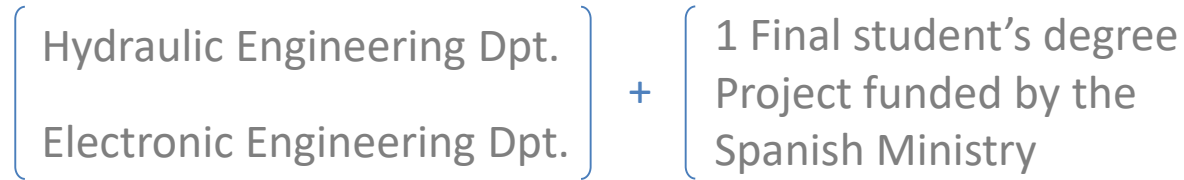
DEVELOPMENT PLAN

Device requirements

- Easy attachment to (i) inlet water hoses or (ii) water appliances
- Registration of water noise during water consumption
- Filtering of other noises (environment, people)
- Storage of basic noise information as registered
- Basic signal analysis

DEVELOPMENT PLAN

A short joint project was devised



Sketch of the device components



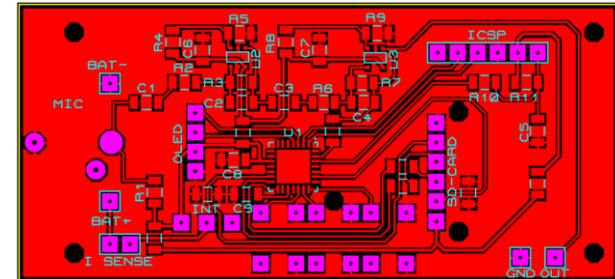
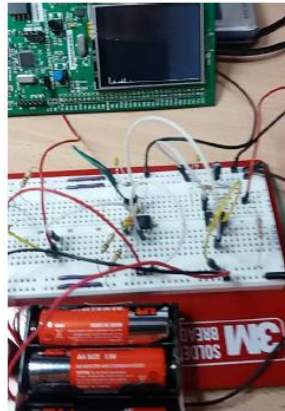
DEVELOPMENT PLAN

Stages planned

#	Stage	Time
1	Requirements and basic design	July 2017
2	Performance simulation	Sept. 2017
3	First prototype construction	Oct. 2017
4	Preliminary tests	Nov. 2017
5	Definitive prototype construction	Jan. 2018
6	Full performance tests	Feb. 2018
7	Future developments	June 2018

THE PROTOTYPE

- Theoretical design
- First assembling
- Tests on Proteus software
- Tests on bench



THE PROTOTYPE

Key trials and decisions

THE PROTOTYPE

Key trials and decisions

- Selection of the sensor type:



Microphone



Piezometer

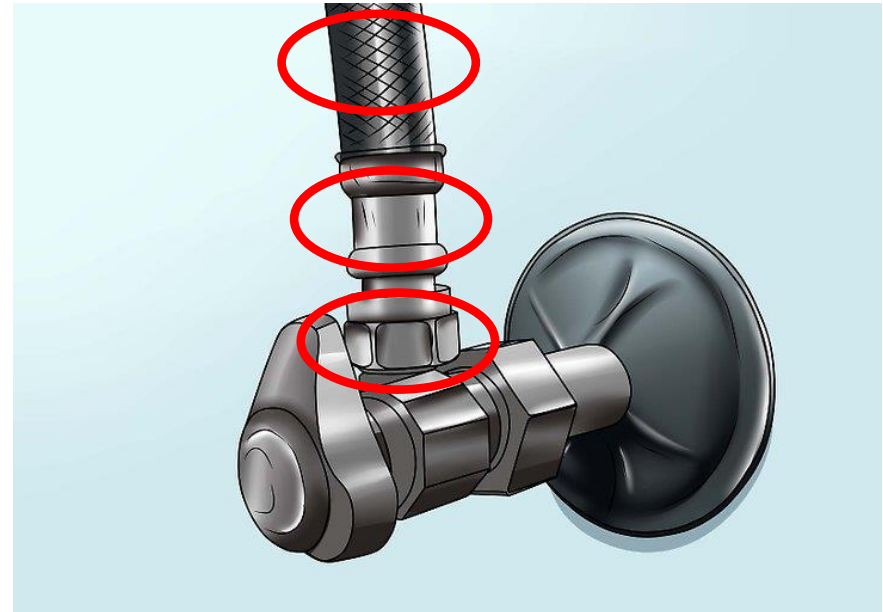


Accelerometer

THE PROTOTYPE

Key trials and decisions

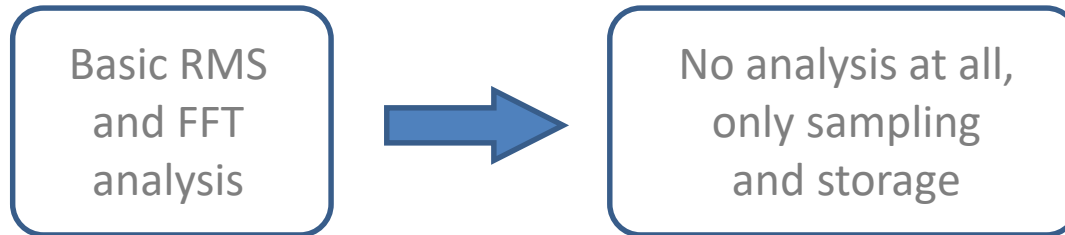
- Selection of the sensor element.
- Selection of the point for sensor installation.



THE PROTOTYPE

Key trials and decisions

- Selection of the sensor element.
- Selection of the point for sensor installation.
- Degree of signal process performed by the microcontroller:



THE PROTOTYPE

Main (initial) features

- Sampling rate: 120 kHz
- Bandwidth: 60 kHz
- Raw sampled information stored with no processing
- Noise threshold setting
- Battery life: < 2 months



