LAB-SCALE CHARACTERIZATION OF TOTAL SUSPENDED SOLIDS USING ACOUSTIC BACKSCATTERING

Manuel Regueiro-Picallo

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UNIVERSIDADE DA CORUÑA

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INTRODUCTION

Context

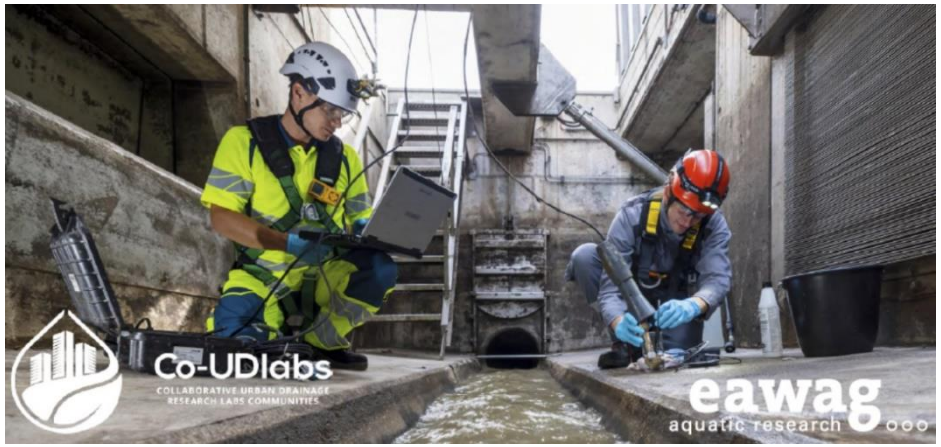
- European directives for the protection of water bodies (WFD), and monitoring of overflows (UWWTD). Challenge!
- Particulate matter (also referred to as SSC or TSS) is typically used as a proxy for urban drainage assessment. Pollutant impact.

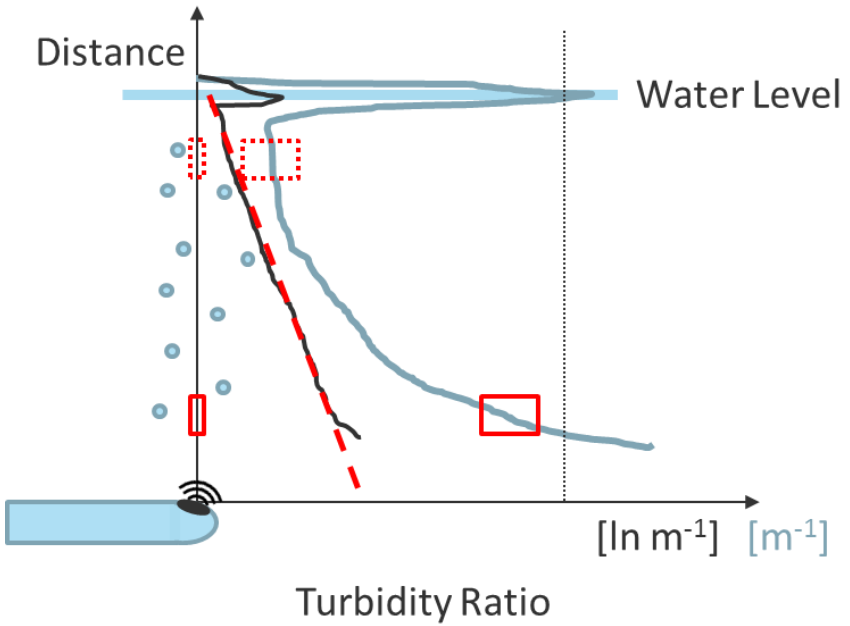
Gaps

- Limited knowledge of particle matter dynamics in urban stormwater and combined sewer systems: Particle size distribution

