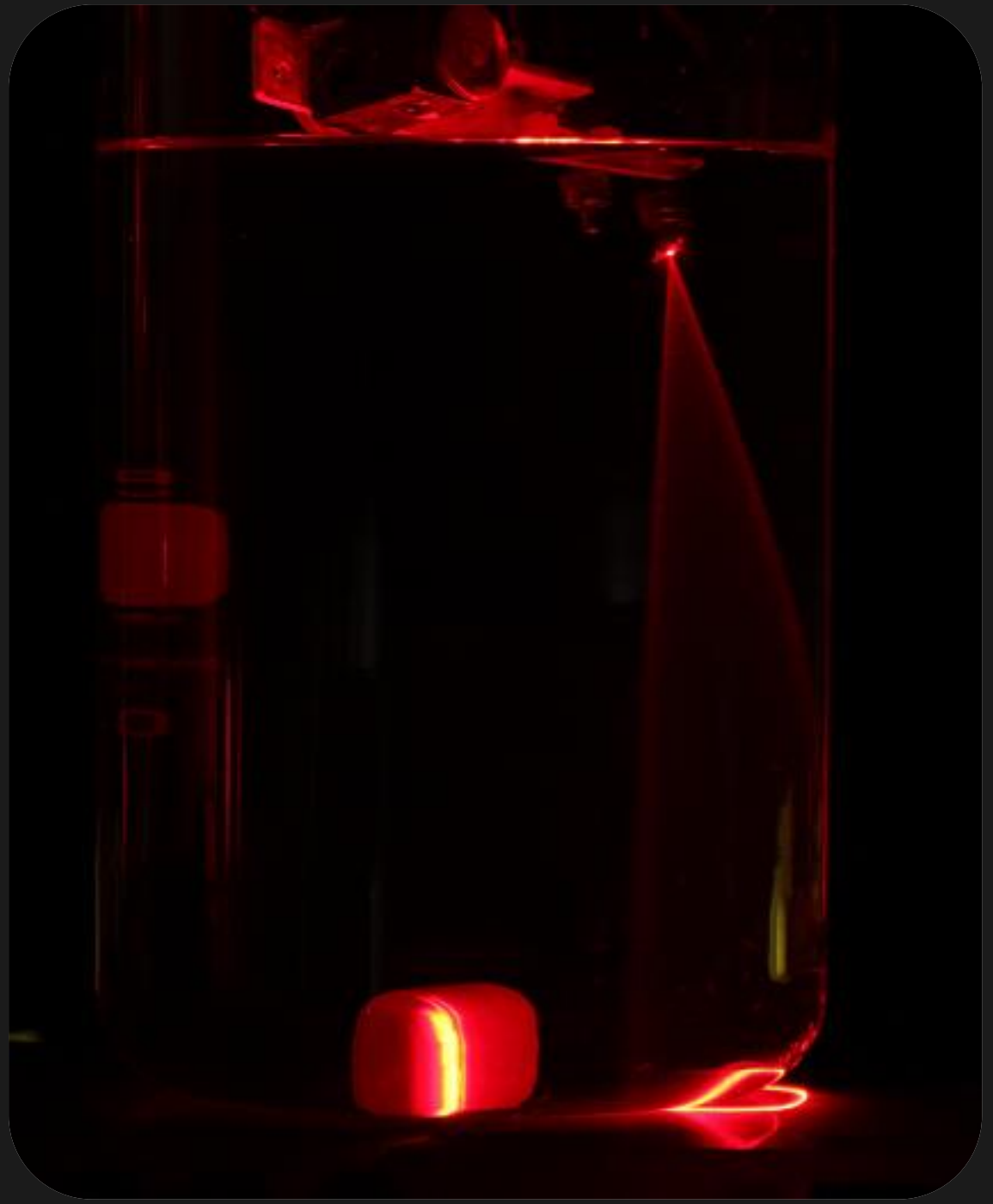
Time Resolved Optical Turbidity



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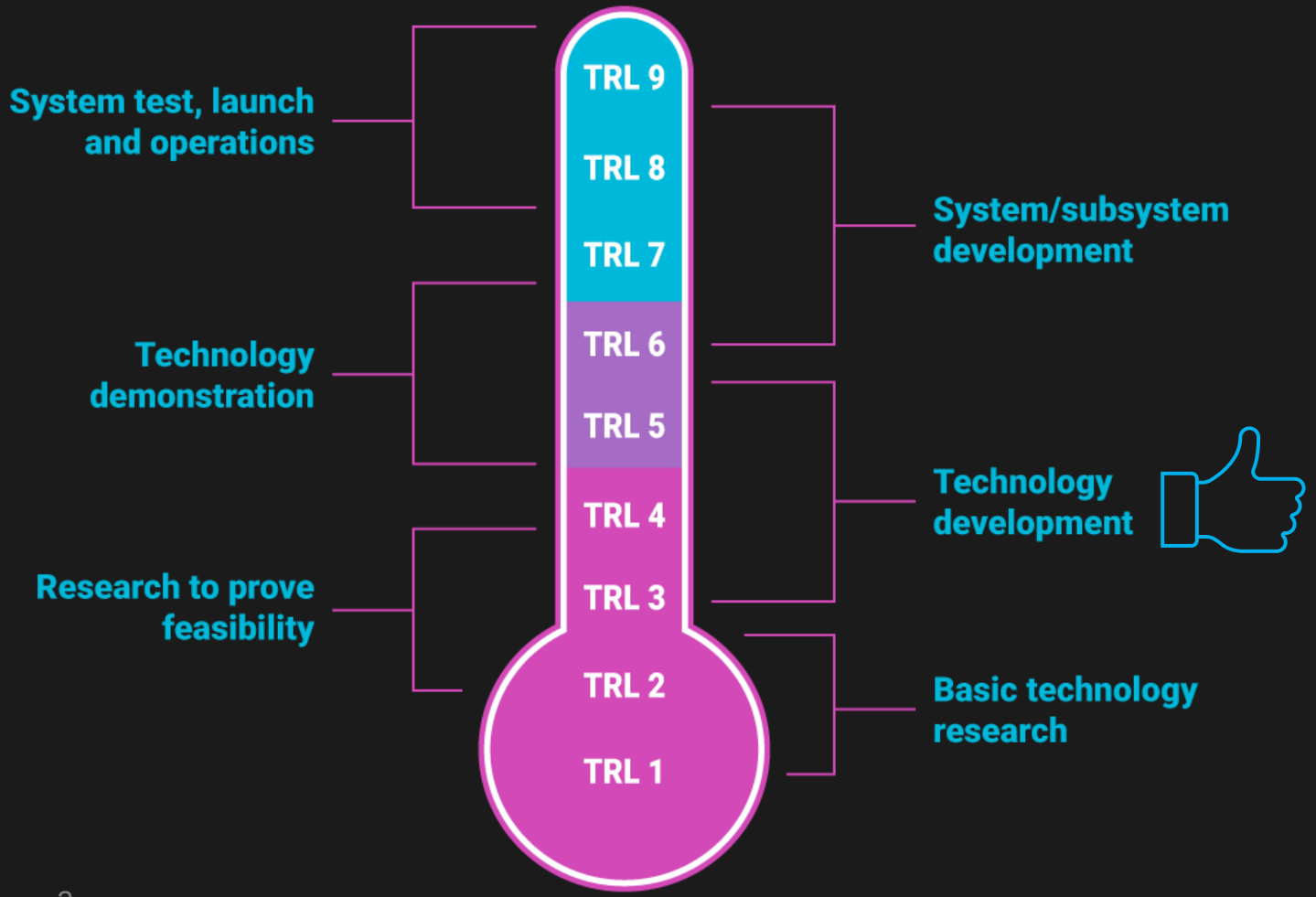
State of the art

