Razor Clam Burrowing: RazorBot

Bioinspired burrowing method

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INTRODUCTION

Figure 1: Pacific Razor Clam

- Pacific Razor clams are one of nature's most prolific burrowing species. They can dig twice their own body length (6 inches) in 1 minute (Link, 2000).
- The clams foot muscle and shell both have important functions when it comes to burrowing. The foot is the primary digging and anchoring mechanism while the smooth, low friction shell aids in fluidization and further sinkage into the granular media.

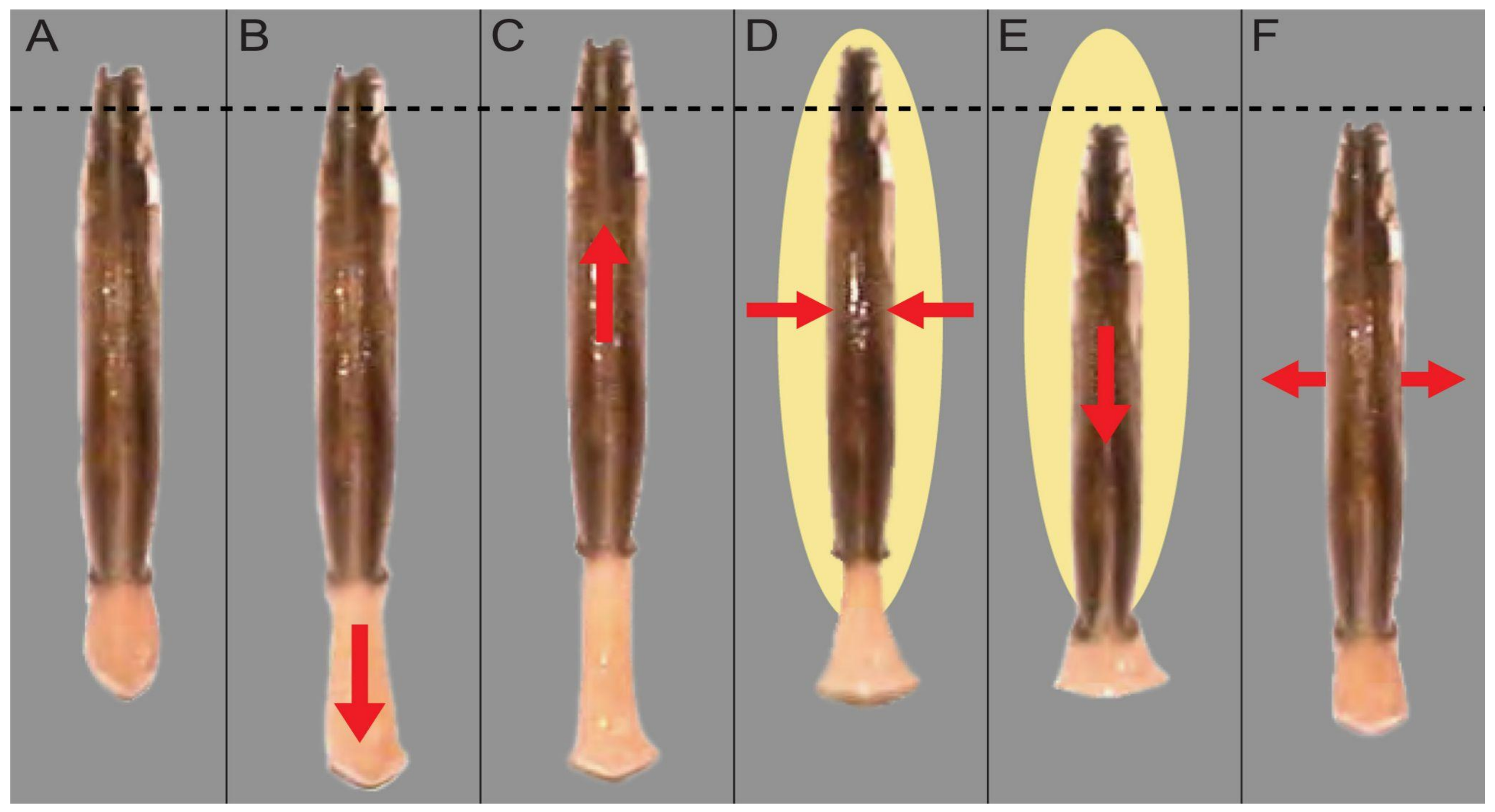


Figure 2: Clam movement mechanics

Previous work:

- MIT RoboClam: Complicated, non portable, accurate clam mechanics
- Seavo II: External tether/connection, Strict procedure for moving parts, dry sand dependent, can burrow multiple body lengths

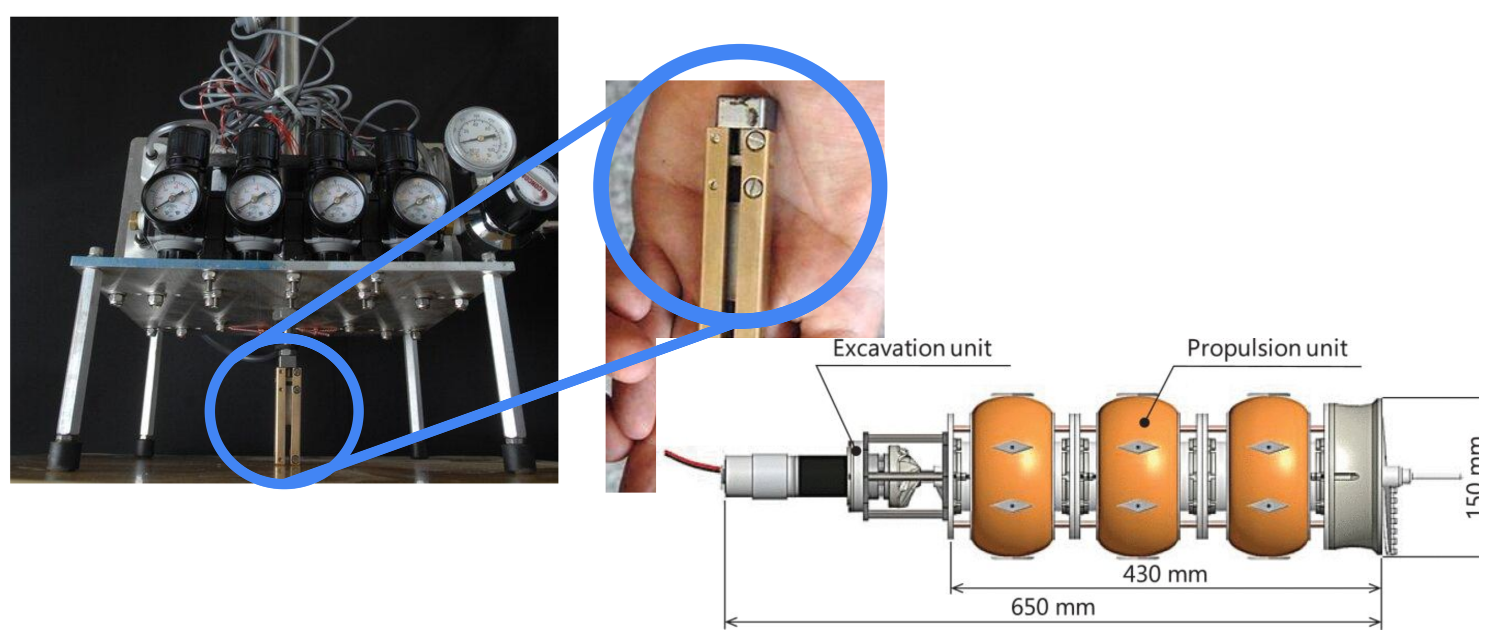


Figure 3: Previous clam models from left to right : MIT's Roboclam, Seavo II

Our Approach:

- Handheld, battery driven, smooth, cylindrical clam model which incorporates all imperative components of the razor clams burrowing methods.

