

# Acoustic Machining

*ManTech Project No. S2552*



## NSRP All Panel Meeting Ship Production Technologies Track

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**GENERAL DYNAMICS**  
Electric Boat



*Acoustic Machining (S2552)  
2015 NSRP All Panel*

# Agenda



- Opportunity
- Project Goals
- Project Execution
- Project Team Structure
- AcousTech™ Machining Technology
- Accomplishments
- Next Steps
- Questions

# Opportunity



- Drilling numerous, large, tightly-toleranced holes through multiple composite material layers is a difficult and time-consuming effort.
- Years of refining the drilling process has decreased the cost and improved the quality of drilling operations.
- AcousTech™ Machining represents an opportunity for additional time-savings and improved quality.

# Project Goals



- **Determine the overall steps and requirements for the development and implementation of a modular drilling system with AcousTech™ Machining Technology.**
  - AcousTech™ Machining is a new technology that represents a first time implementation at a shipyard.
  - The feasibility of the AcousTech™ Machining Technology will be demonstrated through the research and development conducted during this project and via extrapolation using existing technology.
- **Achieve a 50% reduction in machining time.**

# Project Execution



The project will be executed in two phases:

- **Phase I – Defining Requirements & Prototype Testing**
  - Feasibility study of an early prototype at EWI.
  - Identification of candidate applications to be drilled.
  - Refinement of the business case analysis.
- **Phase II – Prototype Refinements & Shipyard Evaluations**
  - EWI will incorporate design improvements (lessons learned) into an enhanced prototype system.
  - Enhanced system will be installed at EB to conduct shipyard evaluations.

# Project Team Structure



**Dale Orren** – Deputy Director  
**Warren Southerland** – Project Manager/PTR



**Charles McNamara** – PMS 450  
**Dave Hart** – LCE



**Byron Rose** – PMS 397  
**George Becker** – BAH



**Matt Short** – Technology Leader  
**Kris Vollrath** – Applications Engineer  
**Nancy Porter** – Senior Project Manager

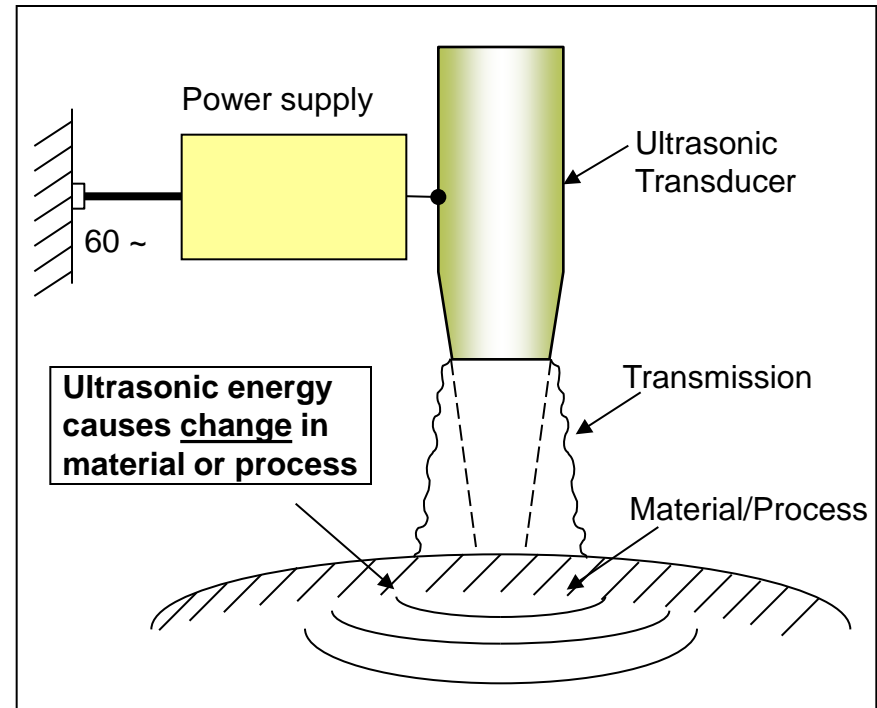


**Ed Waterman** – Project Leader  
**Mimi Reis** – ManTech Program Manager  
**Mike Loosa** – ManTech Project Coordinator

