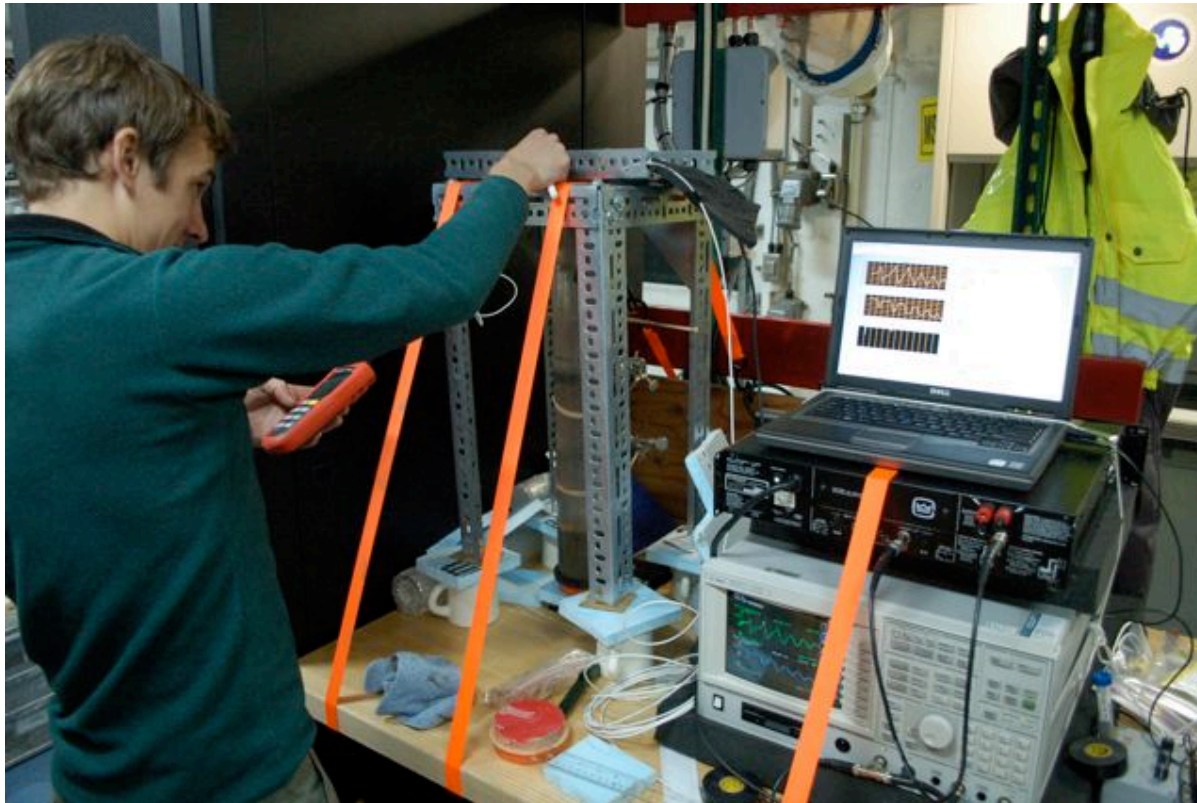
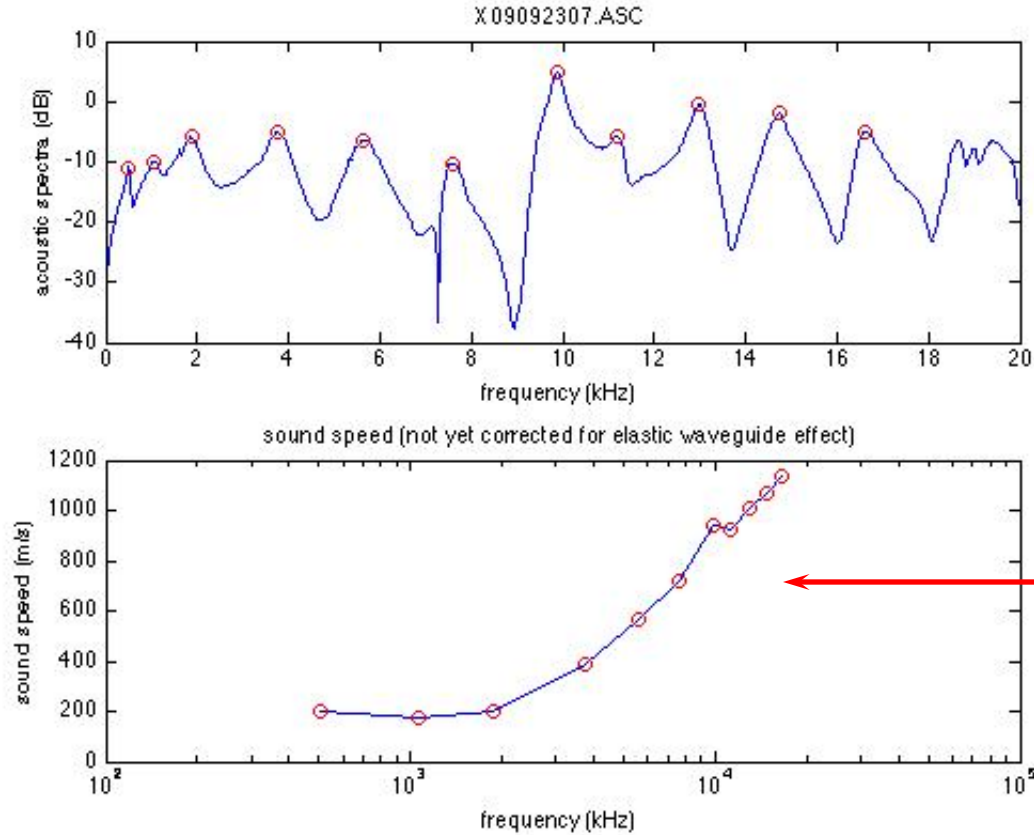


effective sound speed in tube

Use elastic waveguide model to extract sounds speed in free space.



1-D resonator apparatus on Polar Sea



Qualitatively similar to A & H prediction as frequency goes across bubble resonance.

