

LARGE AREA, REAL TIME INSPECTION OF ROCKET MOTORS USING A NOVEL HANDHELD ULTRASOUND CAMERA



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Report Documentation Page

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Purpose of Work

- Describe operation of Imperium ultrasound camera
- Describe work done with camera under Air Force Research Laboratory SBIR program
- Present results to date and work remaining under this contract

Objectives

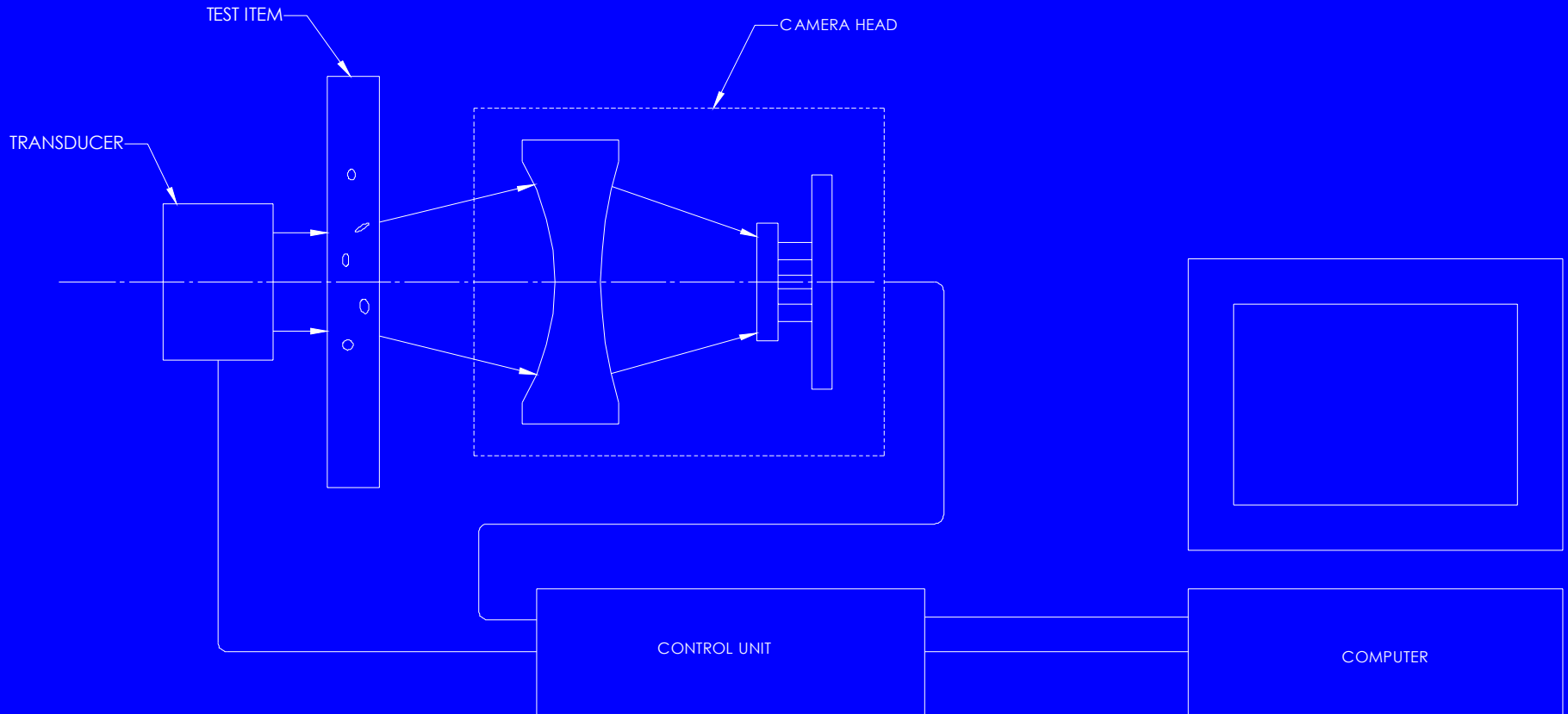
Phase I

- Demonstrate the applicability of the Imperium ultrasound camera to the inspection of Solid Rocket Motors (SRM)