# AcousTech™ Technology

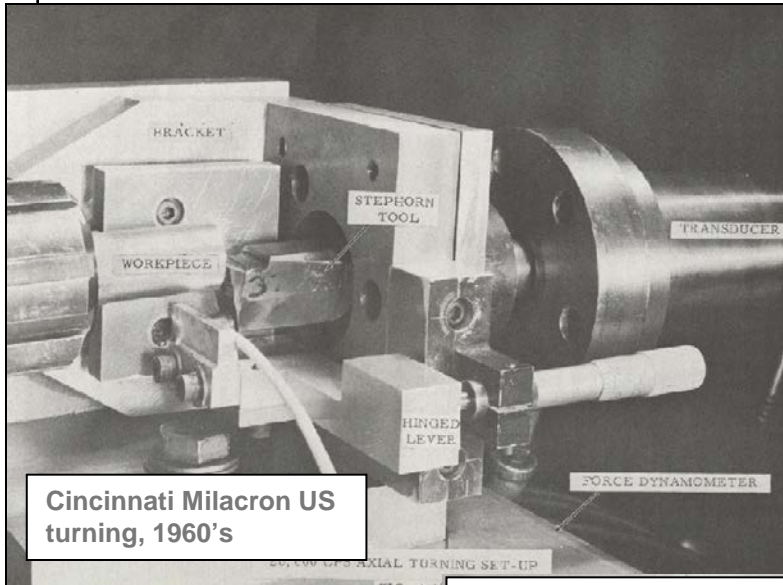


*High Power Ultrasound:*  
the application of  
intense, high-frequency  
acoustic energy to  
create change in  
materials or processes

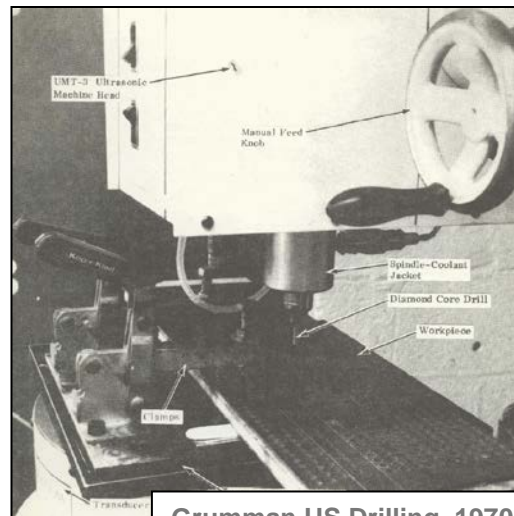




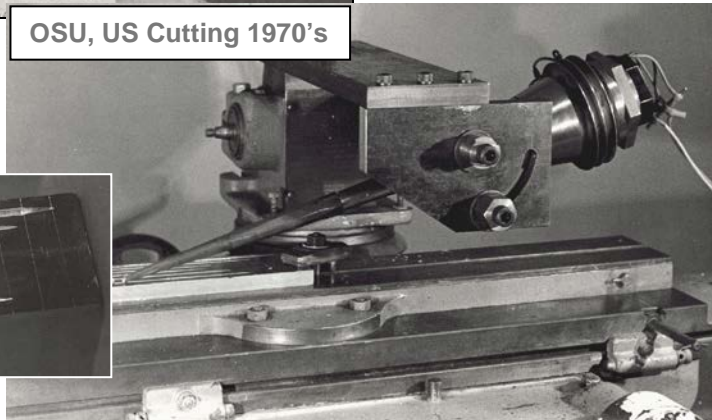
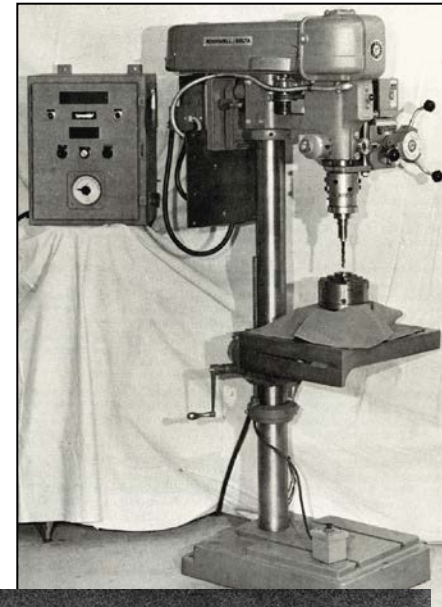
# AcousTech™ Technology



