Effects of locomotor gaits in simulated reduced gravity environments on muscles of the leg

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Presentation Overview

- Background
- Research Question
- Hypothesis
- Methods
  - Experiment
  - ARGOS
  - Equipment & Hardware
- Conclusion
- References

source

Background

- Astronauts Ed Mitchell and Gene Cernan developed skipping gaits because it seems like less effort (Jones, 2010)
- Apollo spacesuits were notoriously hard to maneuver in given that they were pressurized, making it difficult to get a full range of motion or bend their knees while standing (Carr and McGee, 2009)
- The suits exhibit a spring like quality, providing a mechanical advantage to running and skipping motions when compared to walking. (Carr and Newman, 2007).
- Computer simulations suggest skipping in fractional gravity environments is less energy, and therefore could be a prefered locomotion method on the Moon or Mars (Ackermann and van den Bogert, 2012).

Problems with the Background

- Past research focuses on energy expenditure, despite this being a lesser issue in human locomotion patterns on earth.
- Scientists suggest that it is damage to dorsiflexor muscles that cause the gait transition (Hreljac et al. 2001), not energy requirements.
- Increased use of novel locomotion patterns could cause pathologies if performed over an extended period of time.
- Future training or suit design based on improper locomotion methods could further increase problems

Research Question

Does skipping in fractional gravity pose a risk to astronauts on a long term mission in a fractional gravity environment?

Hypothesis

There will be a measurable difference in the muscle activation between different locomotion styles, simulated gravity levels and suited/unsuited status.

Research Objectives

- Expand upon research that initially only focused on energy expenditure
- Add anthropological research to space exploration studies
- Use surface EMG and two motion capture systems for analysis
- Provide scientific analysis for use as a basis for future research

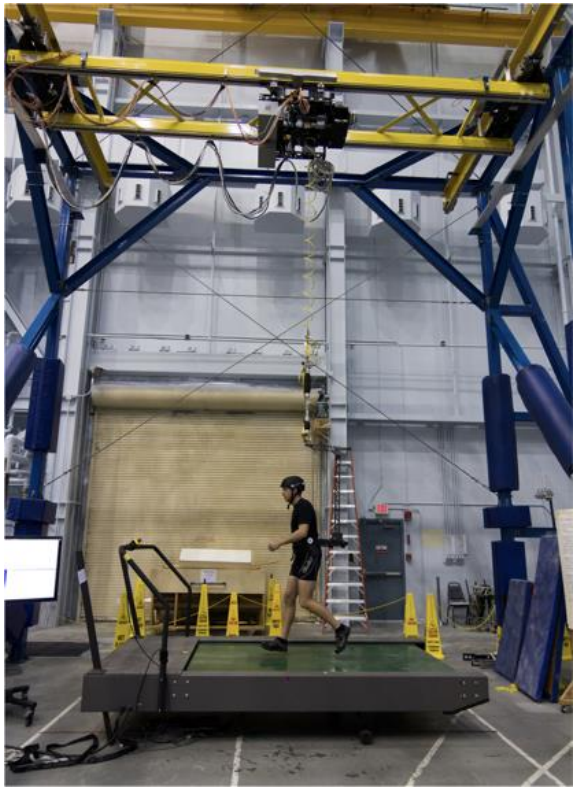
Methods

Subjects will perform 3 different locomotion styles at various speeds, both suited and unsuited:

- Walking
- Skipping
- Running

ARGOS

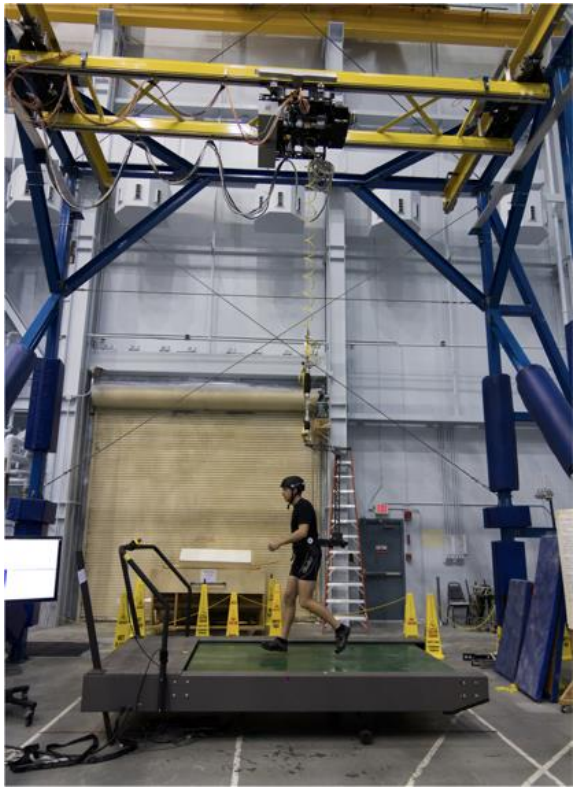
- The Active Response Gravity Offload System
- Located at NASA’s Johnson Space Center
- Simulates Lunar and Martian gravity levels




CAUTION

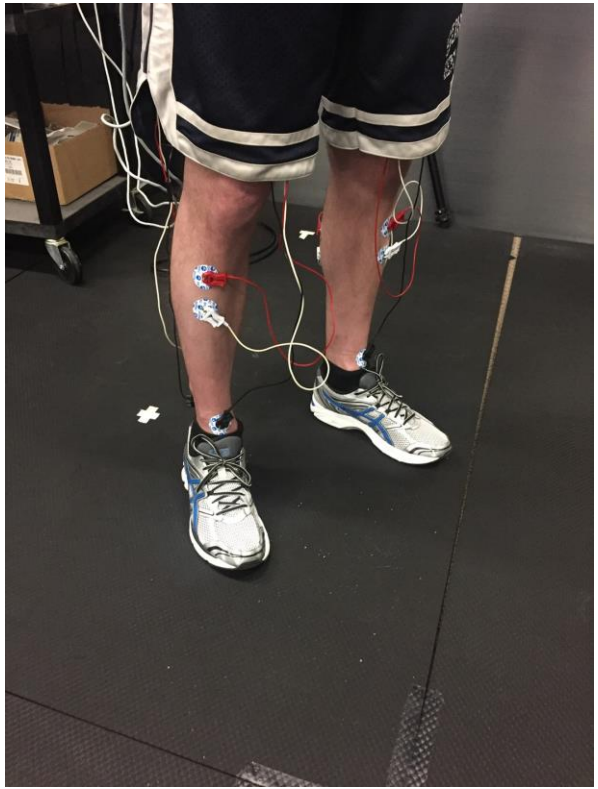
Methods

- EMG data to assess muscle use
- Motion capture data will be collected for analysis of forces related to bipedal locomotion