METHODS

To model the burrowing motion, we employed two methods to emulate the biology of razor clam:

1. Digging using foot muscle ⟶ Agitation by Vibration
2. Shell compression Fluidization ⟶ Water Flow via nozzle

Phase 1

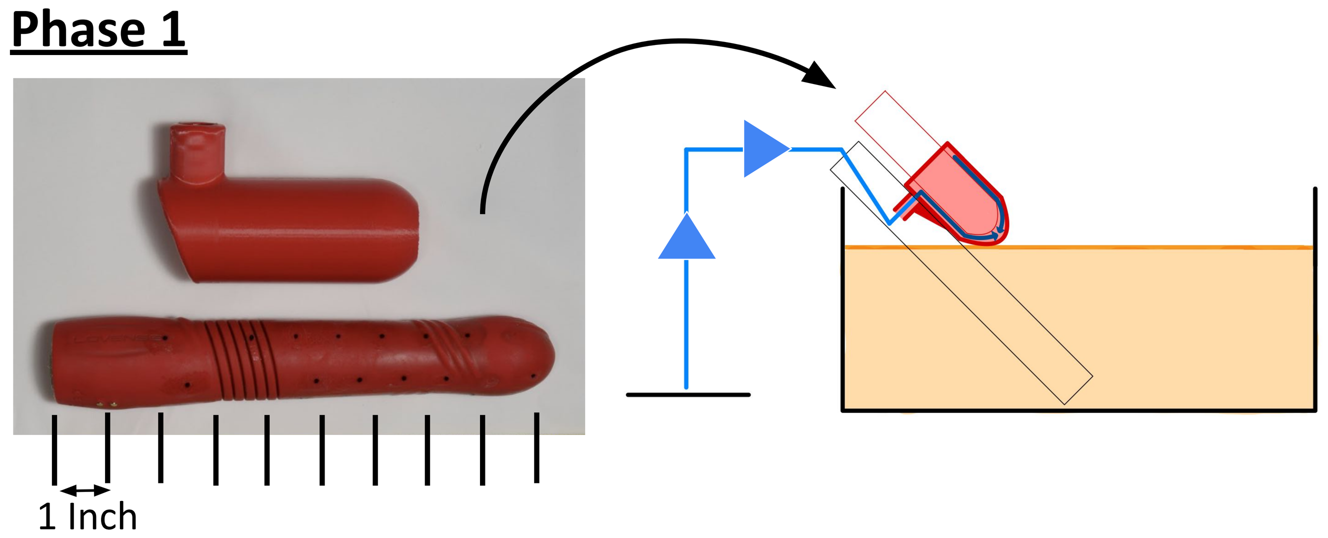


Figure 4: Phase 1 Nozzle geometry and testing device accompanied with 2D schematic of experimental setup

- Various angles of entry (30,45, 60 and 85 degrees).
- Flow rate (no flow, 2 L/min and 4 L/min).
- Vibration (0% [0 W], 50% [0.5 W] and 100% [0.8 W]).

