# AN AUTOMATED SYSTEM FOR ULTRASOUND TRANSDUCER CALIBRATION:

# BEAM PLOTTING AND ACOUSTICAL OUTPUT DETERMINATION

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An automated system for use in ultrasonic transducer characterization, ultrasound attenuation measurements and as a back-up irradiation system for animal studies has been developed at the Ultrasound Research Laboratories of the Indianapolis Center for Advanced Research. This system offers the advantages of quick, accurate data aquisition and storage, plus the processing power of the digital computer for data analysis. All components with exception of the computer are portable for use throughout the laboratory. Although not yet complete, portions of the system are presently being used for routine transducer calibration and characterization. The system will now be briefly described, along with present methods of use and examples of data.

A DEC PDP-11/45 minicomputer, using a Real-time Executive Operating System, is the heart of the system. Other components include an irradiation tank with motorized axes, transducer driving system, and data processing and aquisition instruments.

The irradiation tank incorporates a stirrer and a Haake constant-temperature circulator for accurate temperature control. The three coordinate axes are driven by stepping motors which may be controlled manually or by computer. A transducer mounting scheme allows precise alignment of a variety of shapes and sizes of transducers with the coordinate system. An interchangeable electrical impedance matching network and motor-computer interfaces as well as the circulator are mounted below the tank.

electrical input system features a crystal controlled fre-
nthesizer and timing components allowing CW or burst oper-
d internal, external, or computer control. An attenuator
control provide a 110 dB range of RF drive. An ENI 320L
ower amplifier is incorporated in the system, but other
s with output powers up to 5 KW are available for use. A
tion-type pulser with control over amplitude and rise and
slopes will soon be incorporated.

essing and calibration devices include a Keithley micro-
, Millivac digital RF millivoltmeter, Lindeck Potention-
llow Springs Telethermomoter, Mediscan Hydrophone, Thermo-
obe calibrator, and several bifilar-mounted steel balls.
/D convertor used with a fast peak detector and associated
scaling circuitry and a Teleray CRT terminal provide for
aquisition capabilities.

e methods of intensity measurement are used with this
The steel ball method remains largely manual with the ex-
f calculations. These include the Yosioka correction for
properties of the ball, and area correction factor for non-
ield coverage of the ball when calibrating focused fields.
ka factor is determined using iterative methods to cal-
e correct order Bessel function.

thermocouple calibrator probe is used as a secondary stand-
output is amplified by the Keithley Microvoltmeter, dig-
d stored for processing. Figure 1 shows an example of this
output. The data is appropriately sampled and averaged
noise effects. Slope at any point desired and peak volt-
lso outputed. RF voltages may also be digitized and a
stant based on a steel ball calibration calculated. As a
r, this constant is used to determine intensity from the
data. The same system can be used for absorption measure-
inserting a thermocouple in tissue and using the appropriate
to process the data.

Mediscan hydrophone may also be calibrated using the steel
od. The fast peak detector allows the hydrophone's peak
be digitized at a slow rate precluding the necessity for
fast, expensive digitizer. Use of state-of-the-art tech-
sures acceptable linearity and frequency response. Delay
e gate are variable for selection of the portion of the
be recorded. Relative measurements of attenuation may
ade using this system.

of the greatest savings in time made possible by this
in ultrasonic field characterization. Either thermocouple
hone may be used for this purpose. Under computer control,



the measuring device scans the ultrasonic field, and the time-gated ultrasonic output is digitized and stored for plotting and processing at a later time.

Figure 2 shows a typical hydrophone plot of a sound field at the focus of a commercial visualization transducer. Programming for presentation of three-dimensional and contour plotting is presently being implemented. Figure 3 shows a comparison of thermocouple and hydrophone beam plots at the focus of an irradiation transducer. Note the close correspondence of data. This and other experimental data have shown that this correspondence holds for focused fields approaching 1 mm half-power beam widths at frequencies lower than about 3 MHz, making the hydrophone a practical instrument for field plotting of all but the most highly focused transducers.

This system uses state-of-the-art technology to relieve the researcher of needless tedium and provide for accuracy of measurement minimally influenced by human errors. At the same time, the system was designed with consideration of the economical aspects of hardware, software and human operator time involvement.