Methods

- Measures muscle activation that is a result of nerve stimulation
- Can be used to extrapolate muscle fatigue



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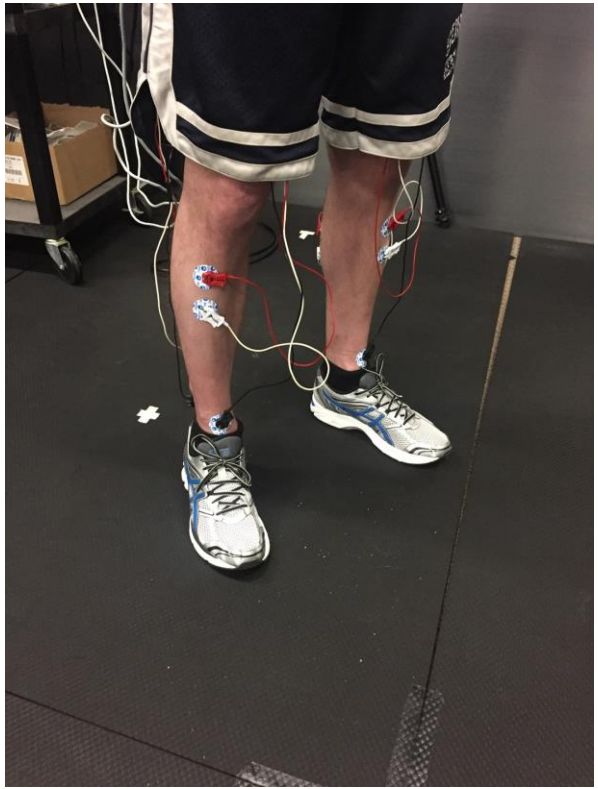

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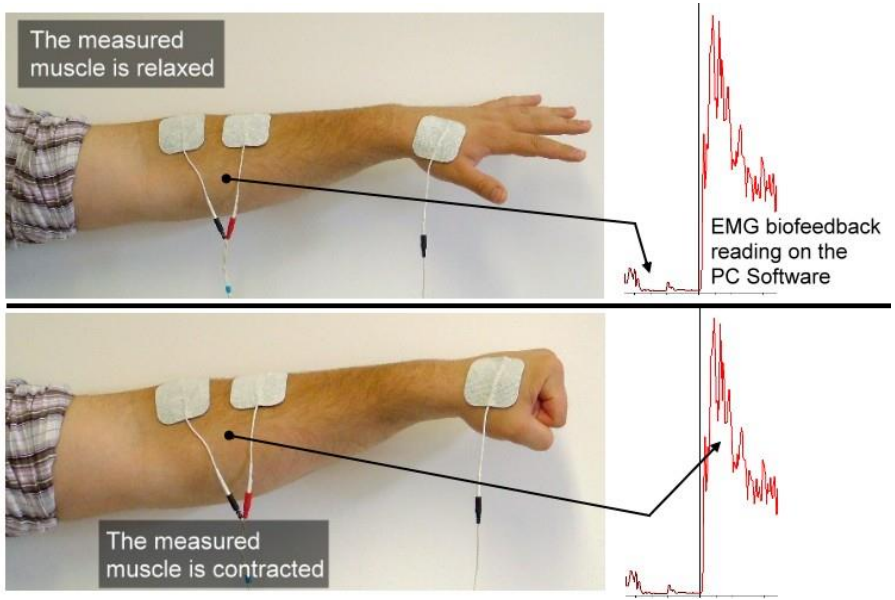

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sEMG

- Surface sensors, so no needles required!
- Shaving of leg and use of electrode gel

BIOPAC MP150 Hardware

- 4 channels for receiving muscle activation data
- Integrates with BIOPAC AcqKnowledge software suite
- This study will be using EMG hardware

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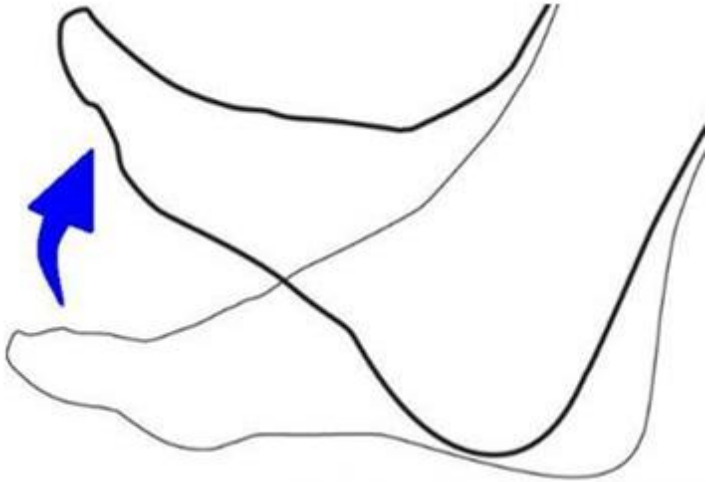
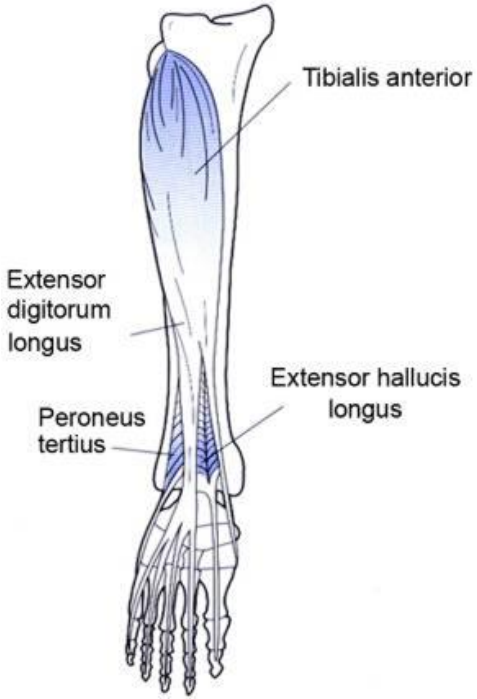
Muscle Selection & Dorsiflexion