Phase 2

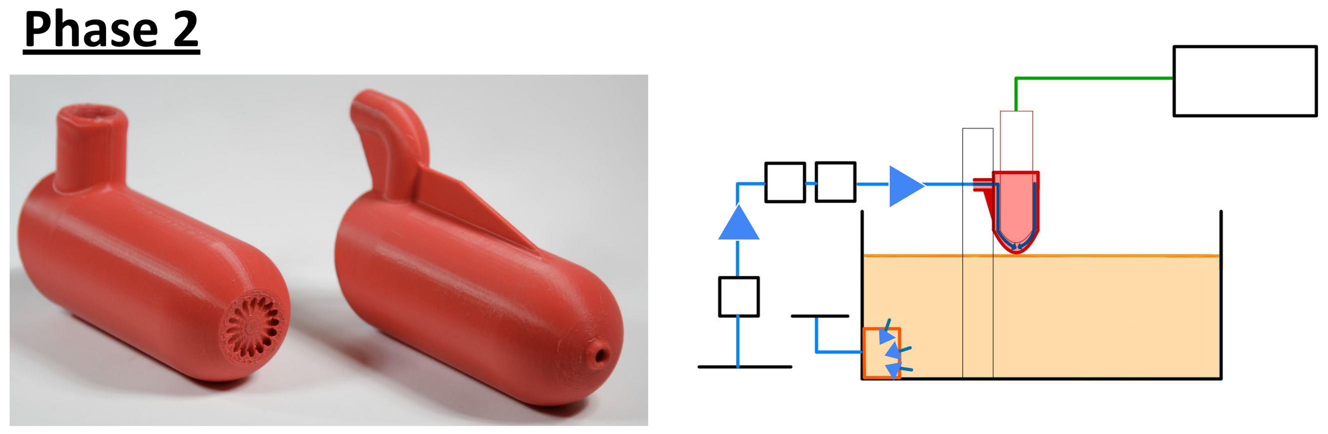
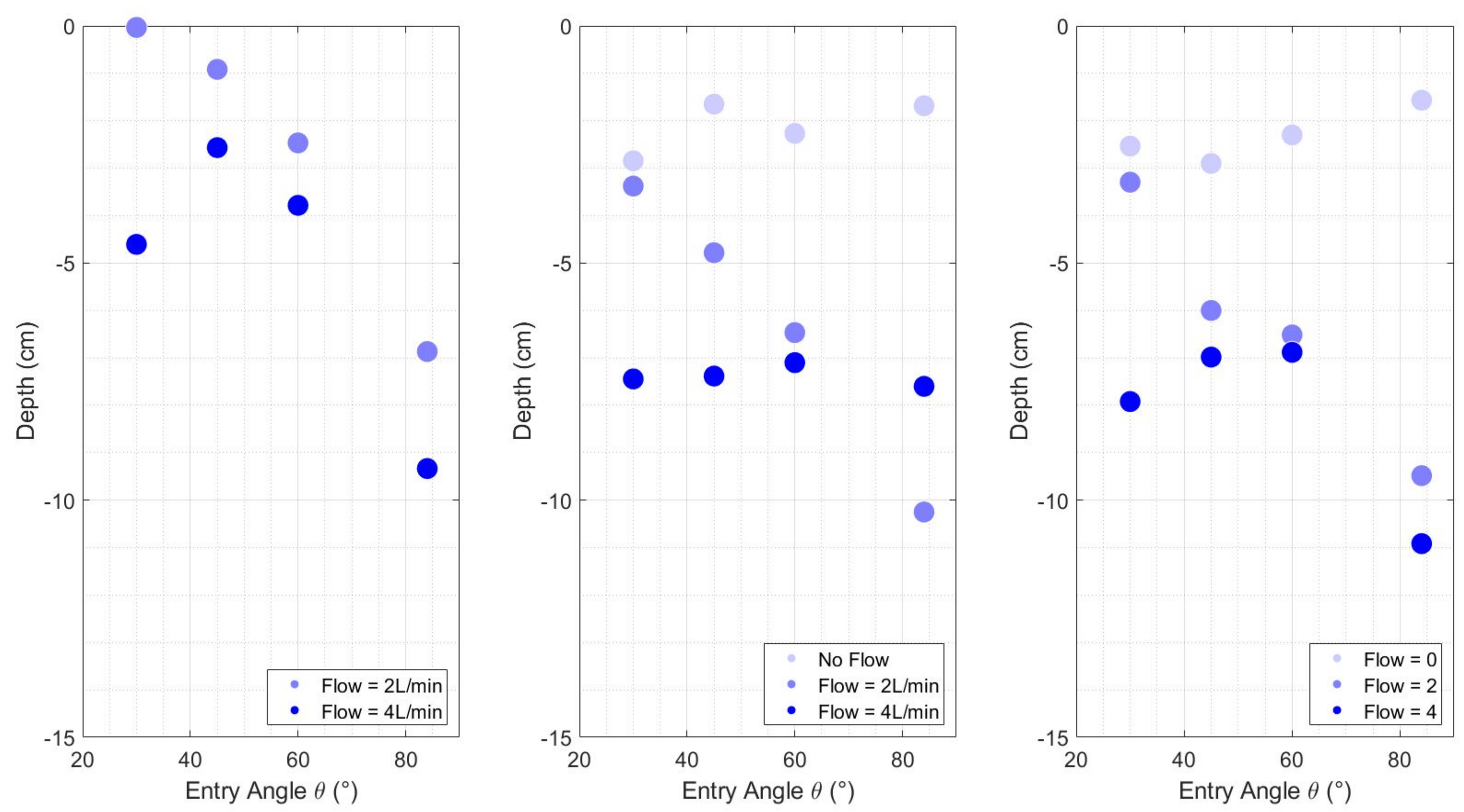


Figure 5: Phase 2 Nozzle geometry change from Phase 1 and 2D experimental setup changes

- We have eliminated the angle parameter to focus on the effects of vibration and flow power.
- Research Question: *What is the optimal ratio to achieve maximum depth?*
  - Ratio = vibration power/water flow power

DISCUSSION

- Water flow + vibration ⟶ greater depth (Phase 1).
- Steeper entry angle ⟶ greater depth (Phase 1).



