# Detection of the pulp-froth interface using the ultrasound transit time technique

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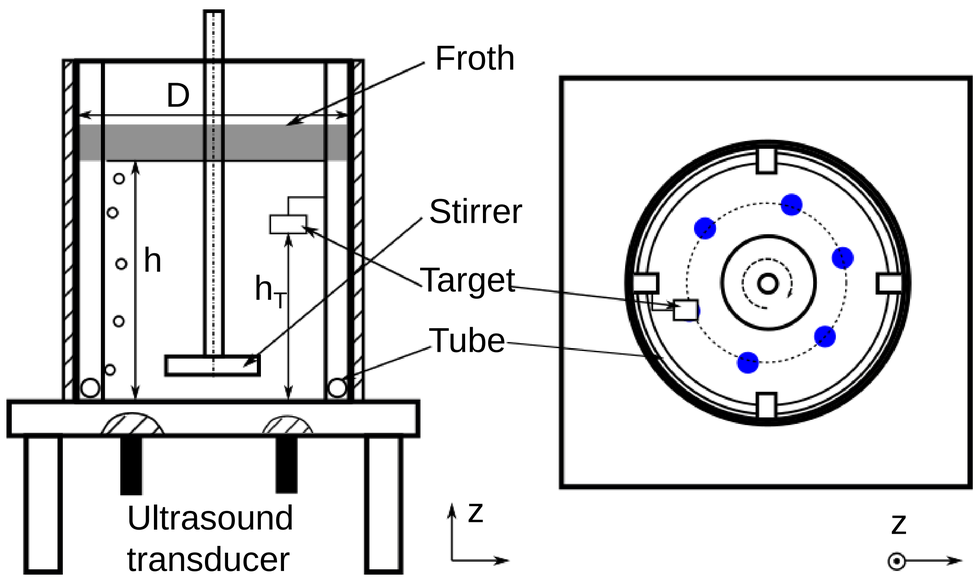
## Technological motivation

**Ultrasound transit time technique (UTTT)**

- suitable technique to detect bubbles and gas interfaces in opaque liquids
- robust technique, already used in liquid metal flows
- experiments to test applicability to detect the pulp froth interface

## Measurement setup



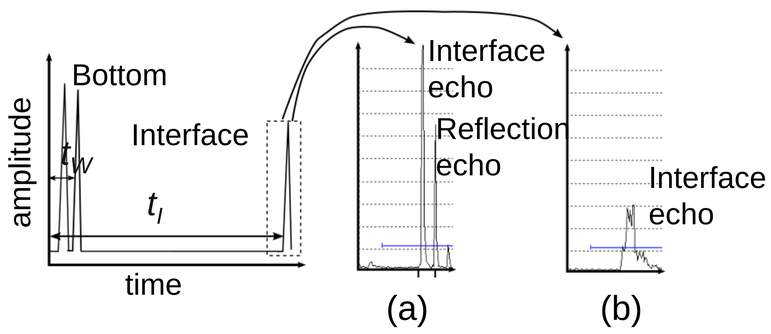

- stirred tank with ultrasound transducers (*f* = 1MHz) attached to the bottom
- transducers detect time of flight ($t_F$)
- target placed over one transducer, to determine speed of sound (*c*) of the pulp

Equations:

$$h = c * {}^{t_F}/_{2} = c * \frac{t_I - t_W}{2}$$

$$h = h_T * \frac{t_I - t_W}{t_T - t_W}$$

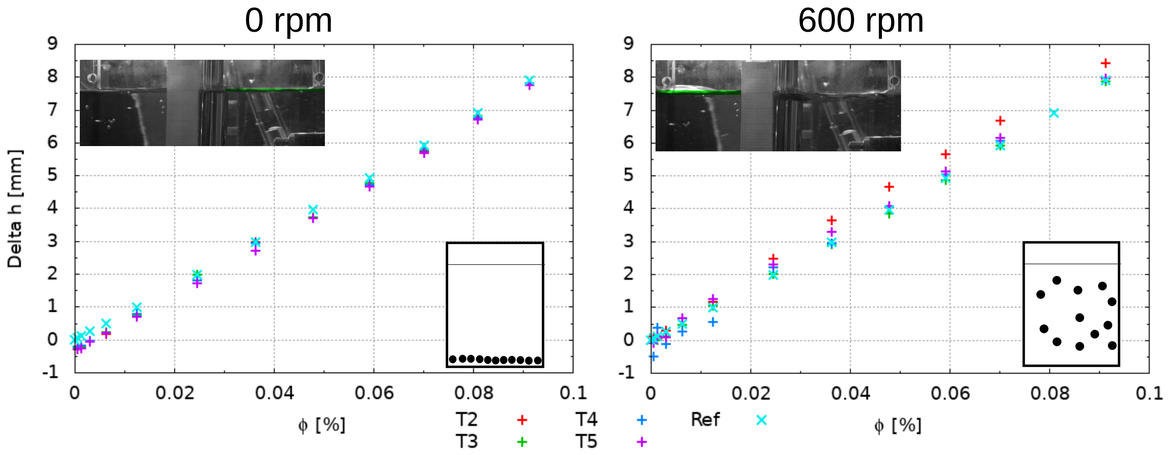
- Jg ≈ 0.2 cm/s
- Quartz sand up to ϕ = 0.09




(a) Echo signal from the pulp-air interface

(b) Echo signal for the pulp-air interface

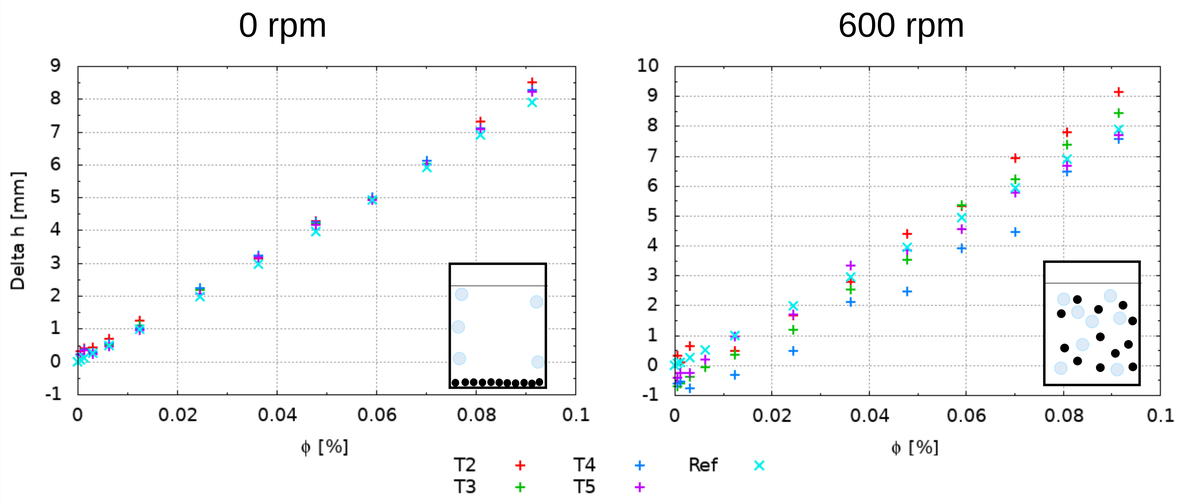
**Calibration: water + MIBC + quartz sand**




- change of height due to the quartz sand covered well
- height deviation at 600 rpm due to surface deformtion