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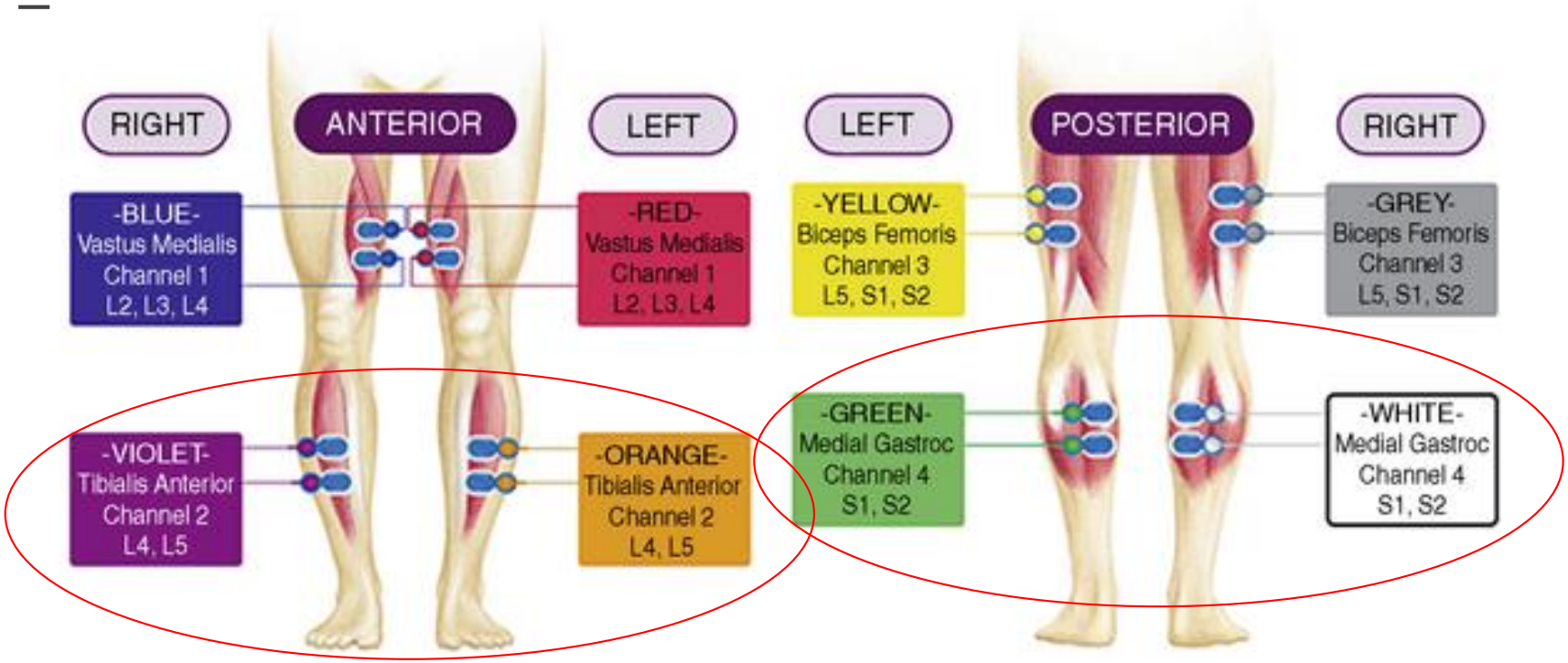
Electrode Placement



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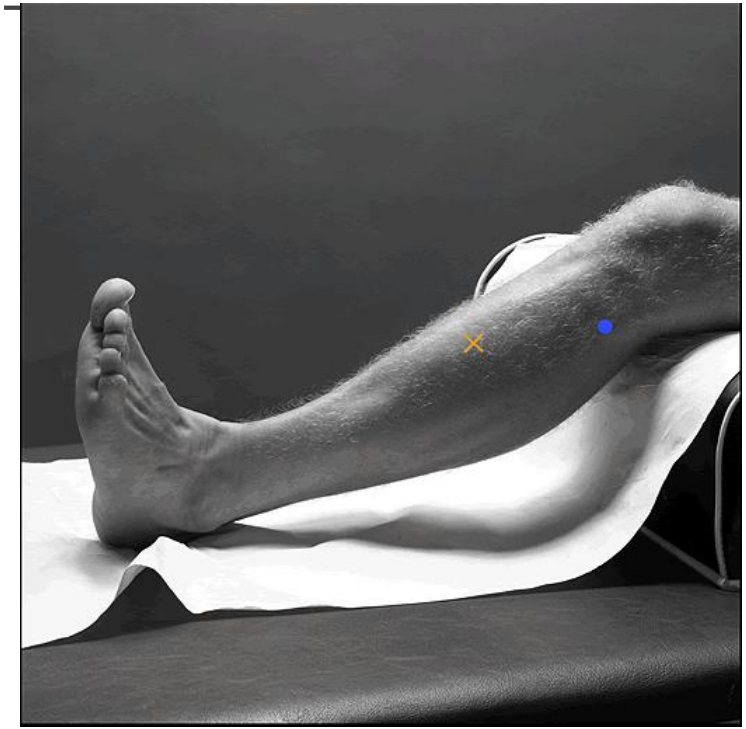

