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# Analyzing Production Processes of Energetic Materials using Ultrasound Technology

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# Overview

Ultrasound is being used in the following applications at ARDEC

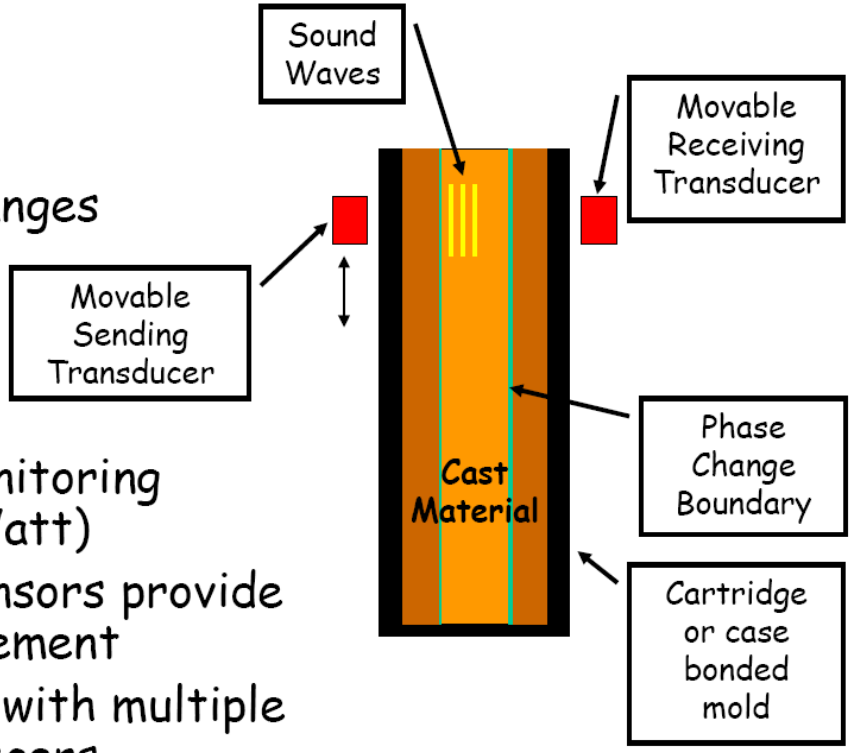
- Melt Cast Analyzer
- Press Analyzer
- Primer Press Analyzer

Ultrasound Technology has proven to be highly viable for characterization

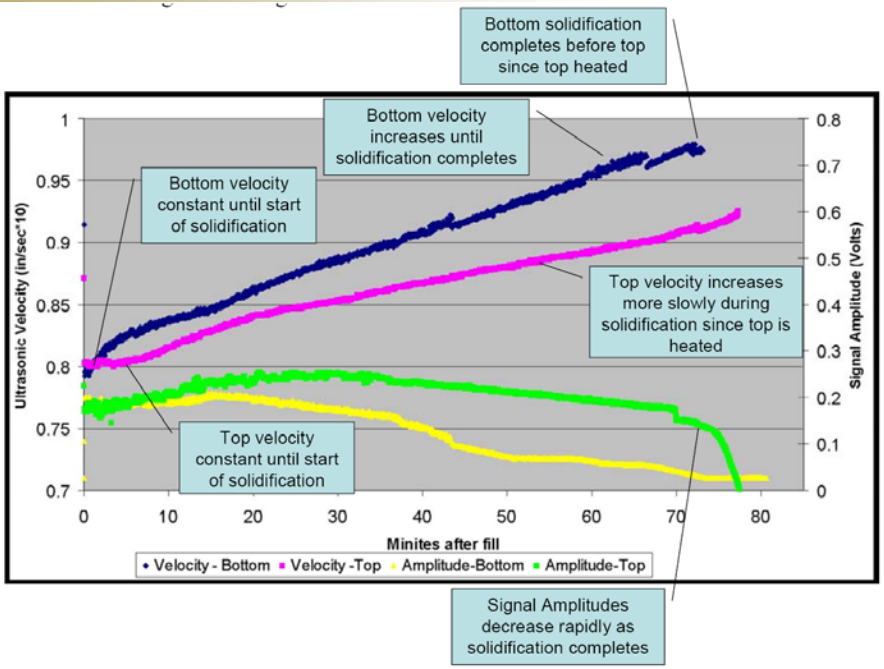
- Extensive amount of information available
- Can be obtained Real Time
- Low Energy, safe for operators and explosives
- Easily pass through metal

# Ultrasound Melt Cast Analyzer

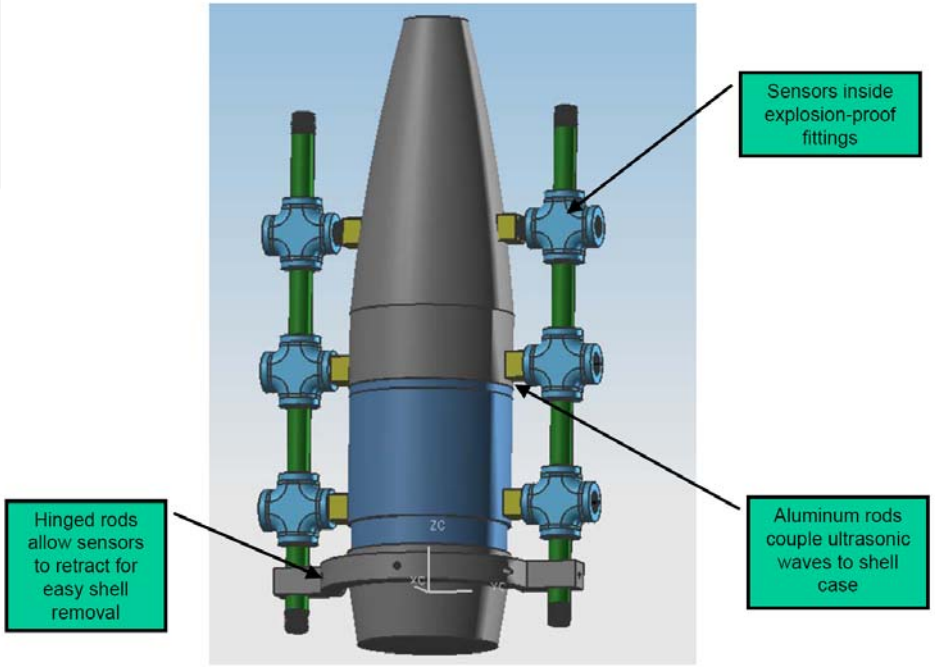
- Non-intrusive
  - No damage to item
  - Fast measurement
- Sense material changes
  - Polymerization
  - Density
  - Mix composition
  - Temperature
- Low energy for monitoring energetics (< 0.1 Watt)
- On-line process sensors provide continuous measurement
- Sense large areas with multiple or movable transducers