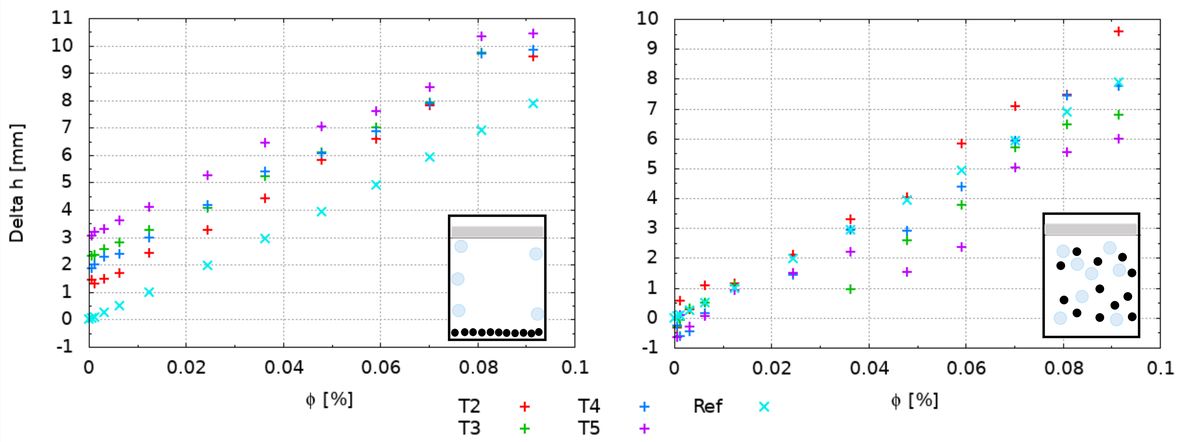
## Measurements and results

**Water + MIBC + quartz sand + air**



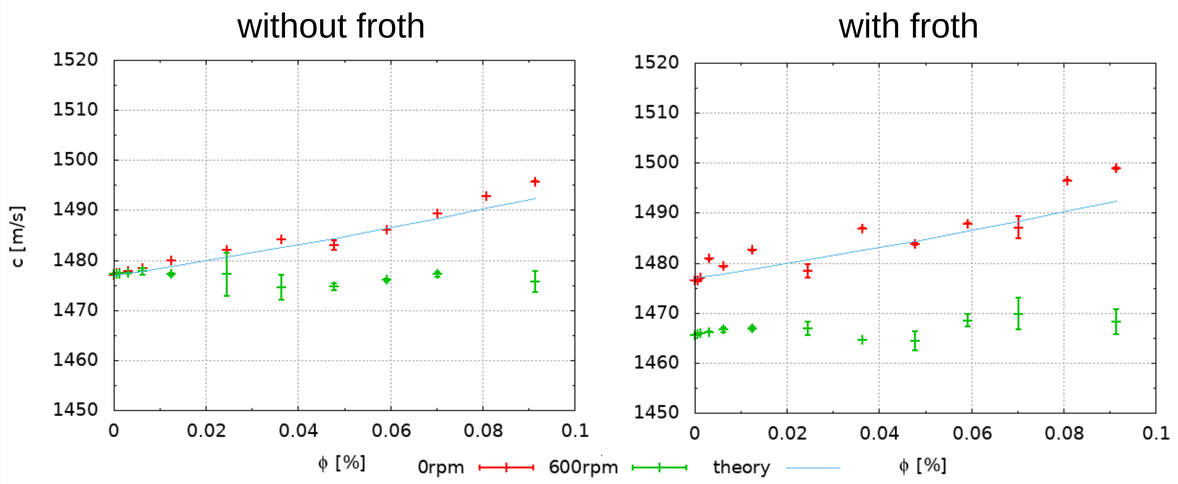

- offset of height due to gas holdup for 0 rpm
- increased gas holdup for 600 rpm ⟶ stronger bulges and stronger deviation of detected interface height

**Water + MIBC + quartz sand + air ⟶ froth**




- strong deviation of detected height caused by froth for 0 rpm ⟶ penetration of ultrasound into froth and shear stress effects
- stirring leads to wide spreading of the height values ⟶ influence of froth

**Speed of sound**




- trend of increasing speed of sound for 0 rpm ⟶ correlates with theory
- speed of sound for stirred case remains stagnant

## Summary and outlook

- UTTT is proved to be suitable to detect the pulp froth interface
- changes of the interface height, due to quartz sand or gas holdup are covered well
- further experiments should be done in flotation cells



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