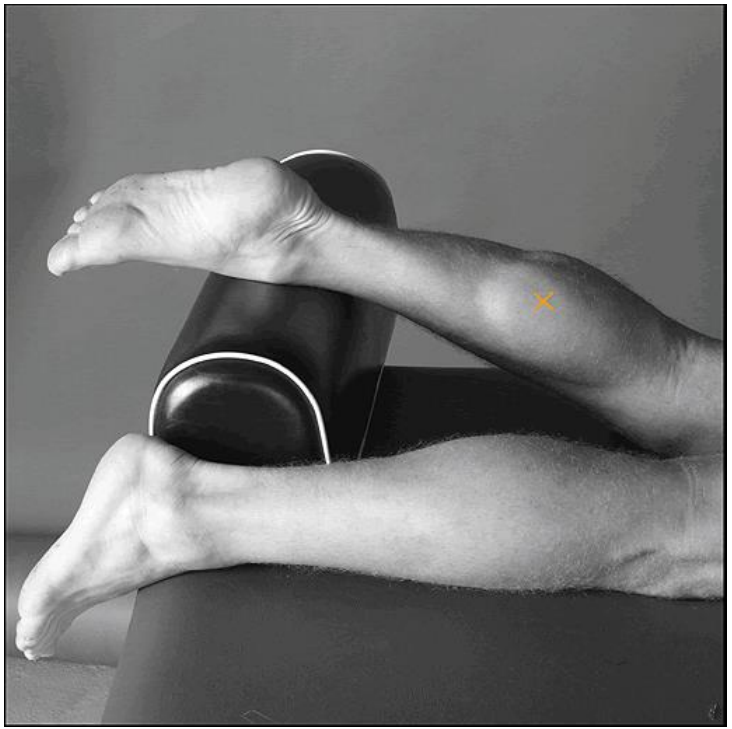

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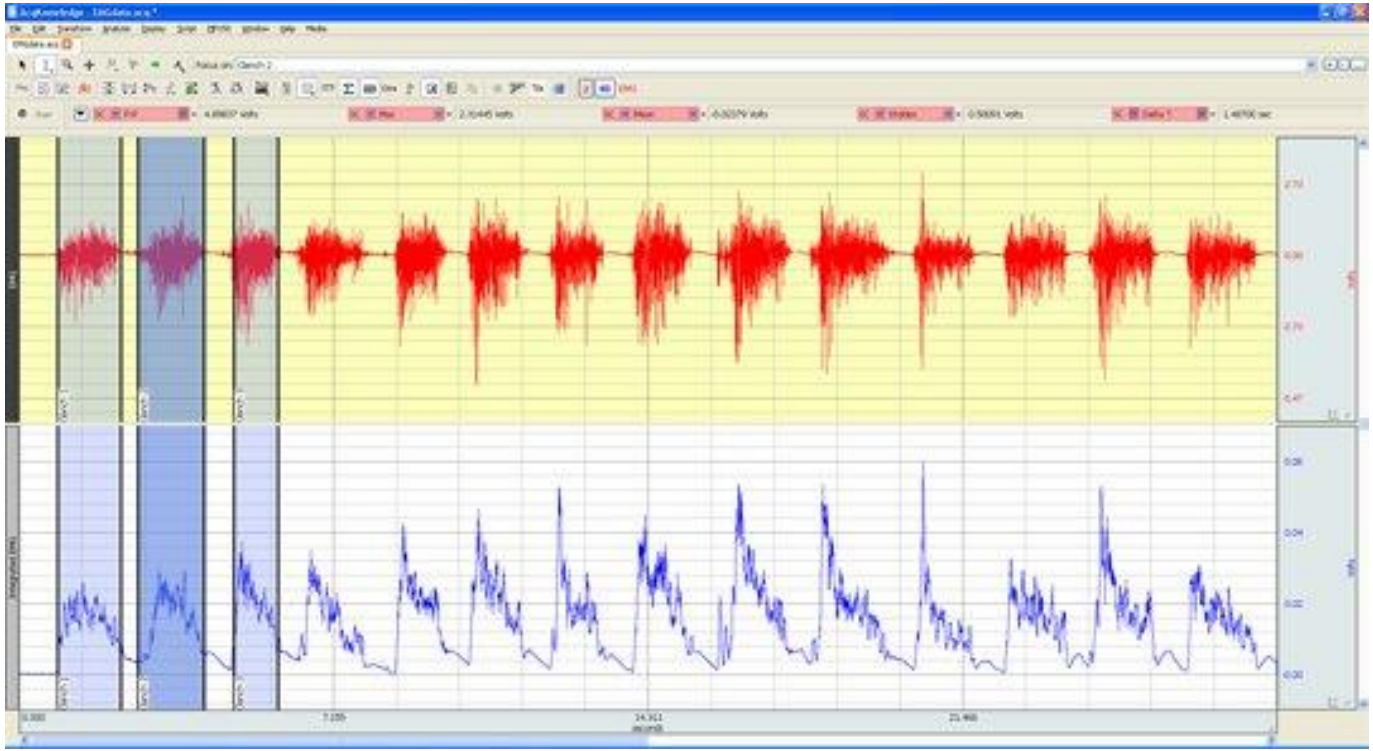
BIOPAC ACQ*KNOWLEDGE* Software



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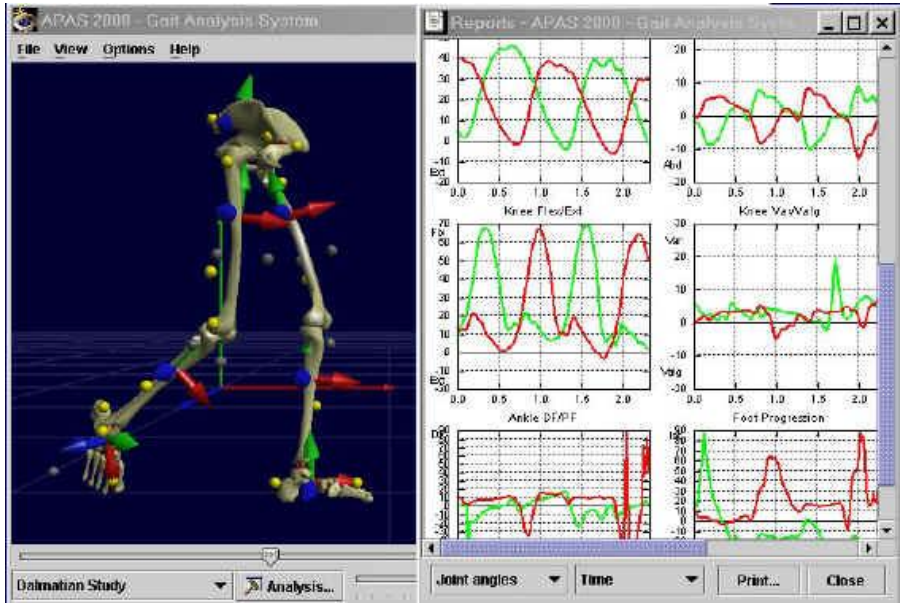
Motion Capture

- Hyper reflective motion capture markers
- Allow for additional 3D modeling and gait analysis
- Useful for future research

Vicon

- Allows for gait analysis of motion capture data
- Uses 3D data collection utilizing a calibration cube



