



Integration of Dual-Frequency Ultrasound Tissue Bubble Detection With B-Mode Imaging



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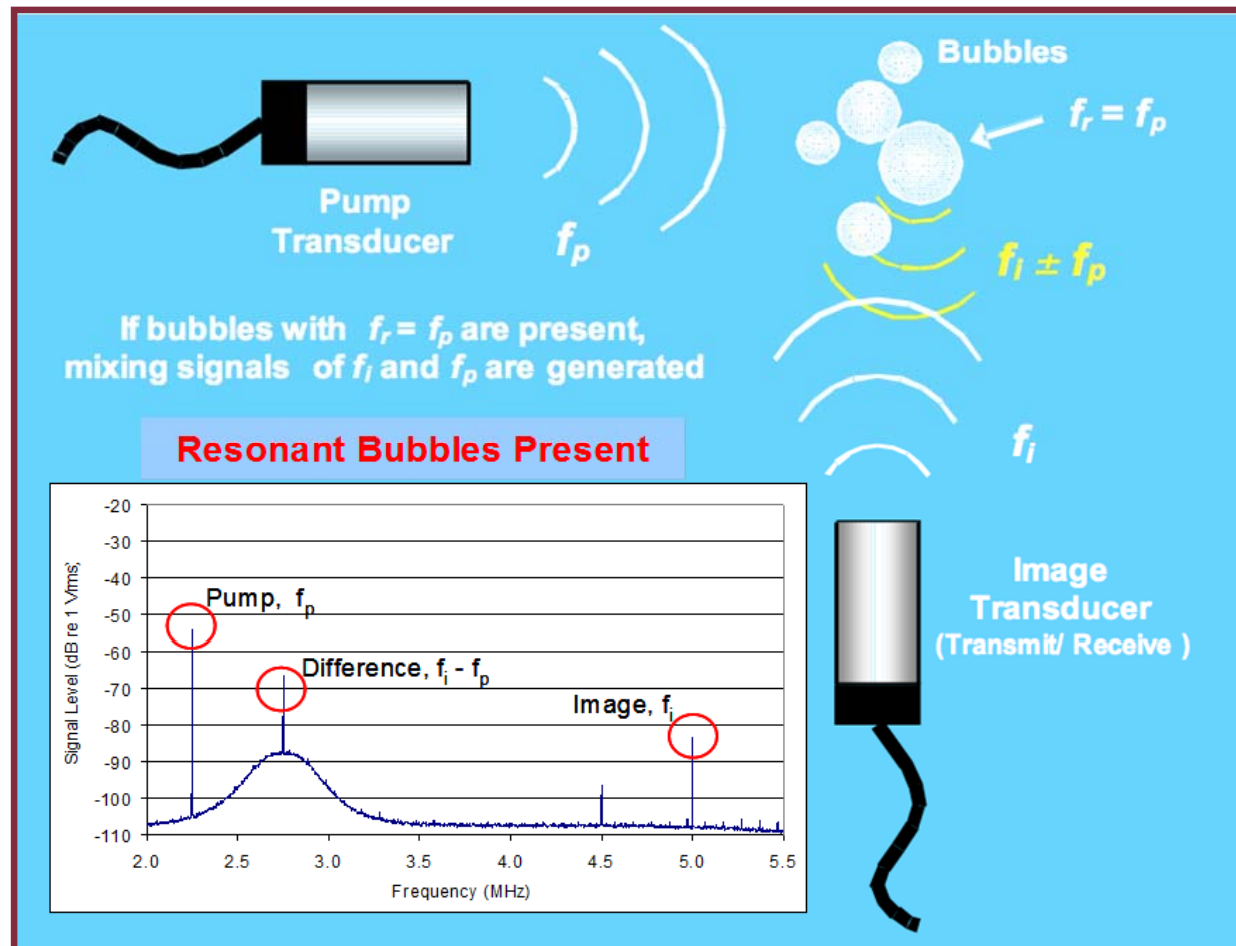


