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Preparing for high-gravity ultrasonic penetration tests in regolith

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Previous Missions

High surface radiation on mars.

3 m depth ~ surface of Earth.

Need to get underground..

Philae negligible Weight on bit (WOB).

Harpoons did not deploy, only a few millimetres of penetration.

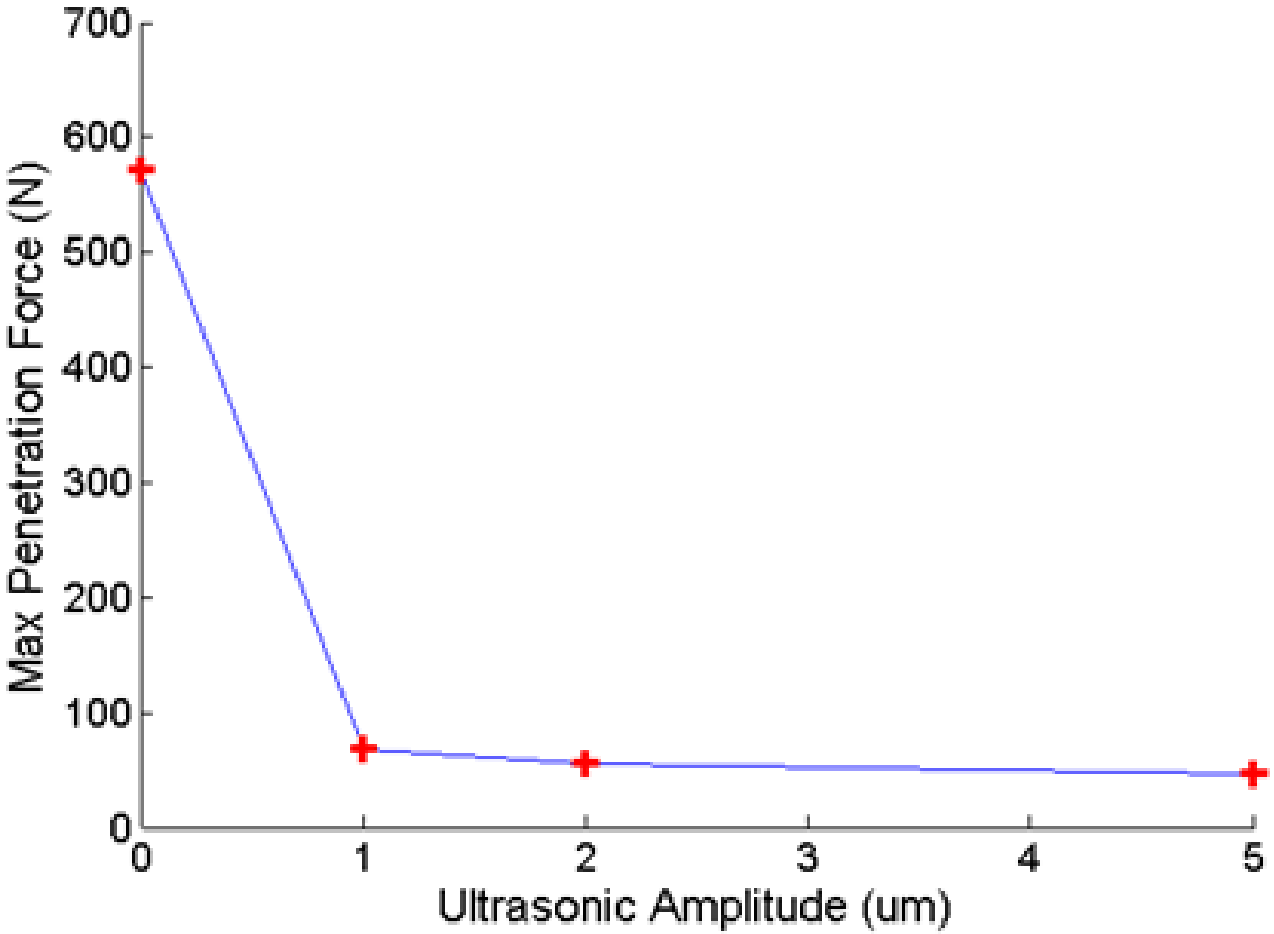
Low power availability.