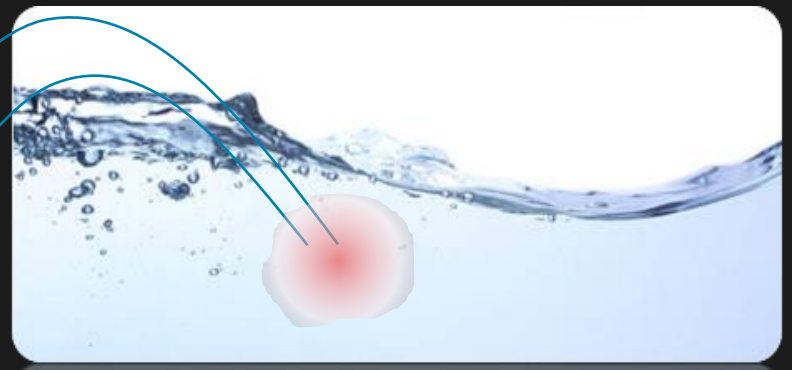


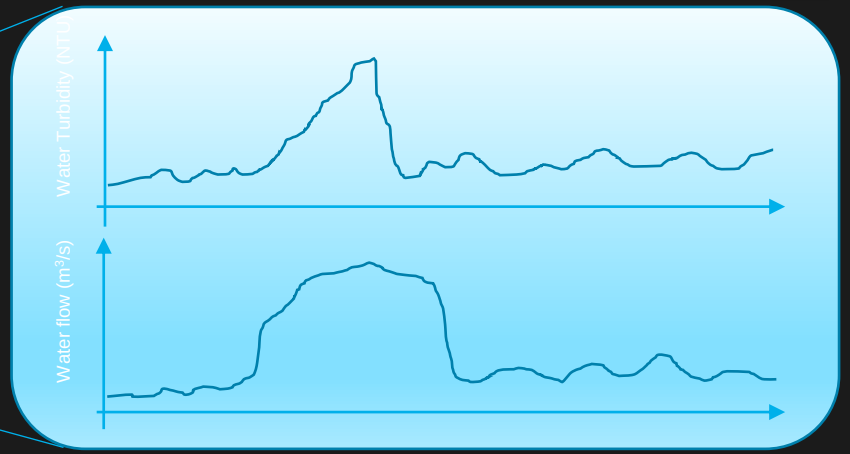
- Promising novel real time technique, still under development
- Made possible thanks to the progress in electronics

