ADCP Beam Clearance Area

1 Introduction

All ADCPs transmit signals into the water and receive the echoes backscattered from this transmission. This transmission is done in a relatively narrow beam width. Normally, the scattering is from life forms and other objects or discontinuities in the water column within this beam width (also referred to as the "main lobe"). All transducers, however, do have sidelobes. This means that a small amount of the transmitted energy falls outside of the main lobe. The transducer is designed to minimize these sidelobes and the effect in open water is that the sidelobes have no appreciable influence on the measurements that an ADCP makes.

Situations do arise, however, where very large backscattering (other than the normal scatterers), can occur in either the main beam or in the sidelobe areas. Examples are structures, cables, other instruments, etc. In these situations, the user has to take care to make sure that these scatterers do not interfere with the normal operation of the ADCP or has to be aware of the consequences if they do interfere.

This application note contains guidelines of how to best mount the transducers in adverse situations and what can be expected if an object is in either the main lobe or the sidelobe of any given transducer beam. It also recommends a "clearance zone". This is an area that we recommend keeping clear of potentially large scatterers.

NOTE. The pictures and tables presented here show a single beam from a standard four beam ADCP or the phased array transducer beams. Special ADCPs may have more or fewer beams. The information and precautions presented here are intended for **all** of the beams on an ADCP.

Table 1: Beam Angles

Beam Angle	NB SC, DR, VM	BB BW, CS, DR	BB VM	WH[1]	Navigator	OS/OO
30 degrees	X		X		X	X
20 degrees		X		X		

Note[1] Sentinel, Monitor, Long Ranger, Rio Grande, and Mariner

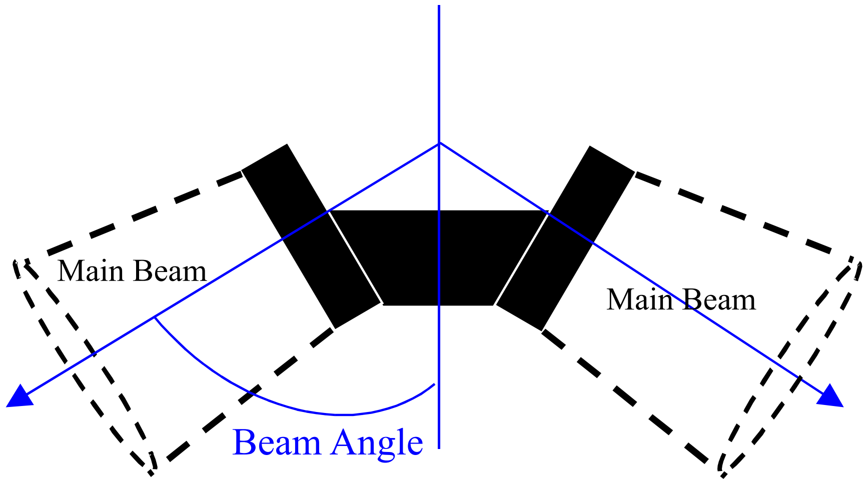

Figure 1. Beam Angle and Pattern with the NB, BB, and WH ADCP Four Individual Beam Transducer

NOTE. Only two beams are shown. The second pair of beams are at right angles to this pair.

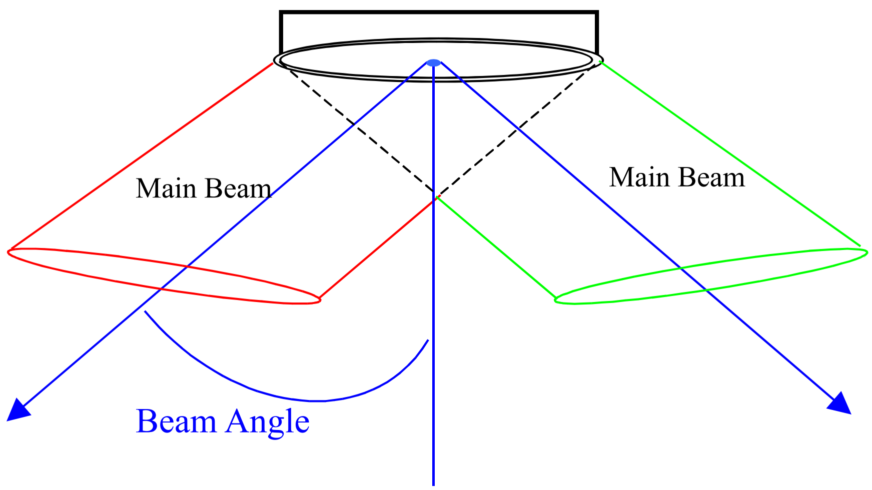

Figure 2. Beam Angle and Pattern with the OS/OO ADCP Phased Array Transducer

NOTE. Only two beams are shown. The second pair of beams are at right angles to this pair.

