

- Q** What is the best elevation resolution possible if the elevation beamwidth at the elevation focus is 0.2 mm using a 6 MHz transducer?
- a) 0.2 mm
 - b) 0.4 mm
 - c) 0.1 mm
 - d) 1.2 mm
 - e) Cannot be determined

A The correct answer to this question is choice A. The elevation resolution is equal to the elevation beamwidth. The best resolution occurs at the focus where the beam is narrowest. (Remember: for resolution smaller values are always better.) Therefore, if the beam is 0.2 mm wide at the elevation focus, the closest structures can reside elevationally and still be resolved at the depth of the focus is 0.2 mm. Note that if the word “elevation” were replaced everywhere in the question with the word “lateral,” the answer would still be choice A (since lateral resolution equals lateral beamwidth).



Exam Lesson #36: Not all information in the question stem is necessarily relevant to solving the problem. Note that in this case, the operating frequency is completely irrelevant to the question. Many people struggle with questions with “extra information” because they try to find some relationship with the unrelated piece of information. Often times, people then claim unfairness since unrelated information was included. This complaint makes no sense since when you are examining a patient, there is no filter that eliminates test results that do not directly relate to the condition of the patient. You are expected to know the material well enough to know what is relevant and what is not.

As mentioned earlier, the technique of parsing (see Chapter 1) can be used to minimize your distress when unrelated information is included in a question. If you parse the problem as you read it, you are less likely to be misled by unrelated information.

- Q** What is the lateral resolution at the lateral focus if the crystal diameter is 2 cm?
- a) 2 cm
 - b) 1 cm
 - c) 4 cm
 - d) 0.5 cm
 - e) 0.8 cm

The correct answer to this question is choice B. This problem requires that you relate two concepts together. First, we know that the lateral resolution equals the lateral beamwidth. We therefore must determine the lateral beamwidth at the lateral focus given the fact that the crystal diameter is 2 cm. Recall from our basic beam drawing, that the beamwidth is approximately half of the crystal diameter at the focus. Therefore, the correct answer is 1 cm, or choice B.

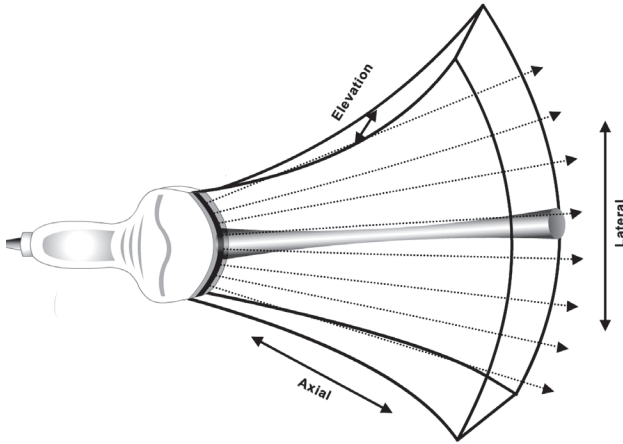


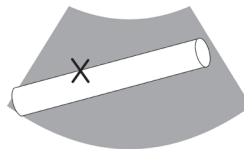
Fig. 36 - Curved Linear Array

- ▶ The basic image shape for a curved linear transducer results from sequencing across the curvature of the transducer face.
- ▶ Besides the large curved linears designed for abdominal scanning, most “endo” transducers such as endorectal and endovaginal are curved linear arrays.

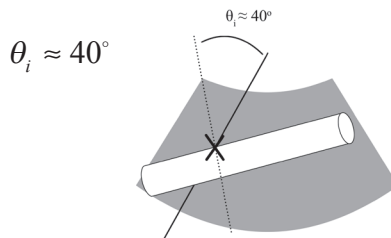
Curved linear images are easily recognizable since the top and bottom of the image are parallel curves that match the curvature of the transducer itself. Like linear arrays in an unsteered format, the basic image shape is created simply by sequencing. As the aperture is sequenced across the transducer face, the curvature of the transducer results in the curvature of the image. In order to create smaller transducers with a large field of view, the curvature is much greater for endo probes than for probes generally used on the abdomen.

Q Estimate the incident angle formed between the beam and the vessel at the location indicated by the X.

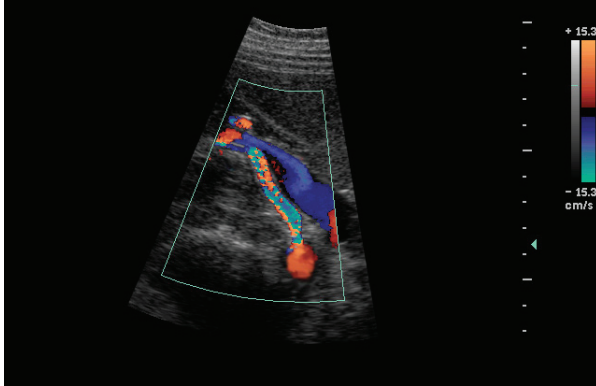
- a) 0 degrees
- b) 20 degrees
- c) 40 degrees
- d) 60 degrees
- e) 70 degrees



A The correct answer to this question is choice C. Recall that the incident angle is measured relative to the line normal to the structure (the line that forms a 90 degree angle). Zero degree incidence implies that the beam direction is perpendicular to the structures.



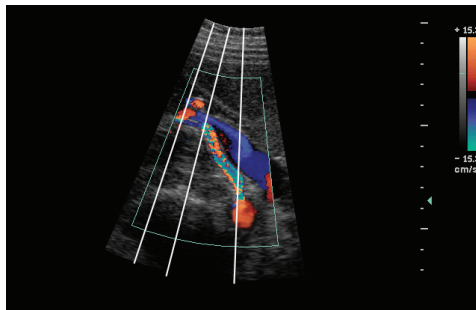
Q Within the color regions of the image, in which direction is the flow?



- a)
- b)
- c)
- d)
- e)

A The correct answer to this question is choice E. This image is of a renal artery stent using a curved linear transducer. Again, using the four steps:

Step 1: specify steer lines:



A The correct answer to this question is choice A. Refraction occurs when there is a change in propagation speed at an interface between two structures, not a change in impedance. Reflection occurs when there is a change in impedance at a boundary.

GRATING LOBES ARTIFACT

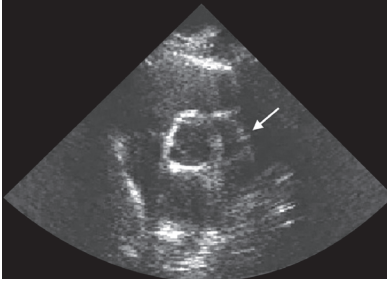


Fig. 71A - Grating Lobe Induced Second Aortic Valve

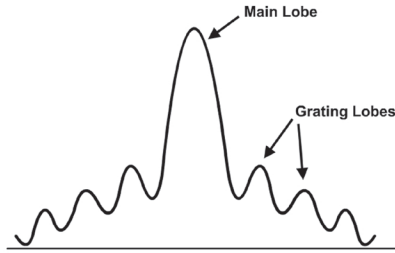


Fig. 71B - Grating Lobes

- ▶ When transmitting a sound beam, energy propagates in all directions, not just along the main axis of the beam.
- ▶ The energy that radiates in directions other than the main beam direction forms weaker beams referred to as grating lobes.
- ▶ When energy reflects back from the grating lobe beams, it is assumed to come from the main beam, resulting in a lateral translation within the image.

Actual beam patterns are extremely complex (especially in the Fresnel zone). The beam profiles drawn to teach about beams and resolution in ultrasound are highly simplified. One known complexity to the beam shape is the existence of lower pressure or weaker beams (relative to the main beam) pointing off-axis. These weaker beams are called side lobes for single element transducers and grating lobes for multi-element transducers.

Grating lobe beams exist, in part, because of partial constructive interference (*see Appendix A: Section 13*). Ideally, we would be able to create beams that add completely constructively in the desired direction, and completely destructively in all other directions. In reality, the waves created from each of the elements are never completely out-of-phase off-axis of the main beam. The result is that energy propagates in undesired directions, returning echoes from undesired locations. Generally the energy in these lobes is much less intense than the main beam and therefore goes unnoticed. However, if these lobes encounter a strong specular reflector, the reflected energy will be added to the reflected energy of the main beam either creating a spurious structure or “clouding” over the image. When a spurious structure is created, it appears laterally displaced from the real structure in the image. Caution must be taken since this artifact can sometimes be misinterpreted as a thrombus or mass.