EXPERIMENTAL VALIDATION OF CFD MODELS TO SIMULATE WASTEWATER TREATMENT PROCESSES.

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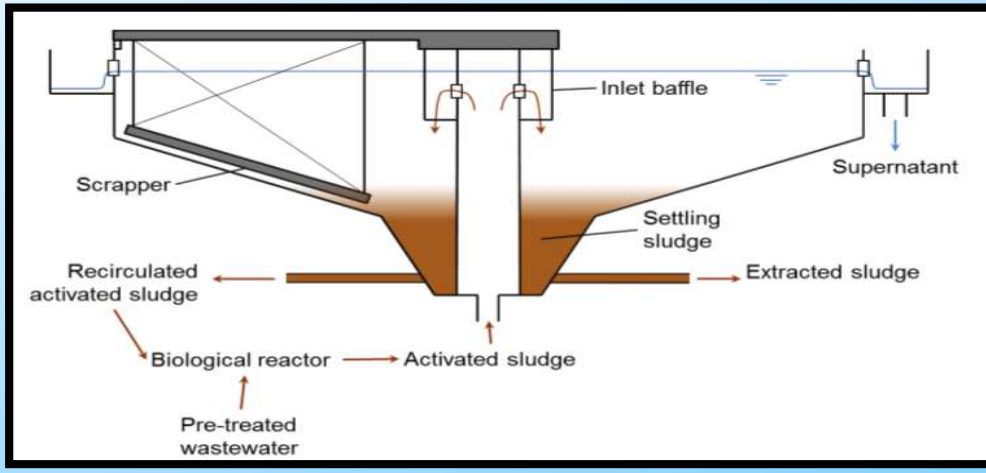
CONTEXT

Within the WRRF, one of the most important processes is the **separation bacteria/water.**

Secondary Settling Tanks (SST) allows such separation but also **govern effluent quality** in terms of suspended solids.



Process modeling and **validation**, is essential to achieve an optimal operation of WRRF.

OBJECTIVE

To validate a Computational Fluids Dynamics (CFD) model in a full-size secondary settling tank

- Measurements on site of sludge blanket and particles velocities.
- Using a CFD model that describes hindered and compression settling.
- Comparing experimental to simulated results.