Ultrasonic Penetration

Titanium

~18 cm long

Tuned to 20 kHz



The ‘Spin Your Thesis’ Campaign

Large Diameter Centrifuge (LDC), ESTEC.

Three main aims:

1) Measure penetration forces in higher gravity.

2) Investigate WOB reductions of ultrasonic penetration in higher gravity.

3) Establish optimum vibration amplitudes for lowest total power consumption.

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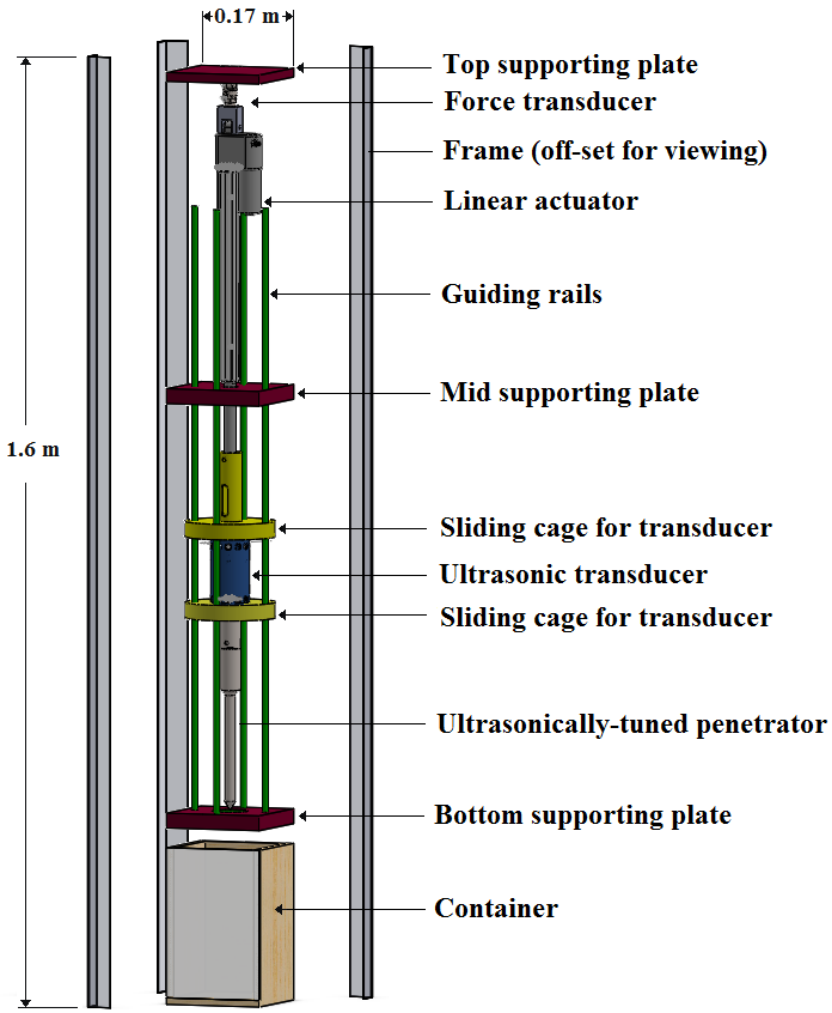
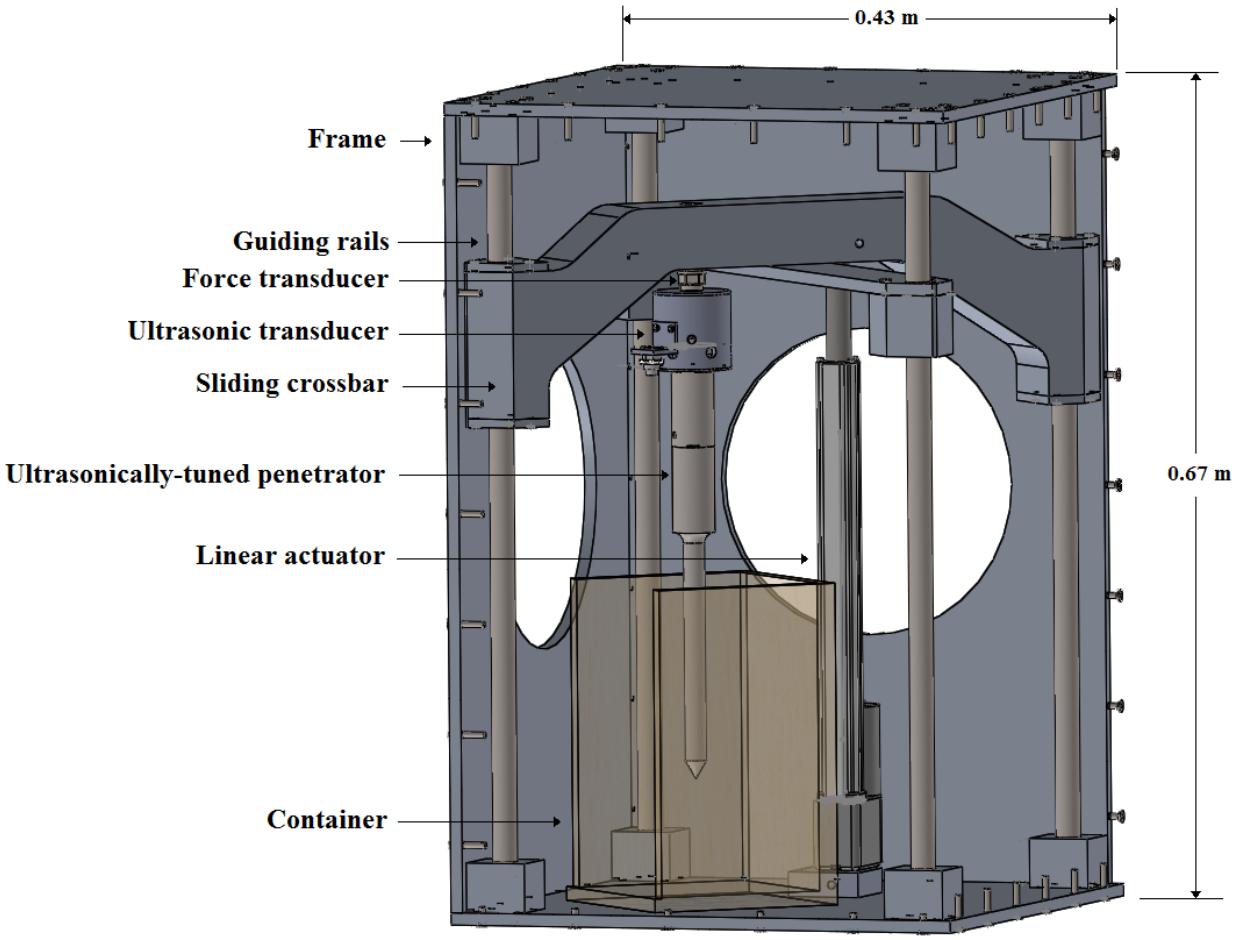
Experimental Rig Design