OPERATION

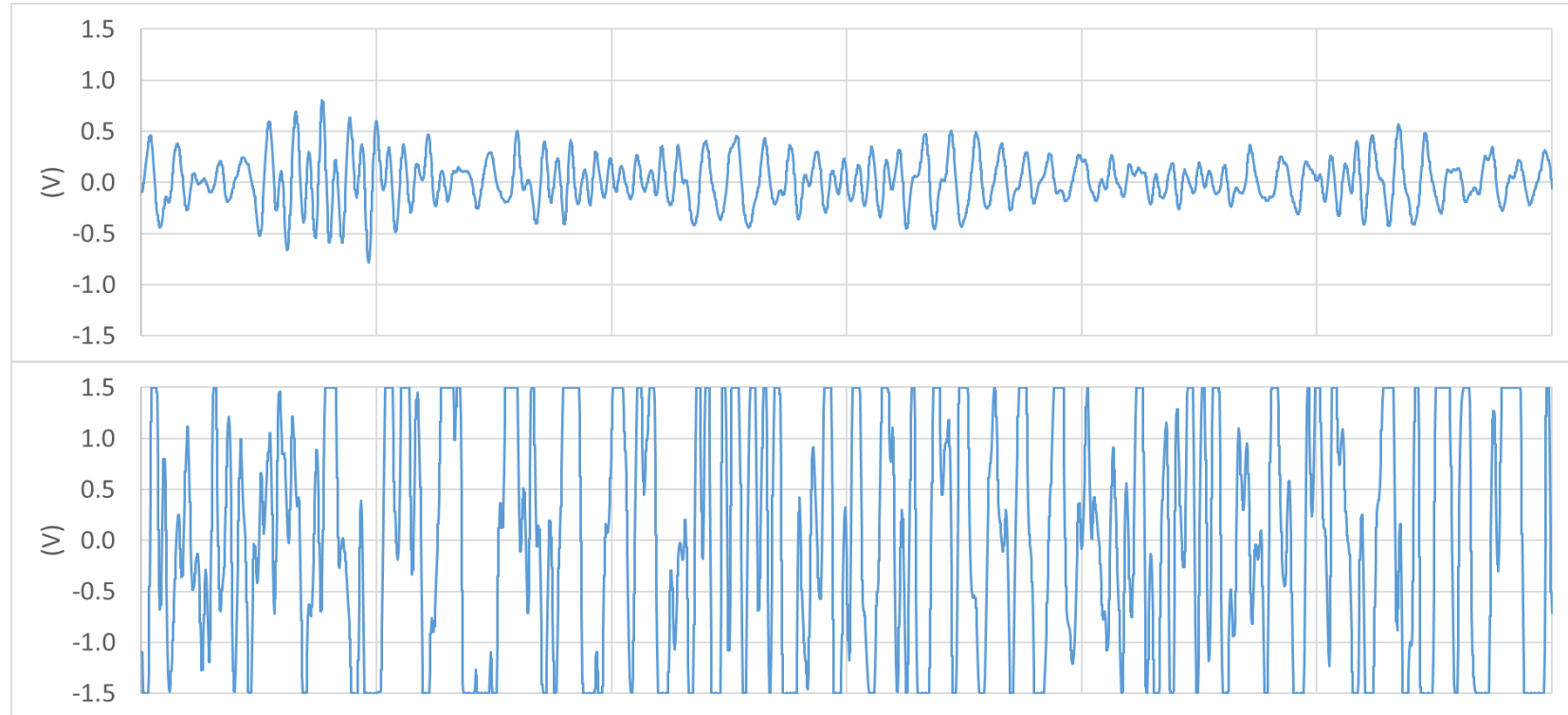
Sensing procedure

- Installation
- Threshold setting
- and listen...



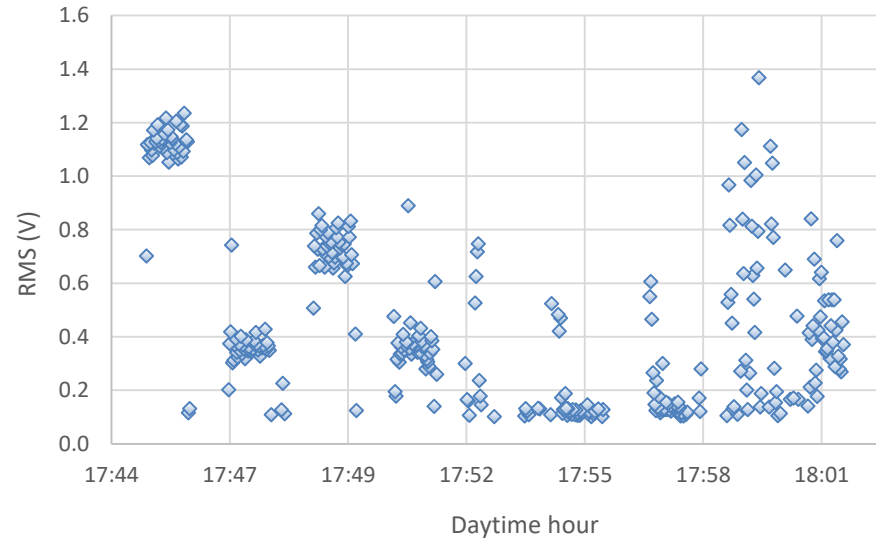
RESULTS

Two example samples (50 ms)



