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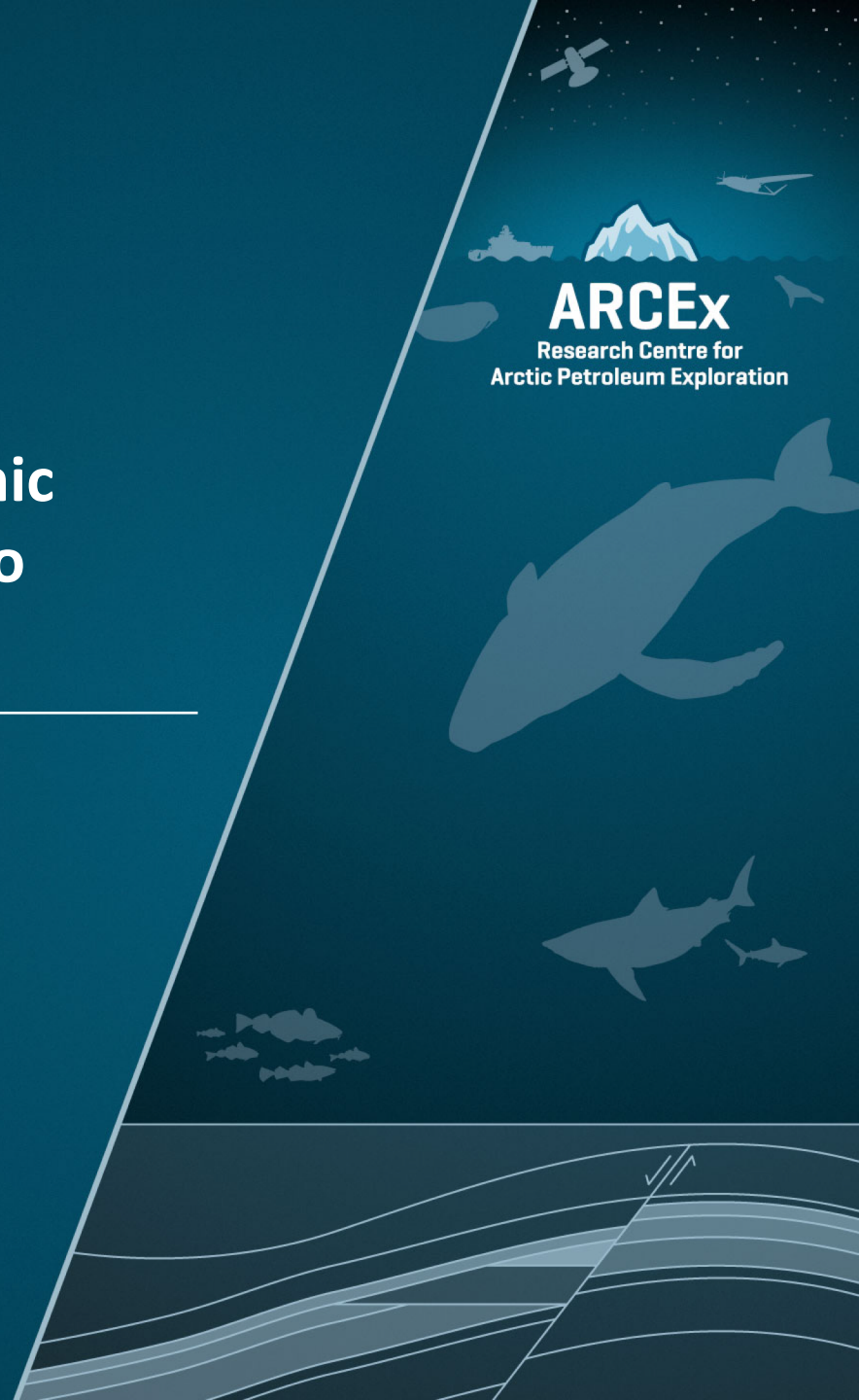
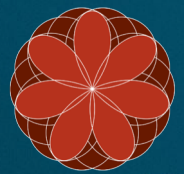
Cavity cloud generated by seismic air-gun arrays – comparing video recordings to modeling

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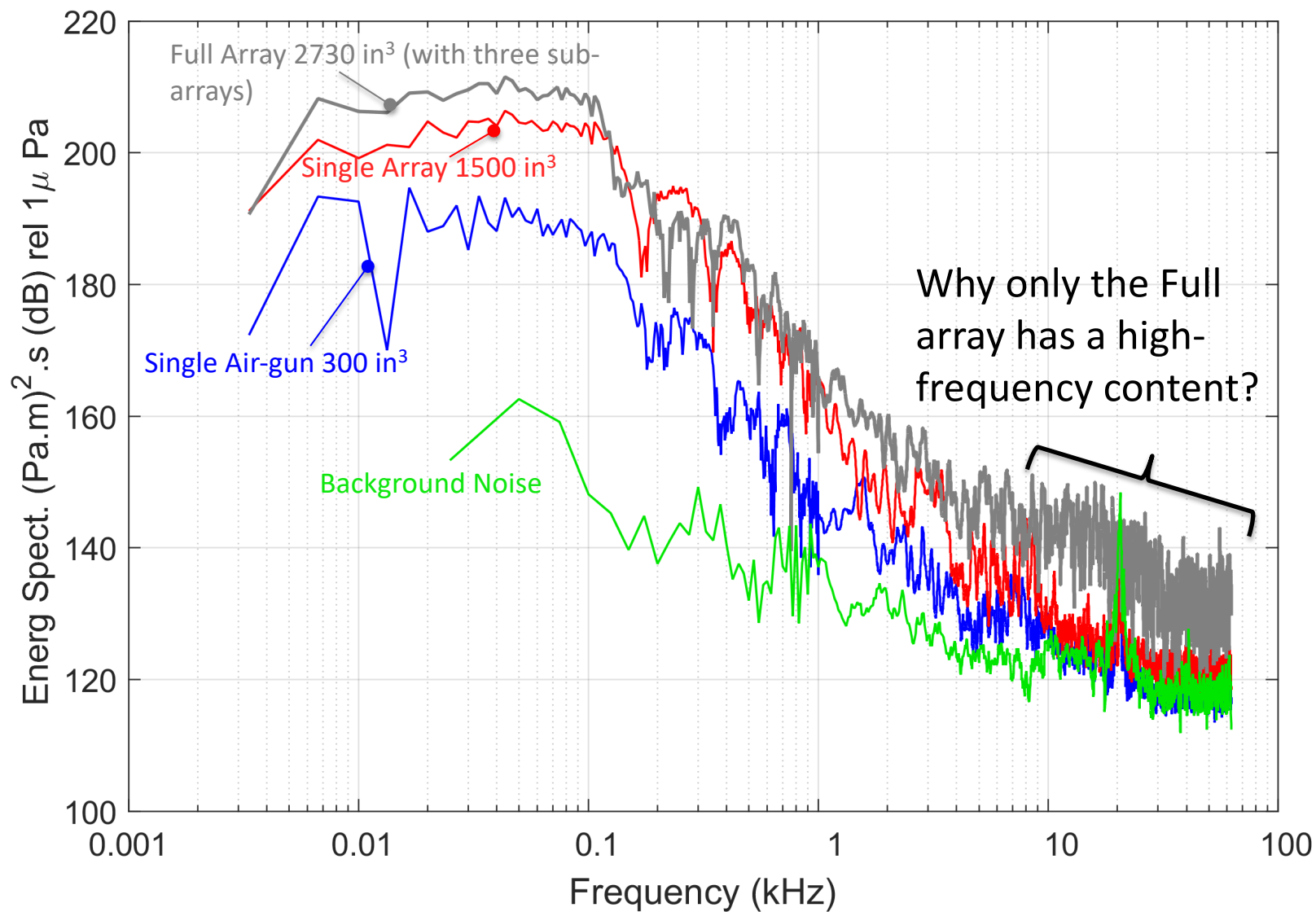
Supervisor: Prof. Martin Landrø