System Overview

Home-made ultra-fast electronics

Optical probe

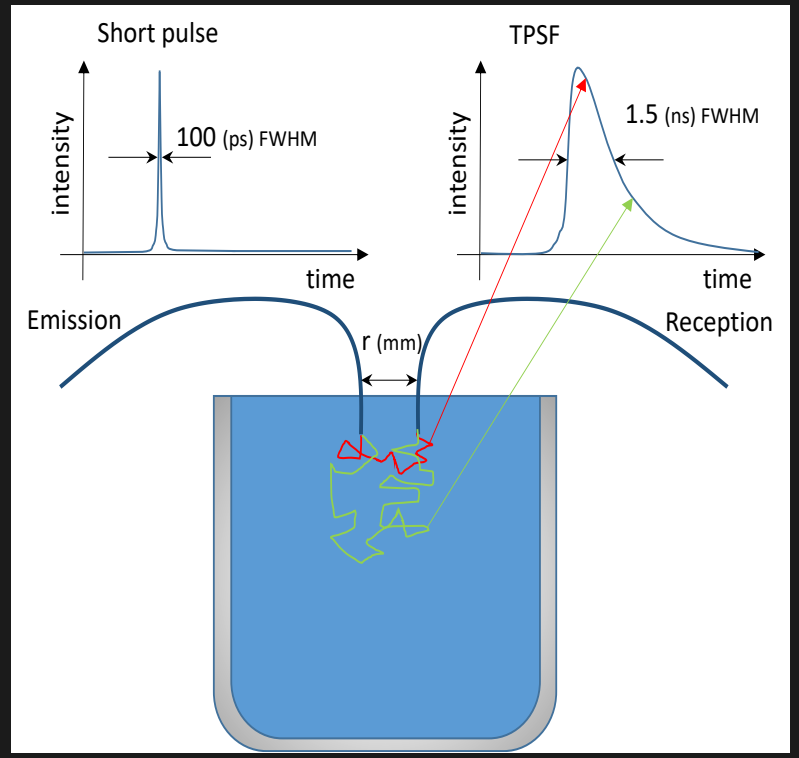




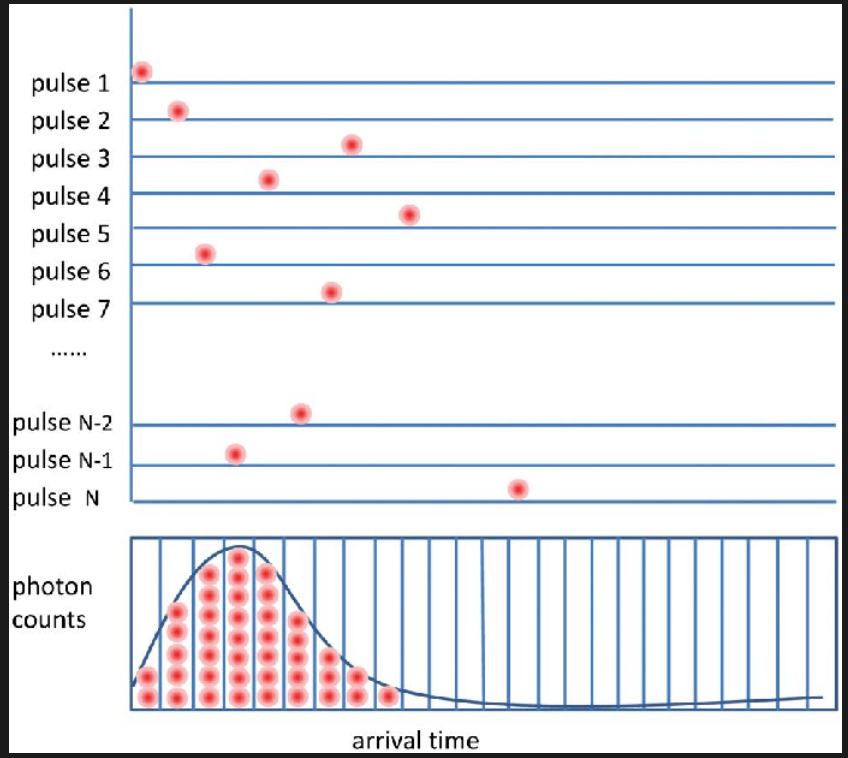
Turbidity measurement

Mean velocity

Principle

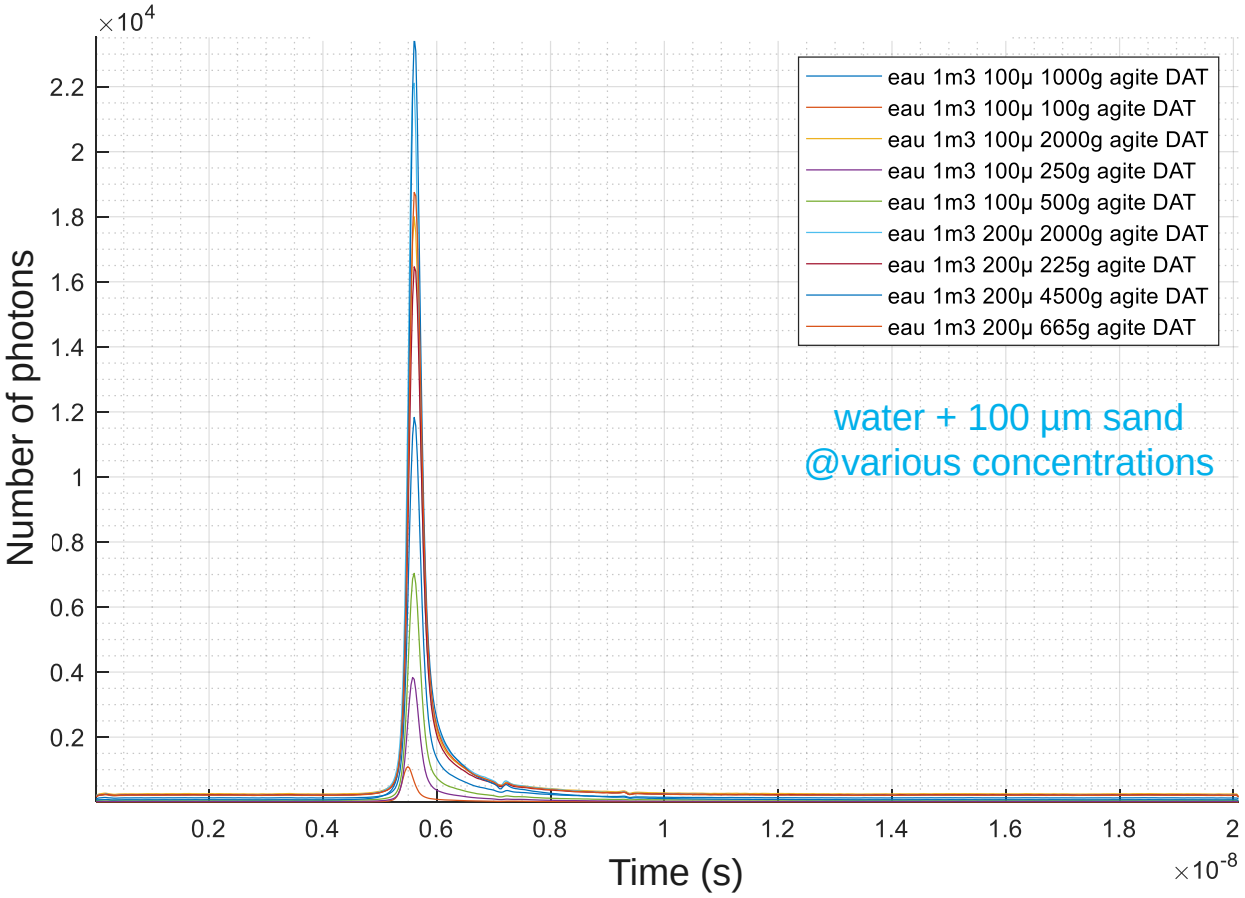


TROT