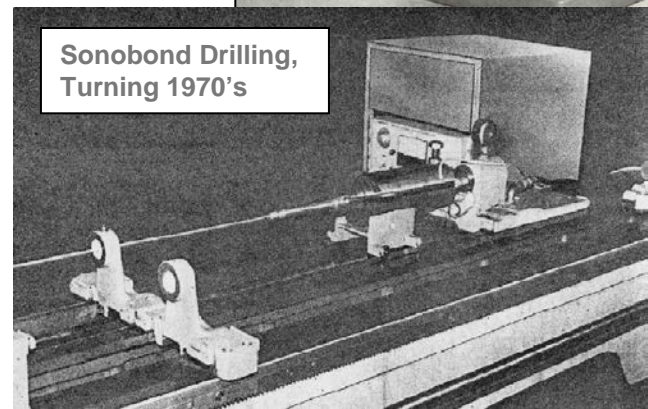
Cincinnati Milacron US turning, 1960's



Grumman US Drilling, 1970's



OSU, US Cutting 1970's



Sonobond Drilling, Turning 1970's



# AcousTech™ Technology



- **AcousTech™ Machining Technology is based on the integration of high power ultrasonic (US) energy with conventional metalworking tools.**
  - The patented AcousTech™ Machining Module transmits high frequency longitudinal vibrations through the longitudinal axis of a cutting tool, producing a reciprocating action of the tool tip similar to the operation of a hammer drill within conventional drill bits.
  - The application of high energy ultrasound reduces total operating forces by as much as 50%, thereby improving tool life while increasing material removal rates.

# AcousTech™ Technology



- AcousTech™ Machining improves the performance of “traditional” machining processes
- Vibrations introduced by piezoelectric transducer convert electrical energy to mechanical axial displacement



# AcousTech™ Technology



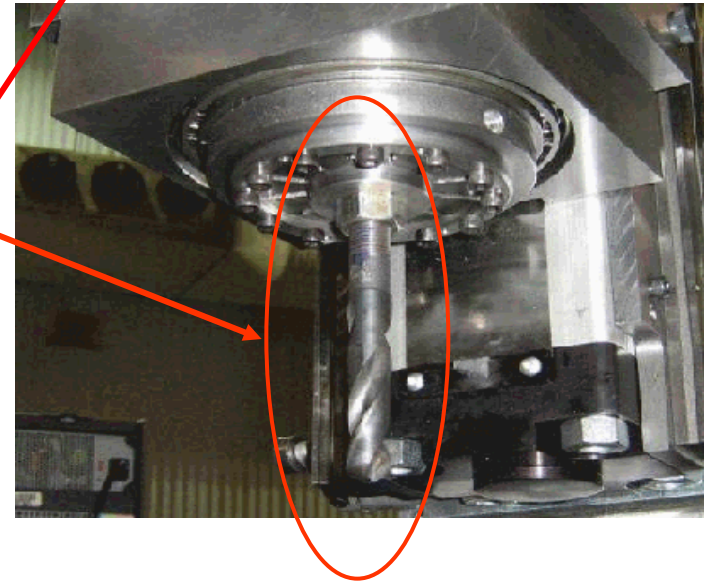
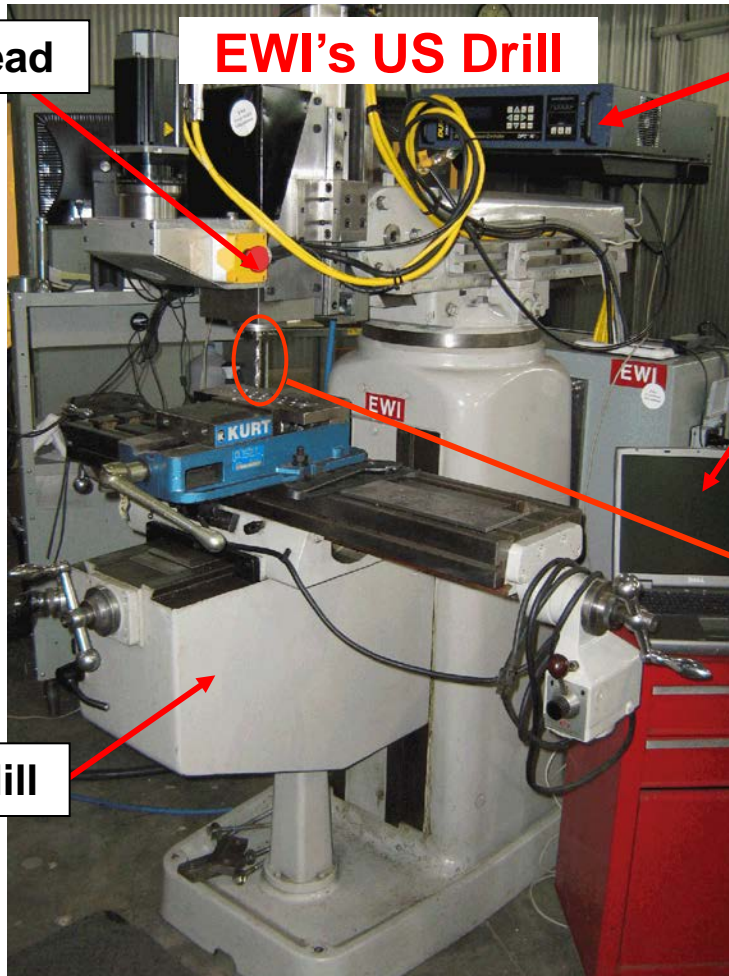
Drill Head