Research

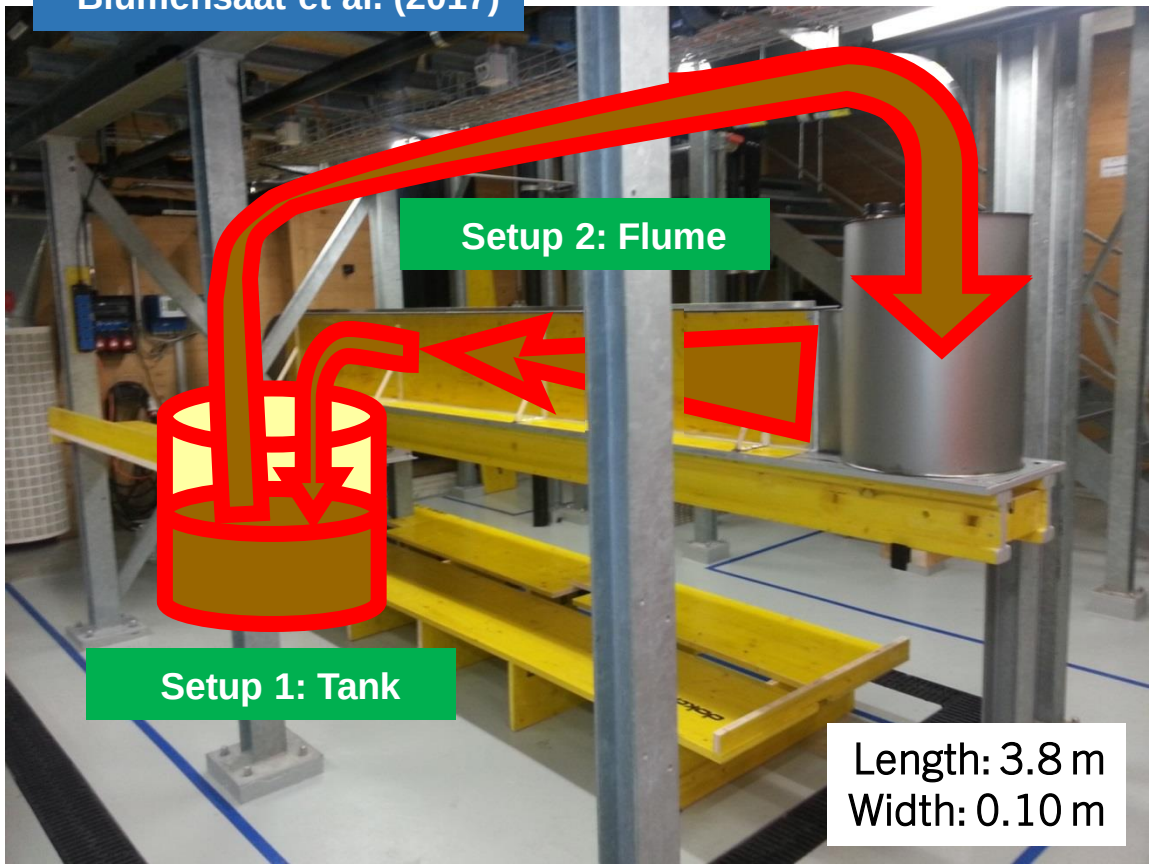
- Acoustic backscattering profilers. Sensitive to suspended particle concentrations and size classes.
- Two experimental campaigns: Laboratory controlled conditions and Flume test facility at a WWTP
- Fine particles < 63 μm: high absorption of pollutants





