

N91 - 18193

**ACOUSTO-ULTRASONIC NONDESTRUCTIVE
EVALUATION OF MATERIALS USING
LASER BEAM GENERATION AND DETECTION**

Robert D. Huber and Robert E. Green Jr.
Center for Nondestructive Evaluation
The Johns Hopkins University
and
Alex Vary and Harold Kautz
NASA/Lewis Research Center

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RESEARCH OBJECTIVE

**TO INVESTIGATE THE POSSIBILITY OF USING LASER
GENERATION AND DETECTION OF ULTRASOUND TO
REPLACE PIEZOELECTRIC TRANSDUCERS FOR THE
ACOUSTO-ULTRASONIC TECHNIQUE.**

ADVANTAGES OF LASER ACOUSTO-ULTRASONICS

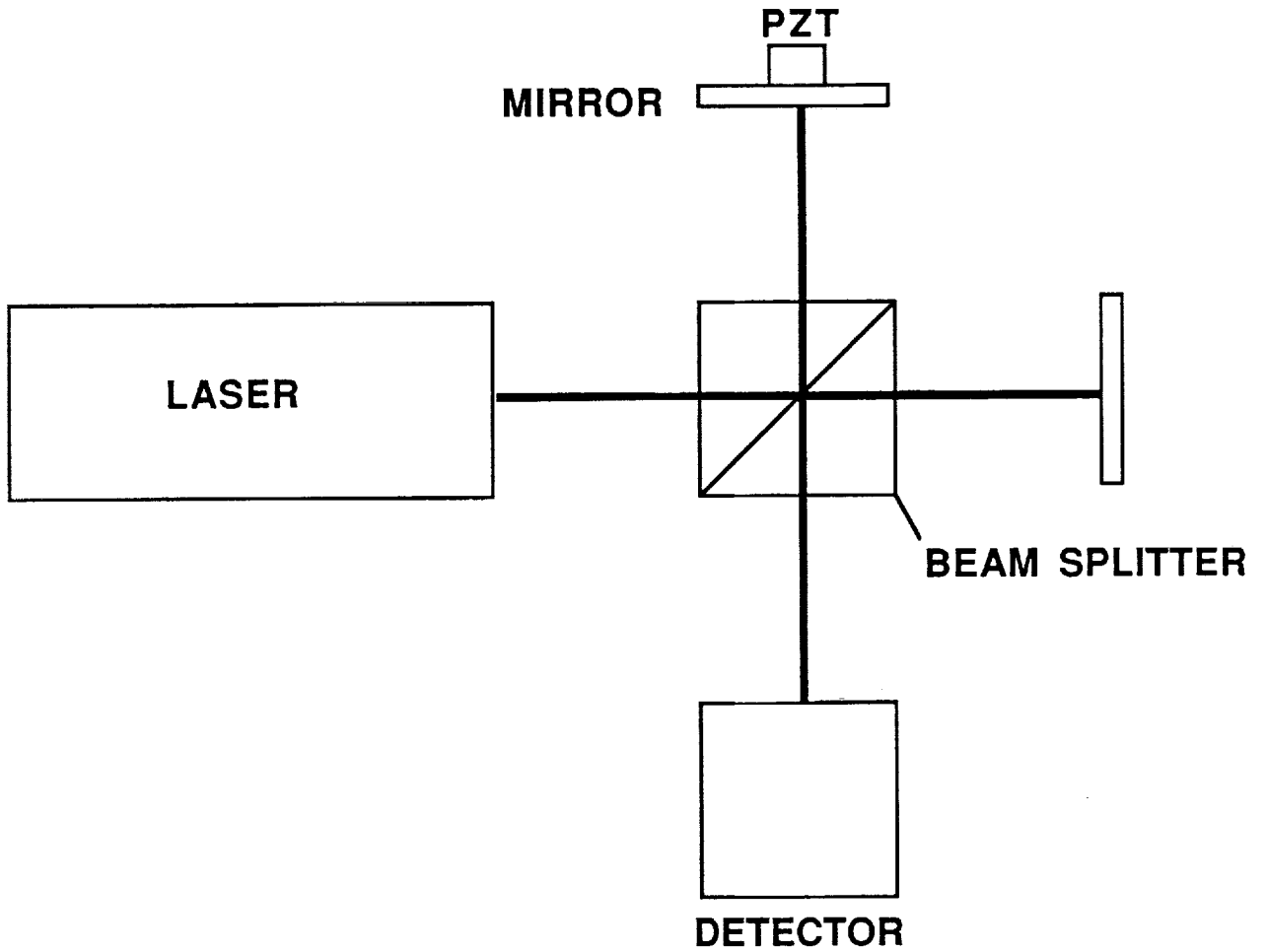
- **NON-CONTACT TESTING**
- **PIEZOELECTRIC TRANSDUCER COUPLING PROBLEMS ELIMINATED**
 - CONTACT PRESSURE**
 - COUPLANT**
 - TESTING HOT SURFACES OR IN HOSTILE ENVIRONMENTS**
- **RESONANCE OF TRANSDUCERS ELIMINATED**
- **POINT DETECTION**
- **NARROW AND WIDE BAND DETECTION**
- **DETECTION NEAR MATERIAL EDGES**

DISADVANTAGES OF LASER DETECTION

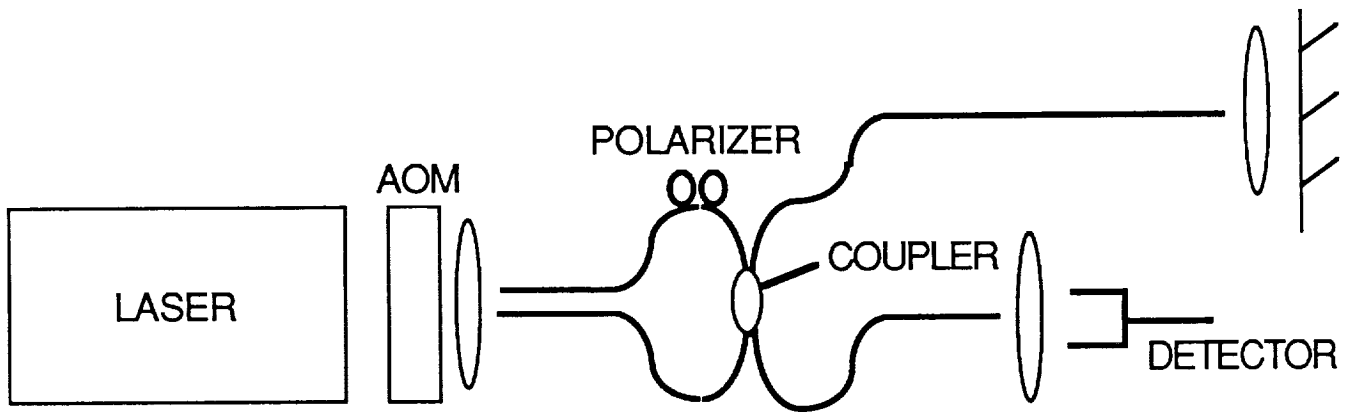
- **SURFACE MUST BE REFLECTIVE**
- **NOT AS SENSITIVE AS PIEZOELECTRIC TRANSDUCERS**
- **OPTICAL SYSTEMS ARE OFTEN MORE EXPENSIVE**

TYPES OF INTERFEROMETERS USED

- PATH STABILIZED BULK SYSTEM**
- HETERODYNE FIBER OPTIC SYSTEM**



PATH STABILIZED INTERFEROMETER



HETERODYNE FIBER OPTIC INTERFEROMETER

INTERFEROMETER

SENSITIVITY CONSIDERATIONS

$$\text{SNR} \propto \left[\frac{R P_o \eta}{h \nu \Delta \nu} \right]^{1/2} \frac{\delta}{\lambda}$$