Phase II

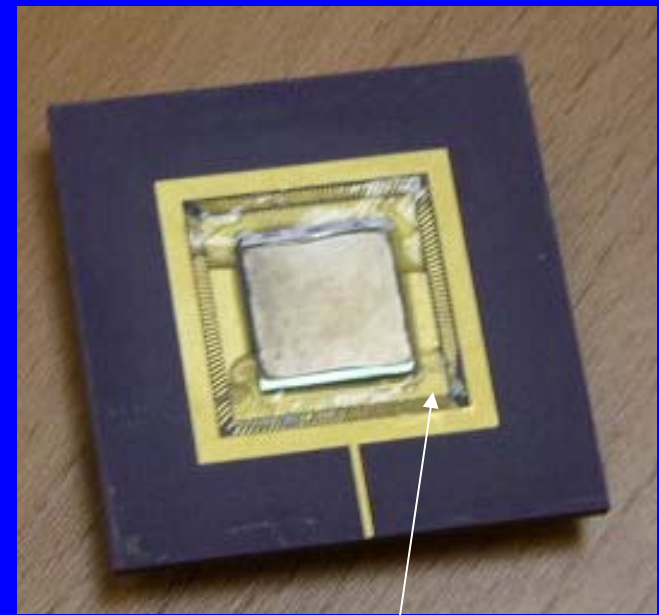
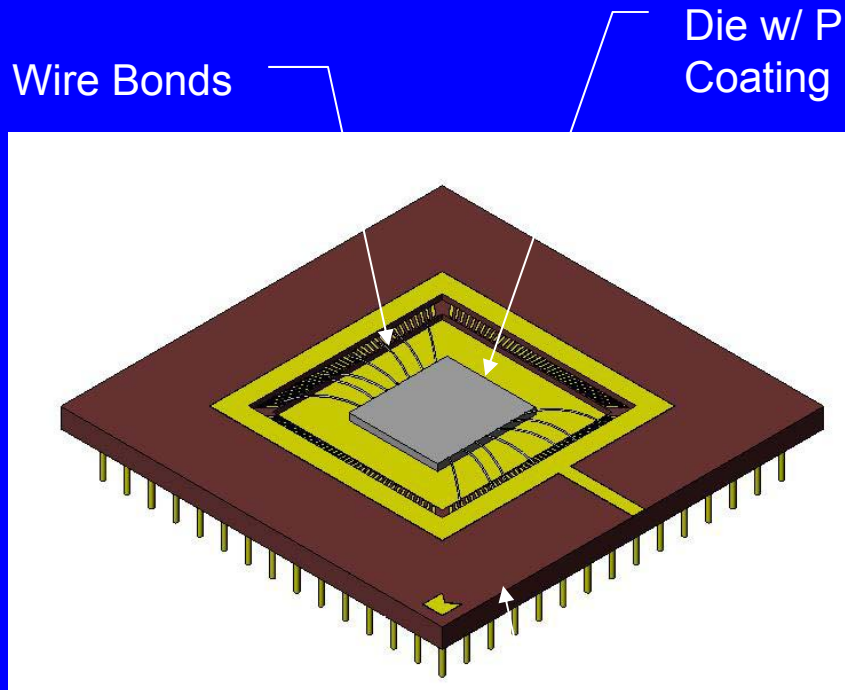
- Develop a prototype camera that can be used in either handheld or production settings
- Test prototype camera to determine:
 - Level of performance
 - Ability to detect typical flaws
 - Determine potential time savings

System Configuration



Detector Array

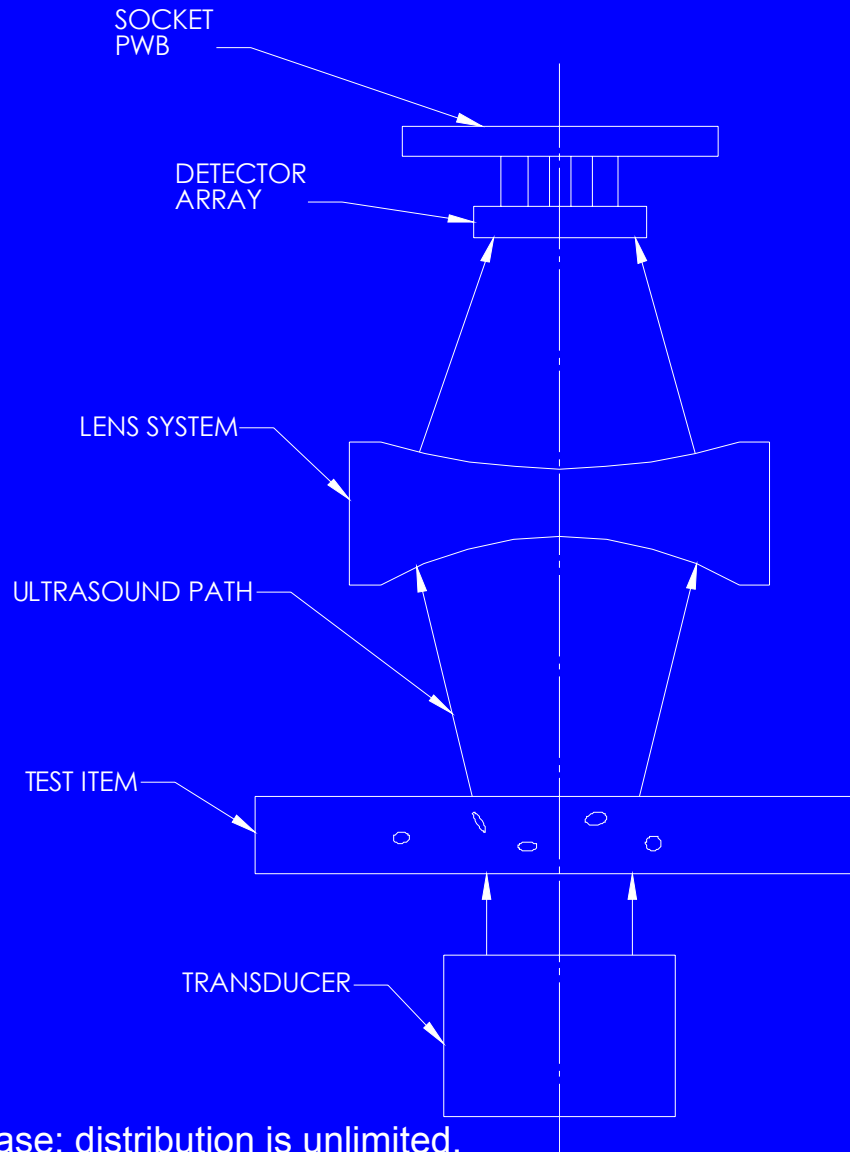
- Key feature to creating ultrasound camera
- Converts ultrasound to electrical signal