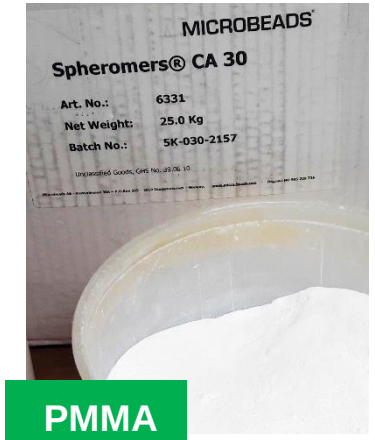
FIRST EXPERIMENTAL CAMPAIGN

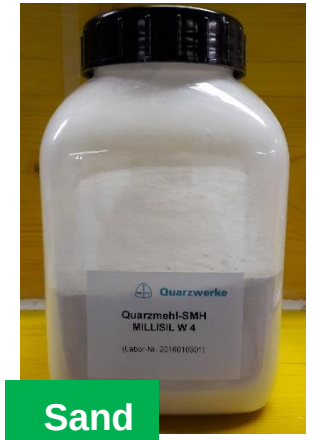
EAWAG facility



Sensors: UB-Flow and UB-Lab

Particles





Concentrations

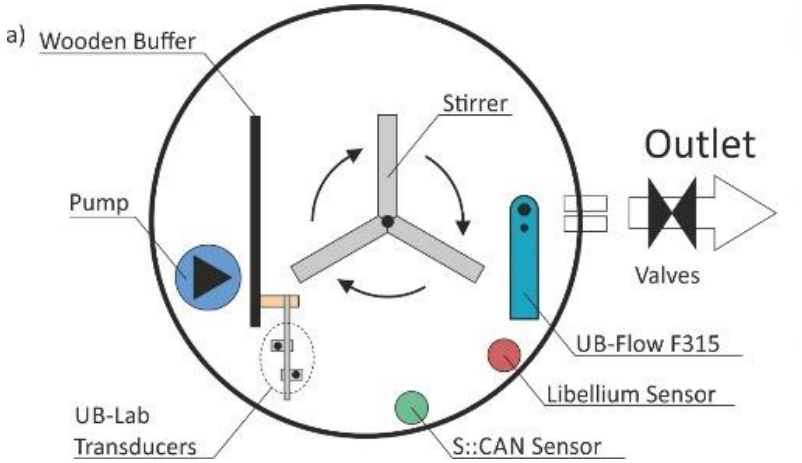
[0 – 1200] mg/L

Particle sizes

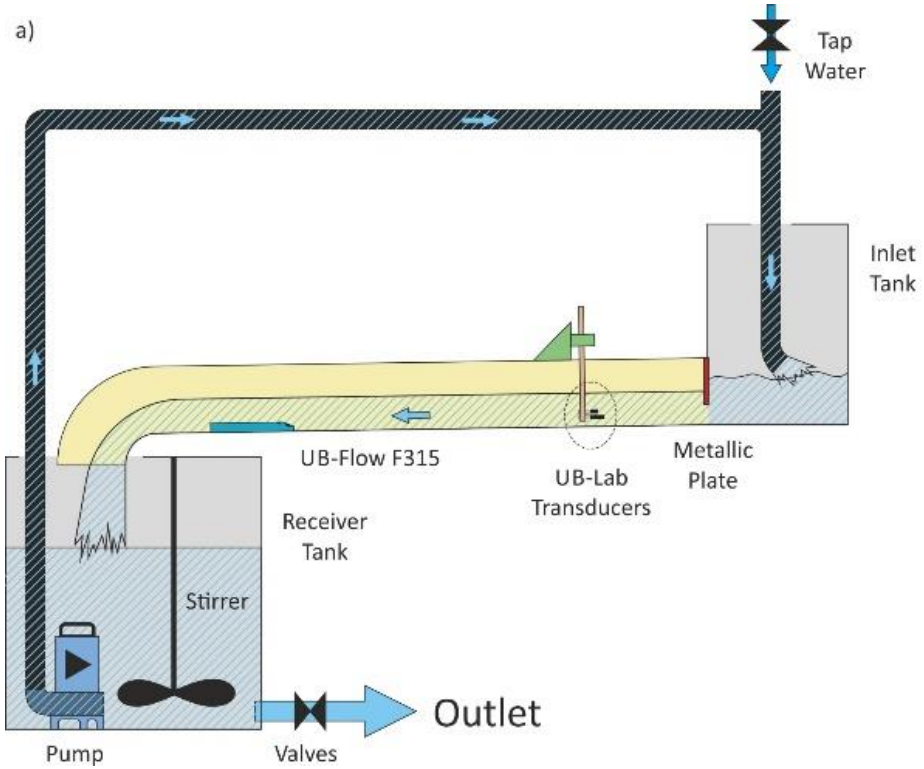
[10 – 60] µm

