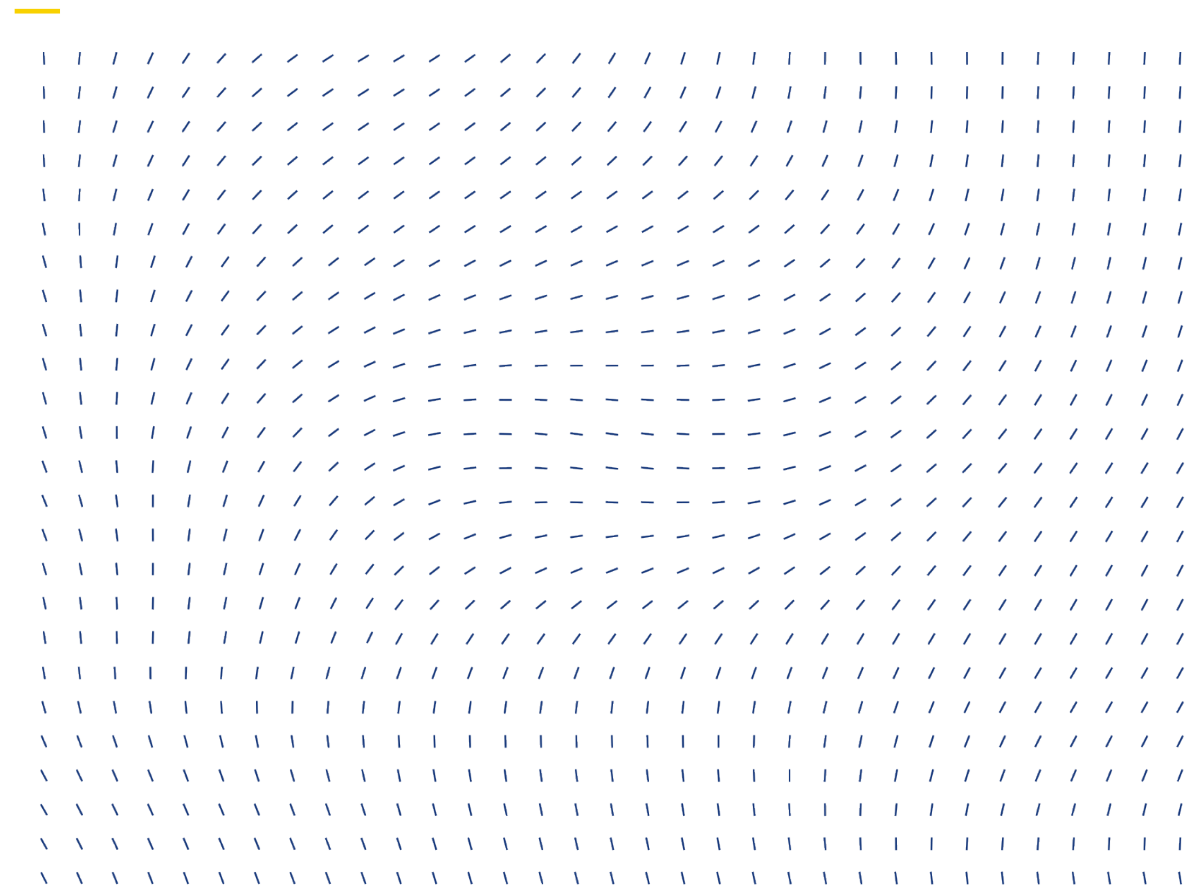


# Guidelines on using the Generation 2 Vector in a laboratory setup



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## Revision history

Minimal Revision Log

| Rev | Issue Date | Change Log                             |
|-----|------------|--|
| 2   | 2026-07-09 | Minor changes and update related to VR |
| 1   | 2026-07-03 | First draft.                           |

## 1 Introduction

This report compiles the characteristics and operating principles of the Nortek Generation 2 Vector, based on laboratory testing and reported user experiences. We present the methods and results for setting up the Gen 2 Vector in the lab based on minimum distance to boundaries and bed type. We also compare data collected by the Vectrino and Gen 2 Vector under the same flume conditions and present the results of the Echosounder, which can also be used to guide instrument setup.

| Topic                           | Recommendation  |
|---------------------------------|---|
| <b>Flume type</b>               | Minimum of 20 cm of water column and wider than 26 cm   |
| <b>Minimum distance to bed</b>  | 17 cm measured from transmitter to bed; 16 cm from bed for first- and second-order (mean flow and fluctuations) statistics    |
| <b>Type of bed material</b>     | Preferably homogeneous opaque surfaces (wood, cement, sand)   |
| <b>Preferred operating mode</b> | Broadband   |
| <b>Instrument mounting</b>      | Rigid mounting to avoid vibration either in the vertical or horizontal  |
| <b>Setup verification</b>       | Using Probe Check and Echosounder (if available)  |
| <b>Seeding material</b>         | Kaolin or glass beads preferably, enough to create a strong signal in the Probe Check   |
| <b>Data validation methods</b>  | Correlation, amplitude and current standard deviation analysis using a time series over 2 minutes, spectral analysis at 64 Hz |

Expanding on the table above, our key findings are as follows:

- The Gen 2 Vector can be used successfully in a wide range of laboratory applications due to its ability to resolve rapid velocity fluctuations and its high signal to noise ratio (SNR). These applications include but are not limited to:
  - turbulence processes;

- sediment transport, particularly when combined with the Echosounder;
- wave-current interaction;
- canopy studies (given the probes can penetrate the canopy);
- biological and bio-physical studies;
- eddy covariance (e.g., dissolved oxygen or CO<sub>2</sub>);
- On the other hand, the applicability of the Gen 2 Vector is constrained by its physical probe size, location and size of sampling volume, its single-point cell sampling, and maximum sampling rate. The following limitations should be taken into consideration and discussed with the sales representative prior to the Gen 2 Vector purchase:
  - Turbulent processes beyond 32 Hz are not accounted for, considering the Nyquist frequency limitation and maximum sampling rate of 64 Hz;
  - The Gen 2 Vector is a single-point velocimeter, not a profiler such as the Vectrino Profiler. It is not suitable for resolving spatial flow structures, including vertical shear profiles, or vertical variations in eddy covariance, and Reynolds stresses. These processes can only be investigated with the Gen 2 Vector by repeating flow conditions and repositioning the instrument at different elevations for successive measurements;
  - The sampling volume has dimensions of 15 mm height and 8 mm width, resulting in spatial averaging of the measured velocity field. This attenuates turbulent structures with characteristic length scales comparable to the sampling volume;
  - Measurements collected at 16 cm from the boundaries (measured from the transmitter) or less showed a high noise level and consequently a higher number of outlier data. At this height, the top of the sampling volume sits less than 0.5 cm from bed;
  - Measurements over 16 cm from the bed up to 17 cm provide reliable first- and second-order statistical data but require additional validation using spectra and signal-quality metrics. At this height, the measurement volume sits between 0.5–1.5 cm from the bed;
  - Measurements over 17 cm from bed offered highly reliable data up to third-order statistics and require no further validation (Figure 1). At this height, the top of sampling volume is located over 1.5 cm from the bed;

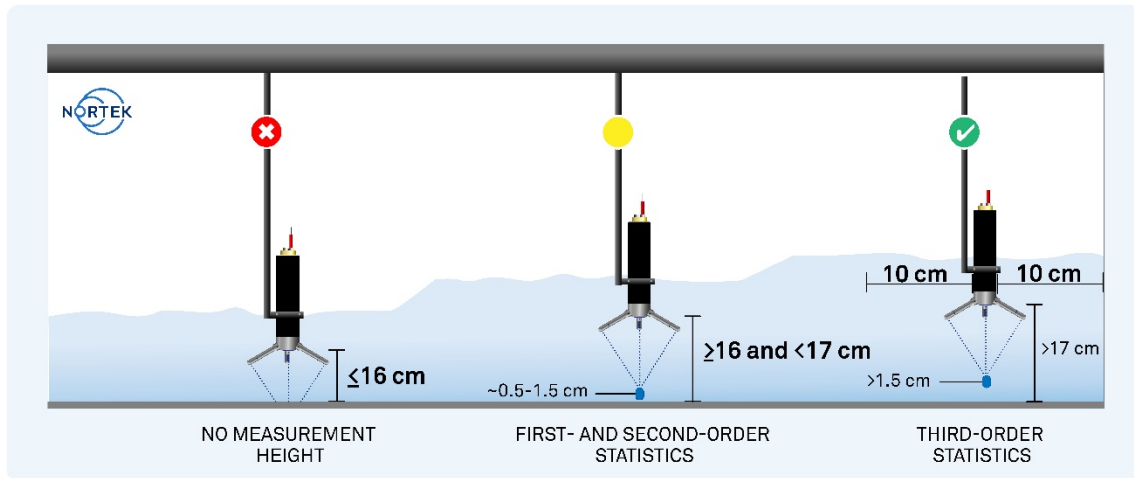


Figure 1: Minimum distance to boundary requirements for the Gen 2 Vector

- Although not mandatory, we recommend adding at least 4 cm of water column on top of the values above to submerge the pressure and temperature sensors.
- The Gen 2 Vector should be mounted preferably over opaque surfaces such as wood, cement or sand. Reflective surfaces such as glass and glass beads can produce beam reflections and interfere with acoustic signal interpretation near-bed but not in the water column. Flexible canopies, vegetation, and rocks can be used but their heights need to be considered.
- The Gen 2 Vector can also be mounted in the horizontal, provided all the sensors are submerged. That requires at least  $\approx 26$  cm of water column.
- Proper seeding concentration and rigid mounting are critical for obtaining stable measurements. Common seeding materials include kaolin and small (micron-sized) glass beads.
- The Echosounder function significantly improves setup verification and distance estimation.

## 2 Motivation

In the early 2000s, Nortek introduced two types of acoustic Doppler velocimeters: the Vectrino, offered as a single-point or profiler instrument, and the Vector (hereafter legacy Vector, single-point only, Figure 2). The Vectrino was designed primarily for laboratory investigations, offering users a slender probe and small sampling volume ideal for velocity measurements in flumes (e.g., Chanson et al., 2008; Juarez et al., 2019; Koca et al., 2017). The Vector, on the other hand, was developed with a more robust design intended for field applications, including measurements in the wave breaking zone (e.g., Contti Neto et al., 2022; Nash et al., 2024; Norris et al., 2017).



Figure 2: Comparison in scale between (from left to right) the flexible probe Vectrino, legacy Vector, fixed probe Vectrino and Generation 2 Vector

The Vectrino and Vectrino Profiler have become widely used by the scientific community for laboratory hydrodynamic investigations. Alternative measurement techniques in laboratory to acoustic-based instruments have existed since the 70s, including Particle Image Velocimetry (PIV), Laser Doppler Anemometry (LDA) systems and electromagnetic sensors. These,

however, come at a high cost and/or raise additional safety concerns. In June 2020, Nortek discontinued the Vectrino and Vectrino Profiler product line due to limitations in instrument manufacturing and maintenance.