0% Vibration **50% Vibration** **100% Vibration**

Figure 6: Phase 1 test results: angle, flow and vibration effect

- Higher power ratios ⟶ burrow deepers, and faster (Phase 2).

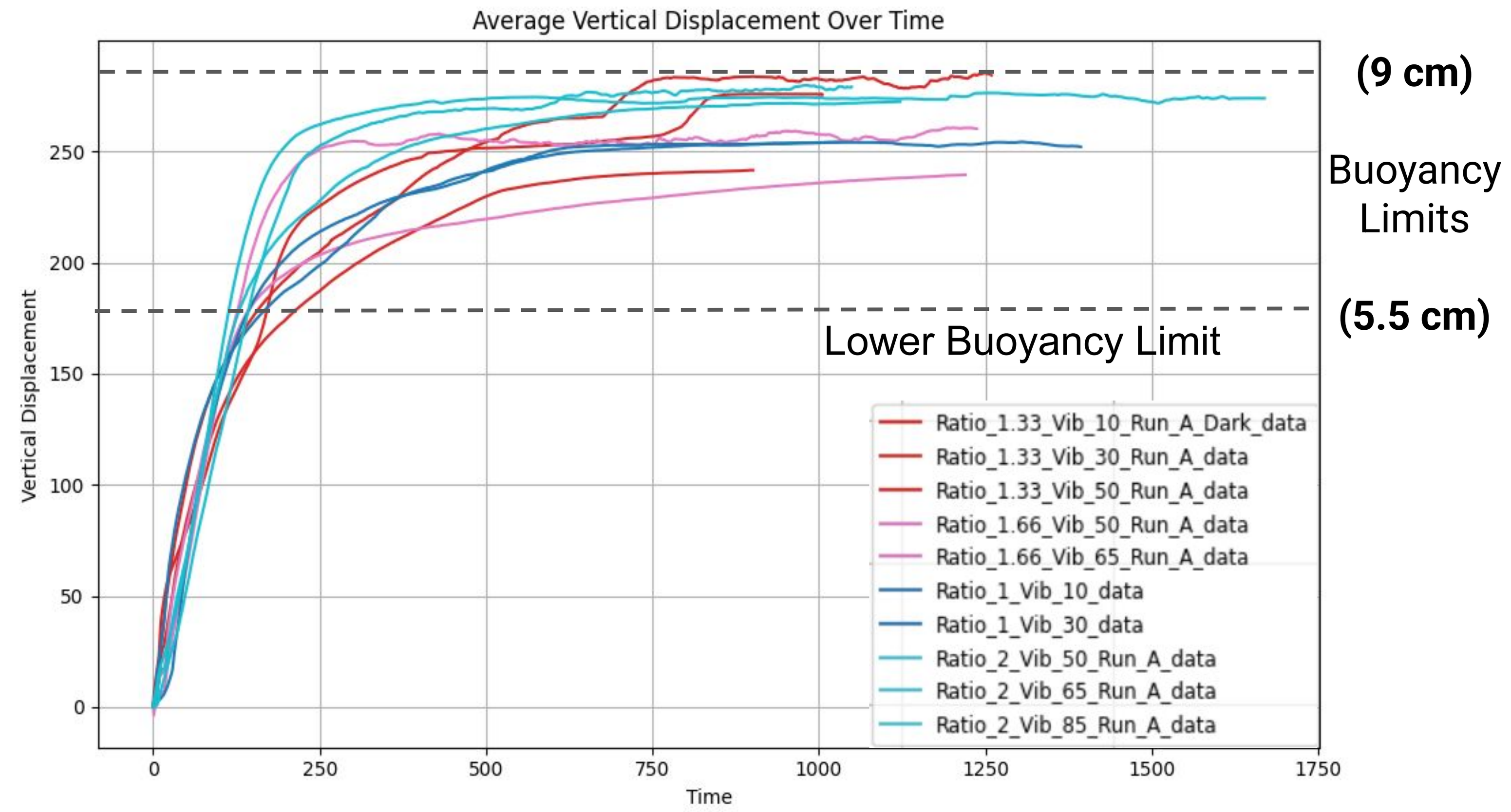


Figure 7: Phase 2 test results: Higher ratios dig faster then small

- Higher power ratios ⟶ achieve greater depth for same energy (Phase 2).