Rose Meeting

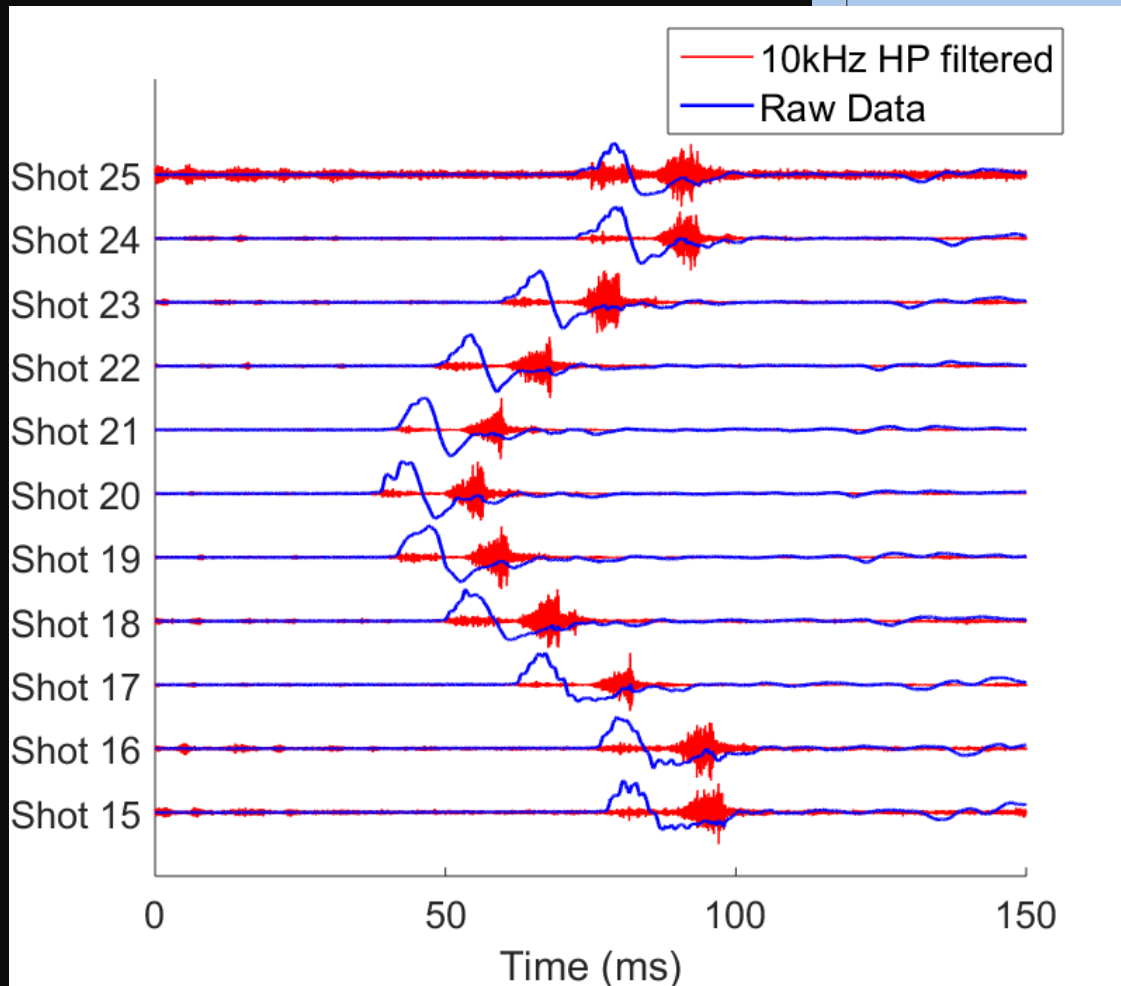
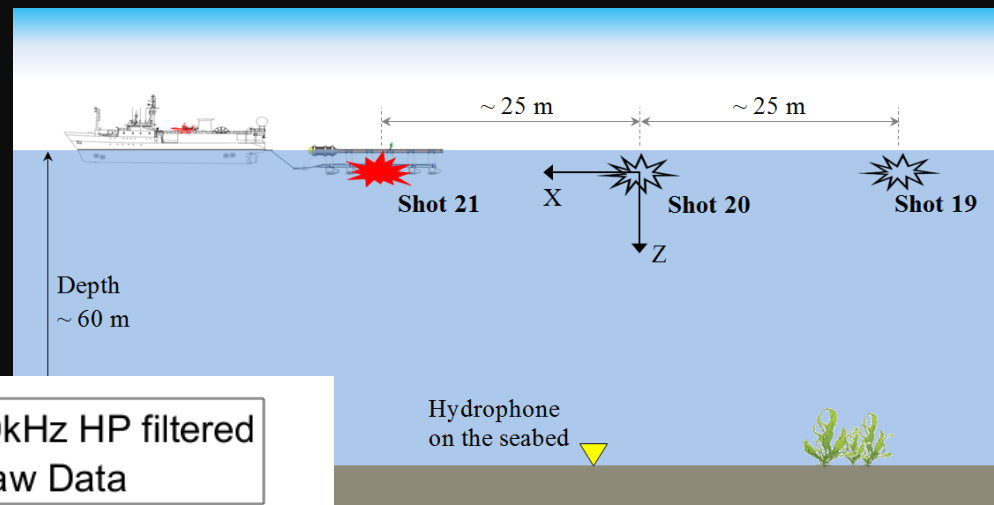
23 April 2018



Field Measurement with a Broad-band Hydrophone (125 kHz):

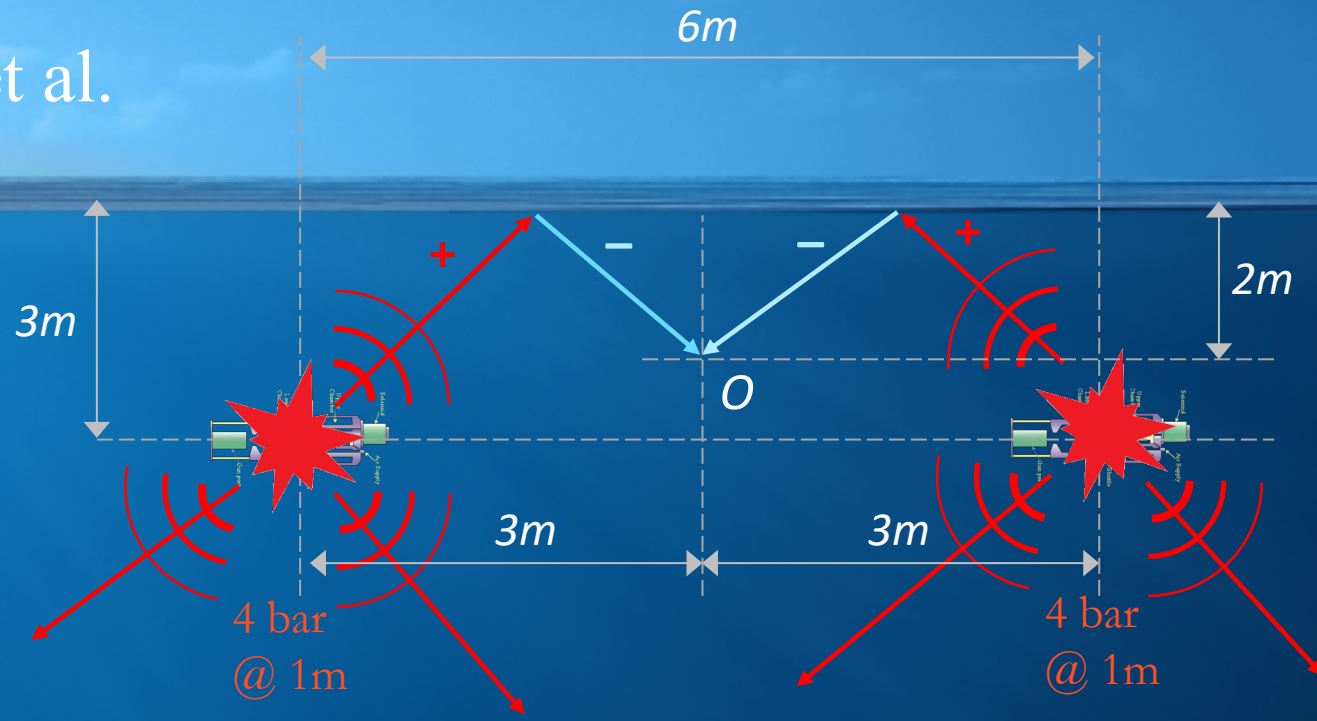


Source is a full air-gun array.



Underlying mechanism for
high-frequencies (>10 kHz) in
seismic air-gun arrays?

➔ Ghost cavitation hypothesis by Martin Landrø et al. (2011)



Pressure at point O: $(-0.65) + (-0.65) + 1.2 = -0.1 \text{ bar!}$

Ghost Cavitation Cloud Modeling

Technique:

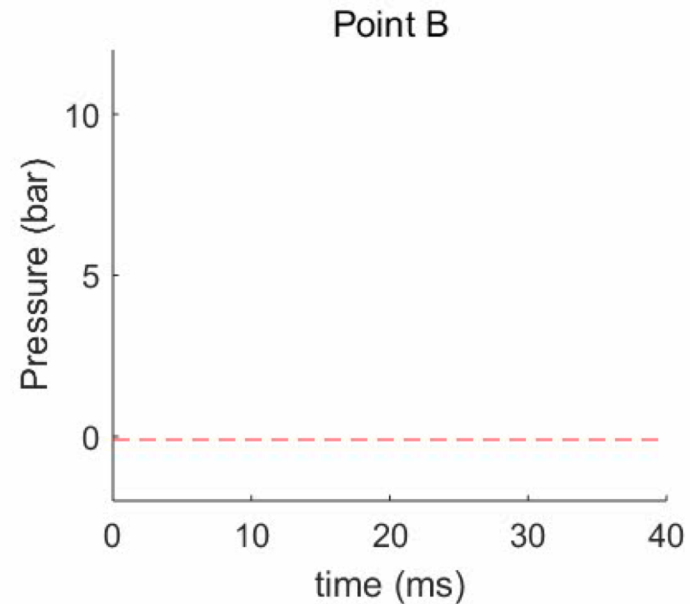
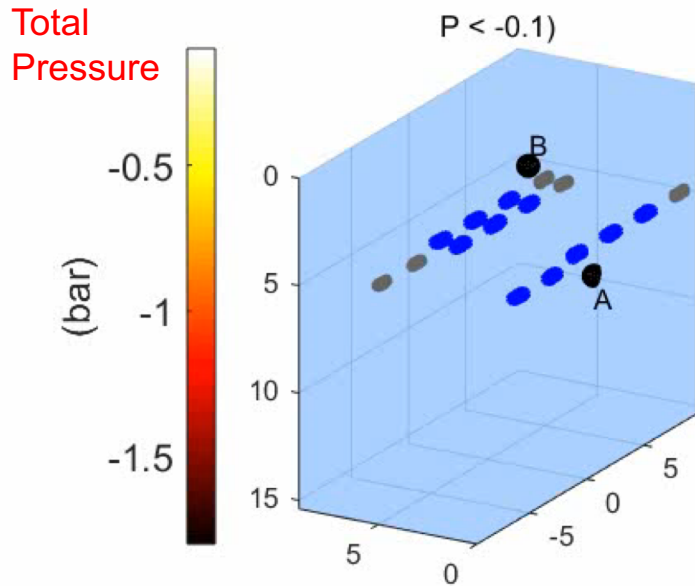
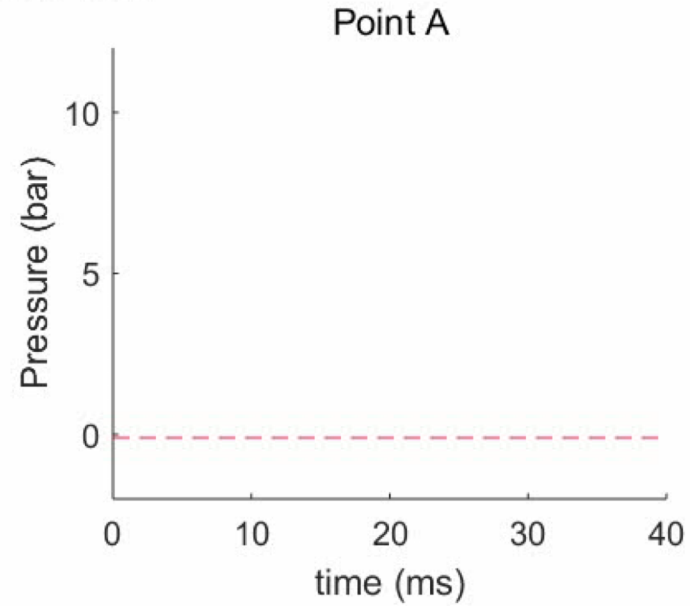
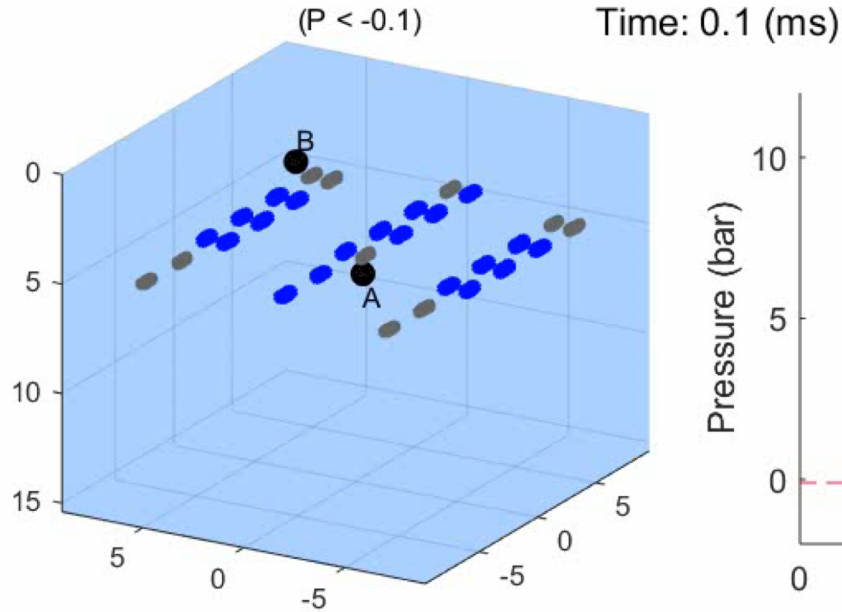
Where and When?

Individual Cavity Signatures

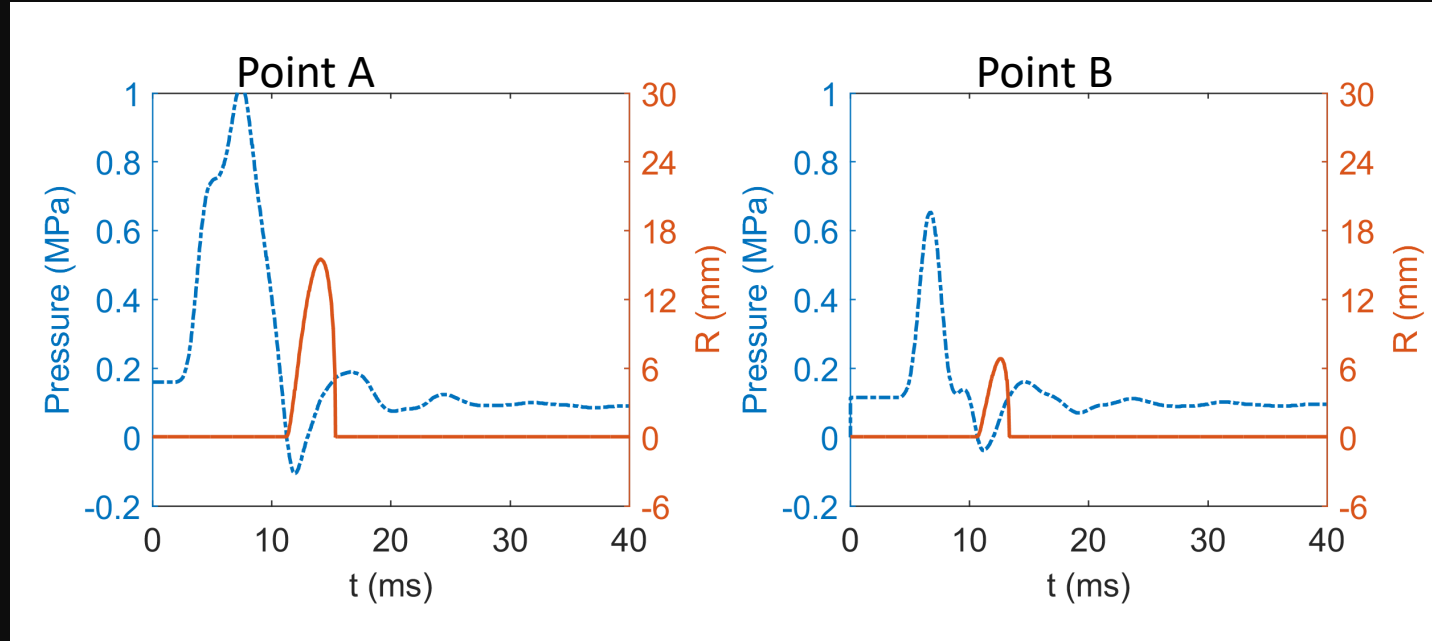
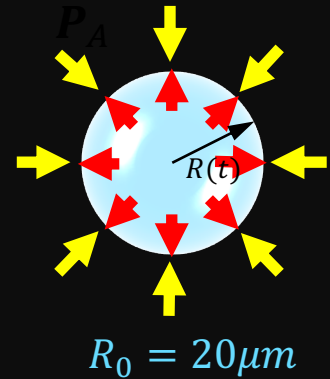
Propagation of Cavities

Superposition of Cavities

Estimating pressure around a seismic air-gun array:



Response of a microbubble to the pressure variations at points A and B:

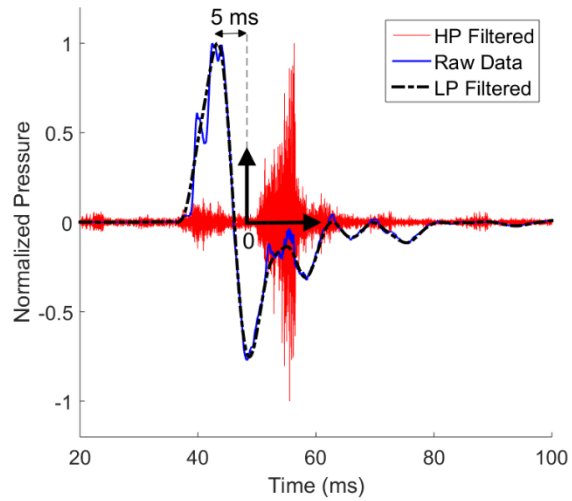


Bubble dynamics equation (Prosperetti and Lezzi, 1986):