In July 2025, Nortek released the Generation 2 Vector (hereafter Gen 2 Vector), with a smaller form factor, updated electronics, and a new transducer design. The traditional rigid stem from the legacy Vector was removed, enabling the Gen 2 Vector sensors to be deployed in shallower sites, getting closer to the boundary layers. Broadband mode was also introduced, increasing the measurement precision, an improvement when compared to narrowband-only measurement on the legacy Vector (Thomas et al., 2017; Ursic et al., 2012). Additionally, the optional Echosounder function added more versatility.

While the legacy Vector has historically seen limited use in laboratory settings, some studies have shown its applicability in flumes, such as oil jets (Daskiran et al., 2020), wave-induced flow (Bricker & Monismith, 2007; Pendergast et al., 2026), tidal-bore induced turbulence (Chanson et al., 2008, 2011; Chanson & Leng, 2024) and sediment concentration (Salehi & Strom, 2011, 2010). Since its release, Nortek received increasing interest regarding the potential use of the Gen 2 Vector in laboratory applications as a replacement for the discontinued Vectrino systems. With the improvements introduced in the Gen 2 Vector, we expect that the instrument can be successfully applied in laboratory settings when appropriate setup considerations are considered.

In collaboration with the Coastal and Offshore Research Lab from the University of Western Australia (CORL, Perth, Australia), Nortek conducted a series of experiments to validate the capabilities of the Gen 2 Vector for laboratory measurements. We used the Large Scale Wave flume (54 m long × 1.5 m wide × 1.1 m high, Figure 3) and the Constant Flow flume (25 m long × 0.6 m wide × 0.5 m high, Figure 4). This report shows the results of the experiments conducted on both tanks. It also presents guidelines for how to setup the Gen 2 Vector according to the research and finishes with some Frequently Asked Questions (FAQ) from clients.



Figure 3: [Large Scale Wave flume](#). Photo credit: UWA (left) and Miles Noel (right)

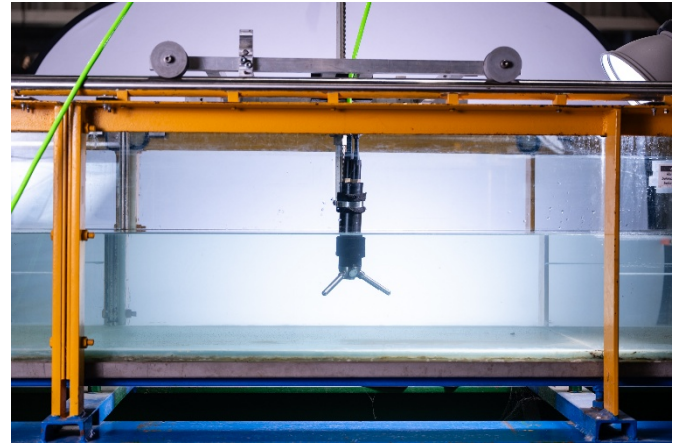


Figure 4: [Constant Flow flume](#) at CORL. Photo credit: UWA (left) and Miles Noel (right)

### 3 Experiments and results

In this section we present the method and results for each one of the experiments: minimum distance to boundaries, horizontal setup, comparison between Gen 2 Vector and Vectrino, influence of bed type in the signal, and the Echosounder function. Combined, these can be used as guidelines on how to set up your Gen 2 Vector.

#### Minimum distance to boundaries

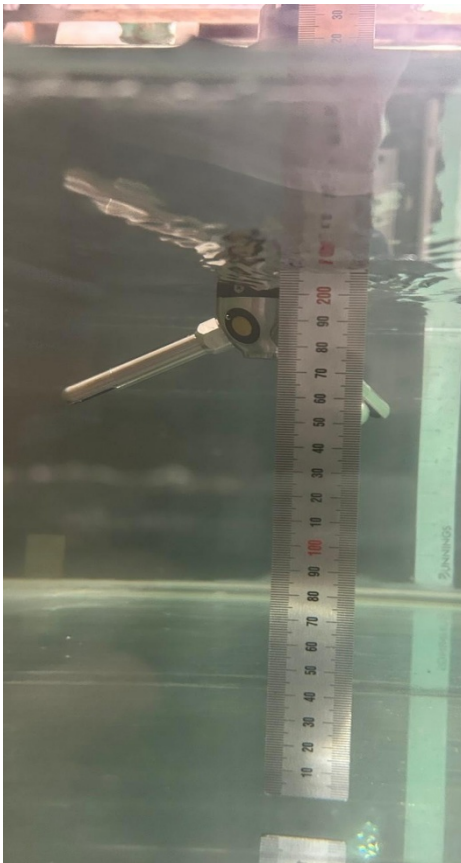


Figure 5: Physical measurement of the distance between the Gen 2 Vector transmitter and the bottom of the flume, indicating 17.5 cm

To determine the minimum distance the Gen 2 Vector can be deployed from the flume bed, we recommend analysing the Probe Check, collecting mean statistics and spectral data. Figure 5 illustrates the distance measurement used in this section, taken from the transmitter to the bed using a ruler.

#### Probe Check

The first experiment consisted of setting up the Gen 2 Vector in a frame in the Large Scale Wave Flume (Figure 3). Since no signal interference or reflection from the lateral walls (1.5 m apart) could be identified, we moved to the smaller Constant Flow flume (whose walls are 0.6 m apart, Figure 4). Again, no lateral interference or signal reflection was identified. We moved the Gen 2 Vector at different distances from the bed observing the Probe Check (Figure 6), Correlation and Amplitude.

The Probe Check is a powerful diagnostic tool that shows how the instrument signal varies with range and can be used during setup and troubleshooting. Mosquera & Pedocchi (2019) have also used the Probe Check to estimate salinity.

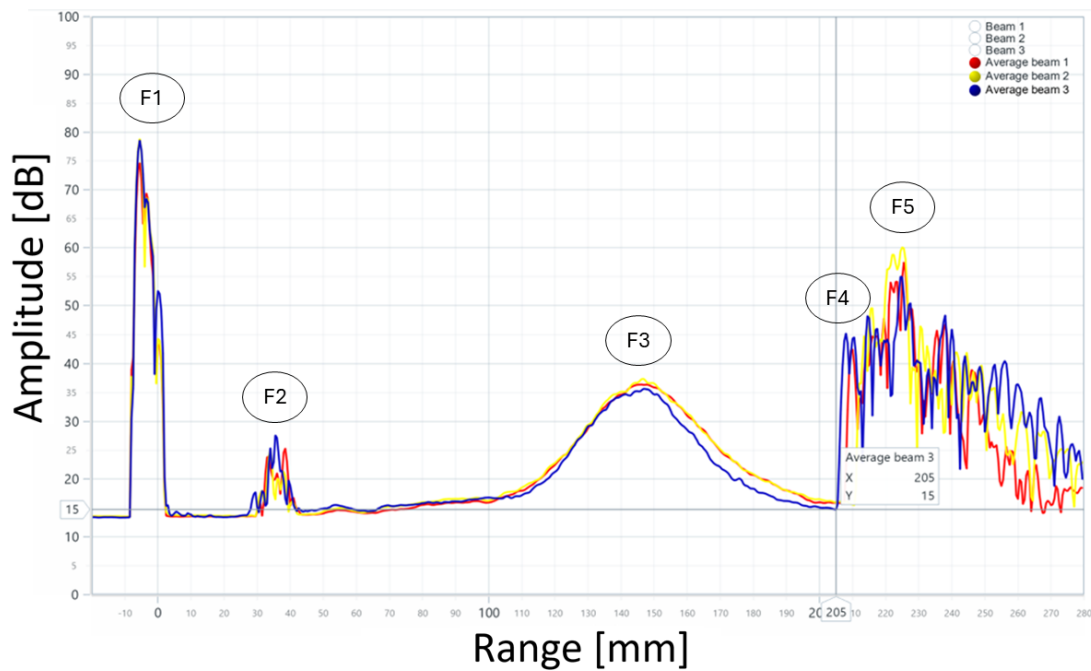


Figure 6: Probe Check from Nortek Deployment Software with the instrument at 22 cmab (as measured from transmitter) showing the expected features the user could find (F1–F5).

Figure 6 shows the Probe Check when the Vector was positioned at 22 cm above bed (cmab). The circles ranging from F1 to F5 indicate important features from the Probe Check:

- The first feature (F1) indicates the transmit pulse and is always present.
- F2 is a direct response from the sound travelling along the Gen 2 Vector rigid arm, bearing no influence on current measurements. F2 might also be absent from your deployment, and no further problem solving needs to be addressed as it is out of the measurement area.
- F3 is arguably the most important feature. It represents a Gaussian peak that indicates the sampling volume (where the current measurements are being taken), centred around 15 cm for this specific instrument used in this project.
- F4 is a sharp change in the acoustic signal that indicates interference from the boundary. In this scenario, the boundary (bottom of the flume) is made of double glass, so it might also be responsible for creating a more remarkable peak, shown as F5 in Figure 6.

To analyse how close the Gen 2 Vector can get to the boundary, we observed how F4 and F5 acoustic signals interacted with the Gaussian curve (F3). Figure 7 shows the progressive approach of F4/F5 to F3, showing that the bottom begins to interfere with the measurement volume between 19-20 cmab.

It is important to note here that the acoustic signal and algorithm interpretation during Probe Check is different from the acoustic signal sent during data collection, which uses pulse coherent sampling. This led to an offset of  $\approx 1.8$  cm between the Probe Check bottom detection peak (F5) and the first bottom detection (the sharp signal increase, F4) in this setup. For more accurate measurements of the Gen 2 Vector distance to bed, please refer to the Echosounder section in this document. Hence, considering the offset, the Gen 2 Vector can potentially be used to measure currents at  $\approx 17$  cmab.