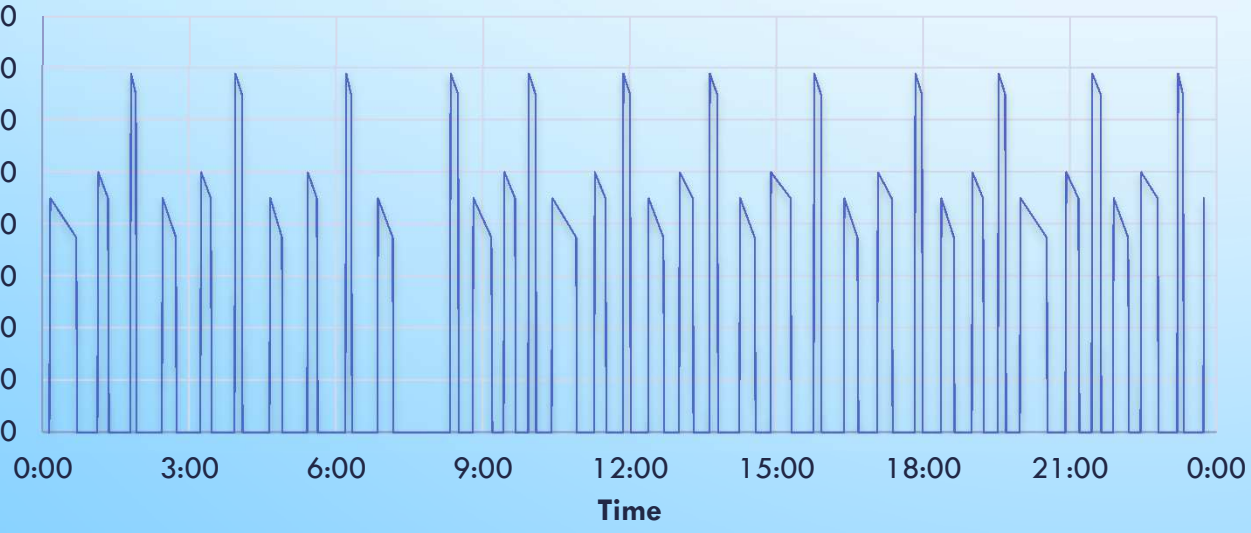
XPERIMENTAL DESCRIPTION

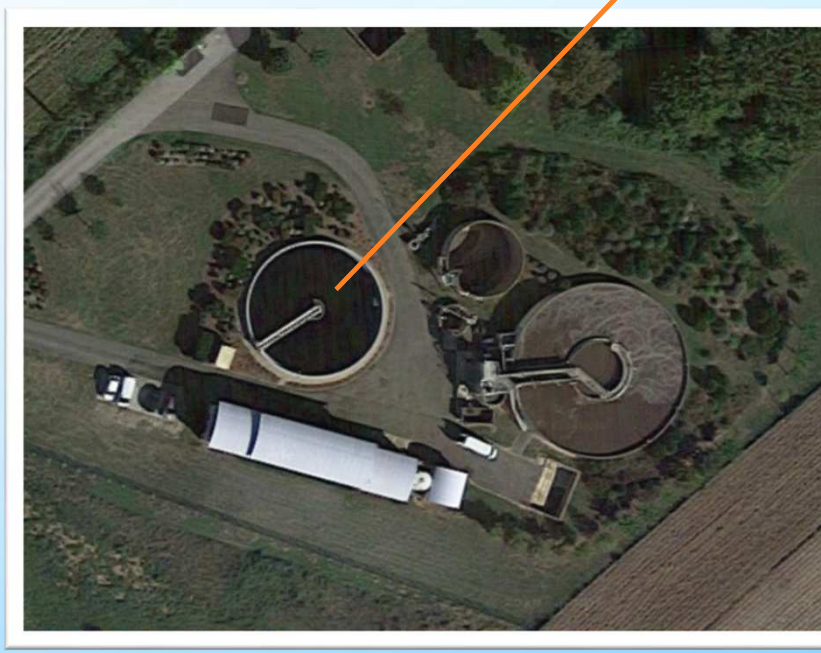
RRF of Achenheim

Located 13km far from the city of Strasbourg in France.

Capacity 9930 people-equivalent.

Design inflow 113 m3·h-1.

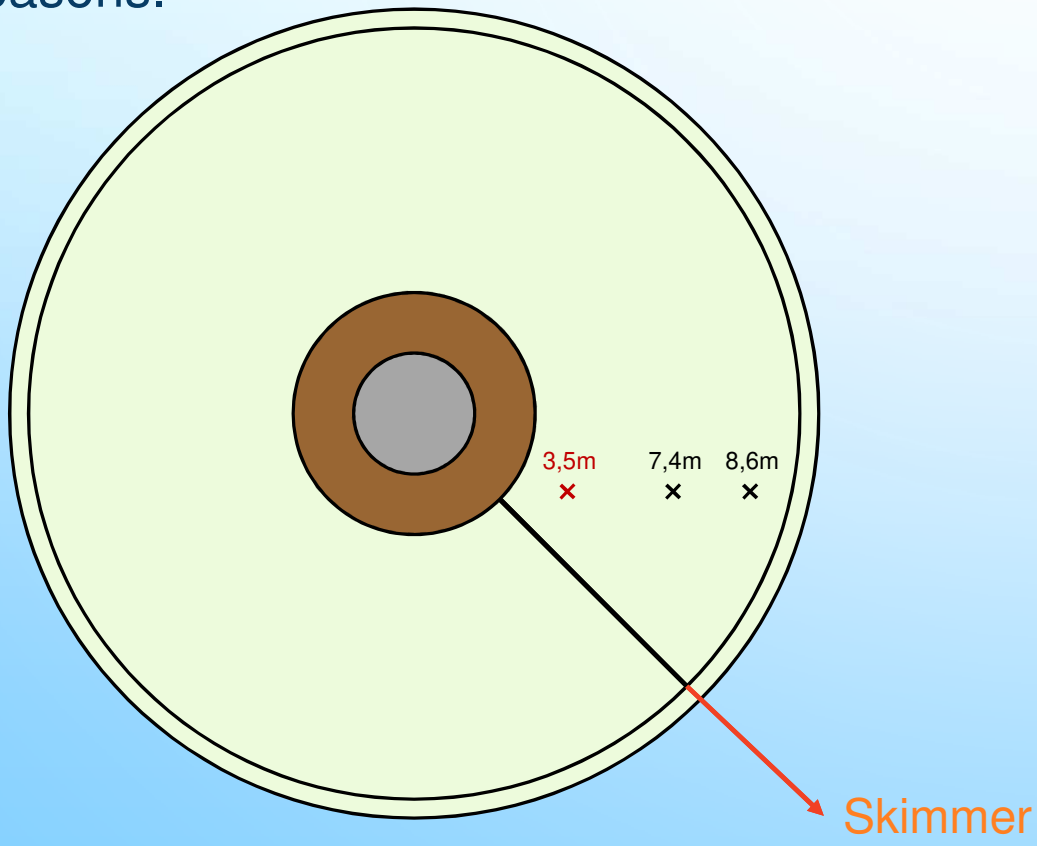




XPERIMENTAL DESCRIPTION

site Measurements

Several *punctual* and *continuous* measurements at different radial locations were carried on in different seasons.