SETUPS

Setup1: Water tank



Setup 2: Flume



ACOUSTIC TURBIDITY

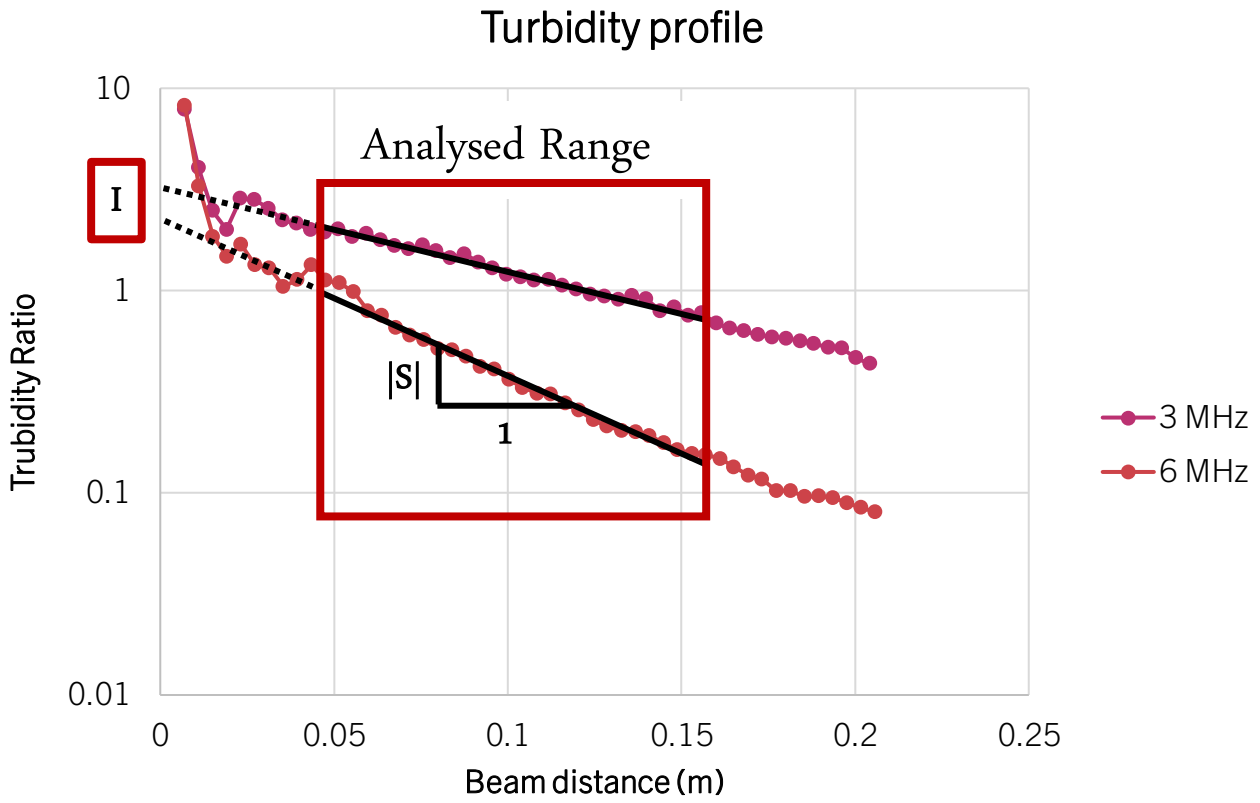
- Turbidity ratio profile

Assumptions: uniform particle size and density distributions along the transducer beam

$$T_{i,j}(r) = \beta_{i,j} C_v e^{-4r\left(\alpha_{i,j} C_v + \alpha_{w,j}\right)}$$

