



# **VALIDATION OF MARKERLESS MOTION CAPTURE SOFTWARE IN BALANCE ASSESSMENT**

Marvin Uwalaka and Gloria Sanouvi-awoga

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# RECAP

BALANCE IN RURAL  
LONG-TERM CARE

## THE NEED RURAL BURDEN

- CONSEQUENCES AND REHABILITATION POST FALLS
- PREDICTION
  - PREVENTION
  - PREDICTOR FOR DEMENTIA

A SOLUTION  
TELEHEALTH



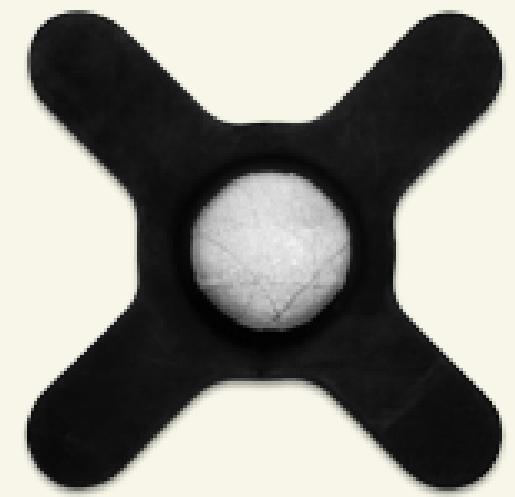
# RECAP

## BALANCE ASSESSMENT IN LONG TERM CARE

FORCE PLATES



MARKER-BASED MOTION  
CAPTURE



WEARABLE SENSOR(IMU)



Kinetisense



# **OBJECTIVE**

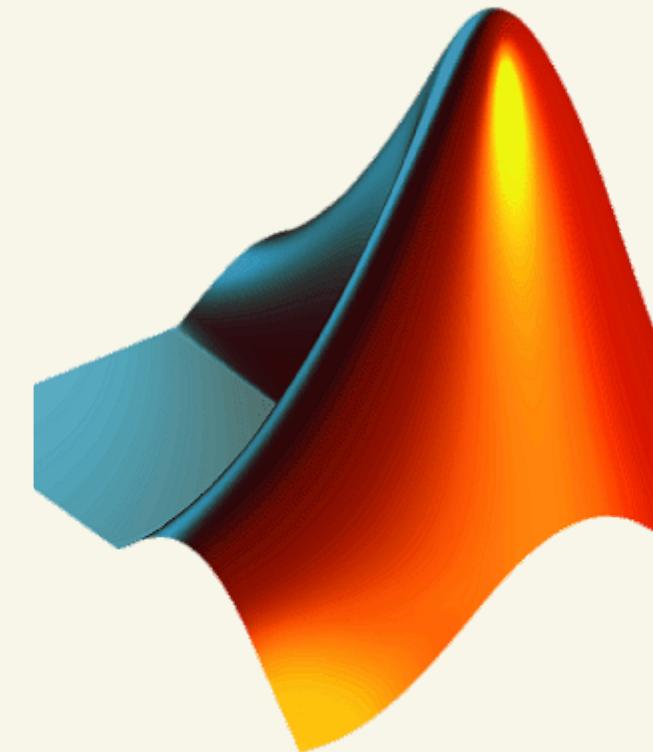
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TO VALIDATE THE USE OF KINETISENSE IN BALANCE  
ASSESSMENT AS A TOOL TO REPLACE THE GOLD STANDARD  
FORCE PLATES



# NEXT STEPS

The screenshot shows the ARISE Alberta Research Information Services dashboard. The top navigation bar includes the University of Alberta logo, the ARISE logo, and links for Dashboard, Home, and Applicant. The main content area is titled "Page for Yawa Sanouvi-Awoga". It displays a list of items requiring action, such as "Inbox - Items appearing in this tab require your action to move an application forward" and "General - Link to your profile management space". Below this, there are sections for "Human" (with a single item listed), "Conflict of Interest" (empty), and "Incident Reports" (empty). On the left sidebar, under "My Roles", the "Applicant" role is selected, showing options like "New Human Study", "New Study From OnCore", "New FCOI Disclosure", "New Incident Report", and "Request Additional Roles". The "Activity Newsfeed" section indicates "No activity details to display".



