CUBDL Data Guide

Version 4

May 6, 2020

1 Overview

Organizers of the 2020 IEEE IUS Challenge on Ultrasound Beamforming with Deep Learning (CUBDL) solicited channel data from multiple ultrasound groups worldwide to be used as test data for the challenge. The compiled database of test images includes a total of 106 datasets with the following breakdown: (1) 49 experimental phantom data sequences acquired with plane wave transmissions; (2) 25 *in vivo* data sequences of the heart of thirteen patients, the carotid of two healthy volunteers and the brachioradialis of a healthy volunteer, each acquired with plane or diverging wave transmission; (3) 6 experimental phantom data sequences acquired with focused transmissions; (4) 24 *in vivo* data sequences of the breast of ten patients, the carotid of a healthy volunteer, and the heart of a healthy volunteer, each acquired with focused transmissions; and (5) 2 Field II [1, 2] simulations.

The phantom data consisted a total of 12 different phantoms from 6 manufacturers including: (1) CIRS models 040, 049, 054GS, 050 and 059; (2) GAMMEX models 404GSLE, 403TM and 410 SCG; (3) NPL Thermal Test Phantom; (4) CAR Blue Phantom Elastography Breast Model; (5) True Phantom Solutions Brain Phantom; and (6) Dansk Phantom Service Model 453. Three of the phantom acquisitions included a layer of *ex vivo* porcine abdominal tissue to introduce acoustic clutter.

This wide range of channel data was acquired with 4 ultrasound scanners and 8 ultrasound transducers. The acquisition center frequencies ranged from 2.5 MHz to 12.5 MHz. The sampling frequencies ranged from 10 MHz to 78.125 MHz. The ultrasound transducers consisted of linear and phased arrays.

Data were provided by 9 groups total, referenced hereafter by the shorthand 3-letter code provided in parentheses: (1) Department of Radiology, Mayo Clinic, US (MYO); (2) Microelectronic Systems Design Laboratory, University of Florence, Italy (UFL); (3) Signal Processing Systems group, Eindhoven University of Technology, Netherlands (EUT); (4) CREATIS, Insa Lyon, France (INS); (5) Research Group for Digital Signal Processing and Image Analysis, University of Oslo, Norway (OSL); (6) Ultrasound Elasticity and Imaging Laboratory, Columbia University, US (COL); (7) Department of Biomedical Engineering, Tsinghua University, China (TSH); (8) Department of Biomedical

Engineering, Lund University (LUN); and (9) Photoacoustic and Ultrasonic Systems Engineering Lab, Johns Hopkins University, US (JHU).

2 Example Images

In order to provide participants with example images from the test set database, Figs. 1-3 show a sampling from 30% of the above-described data.