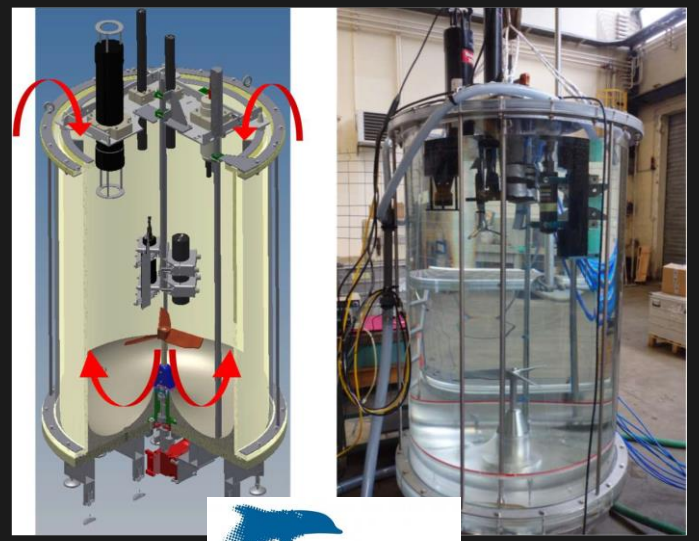


Time Correlated Single Photon Counting

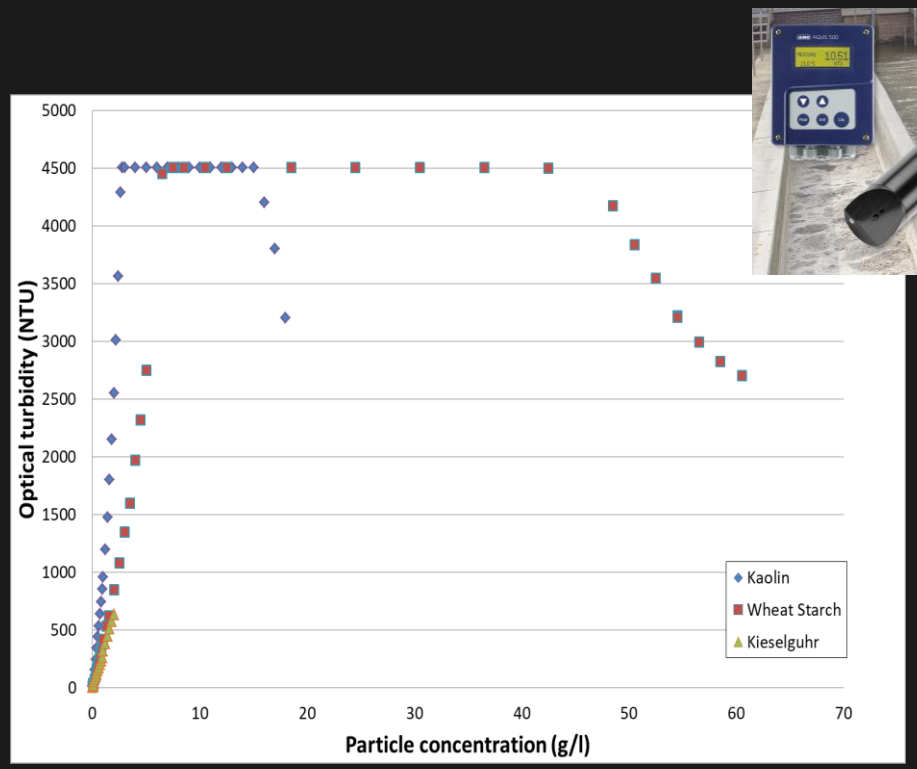
Typical Time Point Spread Function (TPSF)



- Spectrum with multiple characteristics
  - Number of photons
  - Exponential tail
  - Mean time of flight
  - …