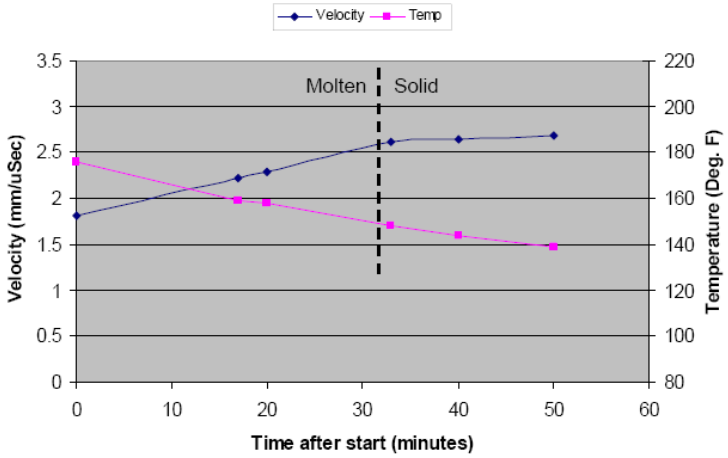
# Ultrasound Melt Cast Analyzer



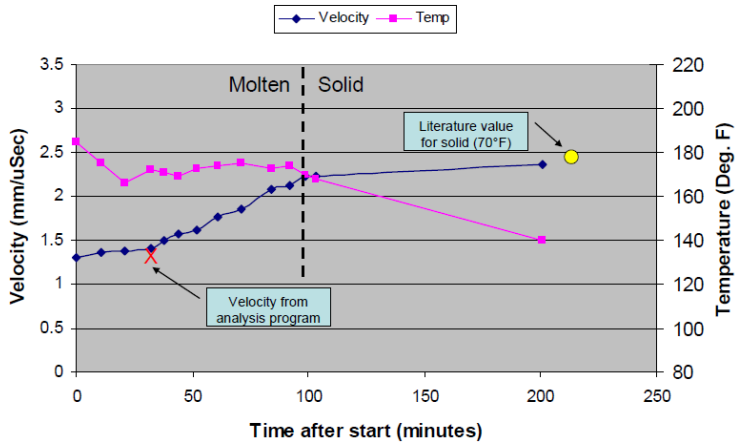

- Ultrasound can use attenuation to detect time of solidification throughout the munition.
- Ultrasound can also be used to detect settling



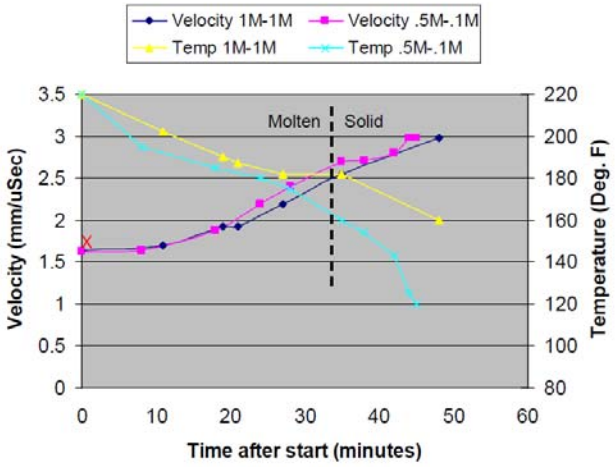
# Results from Initial Tests of Equipment

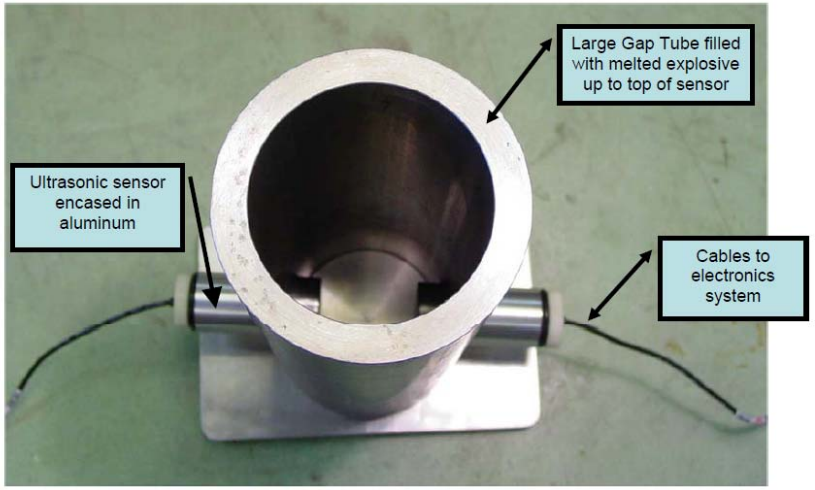



Plot of measured ultrasound velocity versus cooling time for comp B using 1MHz transmitter and receiver