Cv: volumetric concentrations
i: size class
j: emission frequency

$$\ln\left(T_{i,j}(r)\right) = \underbrace{-4\left(\alpha_{i,j} C_v + \alpha_{w,j}\right)}_{\text{Slope}} r + \underbrace{\ln\left(\beta_{i,j} C_v\right)}_{\text{Intercept}}$$



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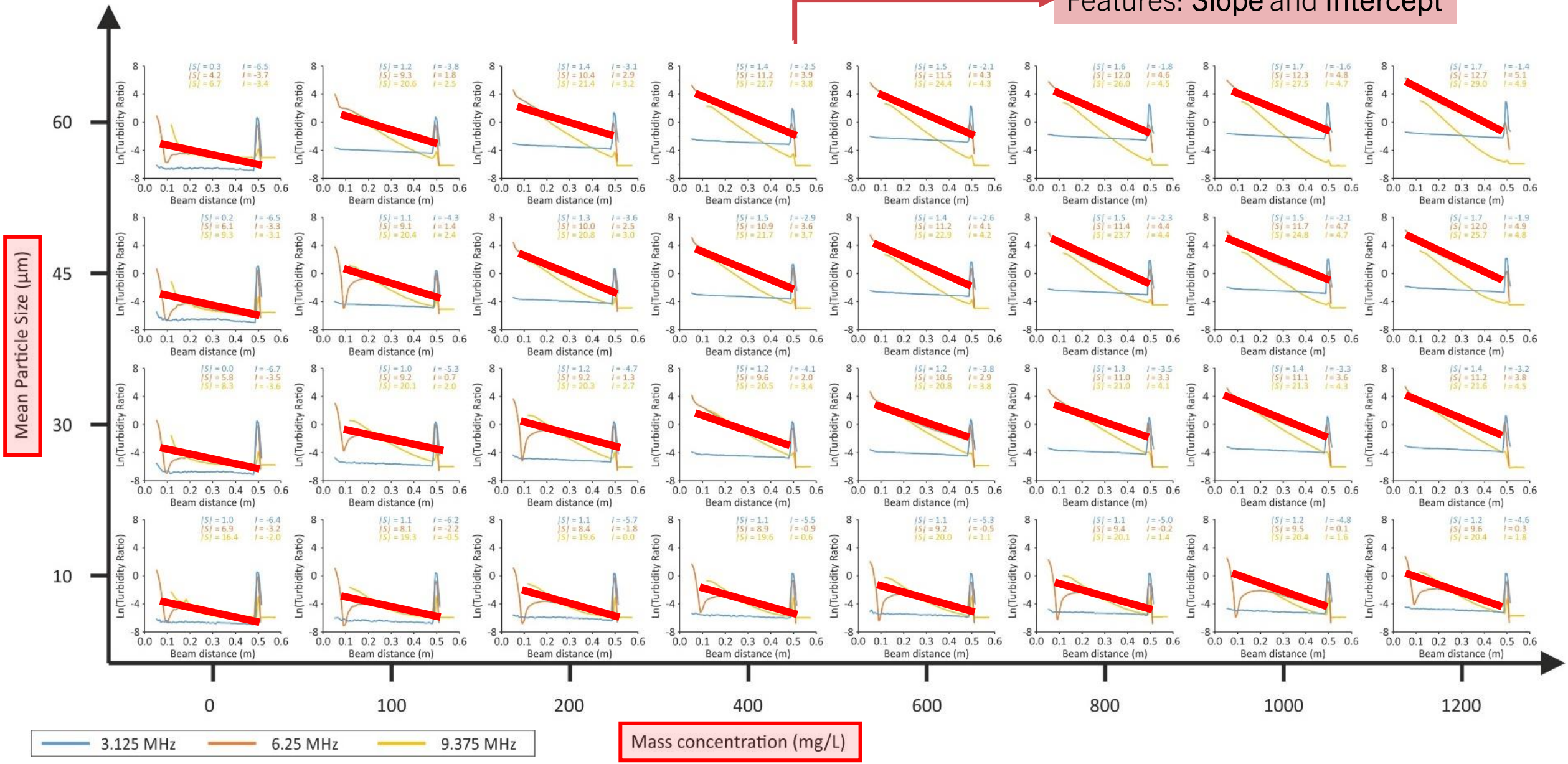
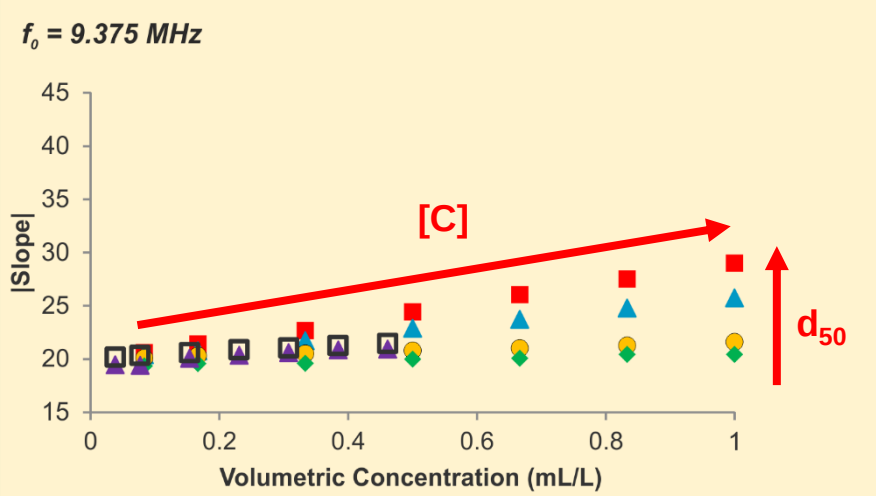
TURBIDITY PROFILES

