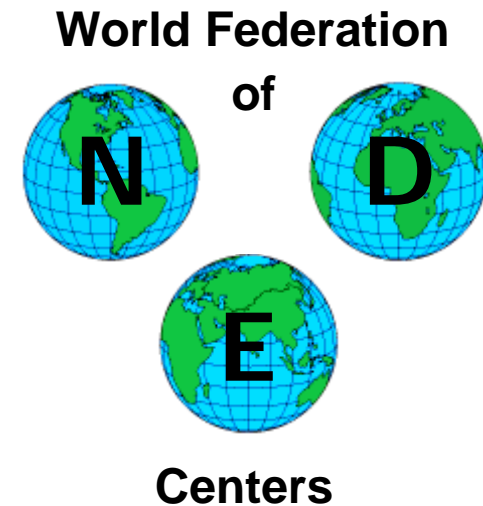


2005 ULTRASONIC BENCHMARKS



Problems for 2005

This year the first ultrasonic benchmark study involves scanning of one of the side-drilled hole blocks we used in the 2004 benchmark studies. This experiment will provide a more rigorous test of the beam models and may also help us to understand some of the differences seen in last year's study for the shear wave responses.

For this year we also have a "crack" sample to study. This is a diffusion-bonded titanium alloy sample with a manufactured thin "pillbox" flaw to represent a crack-like geometry.

Below is outlined the experimental studies performed with these samples.

2005 Benchmark Problems

Side-drilled hole (SDH) Specimen

The sample used is the same as one of the two aluminum SDH blocks used in the 2004 benchmark study. The block used here contains a 4 mm diameter SDH at the 25.4 mm depth shown in Fig.1 (the depth is measured to the center of the hole).

A planar transducer was scanned parallel to the surface at various refracted angles ($\theta = 0, 30, 45, 60,$ and 70 degrees for P-waves, $30, 45, 60, 70$ for S-waves). The peak-to-peak amplitude of the received voltage signal was obtained as a function of transducer location, with the origin of the scan taken at the edge of the block as shown in Fig. 1. At the location where the maximum peak-to-peak value was obtained the A-scan wave form was also recorded. A reference A-scan response (at the same system settings as for the SDH response) was obtained from the front surface of the block at normal incidence in the setup shown in Fig. 2. Note the water path was held fixed at 50.8 mm in all these cases.

These same experiments were repeated with a spherically focused transducer. The reference experiment was done with the focused transducer at the geometrical focal length, as shown in Fig. 3. However, the water path was again 50.8 mm for the measured SDH responses.