ETHICS APPLICATION

DATA  
COLLECTION+STRESS  
TESTS

PROCESSING DATA



# PART III

Marvin Uwalaka and Gloria Sanouvi-awoga

▼ 1 - STUDY STAFF, FUNDING, LOCATION

- 1.1 Study Identification
  - 1.2 Additional Approval
  - 1.4 Conflict of Interest
  - 1.5 Research Locations and Other Approvals

## ▼ 2 - STUDY SUMMARY

- ## 2.1 Study Objectives and Design

## ▼ 3 - RISKS AND BENEFITS ASSESSMENTS

- ### 3.1 Risk Assessment

### 3.2 Benefits Analysis

## ►4 - PARTICIPANT INFORMATION RECRUITMENT, AND INFORMED CONSENT

- 4.1 Participant Information
  - 4.2 Additional Participant Information
  - 4.4 Recruitment of Participants (non-Health)

- ## 4.5 Informed Consent Determination

## ▼ 5- DATA PRIVACY AND CONFIDENTIALITY

- 5.1 Data Collection
  - 5.2 Data Identifiers
  - 5.3 Data Confidentiality and Privacy
  - 5.4 Data Storage, Retention, and Disposal

▼ DOCUMENTATION

arise.ulberta.ca/ARISE/app/portal/smartform/read?project=com.webbridge.entity.Entity%5B0ID365B46AAB0465C7611F0B2A95592A2565000%5D%5D&projectEditorView=com.webbridge.entity.Entity%5B0ID%5BD815546F568E6942A0B8A53744... ☆

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**1 - STUDY STAFF, FUNDING, LOCATION**

**2 - STUDY SUMMARY**

**2.1 Study Objectives and Design** 1

2.2 Research Methods and Procedures

**3 - RISKS AND BENEFITS ASSESSMENTS**

**4 - PARTICIPANT INFORMATION, RECRUITMENT, AND INFORMED CONSENT**

**5 - DATA PRIVACY AND CONFIDENTIALITY**

**DOCUMENTATION**

Documentation

Markerless motion Capture systems such as Kinetisense use artificial intelligence to find and track body landmarks in space through time. This will inform clinicians about body segments. The purpose of this study is to validate the use of Kinetisense in balance assessments as a replacement for the force plate. We will be using a 3 Dimensional camera to collect Kinetisense data and the VALD force plates as a gold standard reference. Participants will perform quiet stand balance(feet shoulder width apart and arms crossed) and tandem stance (heel-to-toe stand with dominant foot forward) balance tasks using the force plates and Intel RealSense depth camera simultaneously.

2.0 \* Provide a full description of your research proposal outlining the following:

- Purpose
- Hypothesis
- Justification
- Objectives
- Research Method/Procedures
- Plan for Data Analysis

**Purpose:** The purpose of the study is to determine whether Kinetisense markerless motion capture system is comparable to the gold standard force plates in balance assessments.

**Hypothesis:** Using Kinetisense center of mass data, it will be possible to successfully predict force plate center of pressure data.

**Justification:**

Falls are the most important cause of injury for older adults living in Canada. They have grave and long-lasting consequences and are even more prominent for seniors living in long term care settings. They can be responsible for physical sequelae, depression, anxiety, loss of mobility. Furthermore their link to loss of independence has in turn been associated with a rise in mortality rates. In order to be able to put preventative measures in place, clinicians and health care professionals use Risk of Fall assessments to predict an individual's particular likelihood of experiencing a fall. Balance Assessments are a core part of Risk of Fall Assessments.

When trying to perform a balance assessment, there are a number of precise tools that provide clinicians with an objective understanding of a patient's stability. The tool considered to be the Gold Standard among others is the Force Plate. A patient stands on it and it tracks the shifting of weight, to inform the clinician about how much the patient is swaying(as they sway their weight will shift in acceleration and direction). The Force Plate is a piece of equipment that is precise but heavy, expensive, and at times, hard to use. Access to it is limited for long term care facilities, the likelihood that Force Plates could be found in that setting is slim. There is an important need for an accessible, portable, user friendly tool in the balance assessment sector. Markerless motion capture software Kinetisense could fulfill that need.

**Objectives:**

We will be creating a model whereby Kinetisense data is converted into a center of mass that can be tracked and will predict the force plate data for the same assessment.

**Primary:**

- Determine whether Kinetisense's center of mass is capable of predicting force plates' center of pressure
- Evaluate the quality of Kinetisense's predictive ability for various balance tasks.

**Secondary:**

- Determine whether sway data of differing body segments are strongly correlated to full body movement and center of pressure movement.