Jay Buckey, Jake Swan, and Donna Alvarenga
Dartmouth Medical School, Hanover NH

UHMS Annual Scientific Meeting
June 16, 2011

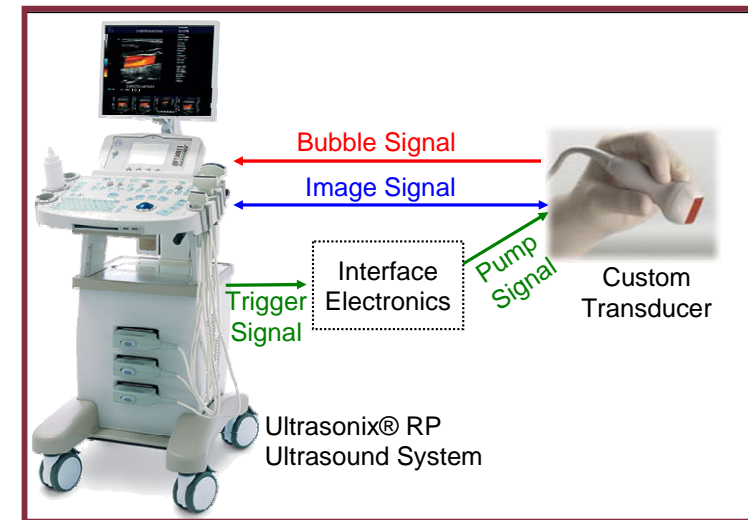
Dual-Frequency Ultrasound

- Based on Non-Linear Behavior of Resonating Bubbles
- Can Detect and Size Stationary Microbubbles in Tissue



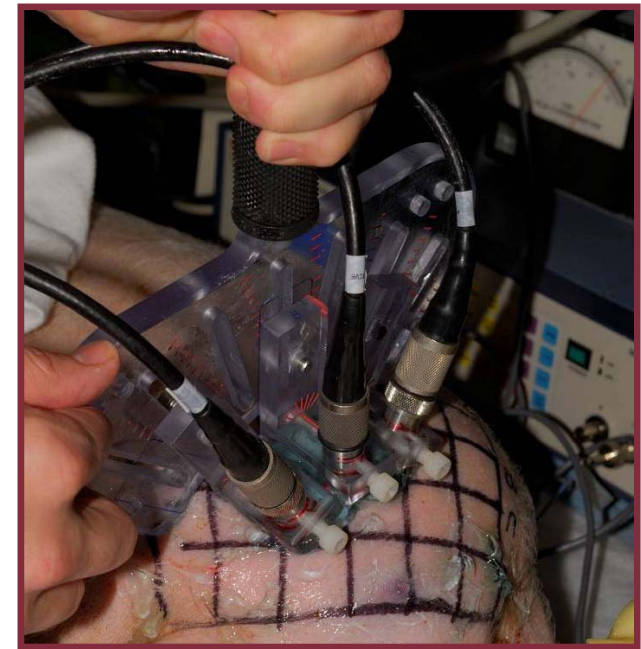
Program Overview

- **Objective**
 - Integrate DFU with B-mode imaging
 - Navigation during DFU measurements
 - Localize microbubble signals
- **Status**
 - ONR Phase II STTR (Swiergosz)
 - Currently Phase II Option 1
- **Collaboration With Dartmouth Medical School (Buckey)**
 - Technology development at Creare
 - *In vivo* experiments at Dartmouth