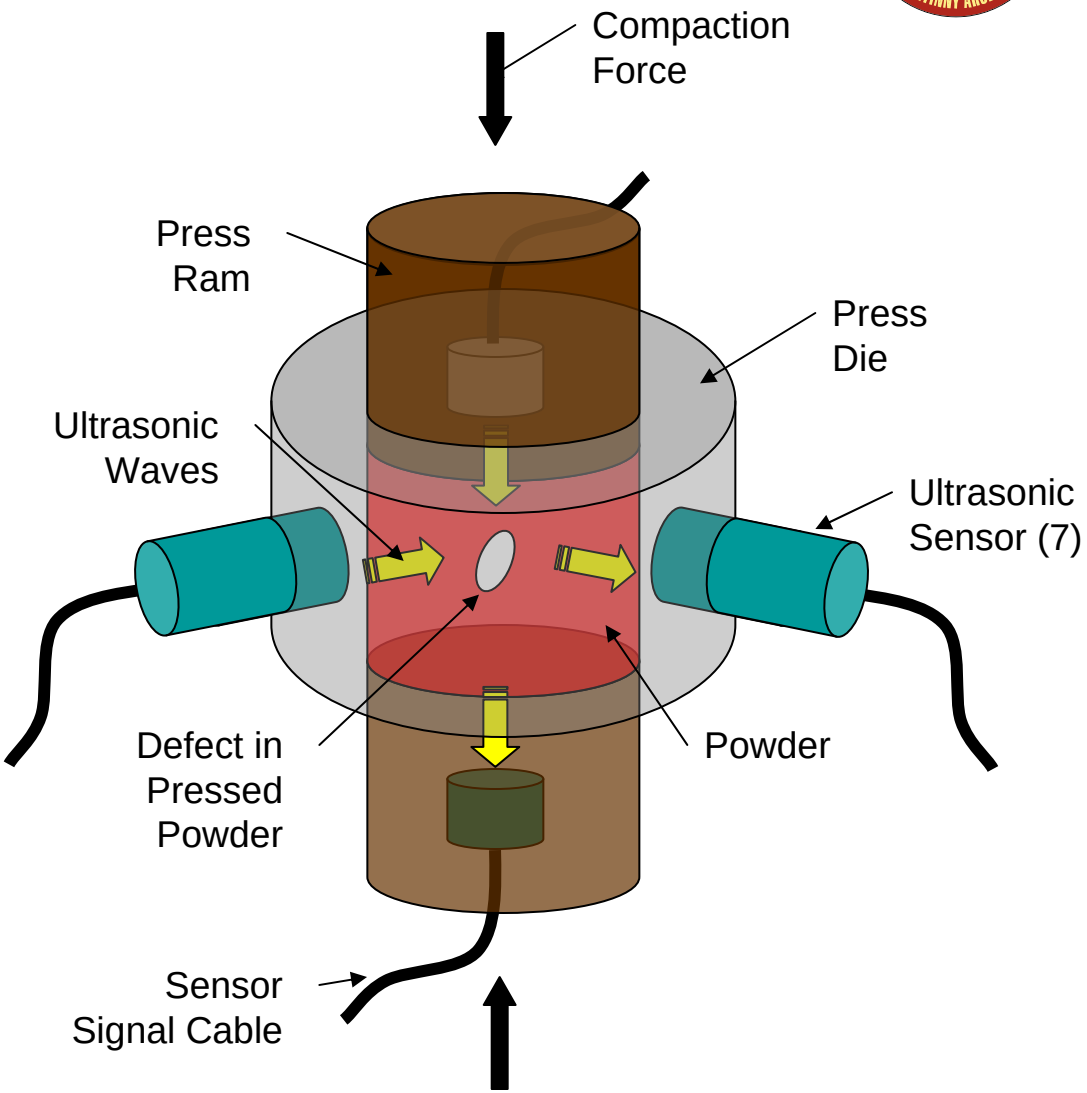

Plot of measured ultrasound velocity versus cooling time for TNT using 1MHz transmitter and receiver



# Ultrasound Large Press Analyzer

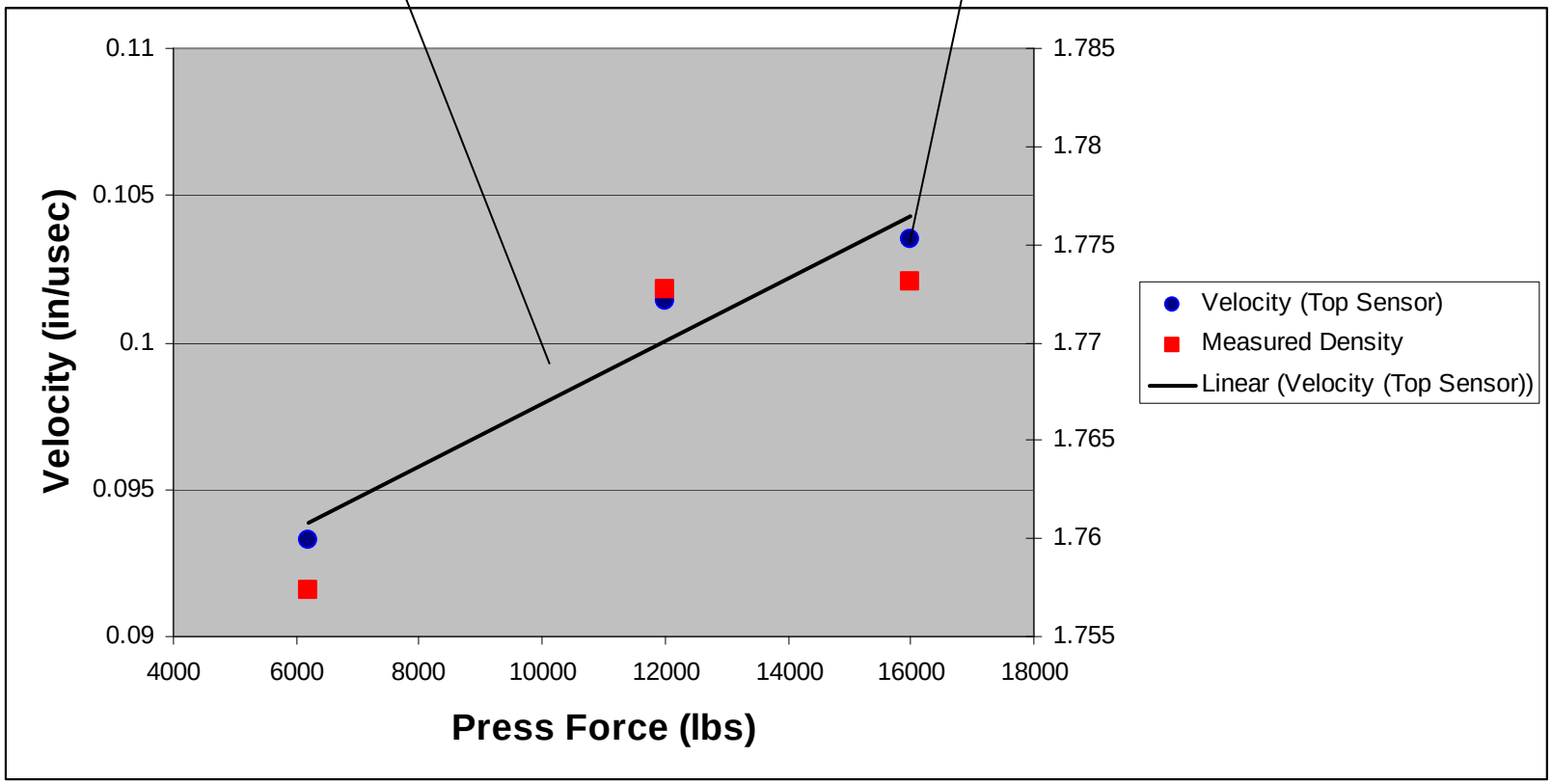
- Ultrasound technology will be added to Large Press
- Will detect voids and defects
- Will also be able to provide characterization such as mechanical properties



