

# Characteristics of flow around aquatic plants in natural conditions: experimental setup, challenges and difficulties

A part of the project:  
'Field experimental investigation of hydrodynamics of water flow-vegetation-sediment interactions at the scale of individual aquatic plants'.

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## Use of the acoustic Doppler velocimeters in flow – biota studies

- Single point ADV used to study mixing layer around finite patch of submerged plants (Sukhodolov and Sukhodolova 2012) .
- Measurements of drag forces exerted on plants or theirs shoots or leafs and corresponding velocity (Siniscalchi et al. 2012).
- Flow measurements (turbulence, diffusion, structure) through large coastal fields of submerged plants (Nepf 2012).
- Impact on turbulence structure within canopies of seagrass in laboratory flume (Ying Pan et al. 2014).
- Impact of microalge on mean and turbulent flow fields using Vecrtrino Profiler (Thomas and Mclelland 2015).

# A new opportunity

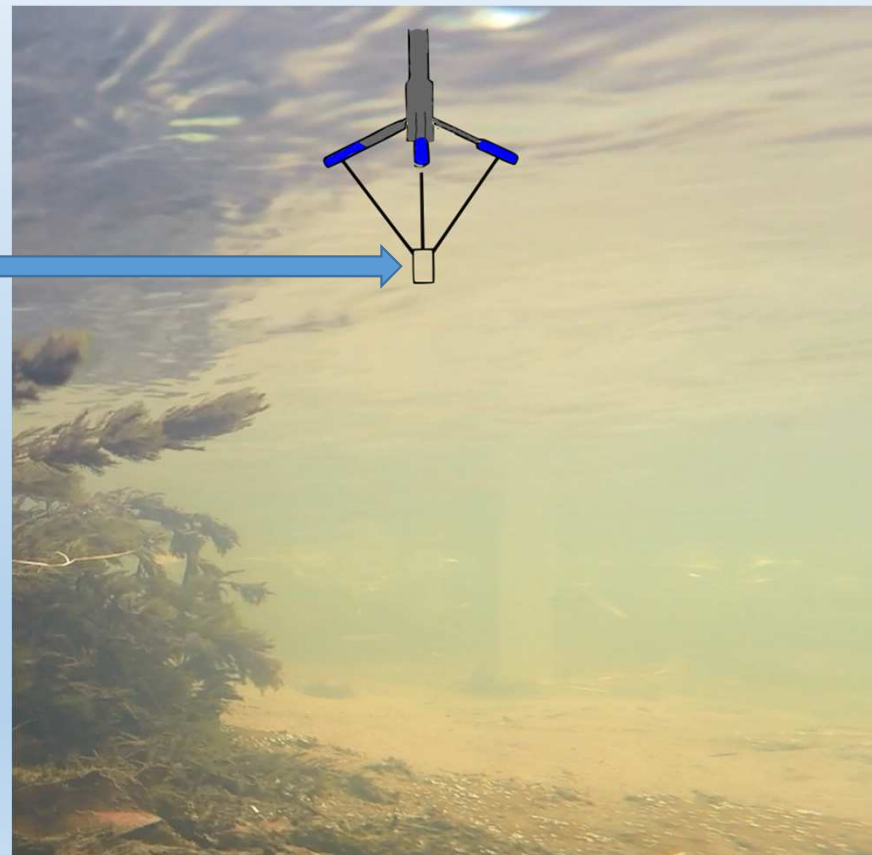
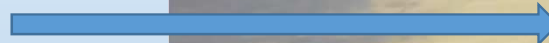


Single point ADV, measuring velocity in 1 to 9 mm thick area – a few synchronised devices or many individual measurements is required to obtain velocity profile.

