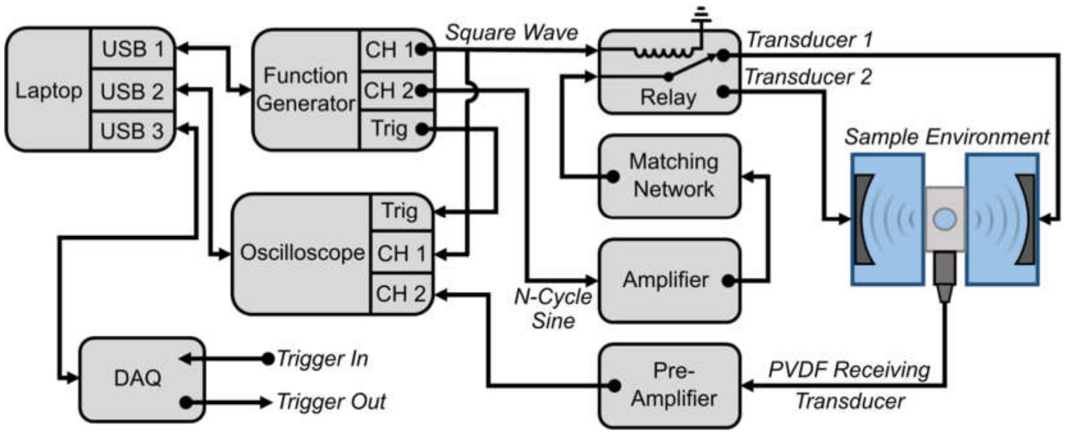
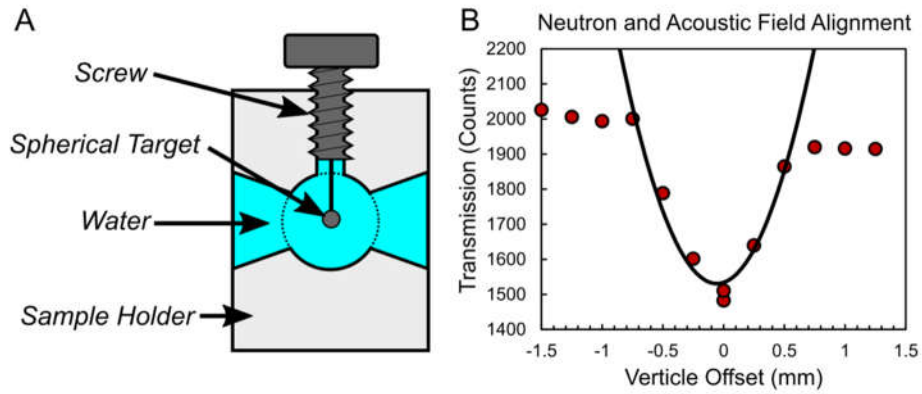
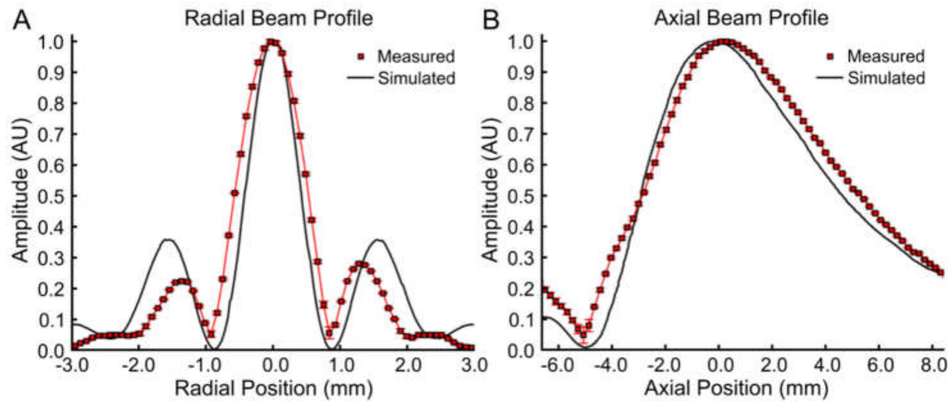
Supplemental Material:



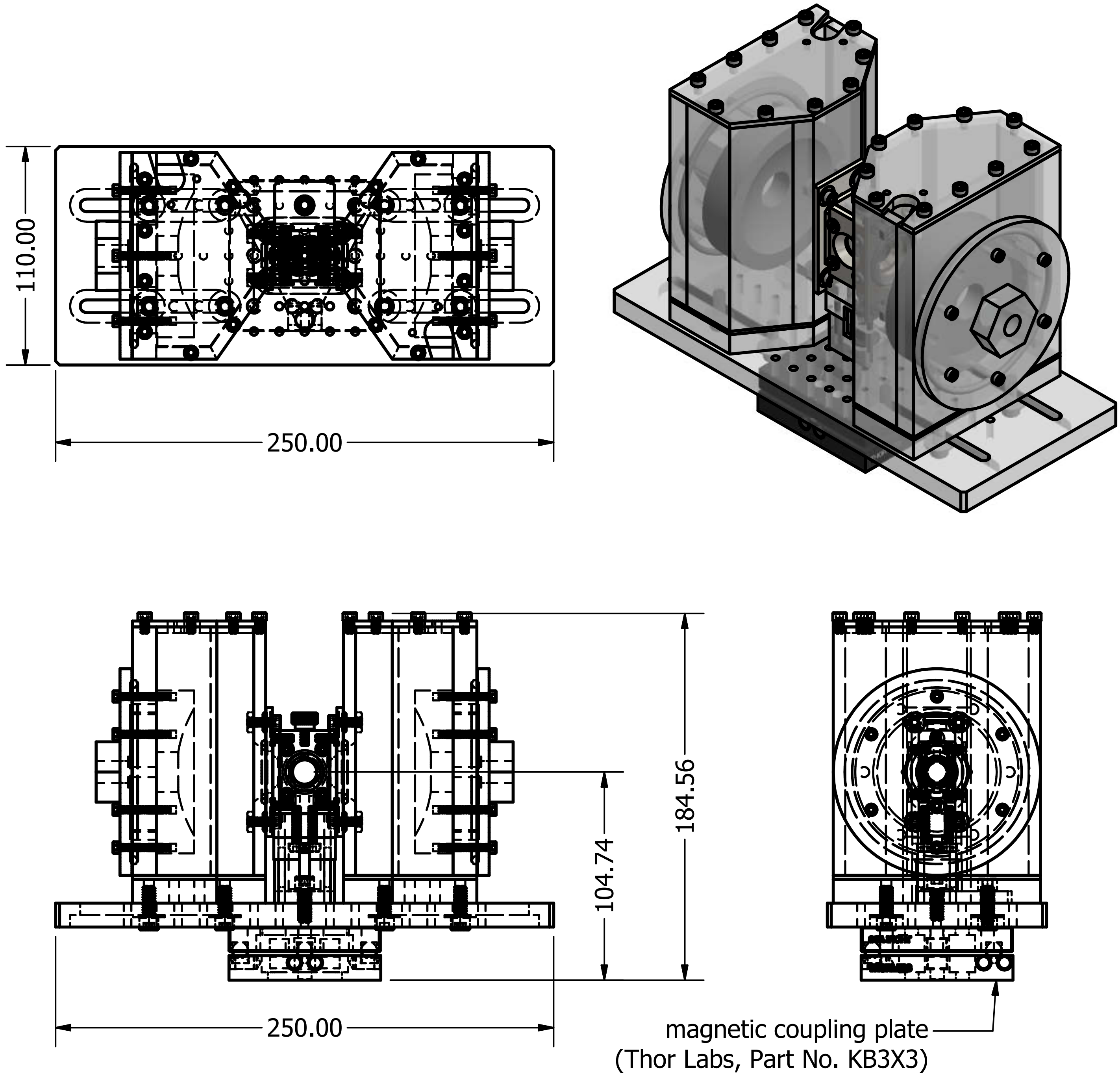
Supplemental Figure 1: Block diagram of the acoustic sample environment. A laptop controls acoustic settings, stores acoustic data, and optionally synchronizes acquisition with the X-ray or neutron scattering source. The acoustic pulse is produced from a spherically focused transducer driven by an N-cycle sine wave produced from a function generator connected to an amplifier. Insonation from the left or right transducer is controlled through a relay circuit operated with a 5 V square wave signal also from the function generator. Any cavitation events or scattered acoustic signals are received by a PVDF transducer connected to an oscilloscope through a pre-amplifier. The oscilloscope is used to digitize received acoustic signals and record them on the laptop. An optional data acquisition card (DAQ) can synchronize the acoustic sample environment to the X-ray or neutron scattering instrument.