RESULTS

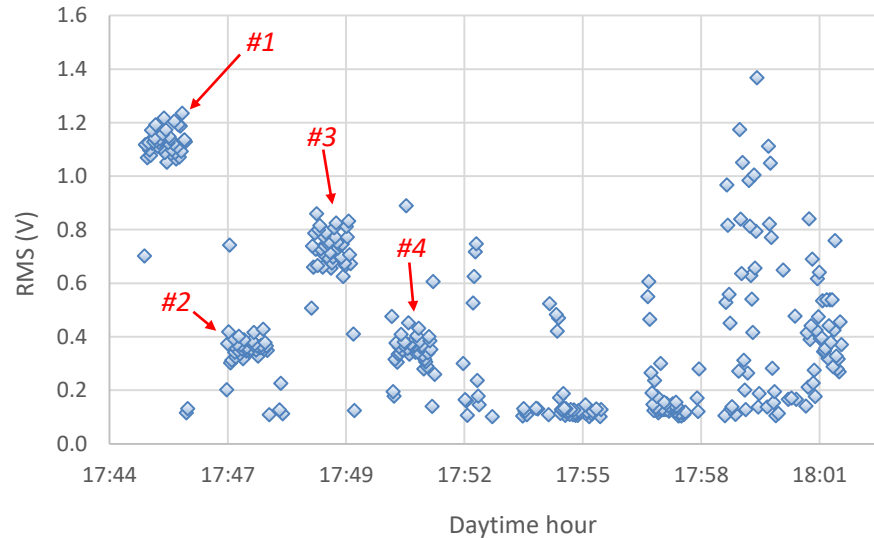
Sample measures in University restrooms



RESULTS

Sample measures in University restrooms

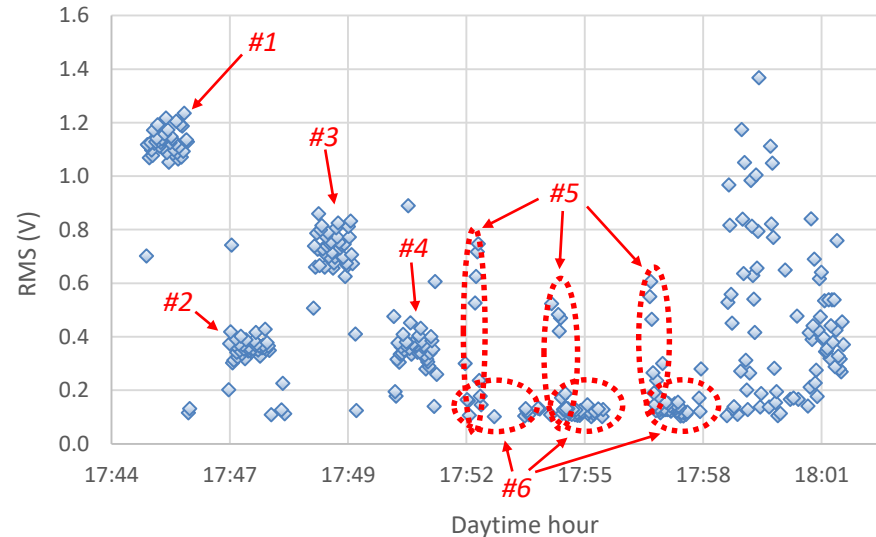
1. Basin tap – full open
2. Basin tap – half open
3. Next basin tap – full open
4. Next basin tap – half open