SDH Specimen

refracted angles
0, 30, 45, 60, 70 P-wave
30, 45, 60, 70 S-wave

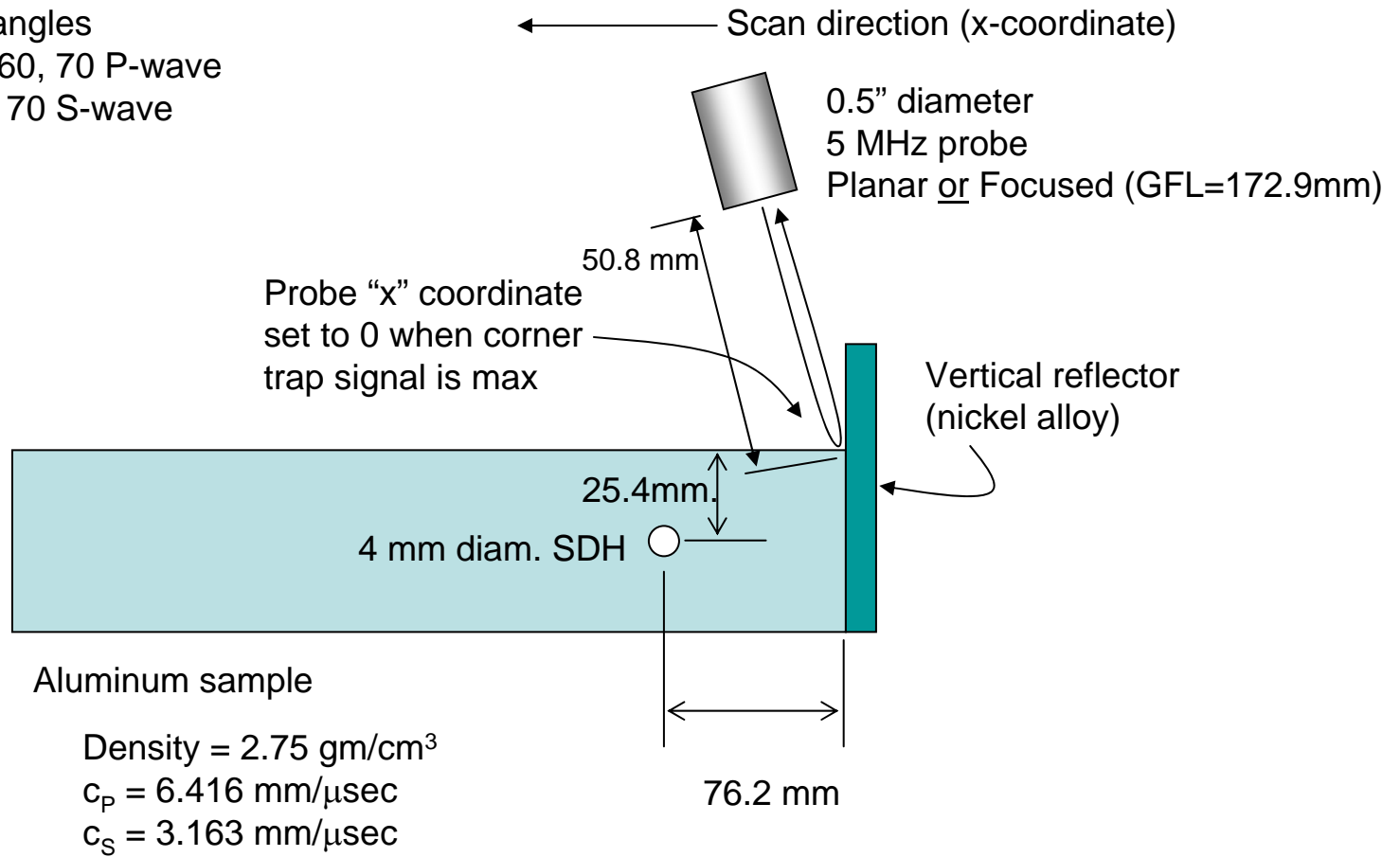


Fig. 1.

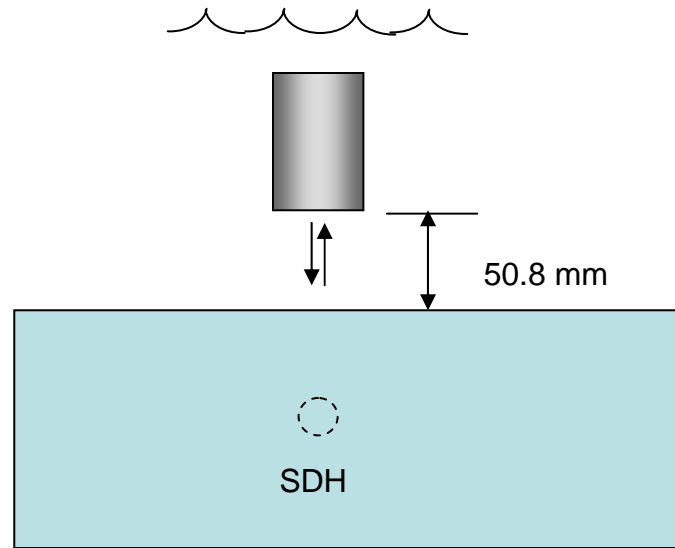


Fig. 2 Reference experiment for a planar transducer and SDH specimen (planar front surface reflection)

For the spherically focused probe, a reference scattering experiment was again performed at the same system settings as the for the SDH cases. However, in this case the transducer was placed at a water path length equal to the geometrical focal length of the transducer, as shown in Fig. 3, and the A-scan response of the front surface measured at normal incidence.