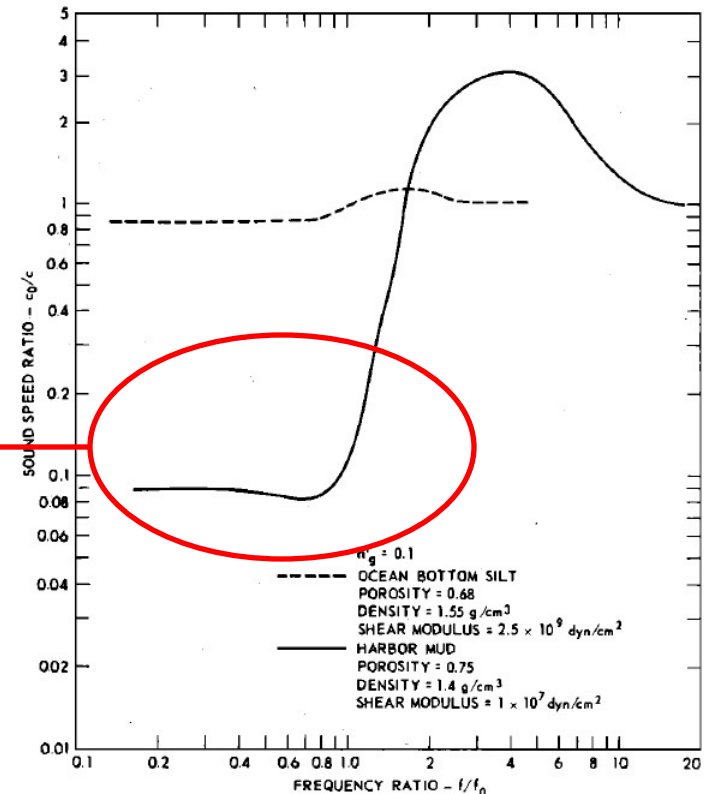
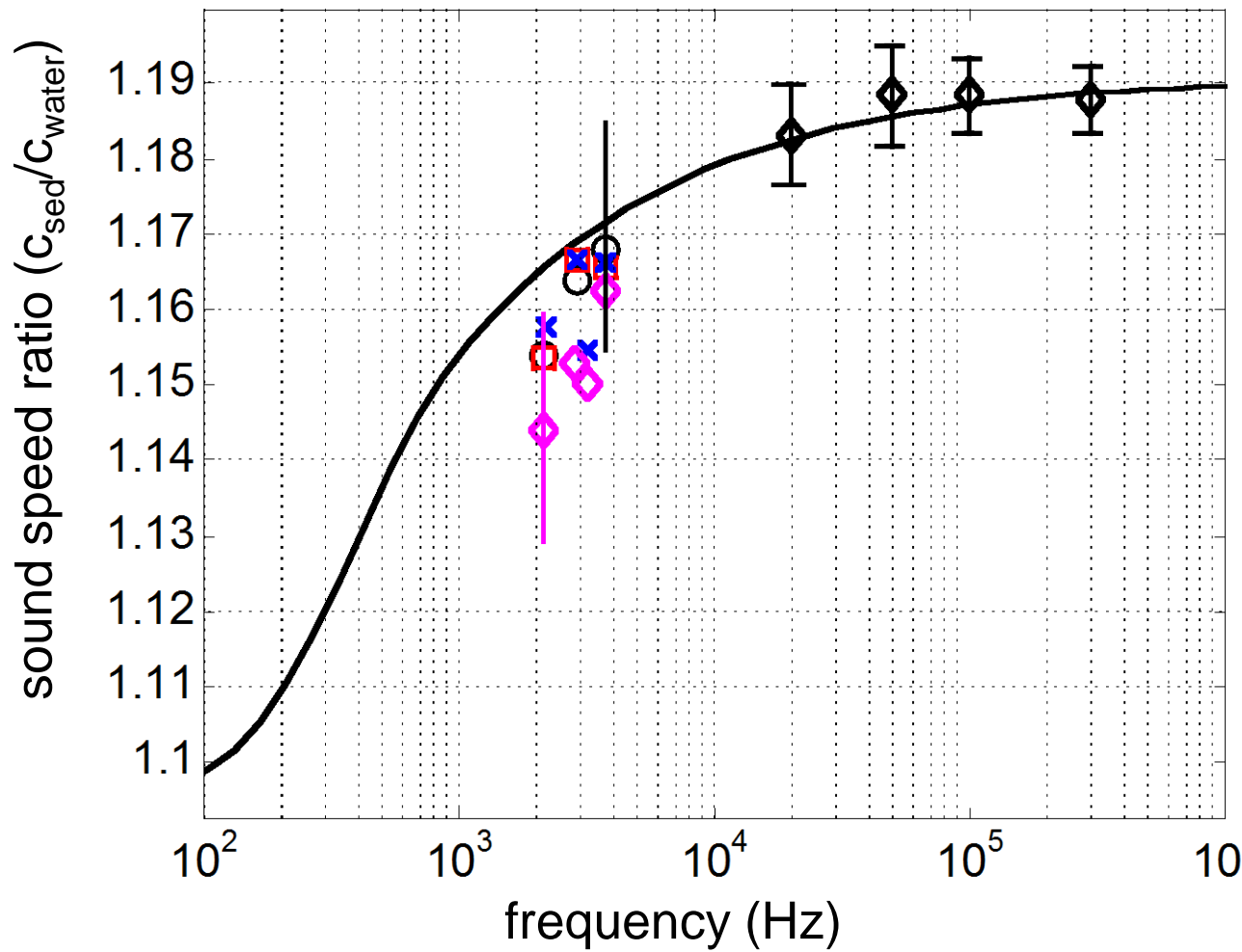


FIG. 15. Gassy sediment sound speed ratio versus frequency ratio.

Typical Results for Sand (medium grain)