# A new opportunity

Multipoint Vectrino Profiler

Measurement area - „section”



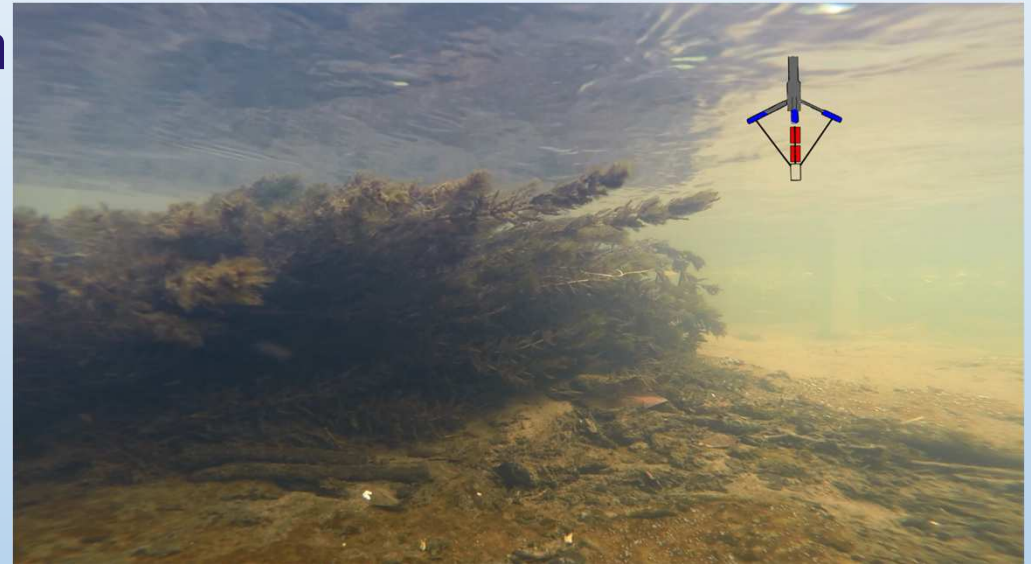
# A new opportunity

Each section has 35 points or cells.



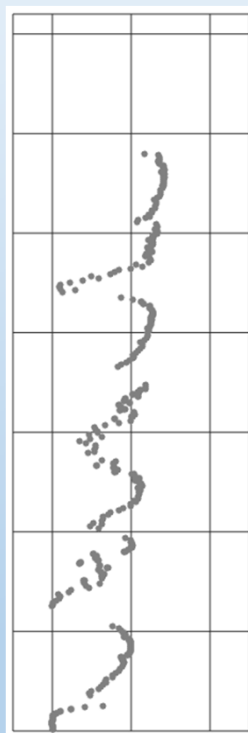
# A new opportunity

- One section has length of 3.5 cm
- Starts 4 cm from the transducer



# A new opportunity

In 30 cm deep water about 8 sections has to be made to acquire complete profile.



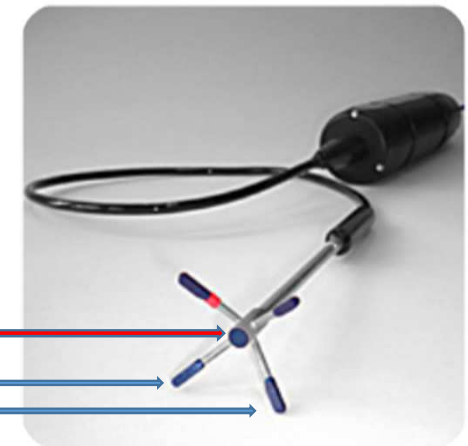
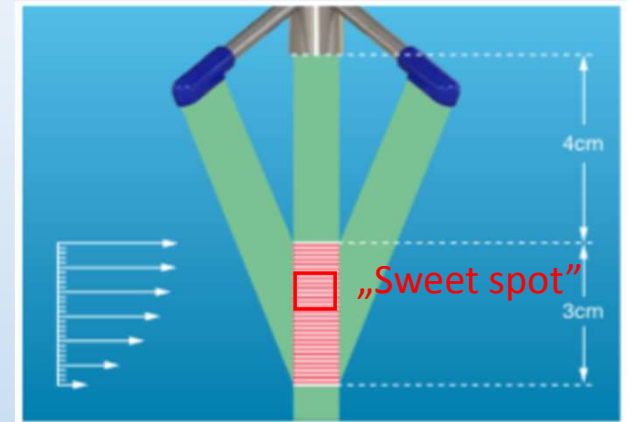
## How Vectrino Profiler measures velocity ?