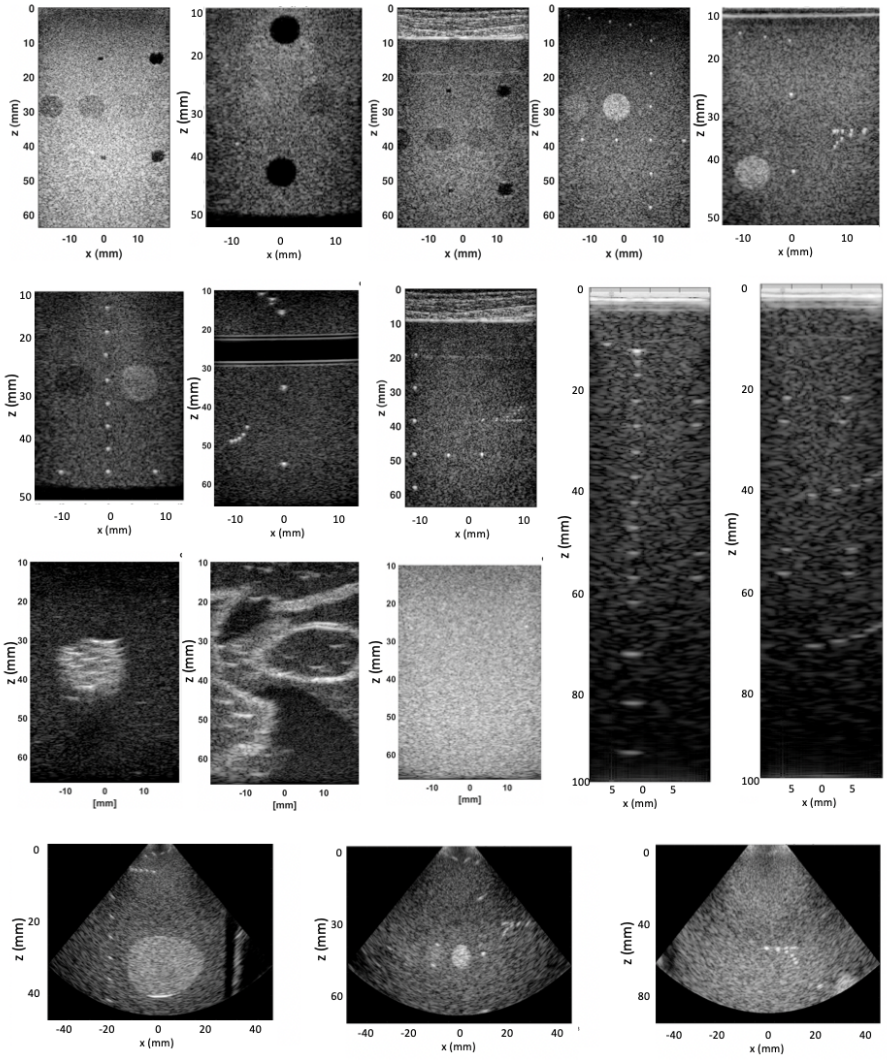

Figure 1: Example phantom images.

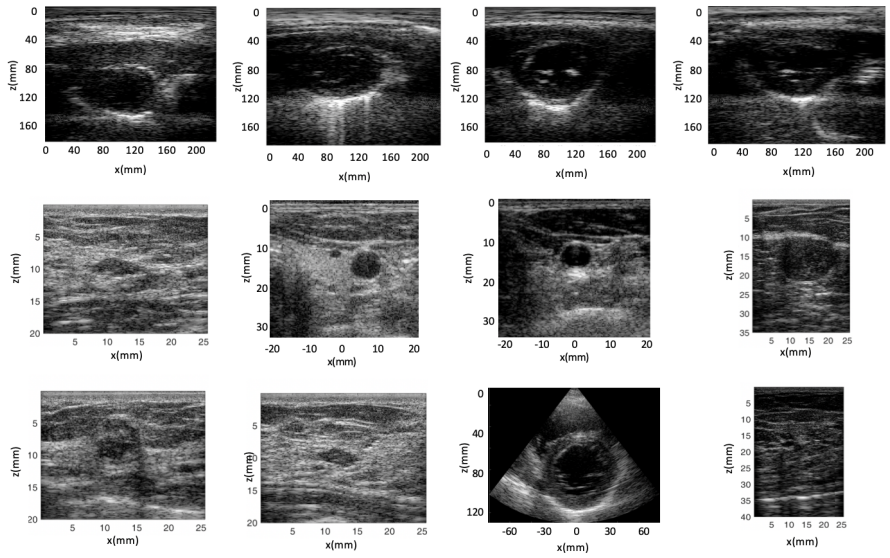

Figure 2: Example *in vivo* images. A subset of the *in vivo* images in the test set were previously published in [3, 4, 5, 6, 7, 8, 9, 10, 5].

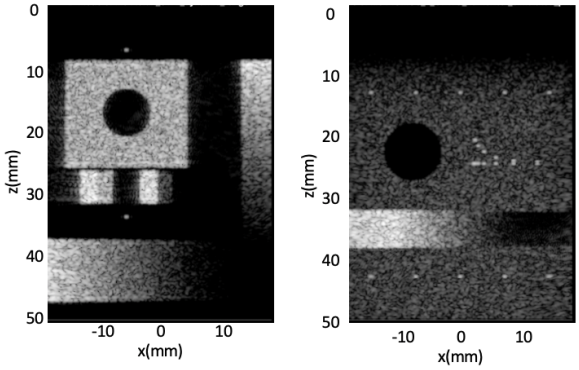

Figure 3: Example simulation images [11, 12]

3 Tabulated Test Data Information

Tables 1 and 2 summarize the *in vivo* test data information. These tables include the institution ID, followed by the number of sequences provided by each institution, ultrasound transmit wave details, acquisition information, information about the type of *in vivo* data, as well as citations to references that use and describe the data in more detail. Diverging wave data will be treated