RESULTS

Sample measures in University restrooms

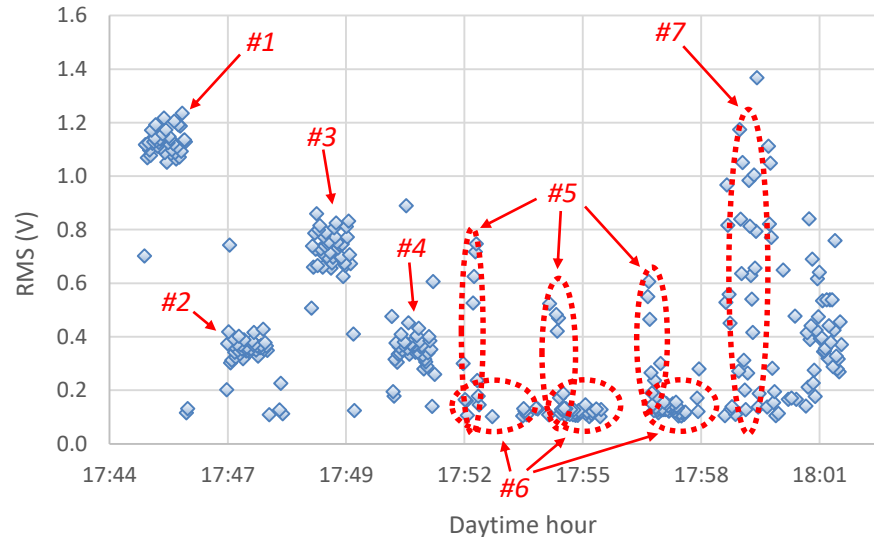
1. Basin tap – full open
2. Basin tap – half open
3. Next basin tap – full open
4. Next basin tap – half open
5. Toilets – flush
6. Toilets – tank filling



RESULTS

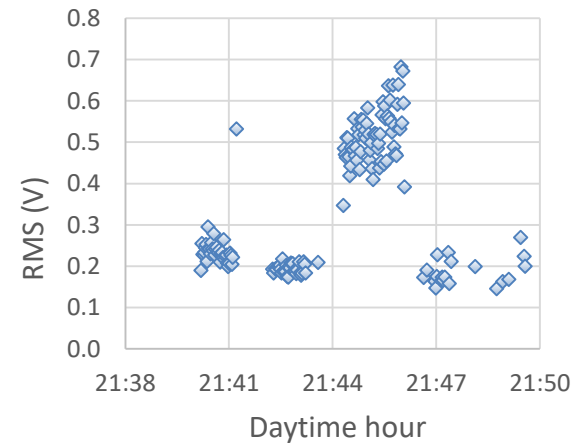
Sample measures in University restrooms

1. Basin tap – full open
2. Basin tap – half open
3. Next basin tap – full open
4. Next basin tap – half open
5. Toilets – flush
6. Toilets – tank filling
7. Urinals – flush



RESULTS

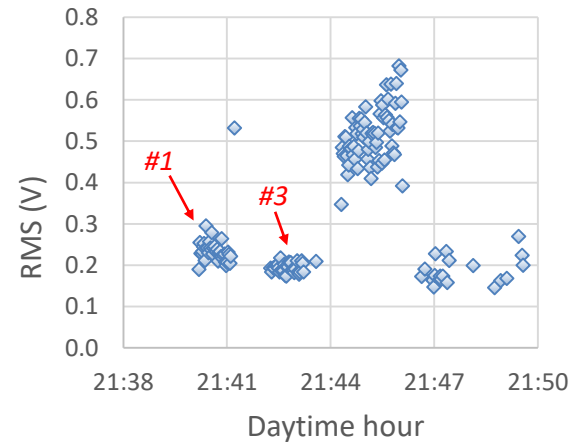
Sample measures in a household bathroom



RESULTS

Sample measures in a household bathroom

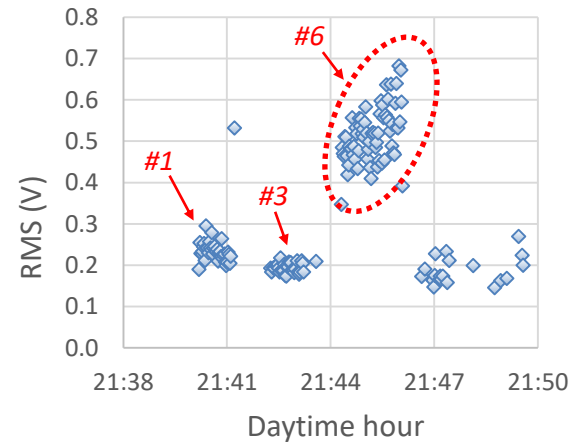
1. Basin tap – full open
2. Shower tap – full open
3. Next basin tap – full open