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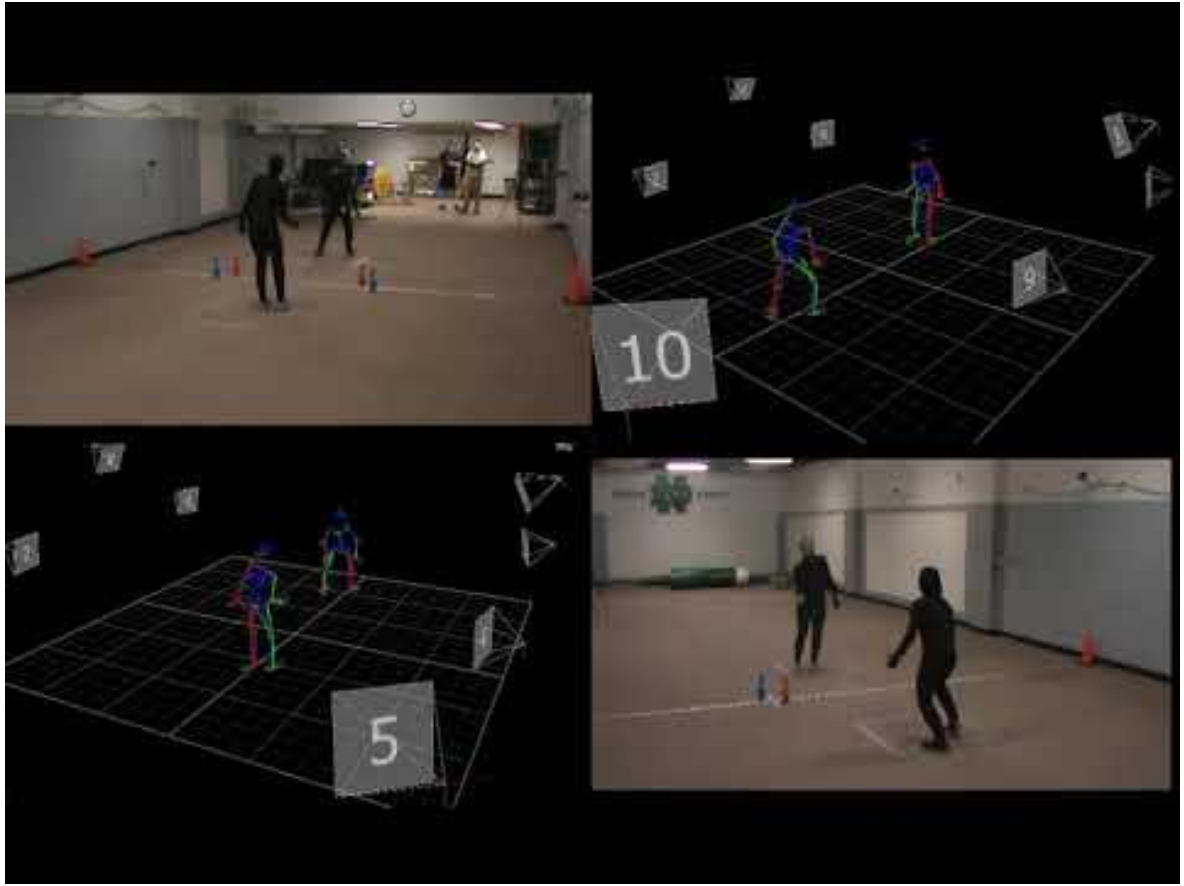
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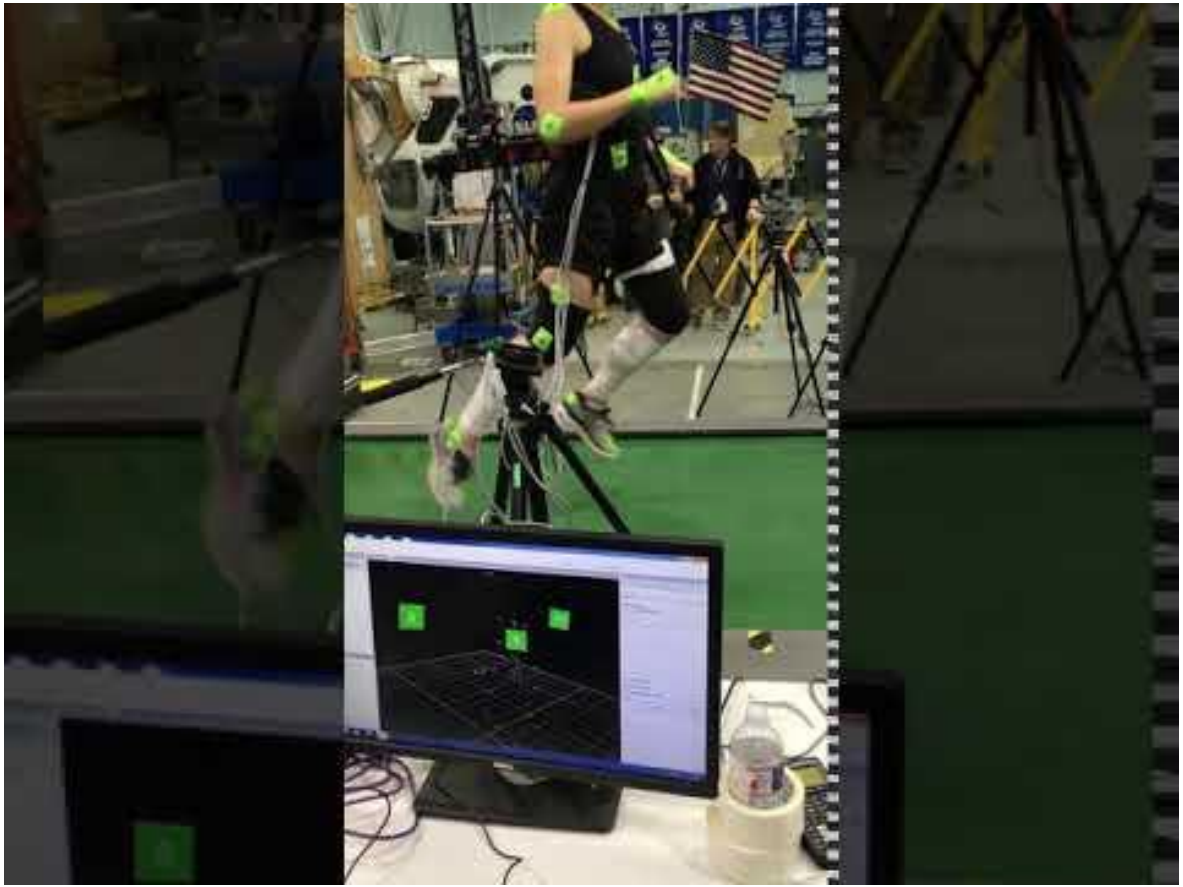
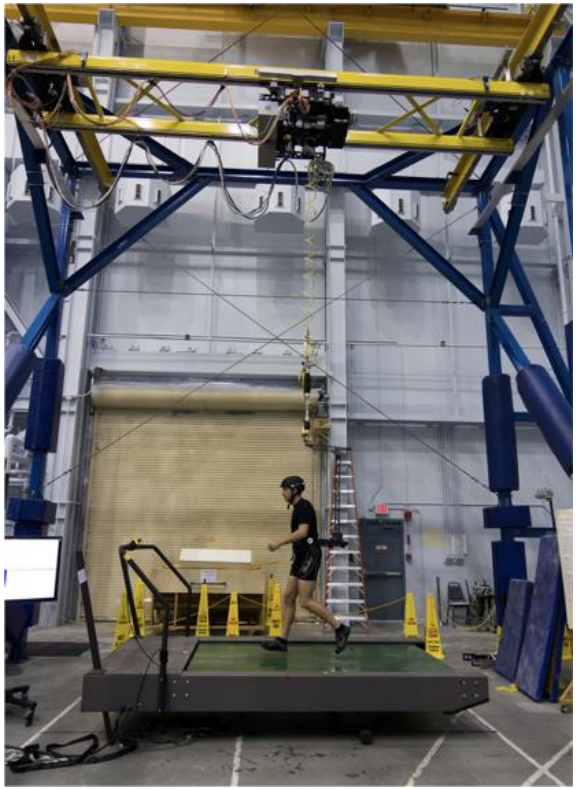
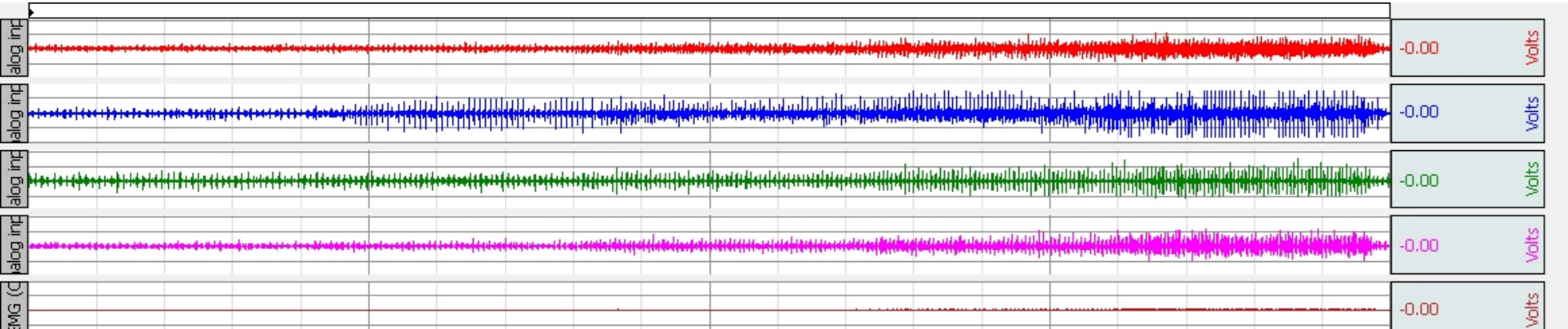


