

### Motivation

- Falls cause 58.1 % of death in seniors 65+, commonly resulting in hip fracture
- Current options: **airbags** or **passive hip pads**.
  - Airbags:** consistently reduce impact but are one-time use
  - Hip pads:** reusable but placement matters (3cm displacement → 23% force increase)
- Goal:** Spring-based system that combines **geometric expansion with reusability**
  - Aim to deploy within 0.5 seconds and achieve comparable 20% reduction

### Design

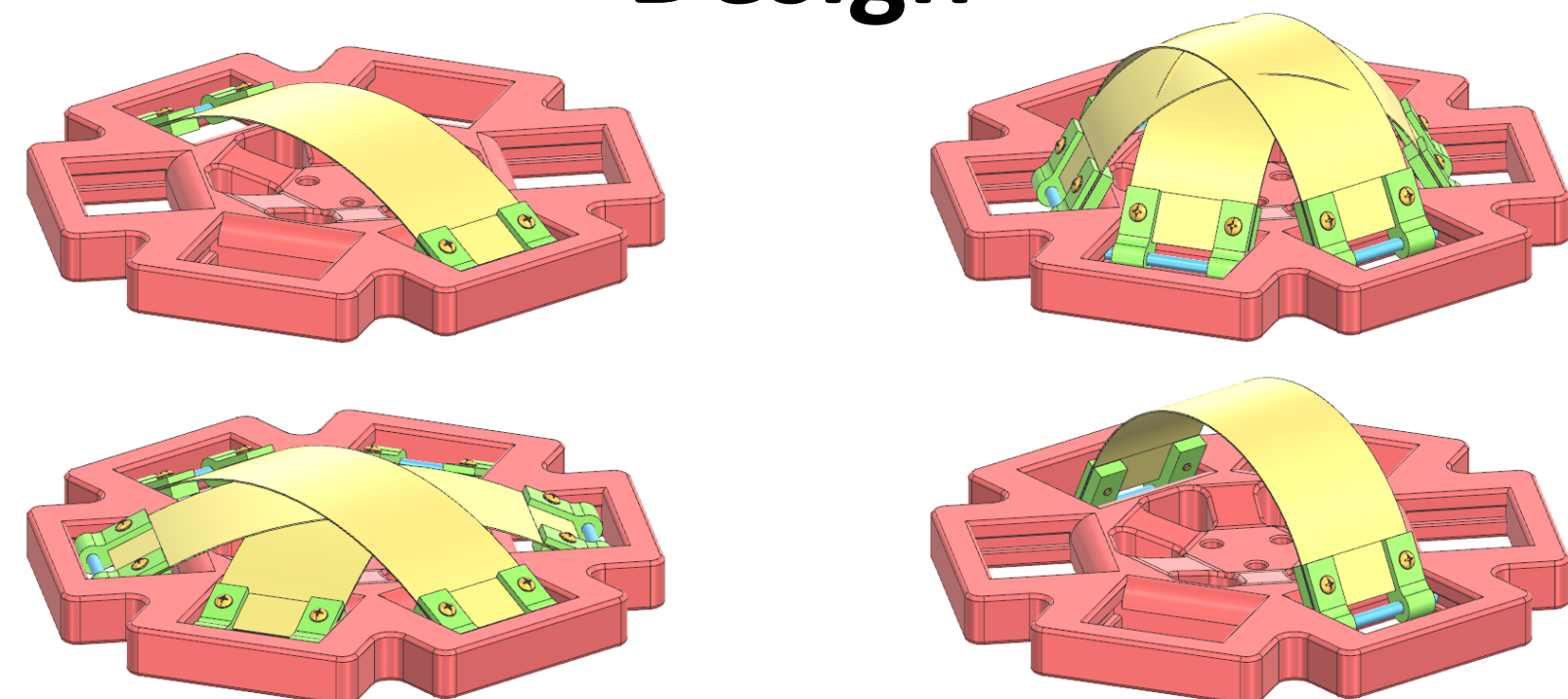


Figure 1. Arches in Slotted Base Plate, Stored State on Right, Expanded Dome Shape on Right