RESULTS

Sample measures in a household bathroom

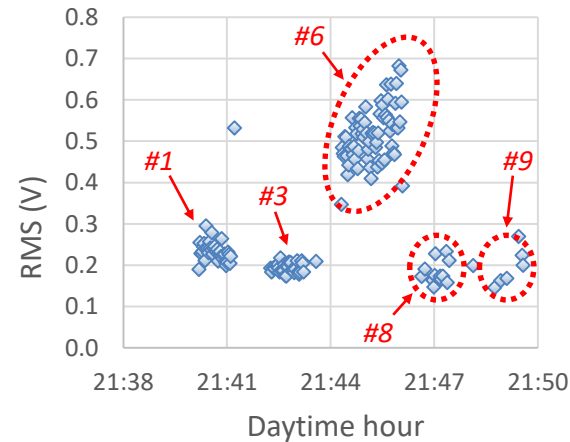
1. Basin tap – full open
3. Next basin tap – full open
6. Toilet – flush and tank filling



RESULTS

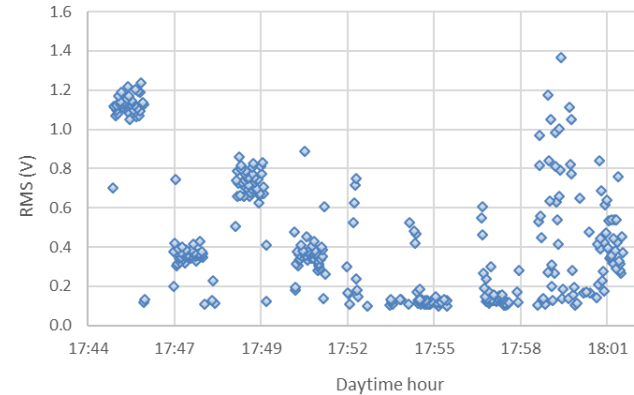
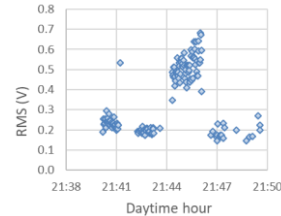
Sample measures in a household bathroom

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6. Toilet – flush and tank filling
8. Bidé tap – full open
9. Shower tap – full open



CONCLUSIONS

- Single uses can be identifiable enough
 - There are differences but they can be calibrated in advance



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 - Uses in different rooms will be clearly identified



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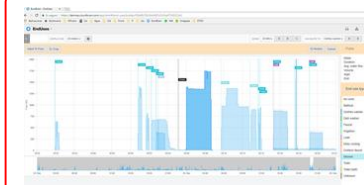
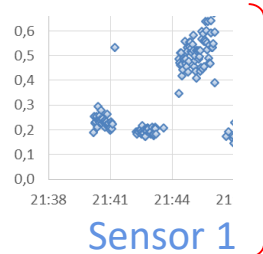
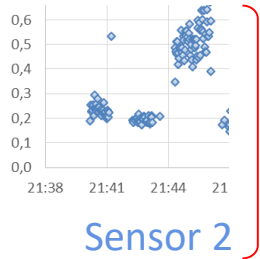
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Household meter