Conclusion

- assessment of locomotion patterns in different levels of gravity to assist in the creation of training regiments for future astronauts
- 3D Models will be created
- EMG data will be collected and analyzed

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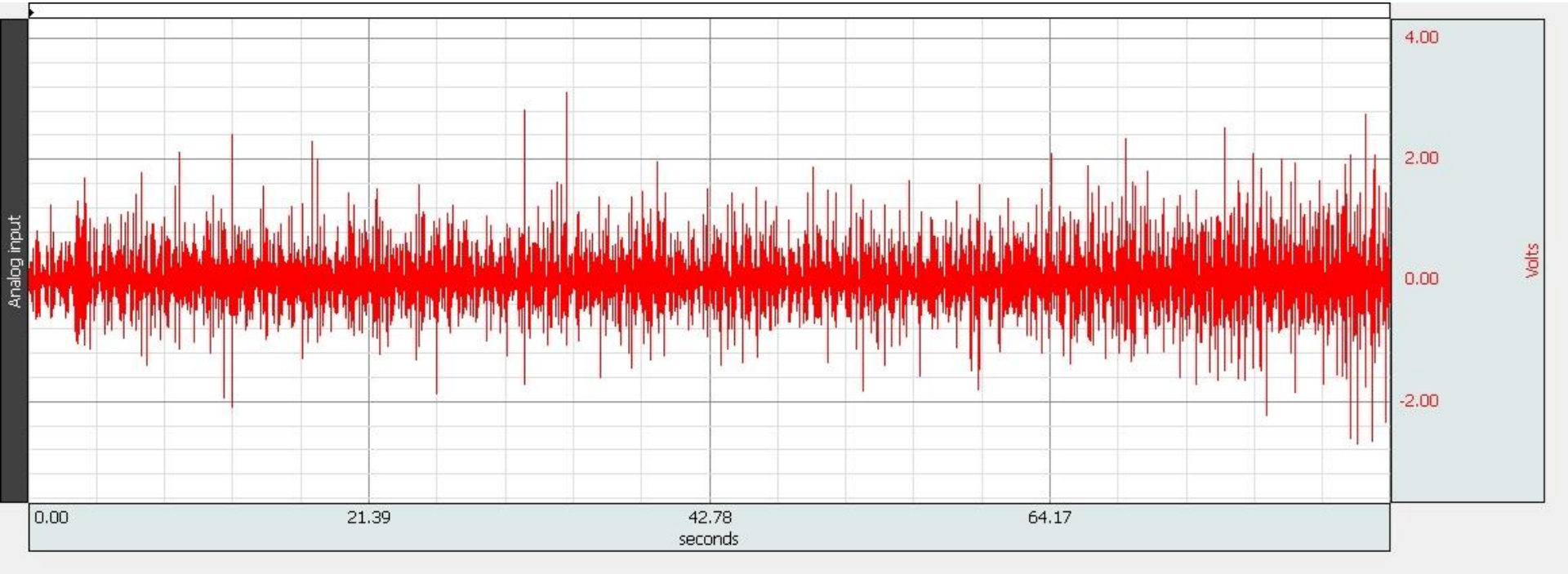