**Research Methods/Procedures:**

Before beginning each test, the participant will be asked to provide their height. If they do not know it, the researcher will measure them. This piece of information is important for calculating center of mass later on. A participant will perform 6 sets of balance tasks. Each set will comprise three trials. For a total of 18 trials. The participant will perform these tasks while standing atop a force plate and in front of an intel realsense depth camera. The tasks are all variants of the quiet stand balance and the tandem stand.

**Quiet stand balance:** the participant will step onto the force plates, cross their arms over their chest so that their fingers are nearly touching the top of their shoulders. They will spread their legs so that their feet are about shoulder width apart. They will then fix their eyes on a particular point in front of them and do their best to remain still for 20 seconds.

There will be two force plates set side by side, and the participant will be asked to place one foot on each of the plates. When using a foam pad, the pad spanning the length of both force plates will be set atop the plates. And the participant will step on top of the pad, making sure to keep a foot on either side so that there is only ever one foot per plate.

**4 of the 6 tasks fall under quiet stand balance:** Quiet stand with eyes open, quiet stand with eyes closed, quiet stand with a foam pad and eyes open, quiet stand with a foam pad and eyes closed.

**Tandem stand:** the participant will be asked to indicate which foot is their dominant foot. If they do not know, the researcher will perform a test to determine which foot that is.

SCREEN RECORDER



## JOIN US TO HELP IMPROVE REMOTE HEALTH ASSESSMENT

Help us validate Kinetisense markerless motion capture software against the gold standard in balance assessment.

**ELIGIBILITY: SEEKING ABLE-BODIED PARTICIPANTS 18 AND ABOVE IN EDMONTON, ALBERTA, WITH NO MEDICAL CONDITIONS AFFECTING YOUR BALANCE.**



### WHAT PARTICIPATION INVOLVES

Participate in a test involving 6 different balance tasks using force plates and 3d camera at the rehabilitation robotics lab in ECHA. It is a one time commitment that will take 30 minutes to complete

### Interested in Making a Difference?



- For more information or to join the study, please contact us at [yawa@ualberta.ca](mailto:yawa@ualberta.ca)
- Participation is voluntary, and your privacy will be rigorously protected.
- Principal Investigator: Dr. Martin Ferguson-Pell
- University of Alberta Ethics ID:Pro00155877



**UNIVERSITY  
OF ALBERTA**

VERSION DATE:  
JULY 18, 2025



2-545 Edmonton Clinic Health Academy, 11405 87 Avenue

Edmonton, Alberta, Canada T6G 1C9

#### PARTICIPANT CONSENT FORM

**Study Title:** Validation of the Kinetisense 3D markerless motion capture system against the VALD force plates.

#### Contact Information

**Principal Investigator:** Martin Ferguson-Pell, Ph.D. [fe4@ualberta.ca](mailto:fe4@ualberta.ca) (780) 492-1858

**Project Manager:** Emily Armstrong, BSc. [earmstr@ualberta.ca](mailto:earmstr@ualberta.ca) (780) 492-1858

**Project Coordinator:** Gloria Sanouvi-awoga [yawa@ualberta.ca](mailto:yawa@ualberta.ca)

You are being asked to take part in a research study. Before you take part, a member of the study team is available to explain the project and you are free to ask questions about anything you do not understand. You will be given a copy of this form for your records.

#### Why am I being asked to take part in this research study?

You are invited to join this study because you are able-bodied and over 18 years old and do not have any medical condition affecting your balance. We want to compare data from a plate that measures sway through weight to a 3D app that measures human movement.

#### What is the reason for doing this study?

It is important to develop tools that can measure how people balance. The current technology is heavy, expensive and often found in urban settings rather than rural ones. The technology we're validating can be used to assess people accurately in remote settings. To do this, you will complete balance tasks using both the gold standard force plates and the Kinetisense software. Your video recordings and force data will help us to confirm this new technology is accurate. The new system only needs a phone or iPad camera, making it practical and affordable for rural

Ethics ID: Pro00155877

Version Date: July 18, 2025

#### SIGNATURE OF STUDY PARTICIPANT

Name of Participant \_\_\_\_\_ Pseudonym (if necessary) \_\_\_\_\_

Signature of Participant \_\_\_\_\_ Date \_\_\_\_\_

#### SIGNATURE OF PERSON OBTAINING CONSENT

Name of Person Obtaining Consent \_\_\_\_\_ Contact Number \_\_\_\_\_

#### SIGNATURE OF THE WITNESS

Name of Witness \_\_\_\_\_ Signature of Witness \_\_\_\_\_ Date \_\_\_\_\_

A copy of this consent form has been given to you to keep for your records and reference.