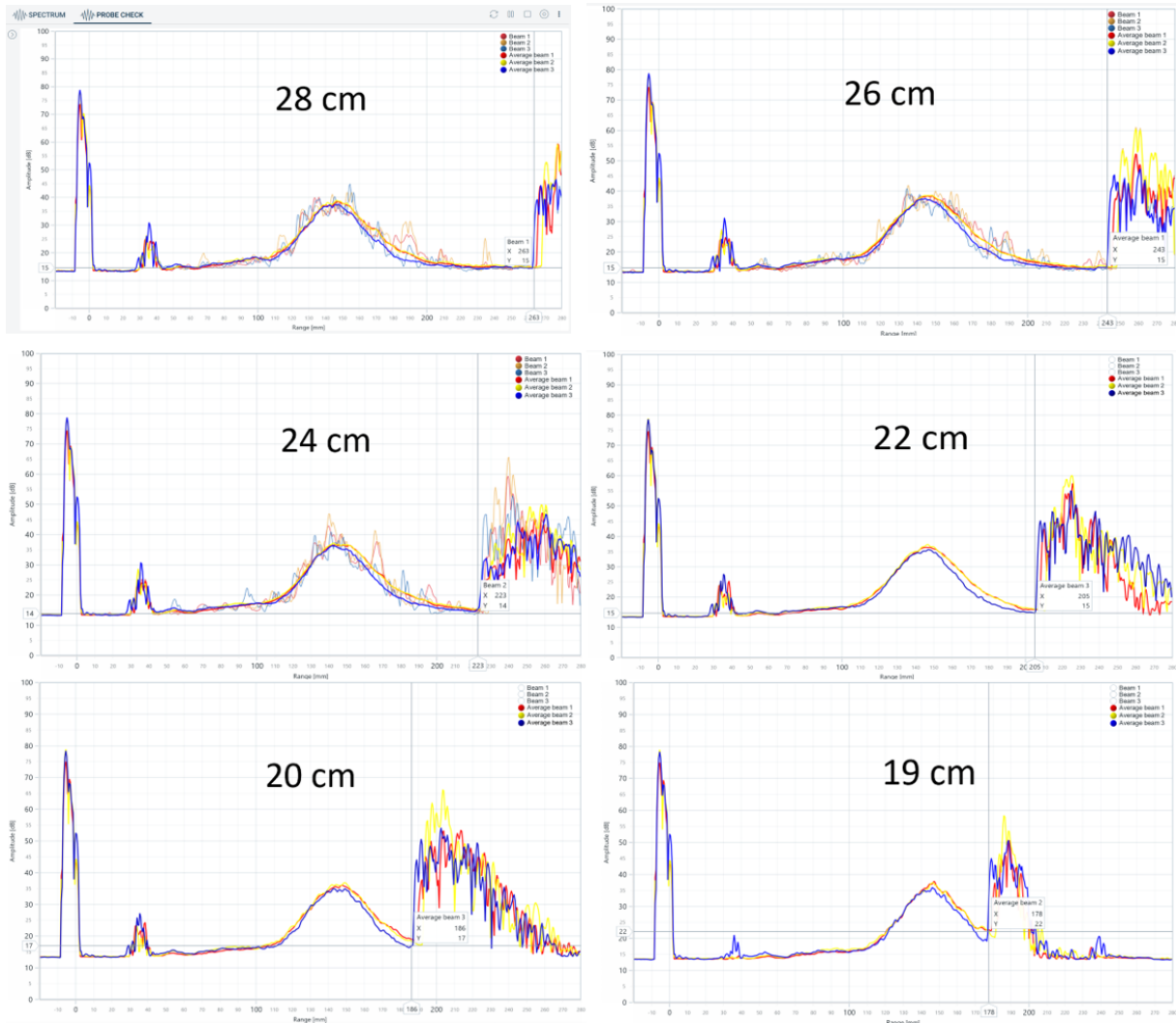


Figure 7: Screenshots from Nortek Deployment of Probe Check of the Vector at different heights from glass bed: x-axis is range (mm) and y-axis is amplitude (dB).

### Mean flow and signal quality statistics

To further investigate the minimum distance to the bed we measured mean current data at each one of these heights for 2 minutes at 2 Hz with velocity range set at 0.3 m/s. To do so, firstly we compared the Vector mean currents results to the laboratory flume calibration metrics. The Constant Flow Flume has a variable frequency drive (VFD)-controlled pump

which allows the user to set different rotational frequencies (in Hz) and an electromagnetic flow meter at the end of the flume that can read the flow (readings in  $m^3/s$ ). For reference, we will use the VFD pump frequency in the results based on the correlation in Figure 8.

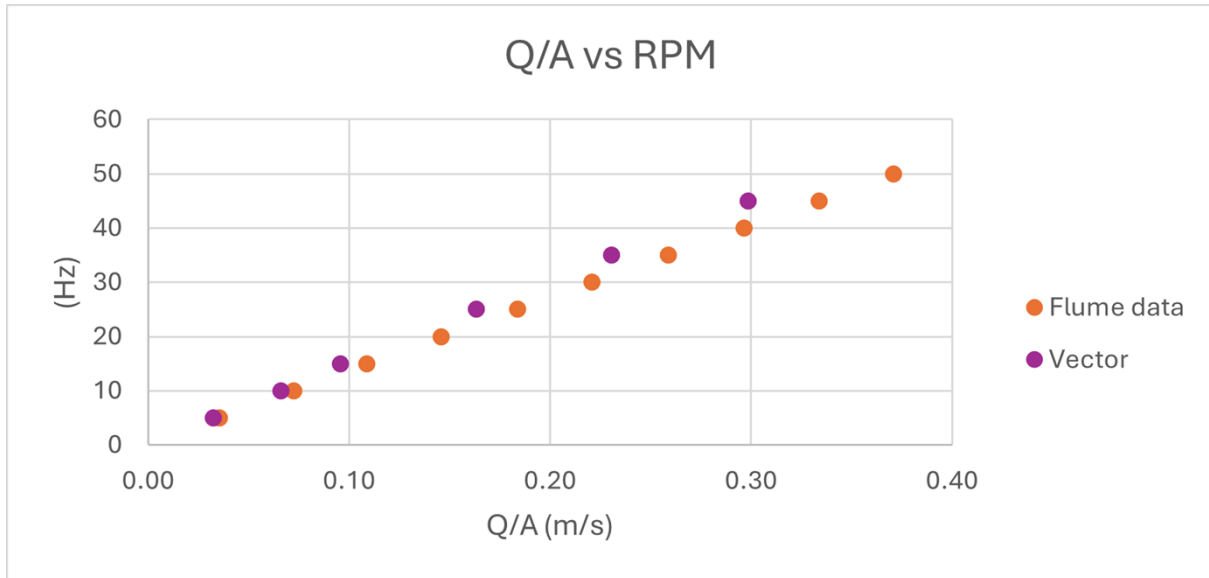


Figure 8: Correlation between the Constant Flow pump frequency and Vector velocity measured at 30 cm from the bed.

Identifying the minimum distance the Gen 2 Vector can get to the bed can be difficult, but some tests may help. In Figure 9 we show results from mean velocity data (first-order flow statistics) over a water column profile, with a log-shaped curve below 20 cm (distance measured as cm from transmitter to bed). That shape is likely due to the Law of the Wall (Cant & Pope, 2000). No significant effect on vertical velocities (second panel) were identified.

The third and fourth panels in Figure 9 represent the amplitude and correlation profiles, showing that amplitude increases with the flow velocities (due to more scatters being suspended) but correlation decreases, as expected. The correlation represents the similarity between the two acoustic pulses sent by the instrument, varying between 0% (no similarities between the two pulses) and 100% (no differences in the two pulses, which results in little to no outliers in the data). For lab tests correlation values are acceptable above 80%, however, 100% correlation may indicate that the signal is being reflected from one of the surfaces. High velocity and/or strong turbulence will typically decrease correlation values, but that alone does not exclude the data from being used. In our experiments, the amplitude profiles showed similar behaviour above 17 cm, but changing drastically at 16 cm (the lowest cell in the profile).

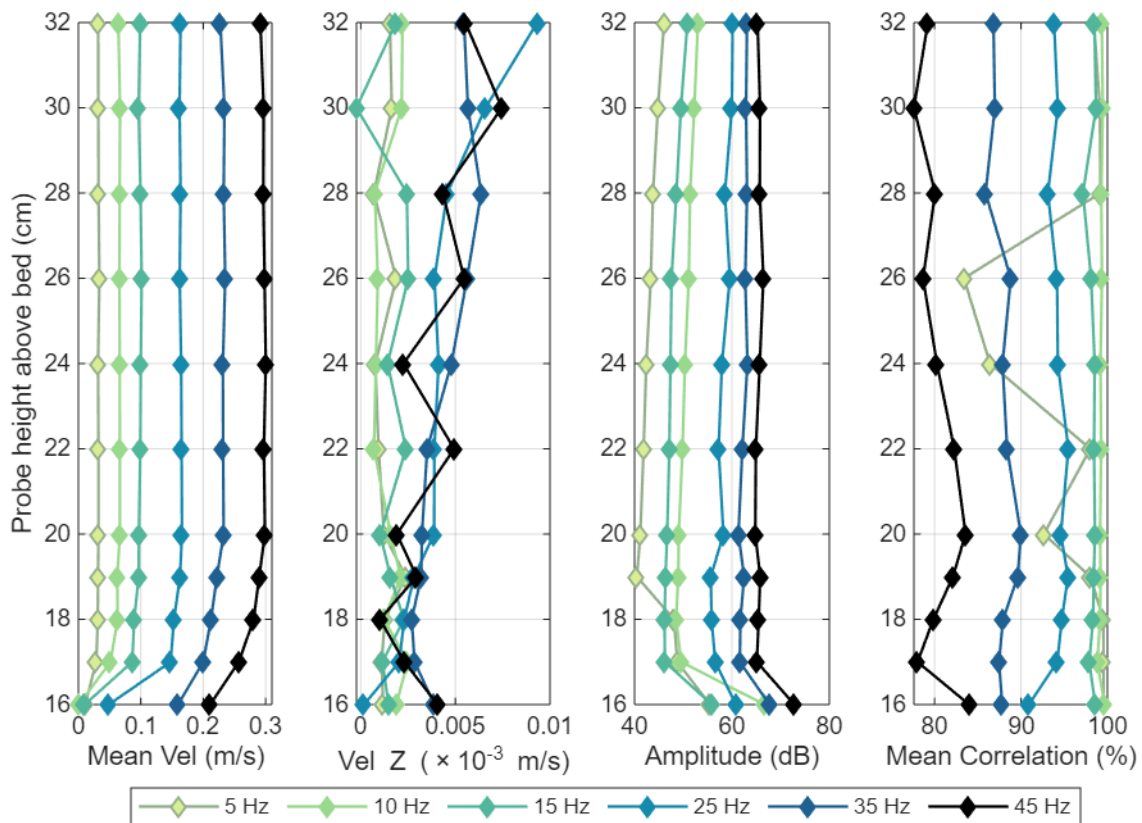


Figure 9: Mean velocities, vertical velocity, amplitude and mean correlation plots during the Vector experiments according to different pump frequencies (pump values in Hz as per calibration shown in Figure 8). Distance is referred to as cm from the transmitter to bed

We also recommend testing the velocity standard deviation (second-order statistics), number of outliers, and Reynolds stress (third-order statistics) to help identify how close the instrument can get to the bed (Figure 11). As expected, in general, there is an increase in standard deviation and Reynold stress with the flow velocity due to the bed influence. In our experiments, the standard deviation increases between 17 and 18 cmab, while Reynold stress decreases. The number of outliers (detected using Goring & Nikora, 2002) increases considerably at 16 cmab, which could be indicative of bad data.