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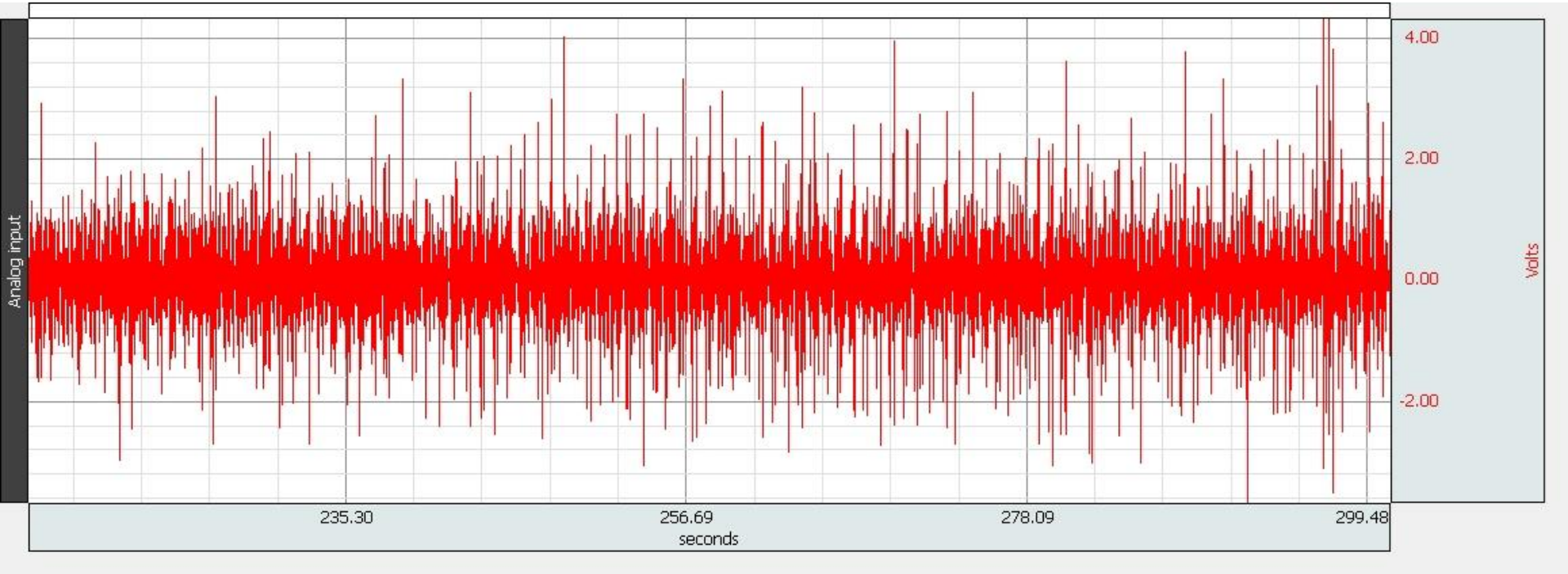
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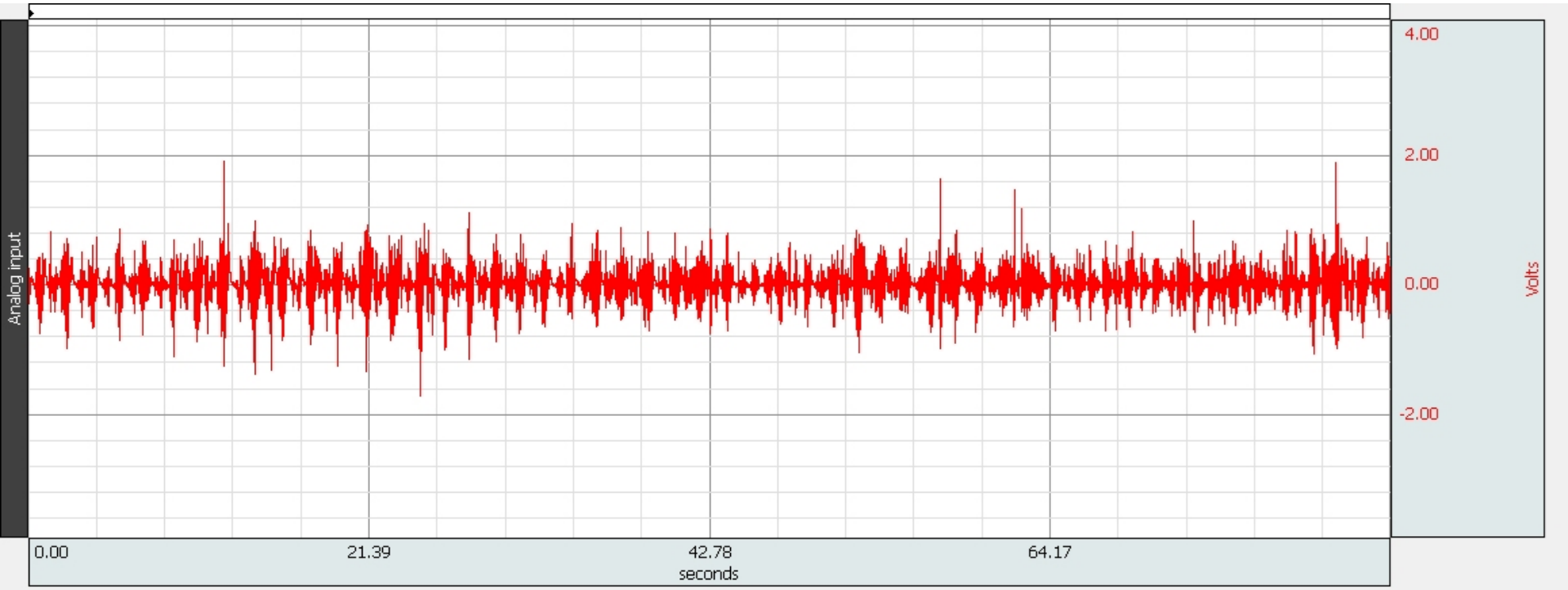
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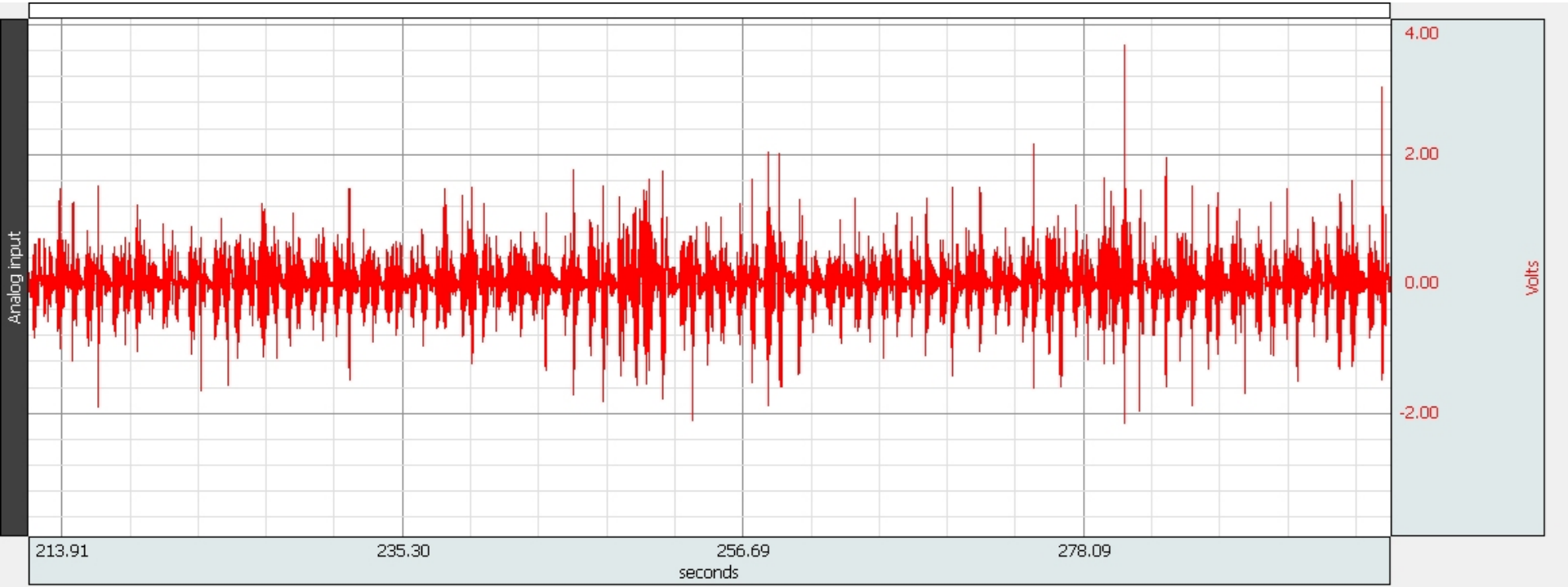