Supplemental Figure 2: The acoustic field is a small fraction of the total sample volume. The beam is aligned with the acoustic focus using a 2-3 mm polymer or metallic bead as an acoustic reflector. Panel (A) shows a section view of the sample holder with the spherical target in place. The bead is suspended on a thin gauge stainless steel rod attached to a fine threaded screw. The spherical target is translated along the vertical axis by turning the screw. The acoustic focus is identified by the maximum reflected acoustic signal intensity from the sphere. For small synchrotron sources, where the X-ray beam dimensions are small, the sample holder can be translated to find the center of the spherical target using a radiography mode or performing a series of transmission measurements at different vertical and horizontal positions. For neutron sources, where the beam diameter can be several centimeters in diameter, a set of rectangular slit apertures translating in the horizontal and vertical axis can help find the spherical target. If the sphere can block the incident X-ray or neutron beam, the center of the sphere and acoustic field will coincide with the minimum transmission as shown in panel (B). The asymmetry in transmission counts before and after the spherical target is due to absorption from the thin gauge stainless steel cylinder used to hold the spherical target.



Supplemental Figure 3: (A) Radial and (B) axial acoustic beam profiles within the sample cell. The simulated acoustic field (black line) was obtained through 2-D simulation of a spherically focused acoustic source geometrically similar to the transducer used in the experiments. Measured values (dotted red line) were obtained using a needle hydrophone placed within the sample cell and translated using a motorized stage. The experimental values match relatively well with the simulated acoustic field. Discrepancies between simulated and measured acoustic fields can be the result of machining errors causing minor acoustic reflections.