The Doppler shift is estimated from a change in phase between two signals. Time between two signals, Doppler shift and speed of sound value is used to calculate velocity. Measured velocity is an average of many velocity estimates (called pings).

$$V = \frac{c}{4\pi f} \frac{\Delta\Phi}{\Delta t}$$

- C – speed of sound  
 – phase difference  
 $\Delta t$  – time between pulses  
 f – pulse frequency

35 cells, each 1 mm thick, middle ones are called „sweet spot” and have the best signal to noise ratio.



Central emitter  
 Transducers  
 (receiving returnig signal)

Source: [www.nortek-as.com](http://www.nortek-as.com)

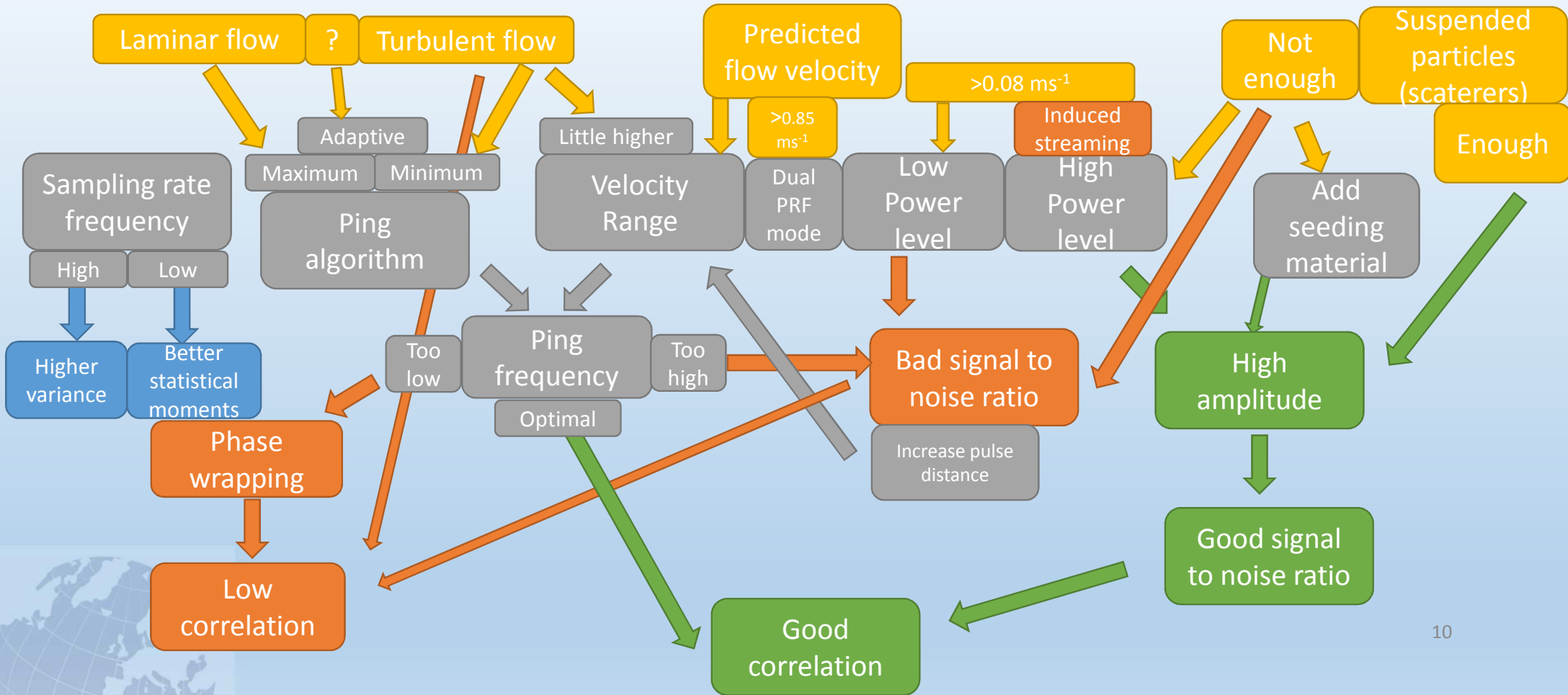