h : PLANCK'S CONSTANT

λ : OPTICAL WAVELENGTH

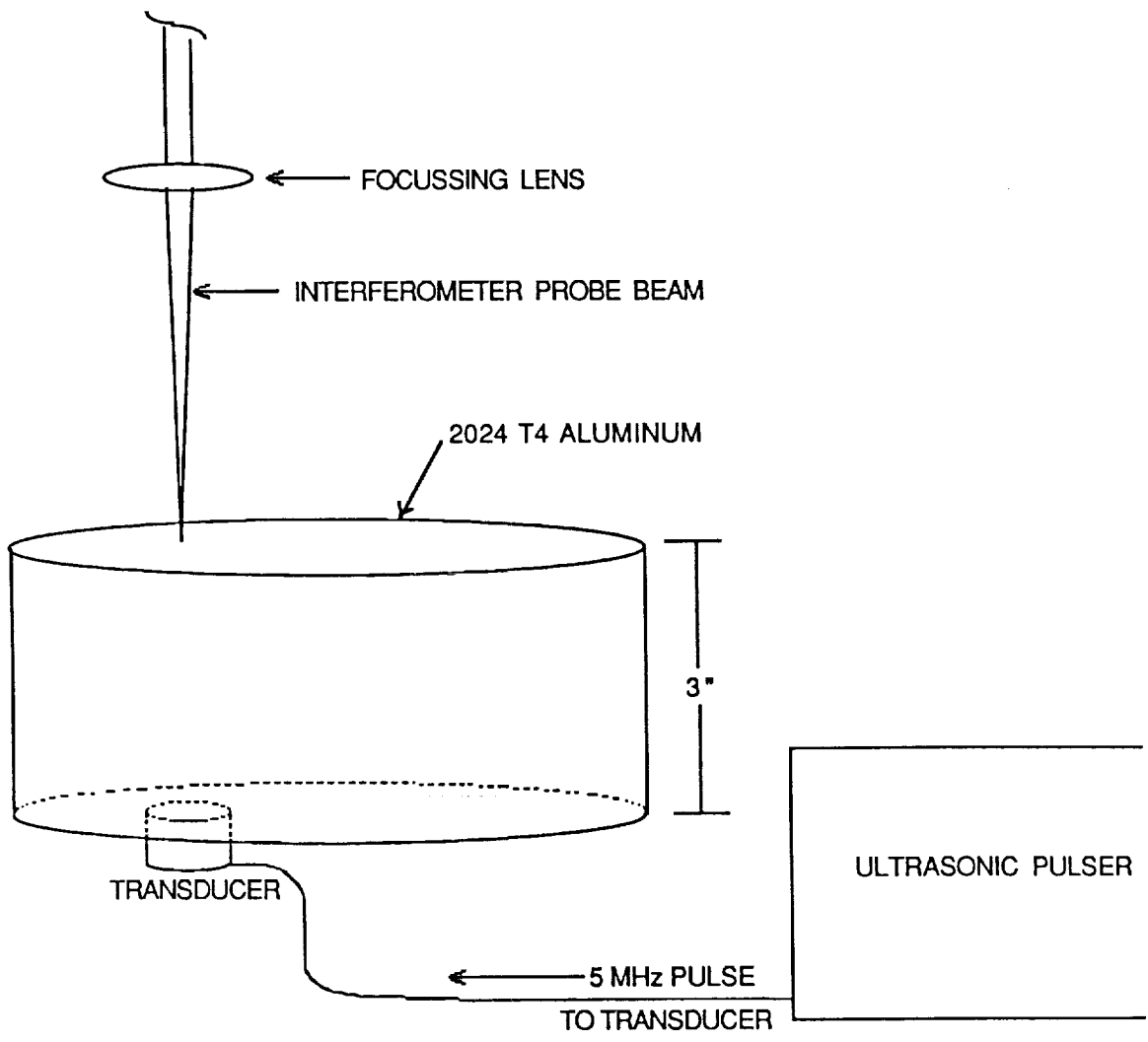
η : DETECTOR QUANTUM EFFICIENCY

δ : SIGNAL AMPLITUDE

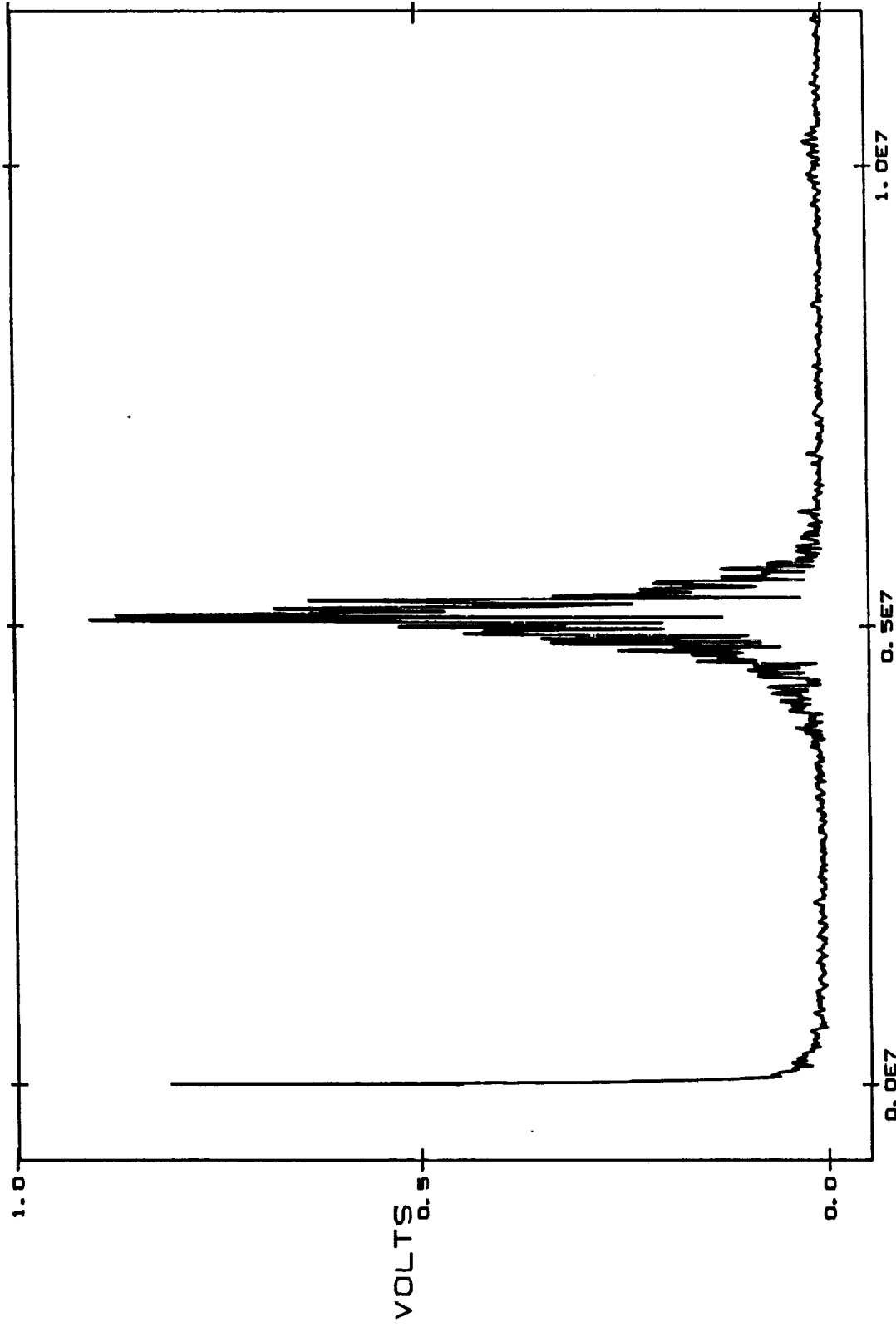
Δν : DETECTION BANDWIDTH

R : SAMPLE REFLECTIVITY

P_o : LASER POWER



MAG. A1



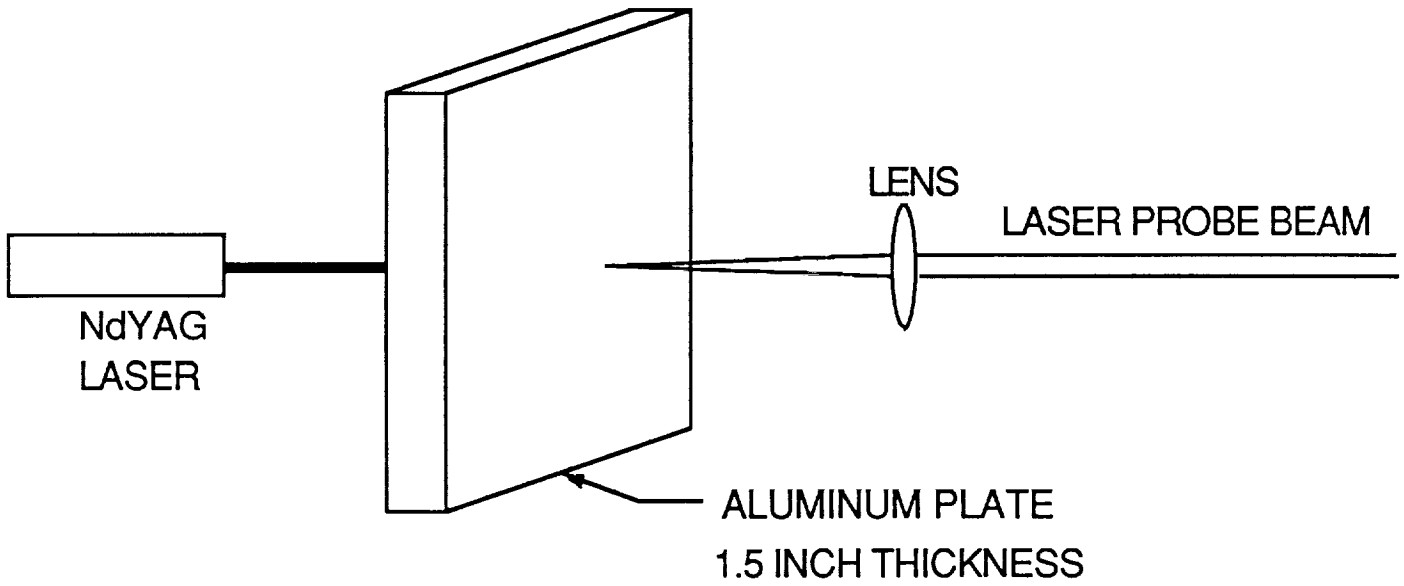
LASER GENERATION OF ULTRASOUND

KIGRE Nd YAG PULSED LASER

17 mJ PER PULSE

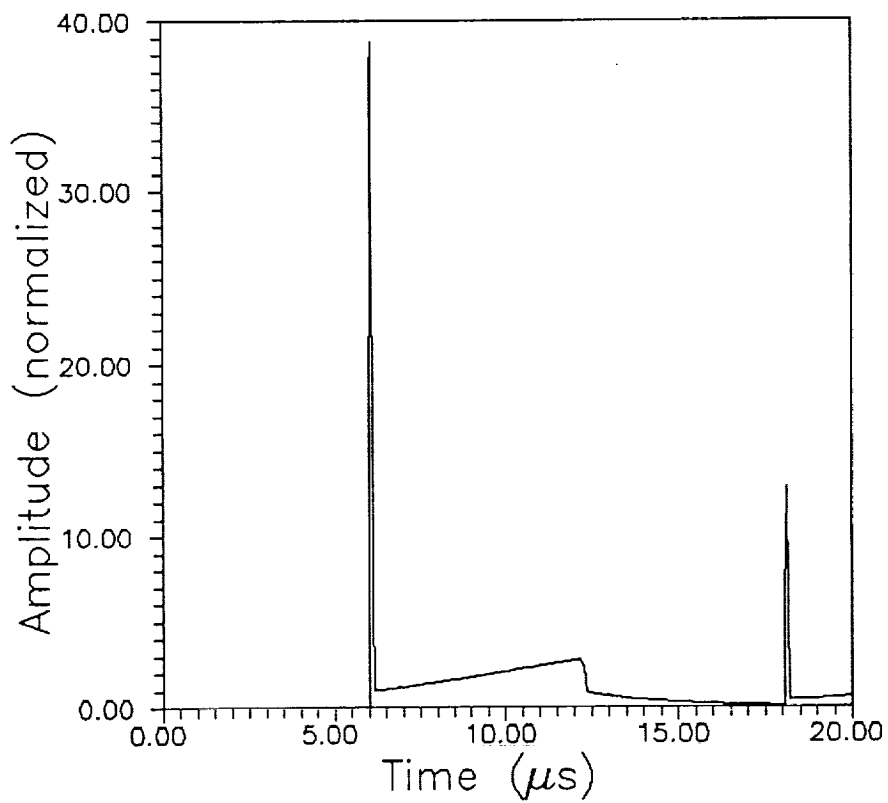
4 ns PULSE LENGTH

3 mm BEAM DIAMETER

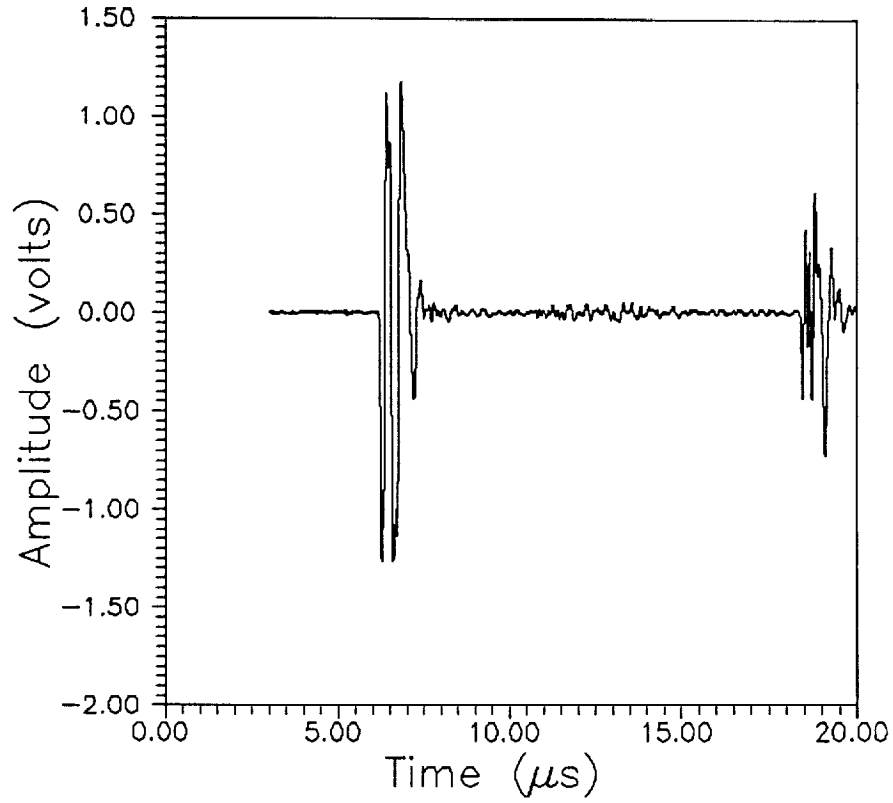


NON-CONTACT GENERATION AND DETECTION OF