Table 2: Beam Widths

System Type and Frequency (kHz)	Estimated One-Way Beam Width (degrees)
NB/BB 75,150	4.0
NB/BB 300	2.0
NB/BB 600	1.5
NB/BB/WH 1200	1.5
WH Long Ranger 75	5.9
WH 300	4.0
WH 600	2.0
OS 150, 75, 38	4.0

NOTE. The values shown above are the approximate one-way beam widths to the –3dB points on the beam. In general, these values should be doubled in determining the width of the main beam.

We now will illustrate the recommended clearance zone (the area outside of the main beam to be clear of objects) on each individual beam. The drawings at this point are only showing a single beam. The single beam descriptions are the same no matter if the beam is created by an individual single beam (as in Figure 1, page 2) or if the beam is created by the phased array transducer (as in Figure 2, page 2).

Figure 3 shows the Main Beam and the spreading of the main beam width. Beam spreading is a geometric cause for echo attenuation as a function of range (for more information, see the ADCP Principles of Operation; A Practical Primer). Beam spreading is represented as a logarithmic loss in echo intensity with increasing range, where echo intensity is measured in dB. In linear units, the echo intensity decreases proportional to the range squared. ADCPs are made to minimize the beam spreading.

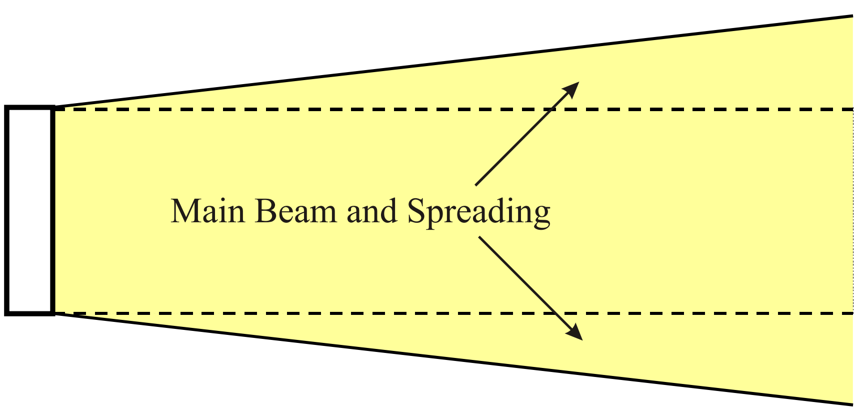

Figure 3. View of Main Beam Spreading

Figure 4 shows the Main Beam and the “Clearance Zone” (area to keep free of objects) around the Main Beam. The edge of the clearance zone is 15 degrees out from the main beam (an additional 11 degrees farther out from the main beam spreading).