Another way of investigating how close to the bed the Gen 2 Vector can make measurements is by inverting the graph and showing how the measured vector velocity varies with the pump frequency for different heights (Figure 10). The 16 cm scenario exhibits mean velocities that are 3–5 times lower than those of the other scenarios.

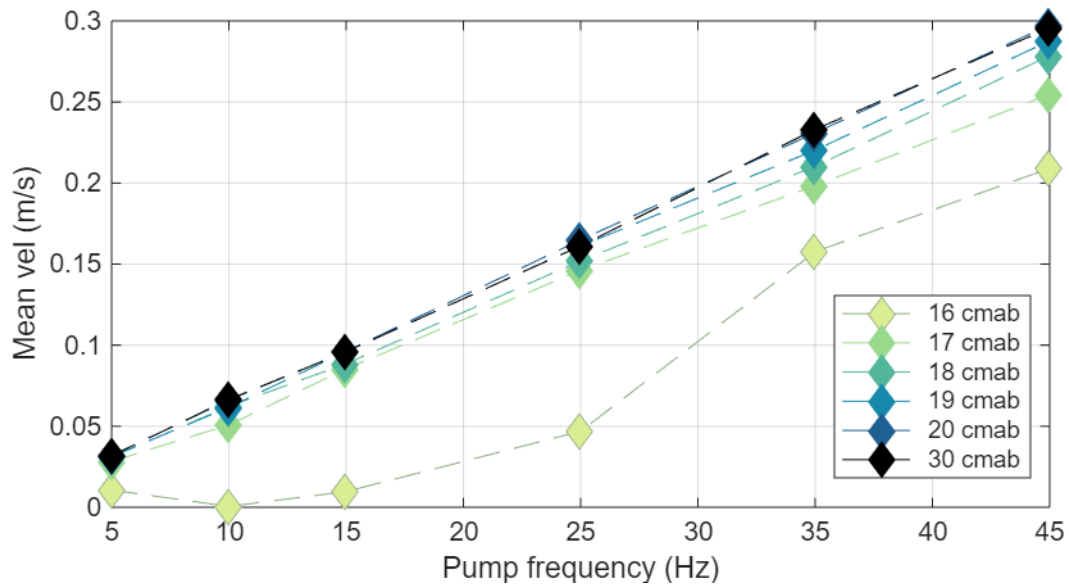


Figure 10: Correlation between pump frequency and measured Vector velocity for different distances from probe to bed showing how the 16 cmab case differs from the others.

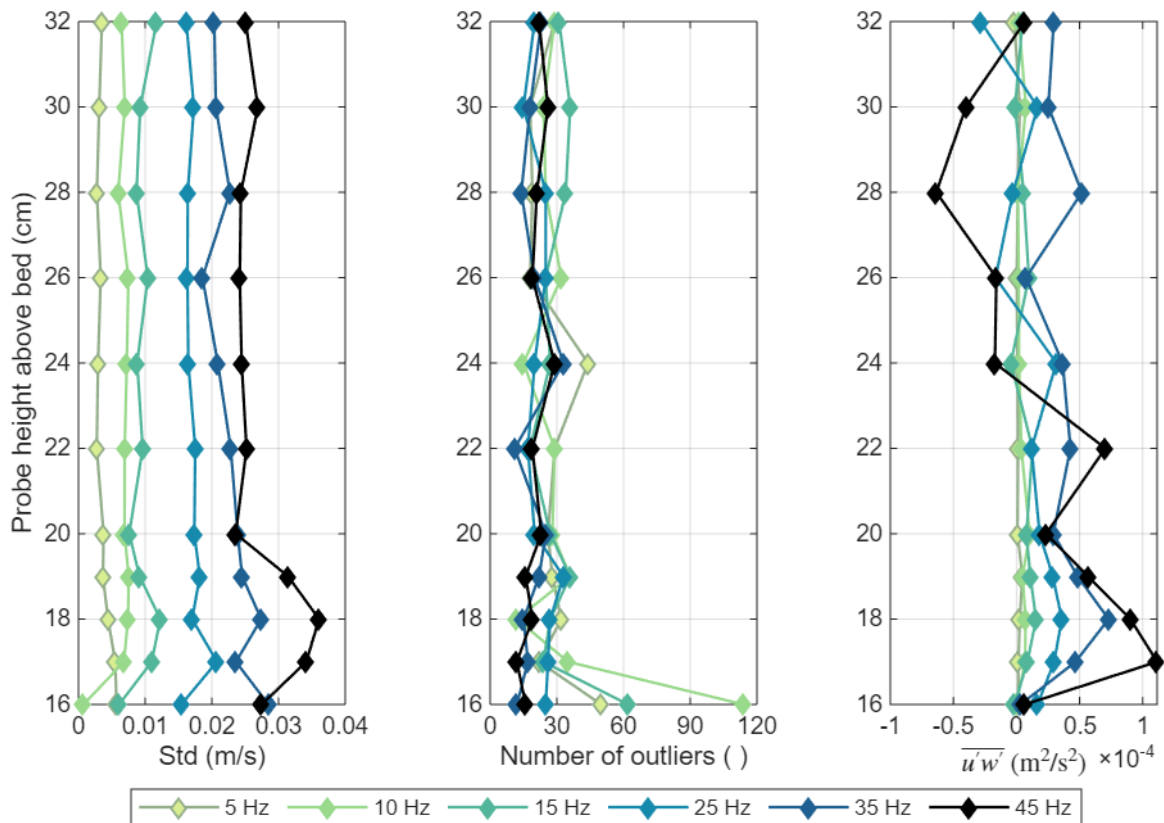


Figure 11: Velocity standard deviation, number of outliers and Reynolds stress plots during the Vector experiments according to different pump frequencies (pump values in Hz as per calibration shown in Figure 8). Distance is referred to as cm from the transmitter to bed

## Spectral data collection

To further investigate the minimum distance to boundaries, we measured the Gen 2 Vector velocity spectra at different elevations, ranging from 16 to 32 cmab (measured between bed and transmitter). We set the pump at 25 Hz ( $\approx 0.16$  m/s) and configured the Gen 2 Vector to collect data at 64 Hz and velocity range at 0.3 m/s. From Figure 12 and the previous section, we can conclude the following:

- In Figure 12, the blue line represents the results at 16 cmab, showing a high noise level and much lower energy values, confirming that the data at this height and lower present very low SNR values and should be avoided.
- The 17 cmab spectrum (red line) aligns well with the 18, 22 and 32 cmab cases in the low frequency range (0.1~2 Hz). The energy at this range is lower than the other lines, as expected. That confirms Vector Gen 2 can be used for first- and second-order statistics for heights above 16 cmab.
- Between 2 and 10 Hz, there is an increase in the influence of noise for the 17 cmab line, whereas the other lines follow the  $-5/3$  reference slope, which indicates the expected inertial-subrange scaling. Interpretation assumes Taylor's frozen turbulence hypothesis, which is considered reasonable here because the experiment was conducted under steady unidirectional flow with no wave forcing. We can assume that the Gen 2 Vector can be used for third-order statistics for heights above 17 cmab. If the instrument is placed at 17 cmab, attention should be paid to filtering techniques and data validation.
- From 10 Hz onwards the signal for all lines increasingly deviate from the reference slope, which is indicative of instrumental noise for this experiment in particular. Depending on the experiment setup, the noise frequency can be higher than 10 Hz. This can be achieved by setting the velocity range as close as possible to the actual current value.

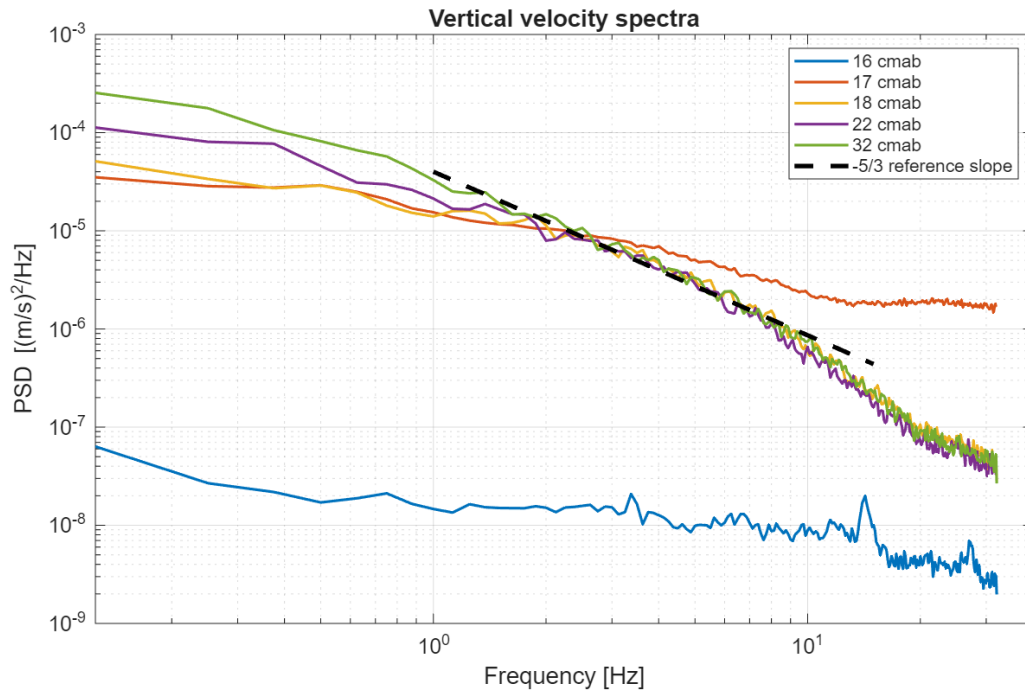


Figure 12: Vertical velocity spectra from Gen 2 Vector at 64 Hz at different heights with the  $-5/3$  reference slope.

### Horizontal setup

In case measurements are needed close to the upper boundary, the Gen 2 Vector can also be positioned in the horizontal facing the flow upstream (Figure 13).