Table 1: Summary of *in vivo* data from each institution acquired with plane waves or diverging waves

Data Info				Acquisition Info						In vivo Info		
Institution	**Total # of sequences**	**Transmission Type**	**Total plane wave**	**US scanner**	**Transducer**	**Center Frequency [MHz]**	**Sampling Frequency [MHz]**	**Bandwith [MHz]**	**Image Depth [mm]**	**Data from**	**Organ**	**References**
CLM	20	Diverging	10	Verasonics Vantage 256	P4-2	2.5	10	3	160	Patient	Heart	[3]
TSH	1	Plane Wave	31	Verasonics Vantage 256	L10-5	7.5	6.25	5	40	Volunteer	Carotid	[10]
TSH	1	Plane Wave	31	Verasonics Vantage 256	L10-5	7.5	6.25	5	40	Volunteer	Brachio-radialis	[10]
LUN	1	Plane Wave	1	Verasonics Vantage 256	ULA-OP 256	Esaote LA533	8	78.125	40	Volunteer	Cartoid	[9]
LUN	1	Plane Wave	5	Verasonics Vantage 256	ULA-OP 256	Esaote LA533	8	78.125	40	Volunteer	Carotid	[9]
LUN	1	Plane Wave	1	Verasonics Vantage 256	ULA-OP 256	Esaote LA533	11	78.125	40	Volunteer	Carotid	[9]

Table 2: Summary of *in vivo* data from each institution acquired with focused waves

Data Info				Acquisition Info						In vivo Info		
Institution	**Total # of sequences**	**Transmission Type**	**Focal Depth [mm]**	**US scanner**	**Transducer**	**Center Frequency [MHz]**	**Sampling Frequency [MHz]**	**Bandwith [MHz]**	**Image Depth [mm]**	**Data from**	**Organ**	**References**
JHU	18	Focused	7 - 20	Alpinion	L3-8	5.5	40	9	20 - 40	Patient	Breast	[4, 5, 6, 7]
OSL	2	Focused	22	Verasonics Vantage 256	L7	5.2	20.8	3	38	Volunteer	Carotid	[11]
OSL	1	Focused	67	Verasonics Vantage 256	P4-2	2.97	11.9	3	18.9	Volunteer	Heart	[8]
OSL	3	Focused	52	Verasonics Vantage 256	P4-2	2.97	11.9	3	18.9	Volunteer	Heart	[8]

as both focused and plane wave data during our evaluation. More details about the *in vivo* data acquisitions (e.g., aperture width, element width, pitch) are available in the Appendix in Tables 9 and 10. All *in vivo* data were acquired after informed consent.

Tables 3 and 4 summarize the phantom test data information. These tables include the institution ID, followed by the number of sequences provided by each institution, ultrasound transmit wave details, acquisition information, and the information about the type of phantom targets. More details about the phantom data acquisitions (e.g., aperture width, element width, pitch) are available in the Appendix in Tables 6, 7, and 8.

Table 5 summarizes the test data information from Field II simulations. This table includes the sequence number (composed of the institution ID and a unique identifier number for the institution), followed by ultrasound transmit wave details and simulation parameters.

Table 3: Summary of phantom data from each institution acquired with plane waves

Data Info				Acquisition Info						Phantom Info
Institution	**Total # of sequences**	**Transmission type**	**Total plane waves**	**US scanner**	**Transducer**	**Center Frequency [MHz]**	**Sampling Frequency [MHz]**	**Bandwith [MHz]**	**Image Depth [mm]**	**Targets Included**
MYO	6	Plane Wave	75	Verasonics Vantage system	L11-4v	6.25	28.96	6.78	63.8	Wire targets and inclusions
UFL	5	Plane Wave	75	ULA-OP256	LA533 (Esaote)	8	78.125	4.9	50	Hypoechoic target, grey scale target and wire targets
EUT	6	Plane Wave	75	Broadband sector array transducer, Philips	S5-1	3.1	12.5	4	100	Wire targets
INS	13	Plane Wave	75	Verasonics Vantage 256	L7-4	5.2	20.8	3.1	56.7	Vessel and wires, Homogeneous, Stiff inclusions, Cyst, brain structure
INS	13	Plane Wave	75	Verasonics Vantage 256	L12-5	7.8	31.25	4.7	56.7	Vessel and wires, Homogeneous, Stiff inclusions, Cyst, brain structure
OSL	6	Plane Wave	75	Verasonics Vantage 256	L7	5.2	20.8	3.1	50	Cyst and point targets

