Initial Evaluation of QIBA phantoms
Duke University
February 6, 2012

Duke received 12 boxes from CIRS containing 22 phantoms:

CIRS box	phantoms	
1	E1786-1	E1787-1
2	E1786-2	E1787-2
3	E1786-3	E1787-3
4	E1786-4	E1787-4
5	E1786-5	E1787-5
6	E1786-6	E1787-6
7	E1786-7	E1787-7
8	E1786-8	E1787-8
9	E1786-9	E1787-9
10	E1786-10	E1787-10
11	E1788-1	
12	E1788-2	

After inspecting the phantoms, it was discovered that E1786-8 was damaged. CIRS sent a replacement phantom numbered E1786-11, and E1786-8 was returned to CIRS.

Measurements were made on each of the phantoms as follows. Shear wave speed (SWS) acquisitions were performed using a Verasonics scanner with a Phillips C5-2 transducer. Data were acquired using three focal depths, 40, 60, and 80 mm. For the E1786-X and E1787-X phantoms, water was added to the water wells to achieve acoustic coupling into the phantoms (approximately half full). (Note that several of the water wells had leaks, and it was sometimes necessary to add more water during the acquisition. Ted Lynch has indicated that it would be possible to try putting a bead of RTV around the joint where the cover meets the casing to stop the leaking. However, Duke did not do this.) Phantoms E1788-1 and E1788-2 did not have water wells and ultrasound gel was used for the acoustic coupling. Each phantom was placed on a turntable, with the transducer held vertically in a ring stand, just touching the top of the phantom, but without compression such that the phantom could be easily rotated. Shear wave data acquisitions were acquired for each of eight angular positions of the turntable (~45 degree increments). This acquisition sequence was repeated with the phantom translated on the turntable so that rotations were carried out for each of seven phantom locations arranged in a hexagonal pattern (including the center) with an approximately 1 cm separation between adjacent locations.

Shear wave speed (SWS) estimates were determined for each focal depth for each of the eight angular positions at the seven phantom locations. For each focal depth, the mean of the SWS estimates at the eight angular positions was calculated. These results were averaged to obtain the mean ± standard deviation over the seven phantom locations.

For each focal depth, normalized results for the 10 E1786-X phantoms were determined by normalizing the SWS results obtained in each phantom by the average of the mean speeds. A similar process was performed for the 10 E1787-X phantoms. These results for the 60 mm focal depth are shown in Figure 1. Results for the 40 and 80 mm focal depths are similar to the results shown here. Note that the abscissa in these plots is NOT the serial number from the phantom, but instead is a number assigned after sorting the results in ascending order.

After measuring shear wave speeds in all 22 phantoms, it was observed that the speed for phantom E1788-1 was approximately the same as for the 10 E1786-X phantoms. Similarly, the speed for phantom E1788-2 was approximately the same as for the 10 E1787-X phantoms. Thus, these speeds were normalized by the same factors as had been used for the E1786-X and E1787-X phantoms and these values were added to the plot as phantom number 12.

For the E1786-X phantoms and 60 mm focal depth, the range of values for the (normalized) shear wave speed is 0.950 – 1.024 with a mean ± standard deviation of 1.0 ± 0.022. For comparison, the average standard deviation from the measurements at the seven locations in each phantom is 0.003. Similarly, for the E1787-X phantoms and 60 mm focal depth, the range of values of the (normalized) shear wave speed is 0.977 – 1.022 with a mean ± standard deviation of 1.0 ± 0.016. For comparison, the average standard deviation from the measurements at the seven locations in each phantom is 0.001.

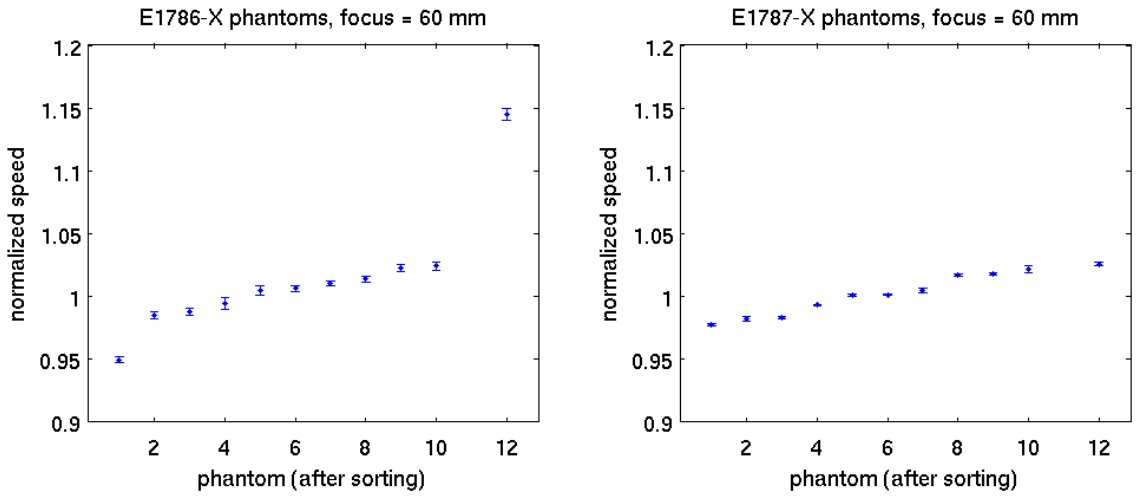

Figure 1. Normalized shear wave speeds in each of the CIRS QIBA phantoms measured at a focal depth of 60 mm. Speeds measured in each phantom were normalized by the average of the speeds measured in the 10 E1786-X or 10 E1787-X phantoms. The E1786-X and E1787-X phantom results have been sorted in order of ascending speed, so the value of the abscissa does not correspond to the phantom serial number. Results for the E1788-1 and E1788-2 phantoms were normalized using the same normalization factors and are included on the plot as phantom 12.

Conclusions: The phantoms in each group are “the same” to within +/- 3% (excluding phantoms 1 and 12 on the leftmost plot). Within each phantom, the measurements were within 0.3 % of each other at each position.