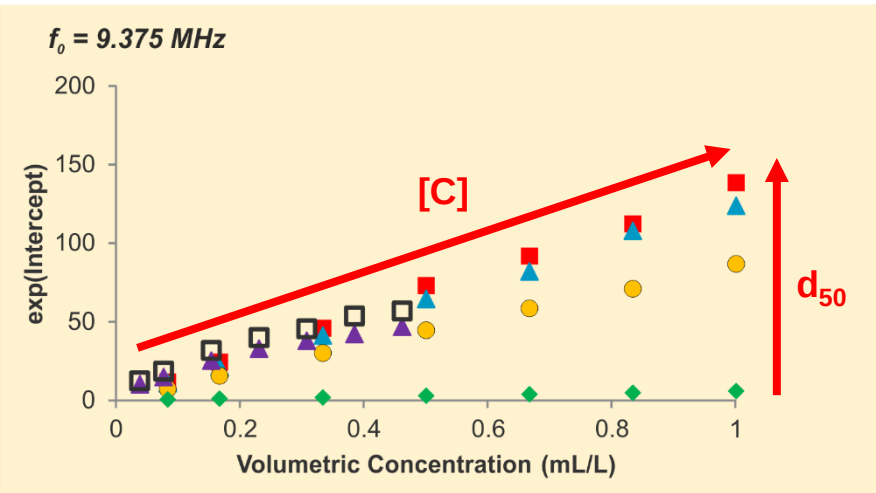
Features: **Slope** and **Intercept**



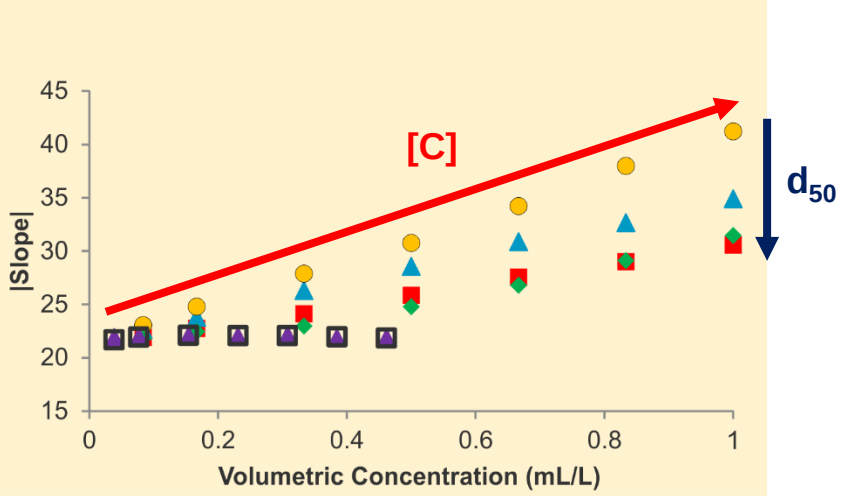
RESULTS

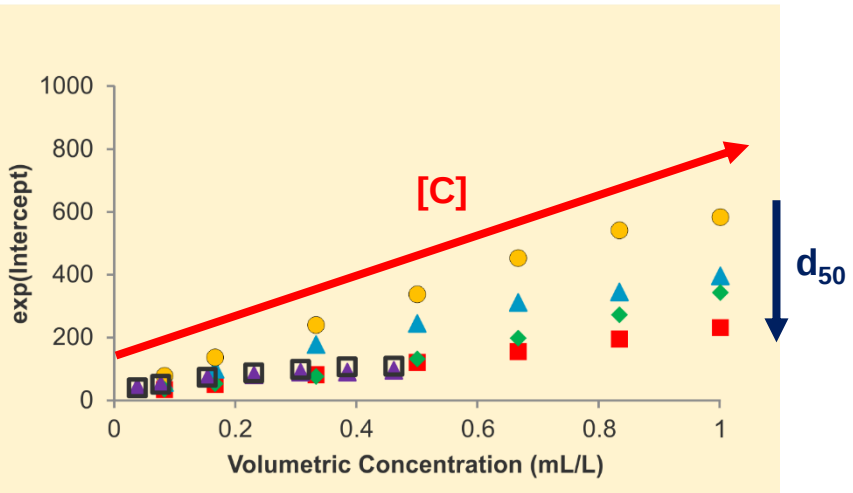
MIXING TANK BATCH TESTS





FLUME BATCH TESTS





PMMA CA60 · PMMA CA30 · MILLISIL W4
PMMA CA45 · PMMA CA10 · MILLISIL W6

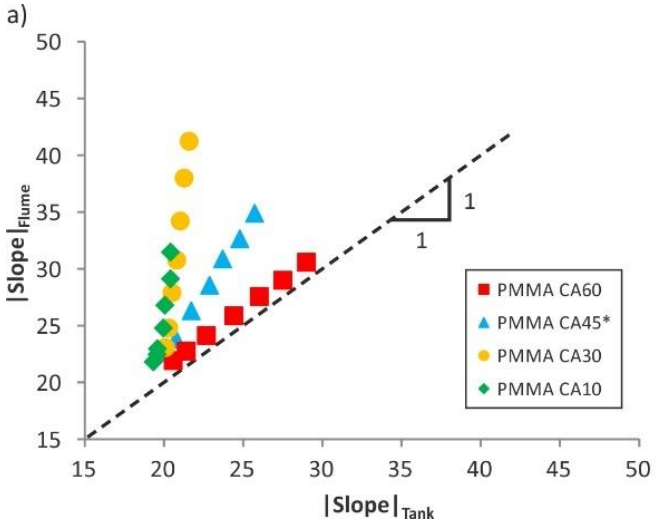
Reminder

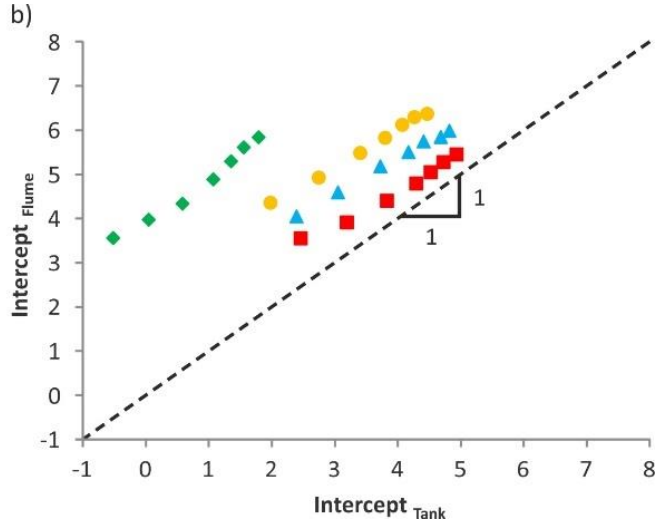
$$\ln\left(T_{i,j}(r)\right) = \underbrace{-4\left(\alpha_{i,j}C_v + \alpha_{w,j}\right)}_{\text{Slope}} r + \underbrace{\ln\left(\beta_{i,j}C_v\right)}_{\text{Intercept}}$$

- Correlation between TSS concentrations and acoustic profile features
- Different results depending on test conditions
- Possible reason: air bubbles

