

### Rationale

- Accurate computational simulations of human movement require intricate knowledge of the center of mass (CoM).
- OpenSim's estimation technique can be imprecise due to the use of generic mass and geometry distributions.
- Statically Equivalent Serial Chain (SESC) technique may improve estimates of CoM location.
- SESC model needs joint angles & relevant node locations.
- **We aim to validate and improve accuracy of OpenSim's estimation by applying SESC.**

### Methodology

- 30 Static poses | 10 Test poses | 5 Walk trials | 5 S.T.S trials
- Mocap System: Vicon Nexus
  - Tag & Gap Fill
- Musculoskeletal Modeling Software: OpenSim
  - Scale Model
  - Inverse Kinematics
  - Inverse Dynamics
  - Reduce Residuals Algorithm
- SESC Program: MATLAB
- Compare results of CoM estimation from RRA to SESC



Fig. 1: Mocap Setup

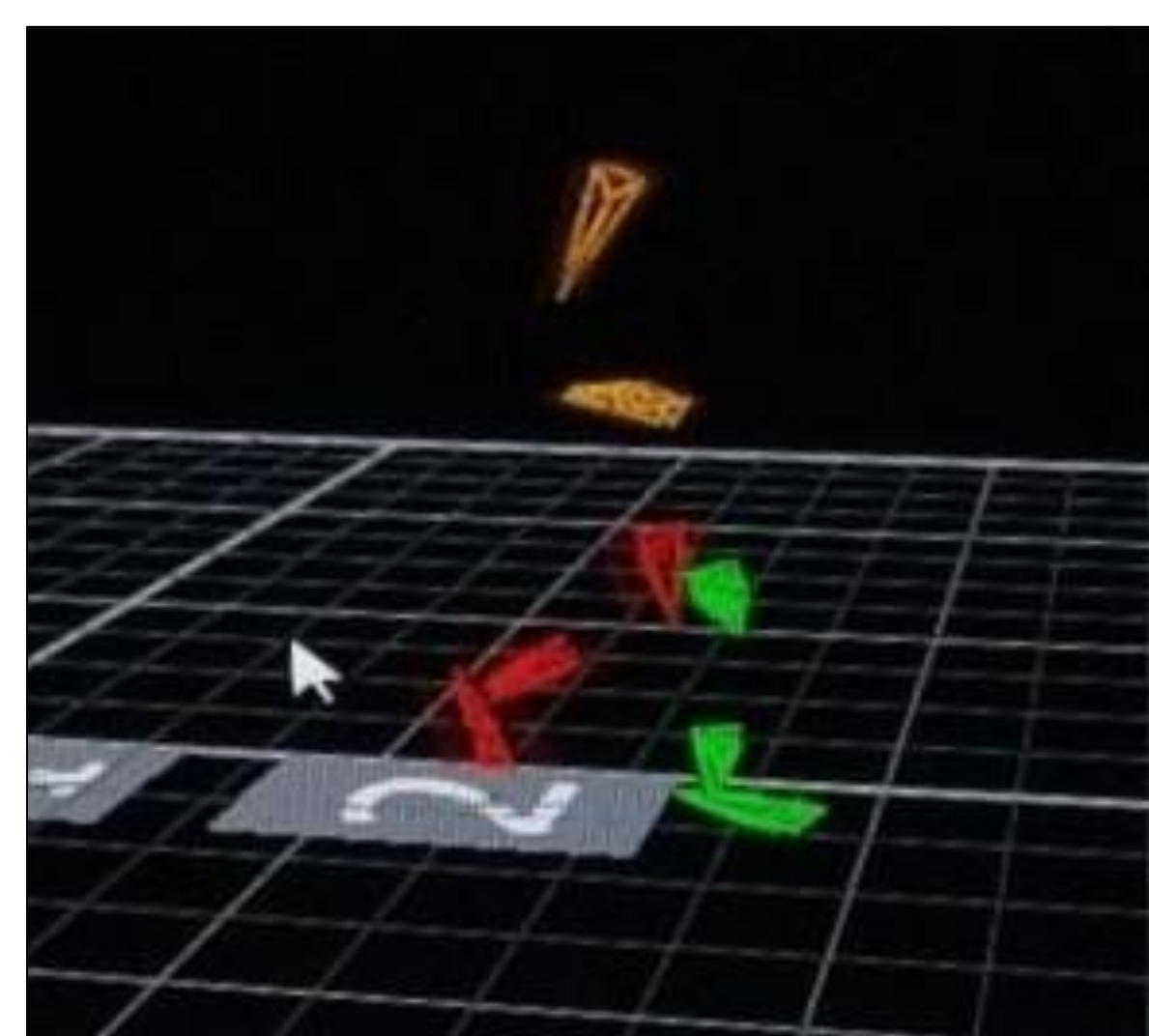


Fig. 2: Nexus Program



Fig. 3: OpenSim Model

### Results

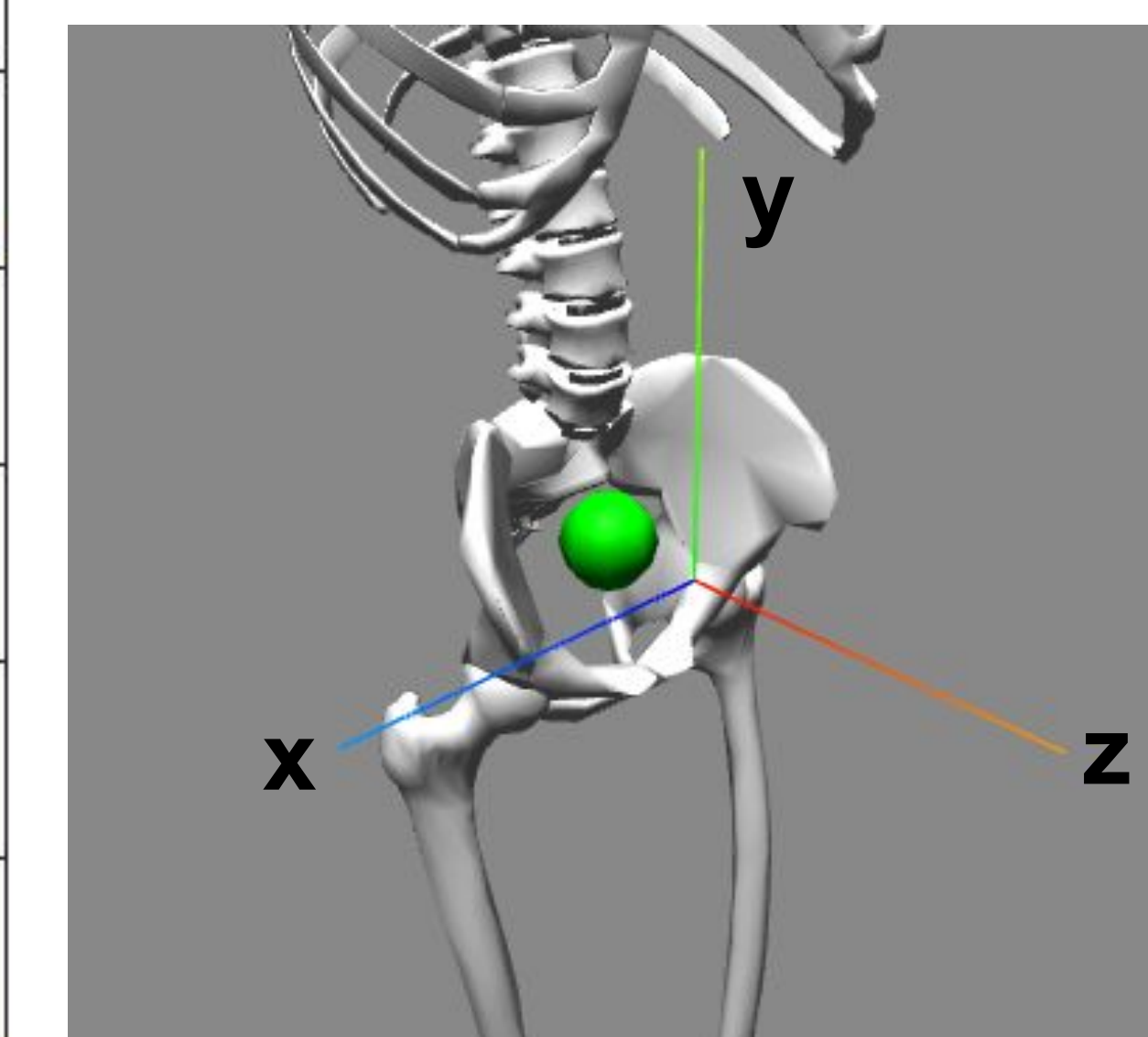
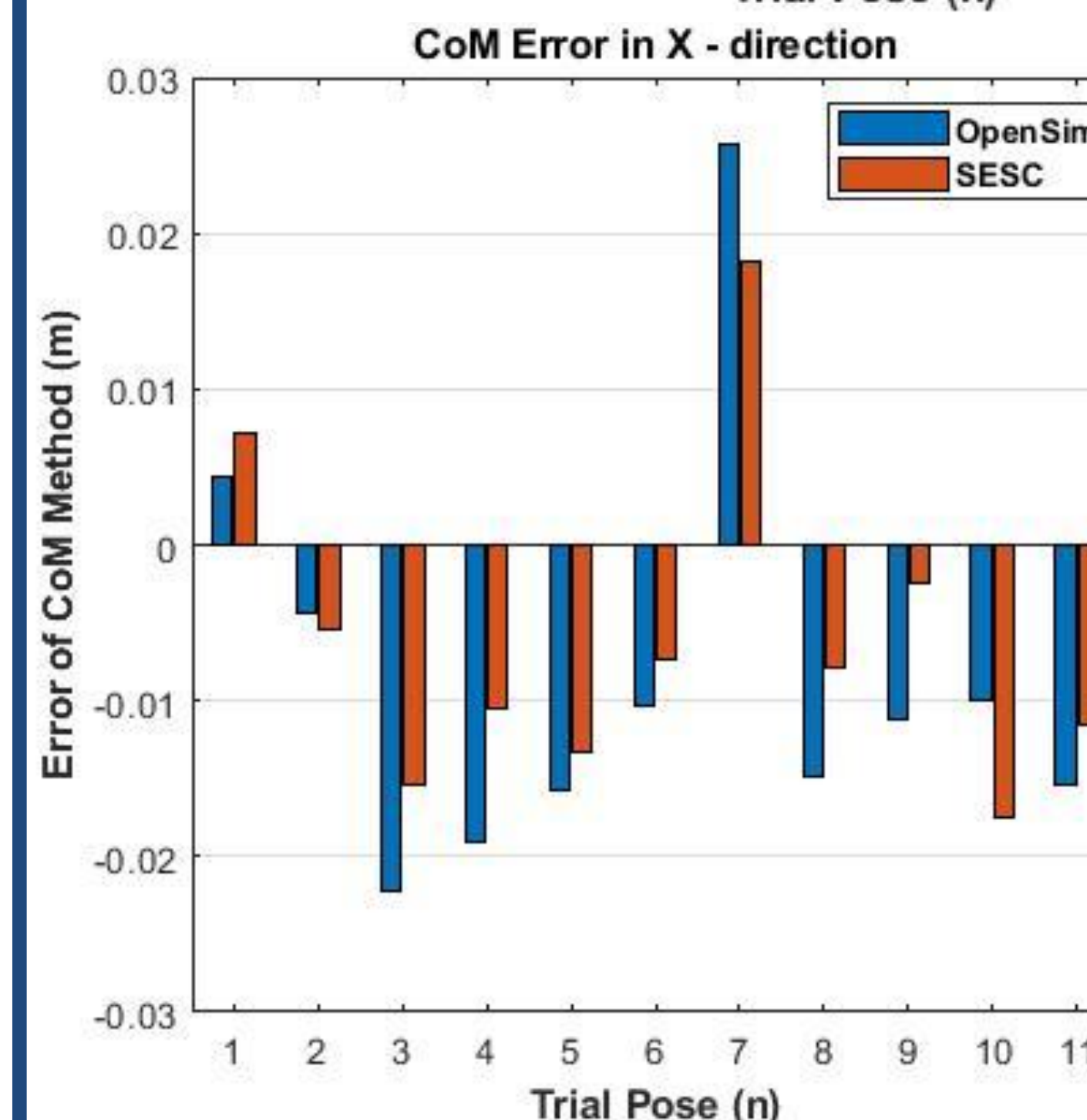