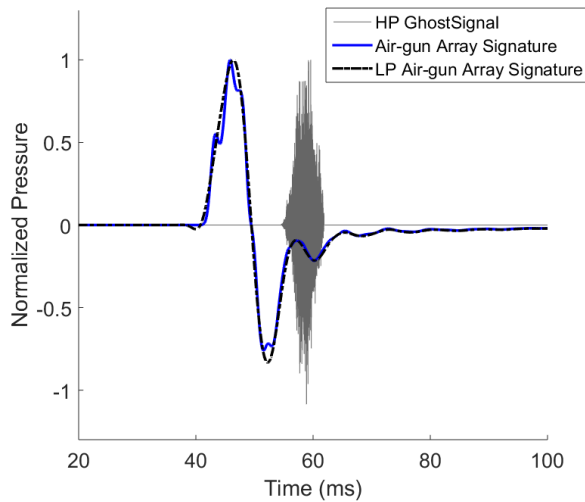
$$\left(1 - \frac{1}{c} \frac{dR}{dt}\right) R \frac{d^2 R}{dt^2} + \frac{4\mu}{\rho c} \frac{d^2 R}{dt^2} = -\frac{3}{2} \left(1 - \frac{1}{3c} \frac{dR}{dt}\right) \left(\frac{dR}{dt}\right)^2 - \frac{1}{\rho R} \left[2\sigma + 4\mu \frac{dR}{dt}\right] + \frac{1}{\rho} \left(1 + \frac{1}{c} \frac{dR}{dt}\right) [P_i(t) - P] + \frac{R}{\rho c} \frac{dP_i(t)}{dt}$$

$R(t)$: the time dependent radius of the cavity,
 ρ, c : density and sound speed of undisturbed water,
 μ : is the dynamic viscosity of water.
 σ : water surface tension
 P_i : The pressure inside the cavity,
 P : external pressure

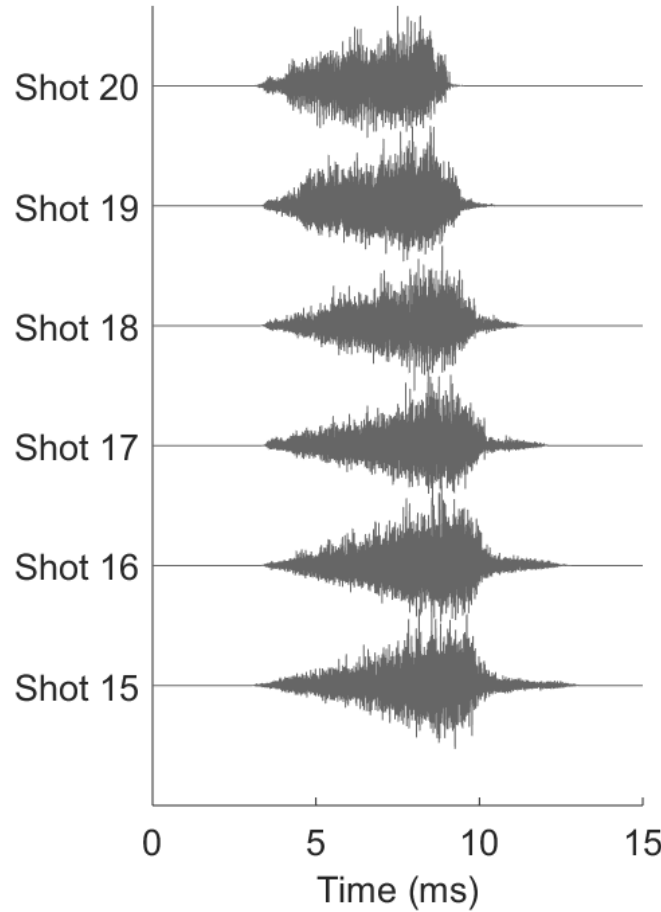
Field measurement



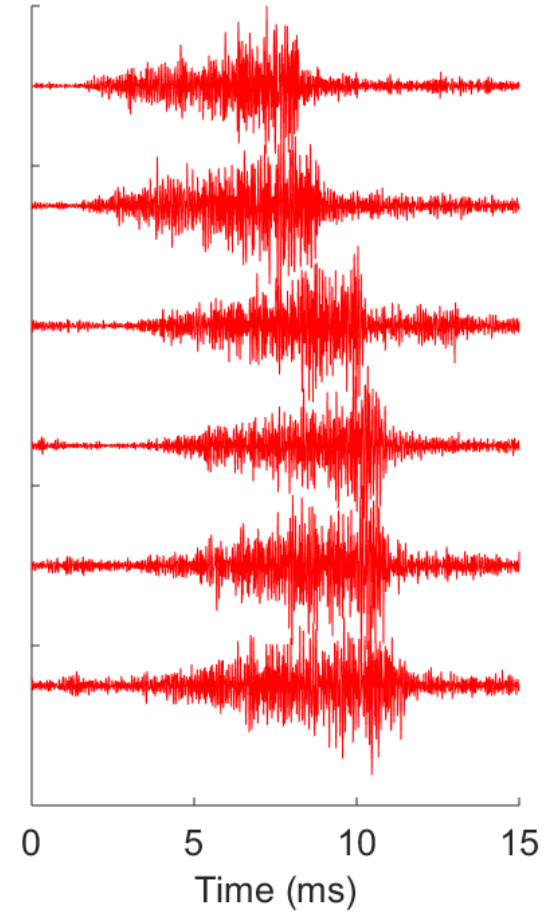
Simulation results

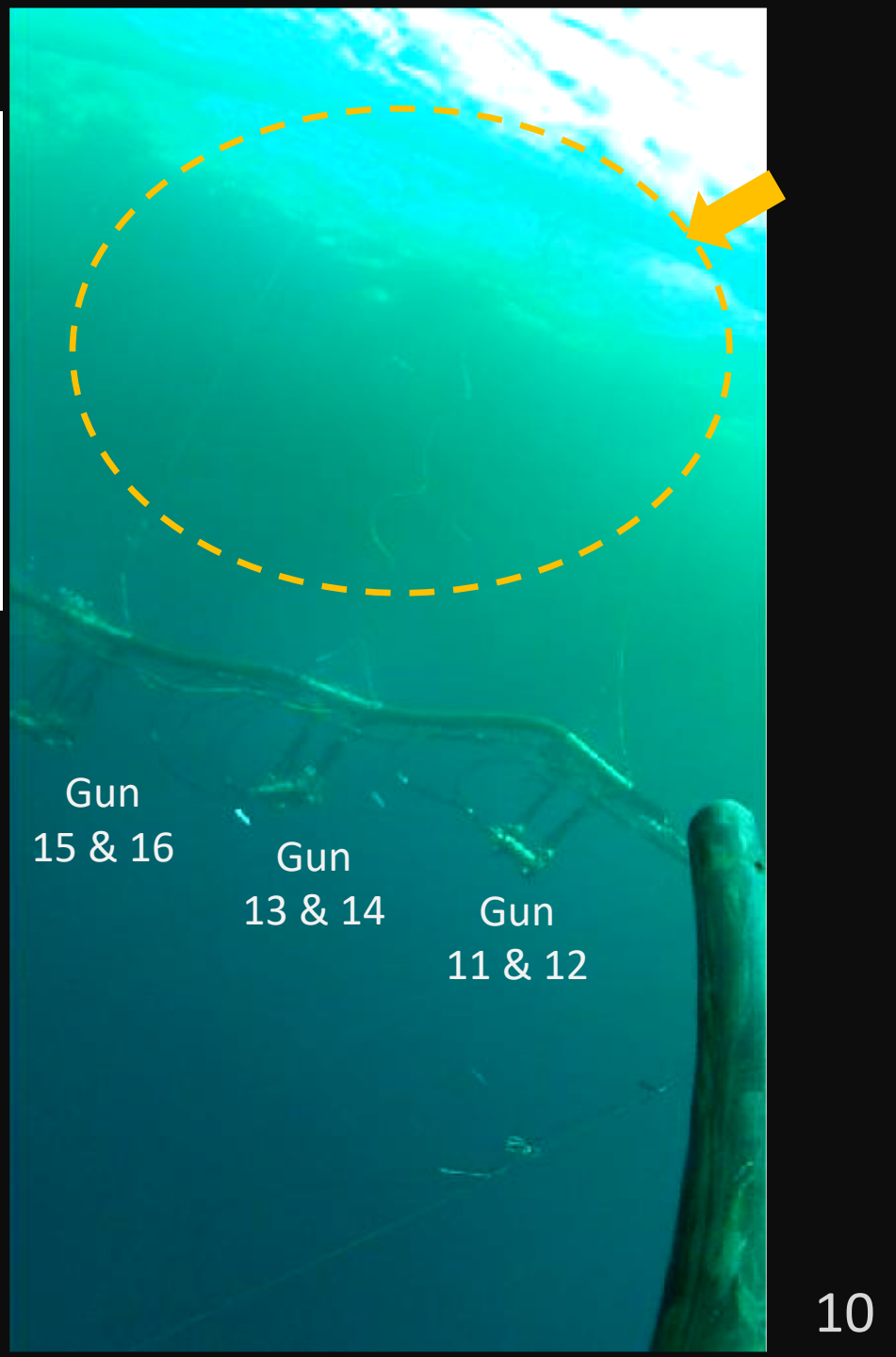
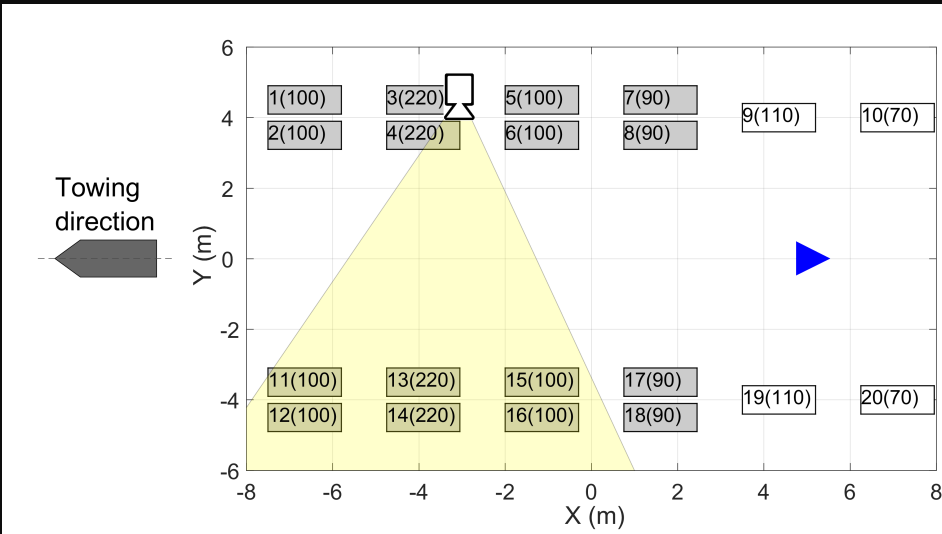