Table 4: Summary of phantom data from each institution acquired with focused transmissions

Data Info				Acquisition Info						Phantom Info	
Institution	**Total # of sequence**	**Transmission type**	**Focal Depth [mm]**	**US scanner**	**Transducer**	**Center Frequency [MHz]**	**Sampling Frequency [MHz]**	**Bandwith [MHz]**	**Image Depth [mm]**	**Targets Included**	**Ref.**
OSL	1	Focused	50	Verasonics Vantage 256	L11	5	20.4	3.1	50	Cyst and point targets	[11]
JHU	5	Focused	36-85	Verasonics Vantage 256	P4-2	3.0	11.9	3	50	Cyst and point targets	-

Table 5: Summary of simulation data from each institution

Data Info				Simulation Info						
Sequence #	**Transmission type**	**Total Plane wave**	**Focal Depth [mm]**	**Software**	**Center Frequency [MHz]**	**Sampling Frequency [MHz]**	**Aperture [mm]**	**Pitch [mm]**	**Image Depth [mm]**	**Ref.**
OSL001	Focused	-	22	Field II	5.13	100	38.1	0.3	50	[11]
OSL010	Plane Wave	75	-	Field II	5.13	20.8	38.1	0.3	50	[12]

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Appendix

Table 6: Detailed summary of phantom data. (Part 1: Plane wave transmissions; Sequences from MYO, UFL, EUT, INS)

Data Info				Acquisition Info									Phantom Info
Sequence #	**Trans-mission type**	**# of angles**	**Plane wave angle range**	**US scanner**	**Transducer**	**Center Frequency [MHz]**	**Sampling Frequency [MHz]**	**Bandwith [MHz]**	**Aperture Width [mm]**	**Element Width [mm]**	**Pitch [mm]**	**Image Depth [m]**	**Targets Included**
MYO001	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L11-4v	6.25	28.96	6.78	38.4	0.27	0.3	0.0638	Wire targets and inclusions
MYO002	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L11-4v	6.25	28.96	6.78	38.4	0.27	0.3	0.0638	Wire targets and inclusions
MYO003	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L11-4v	6.25	28.96	6.78	38.4	0.27	0.3	0.0638	Wire targets and inclusions
MYO004	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L11-4v	6.25	28.96	6.78	38.4	0.27	0.3	0.0638	Wire targets and inclusions
MYO005	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L11-4v	6.25	28.96	6.78	38.4	0.27	0.3	0.0638	Wire targets and inclusions
MYO006	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L11-4v	6.25	28.96	6.78	38.4	0.27	0.3	0.0638	Wire targets and inclusions
UFL001	Plane Wave	75	[-15, 15]	ULA-OP256	LA533 (Esaote)	8	78.125	4.9	31.36	0.215	0.245	0.05	Hypoechoic target, grey scale target and wire targets
UFL002	Plane Wave	75	[-15, 15]	ULA-OP256	LA533 (Esaote)	8	78.125	4.9	31.36	0.215	0.245	0.05	Wire targets, grey scale targets
UFL003	Plane Wave	75	[-15, 15]	ULA-OP256	LA533 (Esaote)	8	78.125	4.9	31.36	0.215	0.245	0.05	Wire targets and hyperechoic target
UFL004	Plane Wave	75	[-15, 15]	ULA-OP256	LA533 (Esaote)	8	78.125	4.9	31.36	0.215	0.245	0.05	Wire targets
UFL005	Plane Wave	75	[-15, 15]	ULA-OP256	LA533 (Esaote)	8	78.125	4.9	31.36	0.215	0.245	0.05	Hypoecoic targets
EUT001	Plane Wave	75	[-16, 16]	Verasonics Vantage 128	S5-1	3.125	12.5	4	20.3	0.25	0.254	0.1	Wire targets
EUT002	Plane Wave	75	[-16, 16]	Verasonics Vantage 128	S5-1	3.125	12.5	4	20.3	0.25	0.254	0.1	Wire targets
EUT003	Plane Wave	75	[-16, 16]	Verasonics Vantage 128	S5-1	3.125	12.5	4	20.3	0.25	0.254	0.1	Wire targets
EUT004	Plane Wave	75	[-16, 16]	Verasonics Vantage 128	S5-1	3.125	12.5	4	20.3	0.25	0.254	0.1	Wire targets
EUT005	Plane Wave	75	[-16, 16]	Verasonics Vantage 128	S5-1	3.125	12.5	4	20.3	0.25	0.254	0.1	Wire targets
EUT006	Plane Wave	75	[-16, 16]	Verasonics Vantage 128	S5-1	3.125	12.5	4	20.3	0.25	0.254	0.1	Wire targets
INS001	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208	20.833	3.1248	37.846	0.25	0.298	56.7	Vessel and wires
INS002	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208	20.833	3.1248	37.846	0.25	0.298	56.7	Vessel and wires with flow circulation
INS003	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208	20.833	3.1248	37.846	0.25	0.298	56.7	Homogeneous
INS004	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208	20.833	3.1248	37.846	0.25	0.298	56.7	Stiff inclusions
INS005	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208	20.833	3.1248	37.846	0.25	0.298	56.7	Wires
INS006	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208	20.833	3.1248	37.846	0.25	0.298	56.7	Cysts
INS007	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208	20.833	3.1248	37.846	0.25	0.298	56.7	Wires
INS008	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208	20.833	3.1248	37.846	0.25	0.298	56.7	Cysts and wire
INS009	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208	20.833	3.1248	37.846	0.25	0.298	56.7	Inclusions