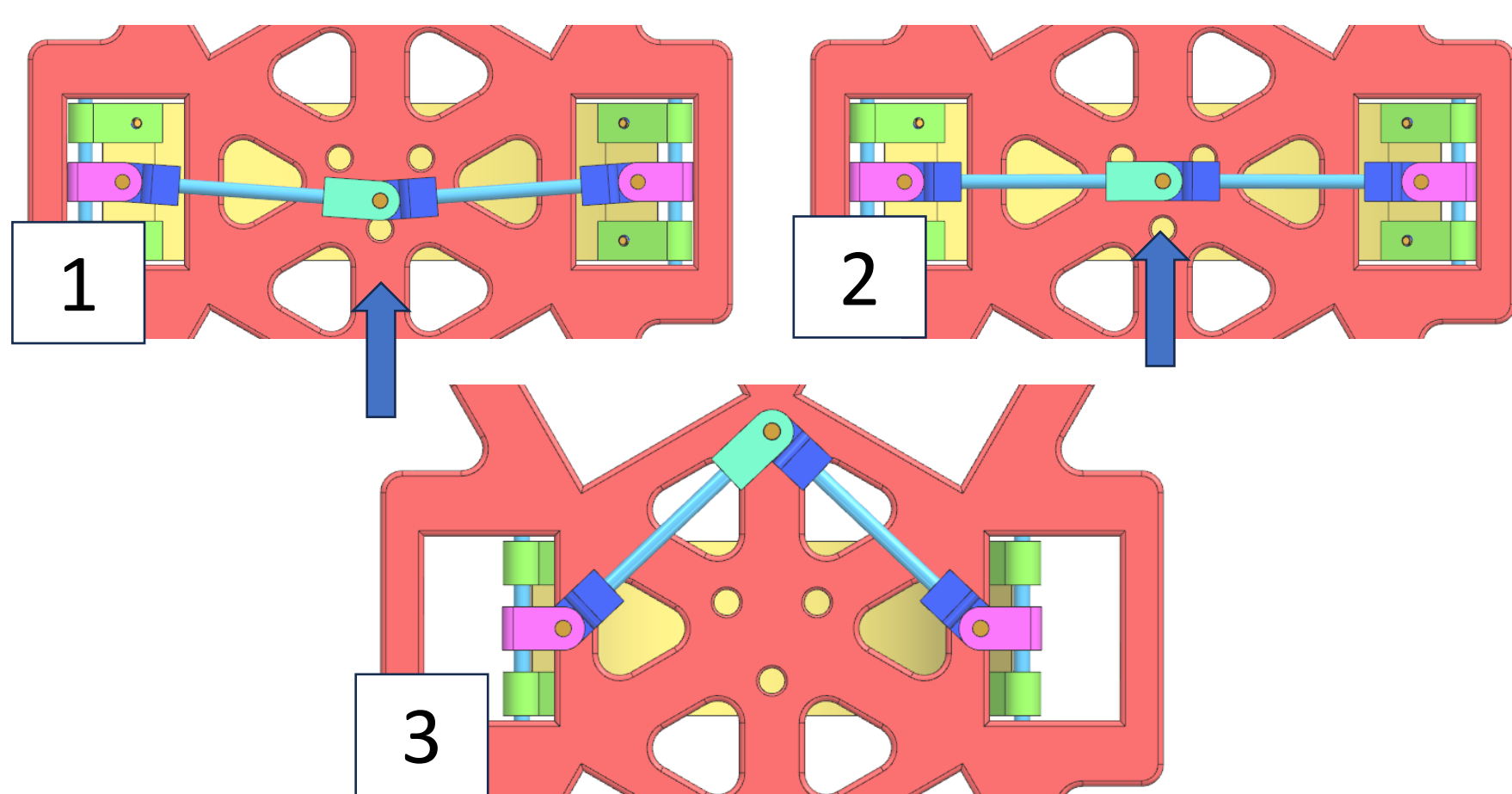