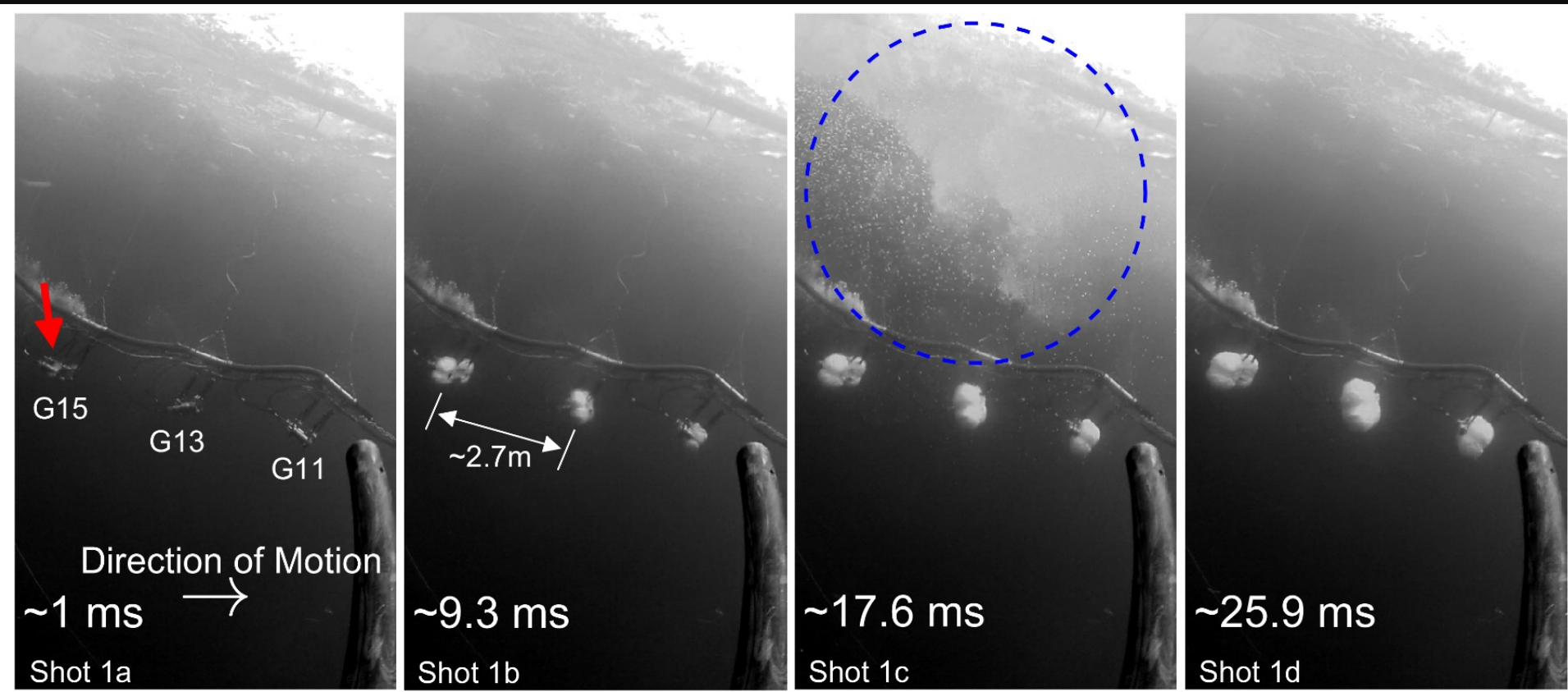
Simulated Data



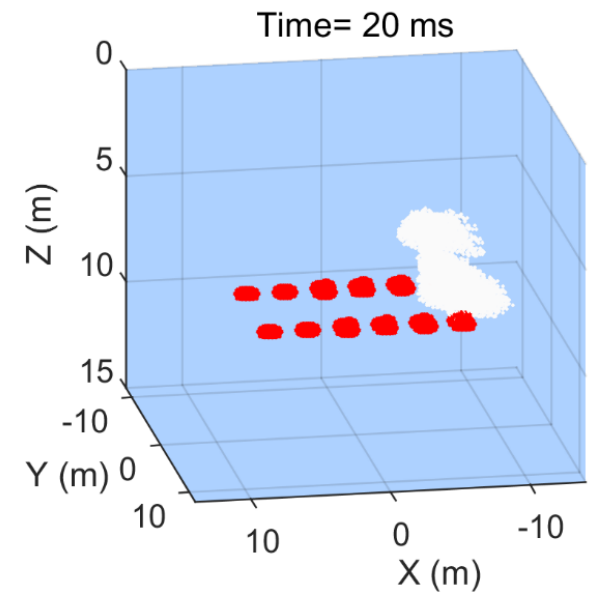
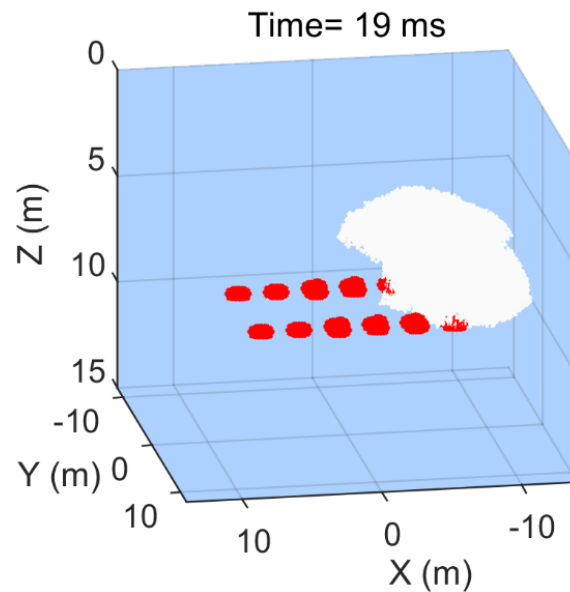
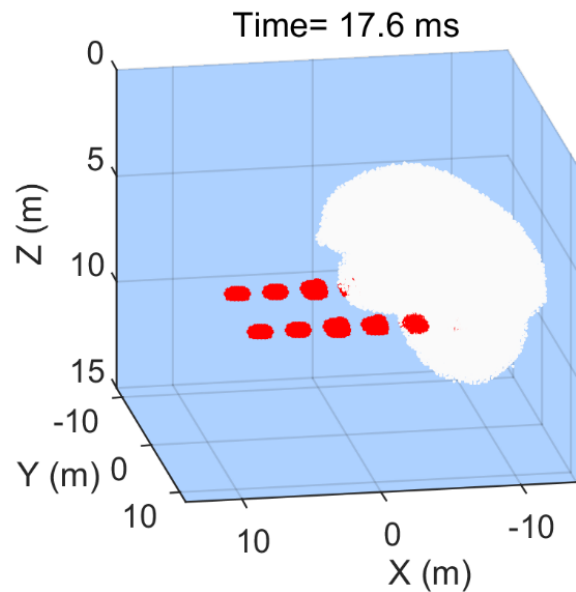
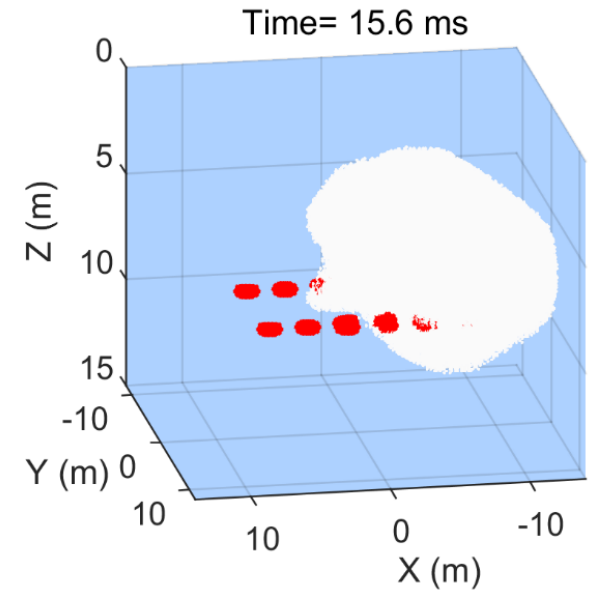
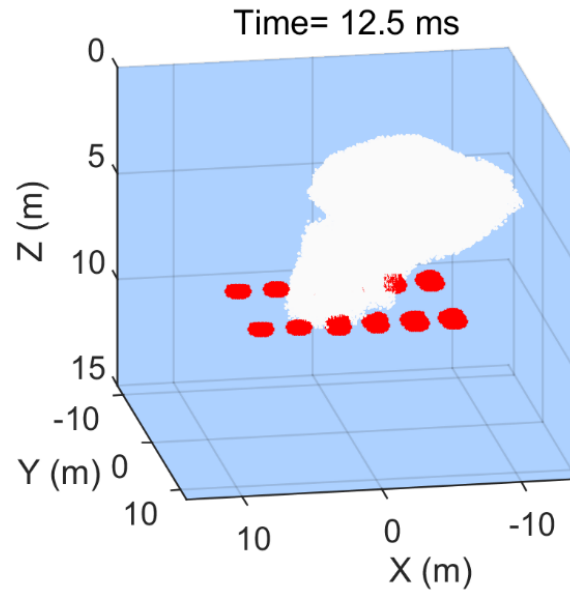
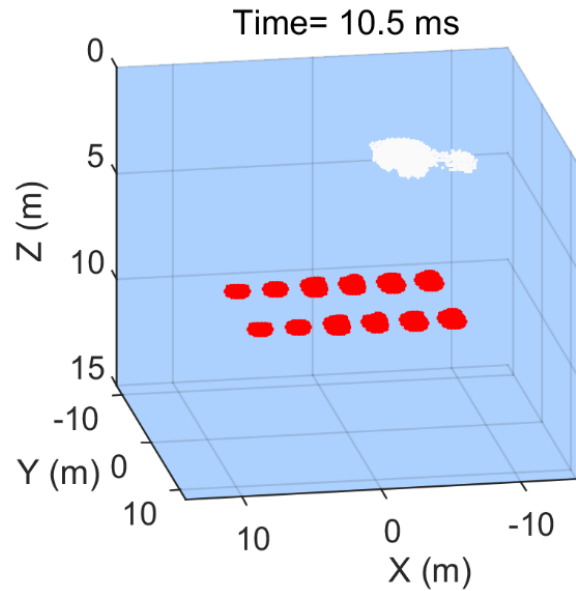
Field Data