resonance time-of-flight

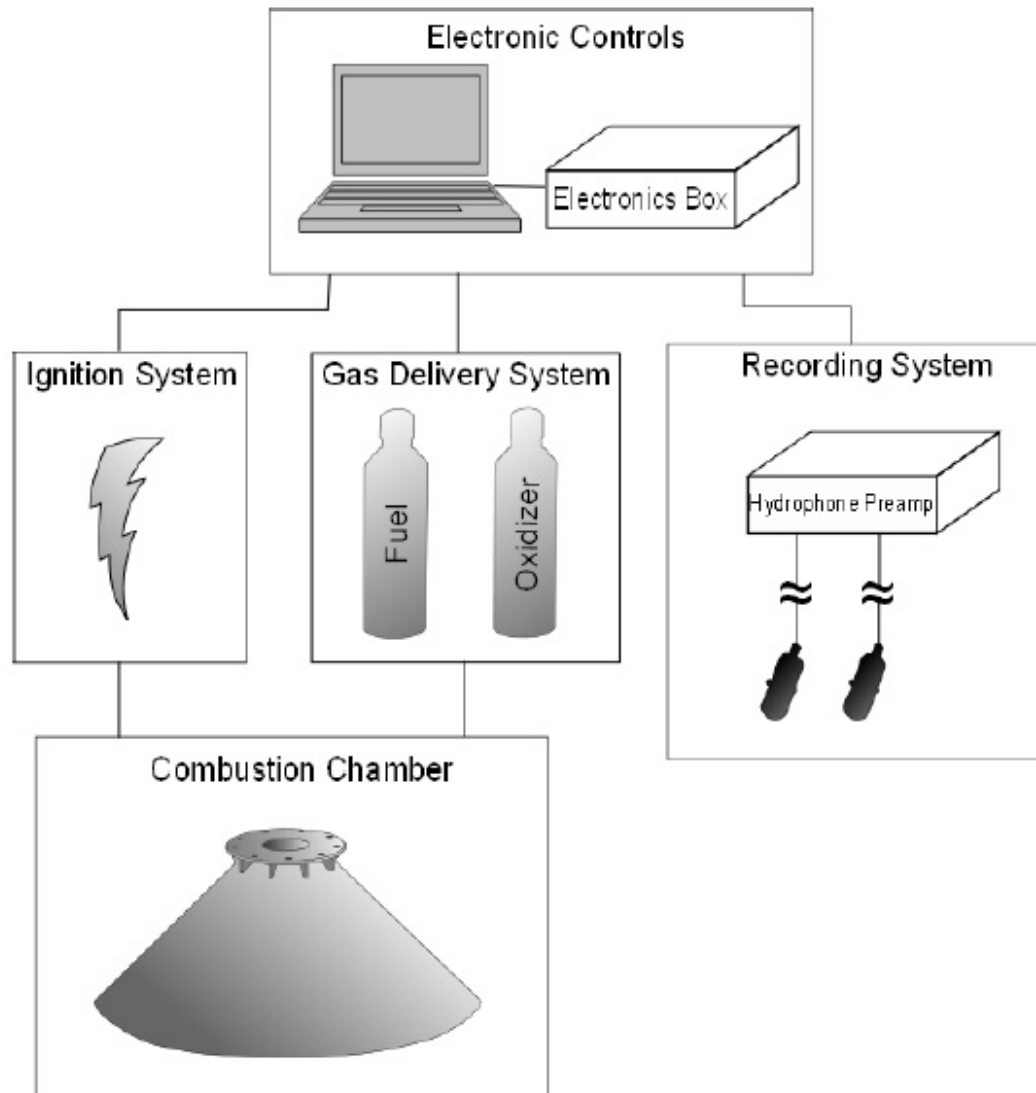


EDFM

Sediment Parameters (SI units)	
porosity	= 0.37
sand density	= 2650
water density	= 998
bulk mod. sand	= 3.6e10
H2O sound speed	= 1492
viscosity	= 0.001
permeability	= 1e -10
tortuosity	= 1.25

(Error bars represent length and time uncertainties.)