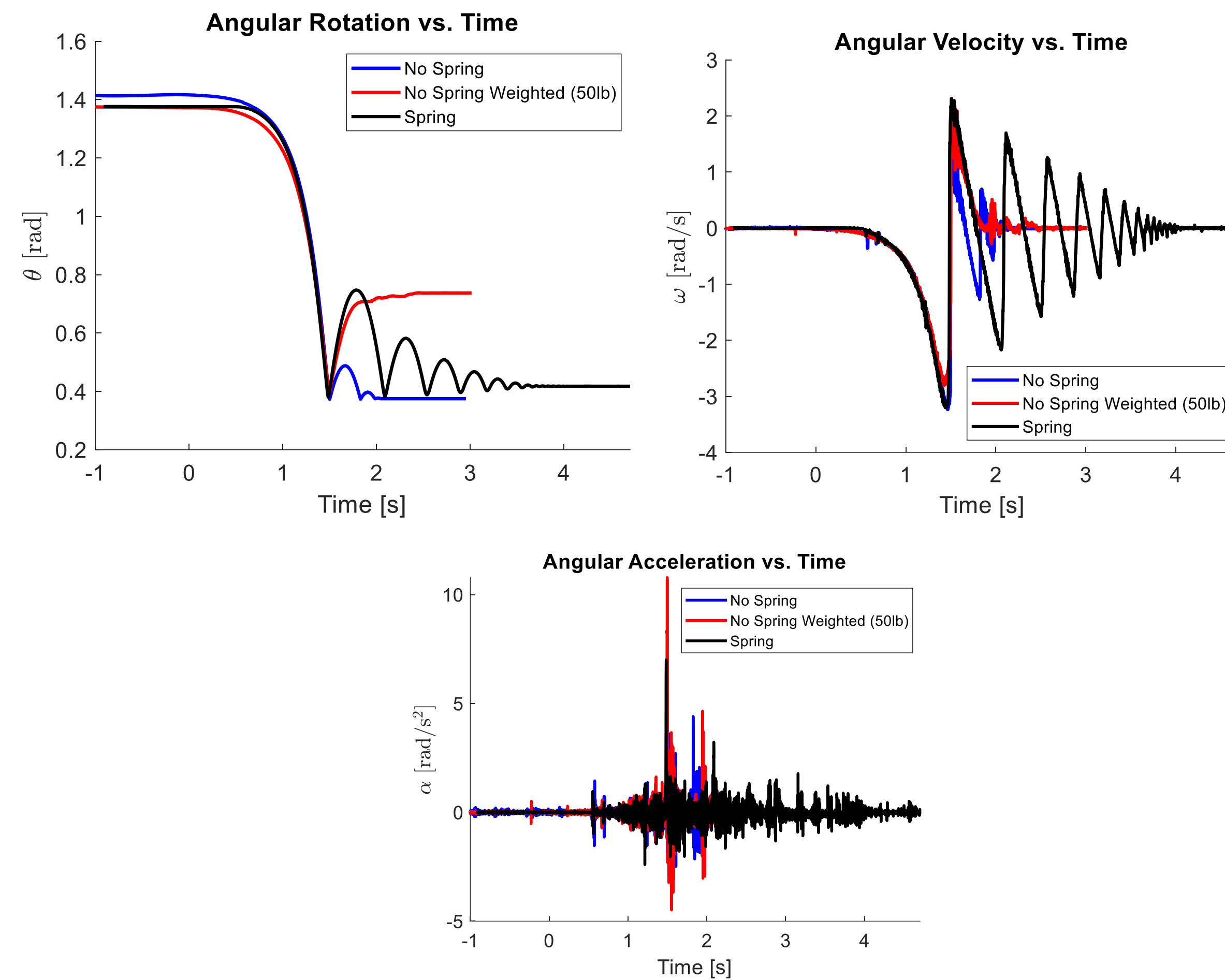