PGA
Carrier

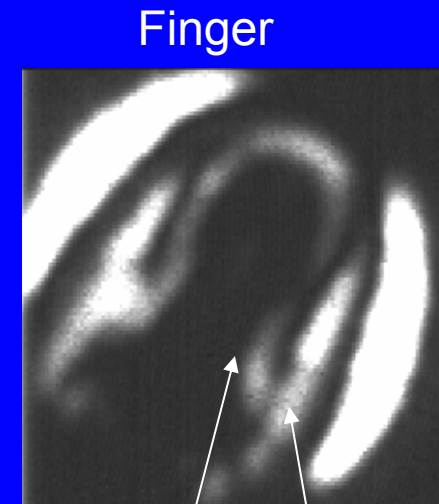
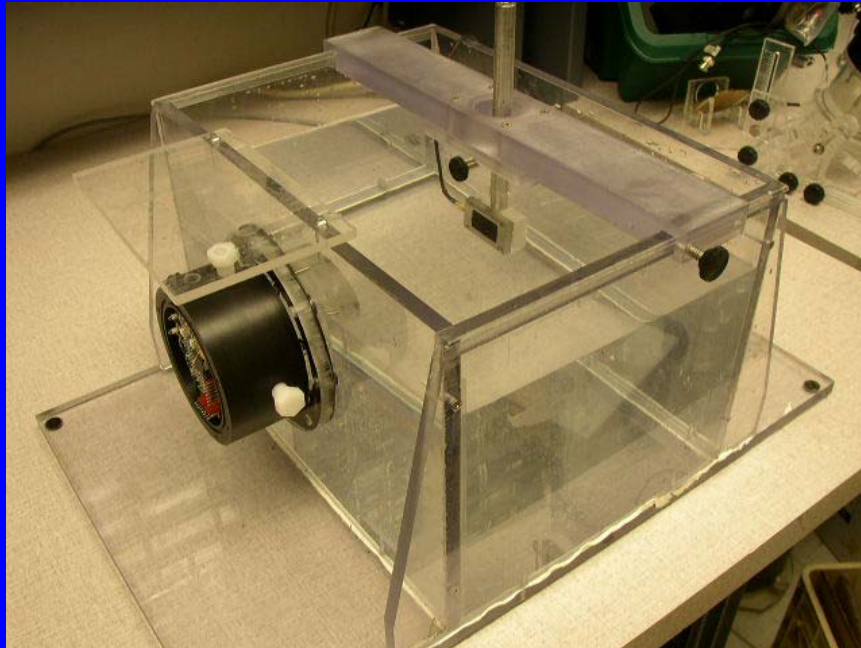
Conformal Coat over
Wire Bonds

Operation – Thru-Transmission



Operation – Pulse Echo

- Often done in water tank:

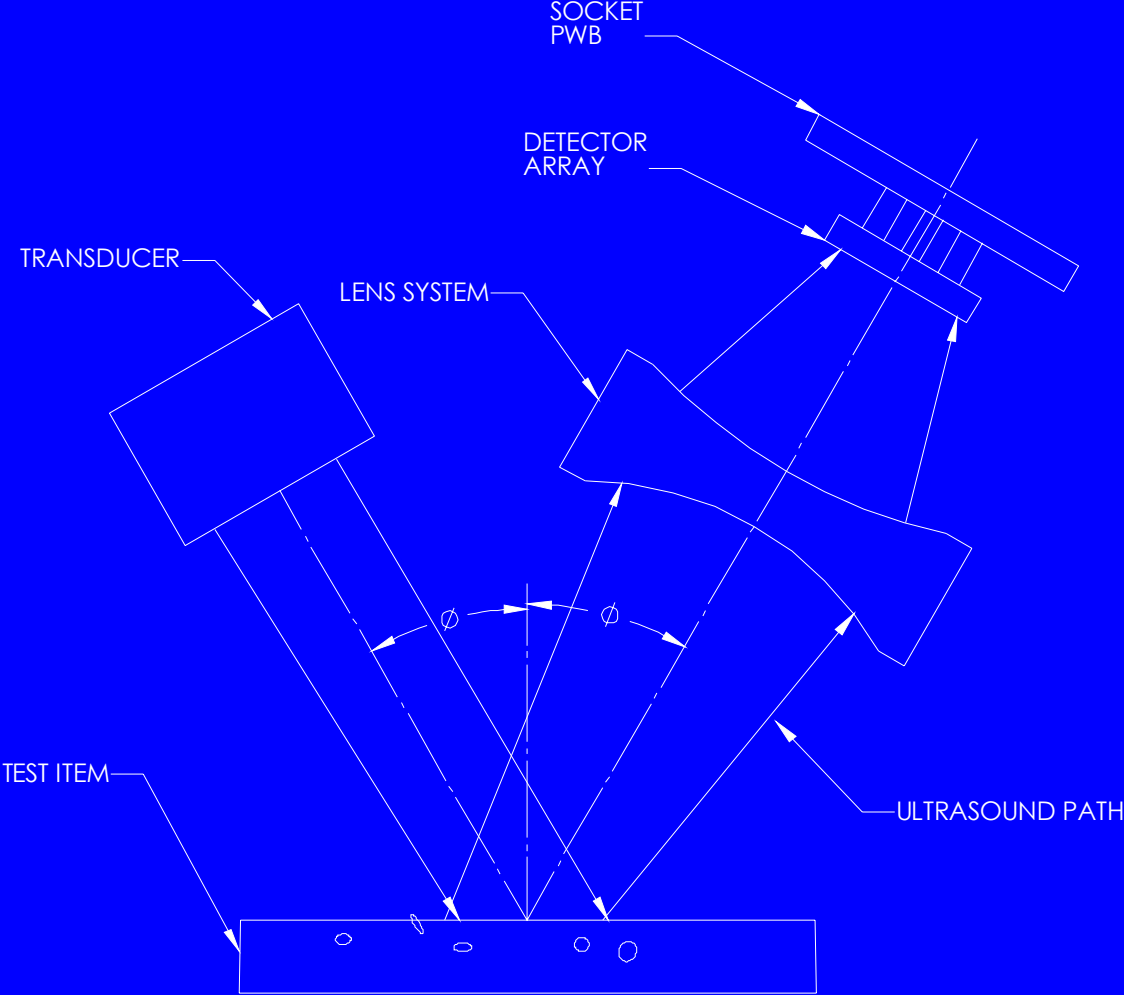


Bone

Tissue

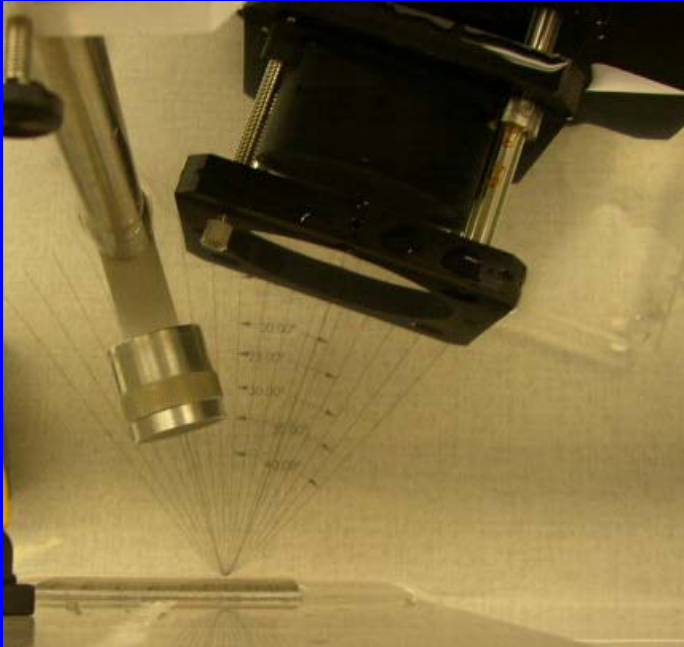
- Dark areas have high attenuation

Operation – Pitch-Catch

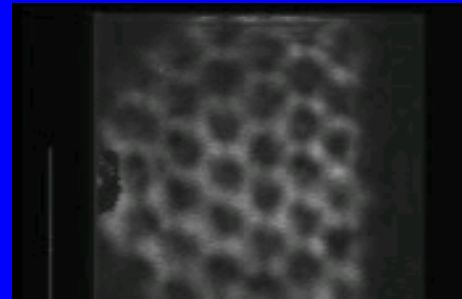


Operation – Pitch-Catch (cont.)