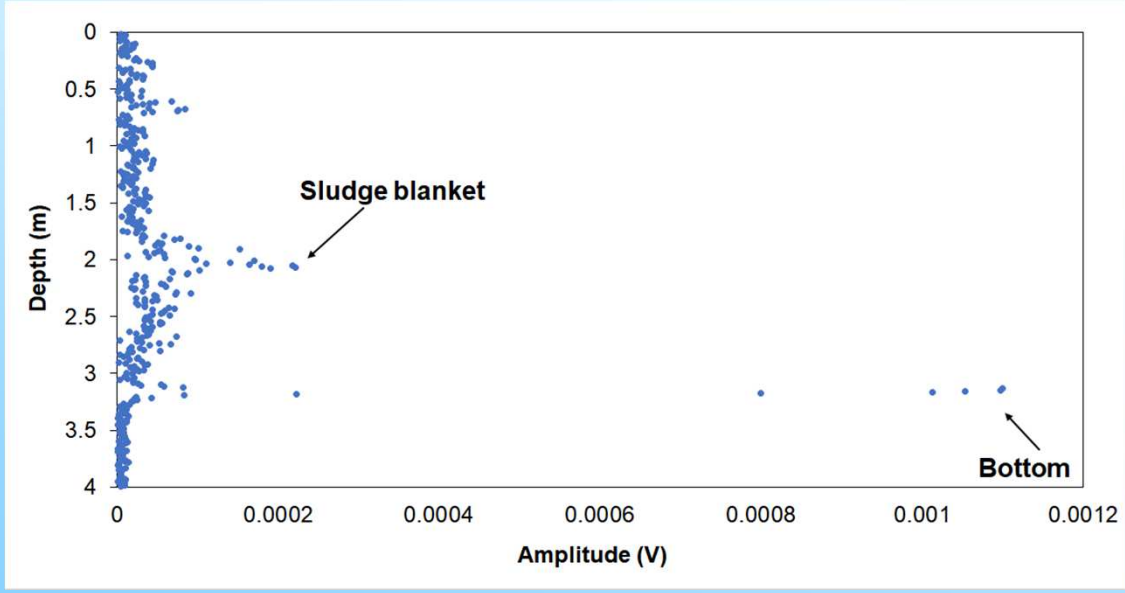
- Measurements performed during 20-30 mi in each location.
- Surface water temperature 10.8 °C.
- Ultrasonic transducer provided by **IC laboratory (Francois et al., 2015)**

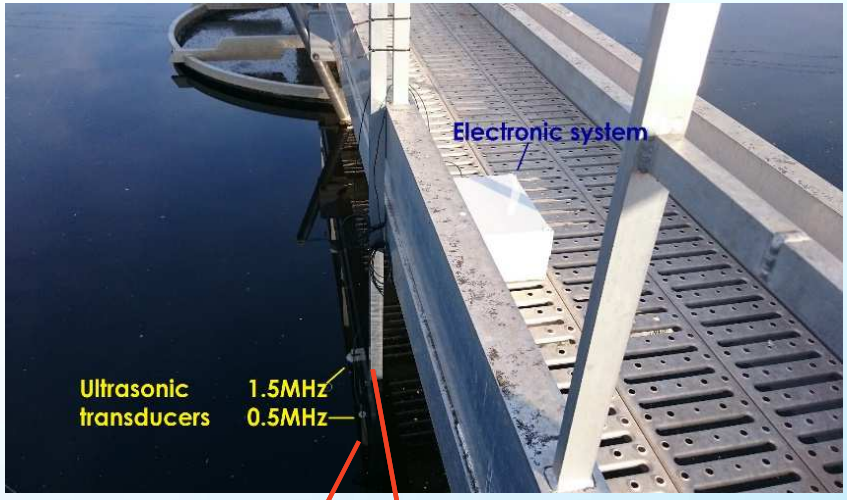
XPERIMENTAL DESCRIPTION

trasonic transducer

The device, based on the Doppler effect, sends an acoustic signal to the medium.

The position, amplitude of the sign and velocity of a particle (scatterer) can be known.





UBERTONE

FD MODELLING USING OpenFOAM®

uid Model

Based on the mixture approach considering the volume fraction of the sludge.

Continuity equation

$$\frac{\partial \rho_m}{\partial t} = -\nabla \cdot (\rho_m \vec{v}_m)$$

Momentum equation

$$\frac{\partial \rho_m \vec{v}_m}{\partial t} + \nabla \cdot (\rho_m \vec{v}_m \vec{v}_m) = -\nabla P_m + \nabla \cdot (\mathcal{T} + \mathcal{T}^t + \mathcal{T}_{Dm}) + \rho_m \vec{g}$$

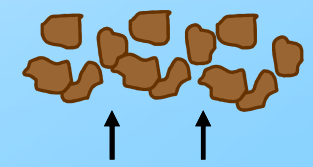
ttling Model

$$\frac{\partial \alpha_d}{\partial t} = -\nabla \cdot (\alpha_d \vec{v}_m) - \nabla \cdot \left(\frac{\alpha_d \rho_c}{\rho_m} \vec{v}_{dj}\right) + \nabla \cdot (d_{comp} \nabla \alpha_d) + \nabla \cdot (\Gamma \nabla \alpha_d)$$