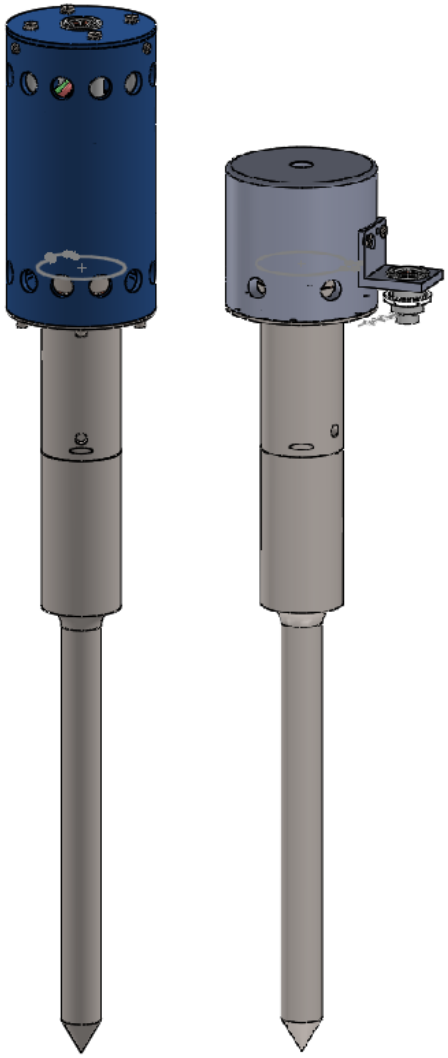


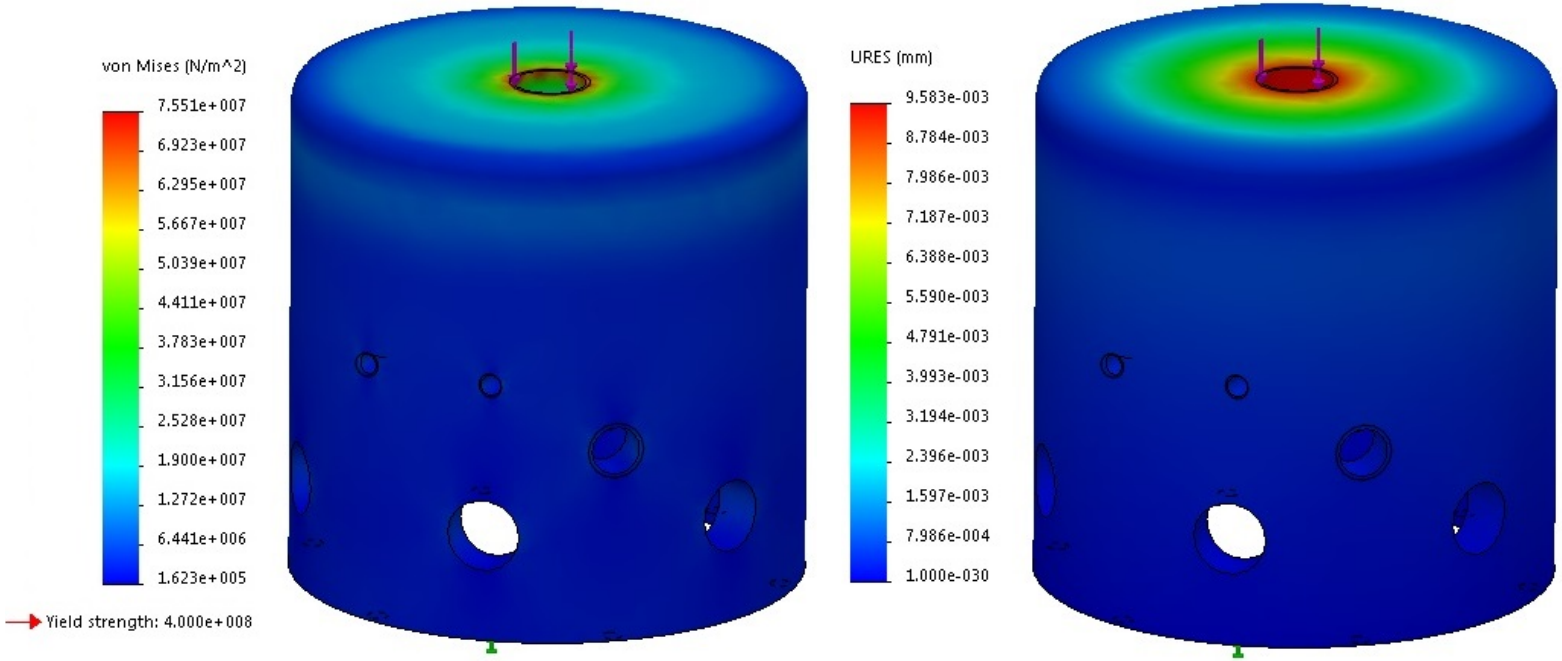
Previous Ultrasonic Penetration Rig