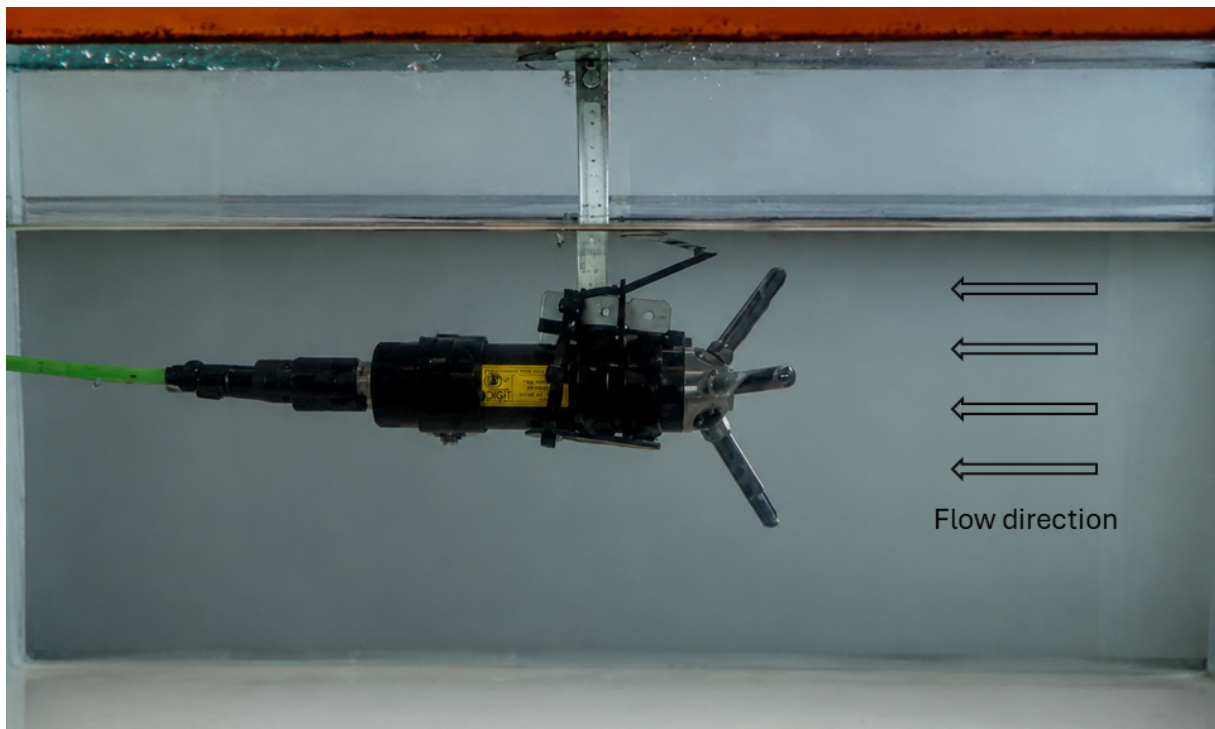


Figure 13: Image of the Gen 2 Vector positioned in the horizontal close to the upper boundary (water/air interface).

We positioned the Gen 2 Vector at three heights: top of the water column (middle of the central beam at 13 cm below the water/air interface), middle (20 cm below water/air interface), and bottom (middle of the central beam at 13 cm above the bed/water interface). Results (Figure 14) show very similar spectra shapes for the three positions, following the  $-5/3$  reference slope up to 32 Hz. The Gen 2 Vector can be safely positioned in the horizontal downstream of the flow.

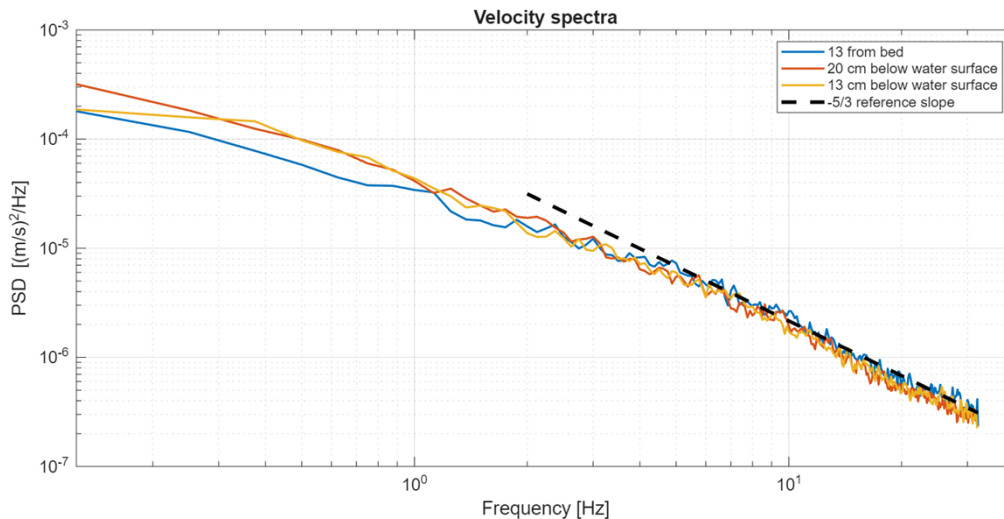


Figure 14: Velocity spectra results of the Gen 2 Vector positioned at the top, middle and bottom of the water column.

### Comparison with the Vectrino

In this section, we compare the Gen 2 Vector data with the Vectrino data under three different velocity scenarios. Because the Vector and Vectrino have different distances between probe and measurement volume, as well as different sampling volume sizes, in this section we represent the height of the instruments as the centre of the measurement volume in cm above bed. These values are different from the previous section, where the distance was measured between the transmitter and the bed (Figure 5). The mean horizontal and vertical velocities are quite similar between the two instruments (Figure 15). Gen 2 Vector vertical velocities were multiplied by  $-1$  to match the Vectrino coordinate convention. The reference system was changed between the two instruments to align with other Nortek instruments. Please refer to Gen 2 Vector release notes for further information. There is a small difference between the Vectrino and Gen 2 Vector velocity values for the lowest measurement point, which is equivalent to the 16 cm measurements in Figure 9 and Figure 10. It is important to note that Mean Amplitude in Figure 15 is different between the two instruments. This is expected as the

amplitude is a value relative to each instrument individually. The correlation, however, can be compared between them.

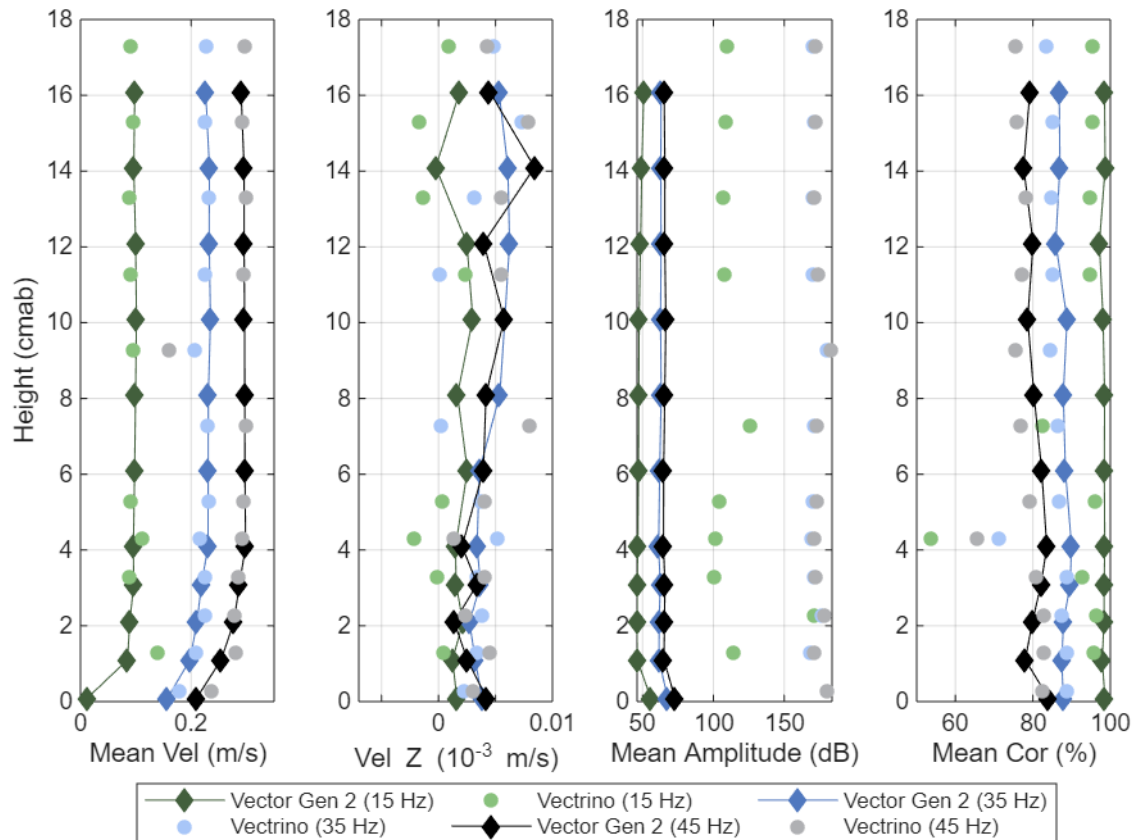


Figure 15: Mean velocity, vertical velocity, mean amplitude and correlation comparison between the Gen 2 Vector and the Vectrino. The frequency here refers to the pump's rotational frequency (proxy for velocity), and not the instrument's sampling frequency.

Similarly to Figure 10, Figure 16 shows the results for standard deviation, number of outliers, and Reynolds stress for the Gen 2 Vector compared to the Vectrino. The results show good agreement, with the expected gradual increase in standard deviation between pump rotation frequencies of 15 and 45 Hz. It also shows a higher number of outliers for the measurement point closer to the bed (equivalent to 16 cm between the bed and the Vector transmitter). For some heights above the bed, the Vectrino shows a higher standard deviation compared to neighboring heights.

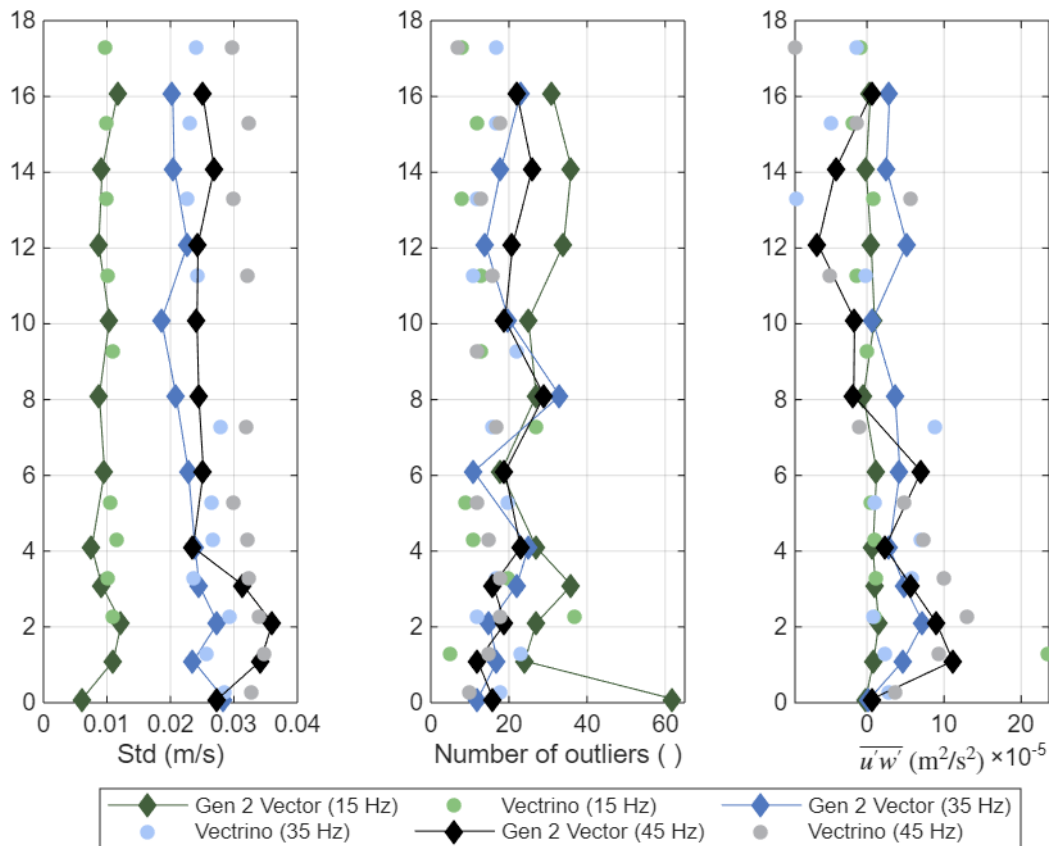


Figure 16: Velocity standard deviation, number of outliers and Reynolds stress comparison between the Gen 2 Vector and Vectrino.