DRAWN	
CHECKED	
QA	
MFG	
APPROVED	

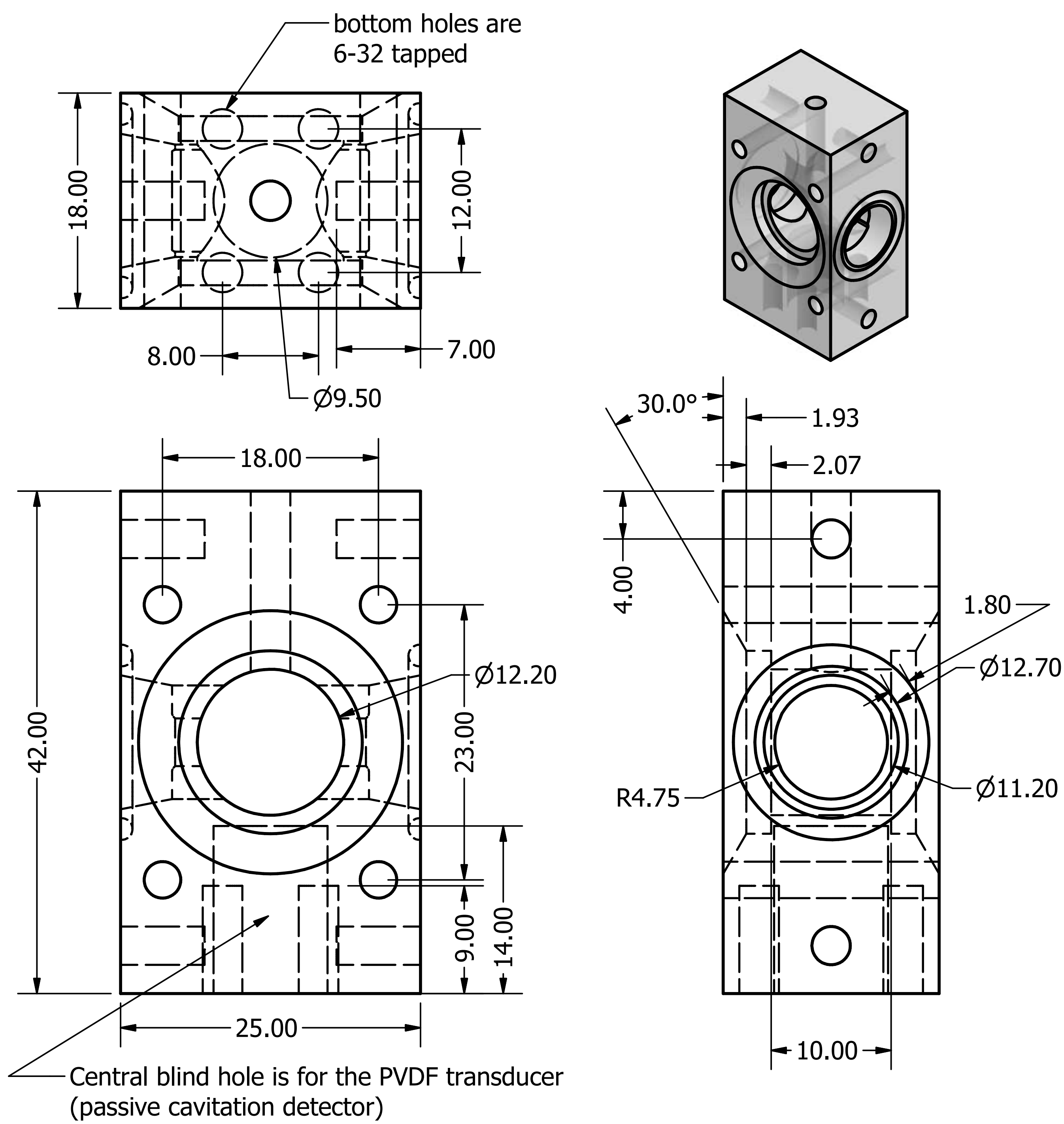
Units are in millimeters

TITLE

Ultrasound Scattering Environment Assembly

SIZE		DWG NO	REV
A		Sample Environment Assembly	

SCALE 1 / 3 | SHEET 1 OF 6



All dimensions in millimeters. All holes are imperial thread.
All holes are 8-32 tapped unless otherwise specified.