General CSS Schematic and Recording System



Apparatus

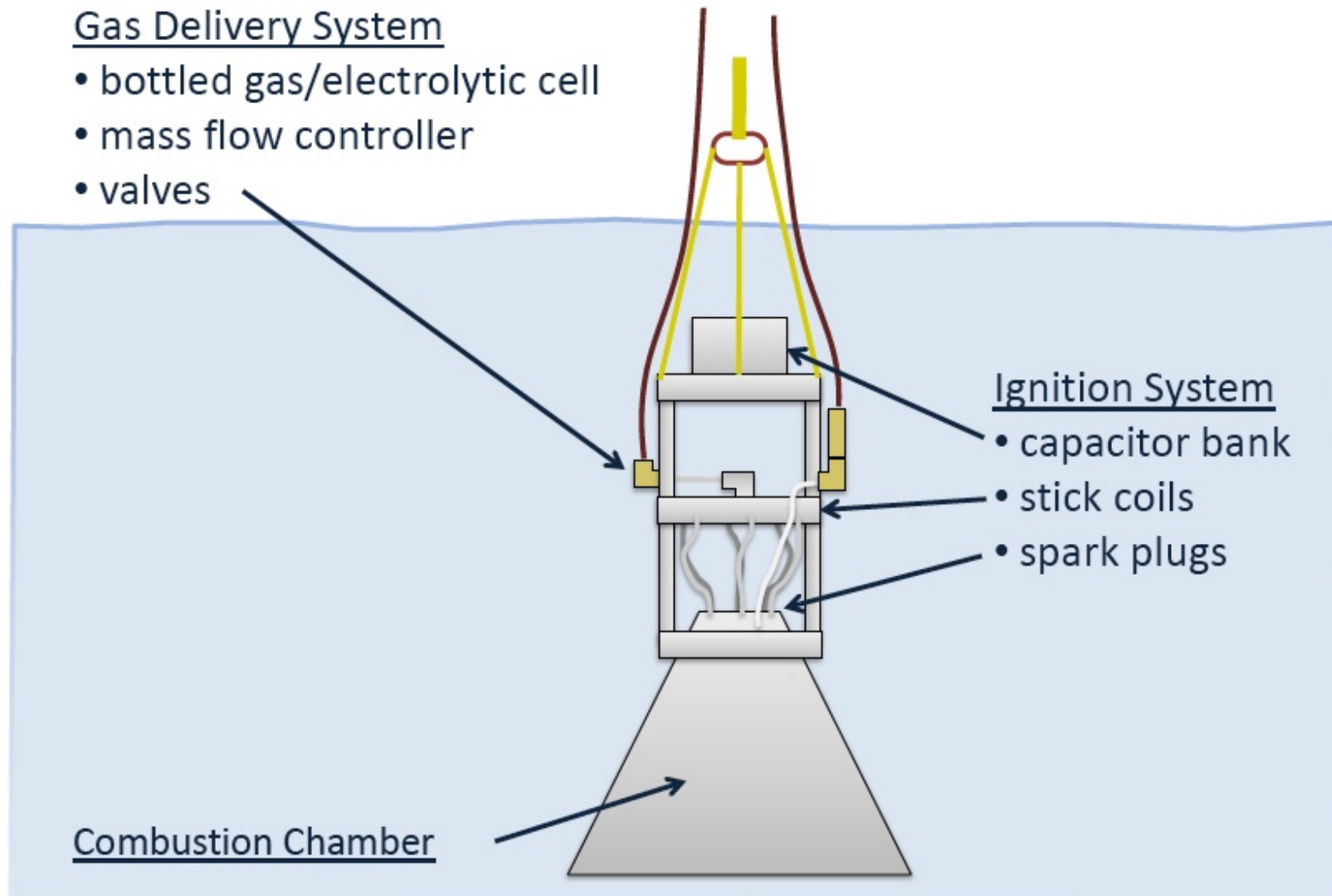
Gas Delivery System

- bottled gas/electrolytic cell
- mass flow controller
- valves

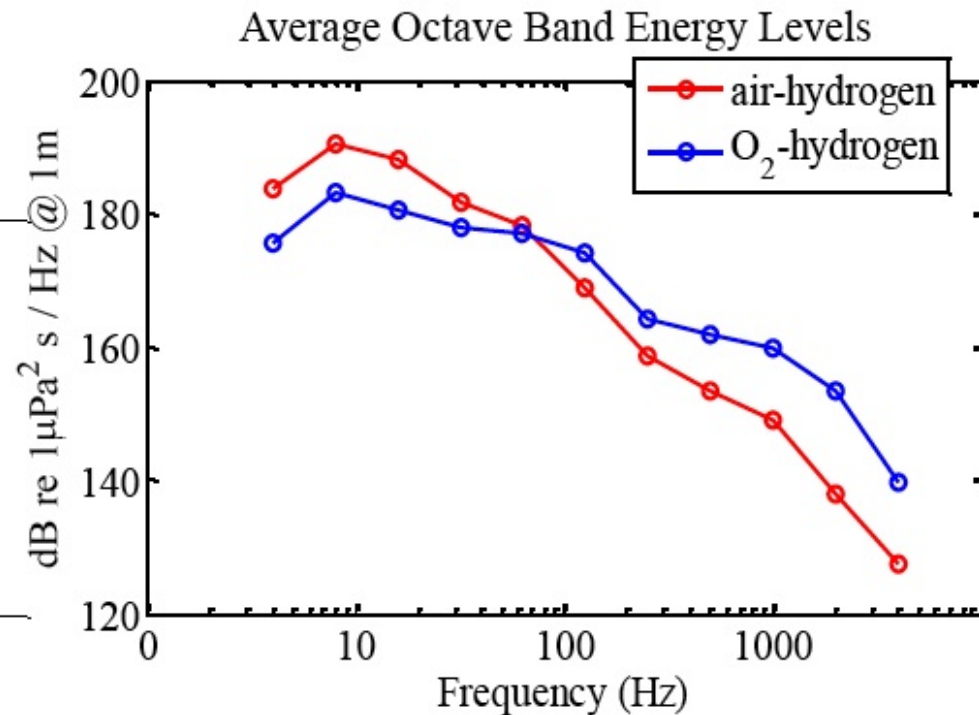
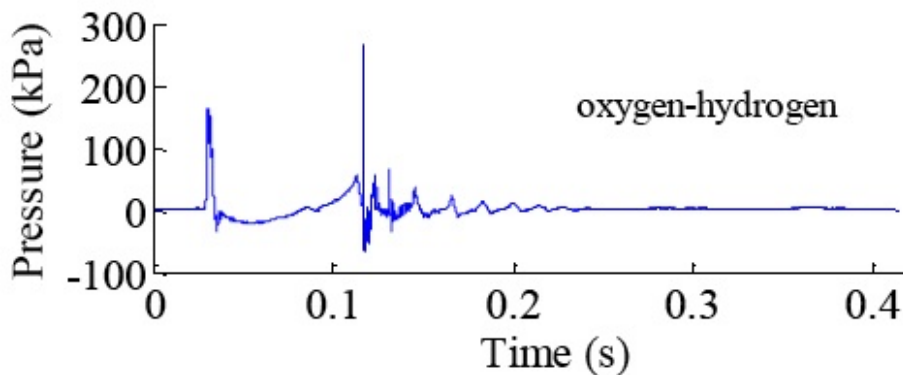
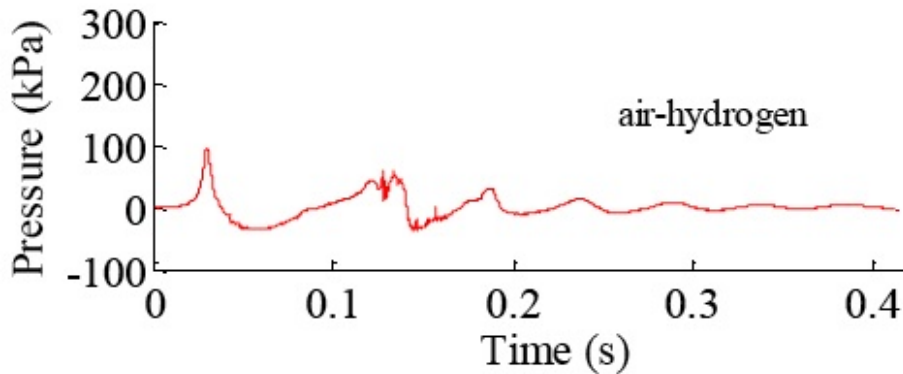
Ignition System