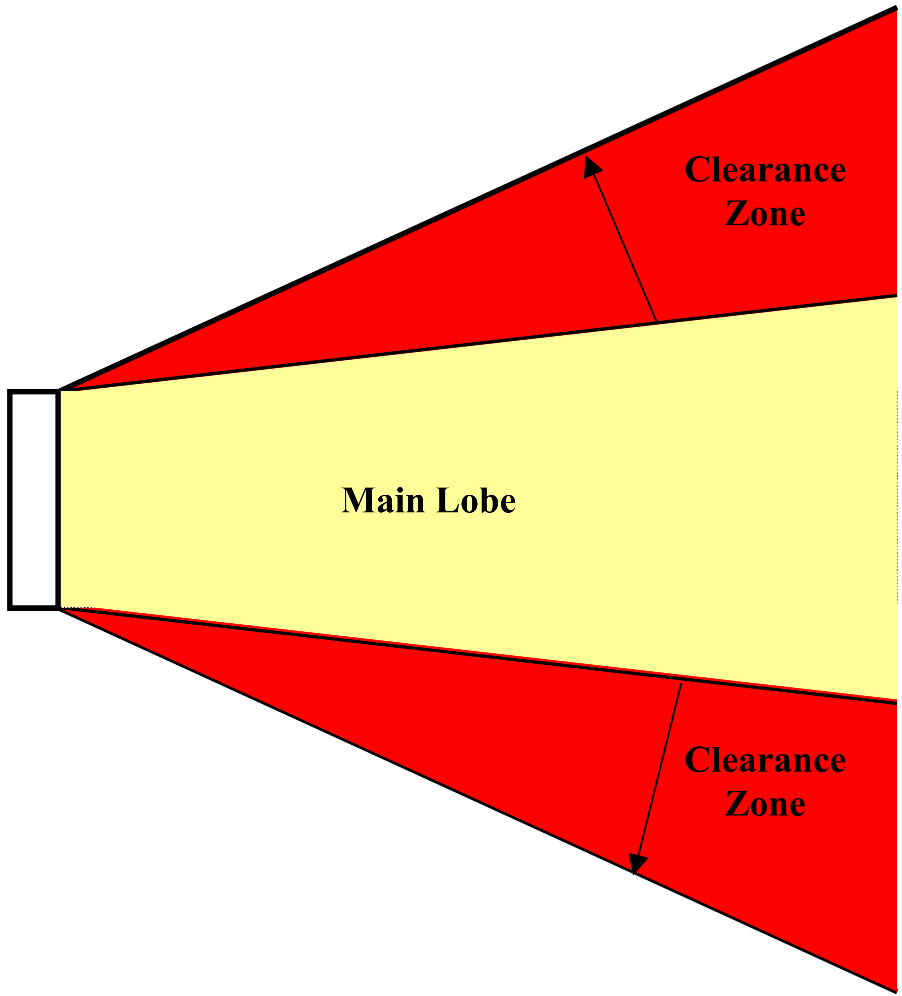

Figure 4. View of Clearance Zone Width

In Figure 3, page 3 and Figure 4 we have represented the beam width and the recommended clearance zone around each beam. In some cases, however, it may not be possible to avoid having objects in the clearance zone.

How much of a problem is an object in the clearance zone? The answer to that question depends on the size of the object and if the object appears inside or outside of the main beam width of the system. The following figures will illustrate what you must avoid and what issues might arise if you have an object inside the clearance zone.

Never allow an object to be inside of the main beam width of the system. Objects inside the main beam width are blocking the main lobe, creating beam distortion, and as a result, the entire water profile may be affected. Any object in this area can bias the ADCP measurement for the bin the object appears in, the bin before the object, and all bins for the entire profile.