ULTRASOUND IN AN ALUMINUM BLOCK

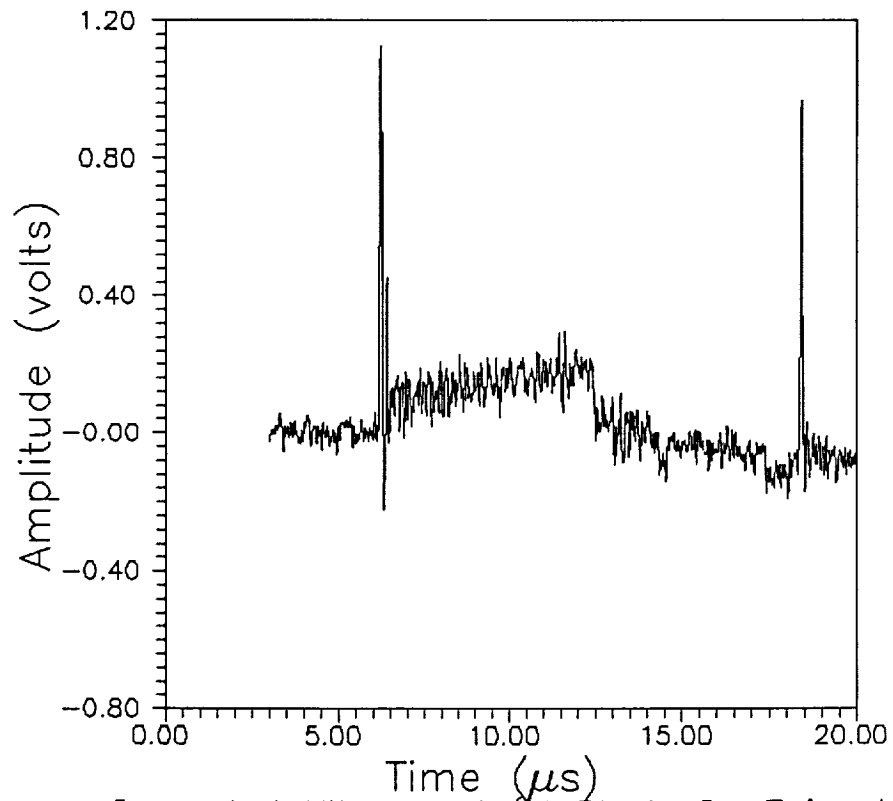
Theoretical Surface Displacement For Laser
Generated Ultrasound In A 1.5 in Al Block
On Epicenter



Piezoelectric Detection

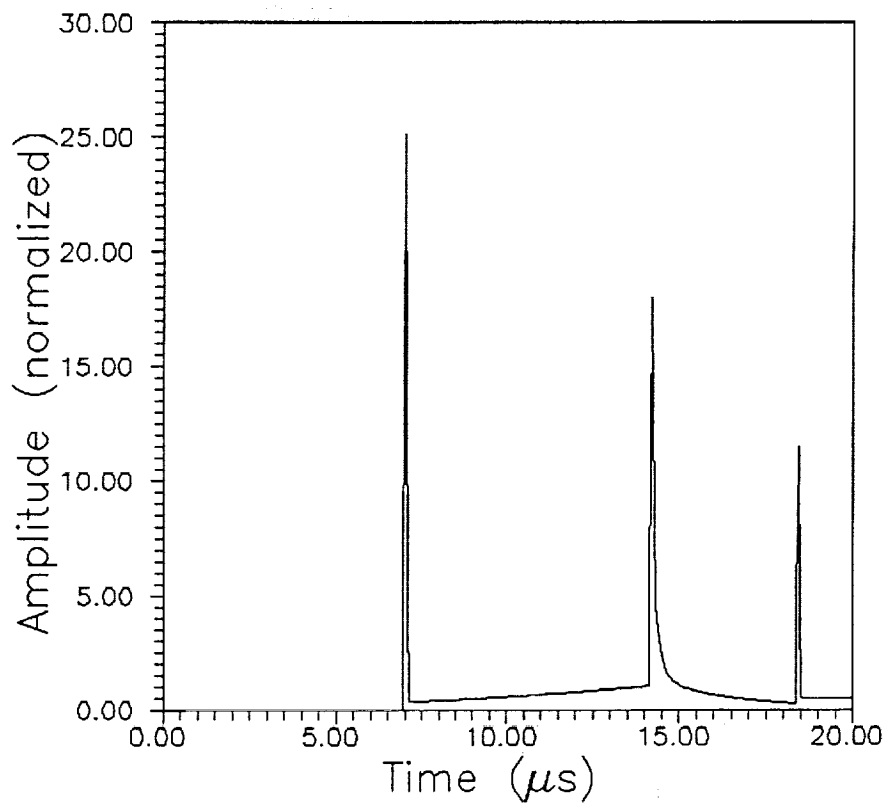


Interferometric Detection

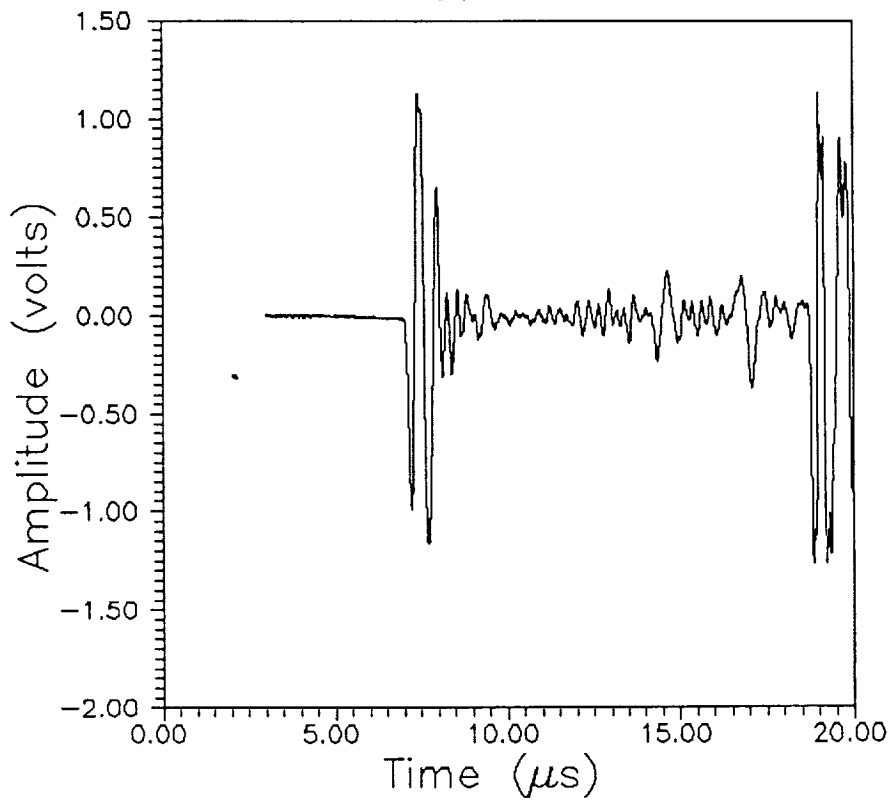


Laser Generated Ultrasound (Al Block-On Epicenter)

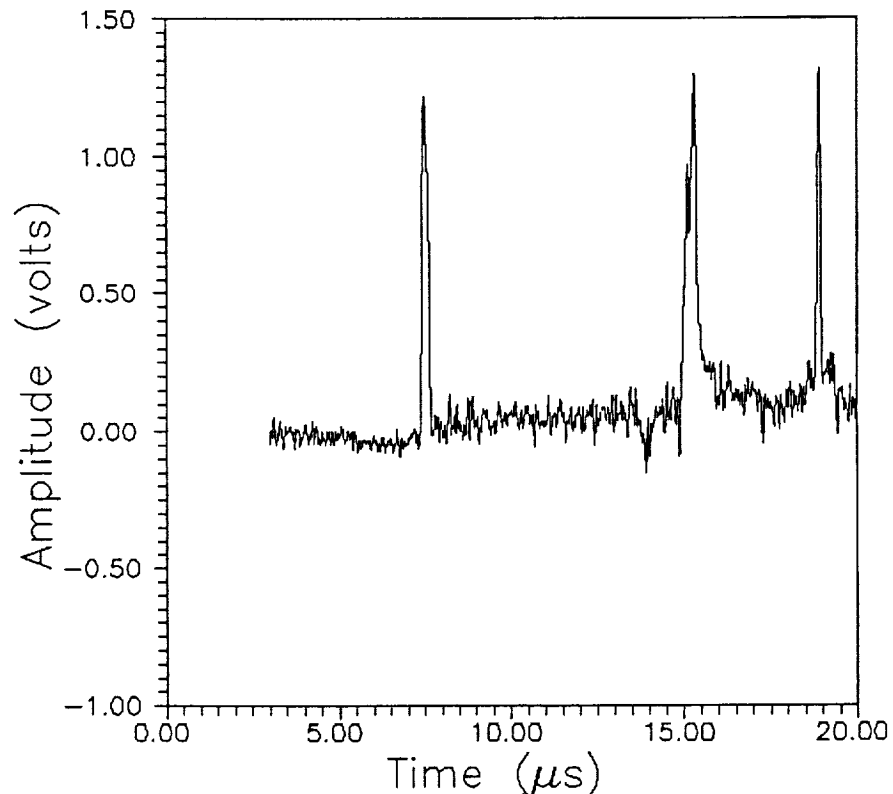
Theoretical Surface Displacement For Laser
Generated Ultrasound In A 1.5 in Al Block
7/8 in Off Epicenter