- capacitor bank
- stick coils
- spark plugs

Combustion Chamber

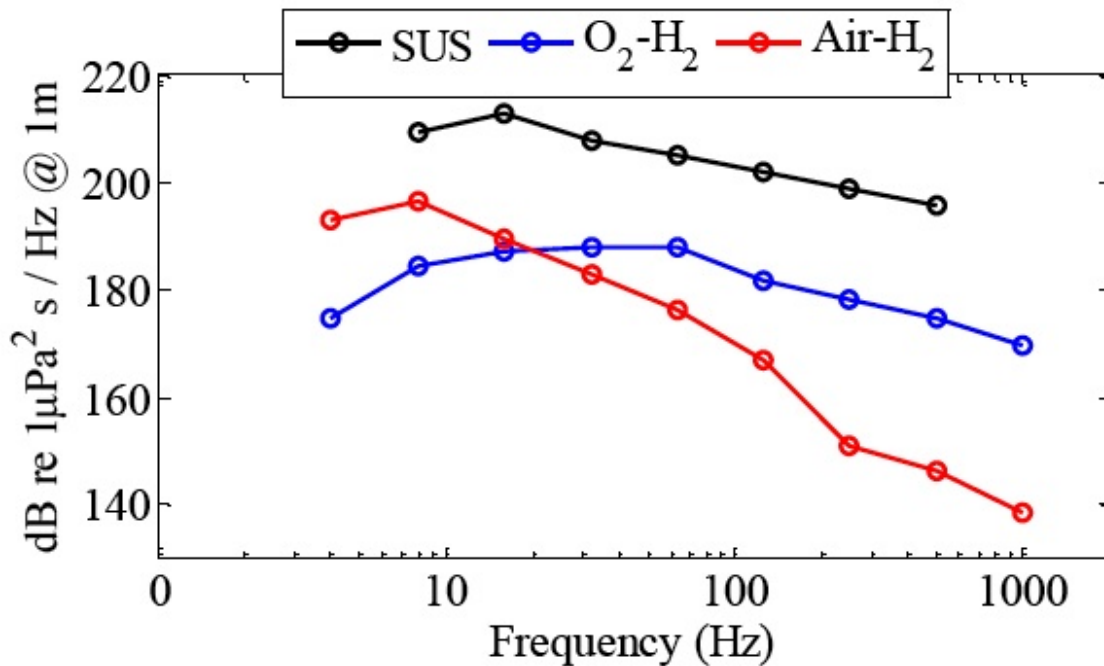


Typical CSS Acoustic Signals



Note: both events have an ESL of 202 dB

Comparison to 1.8 lb SUS

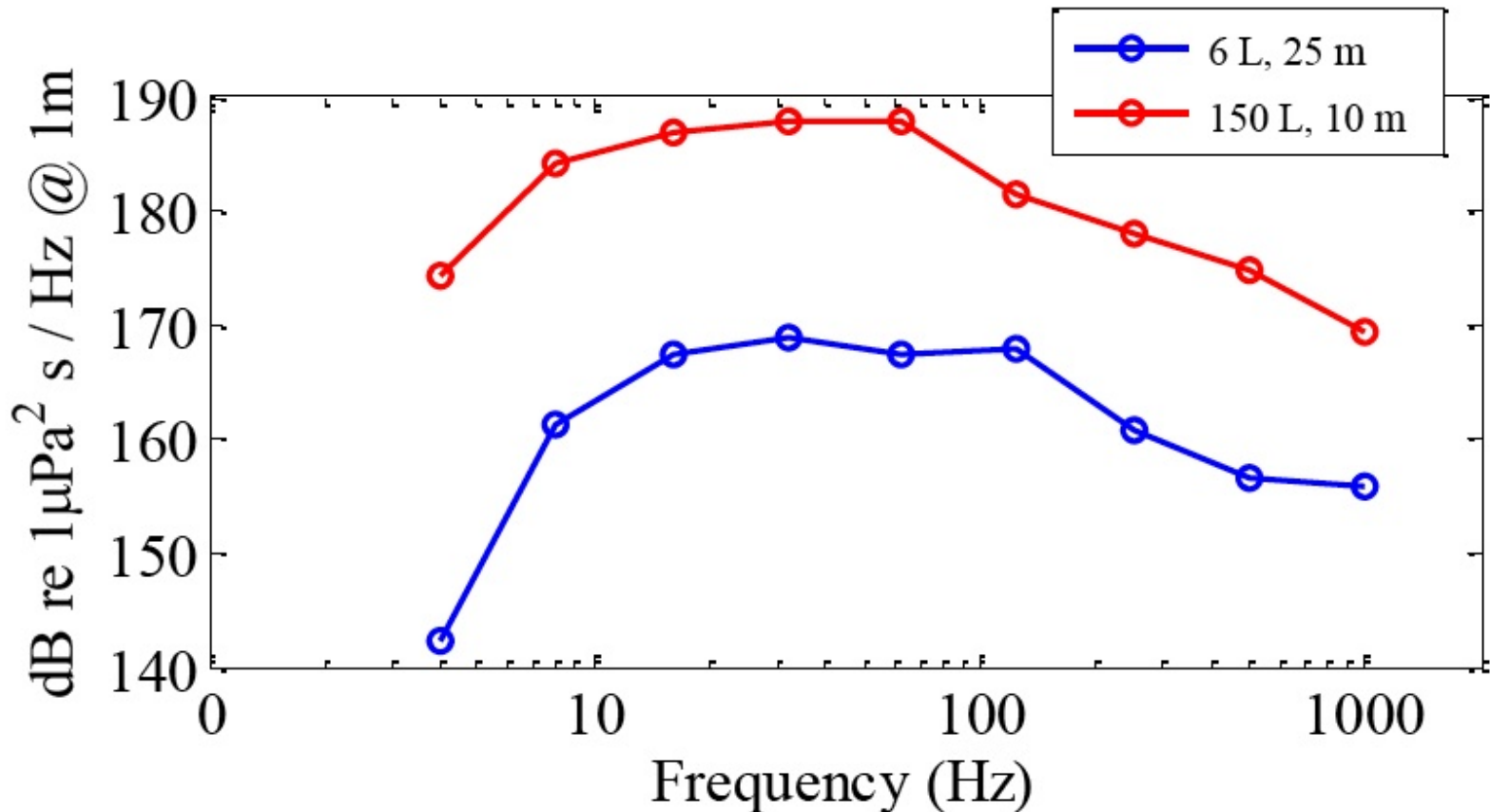


- SUS*:
1.8 lb charge,
detonated at 23.5 m
- oxygen-hydrogen:
150 L (STP),
fired at 10 m
- air-hydrogen:
240 L (STP),
fired at 5 m

*N. R. Chapman, "Source levels of shallow explosive charges," J. Acoust. Soc. Am., vol. 84, no. 2, pp. 697–702, 1988.

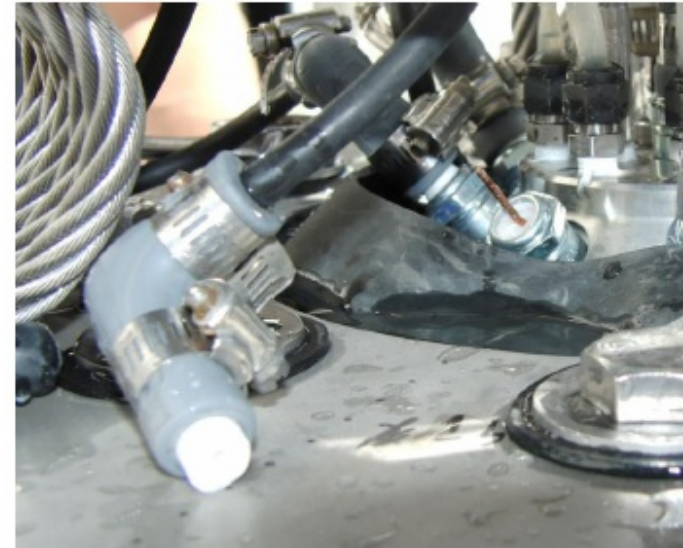
Variation of Source Level at Constant Bandwidth

- Source Level increase
 - ESL: 196 dB to 211 dB
- Bandwidth is maintained



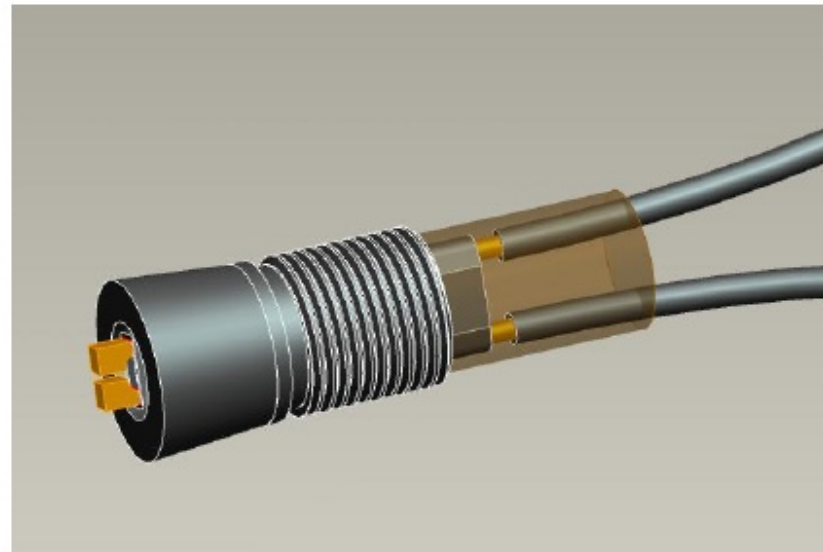
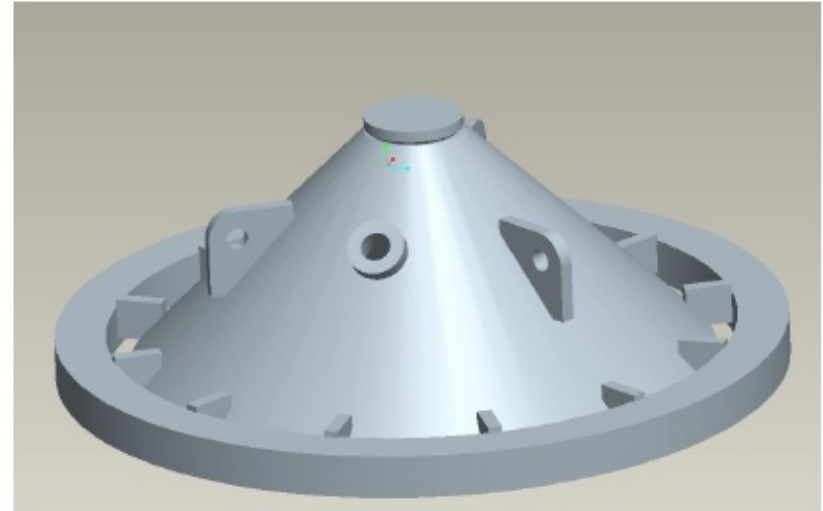
Hardware Malfunctions