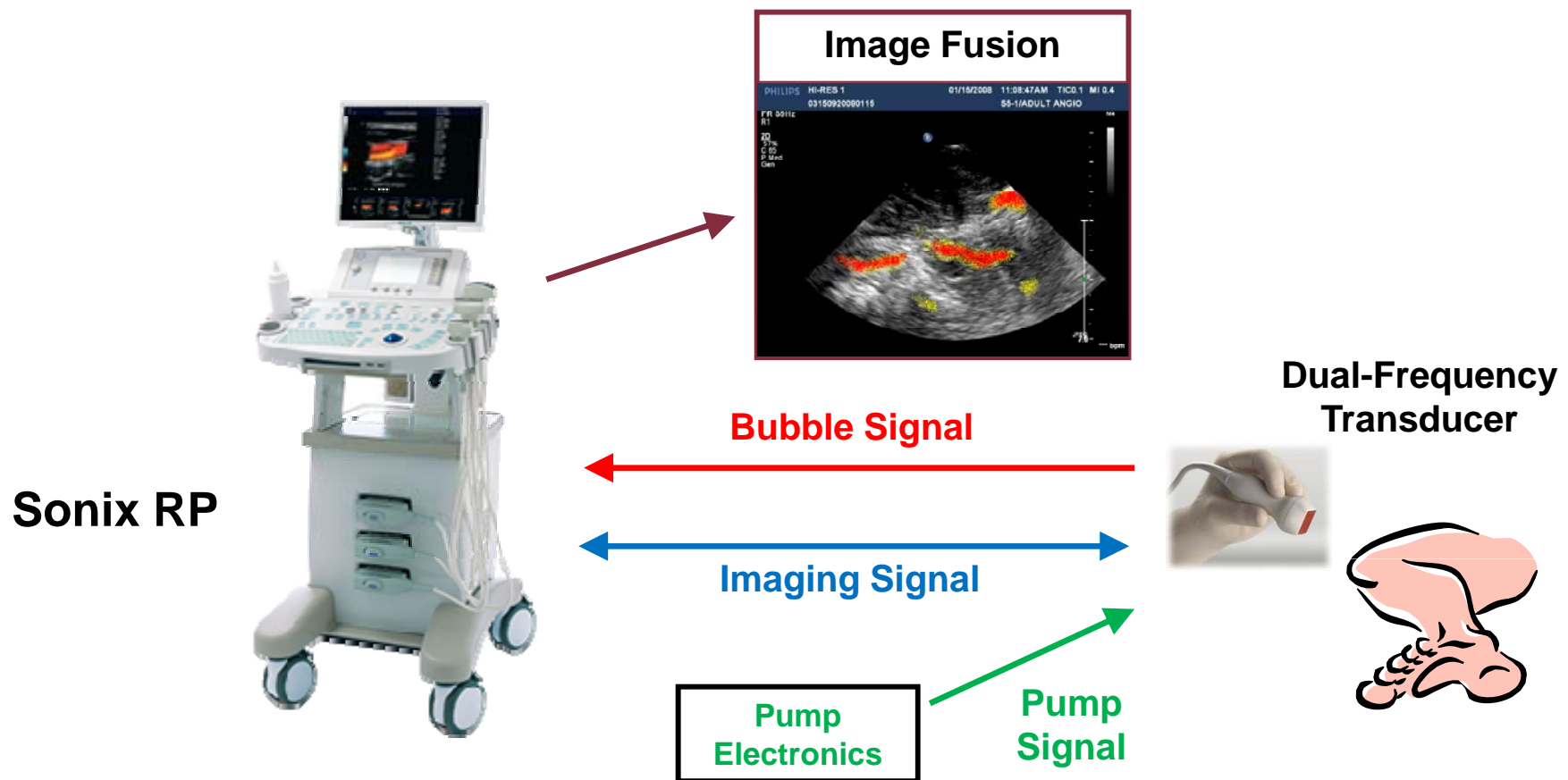
Established DFU Technology

- **LabVIEW® Based**
- **Continuous Wave (CW)**
 - Highly sensitive
- **Single-Element Transducers**
 - Pump, image, receive
- **Limited Spatial Resolution**
 - Focal region approximately 1 cm³
- **Navigation Via Secondary Imaging Ultrasound System**
 - Difficult to reproduce alignment
 - Cannot navigate and measure simultaneously