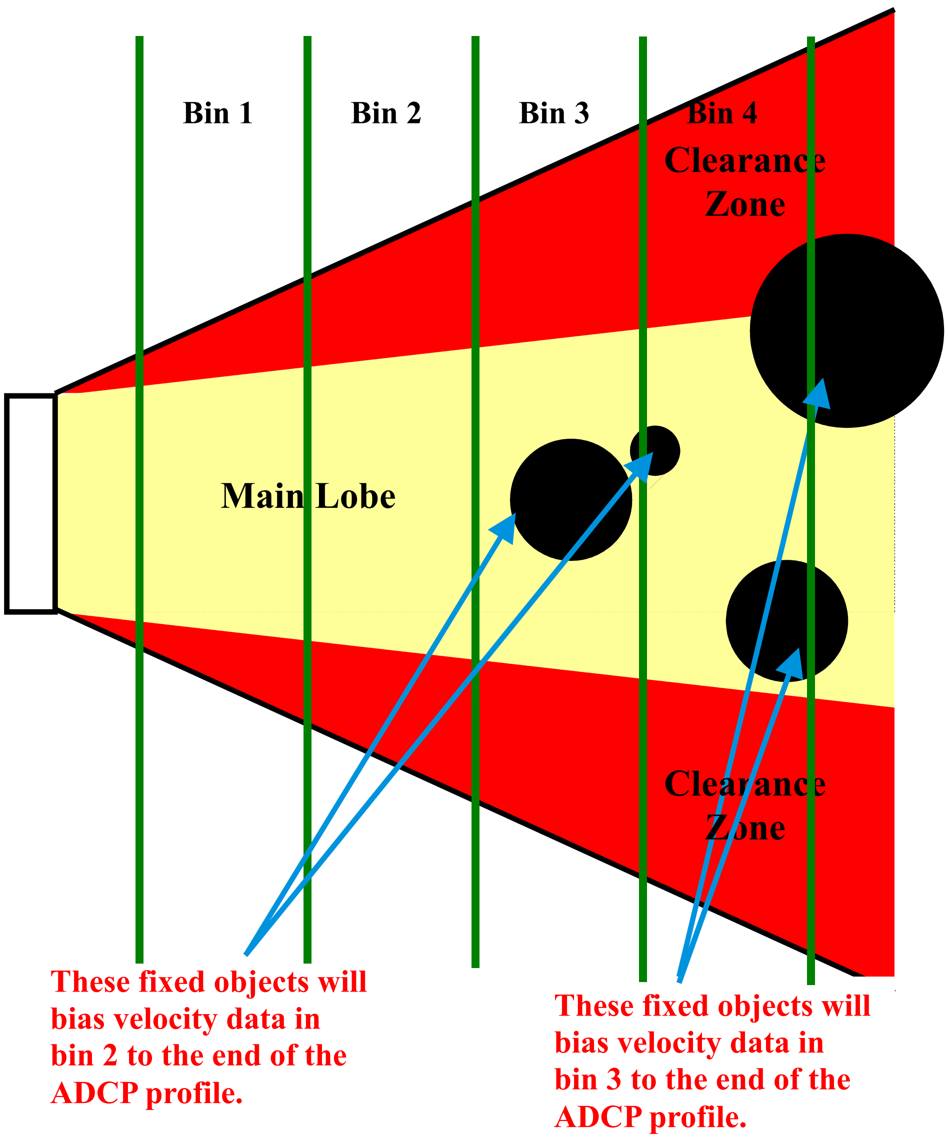

Figure 5. Profile Bias Caused by Objects in the Main Beam

An object inside the clearance zone, but not in the main beam, will bias the velocity estimate in the depth cell that the object corresponds to. Additionally, it can also bias the depth cells on each side of the depth cell shown. The amount of bias will depend on the size of the object and its reflective energy compared to that of the water. The next figures illustrate the expected bias depending on the size of the object.

In Figure 6, page 6 we show a relatively small object located inside the clearance zone of bin three. Here it is expected that bin three will be biased but bins two and four may only be biased slightly. However, it is not possible to determine that and so the recommendation is to flag bins two and four as suspect and not use them.