# Velocity tracks density for PAX-2A billets

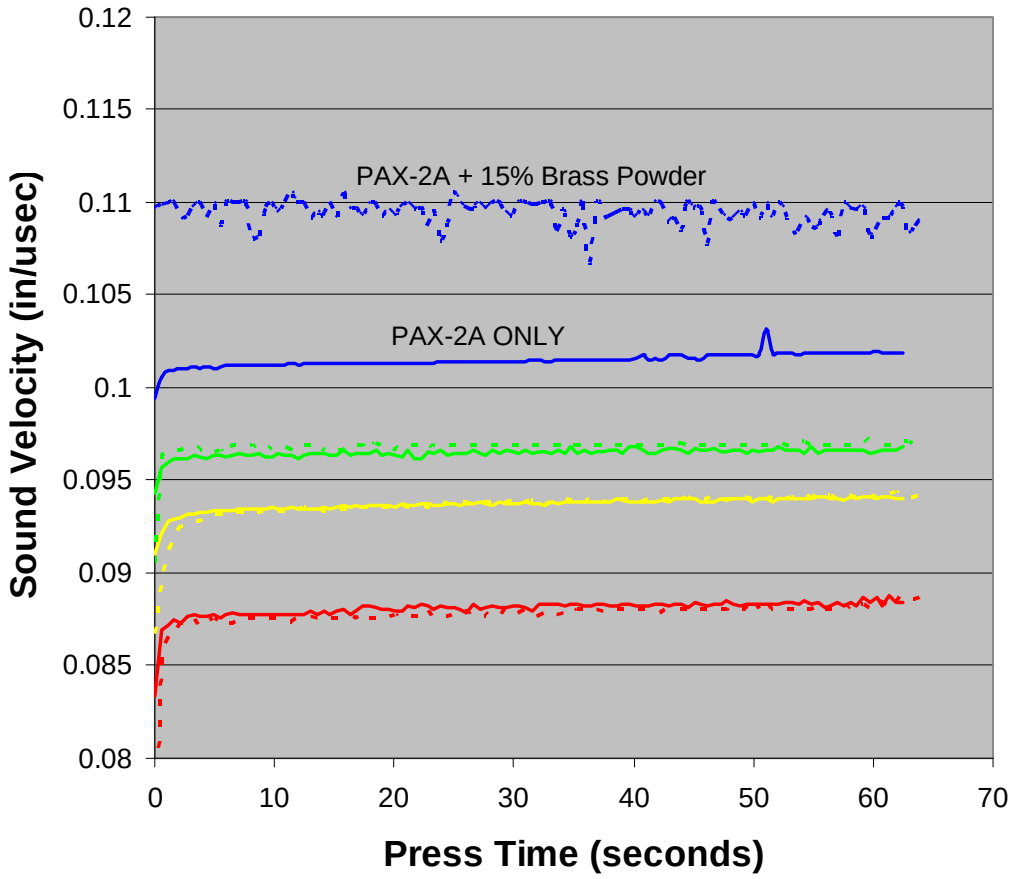
Fitted line shows linear relation of TOF to ram force

Velocity increases with density increase (nonlinear)



# Press contaminant detection

Pure PAX-2A versus PAX-2A with 15% brass powder mixed in at top of billet




Both pressings used 15K pounds force for 1" ram

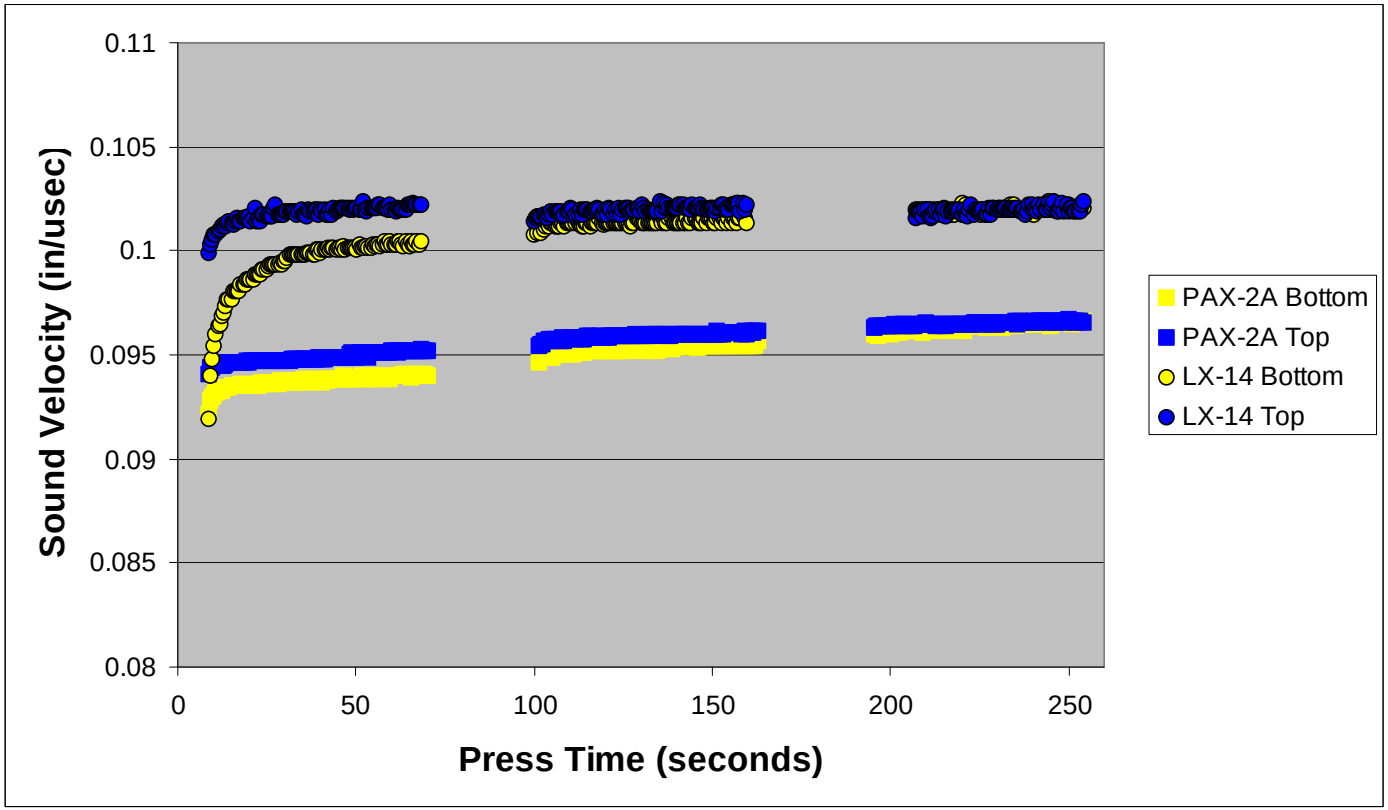
Results:

1. The two pressings are consistent except for sensor locations where brass is concentrated

2. The significant change in velocity may provide sensitive indications of contaminants or explosive material variations

# Compaction in two different explosives

PAX-2A LX-14



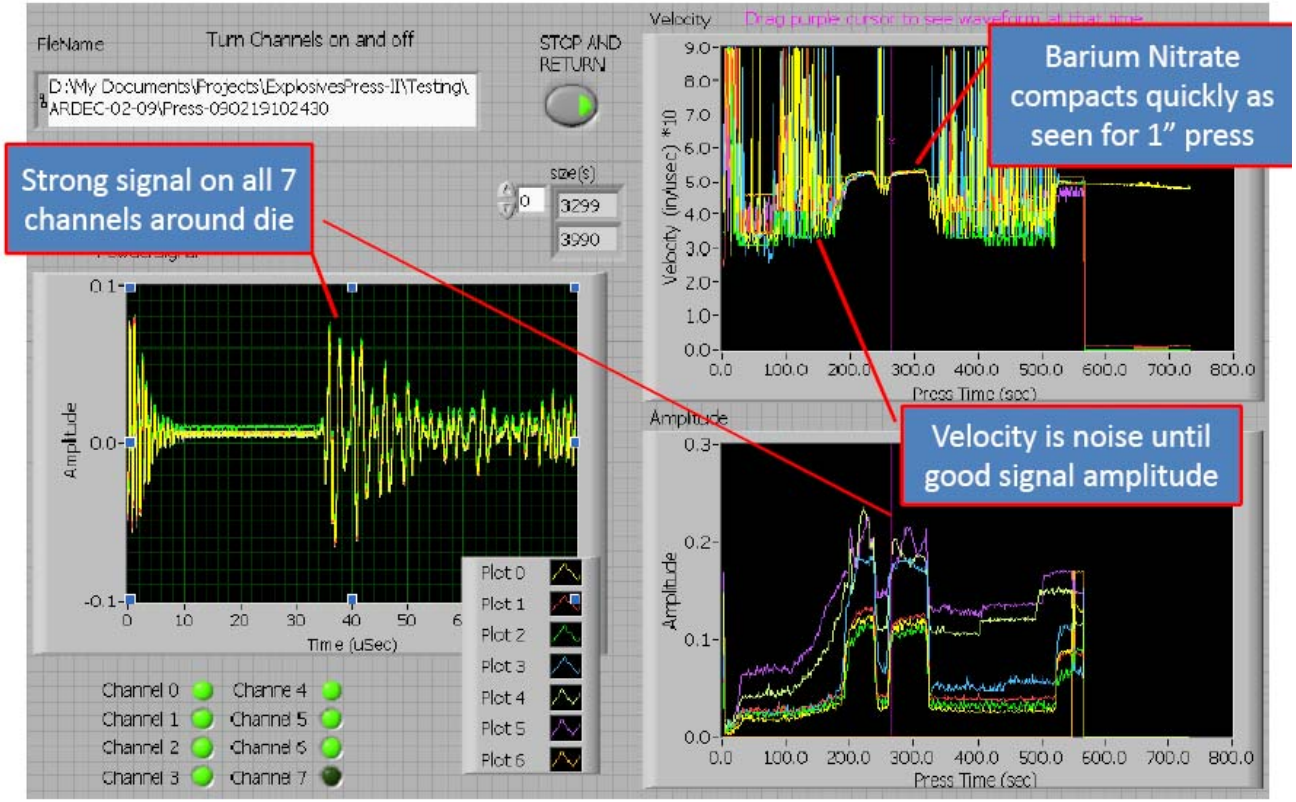

**Results:**

1. The bottom of the LX-14 billet takes much more time to compact than the top (may be due to increased binder in LX-14)

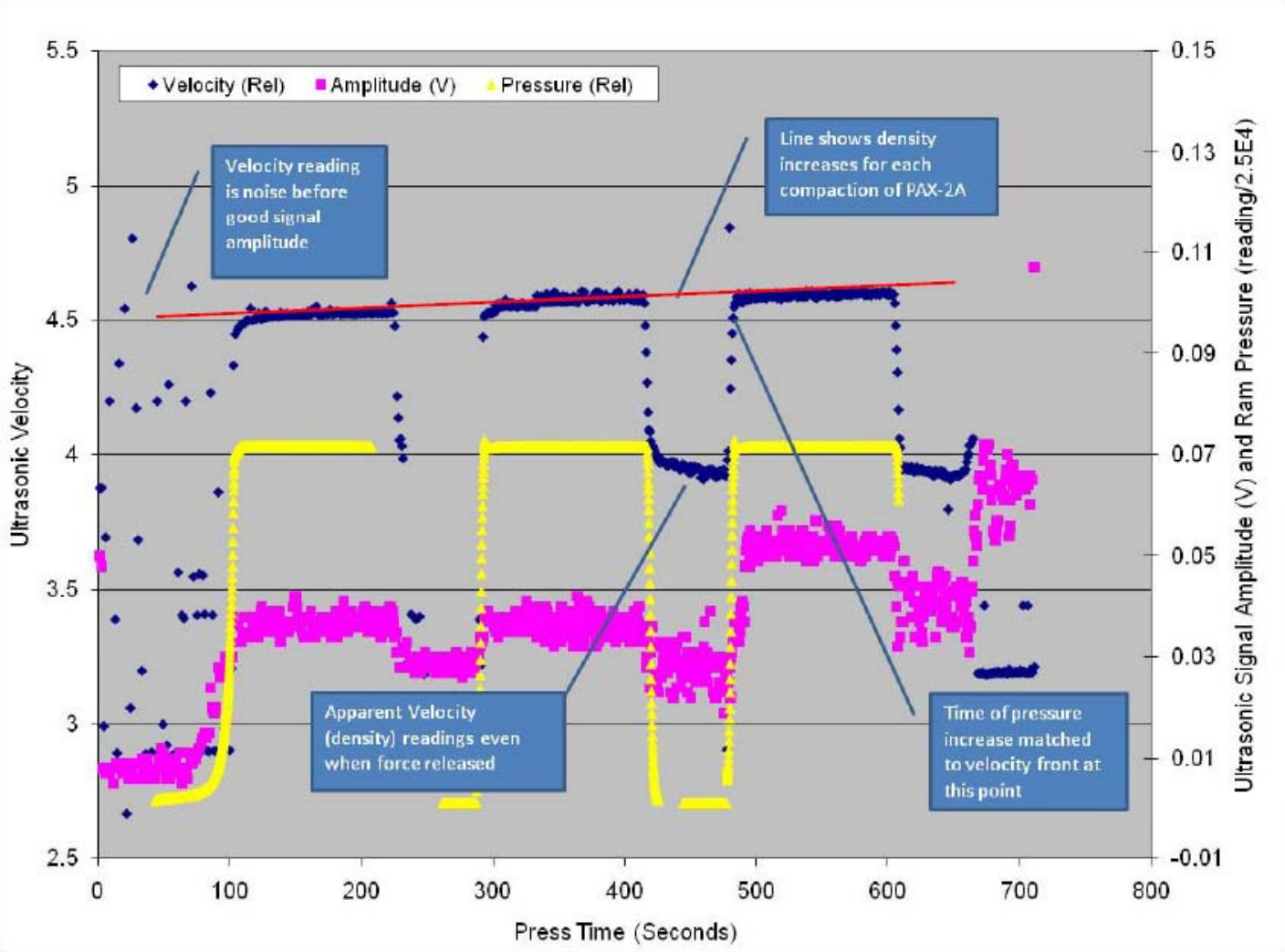
2. Much higher sound velocity in LX-14 is characteristic of the constituents of this material