**EWI's US Drill**

Dukane 20kHz,  
5kW power supply

Laptop for control of drives,  
US, and data collection

Knee Mill

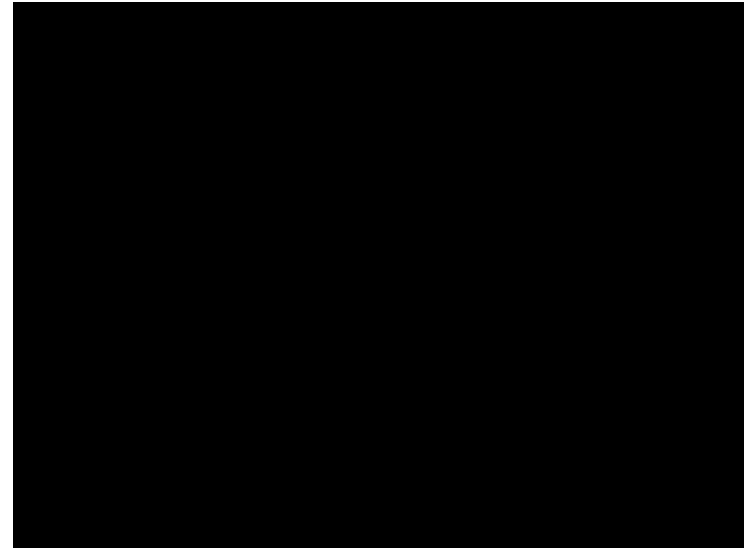


# AcousTech™ Technology



## ● System Features

- 2.5- to 5-kW high power
- 20-kHz nominal operating frequency
- Operates with conventional metalworking tools
- Variable displacement
- Acoustically isolated from machine tool and parts
- Modular packaging



“US Machining Amplitude Demonstration.mp4”