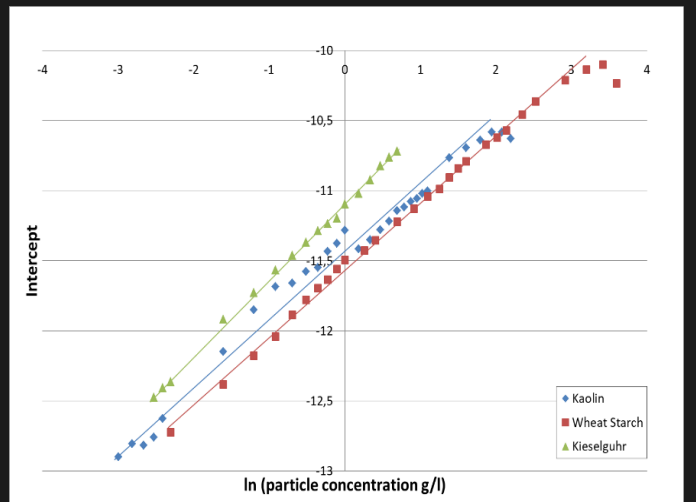
Comparison to standard techniques



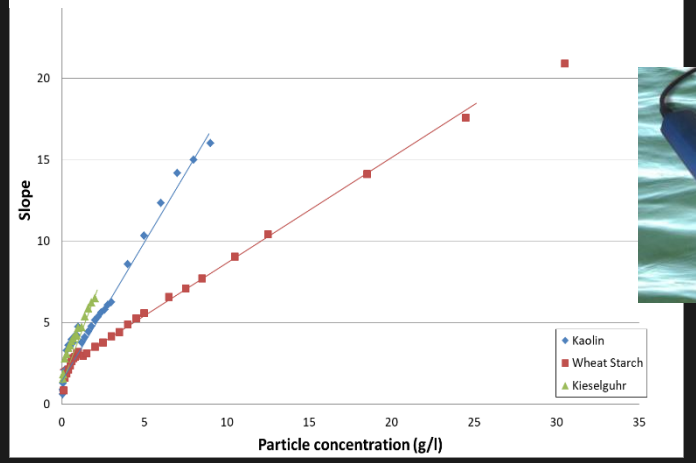
Kaolin: ~5µm
Wheat: ~18 µm
Kieselguhr: ~18 µm

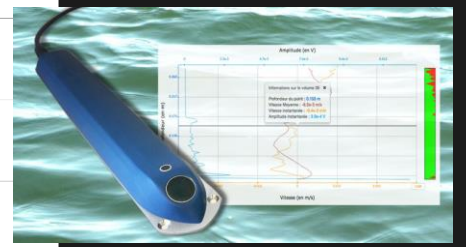
Optical turbidity

- Sensitive to small particles
- Dysfunction at high concentrations



$$\ln(\Psi r V_{rms}) = \ln\left(k_t f_m \sqrt{\frac{M}{\rho_s \langle a_s \rangle}}\right) - 2r\left(\alpha_w + \frac{3\chi_m M}{4\rho_s \langle a_s \rangle}\right)$$