Valle and Laurent, (2020)

Hindered settling

Compression settli

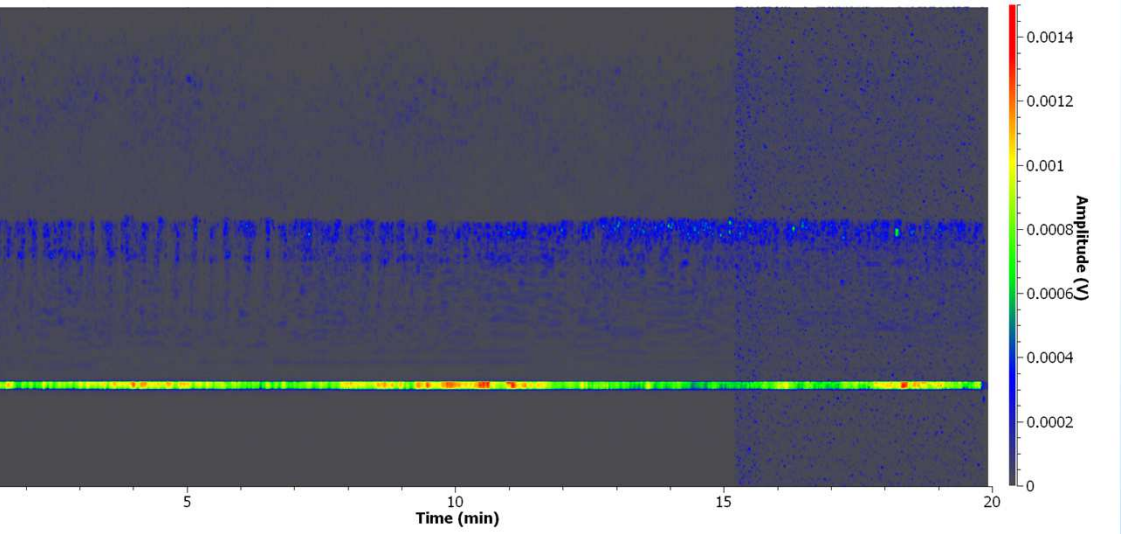


RESULTS

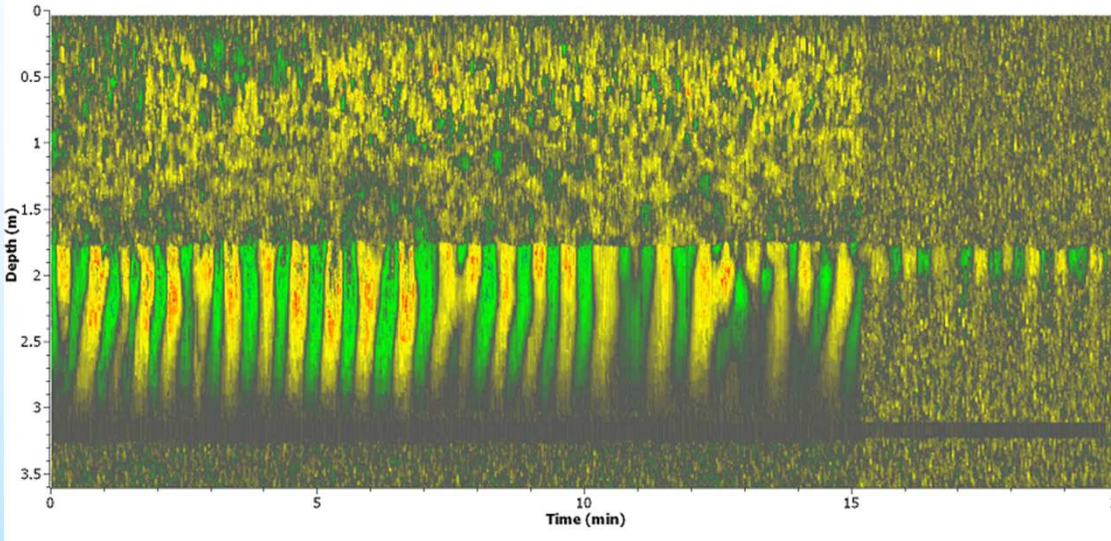
actual experimental measurements

en during 20 minutes at 8.6m from the inlet of the clarifier

Amplitude



Velocity

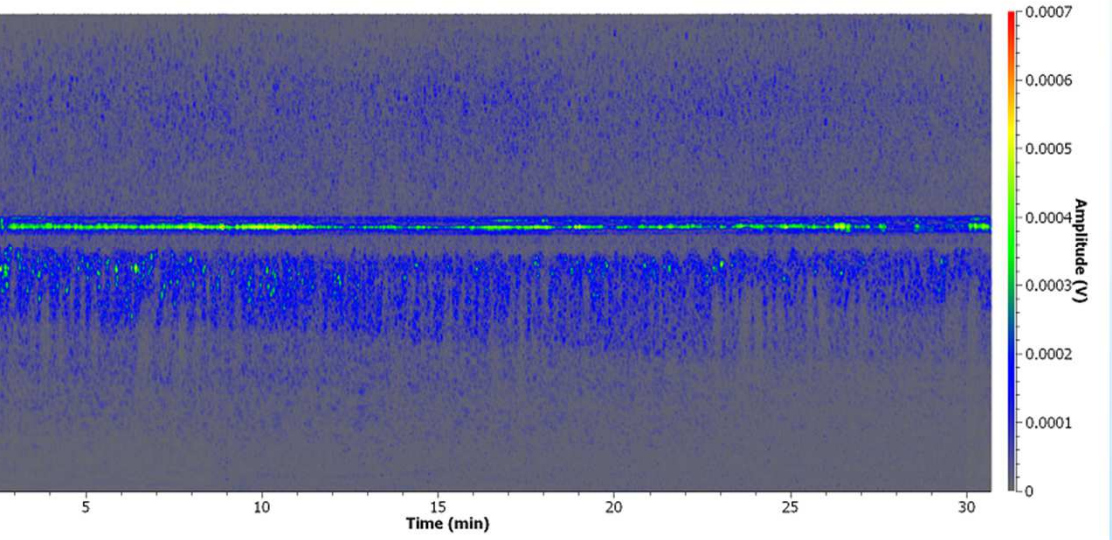