# AcousTech™ Technology



## ● Benefits

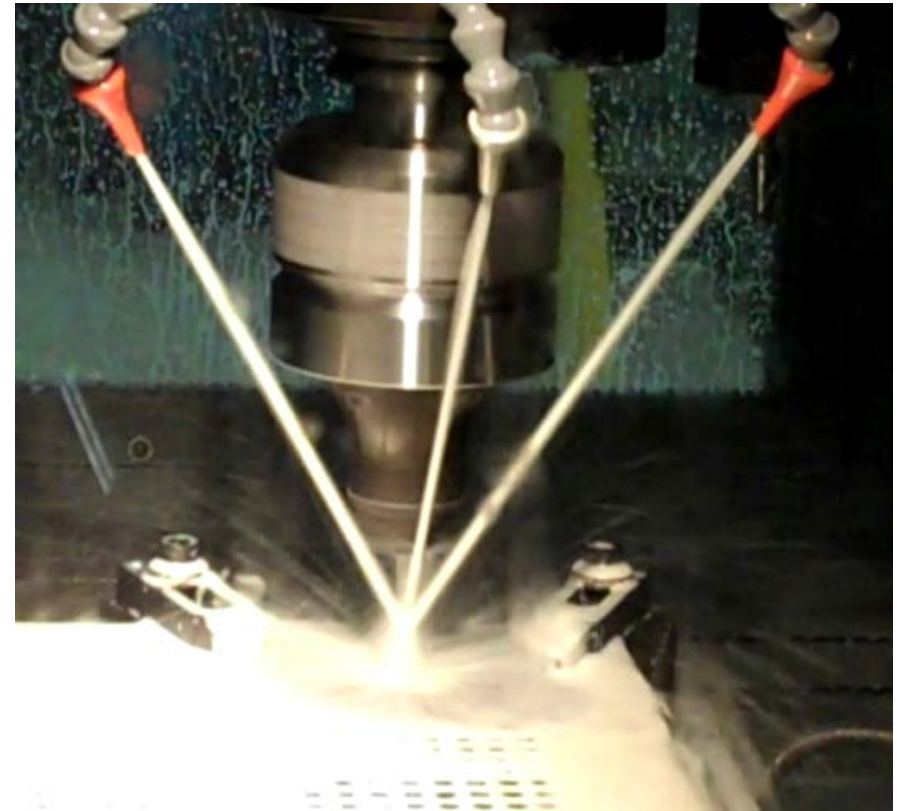
- Lower Operating Forces
- Increased feed rates
- Improved chip extraction
- Lower tool temperatures
- Improved surface finish
- Reduced burr formation
- Machining of hard materials



# AcousTech™ Technology



- Prototype units tested on steel, stainless steel, and titanium
- Uses industry standard tool holders (CAT, HSK, etc.) with existing machine spindles.
- Uses conventional metal working tools (drills, mills, taps, reamers, etc.)





# AcousTech™ Technology



## 1" Thick Stainless Steel Comparison

[View full video at  
acoustechsystems.com/stainlessdemo](http://acoustechsystems.com/stainlessdemo)

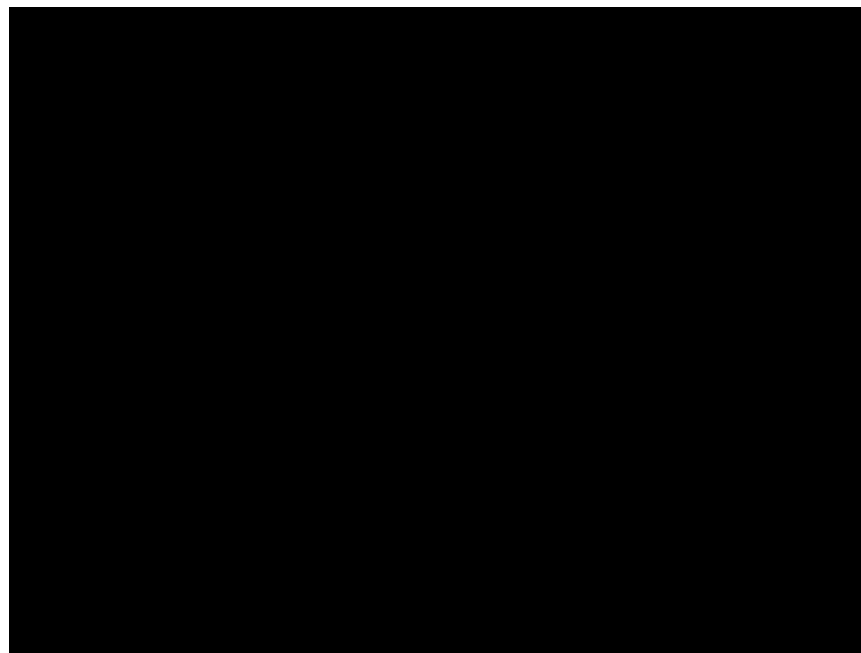


## 1" Thick Titanium Comparison

[View full video at  
acoustechsystems.com/titaniumdemo](http://acoustechsystems.com/titaniumdemo)