Centrifuge Ultrasonic Penetration Rig

Stress Analysis





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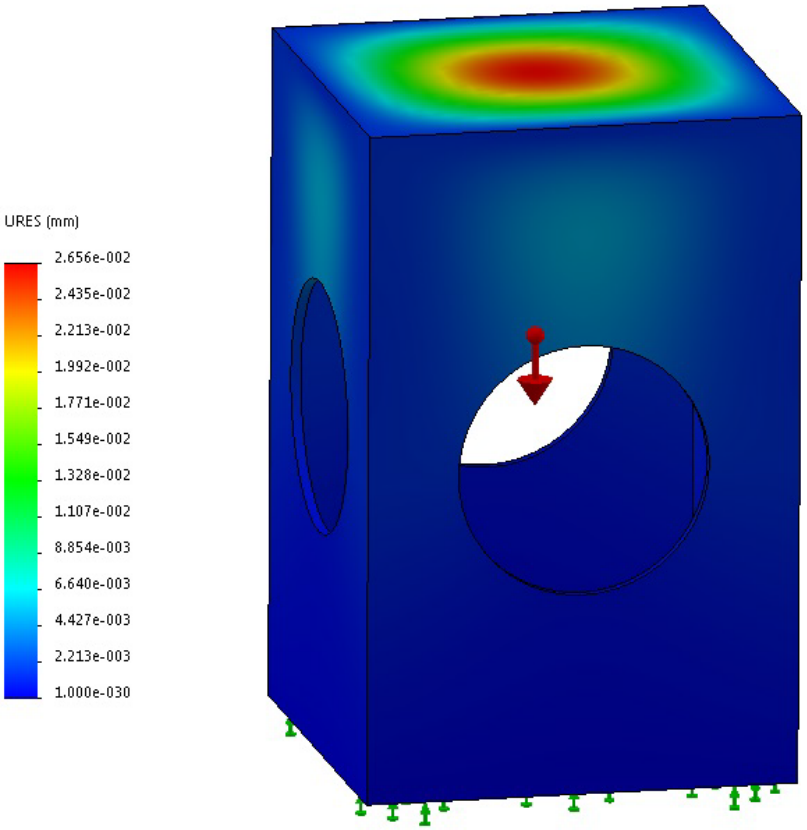