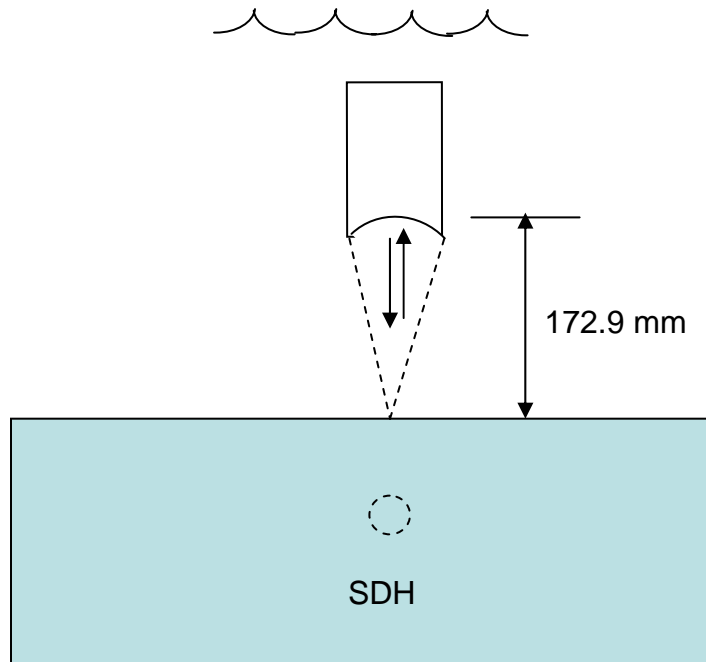


Fig. 3 Reference experiment for spherically focused probe and SDH specimen

Data on the web

All the data for these experiments are available at <ftp://cnde:Bruce@ftp.cnde.iastate.edu> within the pub folder in a sub-folder named 2005_UT_Benchmark. The 2005_UT_Benchmark folder itself contains the sub-folder Benchmark Files and a copy of this document in a READ_ME PDF file.

The data for the side-drilled hole responses is contained in two folders within the folder Benchmark Files:

Folder **SDH_5MHzPlanarProbe** contains the planar transducer responses of the side-drilled hole. That folder will contain files of three types. For example:

Planar_5_SDH_00L_VPP contains the 0 degree (normal incidence) peak-to-peak scan L-wave (P-wave) response of the SDH

Planar_5_SDH_00L contains the A-scan waveform at the maximum peak-to-peak 0 degree (normal incidence) L-wave response location

Planar_5_ref contains the reference front-surface reflection from the block at the same system settings as the flaw measurements

There is also a Word document in this same folder called Planar_5_Parameters that contains details of all the measurement parameters and some example waveforms.

The second folder **SDH_5MHzFocusedProbe** contains similar data and documentation for the focused probe case.

Some remarks:

The attenuation of the water (at the temperature under which all the experiments were conducted) was calculated as

$$\alpha = 0.2479 \times 10^{-3} f^2 \quad \text{Np/cm}$$

where f is the frequency in MHz

The P-wave attenuation the aluminum block was measured but found to be negligible for these problems.

Specifically, the testing procedure was as follows:

We set the incident angle of the transducer relative to the interface normal which theoretically would produce a refracted angle of 45, 60, etc. as predicted by Snell's law. Keeping that angle fixed we peaked up the signal from the corner trap signal at the edge of the block as shown in Fig. 1. We then scanned parallel to the surface of the block, giving the peak-to-peak response versus position. At the position where the maximum peak-to-peak response was obtained the A-scan wave form was also recorded.

"Cracks" specimen

Two small cylindrical-shaped flaws were machined from the surface of a titanium alloy sample and this sample was then diffusion bonded to another sample to produce pill-box crack-like flaws as shown in Fig 4. For this sample the A-scan responses of these "cracks" were obtained at various refracted angles using a 10 MHz planar probe. For P-waves, the refracted angles for P-wave measurements were $\theta = 0, 30,$ and 45 degrees. For SV-waves, the refracted angles was 45 degrees. A reference A-scan response was obtained from the front surface of the block at normal incidence with a water path of 25.4 mm. Note that the water path is held fixed at 25.4 mm in all measurements from the "cracks".

The L-wave (P-wave) attenuation of the titanium block was measured but unfortunately the S-wave attenuation is not available.

The testing procedure was as follows:

We set the incident angle of the transducer relative to the interface normal which theoretically would produce a refracted angle of 45, 60, etc. as predicted by Snell's law. Keeping that angle fixed we peaked up the signal from the front and back edges of the larger "crack", as shown in Fig. 4 (labeled points *a* and *b*) and recorded the A-scan wave form at those two locations. For the smaller "crack", no separate front and back surface peak locations were observable so we just peaked up the overall signal and recorded the A-scan wave form at this location.