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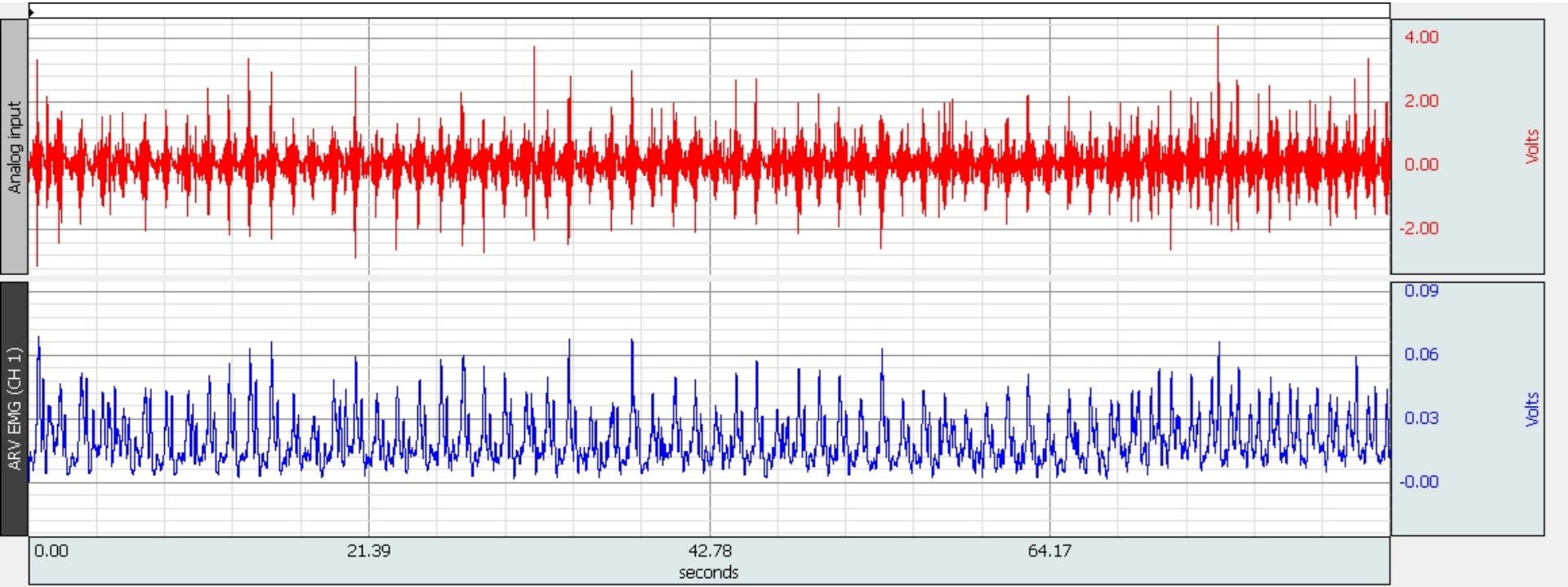
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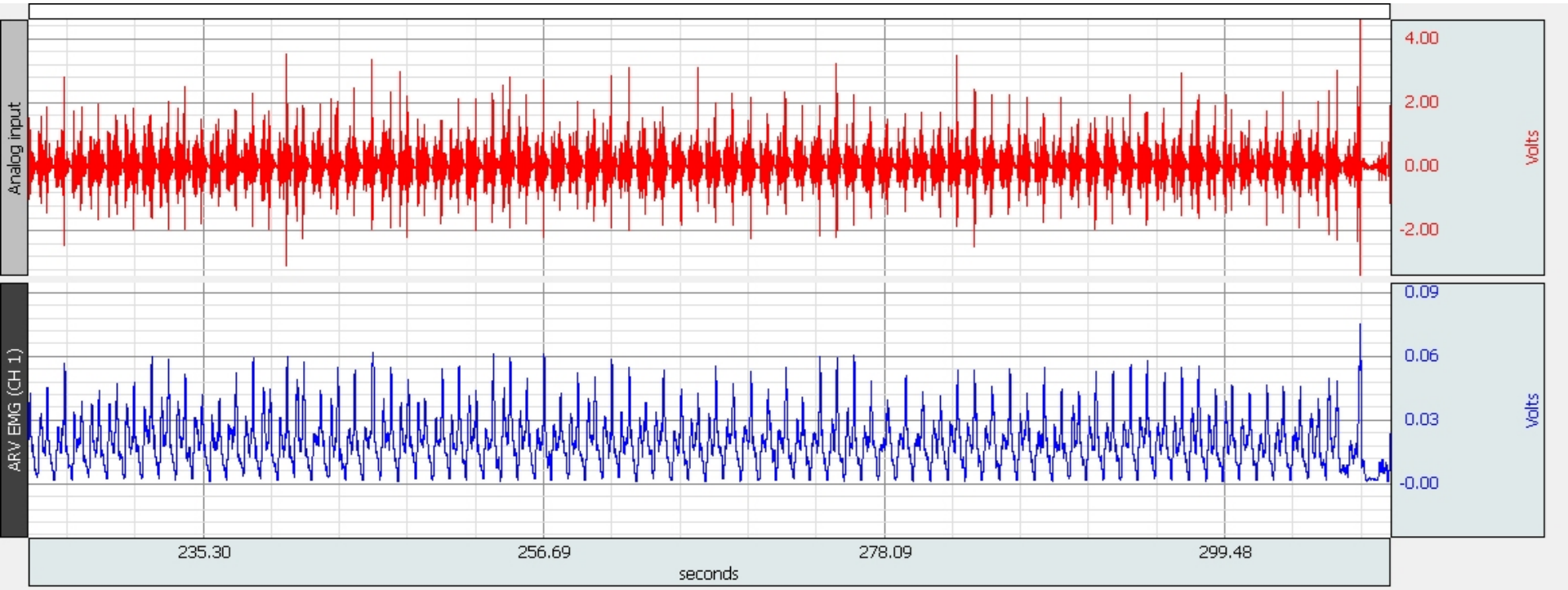
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Acknowledgements

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Questions?