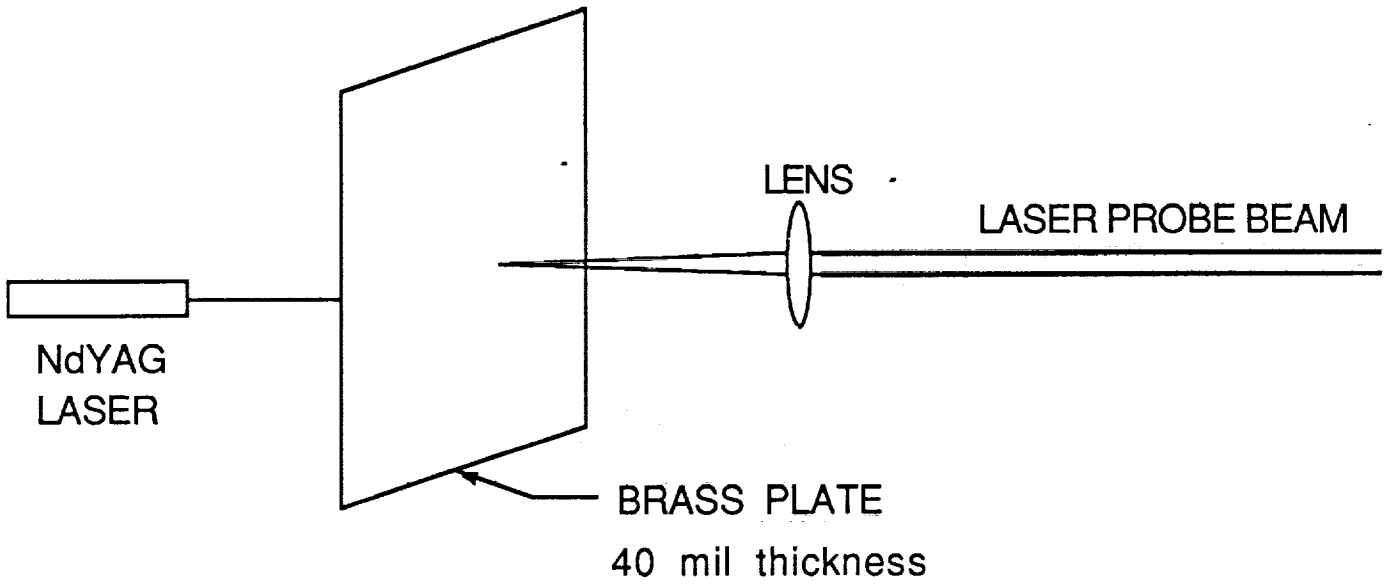
Piezoelectric Detection



Interferometric Detection

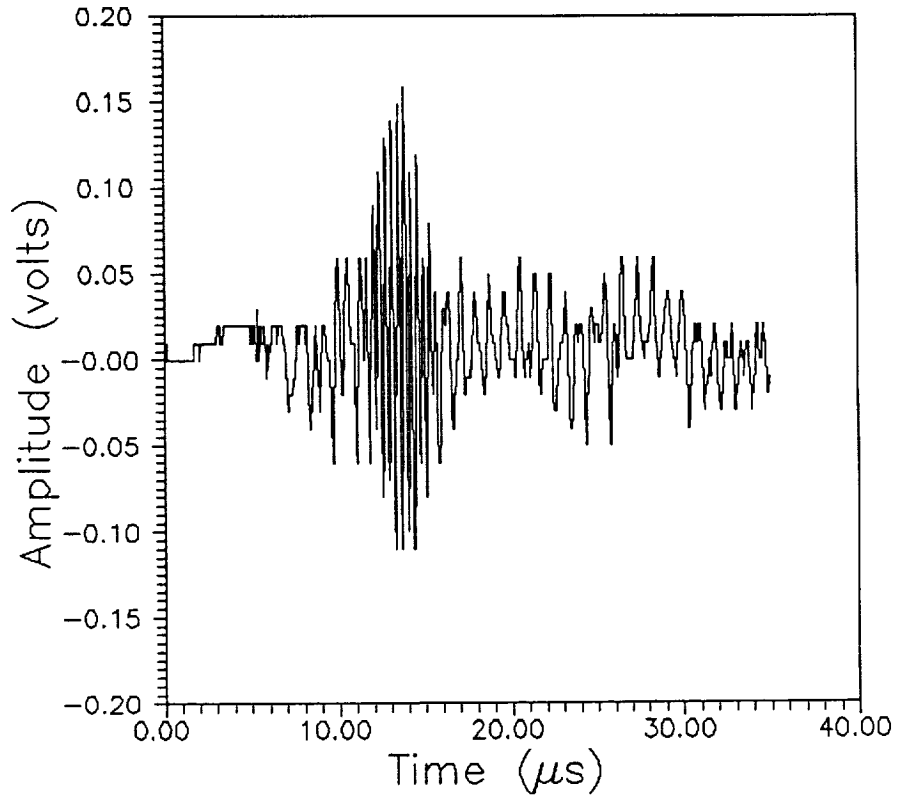


Laser Generated Ultrasound (Al Block-Off Epicenter)

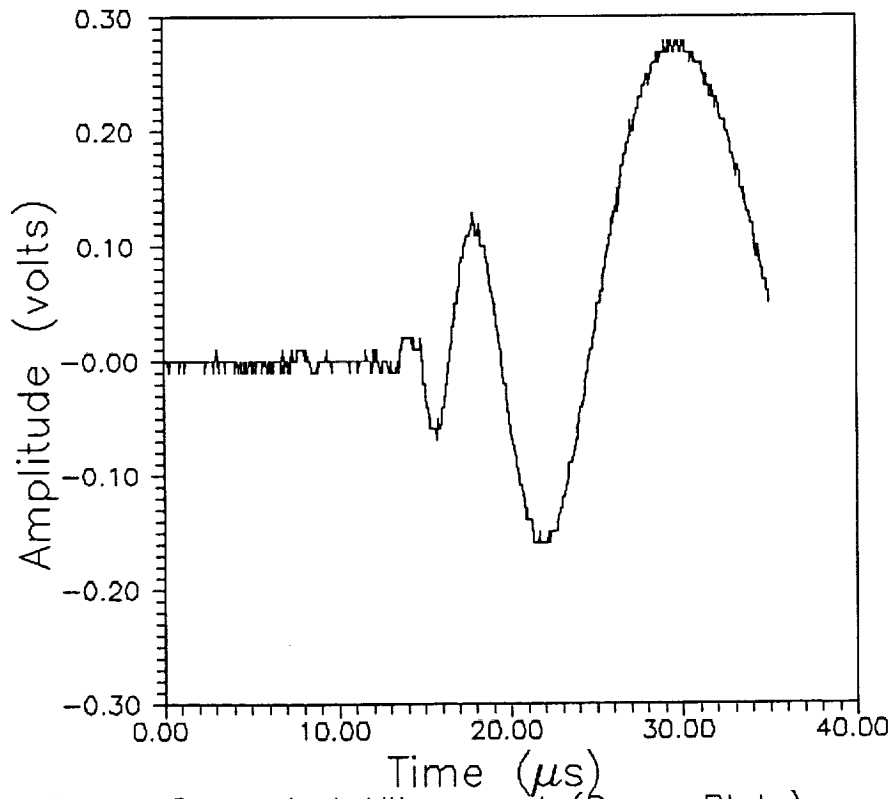


NON-CONTACT GENERATION AND DETECTION
OF ULTRASOUND IN A BRASS PLATE

Piezoelectric Detection

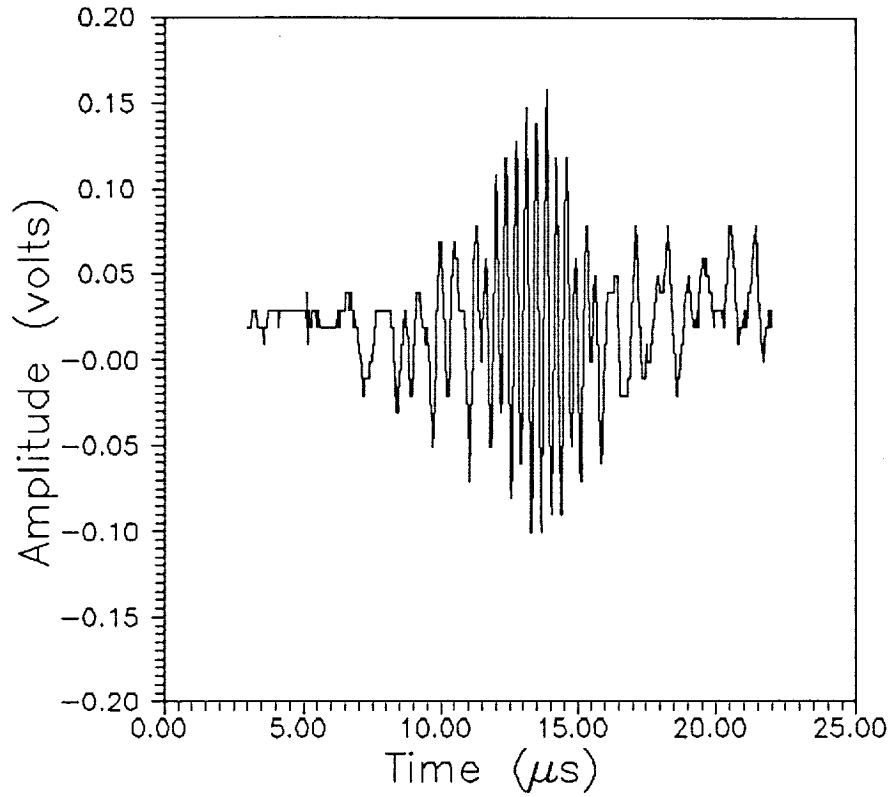


Interferometric Detection

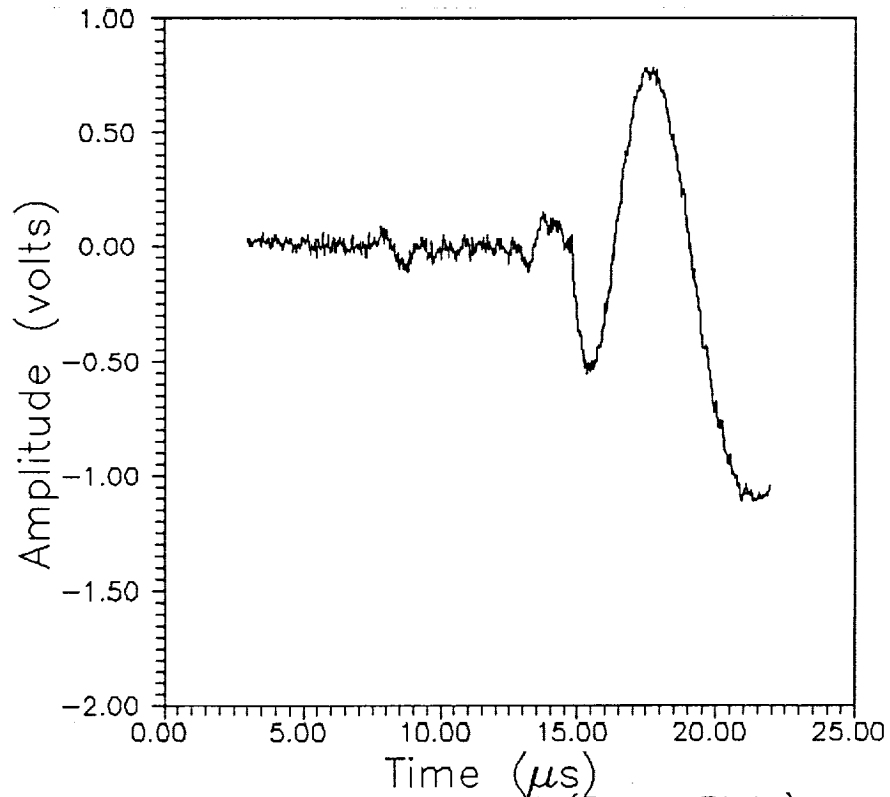


Laser Generated Ultrasound (Brass Plate)