In order to compare the Gen 2 Vector and Vectrino in the frequency space, we set the Vectrino plus software to sample at 200 Hz, the maximum frequency possible. Figure 17 shows how the data is aligned between the two instruments up to  $\approx 8$  Hz, when the Vectrino noise becomes too high. It is important to stress that the Gen 2 Vector demonstrates good SNR up to 10 Hz, whereas the Vectrino is noisier. However, this is also specific for these experiments.

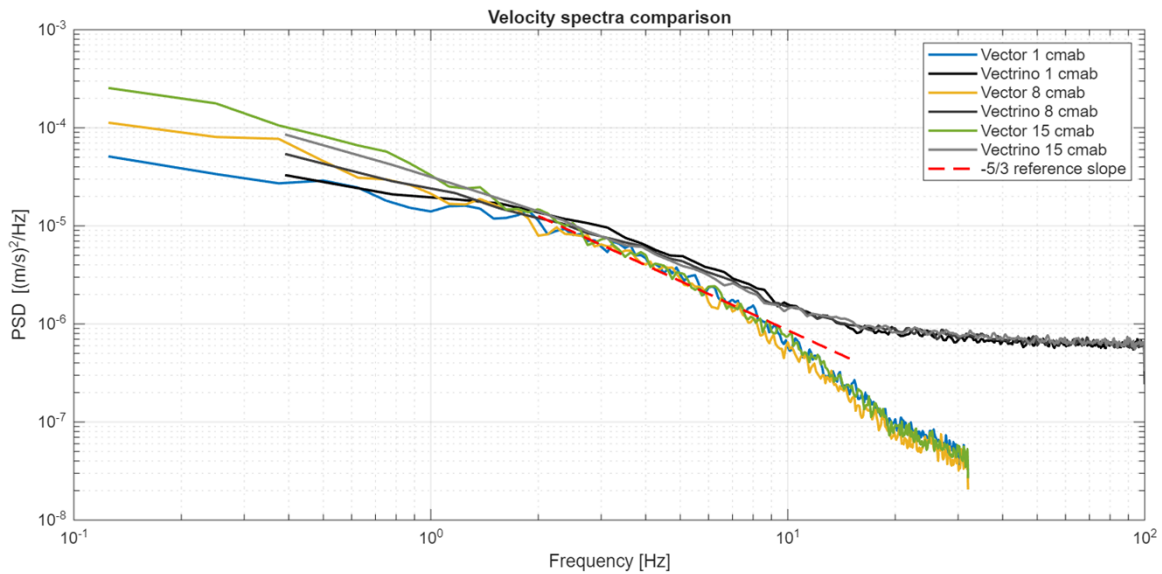


Figure 17: Gen 2 Vector and Vectrino spectra comparison.

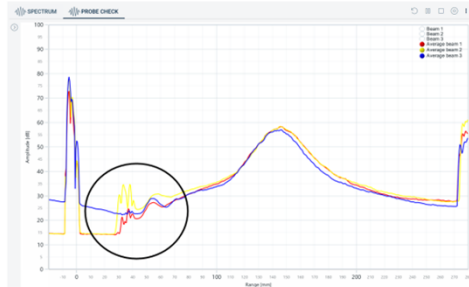
### Influence of Bed type in the signal

For this set of experiments, we kept the Gen 2 Vector at virtually the same height (30 cm from probe to bed) while changing the bed type. Minor variations in the distance from the bed occurred due to surface irregularities between the bed types. We used the following bed types, based on what most laboratories use:

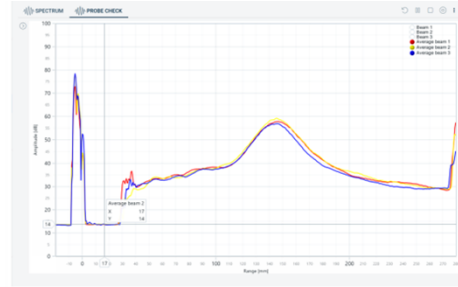
- Glass
- Plastic
- Wood
- Glass beads
- Fine sand
- Coarse sand
- Rocks
- Flexible canopy

The Probe Check results for the different bed materials are shown in Figure 18. In general, the three beams displayed well-defined Gaussian-shaped curves centred at the sampling volume. We observed small variations in Beam 3 (blue line in Figure 18) compared to Beams 1 and 2 for rocks, coarse and fine sand. Small variations are acceptable, as this is probably a result of uneven surfaces. Black circles in Figure 18 represent secondary reflections from uneven surfaces or reflective surfaces (glass, glass beads, rocks and canopy). These reflections are

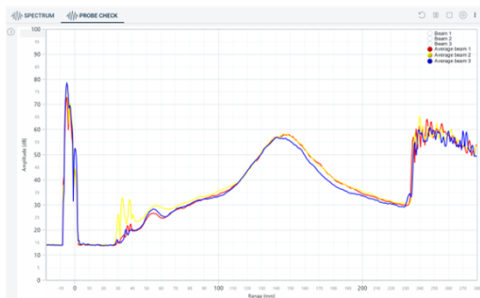
located outside of the measurement volume, so that they cause no interference with the current measurement. It requires no corrective action by the user.



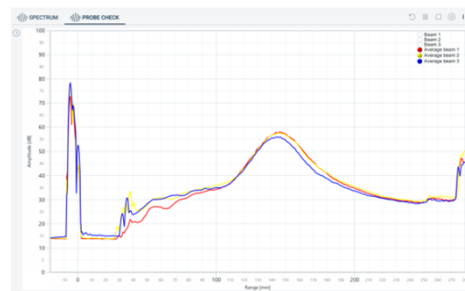
(a) Glass



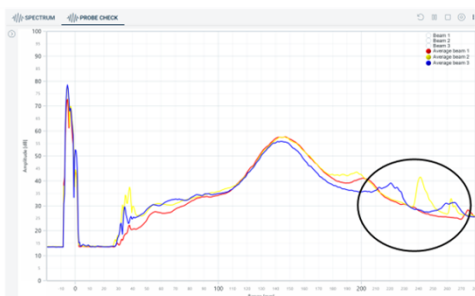
(b) Plastic



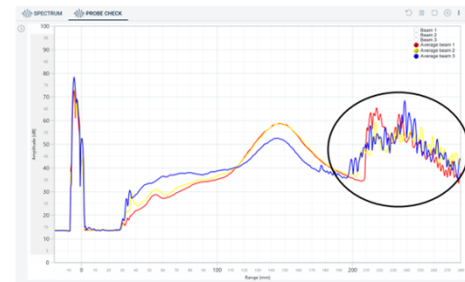
(c) Glass Beads



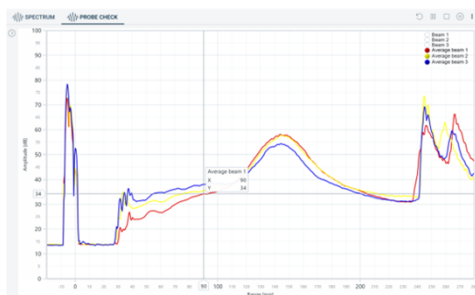
(d) Wood



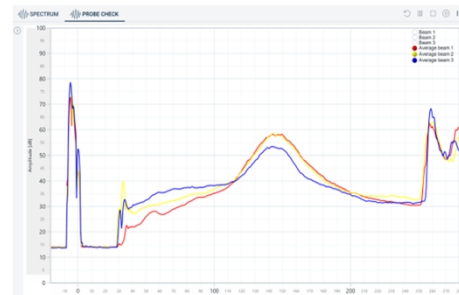
(e) Canopy



(d) Rocks



(d) Coarse Sand



(d) Fine sand

Figure 18: Print screen of Nortek Deployment software showing the Probe Check applying different types of bed. X-axis represent Range (mm) and Y-axis represent Amplitude (dB).

Flexible canopies are widely used to mimic vegetation research in flumes (Schaefer & Nepf, 2022; Tang et al., 2019; van Rooijen et al., 2022), but changes in canopy posture and movement over time can influence the acoustic signal (see Figure 18e). That might appear in the acoustic signal as spikes, irregular signal or very low correlation. Rocks, although not flexible, create a highly variable, rough surface where the signal bounces off (Figure 18f). However, as long as the signal in the Probe Check is high and follows a bell curve, the data can be collected normally. Finally, coarse and fine sand showed quite similar Probe Checks and can both be used as bed types (Figure 18g, h).

## Echosounder

The Echosounder function can also be used to verify the transmitter distance to bed. The  $\approx 1.8$  cm difference between the Probe Check and the measurement ruler are absent with the Echosounder. The Echosounder has a 2 mm bin size resolution, which enables the user to go further into studies like scouring, sediment concentration, zooplankton studies and more.