Figure 2. Buckling release system as it is pushed by a solenoid from locked position (1), past central point of stability (2) and expands to deployed state (3)

### Results



| No Spring [rad/s <sup>2</sup> ] | With Spring [rad/s <sup>2</sup> ] | Acceleration Reduction |
|---------------------------------|-----------------------------------|------------------------|
| 16 ± 5                          | 8 ± 2                             | 50% ± 20%              |

### Future Work

- Proof of concept must be applied to a human model
- Create belted attachment system
- Reduce baseplate profile
- Conduct testing on humans, or accurate kinematic model
- Explore commercial and social viability

### Experiment

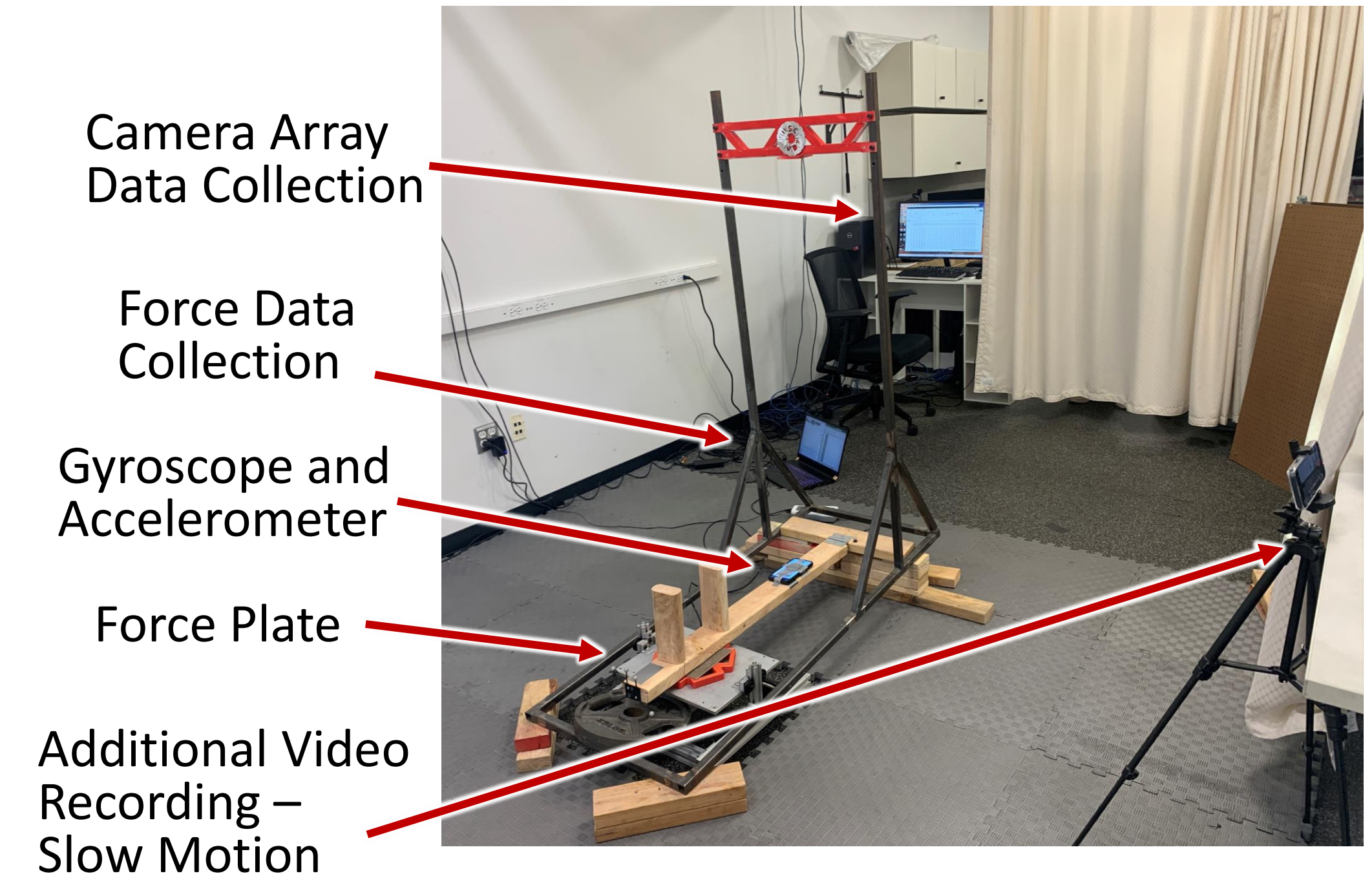


Figure 4. Optitrack Prime X 120 Camera System placed throughout testing space, reflective tracking indicators affixed to base and arm of pendulum to assist in tracking motion.

### Conclusion

- Pendulum-type testing demonstrated a reduction in the angular acceleration of the rebound of the pendulum. Because acceleration ∝ force, the system successfully spread the impact energy over a larger impact duration, reducing peak force and reducing the risk to the wearer.
- Previous testing with a drop tower demonstrated a relationship between the thickness of the spring steel and its spring constant when compressed.
- To scale the device up to human weights, spring steel thickness increase will achieve desired results.