Table 7: Detailed summary of phantom data. (Part 2: Plane wave transmissions; Sequences from INS and OSL)

Data Info				Acquisition Info									Phantom Info
Sequence #	**Trans-mission type**	**# of angles**	**Plane wave angle range**	**US scanner**	**Transducer**	**Center Frequency [MHz]**	**Sampling Frequency [MHz]**	**Bandwith [MHz]**	**Aperture Width [mm]**	**Element Width [mm]**	**Pitch [mm]**	**Image Depth [m]**	**Targets Included**
INS010	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208	20.833	3.1248	37.846	0.25	0.298	56.7	Inclusions
INS011	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208	20.833	3.1248	37.846	0.25	0.298	56.7	Brain structure
INS012	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208	20.833	3.1248	37.846	0.25	0.298	56.7	Brain structure
INS013	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208	20.833	3.1248	37.846	0.25	0.298	56.7	Vessel
INS014	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L12-5	7.813	31.25	4.6878	24.8	0.1703	0.1953	56.7	Vessel and wires
INS015	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L12-5	7.813	31.25	4.6878	24.8	0.1703	0.1953	56.7	Vessel and wires with flow circulation
INS016	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L12-5	7.813	31.25	4.6878	24.8	0.1703	0.1953	56.7	Stiff inclusions
INS017	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L12-5	7.813	31.25	4.6878	24.8	0.1703	0.1953	56.7	Homogeneous
INS018	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L12-5	7.813	31.25	4.6878	24.8	0.1703	0.1953	56.7	Wires
INS019	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L12-5	7.813	31.25	4.6878	24.8	0.1703	0.1953	56.7	Cysts
INS020	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L12-5	7.813	31.25	4.6878	24.8	0.1703	0.1953	56.7	Wires
INS021	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L12-5	7.813	31.25	4.6878	24.8	0.1703	0.1953	56.7	Cysts + wire
INS022	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L12-5	7.813	31.25	4.6878	24.8	0.1703	0.1953	56.7	Inclusions
INS023	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L12-5	7.813	31.25	4.6878	24.8	0.1703	0.1953	56.7	Inclusions
INS024	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L12-5	7.813	31.25	4.6878	24.8	0.1703	0.1953	56.7	Brain structure
INS025	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L12-5	7.813	31.25	4.6878	24.8	0.1703	0.1953	56.7	Brain structure
INS026	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L12-5	7.813	31.25	4.6878	24.8	0.1703	0.1953	56.7	Vessel
OSL002	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208333	20.866720	3.1248	38.100000	0.25	0.298	50	Wires
OSL003	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208333	20.866720	3.1248	38.100001	0.25	0.298	50	Wires and cysts
OSL004	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208333	20.866720	3.1248	38.100002	0.25	0.298	50	Wires and cysts
OSL005	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208333	20.866720	3.1248	38.100003	0.25	0.298	50	Cysts
OSL006	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208333	20.866720	3.1248	38.100004	0.25	0.298	50	Cysts
OSL007	Plane Wave	75	[-16, 16]	Verasonics Vantage 256	L7-4	5.208333	20.866720	3.1248	38.100005	0.25	0.298	50	Cysts