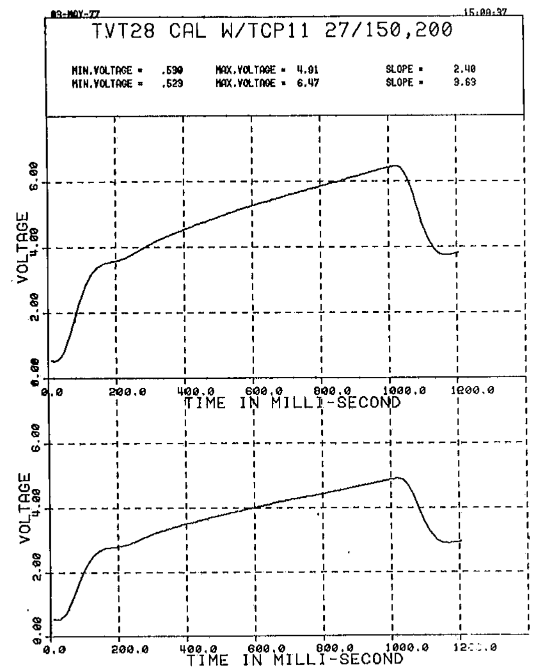


Figure 1

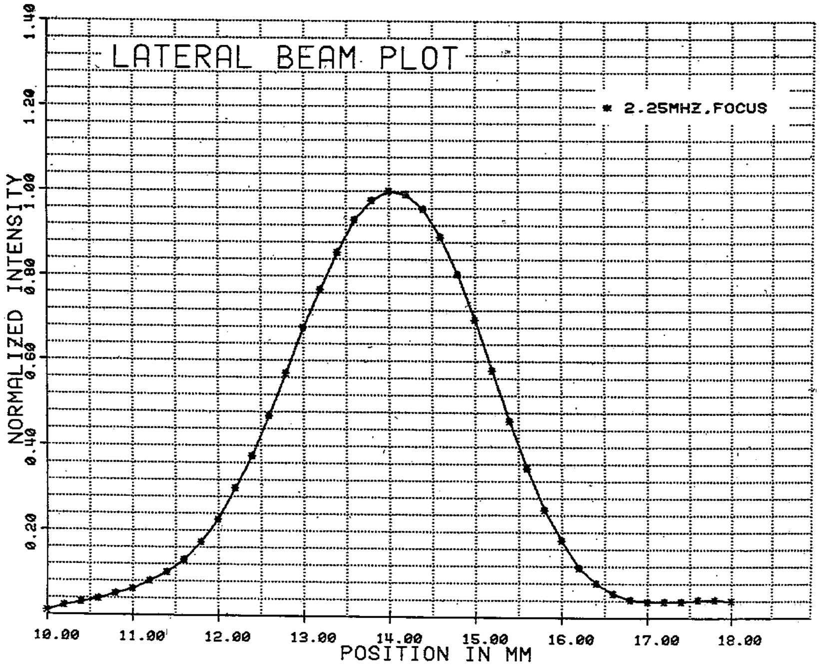


Figure 2

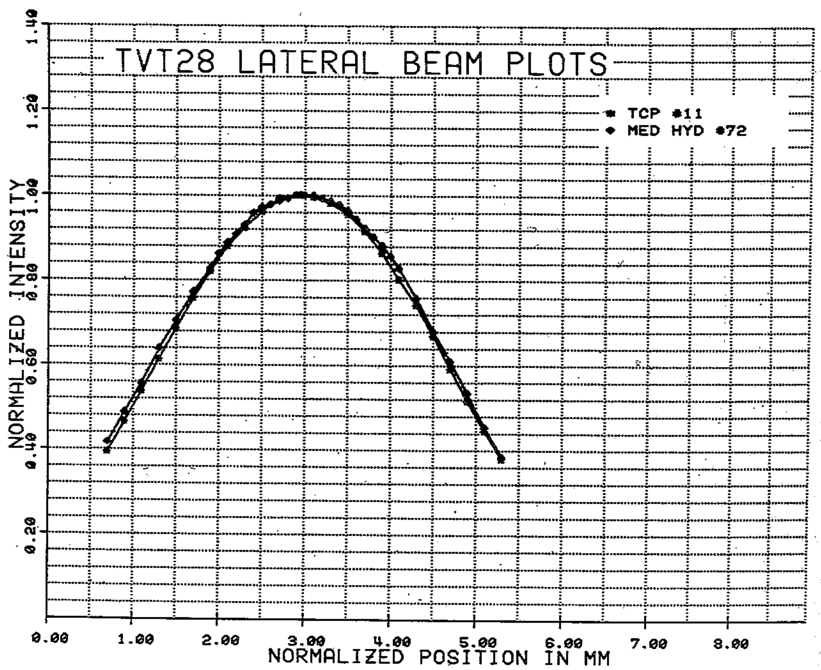


Figure 3