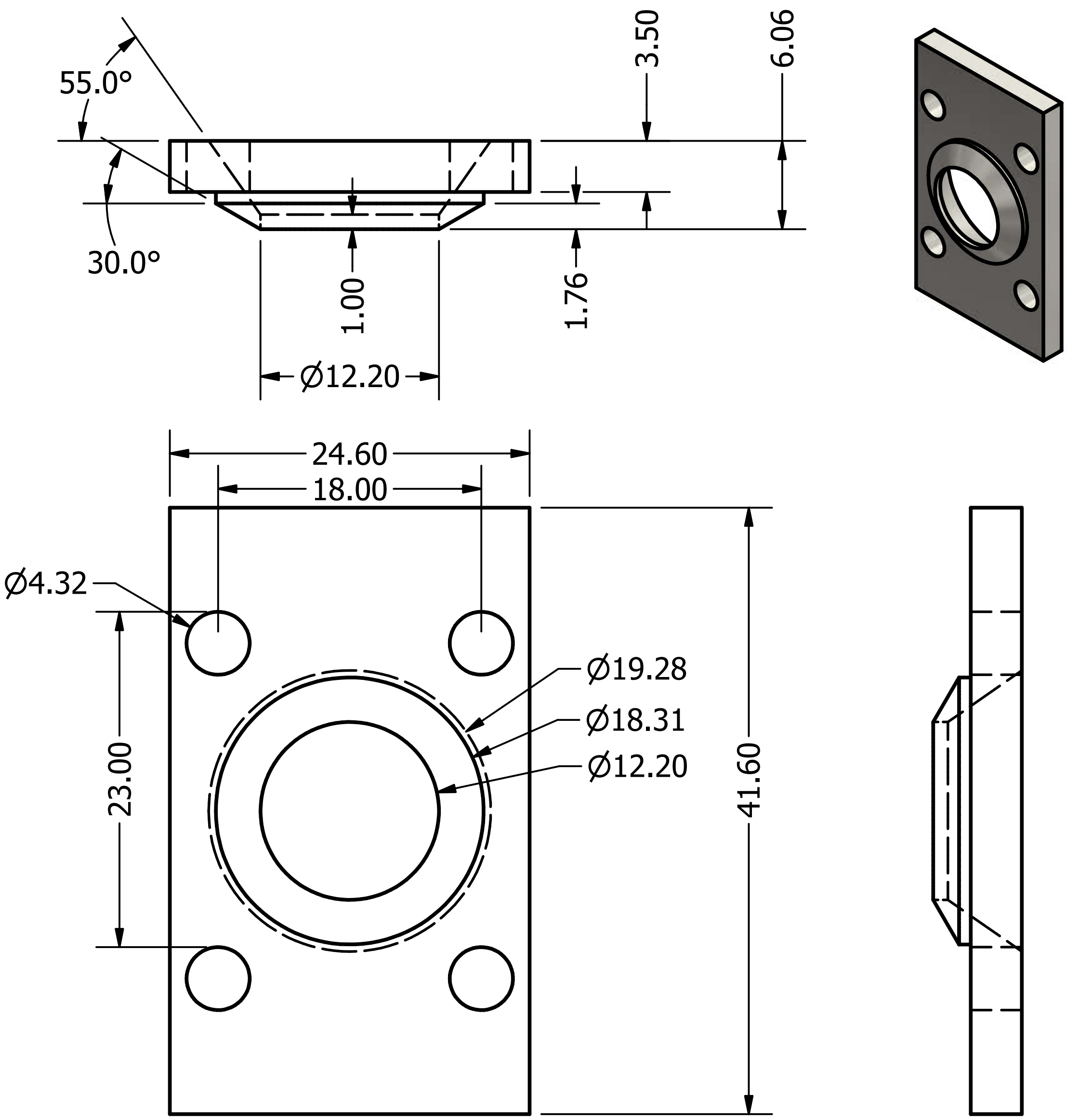
DRAWN	
CHECKED	
QA	
MFG	
APPROVED	

TITLE

Sample Holder

SIZE	DWG NO	REV
A	Sample Environment Assembly	