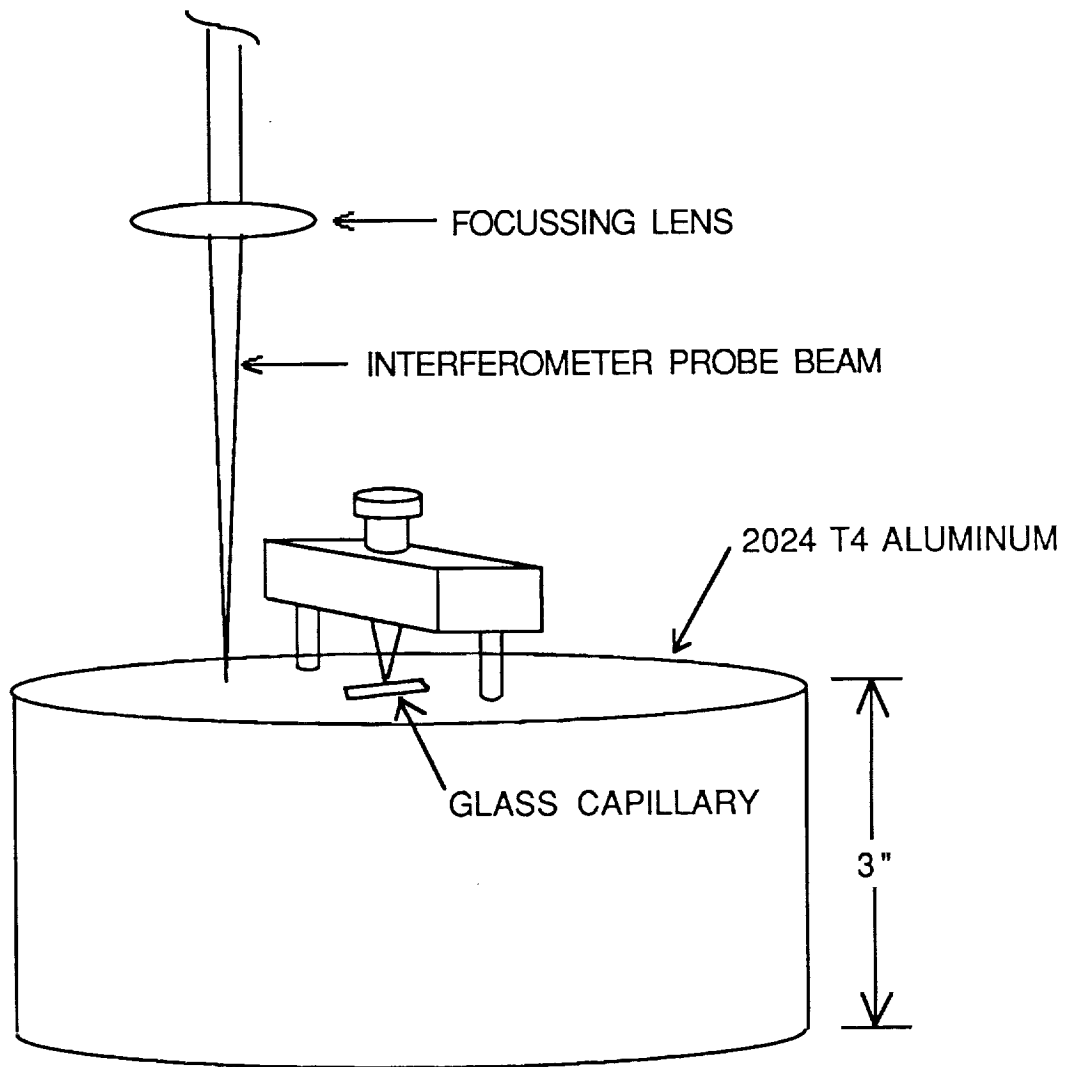
Piezoelectric Detection



Interferometric Detection



Laser Generated Ultrasound (Brass Plate)



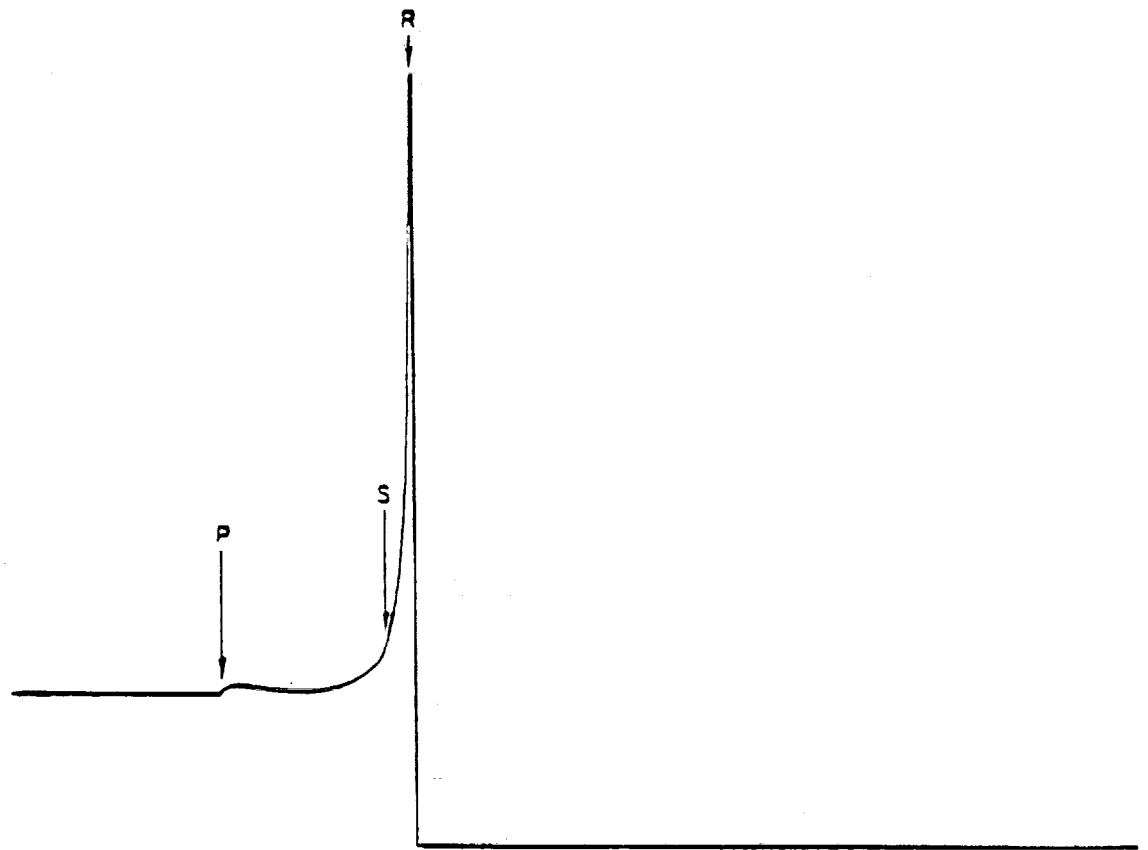
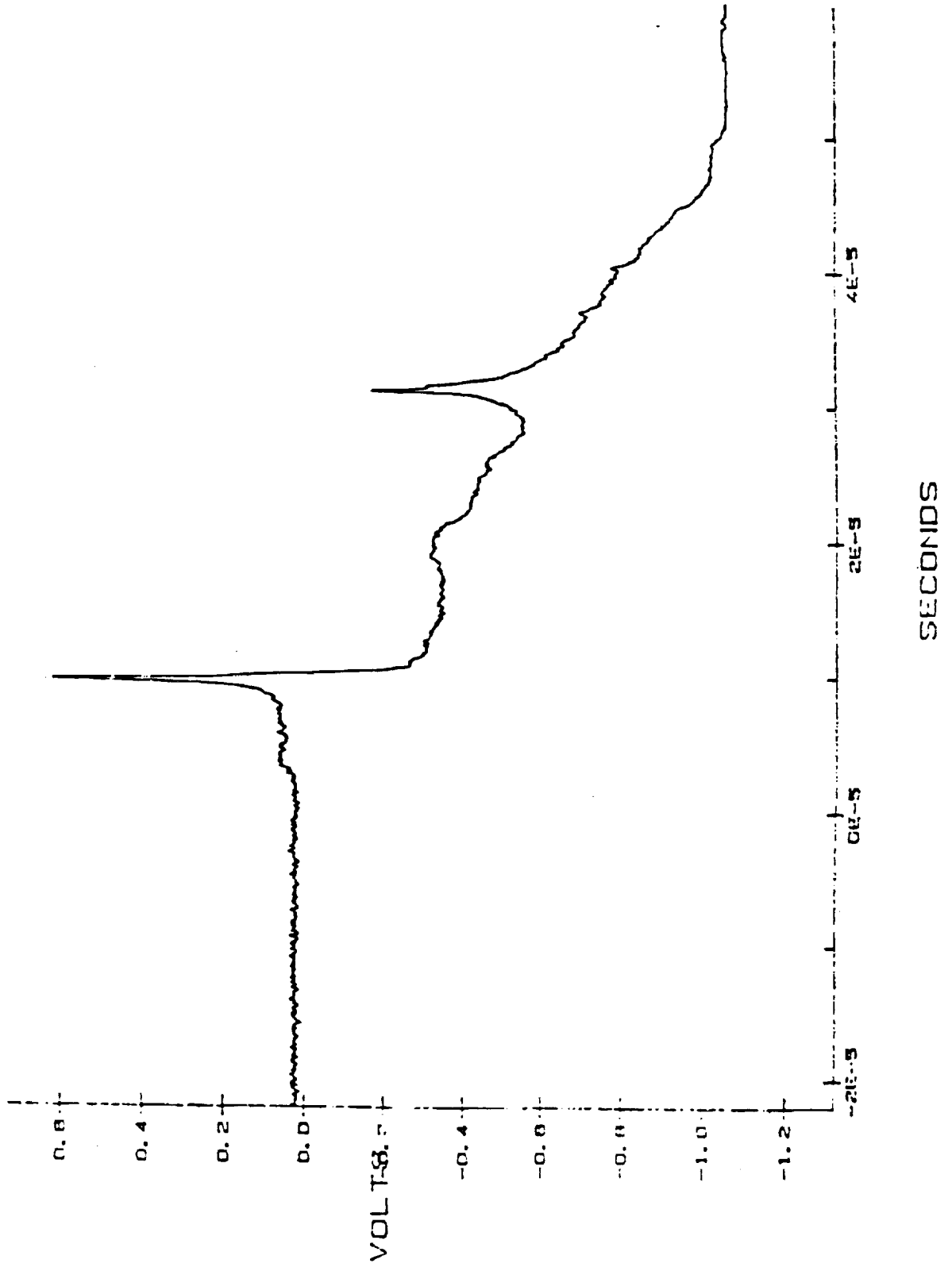