Microbubble Imaging System

- Objective Is to Integrate DFU With B-Mode Imaging
- Ultrasonix RP Development Platform



MIS Status

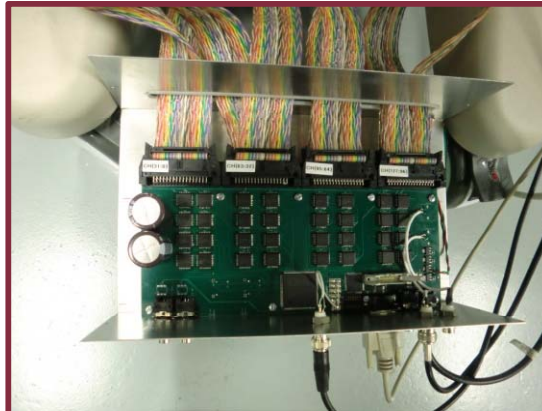
- **Integrated DFU Image With Clinical Transducer**
 - Custom “image” pulses required for adequate frequency resolution
 - Required significant electronics development for switching image circuit
- **Completed Embedded Software Development**
- **Completed Pump Electronics Packaging**



**Original
Transducer
Embodiment**



**Current
Transducer
Embodiment**



**Switching
Electronics**



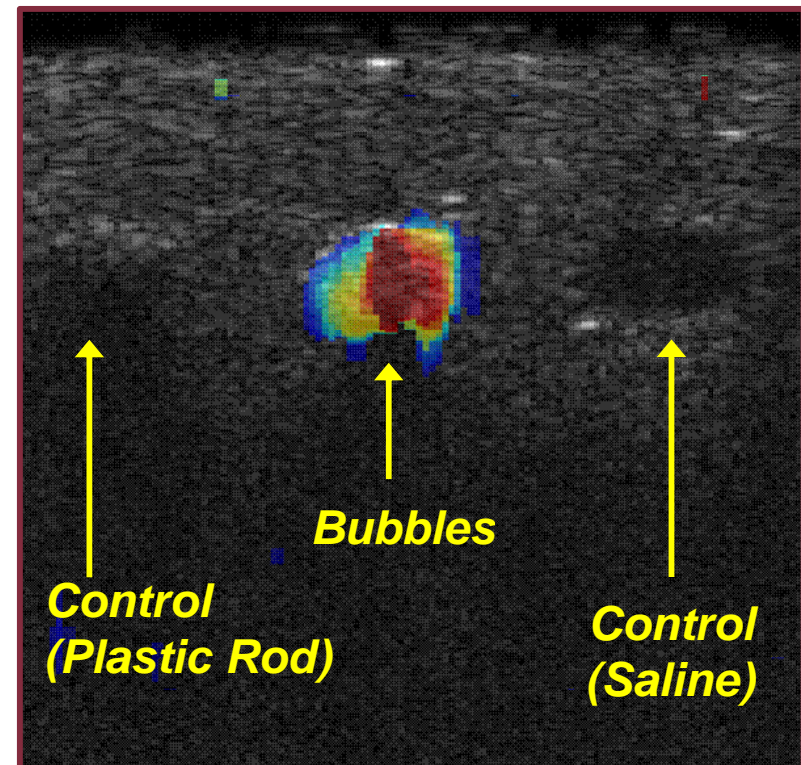
Modified Sonix RP

MIS Results

- ***In Vitro* Demonstration**
 - Urethane tissue phantom
 - Definity contrast agent bubbles
- **Preliminary *In Vivo* Measurements**
- **Recent Focus on Sensitivity**