SCALE 2 : 1



All units are in millimeters

DRAWN	
CHECKED	
QA	
MFG	
APPROVED	

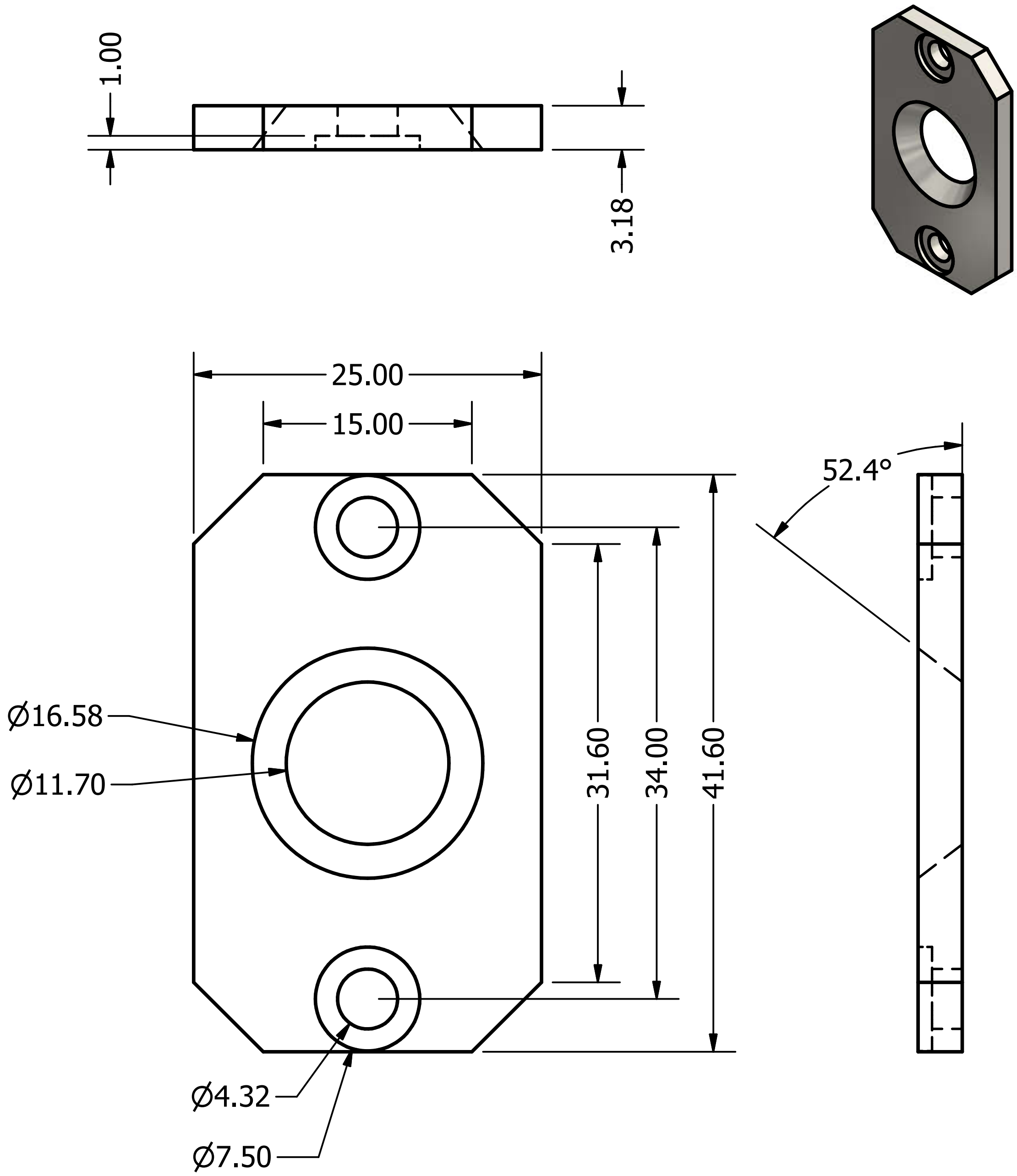