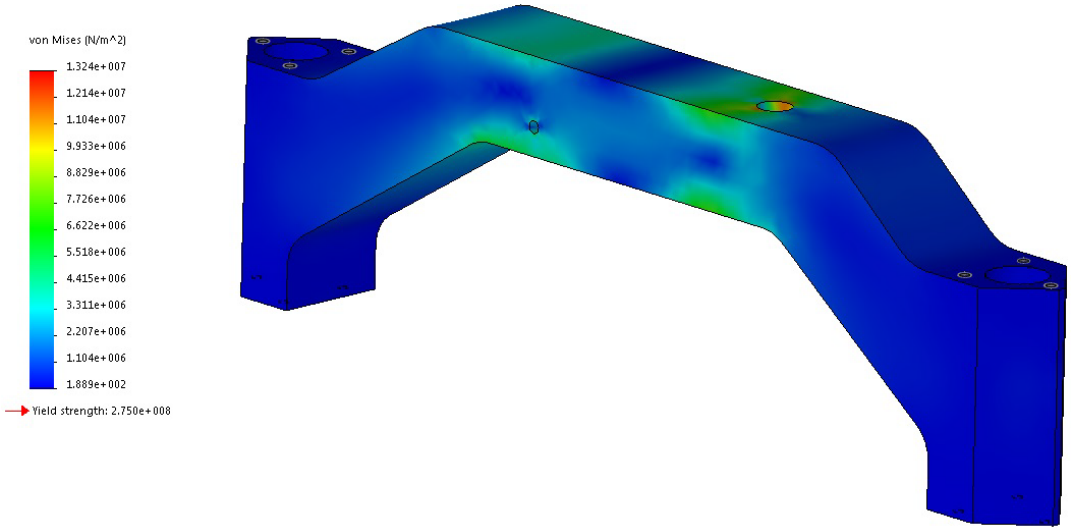
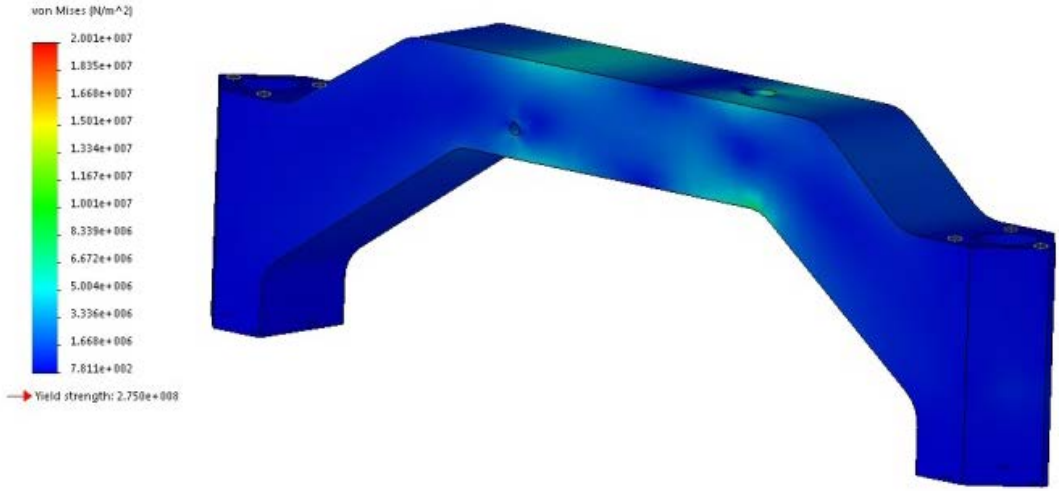
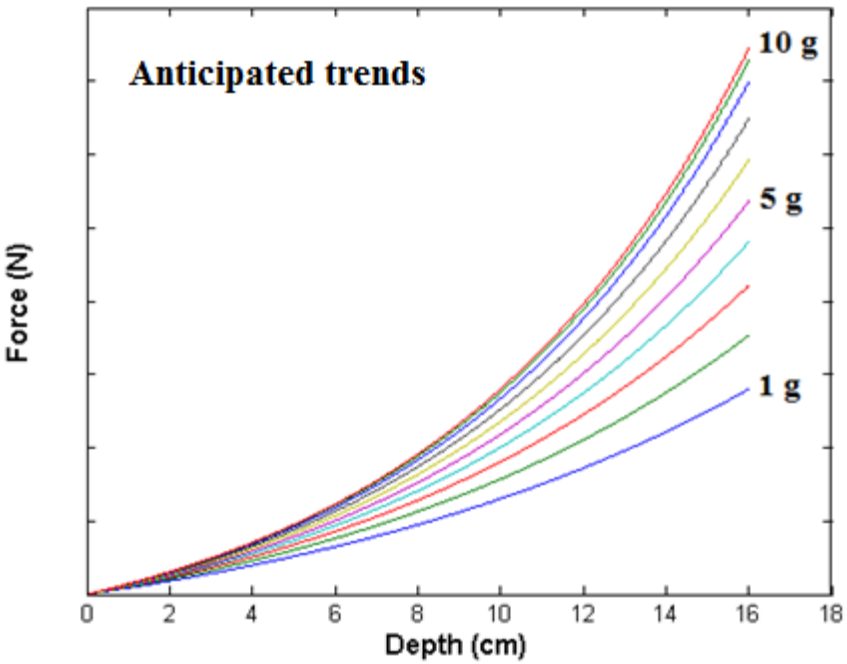