Ethics ID: Pro00155877

Version Date: July 18, 2025

# Title Coding

ID	01 to 15
Fdecks	0
Kine	1
Foam+open	01
Foam+closed	02
Eyes open	03
Eyes closed	04
Tandem open	05
Tandem closed	06
test case	01; 02; 03;

ID-Software-Task-Case-Trial

EX:

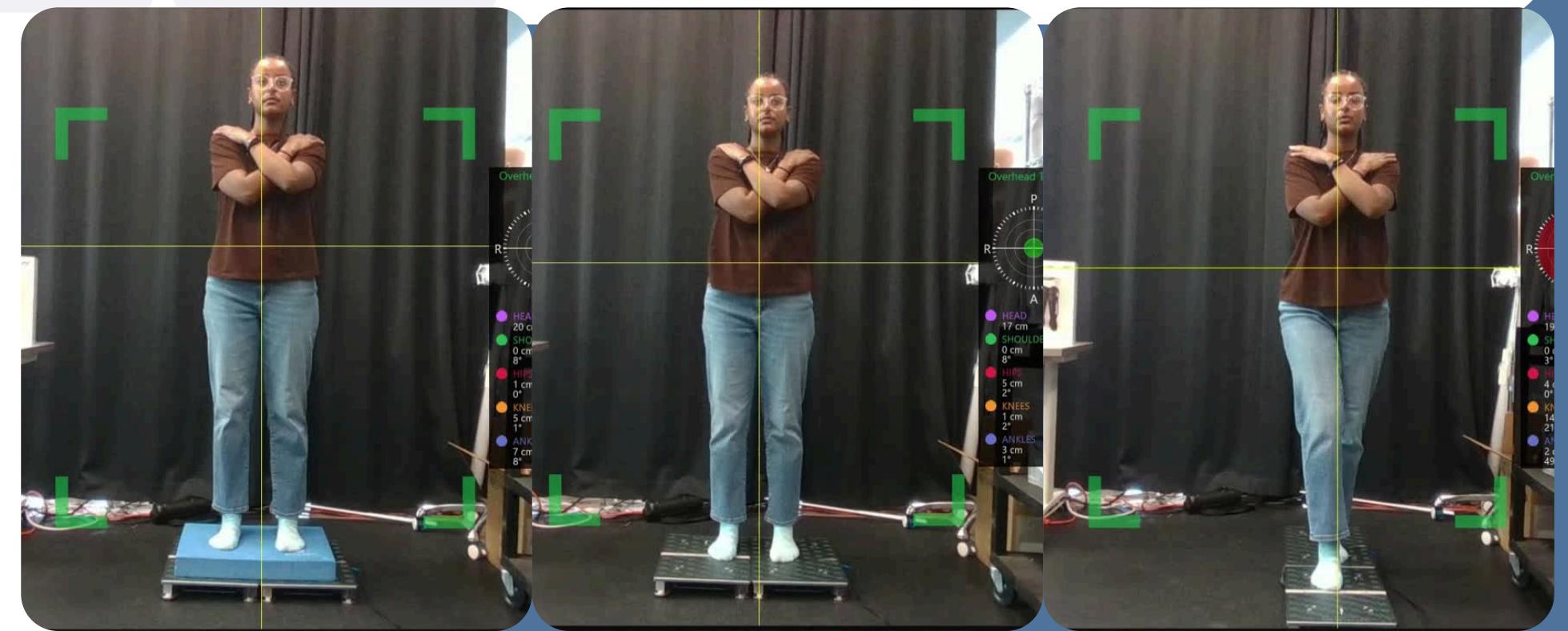
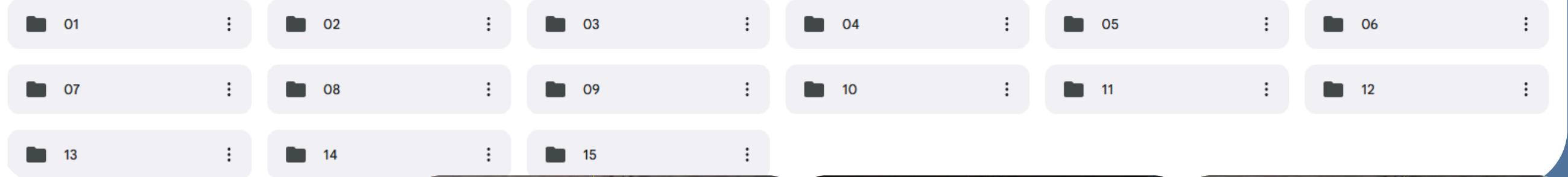
Participant 02-Kinetisense-Tandem closed-Case 01-Trial 16