3. PAX-2A compacts almost immediately compared to LX-14

# Press Output Screen



# Results from Last Pax 2a Pressing

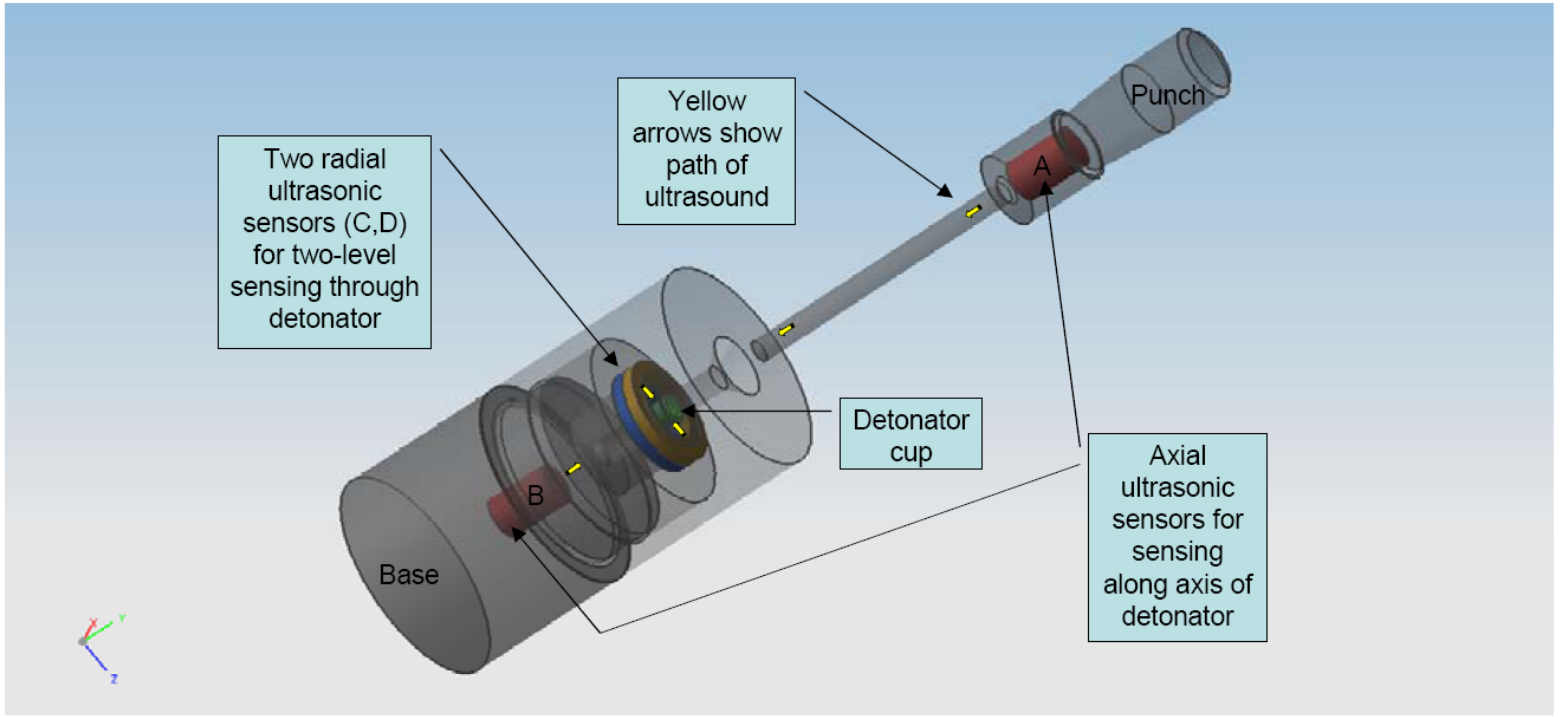


# Ultrasound Primer Press Analyzer



- Detonator project at ARDEC have some problems with inconsistency and quality in product
- Consistency and Quality can be improved with use of Ultrasound Equipment
- Major challenge is design of equipment which can fit small sizes