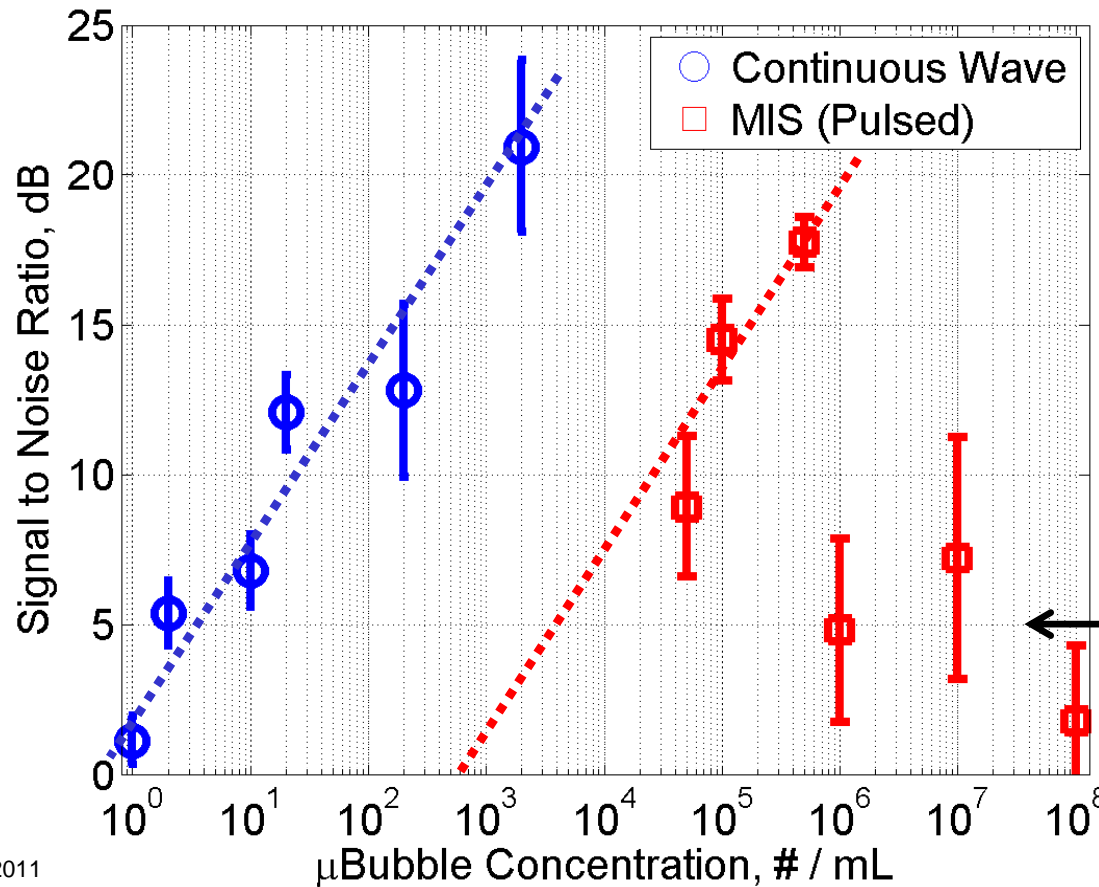
Tissue Phantom



MIS Data

MIS Sensitivity

- **MIS Inherently Less Sensitive Than DFU**
 - Trade-off between sensitivity and spatial resolution
 - Pulsed (MIS) vs. continuous wave (DFU)



DFU Sensitivity Data
(free contrast agent microbubbles in water)

Less ultrasound penetrates into, and is attenuated quickly by, higher microbubble concentrations

Future Plans

- **System Development**
 - Further sensitivity optimization
 - Transducer integration
 - Dual mode operation:
 - High sensitivity, low spatial resolution (CW mode)
 - Lower sensitivity, higher spatial resolution (pulsed mode)
- **Applications**
 - Dartmouth exercise protocols
 - Dartmouth dive studies (swine)
 - Encouraging preliminary results
 - Duke NASA protocols (altitude exposures)
 - NEDU dive protocols?