Table 8: Detailed summary of phantom data. (Part 3: Focused transmissions; Sequences from OSL and JHU)

Data Info					Acquisition Info									Phantom Info
Sequence #	**Trans-mission type**	**# of steering angles**	**Steering angle range**	**Focal Depth [mm]**	**US scanner**	**Transducer**	**Center Frequency [MHz]**	**Sampling Frequency [MHz]**	**Bandwith [MHz]**	**Aperture Width [mm]**	**Element Width [mm]**	**Pitch [mm]**	**Image Depth [m]**	**Targets Included**
OSL015	Focused	-	-	50	Verasonics Vantage 256	L11-5	5.00	20.42	3.12	38.10	0.25	0.298	50	Cyst and point targets
JHU019	Focused	128	[-45,45]	50	Verasonics Vantage 128	P4-2v	2.97	11.90	3	18.90	0.295	0.3	50	Point targets
JHU020	Focused	128	[-45,45]	60	Verasonics Vantage 128	P4-2v	2.97	11.90	3	18.90	0.295	0.3	60	Cyst and point targets
JHU021	Focused	128	[-45,45]	85	Verasonics Vantage 128	P4-2v	2.97	11.904762	3	18.90	0.295	0.3	85	Cyst and point targets
JHU022	Focused	128	[-45,45]	73	Verasonics Vantage 128	P4-2v	2.976191	11.904762	3	18.90	0.295	0.3	73	Cyst
JHU023	Focused	128	[-45,45]	36	Verasonics Vantage 128	P4-2v	2.97	11.904762	3	18.90	0.295	0.3	36	Cyst and point targets

Table 9: Detailed summary of *in vivo* data (Part 1: Plane wave and diverging wave sequences from CLM, LUN, and TSH)

Data Info				**Acquisition Info**									***In vivo Info***		
Sequence #	**Trans-mission Type**	**Total # of plane waves**	**Angle range**	**US scanner**	**Trans-ducer**	**Center Frequency [MHz]**	**Sampling Frequency [MHz]**	**Bandwith [MHz]**	**Aperture Width [mm]**	**Element Width [mm]**	**Pitch [mm]**	**Image Depth [mm]**	**Data from**	**Organ**	**Ref.**
COL001	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL002	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL003	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL004	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL005	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL006	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL007	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL008	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL009	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL010	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL011	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL012	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL013	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL014	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL015	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL016	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL017	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL018	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL019	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
COL020	Diverging Wave	10	[-22,22]	Verasonics Vantage 256	P4-2	2.5	10	3	20.2	0.295	0.32	160	Patient	Heart	[3]
LUN001	Plane Wave	1	0	ULA-OP 256	Esaote LA533	8	78.125	4	31.36	0.215	0.245	40	Volunteer	Carotid	[9]
LUN002	Plane Wave	5	[-6.5,6.5]	ULA-OP 256	Esaote LA533	8	78.125	4	31.36	0.215	0.245	40	Volunteer	Carotid	[9]
LUN003	Plane Wave	1	0	ULA-OP 256	Esaote LA533	11	78.125	5.5	25.6	0.17	0.2	40	Volunteer	Carotid	[9]
TSH001	Plane Wave	31	[-15,15]	Verasinics Vantage 256	L10-5	7.5	6.25	5	38.37	0.27	0.3	40	Volunteer	Carotid	[10]
TSH002	Plane Wave	31	[-15,15]	Verasonics Vantage 256	L10-5	7.5	6.25	5	38.37	0.27	0.3	40	Volunteer	Brachioradialis	[10]

Table 10: Detailed summary of *in vivo* data (Part 2: Focused transmissions; Sequences from JHU and OSL)