# AcousTech™ Technology

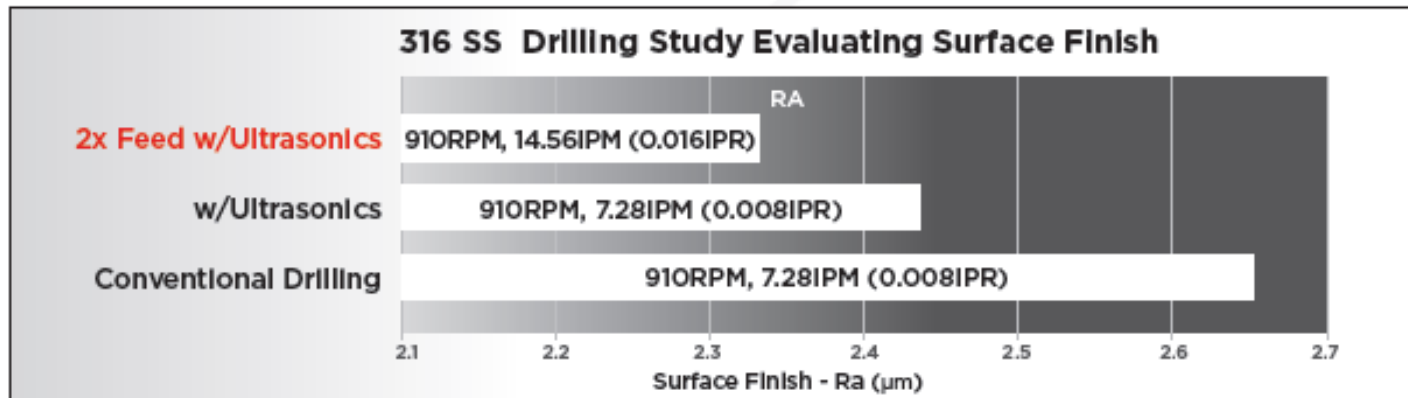
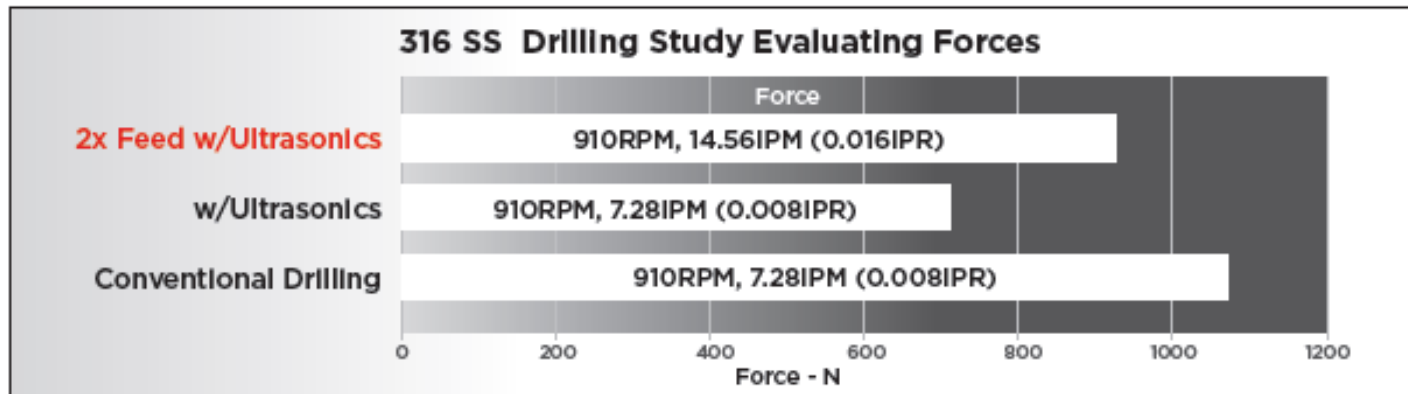


"Acoustech Ultrasonic Revolution-HD.mp4"