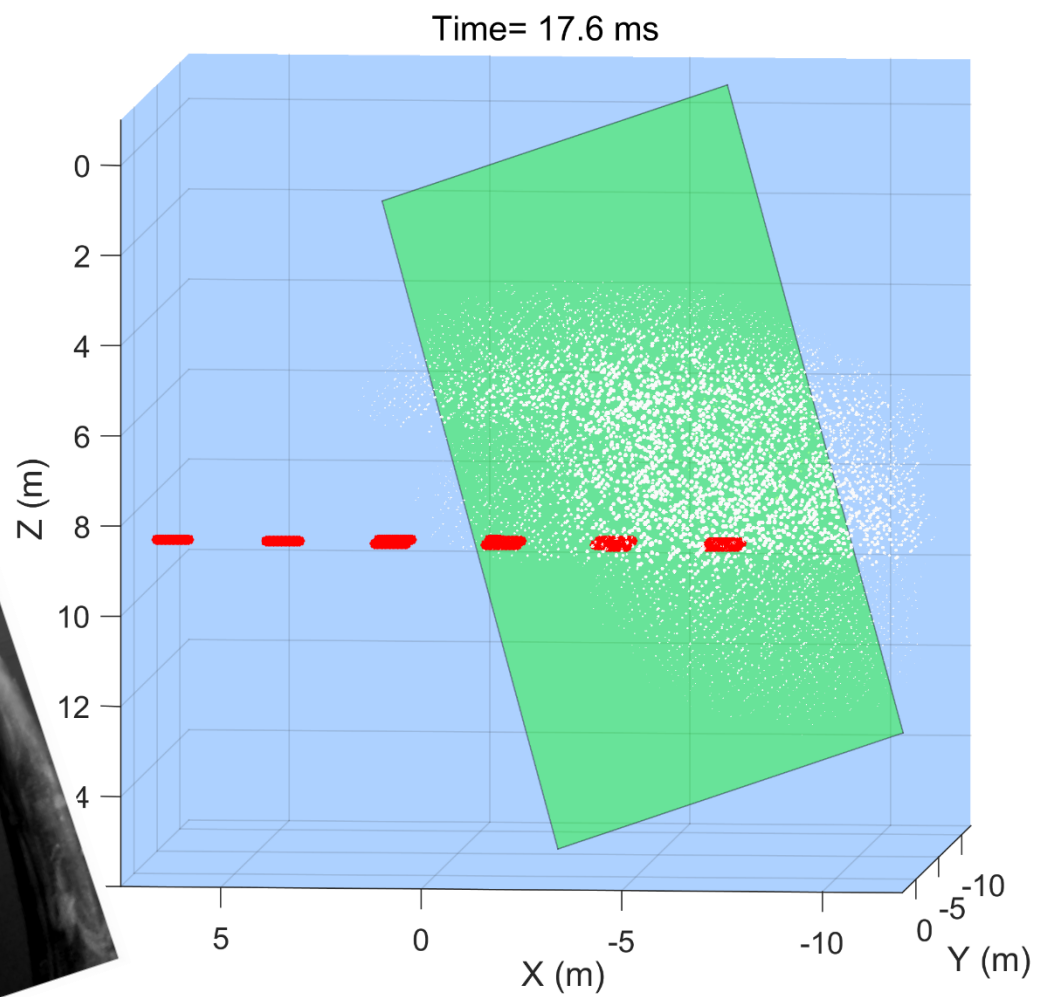
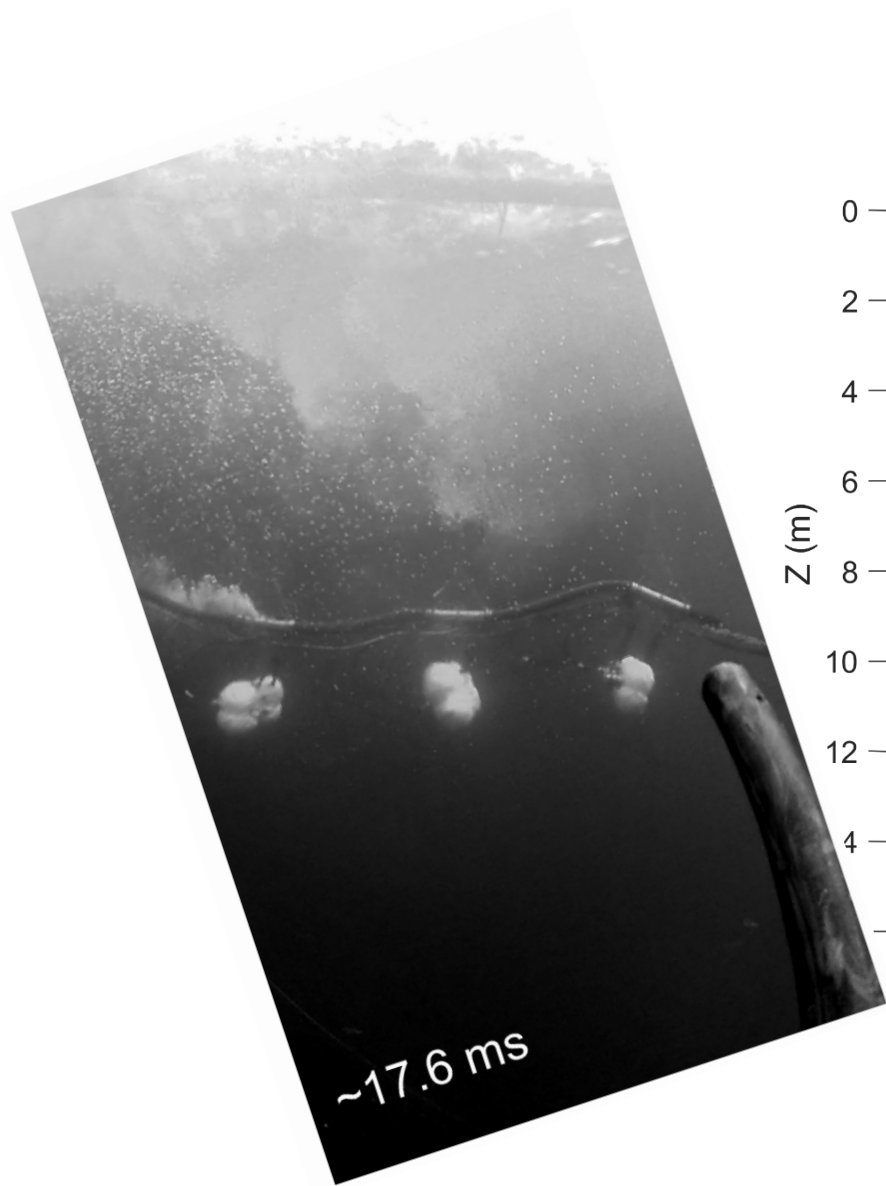