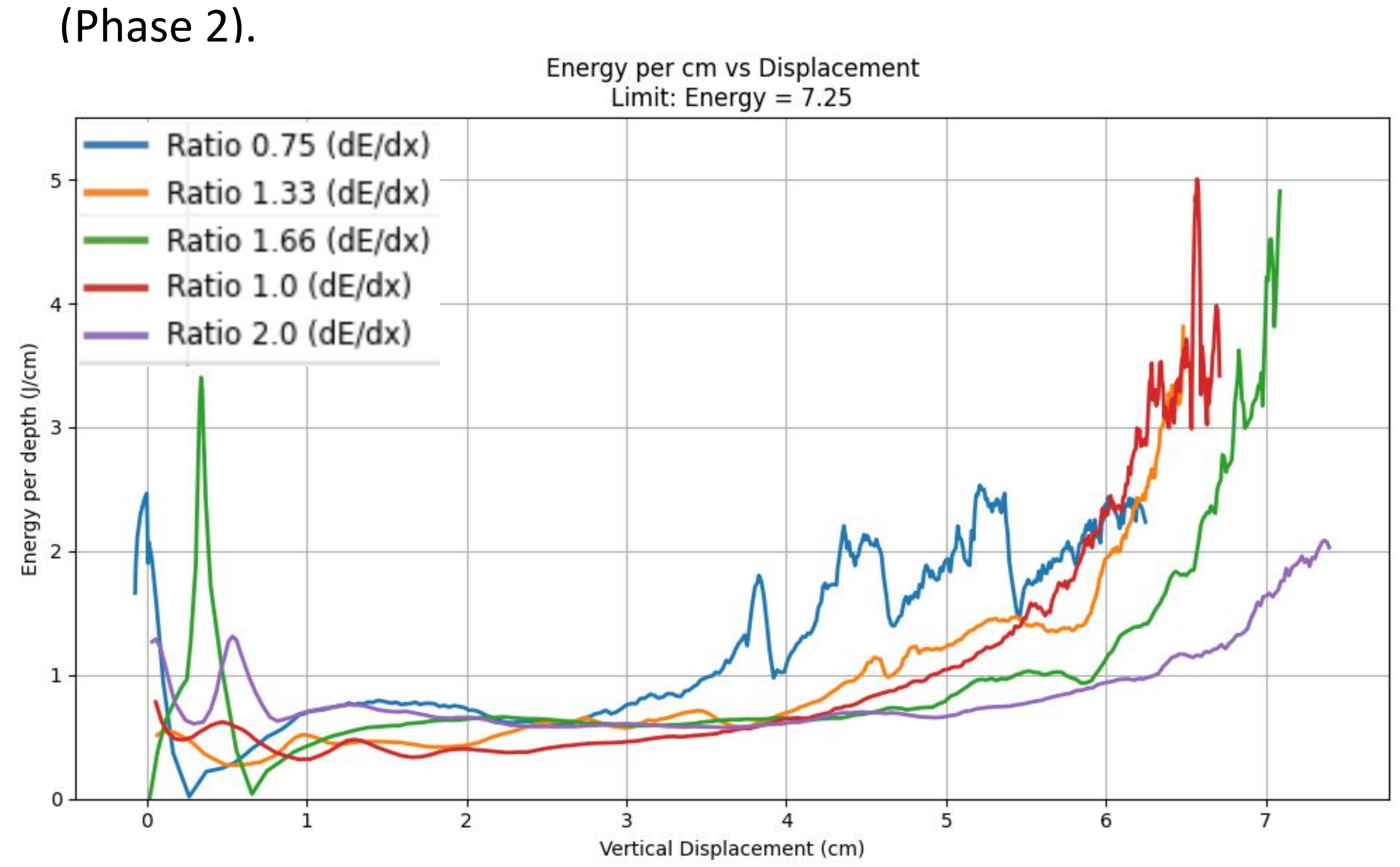


Figure 8: Phase 2 test results: Higher ratios dig deeper than small per given energy

FUTURE WORK

- Denser device and deeper test tank to address buoyancy concerns.
- Adding variable weight to system to simulate thrust.
- Using linear bearings to restrict motion in a unidirectional manner.

LITERATURE

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