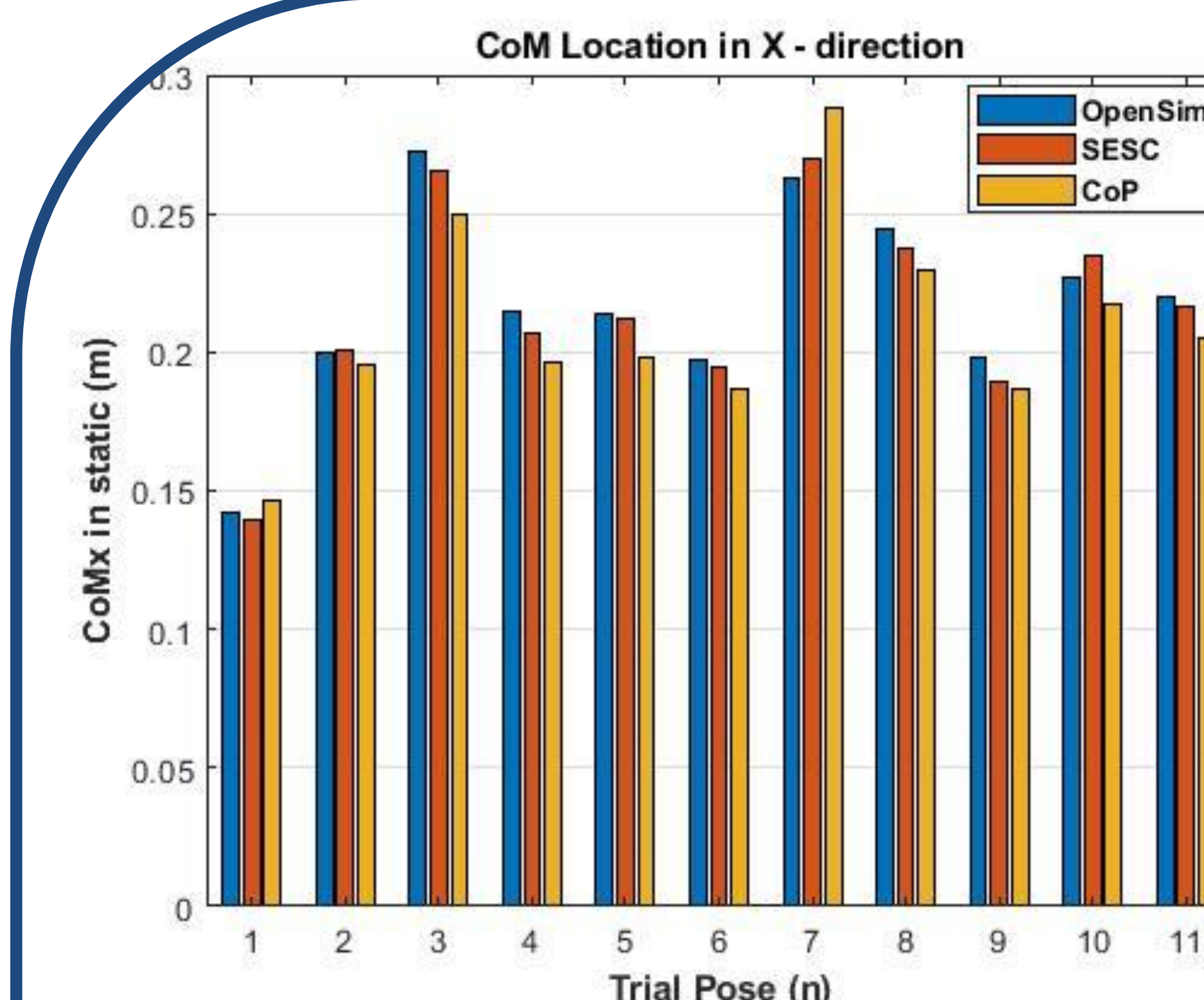
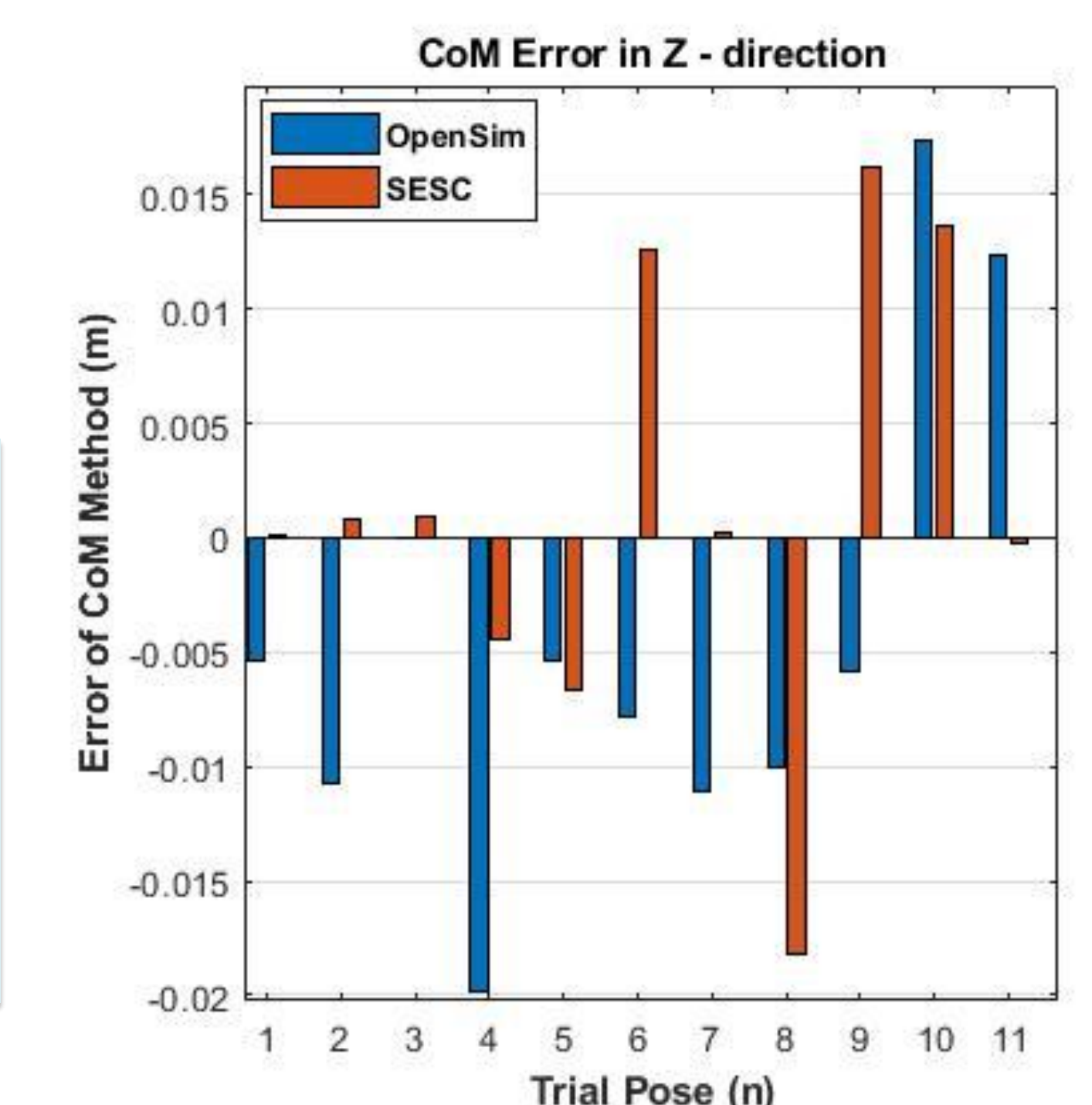
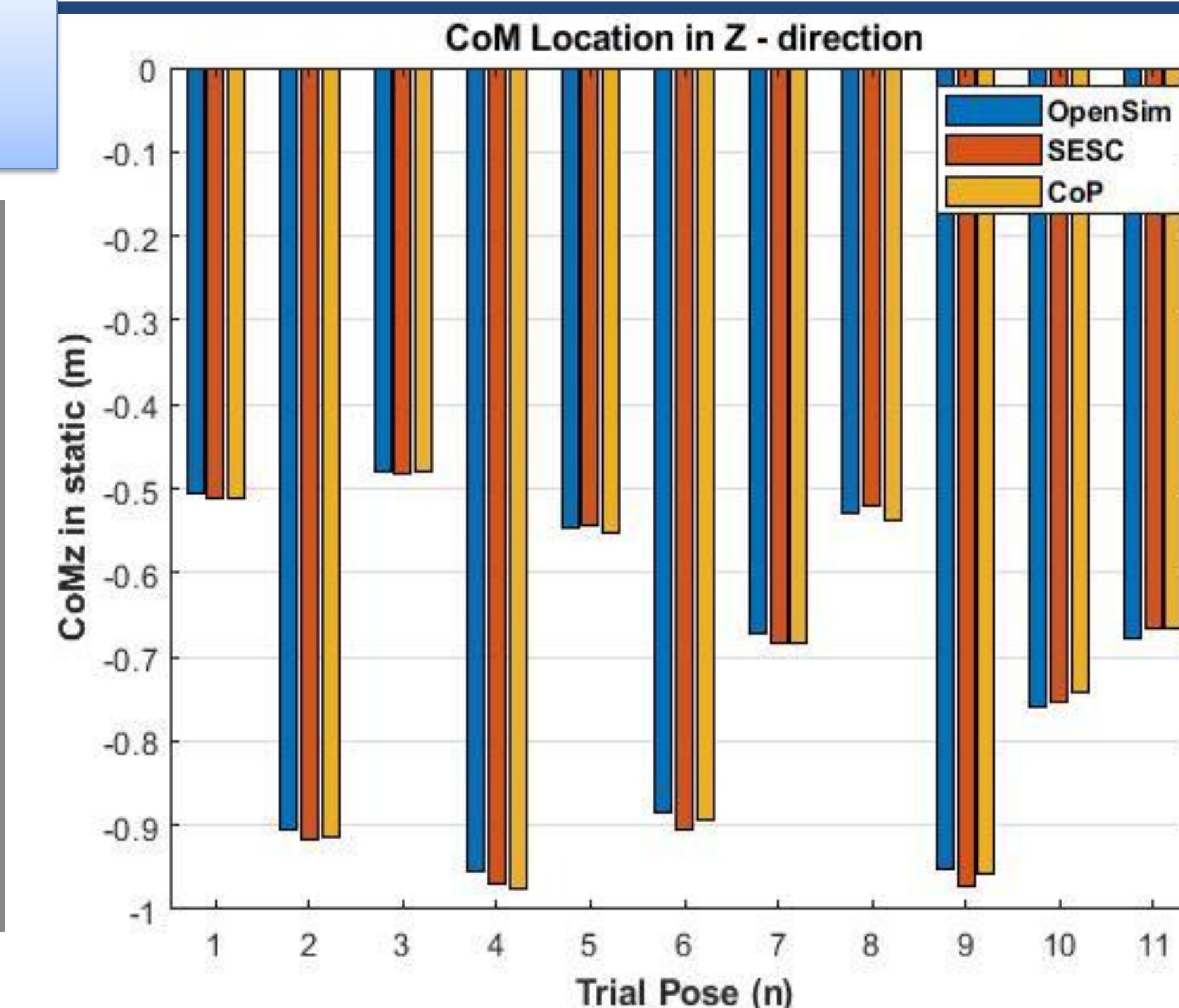


Fig. 4: CoM xyz axis

\* CoMx & CoMz are measured from the pelvic axis

- SESC RMS error = **15.1 mm**
- Avg. SESC x-dxn error = **0.011 m**
- Avg. SESC z-dxn error = **0.007 m**
- Avg. OpenSim x-dxn error = **0.014m**
- Avg. OpenSim z-dxn error = **0.010m**



**The SESC CoM estimate method is more accurate at determining the CoM than the OpenSim CoM estimate method.**

### Conclusions

- SESC is an effective tool to validate the accuracy of OpenSim's CoM estimation method.
- OpenSim's CoM estimation technique is valid; but can be improved upon.
- Next, we would like to integrate SESC into the OpenSim software package as a one step process for validation of CoM location estimates.

### Acknowledgements and References

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1. S Cotton, et al. *Trans on Mech*, **2009**, 14, 707.
2. S. Cotton, et al. *App Bio*, **2011**, 8, 67