## Difficulties in use of the VECTRINO Profiler

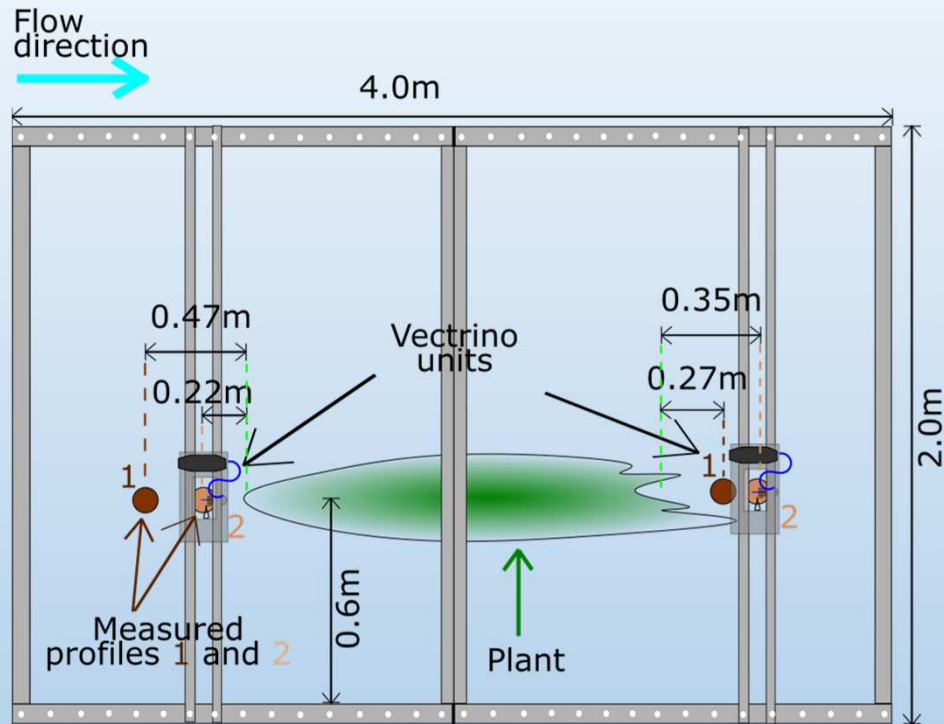
Different device's configuration leads to major changes in obtained results, therefore:

- Careful setup is needed each time to obtain high signal to noise ratio and high correlation – signs of good quality of received data.
- Optimal ping algorithm and velocity range has to be chosen adequately to avoid interferences.
- Despiking the data from the velocimeter is required to get rid of noises and artefacts, without this procedure, data could be unreliable.
- There is no up to date software for further analysis, unlike for older instruments.