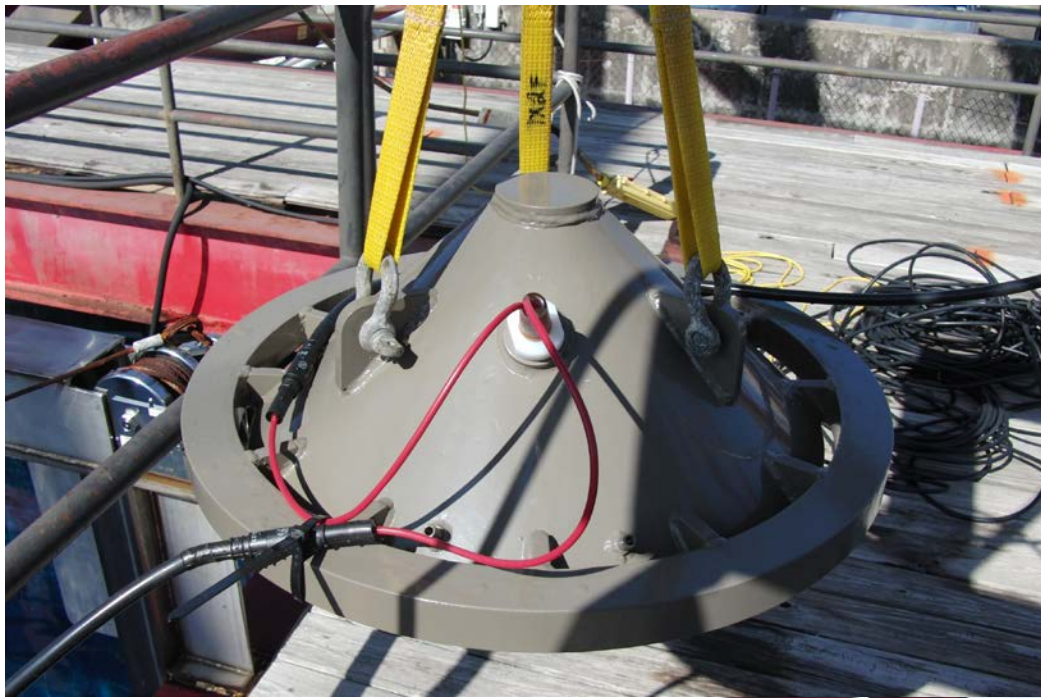
- Spark Plugs Breaking →
- Loosening of Bolts/Screws/Fittings
- Solenoid Valves Stuck Closed
- Premature Flame Arrestor Closing
- Water Level Sensor Inaccuracies
- Blown Gaskets



Hardware Solutions

- Array configuration of smaller chambers
 - Increases SL for large gas volumes
 - Reduces stresses on chambers
- Remove all rigid hardware connections to chamber
 - Prevents loosening of threaded connections
 - Removes shock that jammed solenoid valves
 - Removes need for gaskets
- Custom ignition source removed from apex of chamber
 - Prevents spark plug failure due to bubble collapse





New design has survived hundreds of shots with no damage.

Acoustics and source engineering nearing completion.

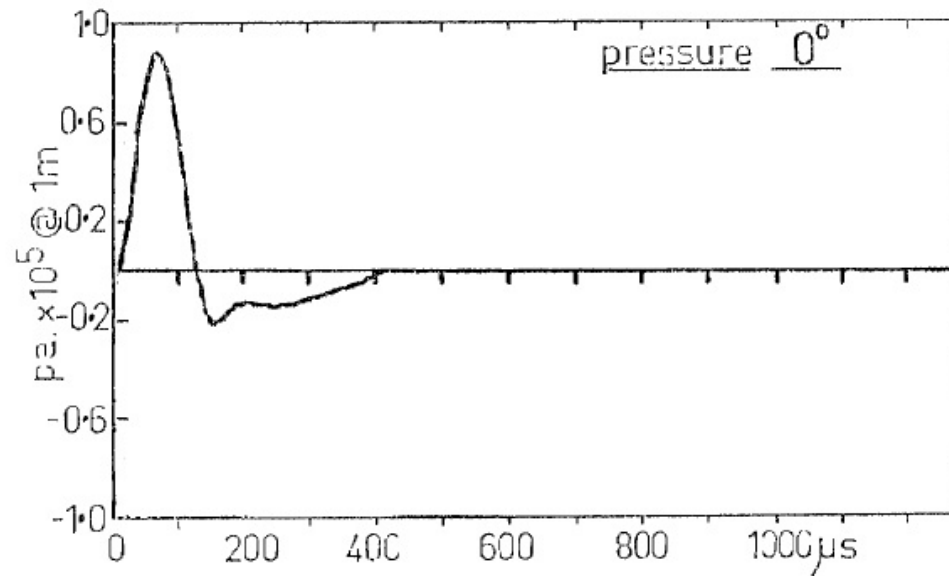


CSS Deployment Options

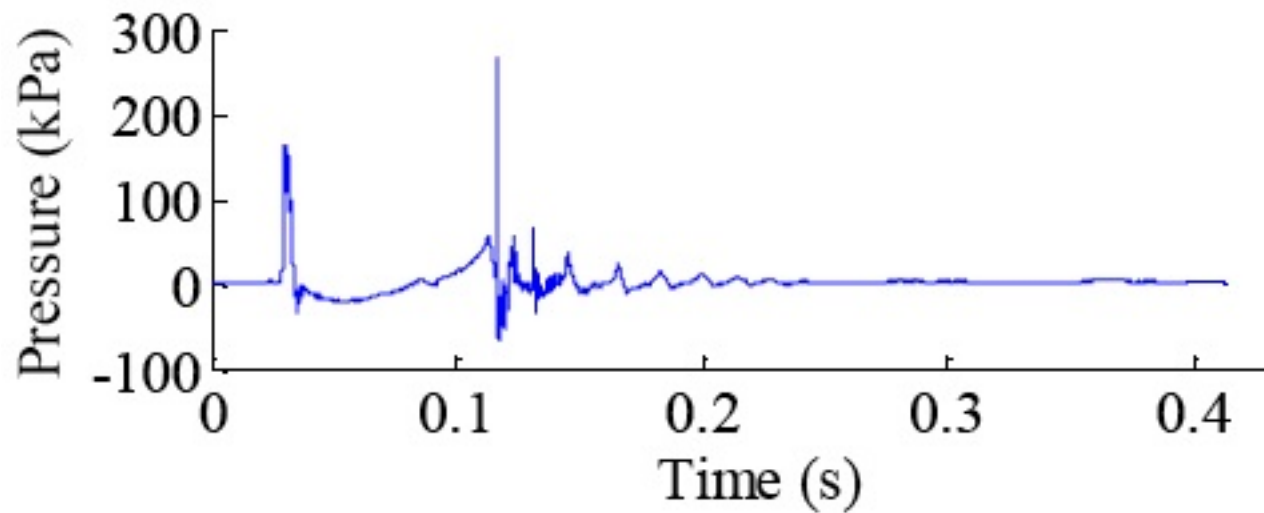
(under development via DURIP)