- Often done in water tank, but portable cameras are feasible

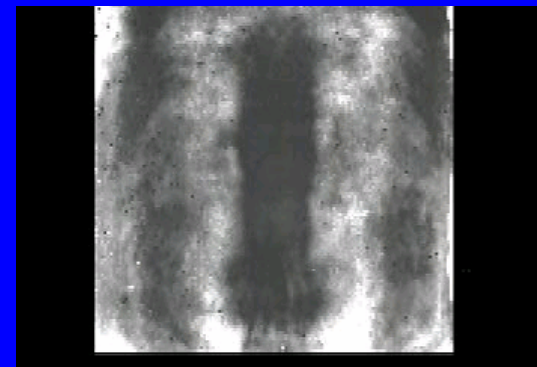


Hole in Core

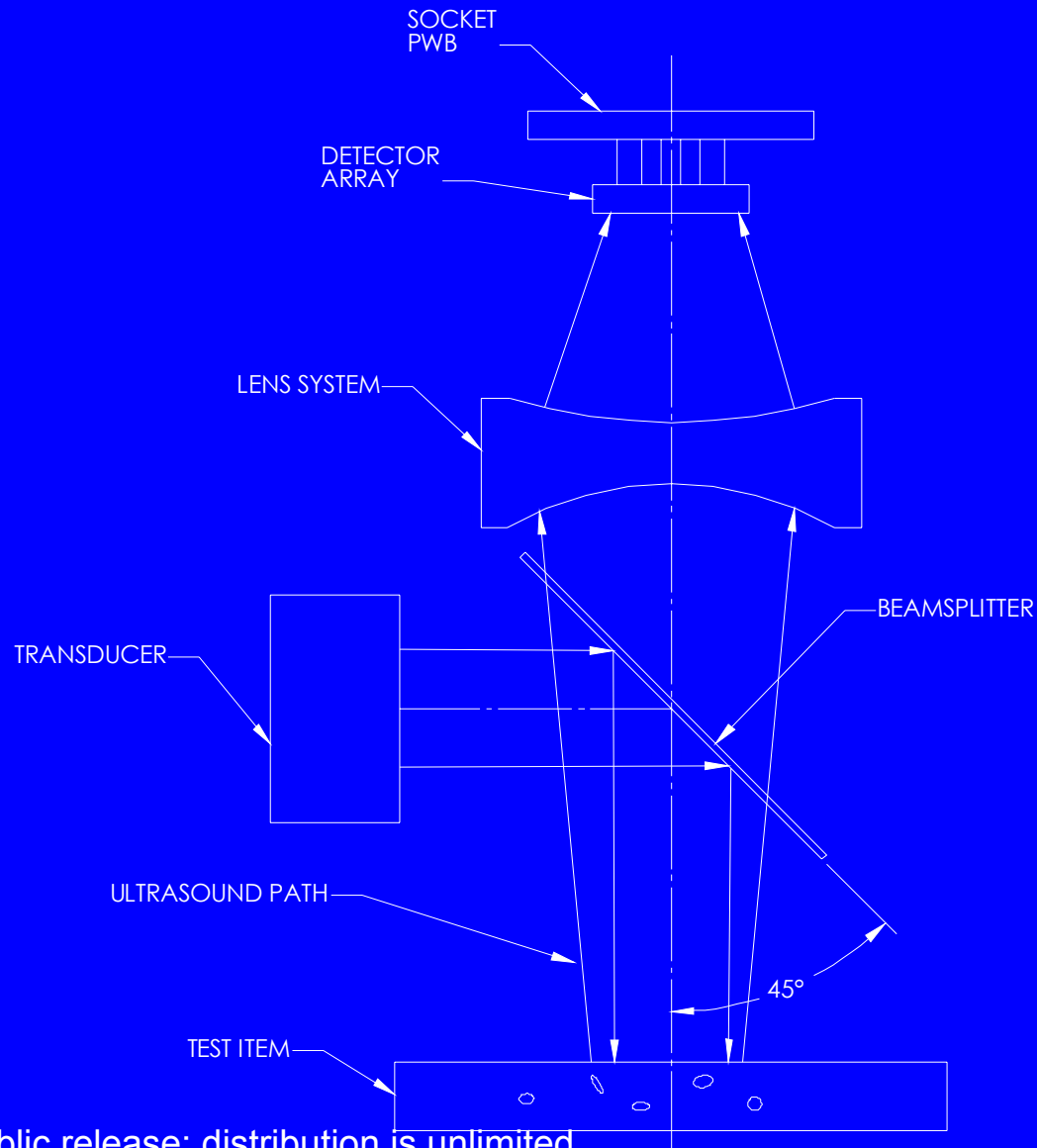


- White areas where there is the highest reflection