Data Info					**Acquisition Info**									***In vivo Info***		
Sequence #	**Trans-mission type**	**# of steering angles**	**Steering angle range**	**Focal Depth [mm]**	**US scanner**	**Trans-ducer**	**Center Frequency [MHz]**	**Sampling Frequency [MHz]**	**Bandwith [MHz]**	**Aperture Width [mm]**	**Element Width [mm]**	**Pitch [mm]**	**Image Depth [mm]**	**Data from**	**Organ**	**Ref.**
JHU001	Focused	-	-	20	Alpinion	L3-8	5.5	40	5	38.1	0.24	0.3	40	Patient	Breast	[4, 5, 6]
JHU002	Focused	-	-	20	Alpinion	L8-17	12.5	40	9	25.4	0.11	0.2	40	Patient	Breast	[4, 6]
JHU003	Focused	-	-	7	Alpinion	L8-17	12.5	40	9	25.4	0.11	0.2	20	Patient	Breast	[4, 5, 6, 7]
JHU004	Focused	-	-	7	Alpinion	L8-17	12.5	40	9	25.4	0.11	0.2	20	Patient	Breast	[7]
JHU005	Focused	-	-	10	Alpinion	L8-17	12.5	40	9	25.4	0.11	0.2	20	Patient	Breast	[4, 6, 7]
JHU006	Focused	-	-	10	Alpinion	L8-17	12.5	40	9	25.4	0.11	0.2	20	Patient	Breast	[7]
JHU007	Focused	-	-	12	Alpinion	L8-17	12.5	40	9	25.4	0.11	0.2	35	Patient	Breast	[4, 6, 7]
JHU008	Focused	-	-	15	Alpinion	L8-17	12.5	40	9	25.4	0.11	0.2	35	Patient	Breast	[7]
JHU009	Focused	-	-	10	Alpinion	L8-17	12.5	40	9	25.4	0.11	0.2	25	Patient	Breast	[4, 6, 7]
JHU010	Focused	-	-	10	Alpinion	L8-17	12.5	40	9	25.4	0.11	0.2	25	Patient	Breast	[7]
JHU011	Focused	-	-	12	Alpinion	L8-17	12.5	40	9	25.4	0.11	0.2	25	Patient	Breast	[4, 6, 7]
JHU012	Focused	-	-	12	Alpinion	L8-17	12.5	40	9	25.4	0.11	0.2	25	Patient	Breast	[7]
JHU013	Focused	-	-	7	Alpinion	L8-17	12.5	40	9	25.4	0.11	0.2	25	Patient	Breast	[4, 6, 7]
JHU014	Focused	-	-	7	Alpinion	L8-17	12.5	40	9	25.4	0.11	0.2	25	Patient	Breast	[7]
JHU015	Focused	-	-	10	Alpinion	L8-17	12.5	40	9	25.4	0.11	0.2	25	Patient	Breast	[5, 6, 7]
JHU016	Focused	-	-	10	Alpinion	L8-17	12.5	40	9	25.4	0.11	0.2	30	Patient	Breast	[7]
JHU017	Focused	-	-	7	Alpinion	L8-17	12.5	40	9	25.4	0.11	0.2	30	Patient	Breast	[5, 6, 7]
JHU018	Focused	-	-	7	Alpinion	L8-17	12.5	40	9	25.4	0.11	0.2	30	Patient	Breast	[7]
OSL008	Focused	-	-	22	Verasonics Vantage 256	L7-4	5.2	20.8	3.1248	37.8	0.25	0.298	40	Volunteer	Carotid	[11]
OSL009	Focused	-	-	22	Verasonics Vantage 256	L7-4	5.2	20.8	3.1248	37.8	0.25	0.298	40	Volunteer	Carotid	[11]
OSL011	Focused	101	[-37.5, 37.5]	67	Verasonics Vantage 256	P4-2	3.0	11.9	3	18.9	0.295	0.3	120	Volunteer	Heart	[8]
OSL012	Focused	101	[-37.5, 37.5]	52	Verasonics Vantage 256	P7-4	3.0	11.9	3	18.9	0.295	0.3	120	Volunteer	Heart	[8]
OSL013	Focused	101	[-37.5, 37.5]	52	Verasonics Vantage 256	P4-2	3.0	11.9	3	18.9	0.295	0.3	120	Volunteer	Heart	[8]
OSL014	Focused	101	[-37.5, 37.5]	52	Verasonics Vantage 256	P4-2	3.0	11.9	3	18.9	0.295	0.3	120	Volunteer	Heart	[8]