- water column
 - ship tow (slow speed, ≈ 2 ping/min)
 - stationary
- ocean bottom–Scholte wave generation
 - tow sled
 - stationary

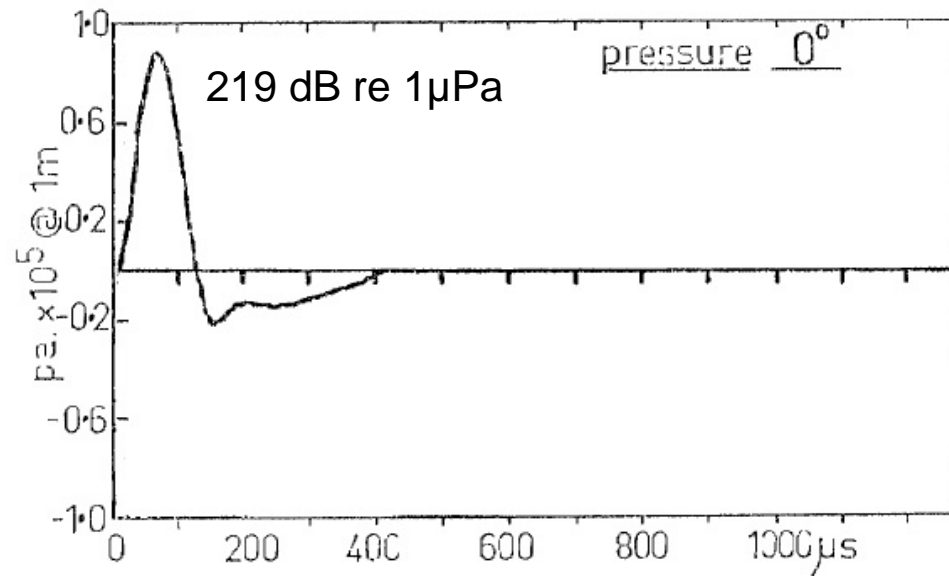
Boomer
(6 kV)



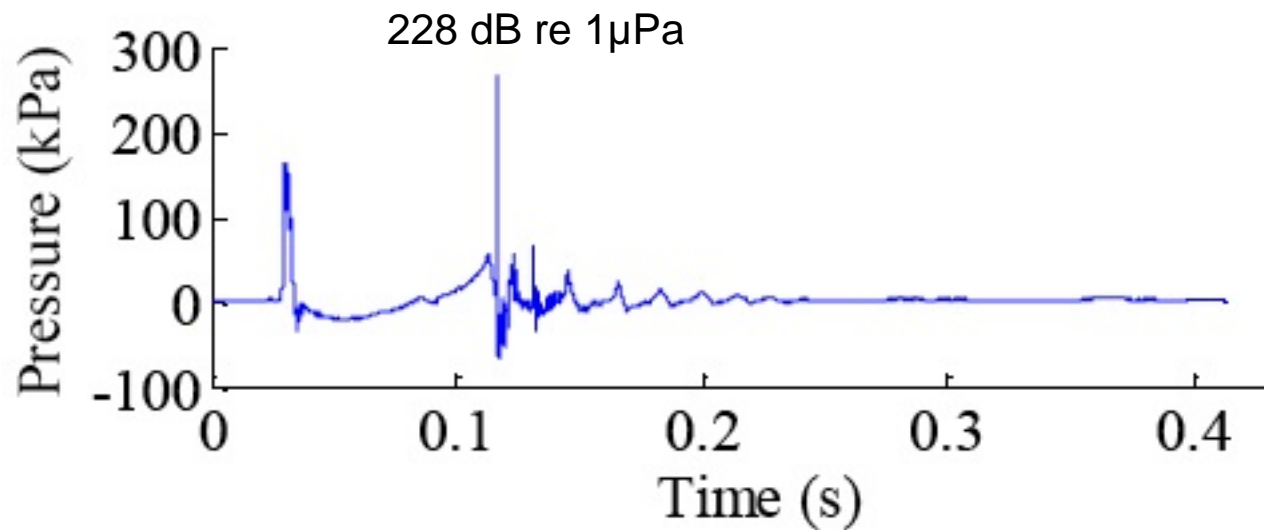
CSS



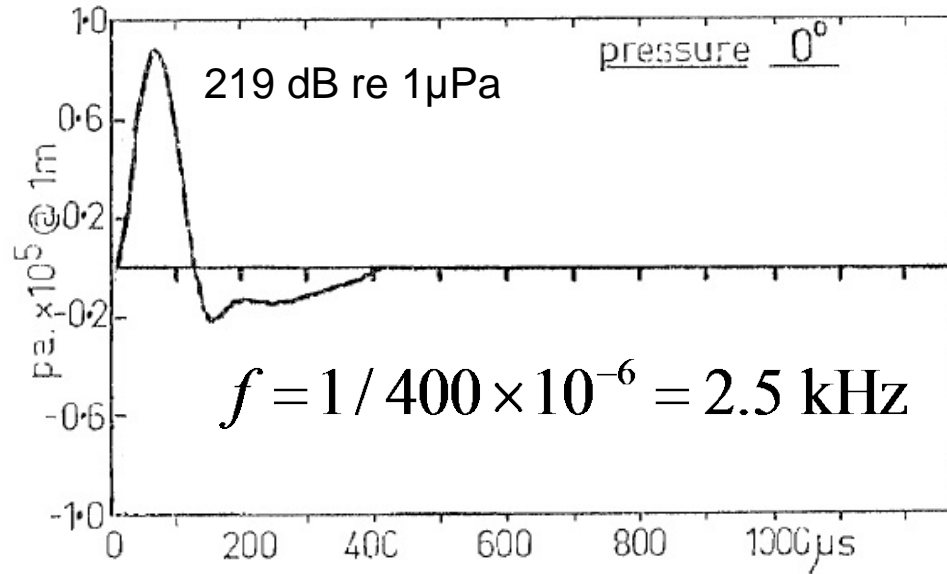
Boomer
(6 kV)