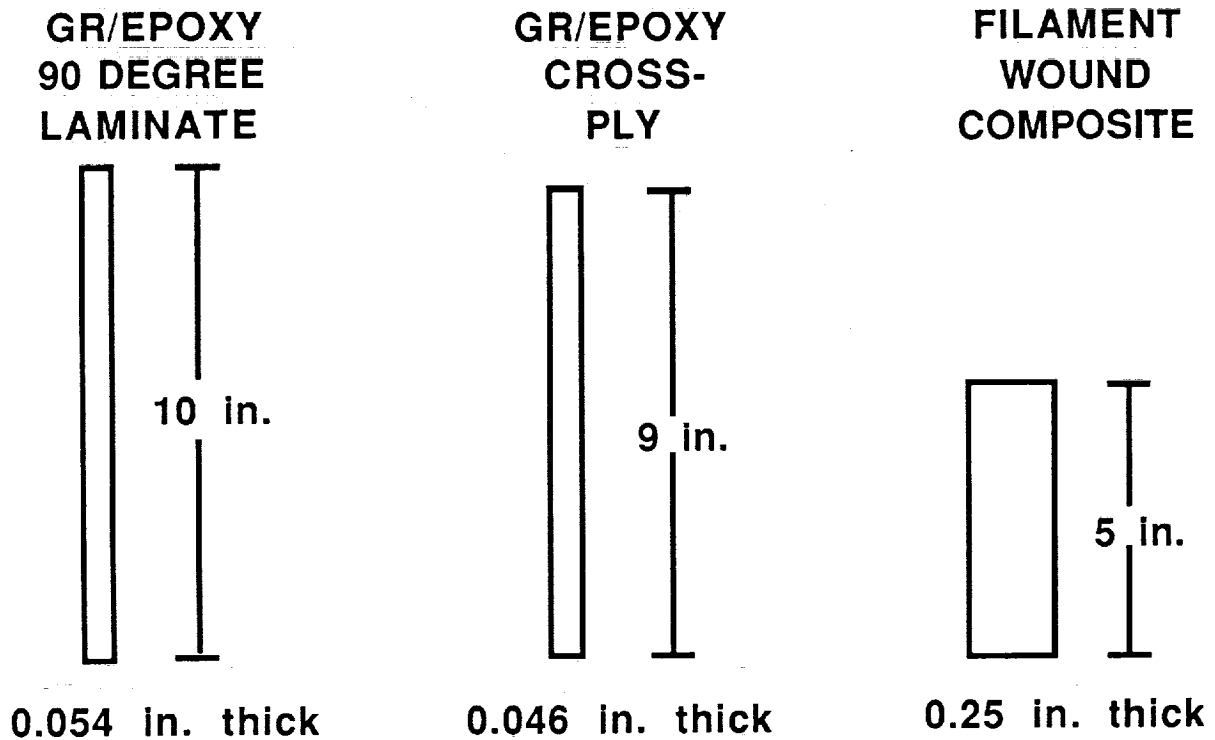
Figure 2.

THEORETICAL RECORD OF A STEP-LOADING
POINT SOURCE STRIKING AN INFINITE HALF-SPACE

FLTRXO

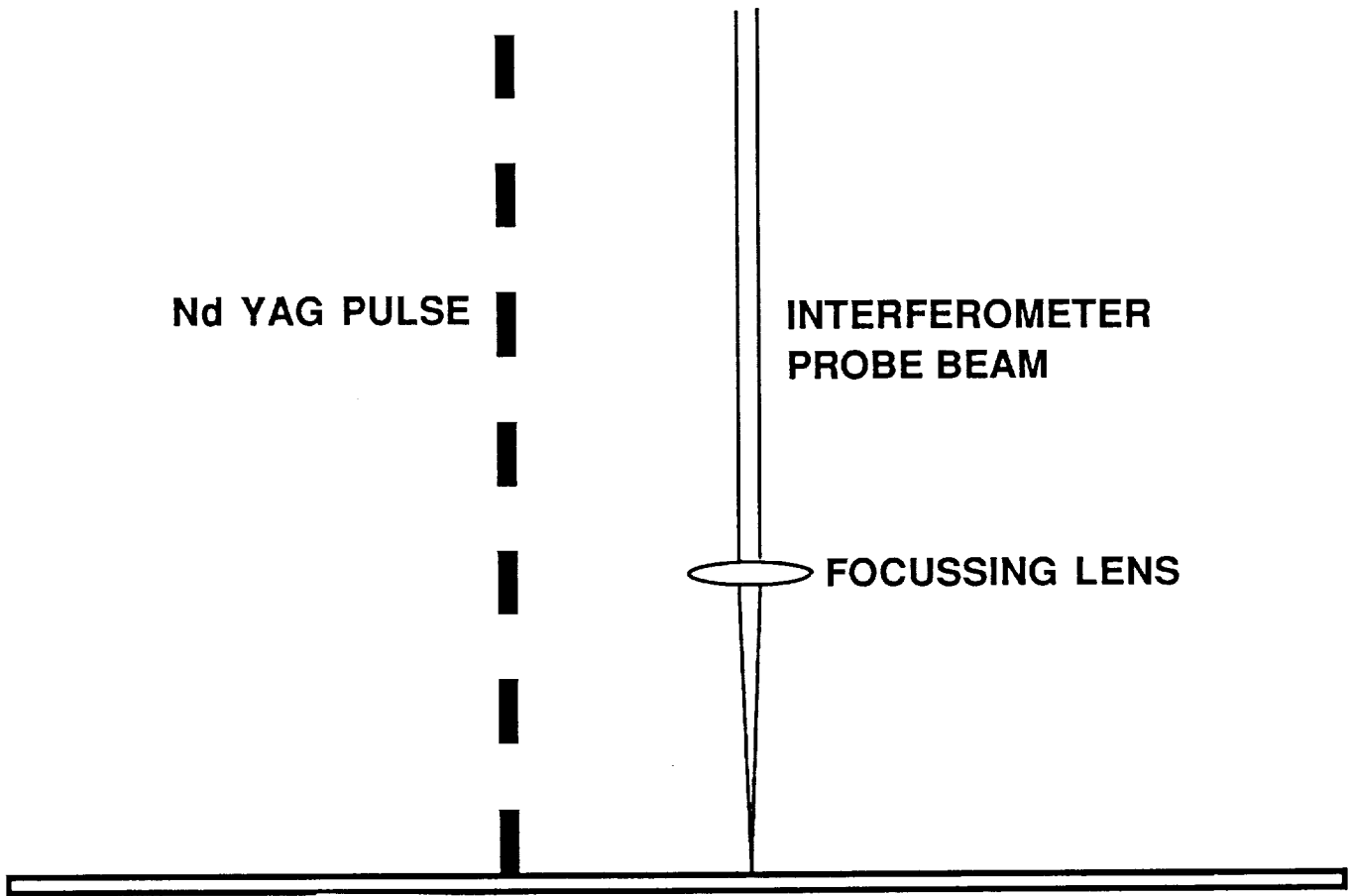


DIMENSIONS OF SAMPLES USED IN LASER ACOUSTO-ULTRASONIC TESTS



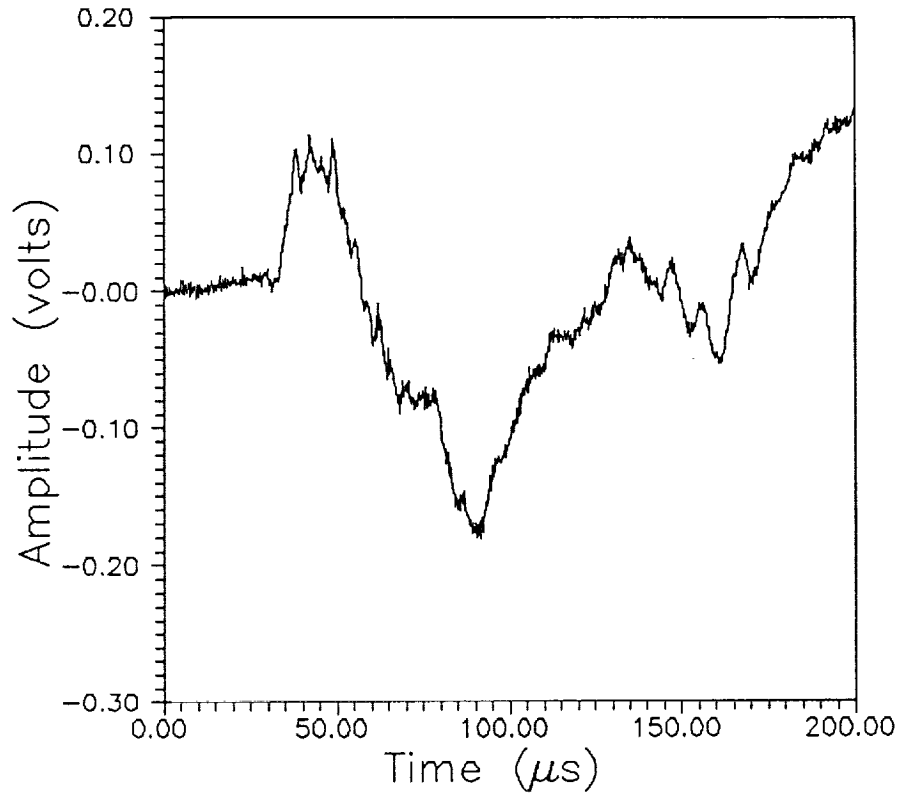
(ALL SPECIMENS 0.5 INCHES WIDE)