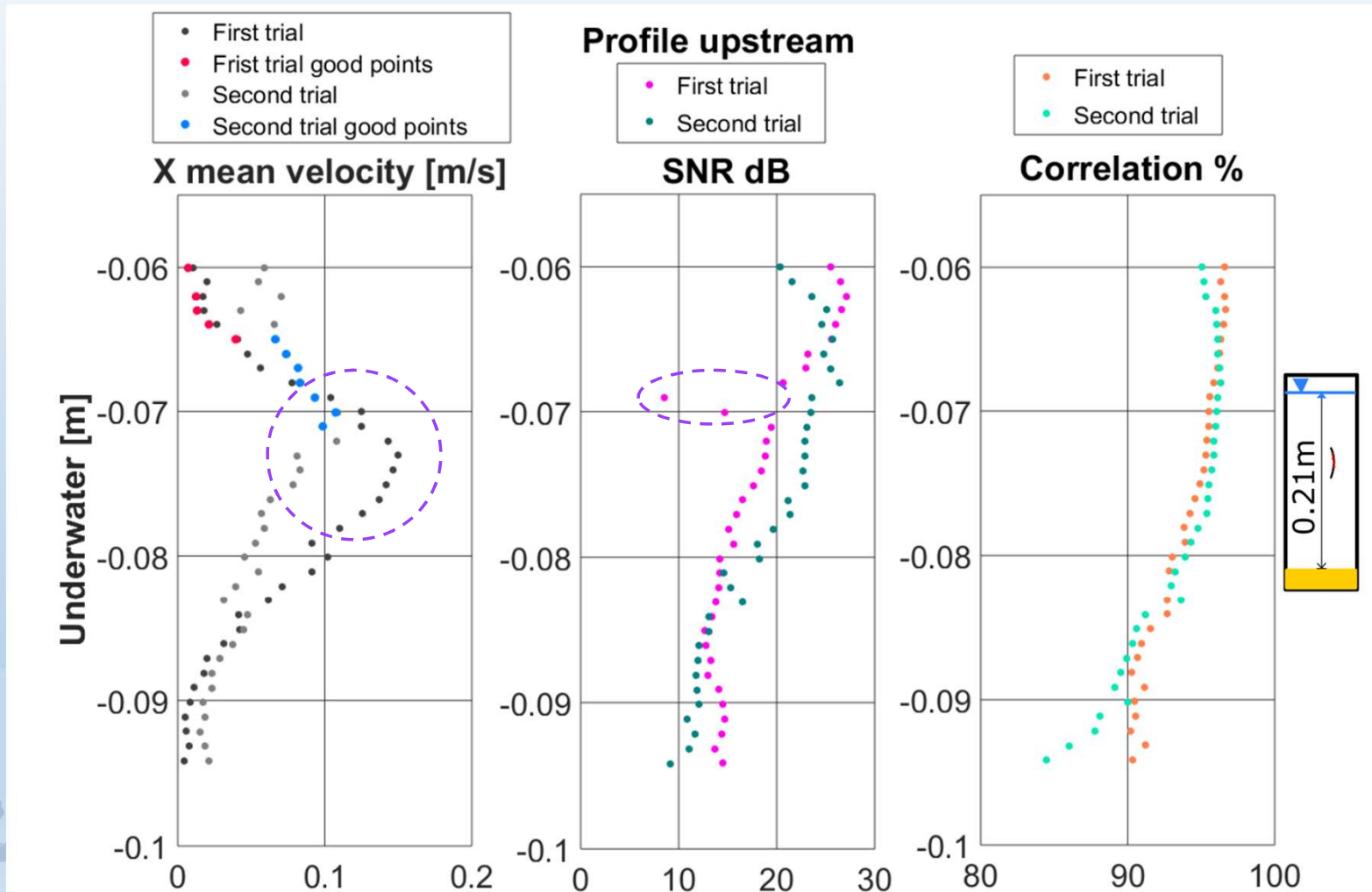
# Vectrino Profiler is user friendly



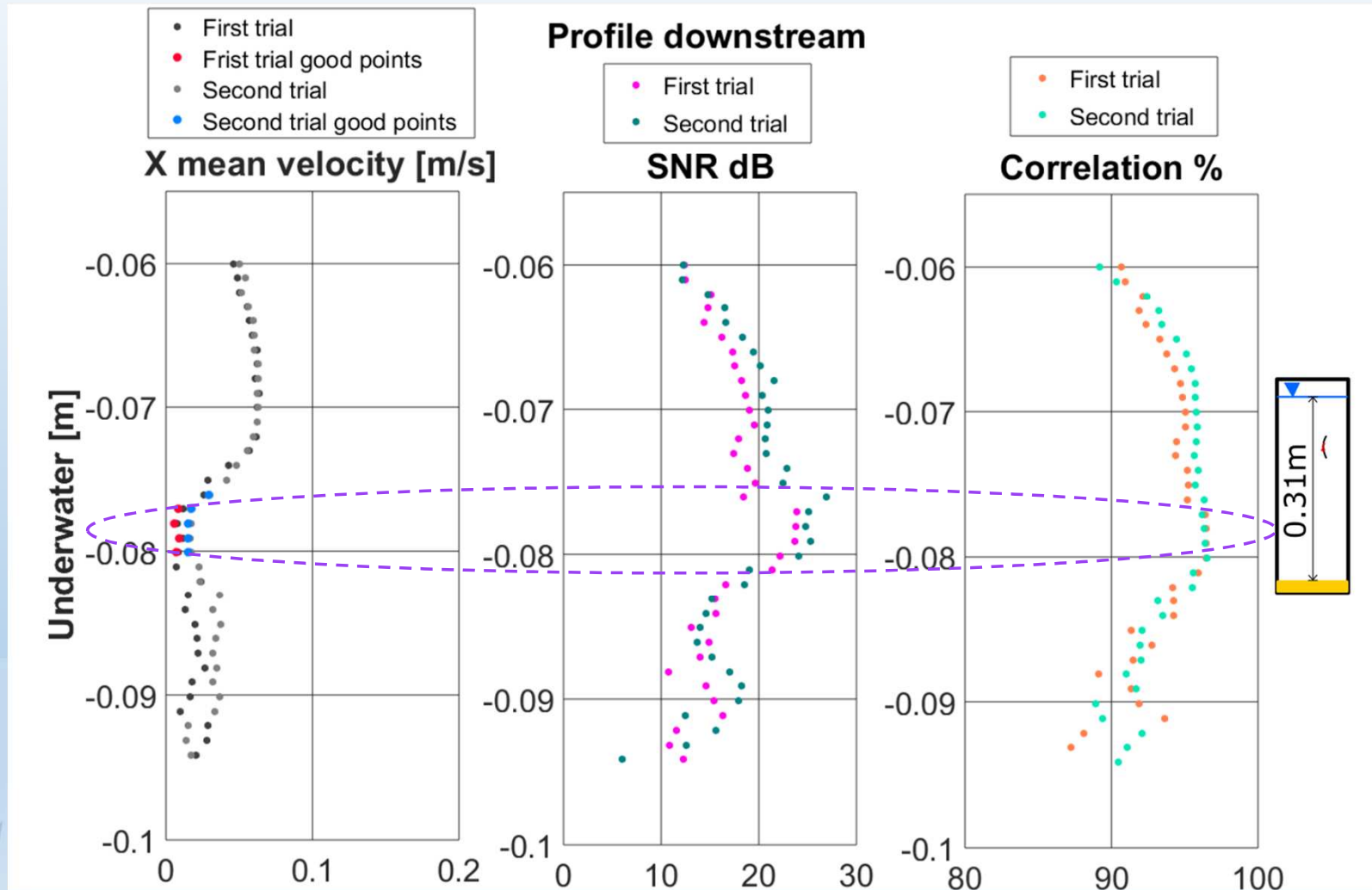
# Field deployment



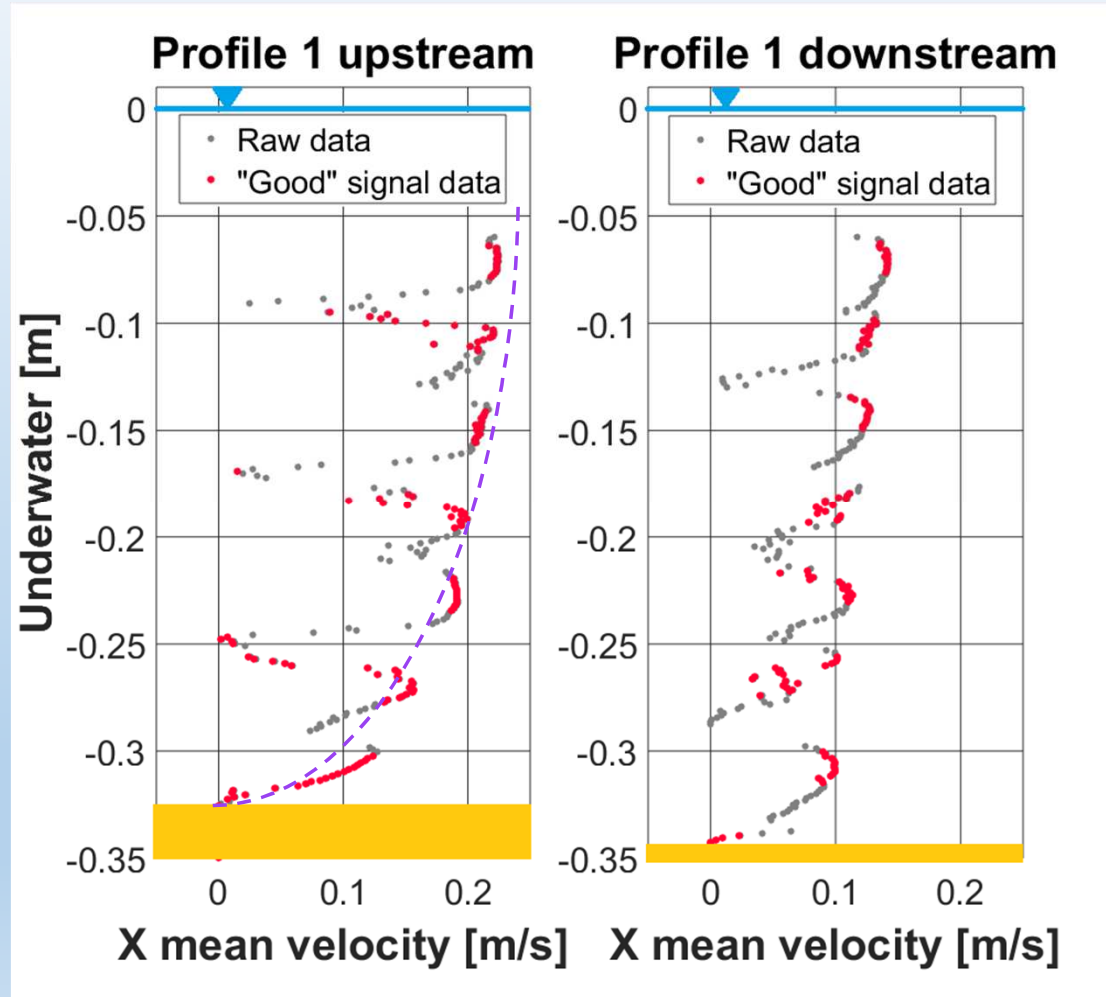
# First trial



# Second trial



# Mean streamwise velocity profiles



# Conclusions

Vectrino Profiler has limited usefulness because:

- SNR is a threshold, limiting data usefulness – obtained data of low SNR can be used only to estimate mean velocities and only when accompanied by high correlation.
- Expect different SNR levels in changeable river's conditions due to different characteristics of suspended particles.
- Difficult and sensitive setup prevent easy measurements in non-controlled environment.
- Even with good signal characteristics in whole 35 mm section, points outside the „sweet spot” tend to have decreased velocities.



# Thank you!