"Cracks" Specimen

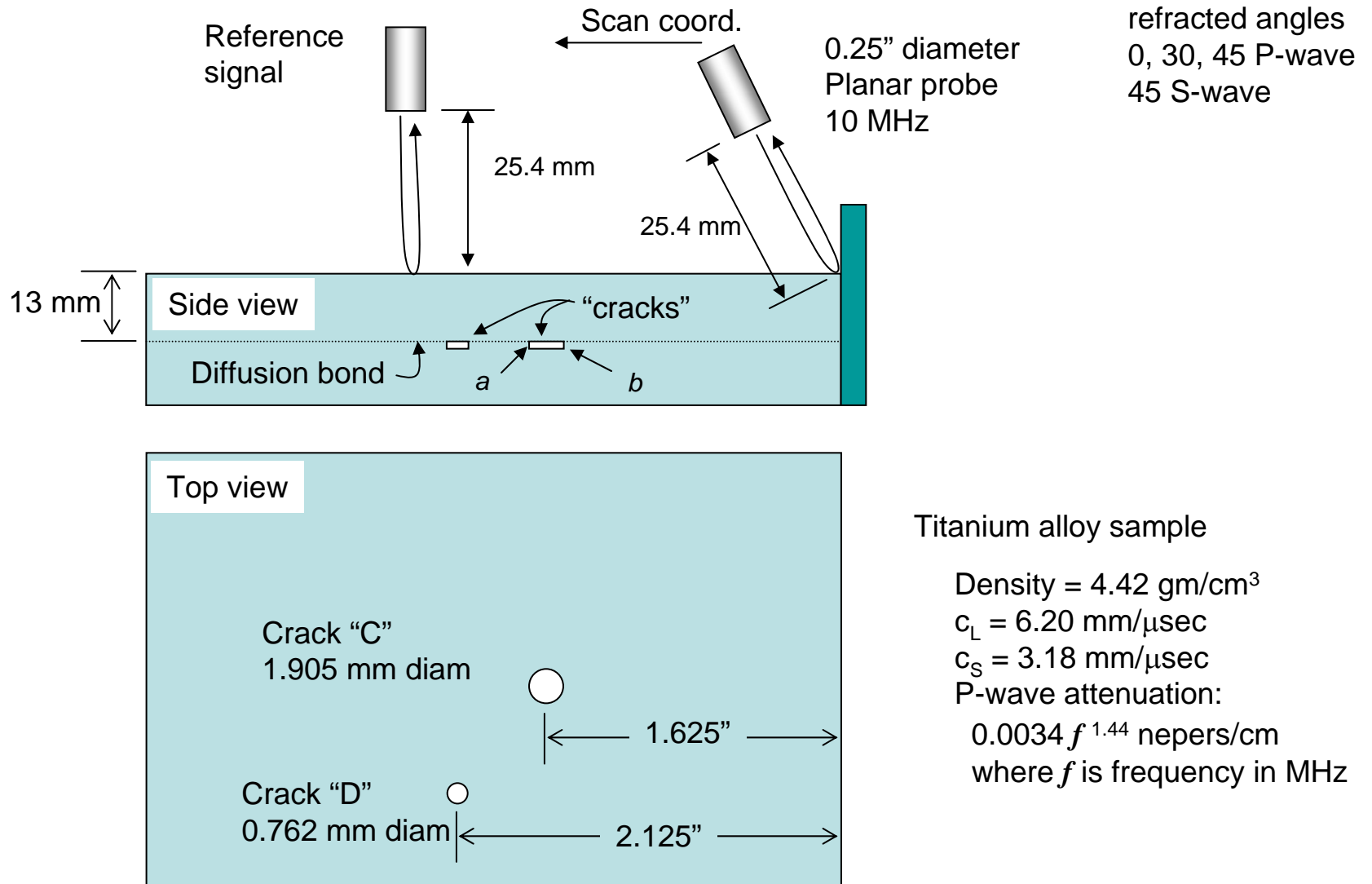


Fig. 4

Data on the web

All the data for the "crack" experiments are also available at <ftp://cnde:Bruce@ftp.cnde.iastate.edu> within the pub folder in a sub-folder named 2005_UT_benchmark

The data for the "crack" responses is contained within the folder Benchmark Files in the folder **Crack_10MHz_PlanarProbe**. Within that folder we have data files of three types. For example:

Planar_10_CrackC_30L_b contains the 30 degree L-wave response of the larger crack C when the signal is peaked from point *b* on the crack

Planar_10_CrackC_30L_a contains the 30 degree L-wave response of the larger crack C when the signal is peaked from point *a* on the crack

Planar/10_CrackD_30L contains the 30 deree L-wave response of the smaller crack D when the overall waveform peaks

Planar_10_ref is a reference wave form taken from the front surface of the block at the same system settings as the crack responses

There is also a Word document in this same folder called Planar_10_Parameters that contains details of all the measurement parameters and some example waveforms.

PARTICIPATION IN THE STUDY

We have placed this data on the web at <ftp://cnde:Bruce@ftp.cnde.iastate.edu>. we would welcome you examining this data, comparing it to model-based predictions, and sharing your results.

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