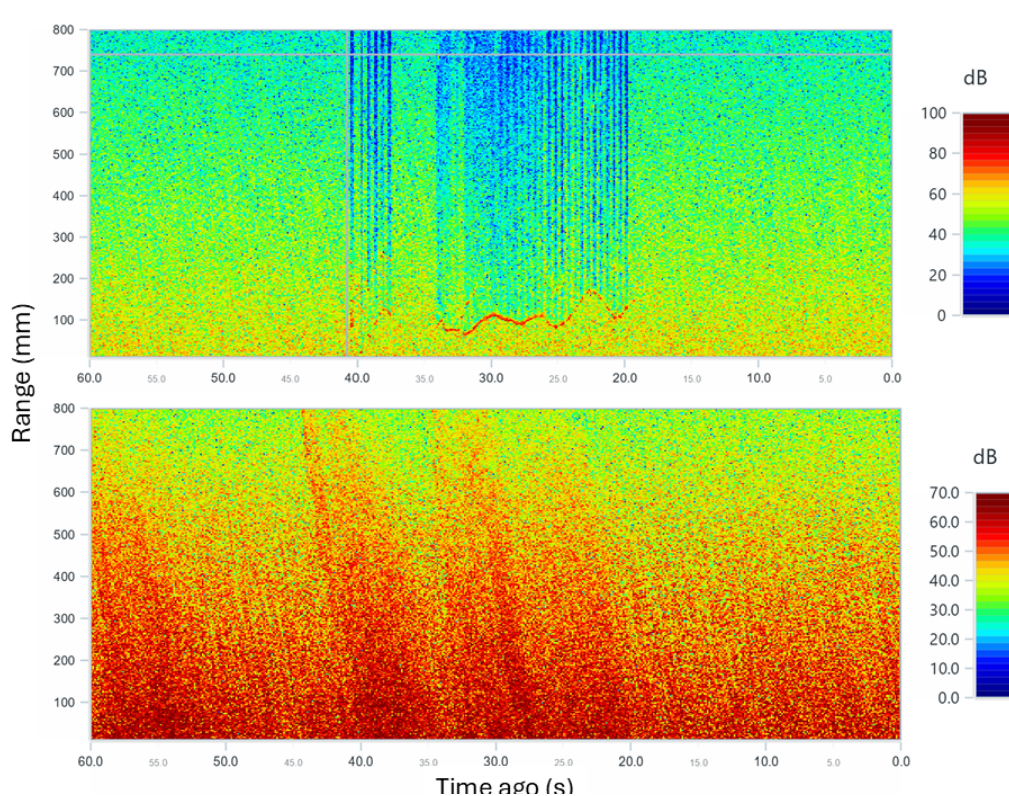


Figure 19: Print screen of Nortek Deployment software showing the Echosounder data when a ruler is held in front of the sensor (top panel) and sediment being resuspended (bottom panel). X-axis is Time ago (s) and Y-axis is Range (distance from Echosounder) in mm. Note that while the Vector was pointed down towards the bed, the plot's Y-axis increases upward in this figure.

Figure 19 shows a screenshot of the Echosounder function in Nortek Deployment emphasizing the high-resolution data. Data is shown in real time as distance from probe, so that the x-axis is Time ago (s) and y-axis is reverted from vertical. The ruler moving in front of the sensor is only 1 mm wide, and the signal is quite clear, including shadowing behind it. The bottom panel in Figure 19 shows how sediment studies can be conducted and related to different setup velocities. We placed the Gen 2 Vector above the same test surfaces as in Figure 18, so that the distance to bed was again  $\approx 30$  cm with small variations.

The glass bed offers a very solid signal for the Echosounder with a clear water/interface boundary. The glass beads, however, show a higher variability. Rocks offer a high interface signal, however, as the surface varies a lot, the high amplitude region is broader. The flexible canopy interface is shown as a high signal variability outside of the measurement zone, so that it does not interfere with the signal. Another way of looking at the dataset is through the signal profile (Figure 20). One important conclusion is that the signal profile before reaching the bed interface has a constant behaviour across different bed types. What changes is the steepness of the curve when the signal reaches the bed interface. Look for instance at the rock interface in Figure 20 (yellow line), where the signal reaches the peak in a more gradual way than the coarse sand (blue line). The glass (black line) and glass beads (red line) show steep slopes, however, the signal does not fade over distance like the sand signal, which might represent how the signal bounces back from the surface.

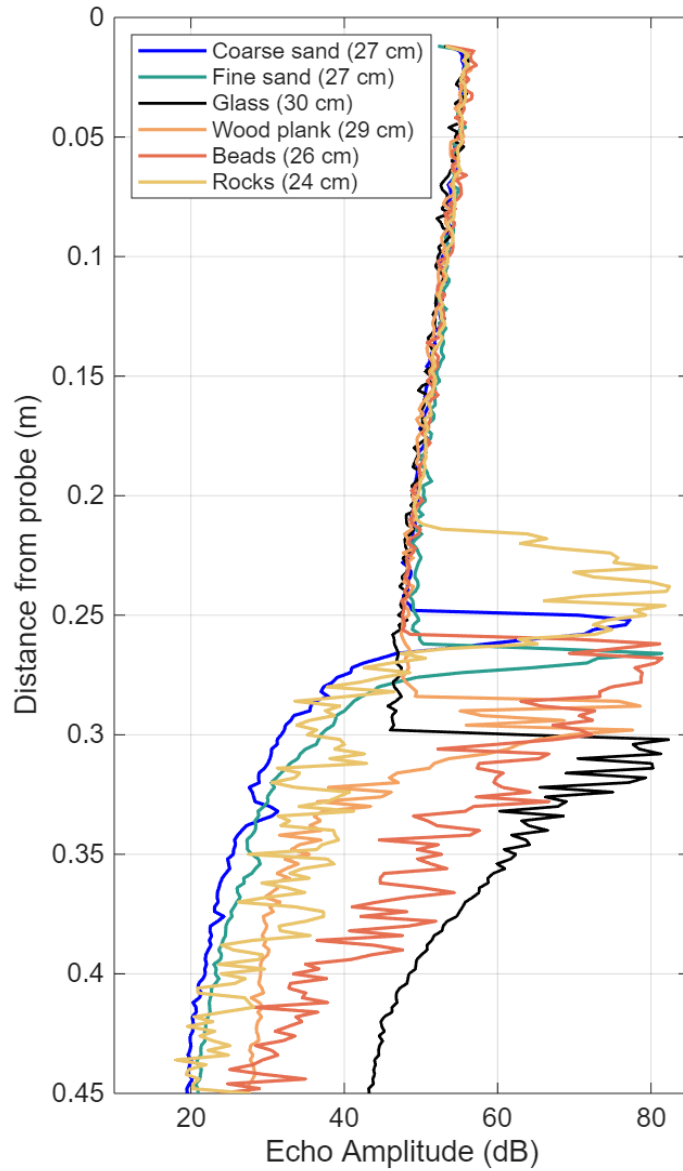


Figure 20: Probe Check applying different types of bed. Top left panel x-axis is dB at selected Time ago, y-axis is Distance (mm); top right panel x-axis is Time ago (s) and y-axis is Range (mm); bottom panel x-axis is Time ago (s) and y-axis is dB at selected Distance shown on the panel above.

## 4 Research recommendations

From previous experiences, the legacy Vector, Vectrino and Vectrino Profiler have successfully proven to work in various types of laboratory research, such as wave-turbulence decomposition, Suspended Sediment Concentration (SSC) data with fieldwork collection and lab calibration, mean current data, biological activity, ice melting rate and so on. Given the results presented in this document, we expect the Gen 2 Vector to perform better than the legacy Vector in laboratory research due to its improved technology. It can be used in certain types of tanks as long as the following guidelines are followed.

- Before purchasing the Gen 2 Vector, make sure you talk to your sales representative about your flume dimensions and type of research. We recommend that the flume be more than 21 cm deep and wider than 26 cm. That represents a conservative estimate of fully submerged pressure and temperature sensors, which are located above the acoustic sensors. Beware of ripples that can influence the fluid velocity.
- Set up the Gen 2 Vector as shown in our [FAQ](#). Due to their high precision, velocimeters in general are very sensitive to any vibration or external movement. To get the best results, secure the Gen 2 Vector rigidly to a stationary frame to eliminate any movement of the instrument.
- Adjust the Gen 2 Vector height using the Probe Check while measuring the distance between sensor and bed with a ruler. There might be some discrepancy, but the Probe Check is a good way for checking the signal over distance. To understand more about how to start and interpret the Probe Check, please refer to our FAQ "[How can I use the Probe Check](#)". This FAQ also explains how to use the Probe Check to problem solve your deployment.
- If available, use the Echosounder to estimate the distance to object more accurately.
- Use enough seeding material such as kaolin or glass beads. We recommend starting the tank with clear water and adding the particles following the results so that there are enough scatterers suspended in the flow. F3 (from Figure 6) should have a Gaussian curve shape and similar height to the bed signal. Figure 21 shows an example of a poorly seeded tank with Probe Check collecting live data. Please note this plot changes depending on the sampling rate. To verify the amplitude signal we recommend turning on the Averaging mode, which can be achieved by clicking on the three vertical dots on the upper right corner of the plot.

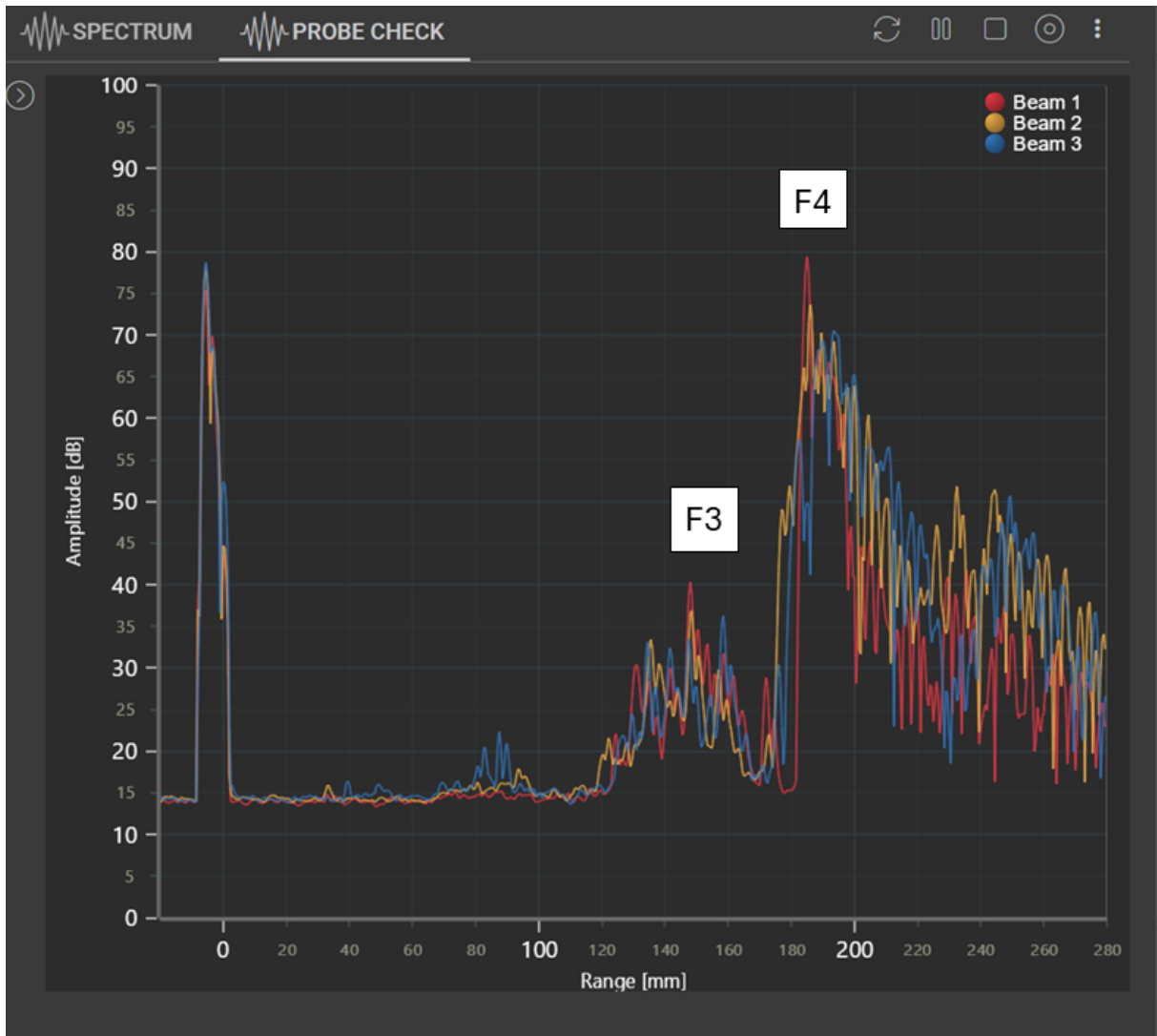


Figure 21: Example of a poorly seeded wave flume.