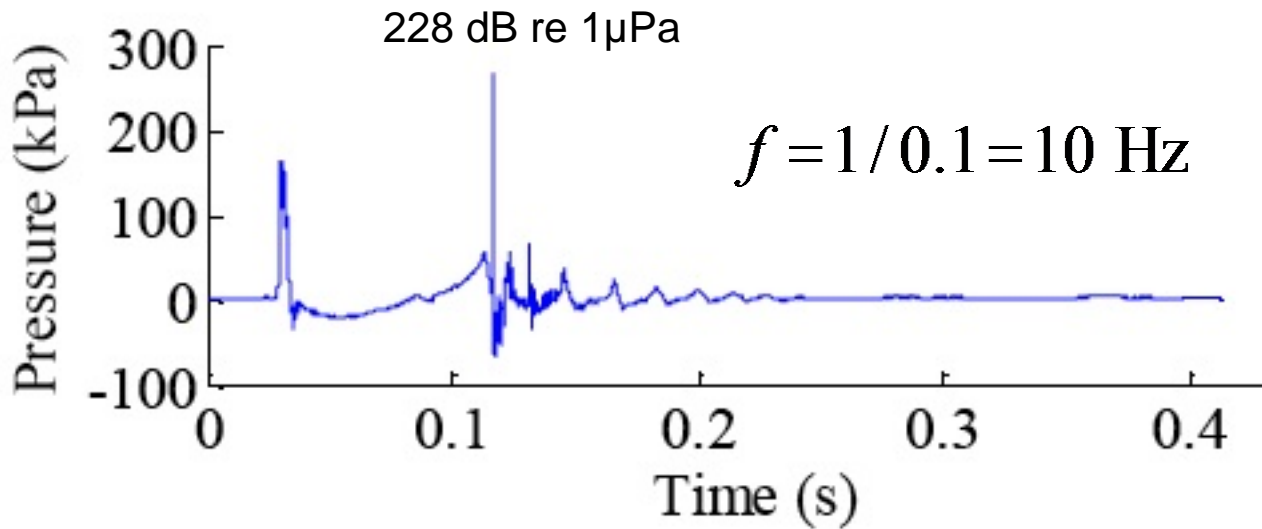
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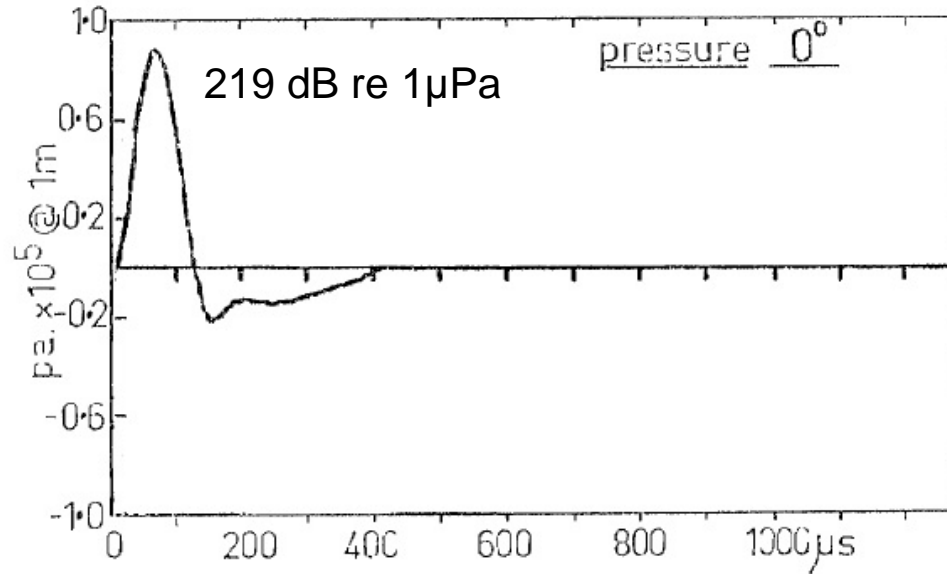
Boomer
(6 kV)



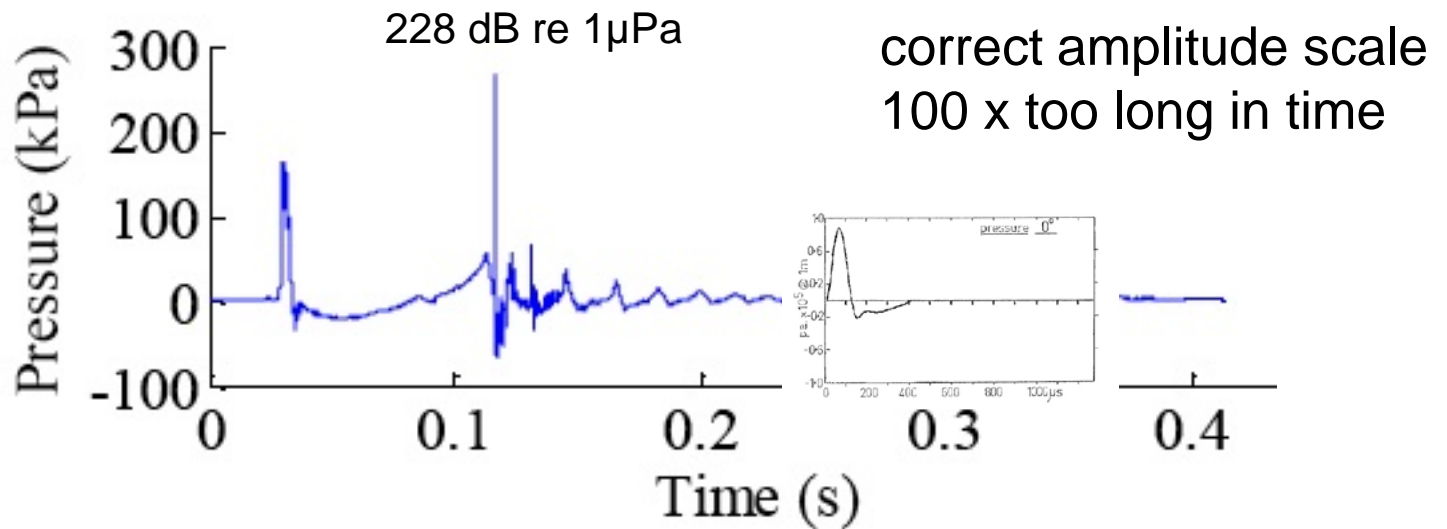
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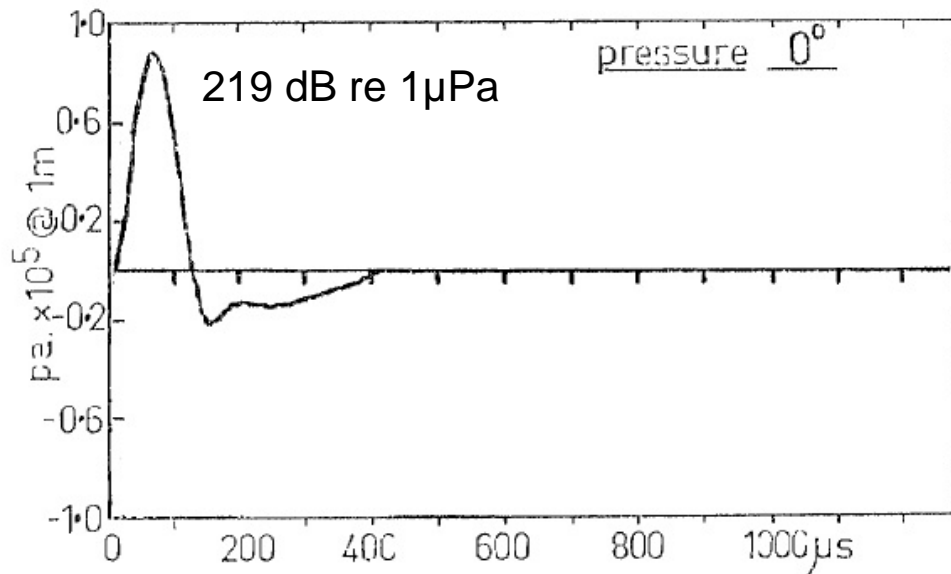
Boomer
(6 kV)



CSS



Boomer
(6 kV)



CSS