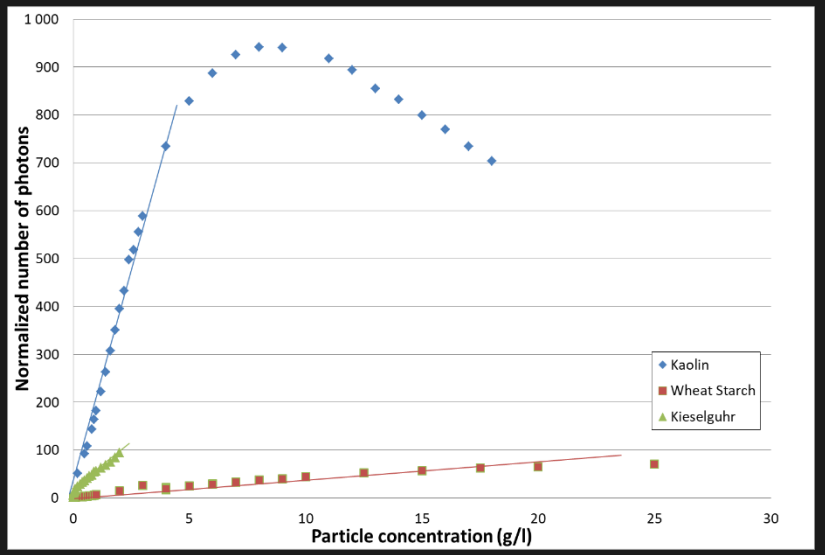


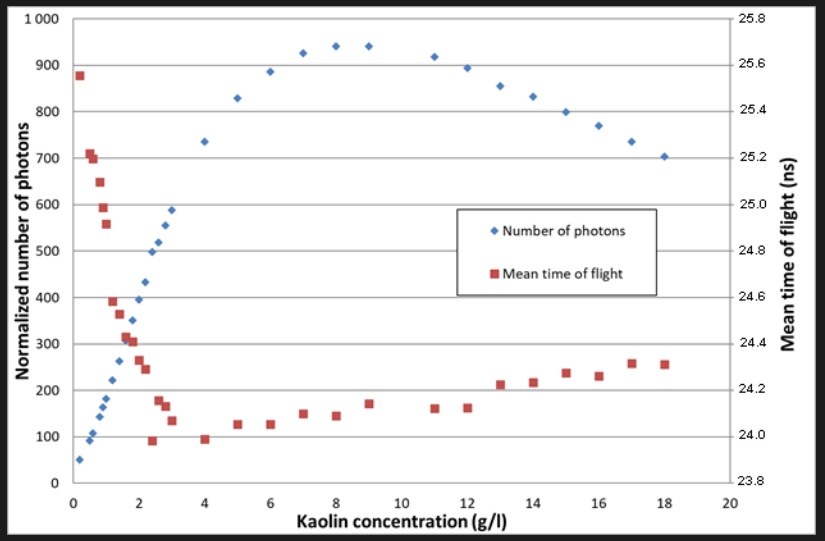
Acoustic backscattering

- Sensitive to large particles
- Not adapted for low concentrations

Comparison to standard techniques

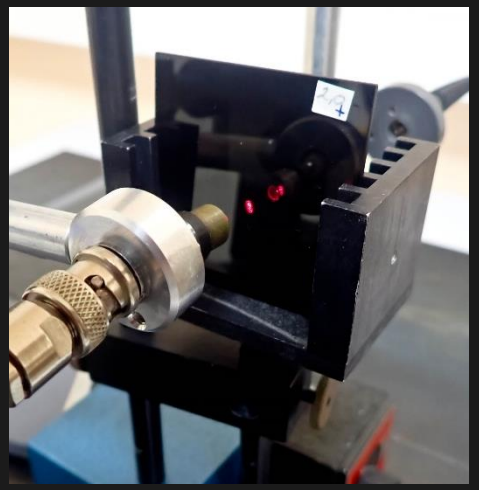
- Equally sensitive to small and large particles
- Measurement dynamics increased **by a factor of 3**