RESULTS

Setup 1: Tank



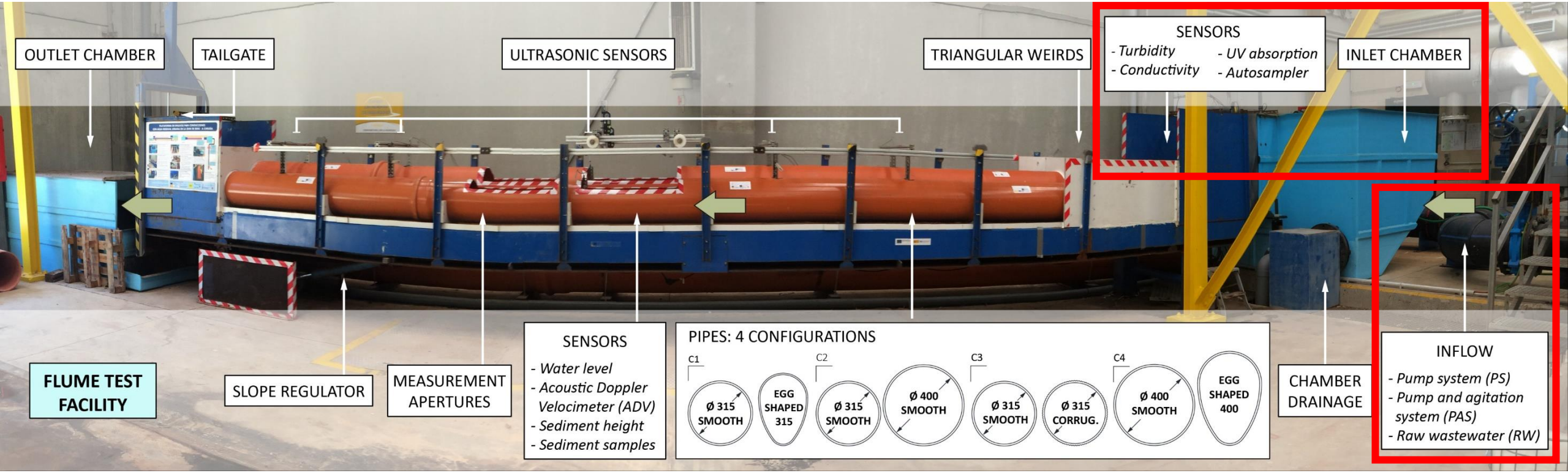


Setup 2: Flume

- Setup 2: air bubbles
- Acoustic profile distorsions
- This effect is almost attenuated for large particles (60 μm)

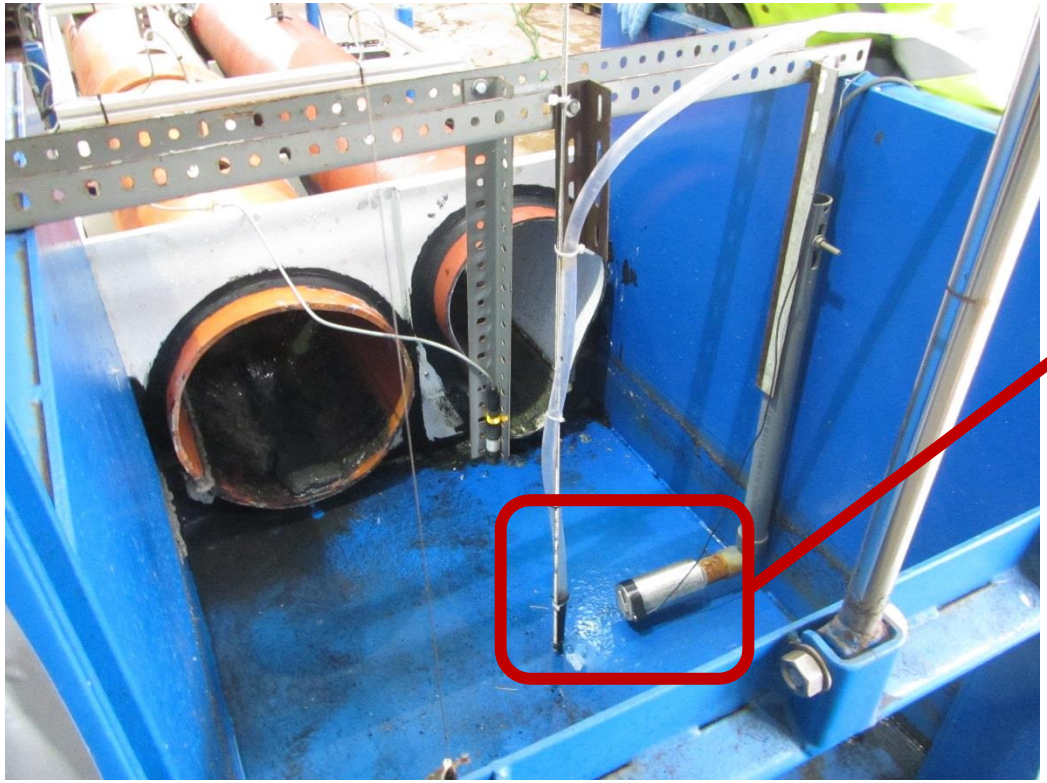
SECOND EXPERIMENTAL CAMPAIGN

- Flume test facility. WWTP Bens (A Coruña)