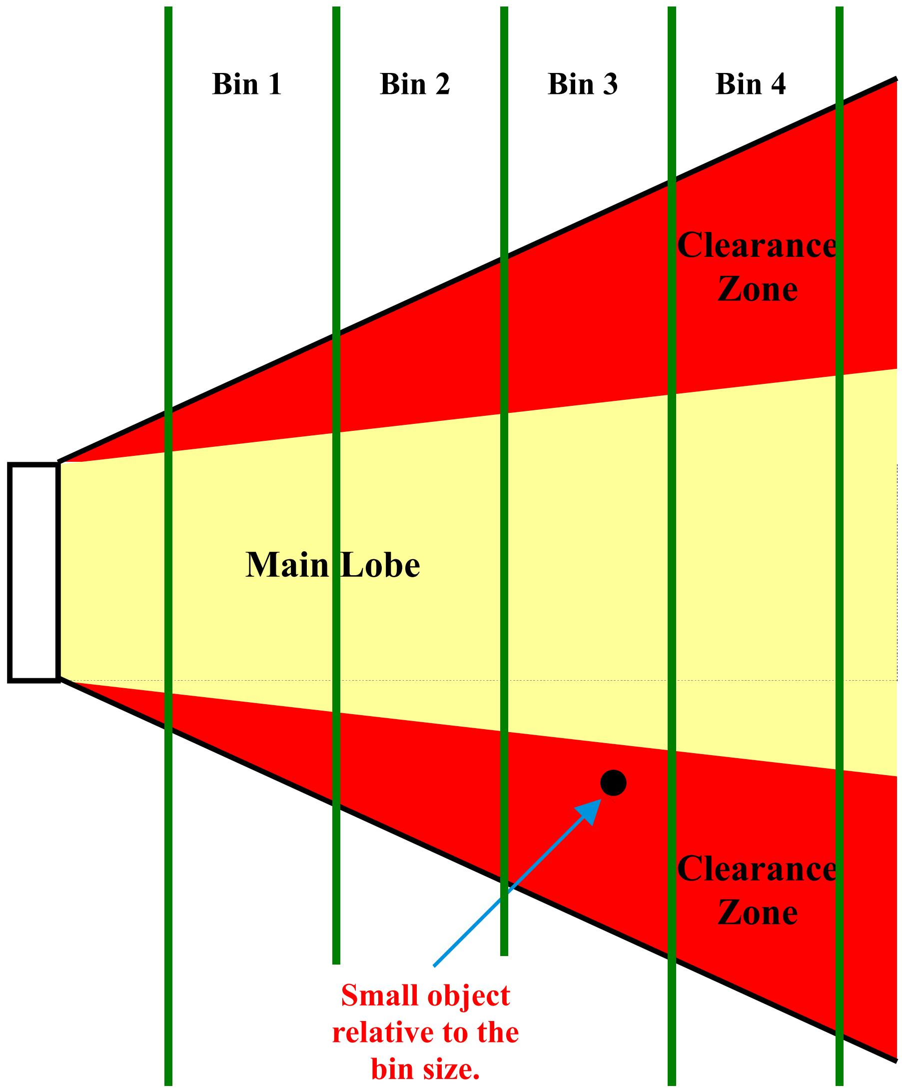

Figure 6. Small Object Biasing a Single Bin and the Adjoining Bins

In Figure 7, page 7 we show a relatively large object located inside the clearance zone of bin two and bin three. Here it is expected that bins one through four will be biased, with bins two and three being more biased than the bins one and four. Once again, it is not possible to determine how biased bins one and four are so the recommendation is to flag bins one and four as suspect and not use them.

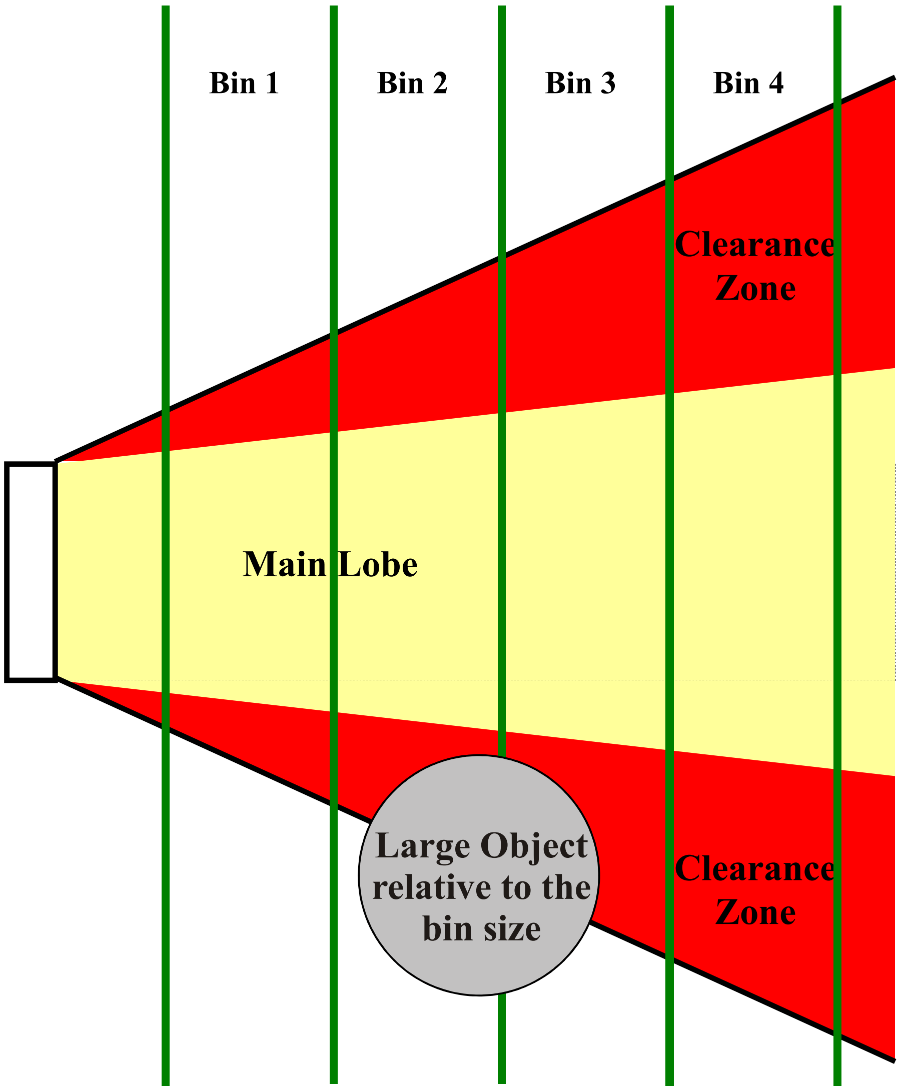

Figure 7. Large Object Biasing Two Bins and the Adjoining Bins

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