- Not very sensitive to biofouling

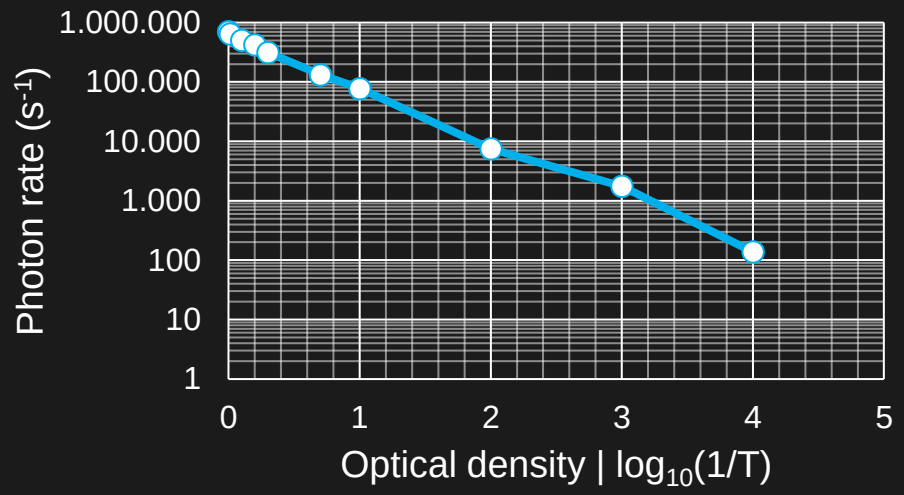




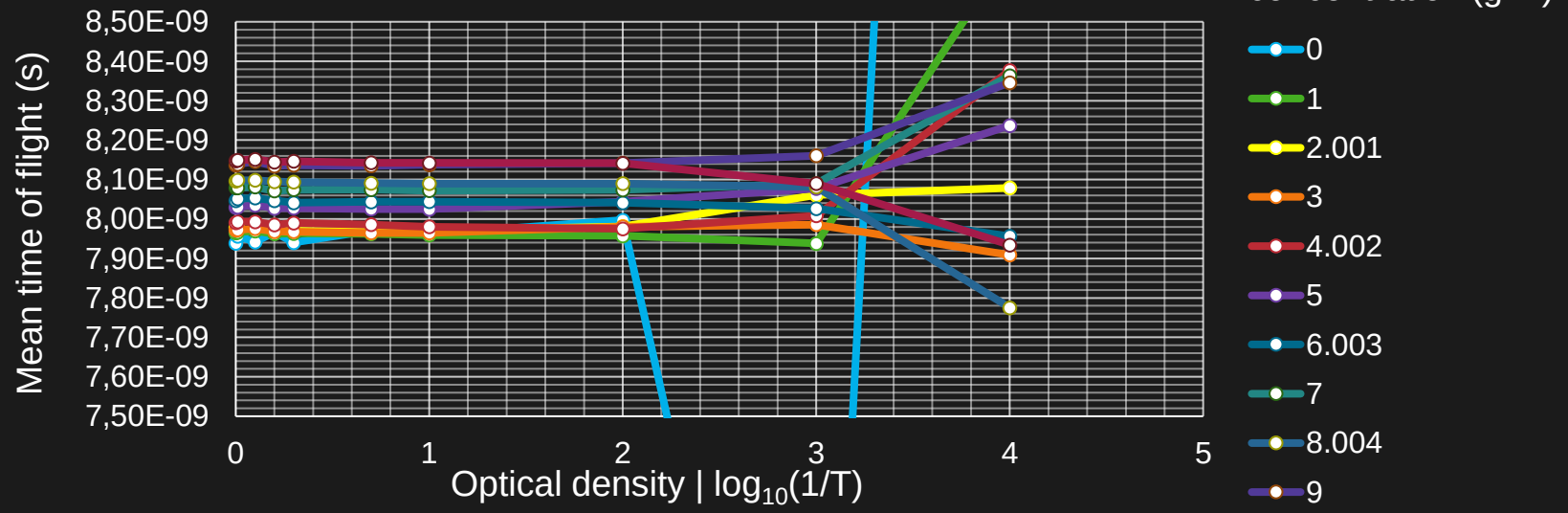
A. Pallarès et al., Comparison of time resolved optical turbidity measurements for water monitoring to standard real-time techniques, Sensors, 2021.
https://doi.org/10.3390/s21093136