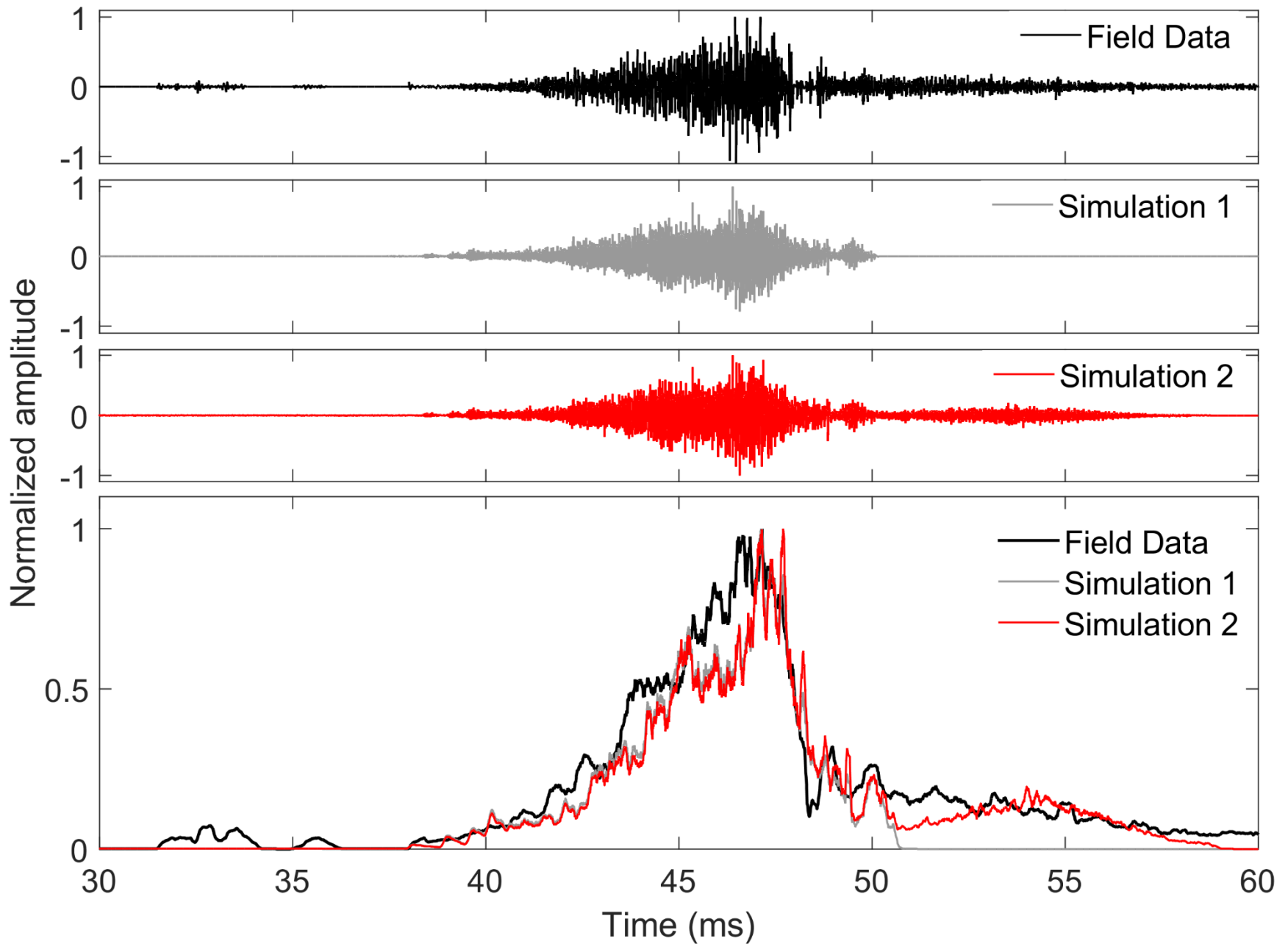




Modeled Cavity cloud:







Conclusions

- The first convincing photographic evidence of ghost-induced cavitation
- Reliable modeling technique for ghost cavitation phenomenon.

Ongoing research

- Acoustic properties within the cavity cloud

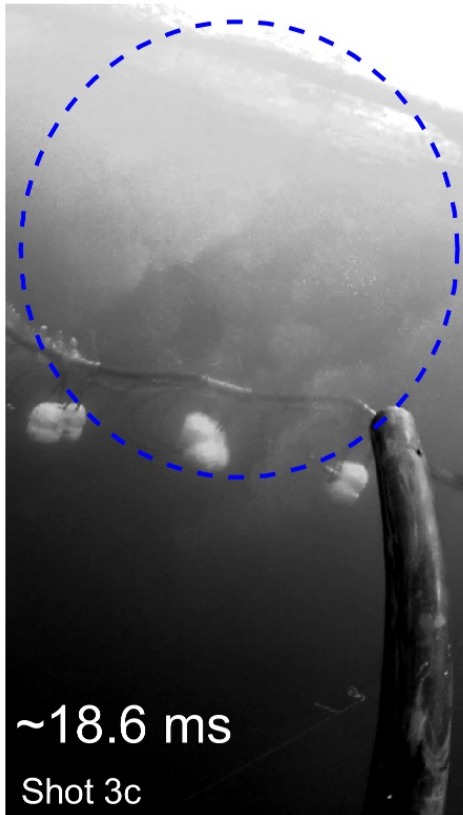
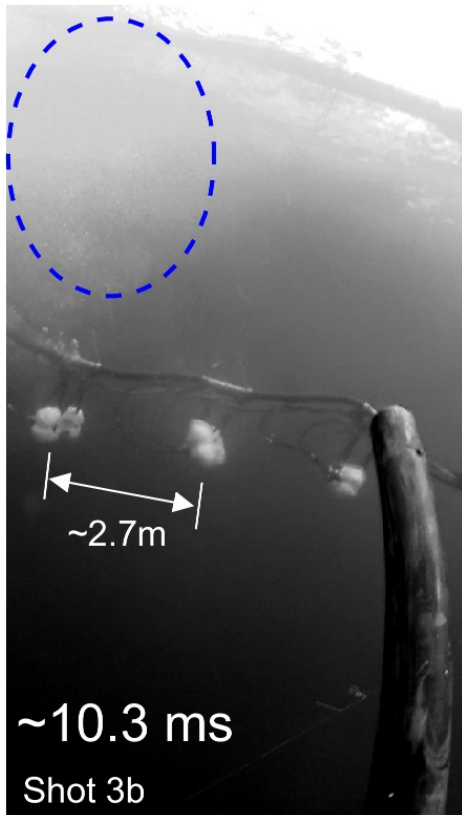
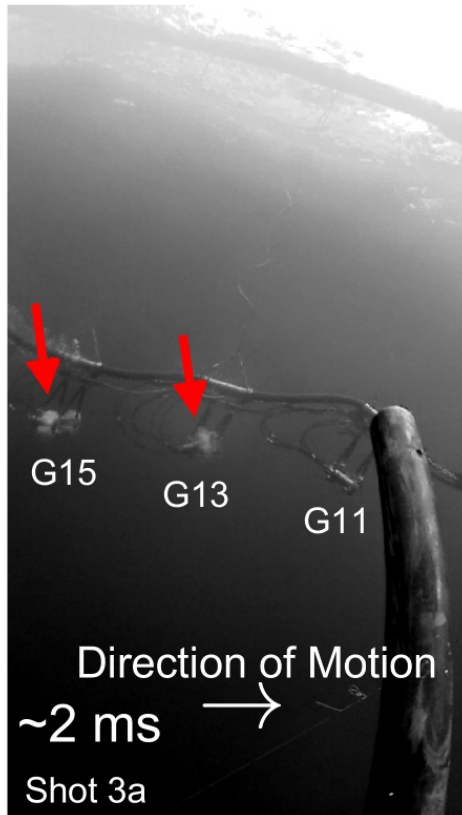
Future work:

- Calibrating the numerical model

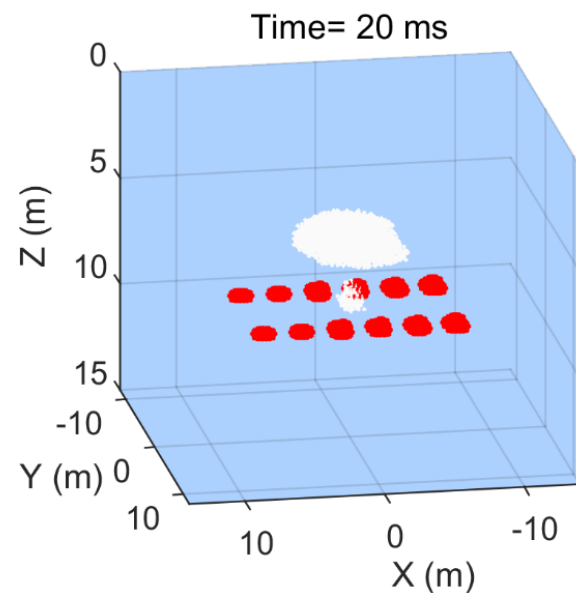
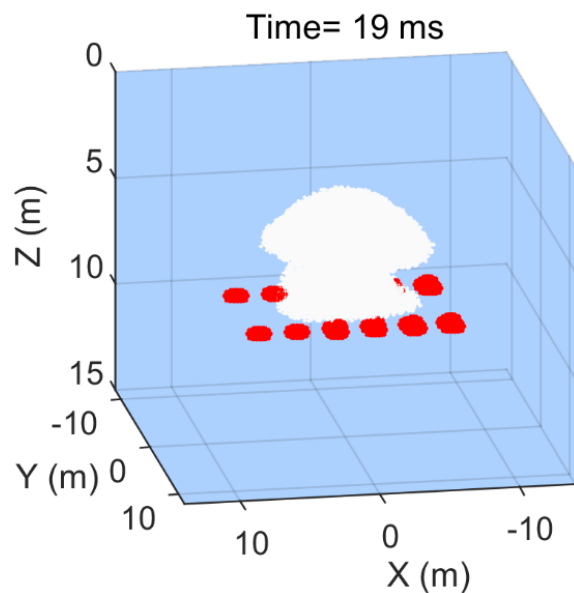
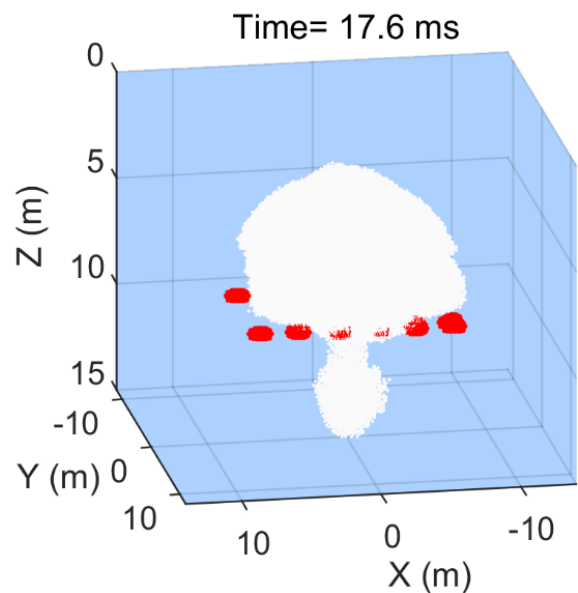
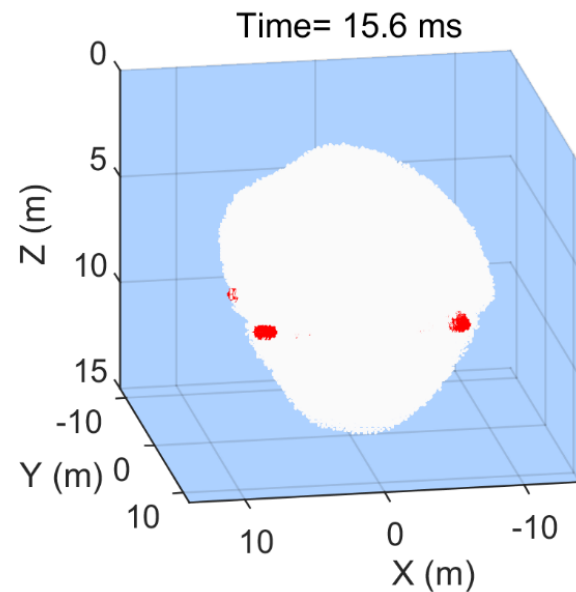
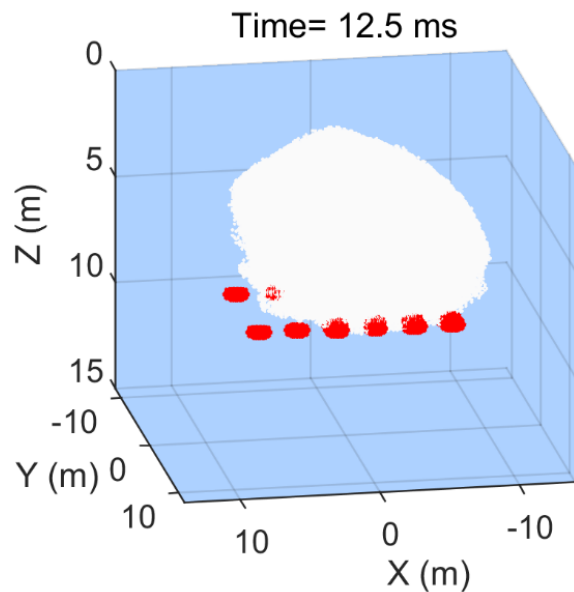
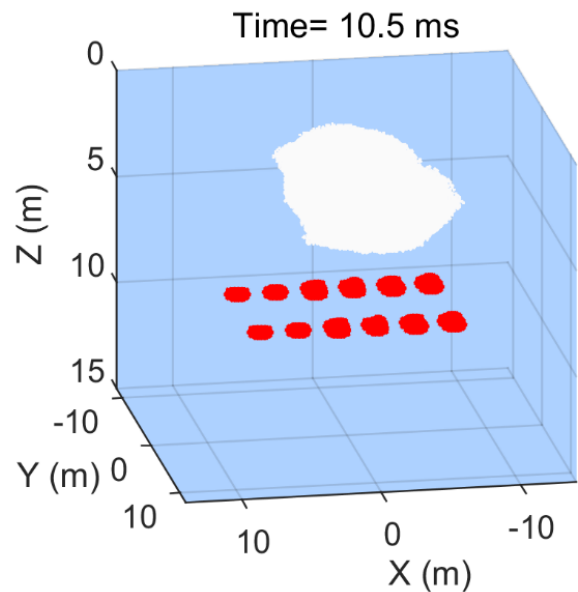
Acknowledgment

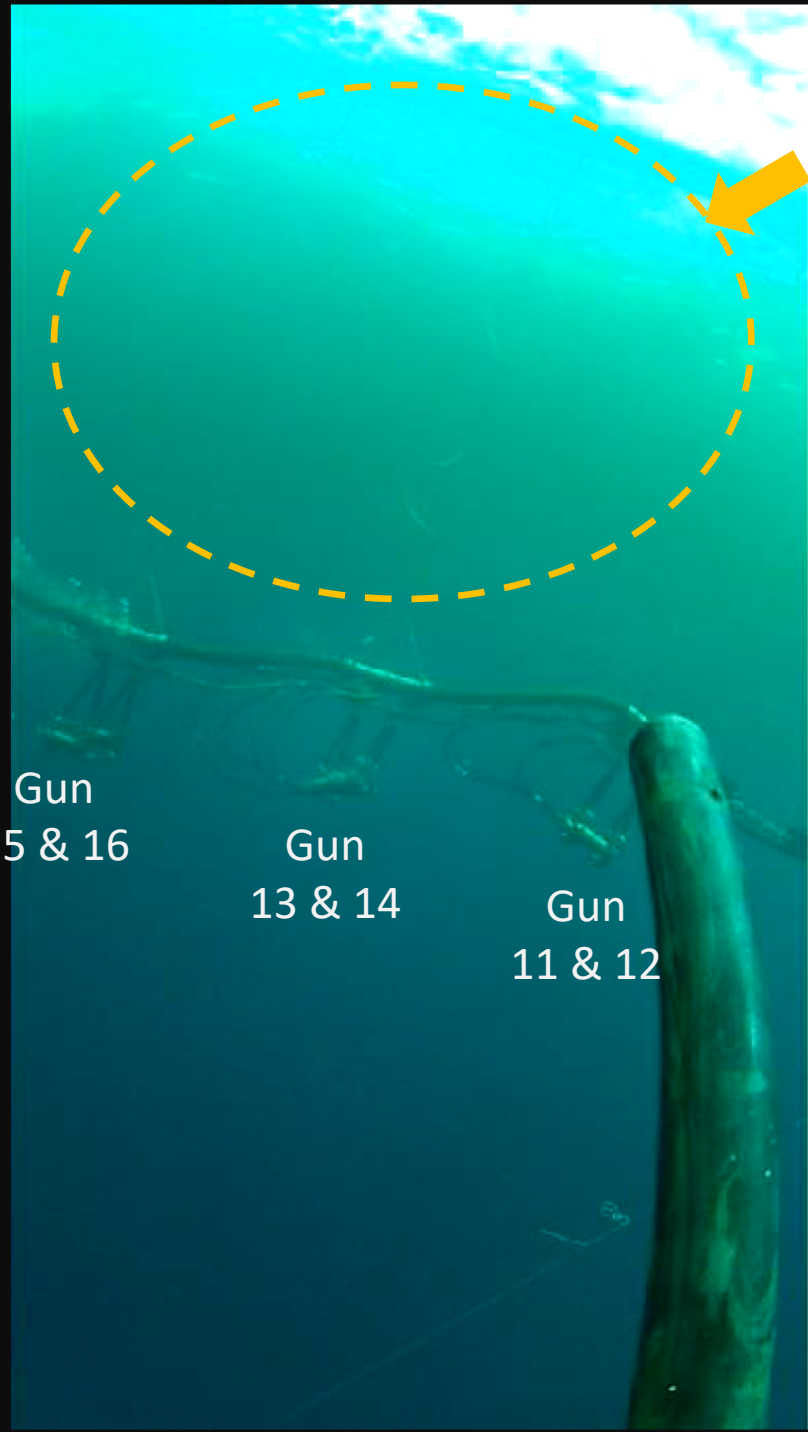
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Modeled Cavity cloud (all air-gun activated simultaneously) :





Gun
15 & 16

Gun
13 & 14

Gun
11 & 12

Air-gun:

