Waves Array FAQs (Frequently Asked Questions):

1. Does Teledyne RDI use the PUV technique for directional wave measurements?
2. I have heard that most researchers prefer the PUV method. Is that correct?
3. If you are measuring waves, then the flow can't possibly be homogeneous across all the beams once you get to any reasonable range from the instrument. How do you account for the flow inhomogeneity?
4. Isn't the array technique limited by Nyquist to resolving waves no shorter than twice the size of the array?
5. How do the depth limitations compare between the Waves Array Technique and a PUV gauge?
6. Do you use a pressure sensor for the Waves Array Technique?
7. How do you measure the non-directional wave statistics?
8. Why doesn't Teledyne RDI rearrange the geometry of the transducers to make one of the beams point vertically?
9. Do you incorporate background currents in your dispersion relationship for transferring your measurements to the surface?
10. How do I choose between the frequencies offered?

1. Question: Does Teledyne RDI use the PUV technique for directional wave measurements?
Answer: We generally use the orbital velocity measurements along the beams to create an array of twelve independent measurements. PUV consists of only three measurements only (pressure, and the two components of horizontal velocity), while using an array of more measurements results in a more accurate measurement of wave direction and of the spread in the direction. In addition, only an array can resolve more than one wave train propagating in different directions at similar frequencies. The PUV method is inherently limited by its limited number of measurements to resolving no more than one direction per frequency. Having said that, there are certain unusual situations where the array processing can not be done, particularly if the ADCP is moving around a lot. In these cases we provide a PUV processing technique, but with the explicit recognition that the measurements will not be of the quality we can provide using array processing from a fixed platform.

2. Question: I have heard that most researchers prefer the PUV method. Is that correct?
Answer: It is not that most researchers prefer PUV, it is that prior to the introduction of the RDI Waves Array Technique the researchers had to choose between a simply deployed, single instrument, or going to the time and expense of a surveyed installation of several instruments to create an array. Arrays are unquestionably more accurate, but deploying an array of instruments is far more expensive than deploying one instrument. The introduction of the RDI Waves Array Technique combines the accuracy of an array of measurements with the simplicity of deploying a single instrument. And what most researchers actually prefer is to make the most accurate and highly resolved measurements that they can possibly afford.

3. Question: If you are measuring waves, then the flow can't possibly be homogeneous across all the beams once you get to any reasonable range from the instrument. How do you account for the flow inhomogeneity?
Answer: This can be a bit confusing, because it is true that any ADCP requires the flow to be homogenous across all beams in order to resolve the three dimensional velocities. However, we are not combining the beams into three dimensional velocities for our wave measurements. The array is actually made up of the individual along beam velocities, because it is precisely the fact that each measurement is in a different part of the wave field that allows us to apply array processing to successfully resolve the wave parameters.

4. Question: Isn't the array technique limited by Nyquist to resolving waves no shorter than twice the size of the array?

Answer: This is another one that can be a bit confusing. First of all, the Nyquist limitation on the measurable waves is that no waves can be resolved whose wavelengths are less than twice the shortest spatial separation within the array – not the overall size of the array. The RDI Waves technique creates the array from three to five measurements along each beam, which are generally chosen to be the ones closest to the surface. Since the beams are oriented at 20? off the vertical, the bins chosen farthest from the surface form the inner elements of the array (with the shortest spatial separation). However, even if we did use only the farthest elements from an array deployed 50 m deep, the beams are separated by a maximum of less than 40 m (2*50*tan20). In practice, the actual limitation on measuring the shorter wavelength, higher frequency waves is the depth of the measurement – and the near surface measurements used by the Waves Array Technique makes the PUV gauge far more depth limited.

5.Question: How do the depth limitations compare between the Waves Array Technique and a PUV gauge?

Answer: The Waves Array Technique is far less limited by depth than the PUV. A PUV gauge must, per force, make all measurements in the vicinity of the instrument, while the ADCP Waves Array Technique uses the velocity measurements nearest the surface. Assuming both instruments are deployed at the same depth, the Waves Array Technique is making its measurements farther up in the water column than the PUV gauge, and can therefore see higher frequency waves than can the PUV gauge. In fact, for the same high frequency cutoff, the ADCP used for the Waves Array Technique can be deployed much deeper than the PUV gauge.

6. Question: Do you use a pressure sensor for the Waves Array Technique?

Answer: We measure pressure primarily so that we know the mean water depth. It is very important that we know this value to accurately transform our orbital velocity measurements to the surface. We also use the pressure sensor as our second redundant measurement of the non-directional wave statistics. It is treated as a redundant measurement precisely because it is the most limited of our three measurements due to its depth.

7. Question: How do you measure the non-directional wave statistics?

Answer: We measure the non-directional wave statistics in three ways. We choose as our primary measurement of the non-directional statistics the twelve along-beam velocity measurements that comprise our directional array. This is our primary method because of its robustness – it will work in nearly any wave environment. As a secondary measurement we also measure the range to the surface along all four beams. When this works, and it usually does, it requires no transfer to the surface, and can in principle measure wave frequencies limited only by the sampling rate. We do not choose it as our primary because there are some sea conditions where this measurement will fail because our signal glances off the surface without returning any reflections to the ADCP. The third measurement is from the pressure sensor, which is not chosen because it is measuring the deepest, and is therefore limited to resolving lower frequencies than the other two methods. It is very important to note that we do all three calculations in any event! That is, with the Waves Array Technique you will always have all three calculations on display for you to compare.

8. Question: Why doesn't Teledyne RDI rearrange the geometry of the transducers to make one of the beams point vertically?

Answer: Teledyne RDI experimented with both geometries (three transducers at 120 degrees with a vertical; and four at ninety degrees all off vertical), and found that both worked pretty well. The vertical beam gives the capability to resolve waves of slightly higher frequency, but at the expense of decreasing the number of elements we can use in the array. Recall that we construct our array by translating three to five measurements along each beam, and each of those measurements becomes one of the elements in the array. If we re-orient one beam to the vertical, then it can only give us one independent element in the array. The single greatest advantage of the RDI Waves Array Technique is its ability to highly resolve wave direction, particularly when there is more than one wave propagating at the same frequency. This capability comes directly from the number of elements in our array, and it would not be as good were we to reorient one of the beams to the vertical.

9. Question: Do you incorporate background currents in your dispersion relationship for transferring your measurements to the surface?

Answer: Yes, and we believe that we are the only ones who do so. Proper correction to the dispersion relationship requires incorporating the vertically weighted profile of the background currents. It is one thing to say the measurements exist for you to make the corrections yourself later, it is quite another to incorporate this capability into the package and make it available for application with the click of a button as we have.

10. Question: How do I choose between the frequencies offered?

Answer: Like everything else it is a tradeoff between several competing factors:

ADCP Frequency	Deployment Depth	Minimum Directional Wave Period	Minimum Resolvable Wave Height
1200 kHz	2.5 – 14 m	1.8 s (from 5 m deep)	10 cm
600 kHz	5 – 45 m	3.5 s (from 20 m deep)	20 cm
300 kHz	10-80 m	7.0 s (from 80 m deep)	40 cm