Length: 10 m
Width: 0.8 m

SETUP



Devices

Transducers: 3 and 6 MHz

Optical turbidity

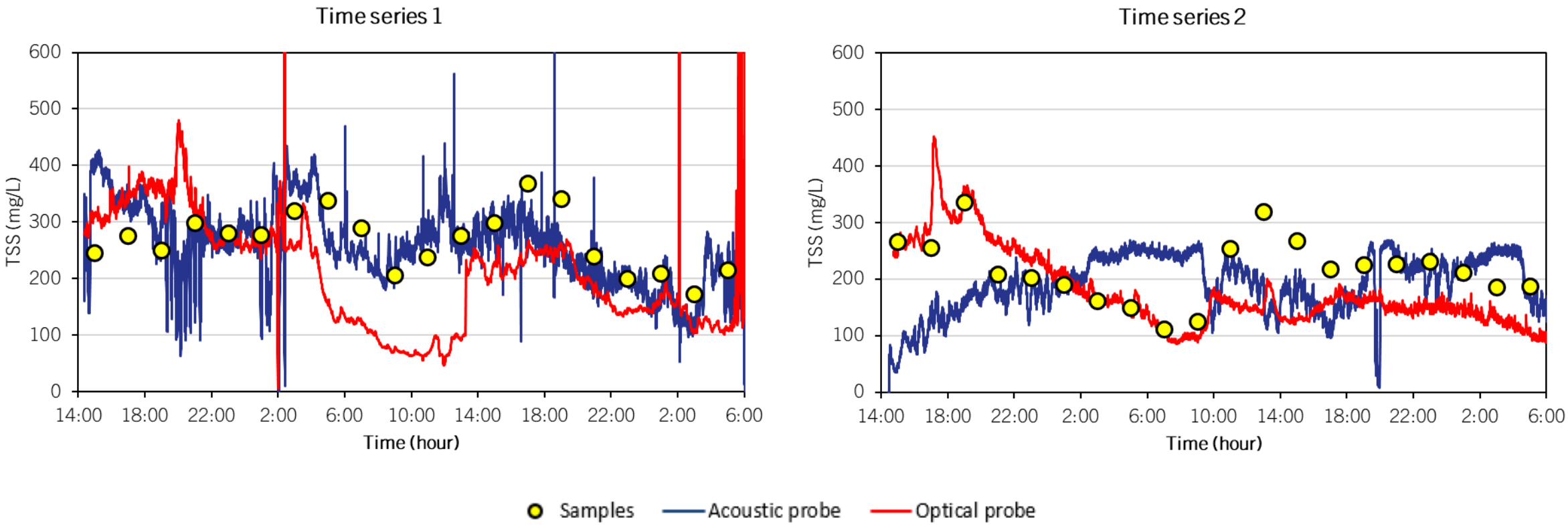
Autosampler: Sample/2hours

Experiment conditions

Raw wastewater

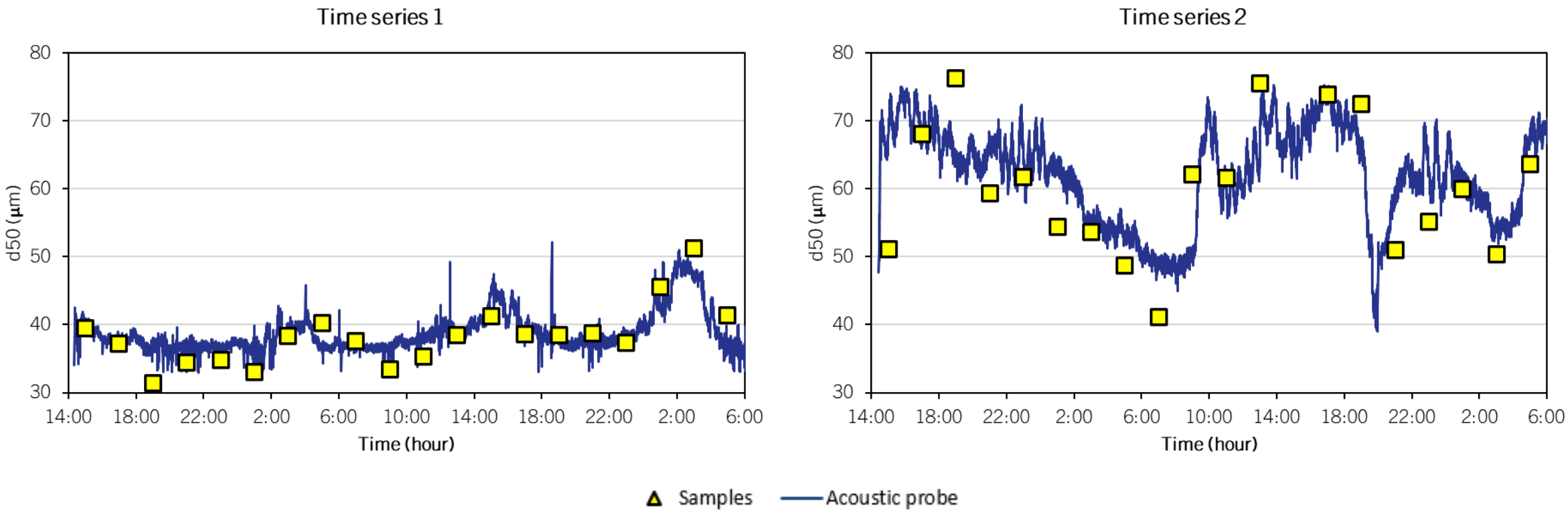
RESULTS

Optical / Acoustic turbidity vs Total suspended solids (TSS)



RESULTS

Acoustic turbidity (slope) vs Mean particle size (d_{50})



FINAL REMARKS

- The experimental campaigns confirmed the potential application of acoustic sensors for **monitoring concentrations and particle sizes** in wastewater.
- Acoustic turbidity measurements were correlated to the TSS and d_{50} values, but considering the cases studies separately. Therefore, **local calibrations** might be required.
- **Air bubbles** in turbulent flows distort acoustic profiles. Question: Is it possible to remove this effect from the profiles? (background removal)
- Under **combined sewer conditions**, weak relationships between Acoustic Turbidity and TSS were occasionally obtained. However, a consistent good fit was obtained between the slope of the acoustic profile and the mean particle sizes.

THANK YOU FOR YOUR ATTENTION

manuel.regueiro1@udc.es

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