Crack in Plate



Operation – Pulse-Echo



Operation – Pulse-Echo (cont.)

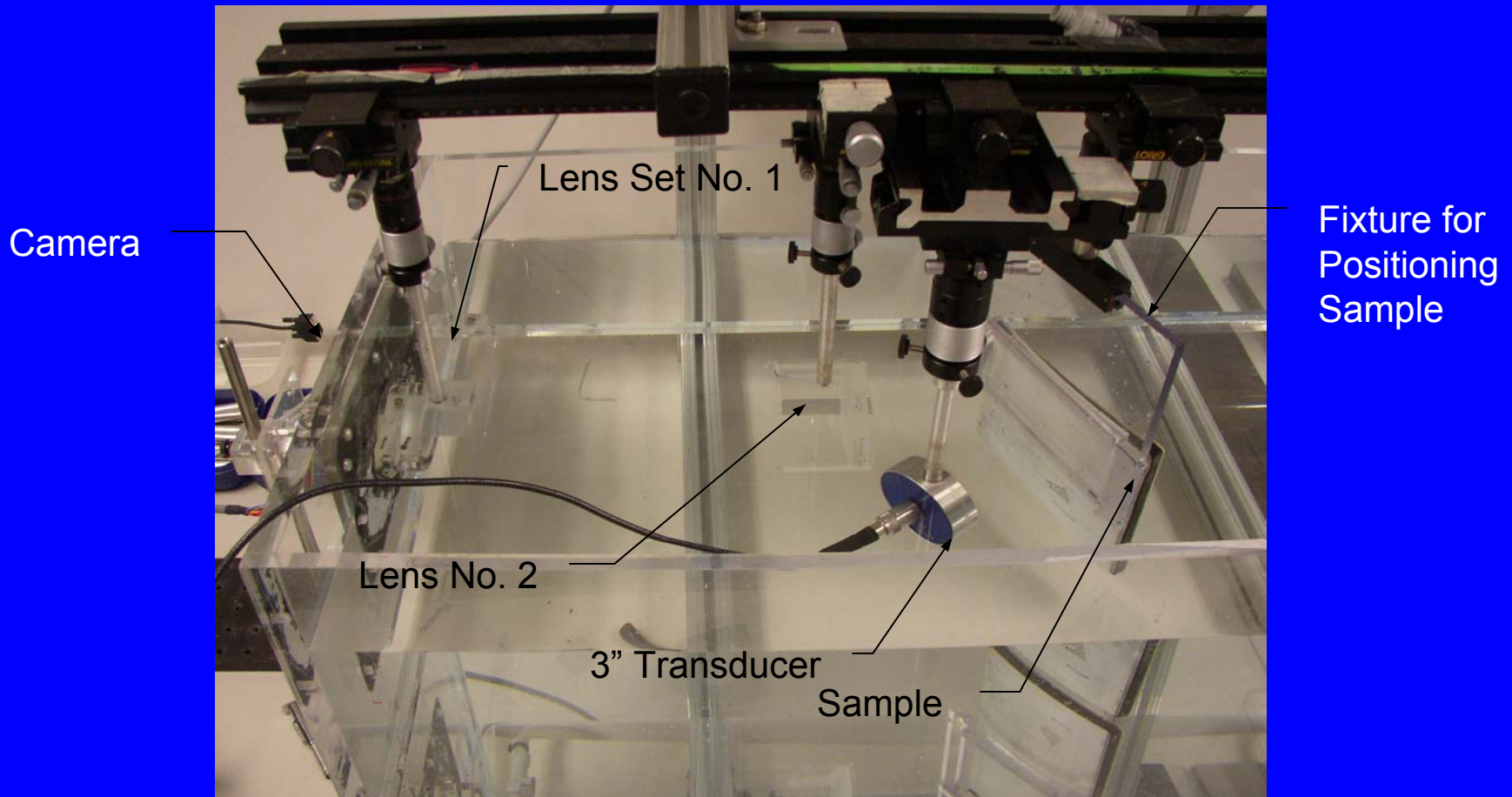
- Beamsplitter allows for collinear transducer beam
- 50% of pressure is lost in reflections