The user needs to set up the velocity range, which is generally easier to estimate in laboratory conditions. A starting range can be estimated based on observation from the flow conditions. For laminar flows, the range can be small but will need to be increased with turbulent flows due to the variation in velocity. If the nominal velocity range is too large for the flow conditions, the signal to noise ratio (SNR) will be low and result in poor quality or noisy data. If the nominal velocity range is too small for the flow conditions, all the velocities will not be captured.

- From our experiments, it can be concluded that the Gen 2 Vector needs to be positioned at least 17 cm from boundaries to get third-order statistics including higher frequencies. For mean and flow fluctuations, the Gen 2 Vector should be positioned

over 16 cmab. Look for which frequency the energy flattens out, which will indicate noise.

- At 16 cmab and lower, the noise dominates the data collection. Beam spreading, side-lobe contamination, and acoustic interference from bed collectively contribute to increasing the practical minimum operating distance beyond the peak signal location.
- The Gen 2 Vector can also be used in the horizontal without compromising the data quality. Be mindful of the signal reflections from the surfaces (water/air, water/bed and water/walls). We recommend at least 13 cm from the boundary measured from the middle of the central beam.
- Mind the weak spots. These are related to the spatial separation between the pulse pairs transmitted by the velocimeter. To be more precise, a weak spot occurs when the first ping hits the bottom and reflects, and this reflected signal reaches the sampling volume at the same time as the second pulse. The position is thus deterministic and can be calculated. For more information, refer to our [FAQ](#).

## 5 Frequently asked questions

Here are some questions we have been asked before.

### 1. Can the Gen 2 Vector be used as a replacement of the Vectrino in the laboratory?

Not as a direct replacement given their different characteristics. However, considering the minimum distance of 17–20 cm between the centre transducer and the closest boundary, the measurement volume and the type of research, the electronics in Gen 2 Vector offer improved per-ping precision and improved noise immunity. That enables the Vector to be used for several applications in the laboratory.

### 2. How does the Gen 2 Vector amplitude compare to the Legacy Vector?

The Gen 2 Vector measures the amplitude with different units to the Legacy Vector so they will not be directly comparable. Following testing, we see the Gen 2 Vector has more stable measurements leading to lower standard deviations.

### 3. How can you setup the Gen 2 Vector to measure in the laboratory?

Default configuration can be used for most applications, always minding the velocity range when using Nortek Deployment.

### 4. Is there a weak spot for the Gen 2 Vector also?

Yes, please refer to our [FAQ](#). Weak spot distances for the Gen 2 Vector are the same as for the Legacy Vector.

### 5. Is there an SNR value in the new Vector?

No. The SNR from the Legacy Vector is not required for the Gen 2 Vector because it already produces amplitude data in units of dB. The amplitude is a better metric, because in the Legacy Vector, the noise level (required for SNR calculation) was taken as the nominal noise floor of the instrument, rather than the real noise (like the Gen 2 Vector does).

## 6 References

- Bricker, J. D., & Monismith, S. G. (2007). Spectral wave-turbulence decomposition. *Journal of Atmospheric and Oceanic Technology*, 24(8), 1479–1487.  
<https://doi.org/10.1175/JTECH2066.1>
- Cant, S., & Pope, S. B. (2000). *Turbulent flows* (Cambridge University Press, Ed.; 4th ed., Vol. 125).
- Chanson, H., & Leng, X. (2024). Acoustic Doppler Velocimetry in Transient Free-Surface Flows: Field and Laboratory Experience with Bores and Surges. *Journal of Hydraulic Engineering*, 150(5). <https://doi.org/10.1061/jhend8.hyeng-14018>
- Chanson, H., Reungoat, D., Simon, B., & Lubin, P. (2011). High-frequency turbulence and suspended sediment concentration measurements in the Garonne River tidal bore. *Estuarine, Coastal and Shelf Science*, 95(2–3), 298–306.  
<https://doi.org/10.1016/j.ecss.2011.09.012>
- Chanson, H., Trevethan, M., & Aoki, S. ichi. (2008). Acoustic Doppler velocimetry (ADV) in small estuary: Field experience and signal post-processing. *Flow Measurement and Instrumentation*, 19(5), 307–313. <https://doi.org/10.1016/j.flowmeasinst.2008.03.003>
- Contti Neto, N., Pomeroy, A., Lowe, R. J., & Ghisalberti, M. (2022). Seagrass Meadows Reduce Wind-Wave Driven Sediment Resuspension in a Sheltered Environment. *Frontiers in Marine Science*, 8(January), 1–16.  
<https://doi.org/10.3389/fmars.2021.733542>
- Daskiran, C., Cui, F., Boudafel, M. C., Zhao, L., Socolofsky, S. A., Ozgokmen, T., Robinson, B., & King, T. (2020). Hydrodynamics and dilution of an oil jet in crossflow: The role of small-scale motions from laboratory experiment and large eddy simulations. *International Journal of Heat and Fluid Flow*, (85).  
<https://doi.org/https://doi.org/10.1016/j.ijheatfluidflow.2020.108634>
- Goring, D. G., & Nikora, V. I. (2002). Despiking Acoustic Doppler Velocimeter Data. *Journal of Hydraulic Engineering*, 128(1), 117–126. [https://doi.org/10.1061/\(ASCE\)0733-9429\(2002\)128:1\(117\)](https://doi.org/10.1061/(ASCE)0733-9429(2002)128:1(117))
- Juarez, R., Kozitza, C., Advisor, F., Tebbe, P., & Yilmaz-Wodzinski, N. (2019). Effective Use of an Acoustic Velocimeter in a Narrow Water Channel. *Proceedings of The National Conference On Undergraduate Research (NCUR)*.
- Koca, K., Noss, C., Anlanger, C., Brand, A., & Lorke, A. (2017). Performance of the Vectrino Profiler at the sediment–water interface. In *Journal of Hydraulic Research* (Vol. 55, Number 4, pp. 573–581). Taylor and Francis Ltd.  
<https://doi.org/10.1080/00221686.2016.1275049>

- Mosquera, R., & Pedocchi, F. (2019). Salinity estimation from Acoustic Doppler Velocimeter measurements. *Continental Shelf Research*, 180, 59–62.  
<https://doi.org/10.1016/j.csr.2019.04.010>
- Nash, J. D., Weiss, K., Wengrove, M. E., Osman, N., Pettit, E. C., Zhao, K., Jackson, R. H., Nahorniak, J., Jensen, K., Tindal, E., Skyllingstad, E. D., Cohen, N., & Sutherland, D. A. (2024). Turbulent Dynamics of Buoyant Melt Plumes Adjacent Near-Vertical Glacier Ice. *Geophysical Research Letters*, 51(9). <https://doi.org/10.1029/2024GL108790>
- Norris, B. K., Mullarney, J. C., Bryan, K. R., & Henderson, S. M. (2017). The effect of pneumatophore density on turbulence: A field study in a *Sonneratia*-dominated mangrove forest, Vietnam. *Continental Shelf Research*, 147, 114–127.  
<https://doi.org/10.1016/j.csr.2017.06.002>
- Pendergast, T., Mulligan, R. P., Davidson, B., Schueller, A., Fall, K., Ethier, D., Pujara, N., Puleo, J. A., & Olsthoorn, J. (2026). Wave-induced horizontal diffusivity from optically sensed dye tracer fields in impermeable beach laboratory experiments. *Coastal Engineering*, 205. <https://doi.org/10.1016/j.coastaleng.2025.104925>
- Salehi, M., & Strom, K. (2011). Using velocimeter signal to noise ratio as a surrogate measure of suspended mud concentration. *Continental Shelf Research*, 31(9), 1020–1032. <https://doi.org/10.1016/j.csr.2011.03.008>
- Salehi, M., & Strom, K. B. (2010). *Relationship between Acoustic Backscatter Strength and Suspended Sediment Concentration using a 6 MHz Nortek Vector Velocimeter*.
- Schaefer, R. B., & Nepf, H. (2022). Flow Structure in an Artificial Seagrass Meadow in Combined Wave-Current Conditions. *Frontiers in Marine Science*, 9(February), 1–12.  
<https://doi.org/10.3389/fmars.2022.836901>
- Tang, C., Lei, J., & Nepf, H. M. (2019). Impact of Vegetation-Generated Turbulence on the Critical, Near-Bed, Wave-Velocity for Sediment Resuspension. *Water Resources Research*, 55(7), 5904–5917. <https://doi.org/10.1029/2018WR024335>
- Thomas, R. E., Schindfessel, L., McLelland, S. J., Creëlle, S., & De Mulder, T. (2017). Bias in mean velocities and noise in variances and covariances measured using a multistatic acoustic profiler: The Nortek Vectrino Profiler. *Measurement Science and Technology*, 28(7). <https://doi.org/10.1088/1361-6501/aa7273>
- Ursic, M., Langendoen, E. J., Wren, D. G., Kuhnle, R. A., & Pellachini, C. (2012). Performance assessment and calibration of a profiling lab-scale acoustic Doppler velocimeter for application over mixed sand-gravel beds. *Proc. of the ASCE/EWRI Hydraulic Measurements and Experimental Methods Conf.* .

van Rooijen, A., Lowe, R., Ghisalberti, M., McCall, R., & Hansen, J. (2022). Modelling wave attenuation through submerged vegetation canopies using a subgrid canopy flow model. *Coastal Engineering*, 176. <https://doi.org/10.1016/j.coastaleng.2022.104153>