TITLE

Sample Holder Front/Back Plate

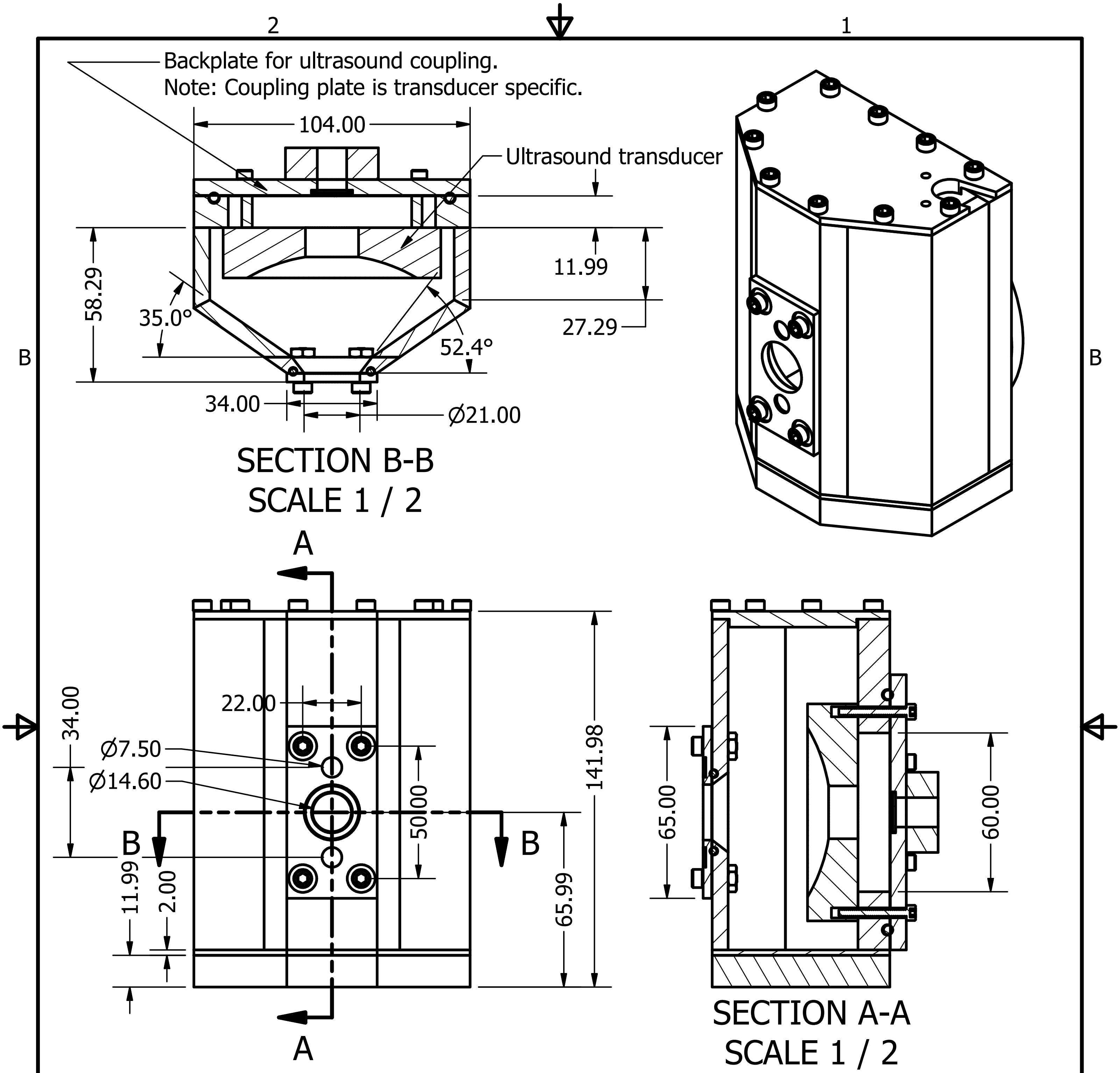
SIZE		DWG NO	REV
A		Sample Environment Assembly	