TROT versus biofouling





- Mean travel time not affected
- Will be tested in marine exposure this summer

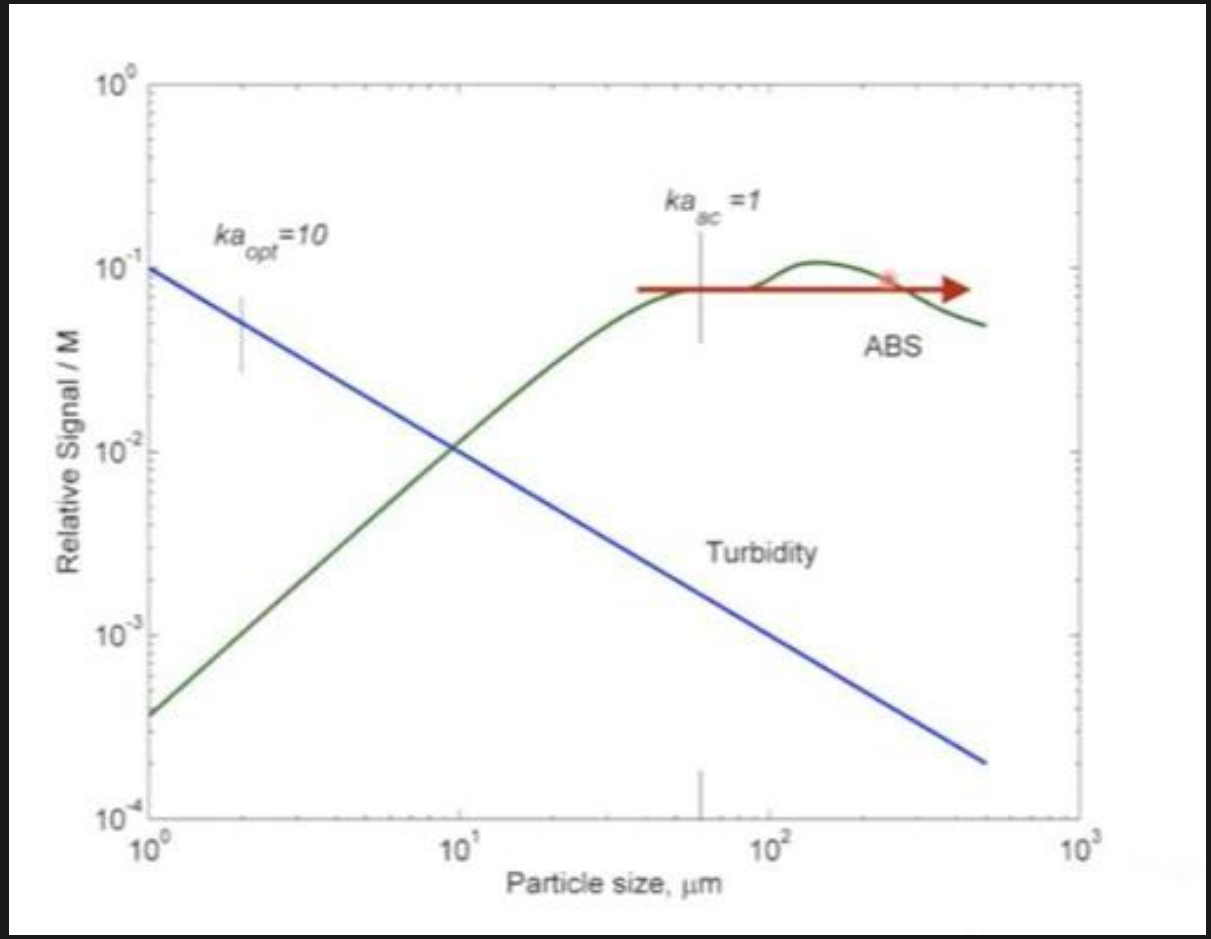


Future developments

- Optical turbidity: effective on small particles (e.g. sludge)
- Acoustic turbidity: effective on larger particles (e.g. sands)

Complementary techniques

The future of sediment transport monitoring lies in a **combination of optical and acoustic signals** at different frequencies in order to be aware of the particle size evolution



THANK YOU FOR YOUR ATTENTION
Any questions?

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