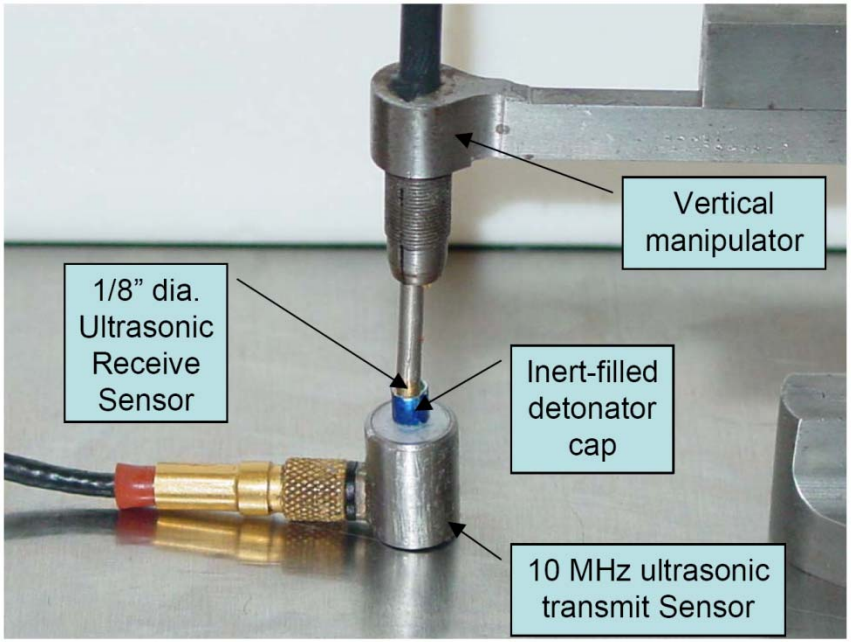
# Ultrasound Primer Press Analyzer

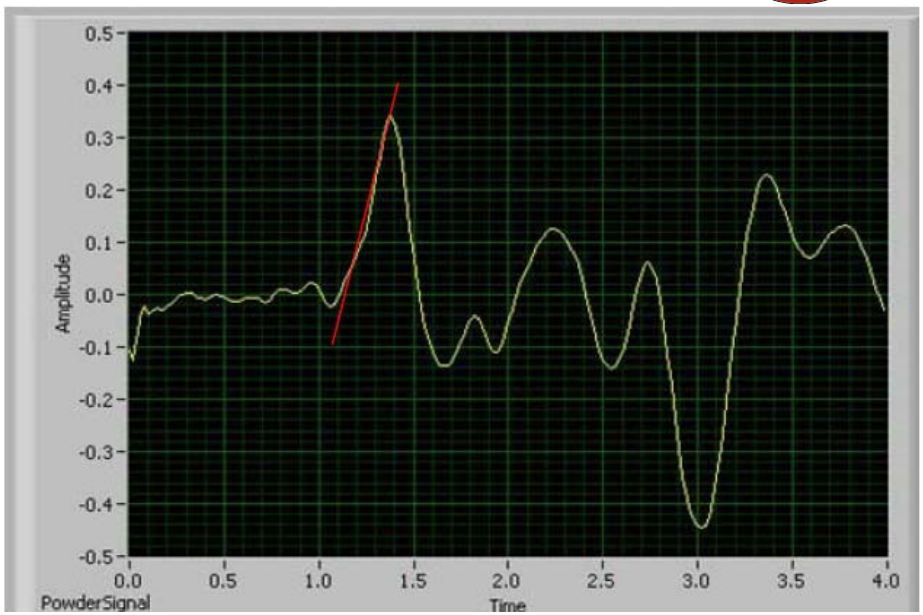


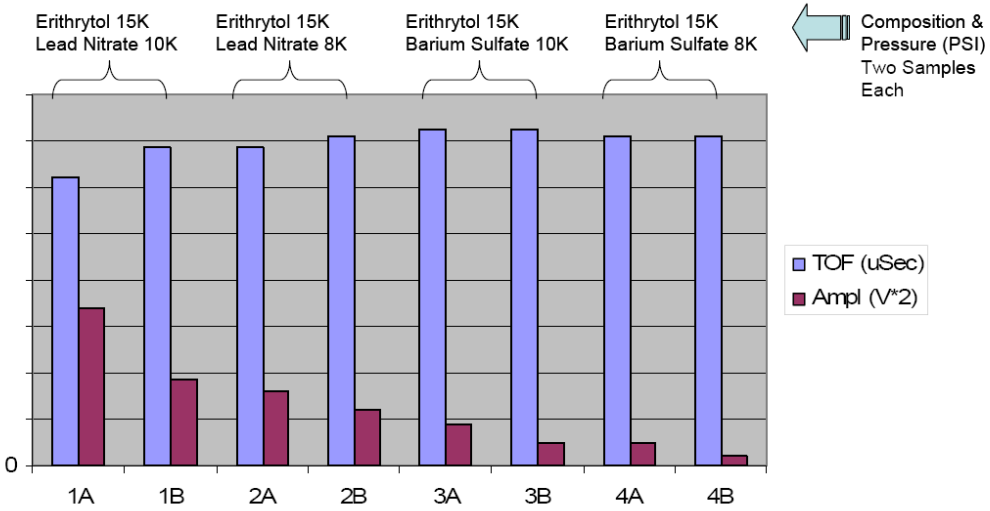
# Ultrasound Primer Press Analyzer



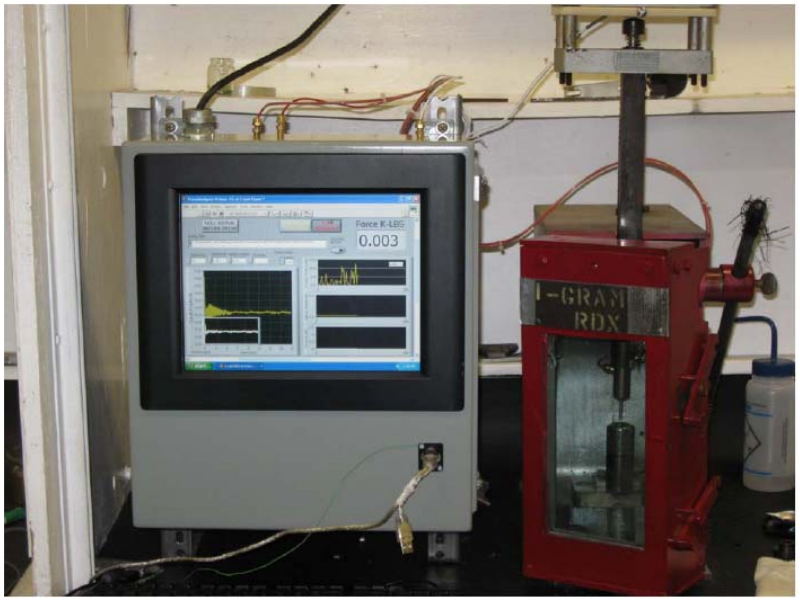
- Initial feasibility study is good
- Time of Flight and Amplitude can be detected through detonator