- White areas are regions of high reflectivity
- Range gating is feasible

Phase I Effort

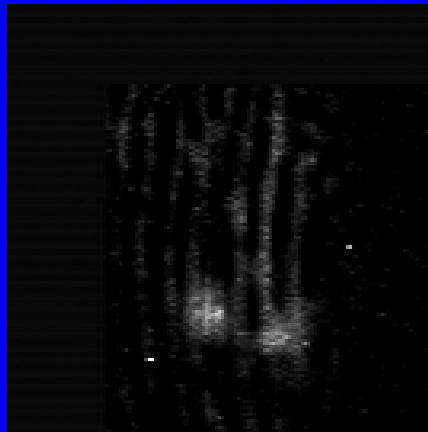
- Demonstrated feasibility when tested in Pitch-Catch mode



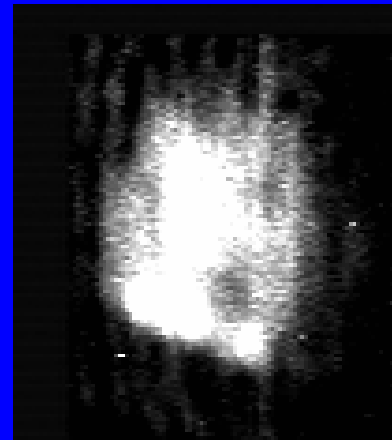
Phase I Effort (cont.)

- Demonstrated ability to detect flaws in many sample parts

Undamaged

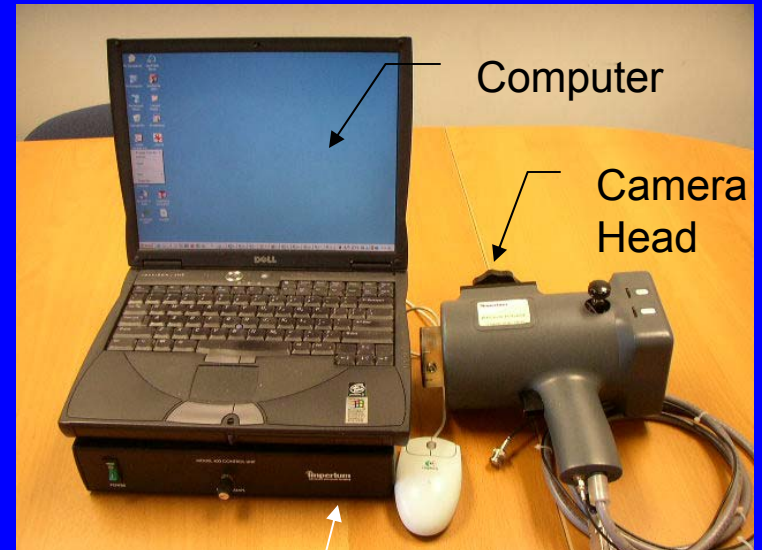
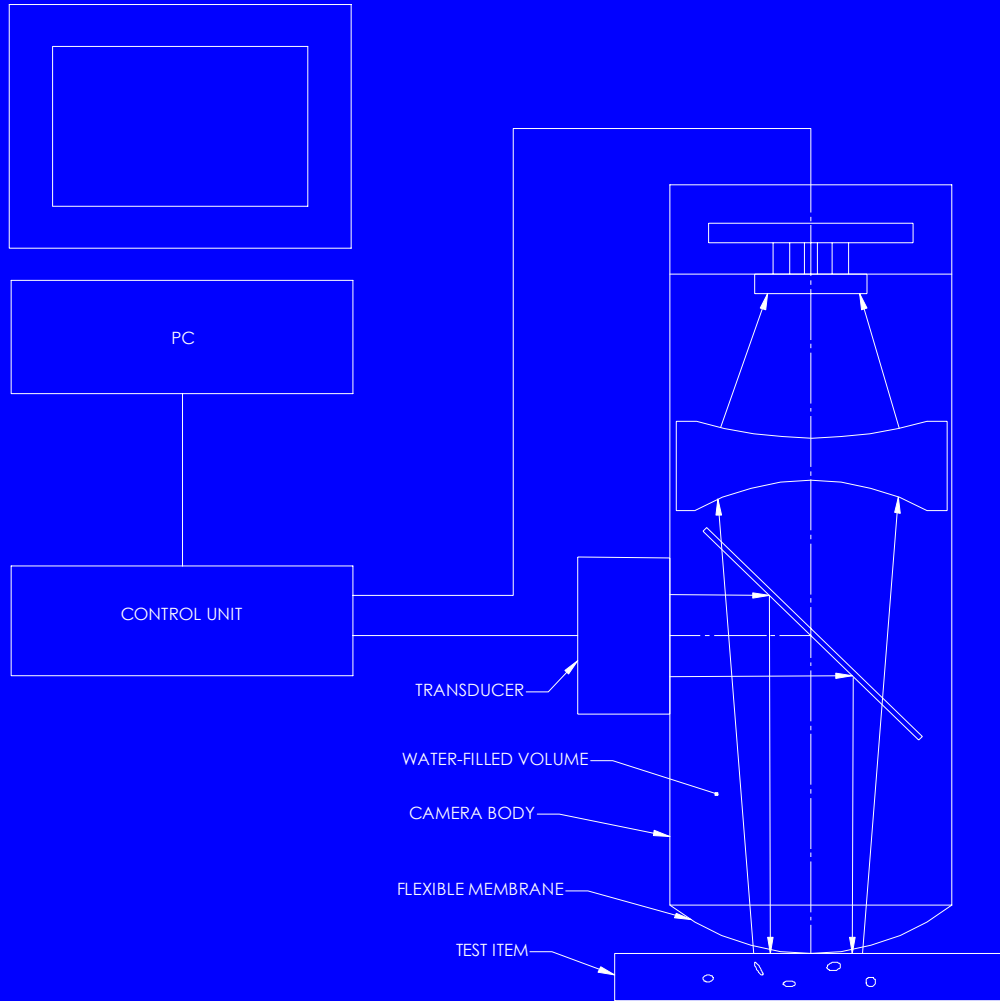