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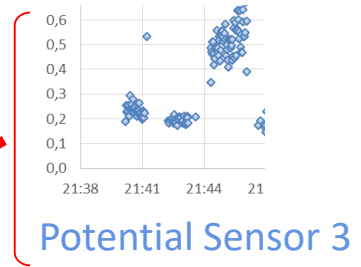
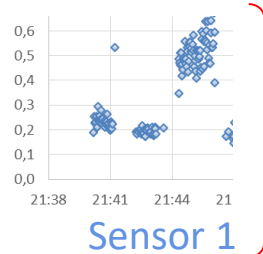
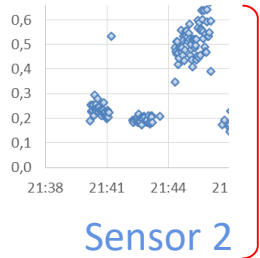
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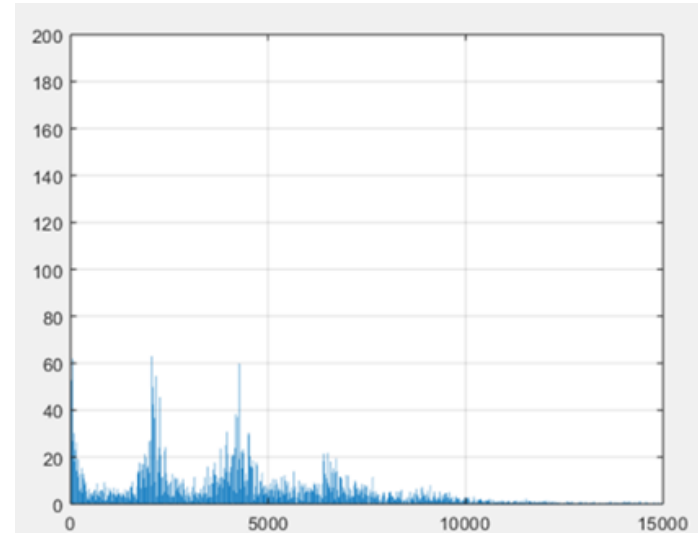
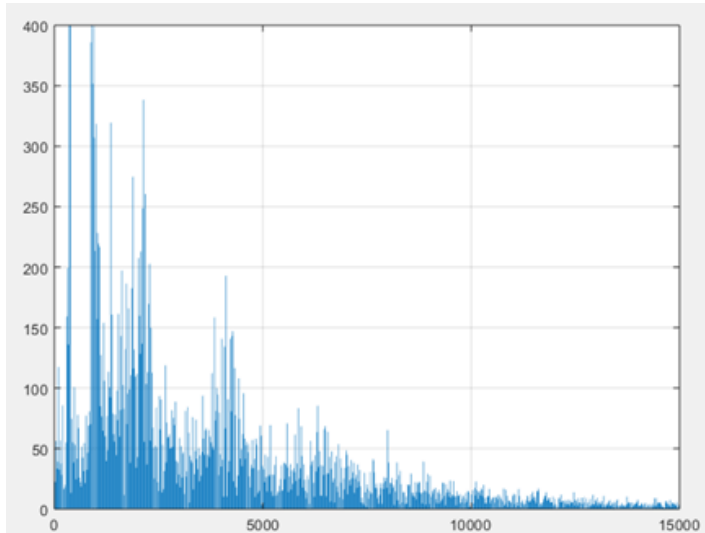
- Single uses can be identifiable enough
 - There are differences but they can be calibrated in advance
 - Uses in different rooms will be clearly identified
 - The sensor is fairly robust against other (normal) environmental noises
- Overlapped uses in the same room are still to be studied
- Potential good supplemental tool for water consumption characterization, with no need of interaction with consumers.

FUTURE AIMS (currently in process)

- Optimization of the sampling procedure – Sample frequency, number of frames per sample, sample time...
- Link between the noise information and the logged flow-trace.
- Enlargement of the sensor's capabilities – Battery life...

FUTURE AIMS (longer run)

- Wider study of the information already available – Noise spectra, pipe materials, pipes layout...



FUTURE AIMS (longer run)

- Wider study of the information already available – Noise spectra, pipe materials, pipes layout...
- Improvements on results analysis – Beyond the FFT...

Thank you very much



Gestión sostenible del agua urbana



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