# AcousTech™ Technology



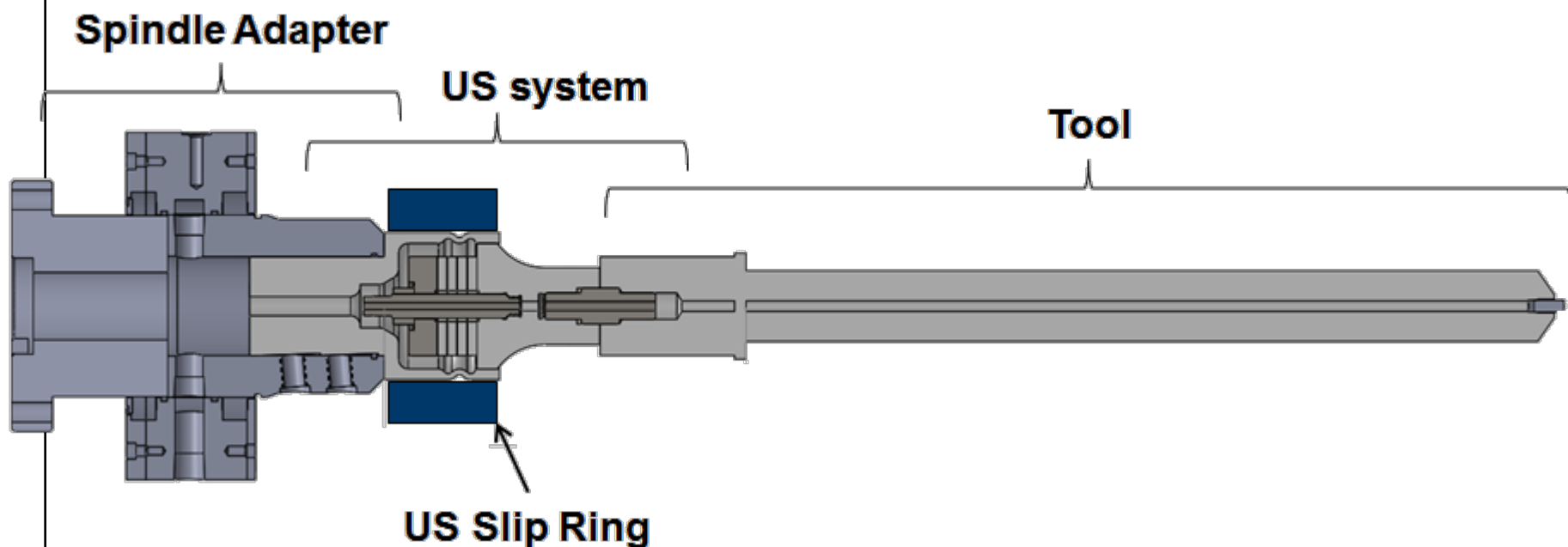
- Drilling study on stainless steel



# AcousTech™ Technology



- For EB application, an ultrasonic transducer system will be added between a spindle adapter and a tool
- This is done so EB can use existing tools
- Only a slight modification is needed for the tool shank



# Anticipated EB Benefits



- Time savings due to increased chip loads, fewer tool changes, and the ability to drill deeper before backing out
- Improved tool life due to reduction in cutting temperatures
- Reduction (potentially elimination) of coolant
- Improved dimensional stability resulting from reduced tool deflection
- Improved surface finish due to force reduction
- Potential reduction in burr formation
- EB anticipates a 50% labor savings or a 50% material cost savings (or some combination thereof)

# Accomplishments



- **Phase I – Defining Requirements & Prototype Testing**
  - Defined Requirements for AcousTech™ Drilling
  - Identified Requirements of Baseline Applications
  - Developed System Functional Specifications
  - Improved Coupling Methods for MagnaDrill Tooling
  - Designed/Built Application Mock-up for Testing
  - Currently Testing Prototype System at EWI



# Future Work



- **Phase II – Prototype Refinements & Shipyard Evaluations**
  - Finalize Prototype System
  - Determine Requirements for Shipyard Evaluations
  - Conduct Shipyard Evaluations with Enhanced System
  - Update Business Case Analysis and Implementation Plan

# Questions

## Ed Waterman

Project Lead

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