***3M SILVER POLYESTER FILM TAPE WAS USED AT
DETECTION SITES TO INCREASE REFLECTIVITY**

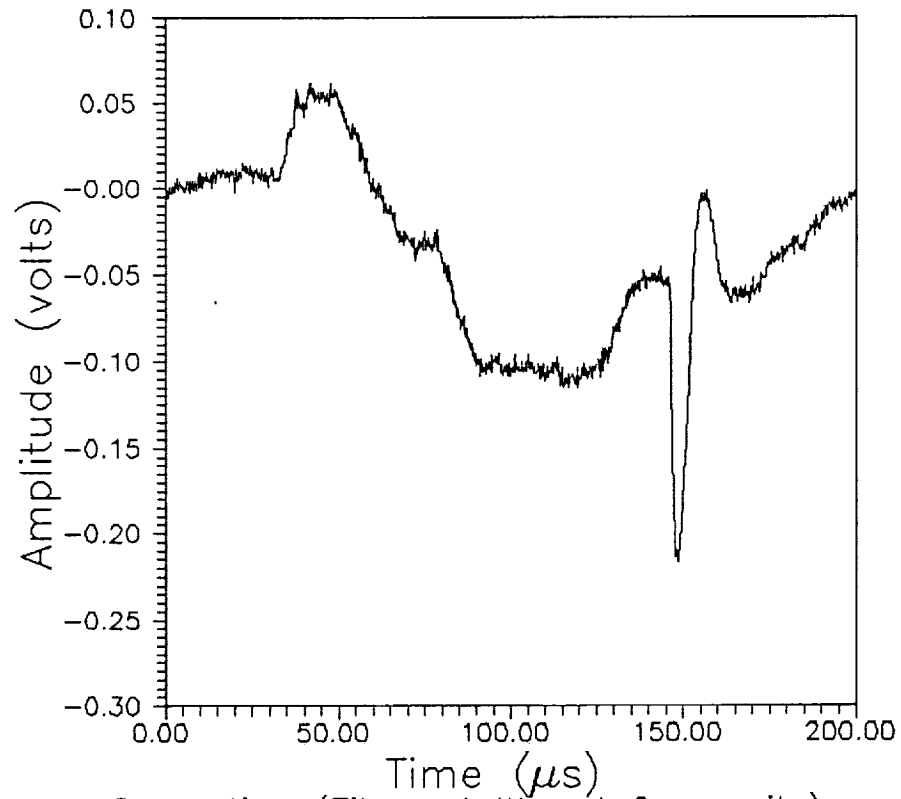


LASER ACOUSTO-ULTRASONICS

Piezoelectric Detection

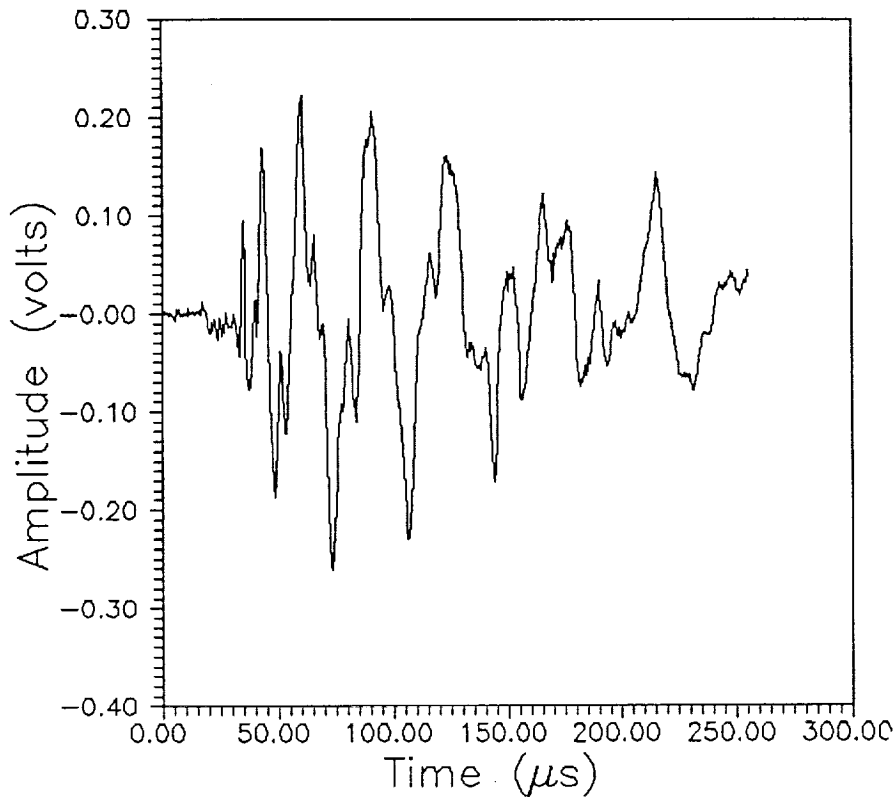


Interferometric Detection

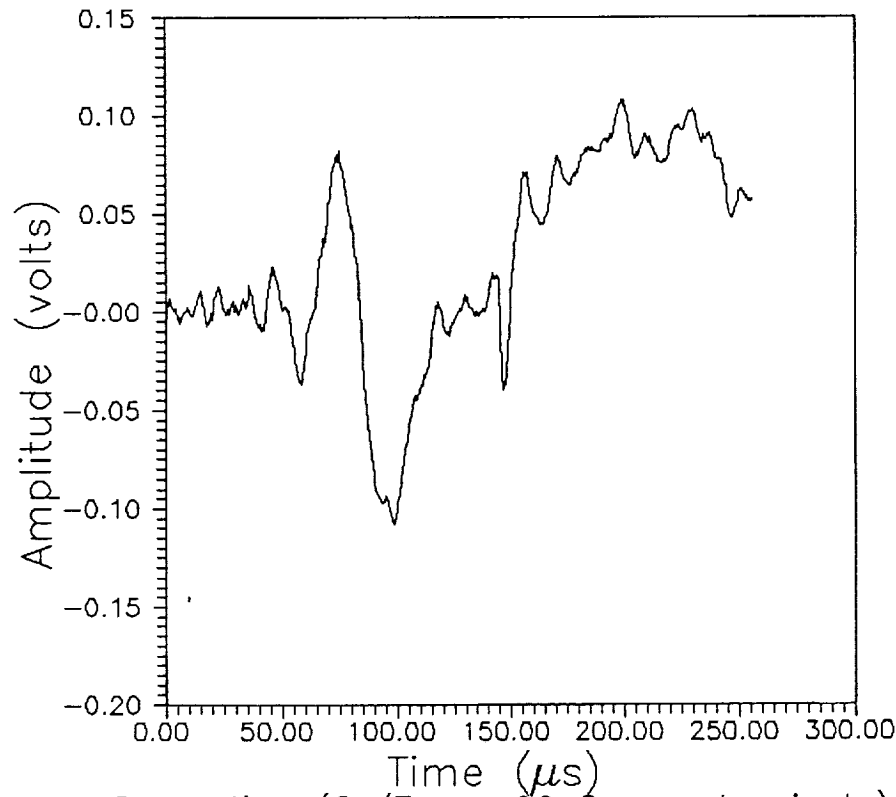


Laser Generation (Filament Wound Composite)

Piezoelectric Detection

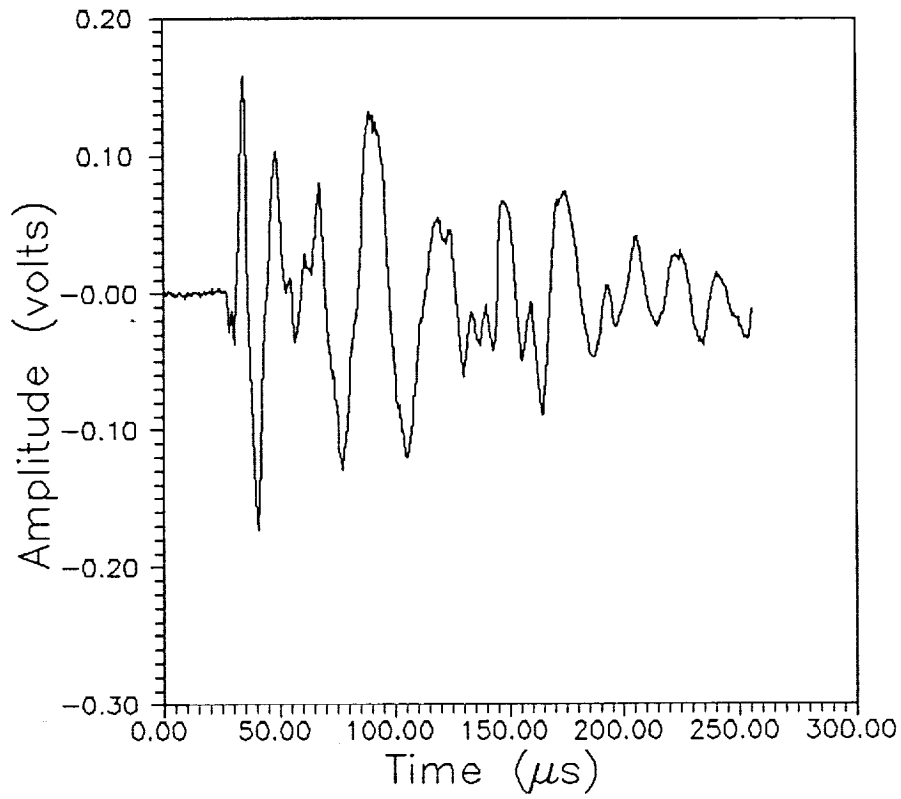


Interferometric Detection

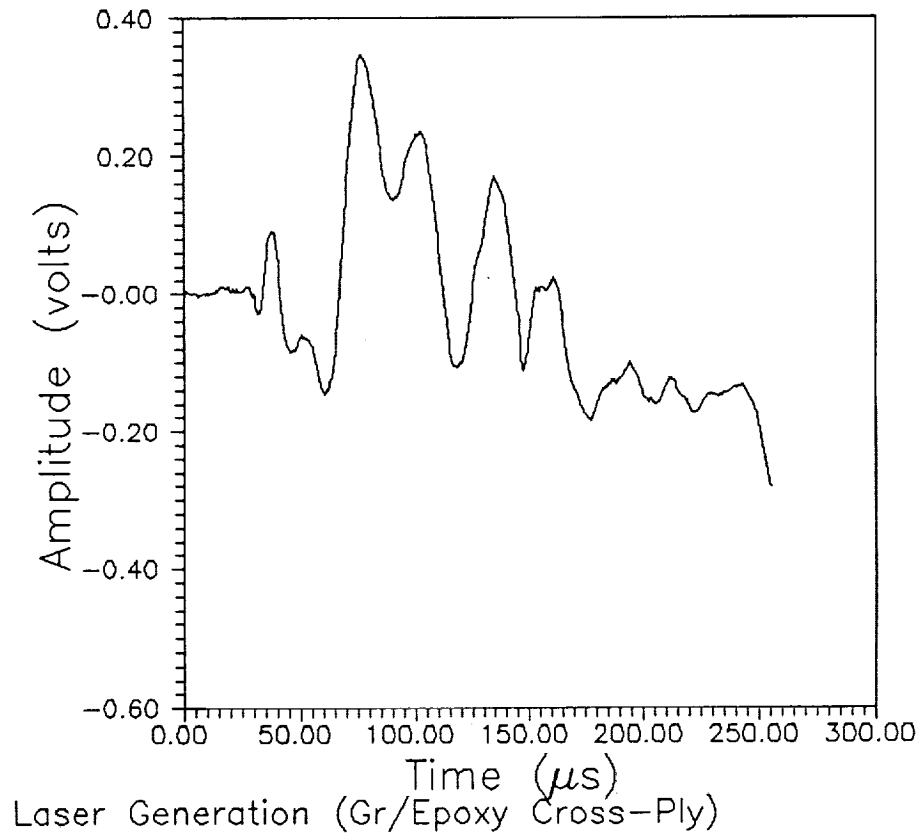


Laser Generation (Gr/Epoxy 90 Degree Laminate)