Delamination



- 1 MHz transducer effective for many solid composites
- Up to 5 MHz used for some honeycomb core
- Exterior cork heat shield not successfully penetrated
- Phase II initiated

Phase II System Configuration



Camera Head

Auxiliary Handle

Fill Ports (2)

Focusing Knob

3.5" LCD



LCD Controls

Trigger for Image Capture

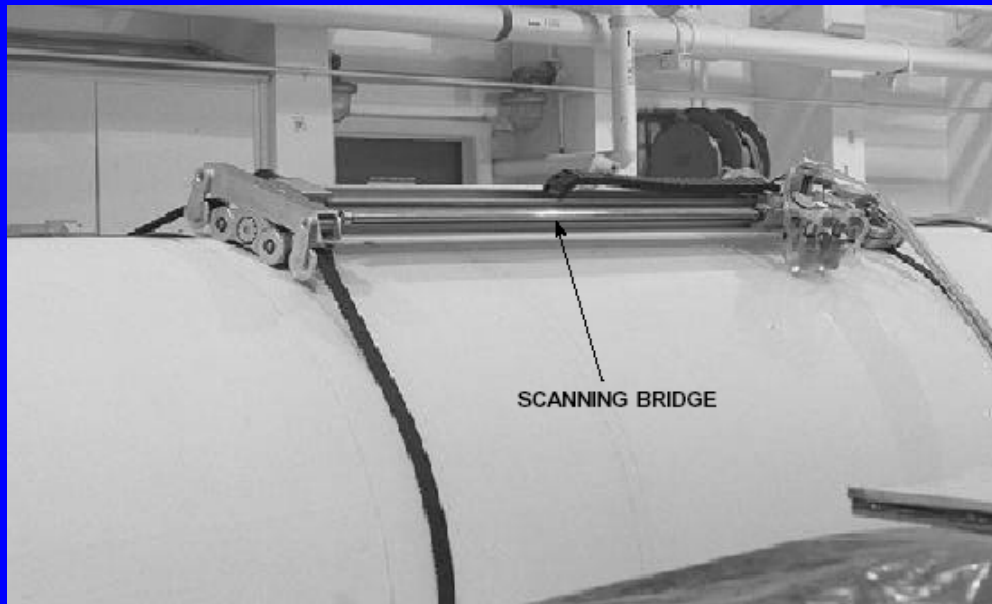
Portable System Performance

- Demonstrated functional capability:



Production Camera

- Designed to interface with existing SRM scanner



- ATK to compare scan times to existing production systems
- Working to create large composite image from multiple small images

Summary and Conclusions

- Concept demonstrated: capability of seeing flaws on representative composite parts
- Limited testing with portable system has detected similar flaws
- It is expected that production system will demonstrate a significant reduction in test time over present systems
- Concept is transferable to areas other than nondestructive evaluation of solid rocket motors

Future Work

Program Tasks

- Complete quantitative testing of system using calibrated standards
- Deliver system to ATK for in-plant use in both handheld and production configurations
- Submit test report on findings
- Deliver hardware to AFRL

IR&D

- Improve image quality
- High-speed digital downloads
- Increased FOV
- Decreased size and weight
- Improved range-gating