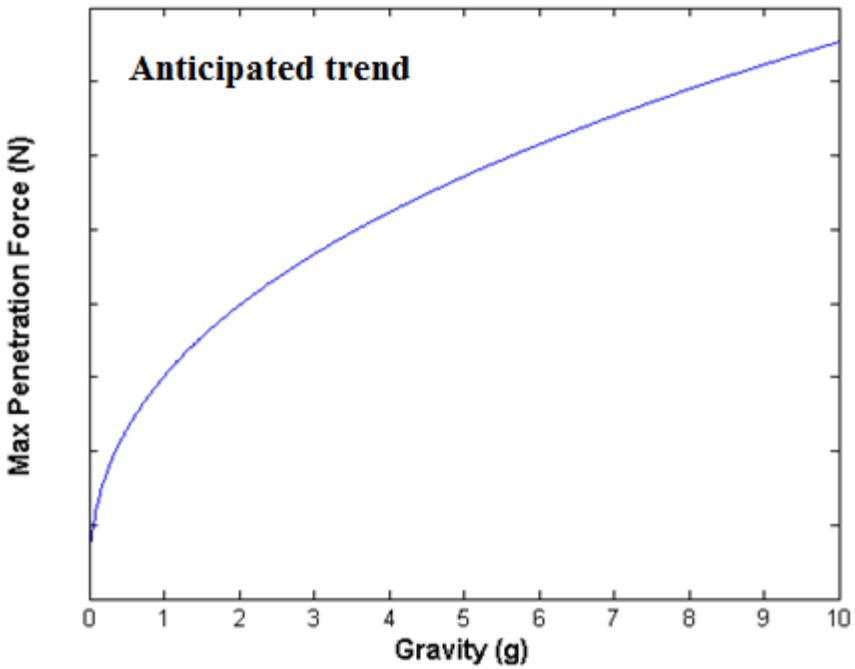




Expected Outcomes

1) Measure penetration forces in higher gravity.