RESULTS

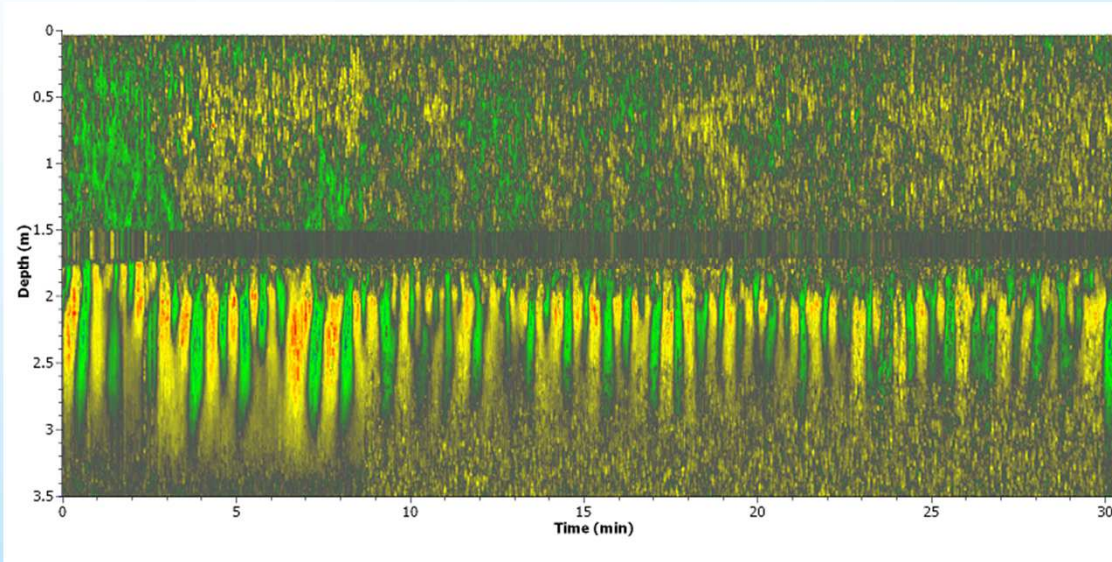
actual experimental measurements

en during 20 minutes at 3.5m from the inlet of the clarifier

Amplitude



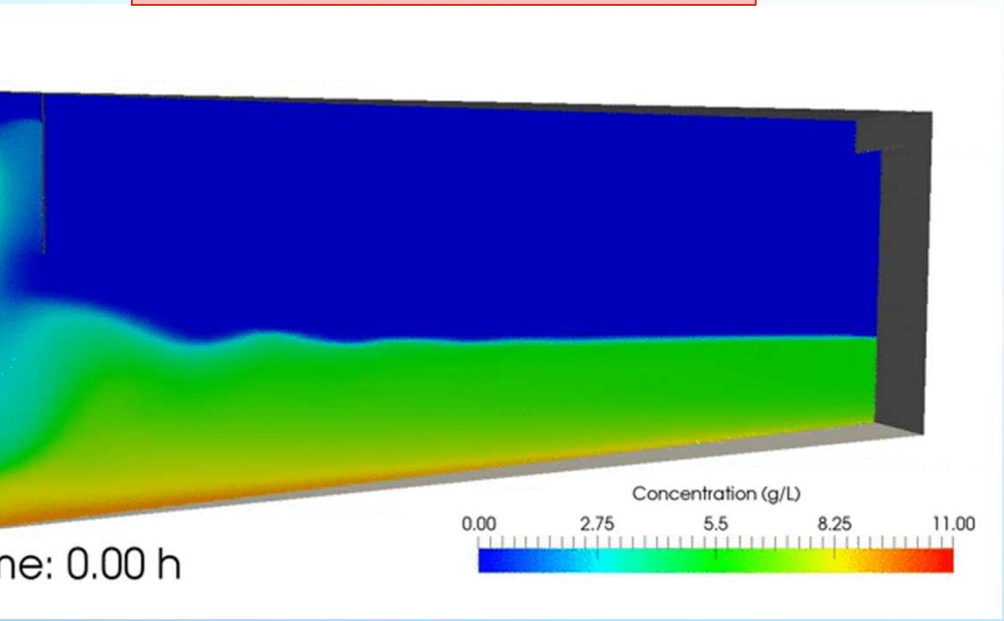
Velocity

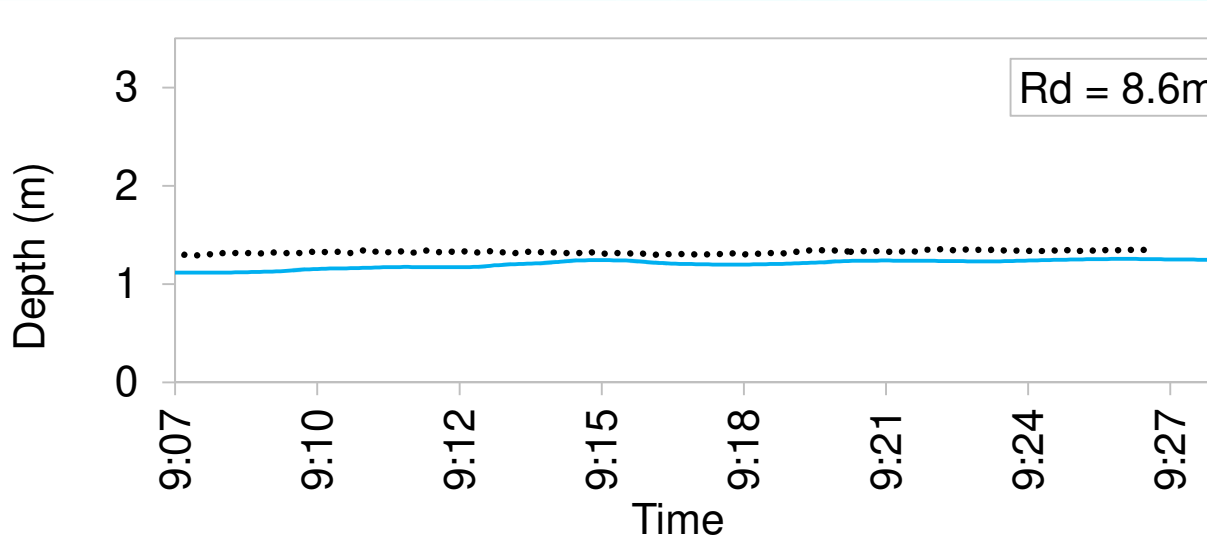


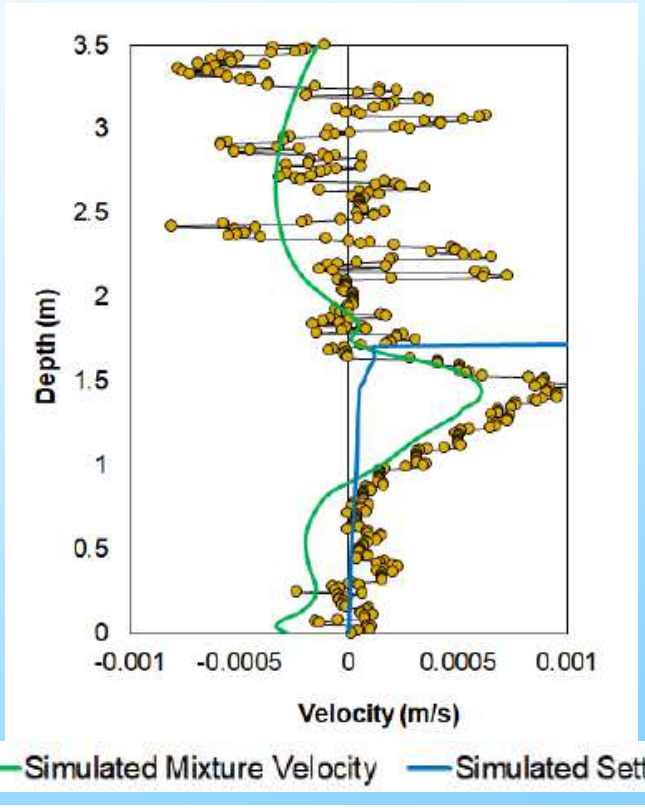
ESULTS

odel validation

Sludge Concentration



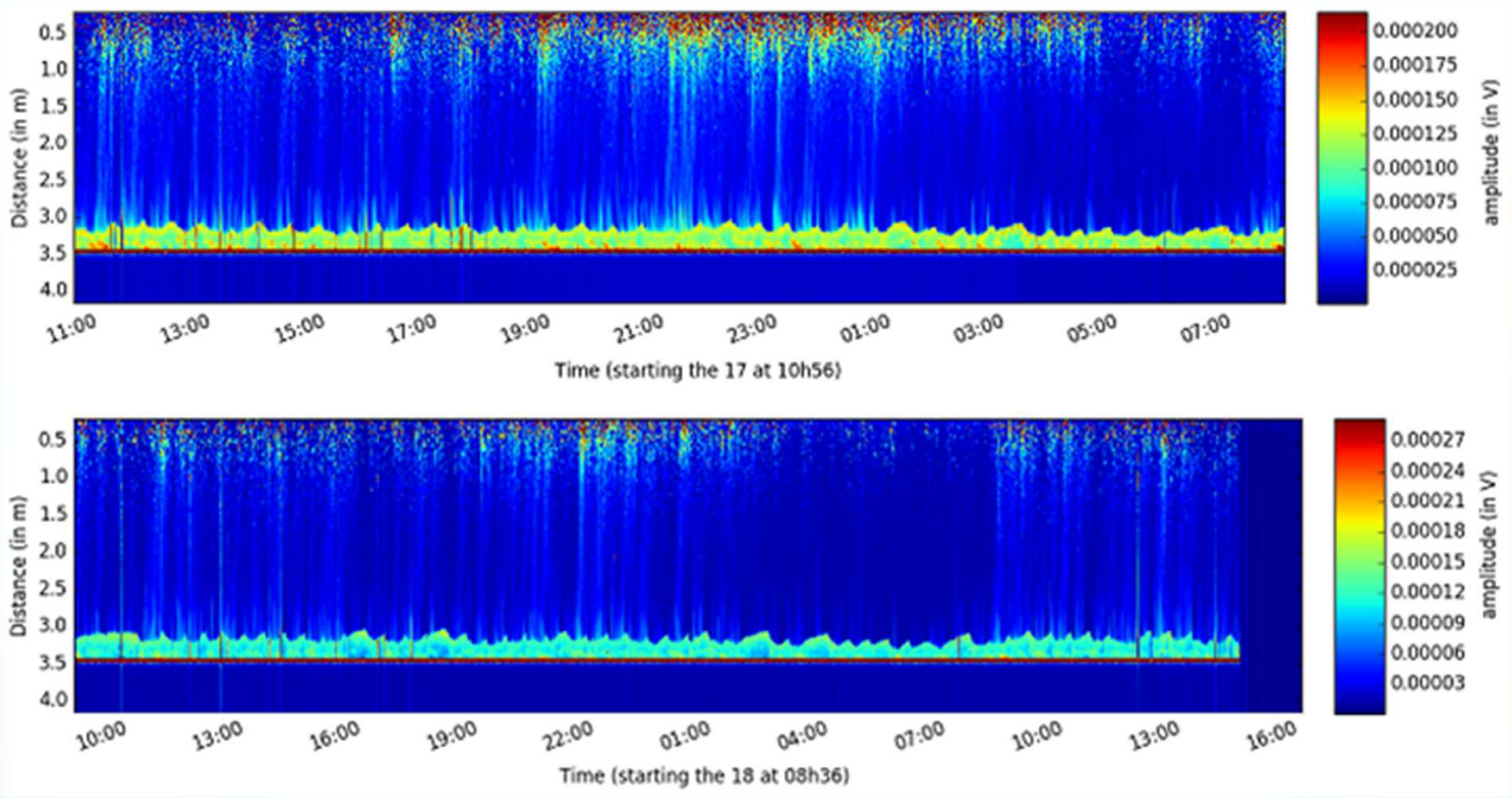




ESULTS

ntinuous experimental measurements

plitude taken during 48 hours at 3.5m from the inlet of the clarifier

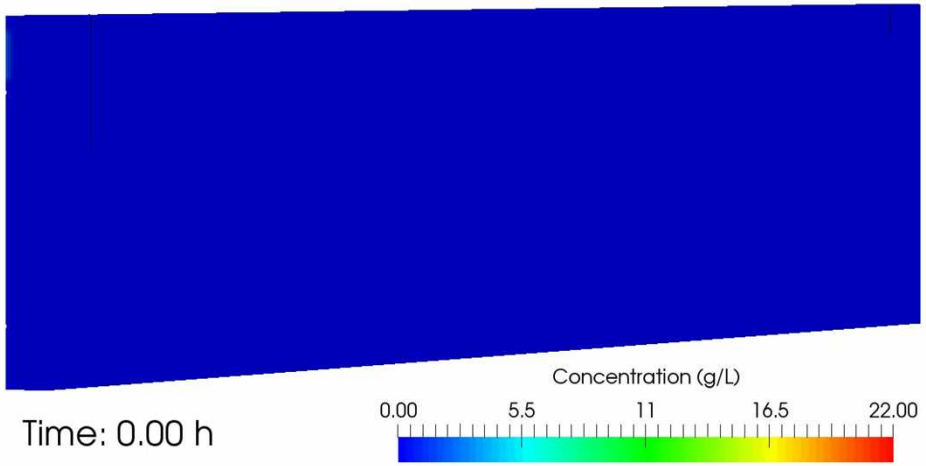


UBERTON

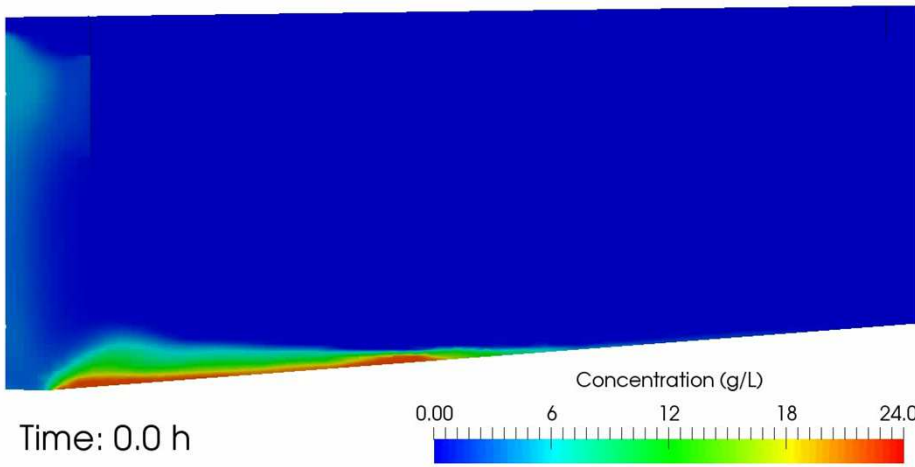
ESULTS

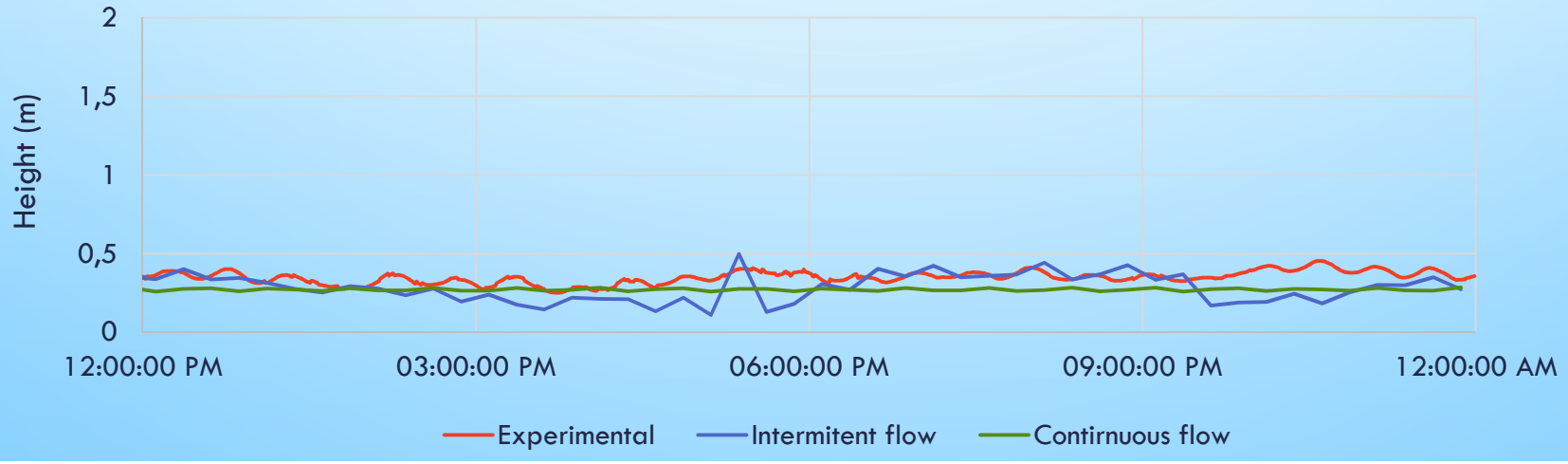
el Validation

Continuous



Intermittent





ONCLUSIONS

he results of the **experiments** carried on in the SST showed that the **sludge blanket behavior** is **dynamic**

he **particles velocities** within a full-scale SST showed fluctuations within the sludge blanket and they ca
ccurate predicted by the CFD model.

uture research using the ultrasonic transducers could be focused on :

- Particle's velocity measurement in a bigger WRRF with both configurations: punctual and continu recording.
- Measurement of the velocity of each class of particle within the clarifier.

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