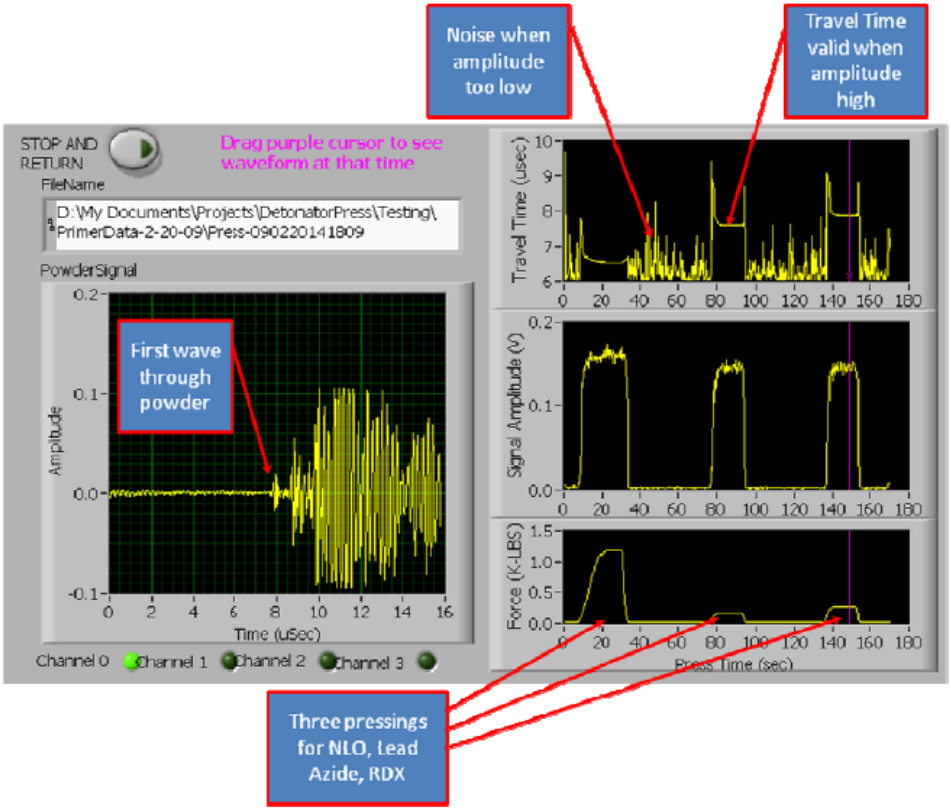


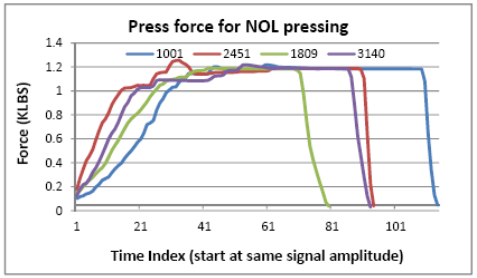



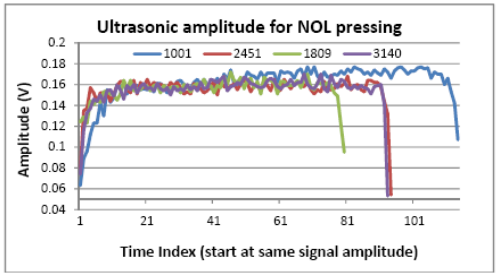
# Primer Press Set Up and Output Screen

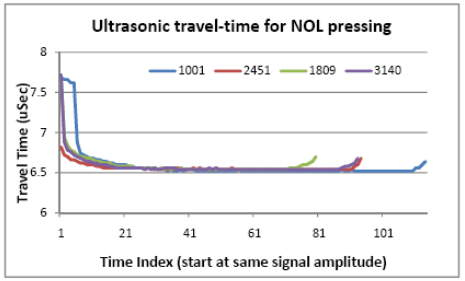


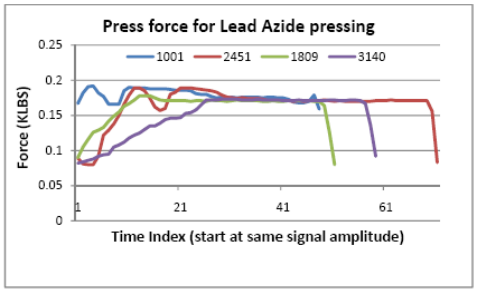



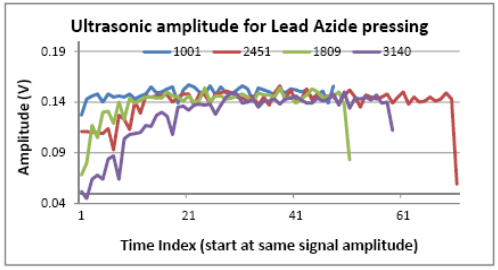
# Results from Primer Press

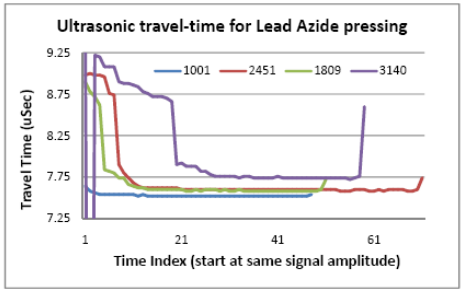


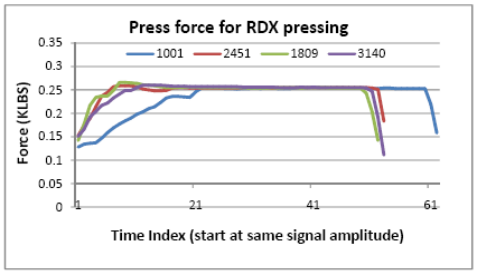



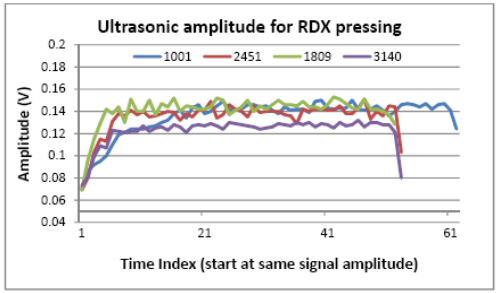



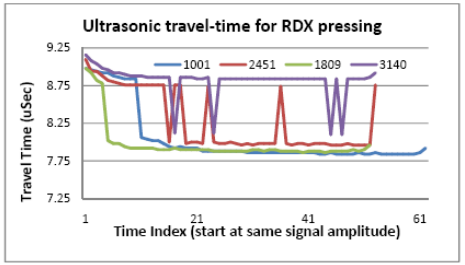



# Other Areas of Interest

Proven that Ultrasound Applications exist in the following

- Viscosity Detection
- Water Content Analyzer
- Advanced Characterization of Aging
- Acoustic Sensing of Combat Threats
- Detection of Closed Cracks in Explosives

Ultrasound at ARDEC is currently pursuing 3 main efforts:

- Ultrasound Large Press Analyzer
- Ultrasound Melt Cast Analyzer
- Ultrasound Primer Press Analyzer

# Acknowledgements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