SCALE 2 : 1

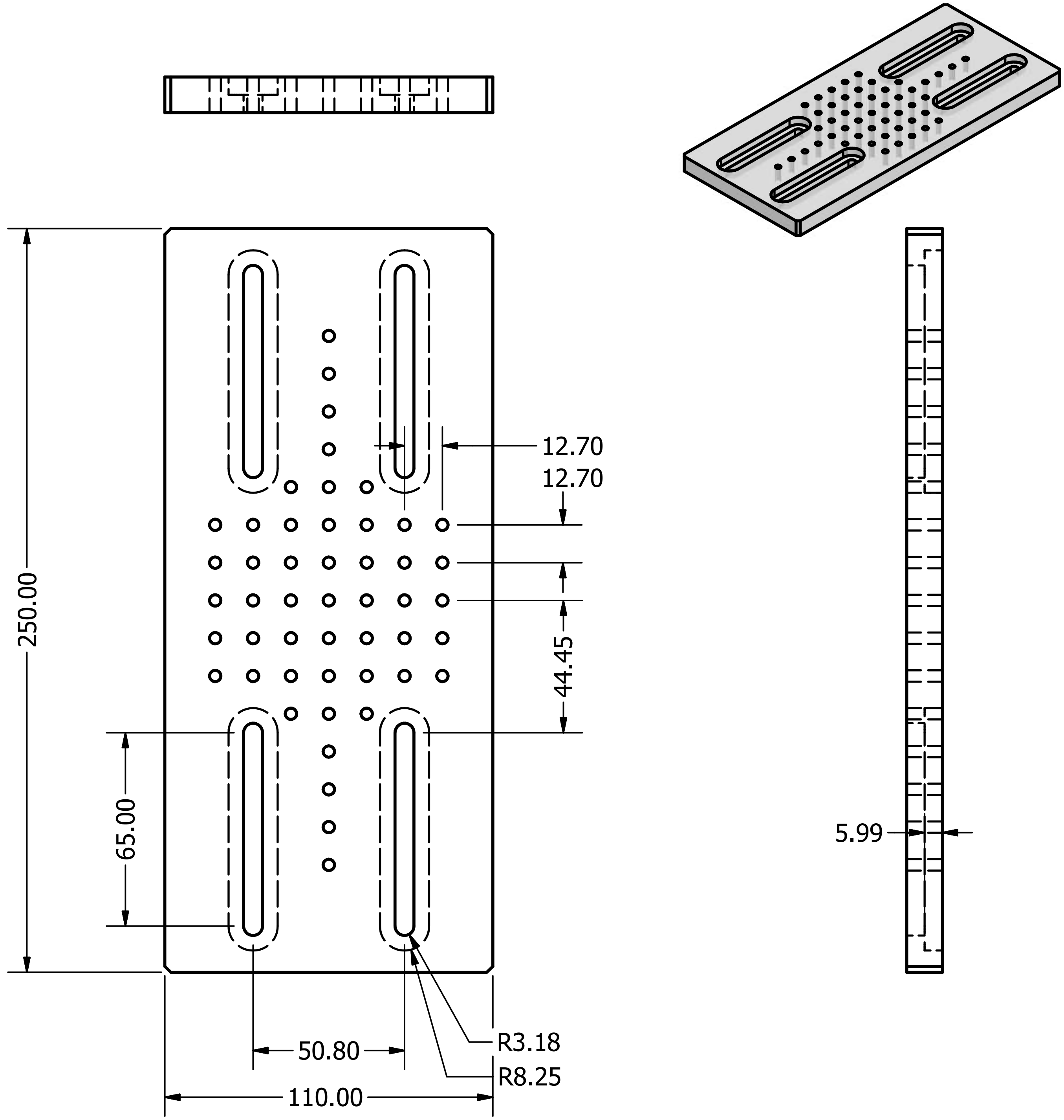
SHEET 3 OF 6



DRAWN		All units are in millimeters
CHECKED		TITLE
QA		**Sample Holder Side Plate**
MFG		
APPROVED		SIZE A — DWG NO Sample Environment Assembly — REV
		SCALE 2 : 1 — SHEET 4 OF 6



DRAWN		All units are in millimeters. All holes have an imperial thread. All holes are 8-32 tapped unless otherwise specified.
CHECKED		
QA		TITLE: Ultrasound Transducer Coupling Chamber
MFG		
APPROVED		SIZE: A; DWG NO: Sample Environment Assembly; REV
		SCALE: 1 / 2; SHEET 5 OF 6



All units are in millimeters.
All holes are 1/4"-20 tapped

DRAWN		
CHECKED		
QA		TITLE
MFG		Base Plate
APPROVED		
		SIZE A | DWG NO Sample Environment Assembly | REV
		SCALE 1 / 2 | SHEET 6 OF 6