Higher gravity can lead to higher bulk density, but there is a strict limit to maximum possible density

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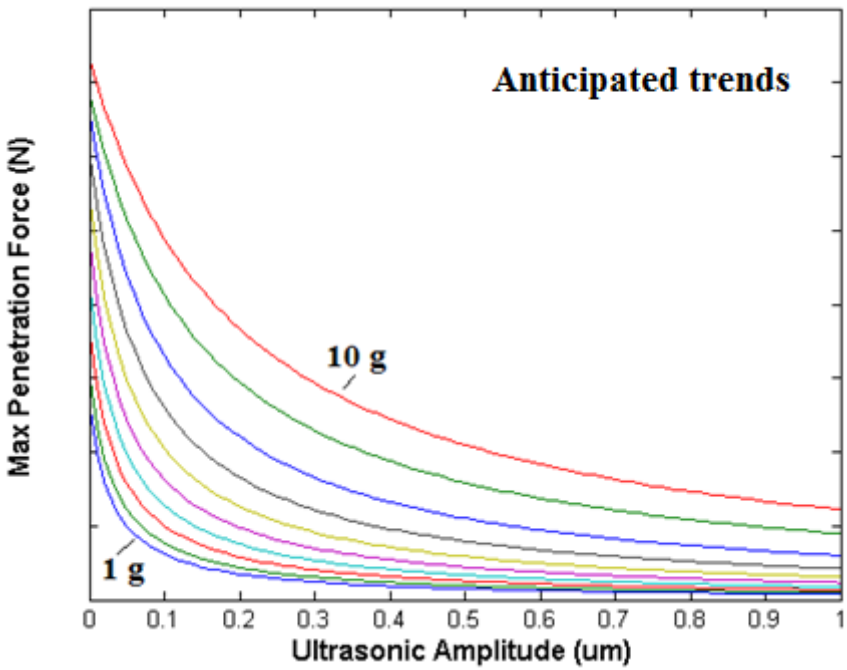
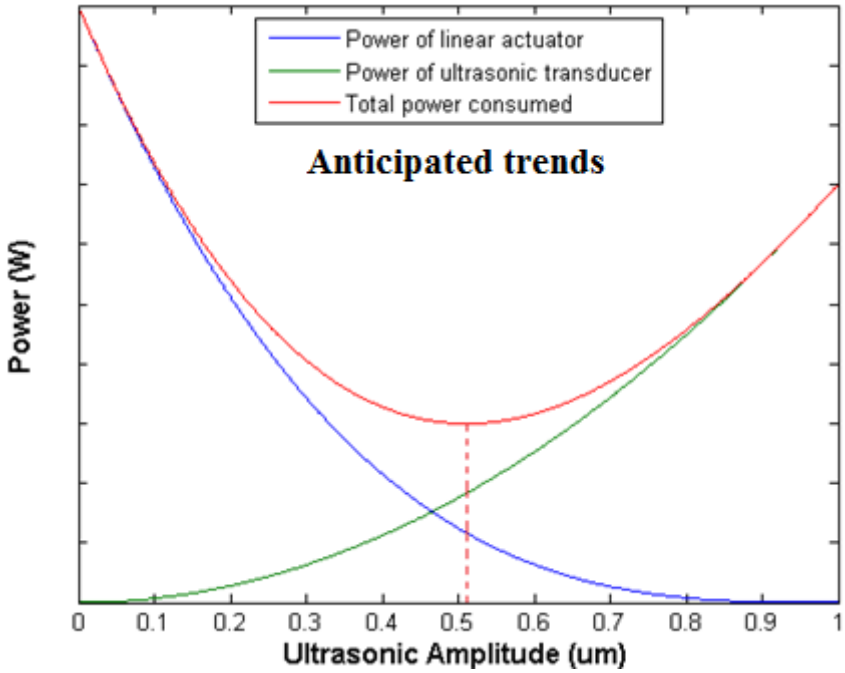
Expected Outcomes

2) Investigate WOB reductions of ultrasonic penetration in higher gravity.



Penetration force reductions due to ultrasonic vibration involve motion of sand particles. Higher gravity could dampen this effect.

3) Establish optimum vibration amplitudes for lowest total power consumption.



Higher ultrasonic amplitudes lead to lower penetration forces. This in turn uses less actuator power, but requires power for the ultrasonic transducer.