Piezoelectric Detection



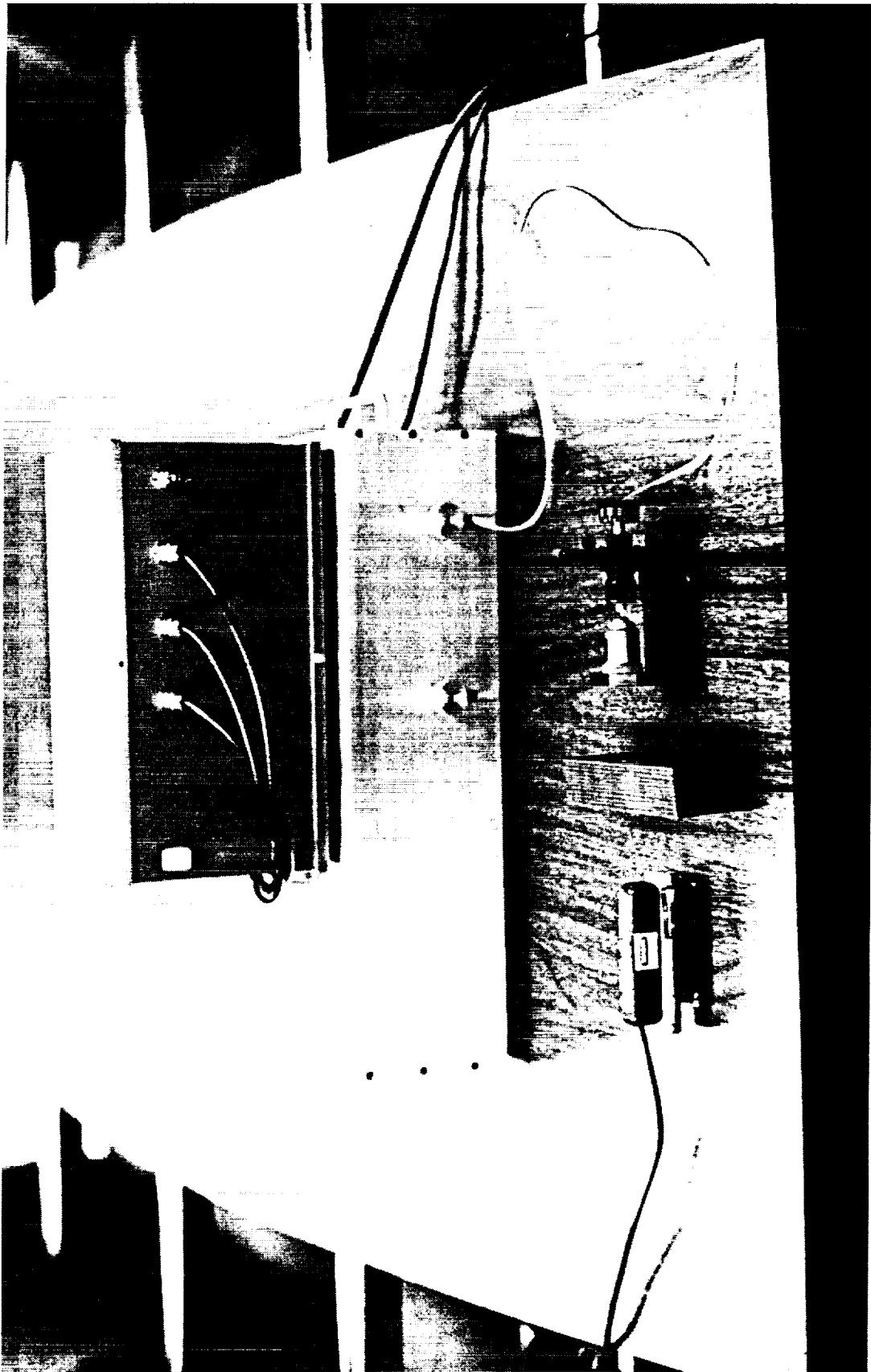
Interferometric Detection



Laser Generation (Gr/Epoxy Cross-Ply)

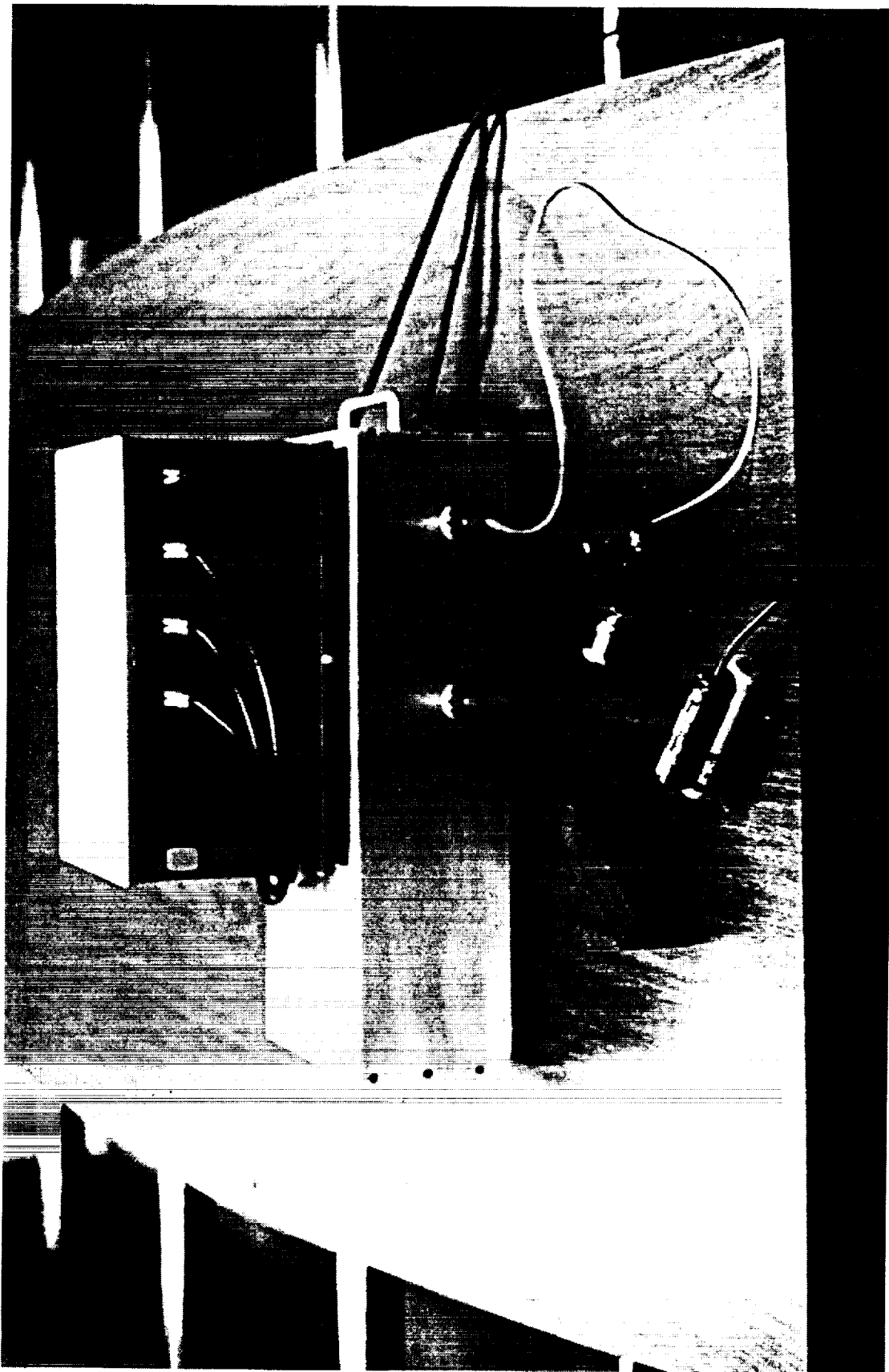
SUMMARY

**LASER ACOUSTO-ULTRASONICS COMPLEMENTS
STANDARD PIEZOELECTRIC ACOUSTO-ULTRASONICS
AND OFFERS NON-CONTACT NONDESTRUCTIVE
EVALUATION.**



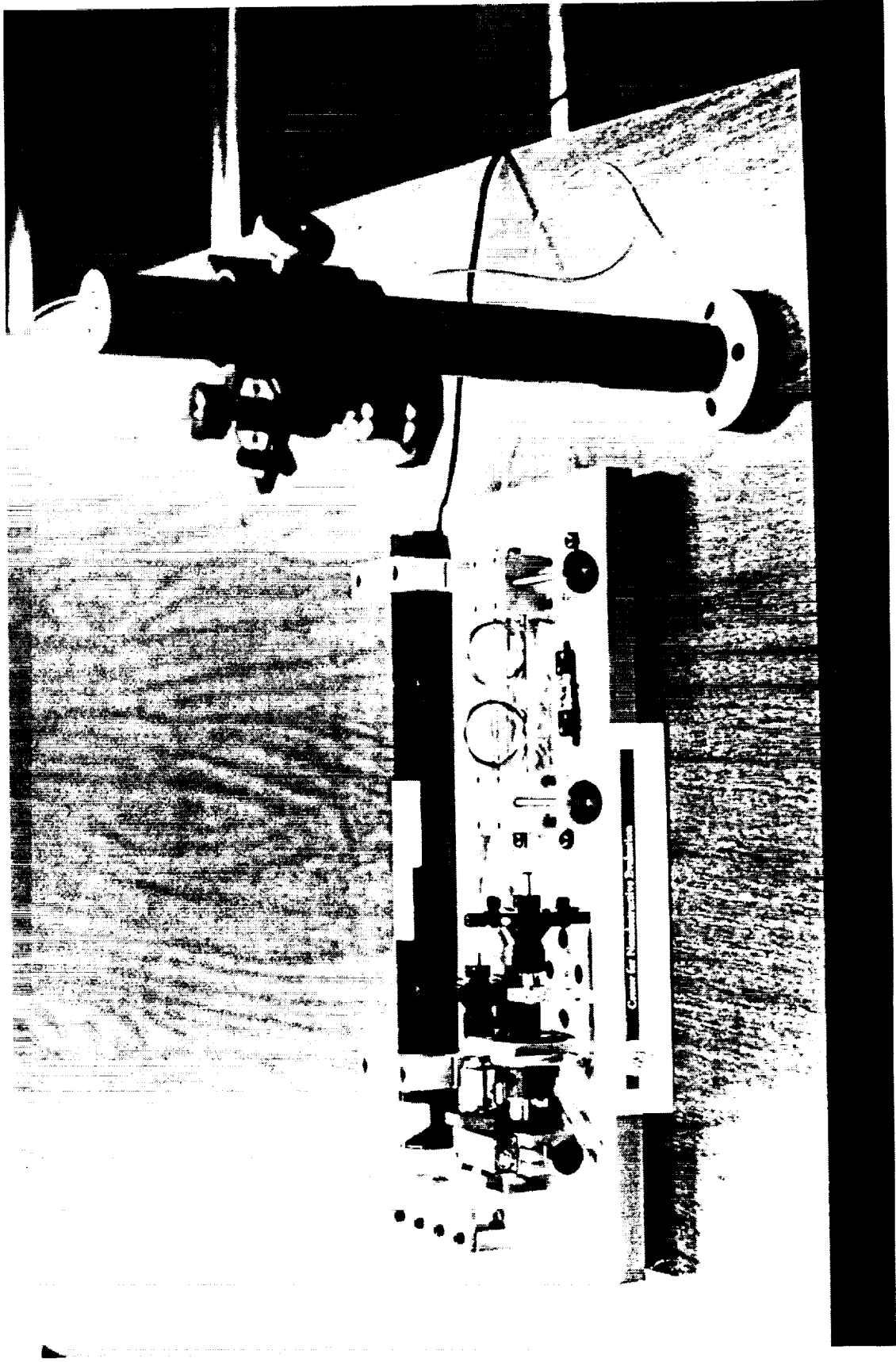
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