- 02-1-06-01-16

... > Force Plates (2025) > Data Collection ▾

Type ▾ People ▾ Modified ▾ Source ▾

Folders



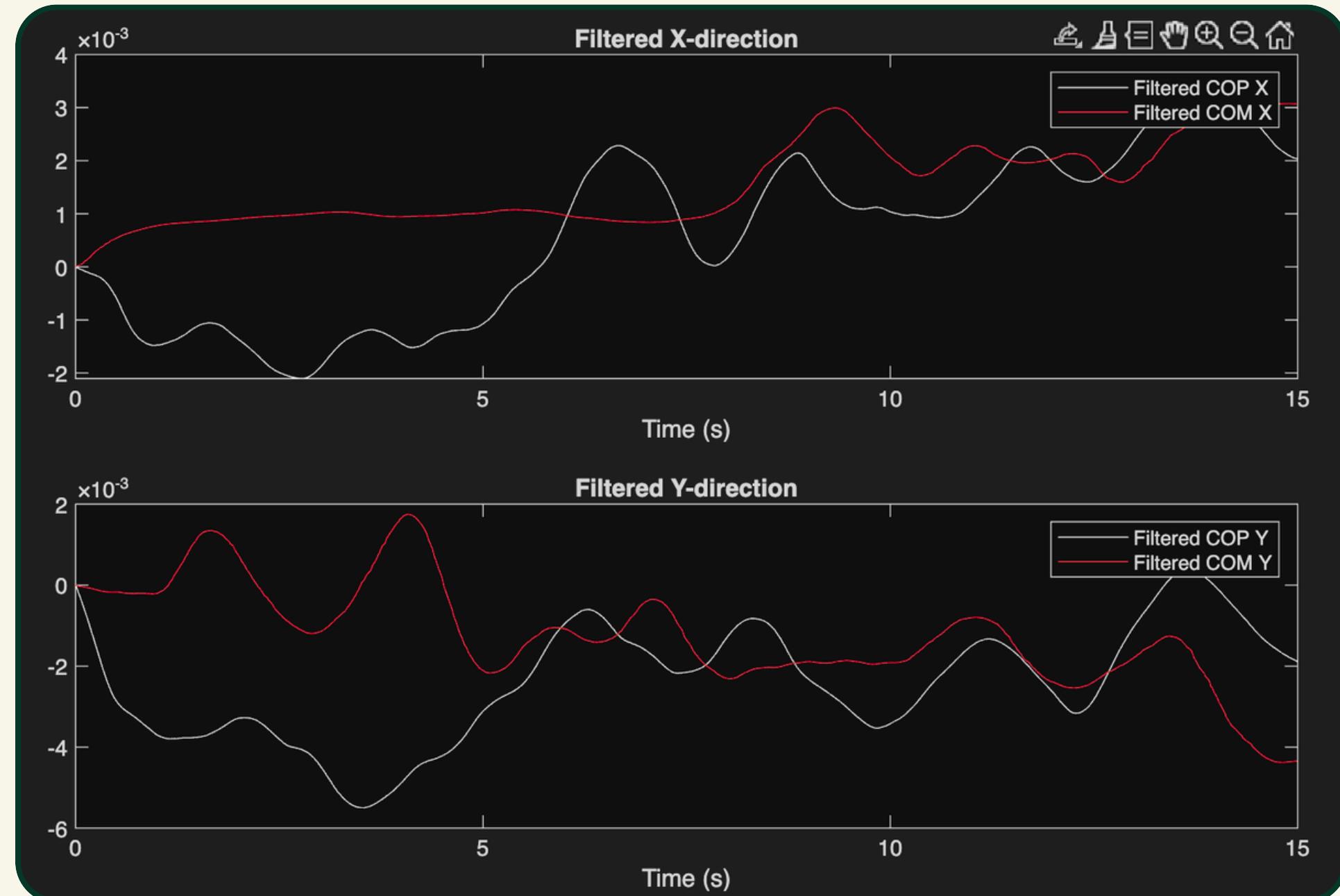
FOAM QUIET STAND

QUIET STAND

TANDEM STAND

# ANALYSIS

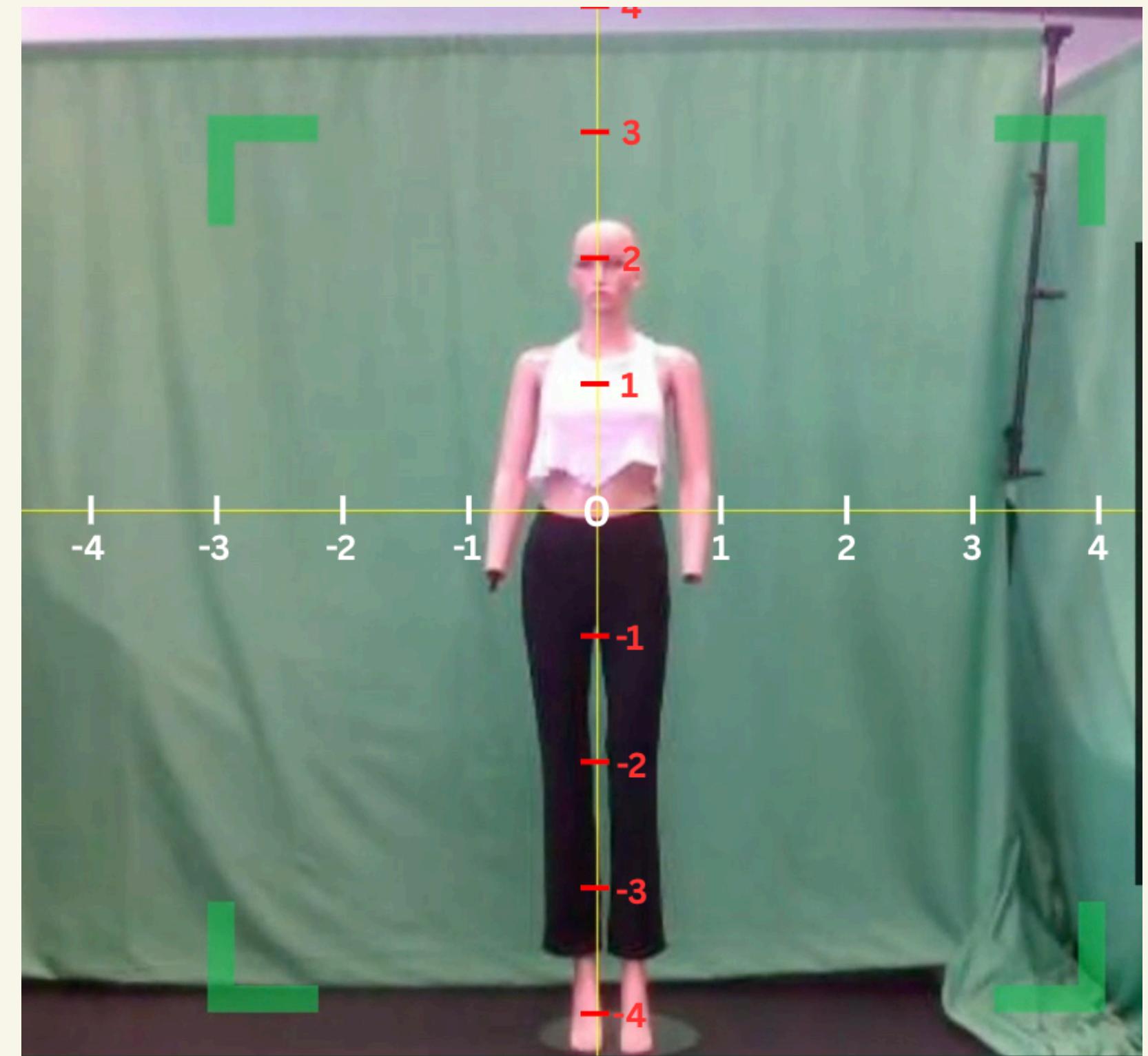
- 20-SECOND TESTS SIMULTENOUSLY.
- PYTHON AUTOCOMMANDER REDUCES TIME DELAY.
- ASSUMED THIS WOULD ALIGN THE DATA FOR TIME SERIES ANALYSIS.
- HOWEVER, INITIAL CORRELATION ANALYSIS SHOWED POOR ALIGNMENT AND LOW CORRELATION. WHY?



# KINETISENSE

## UNDERSTANDING KINETISENSE

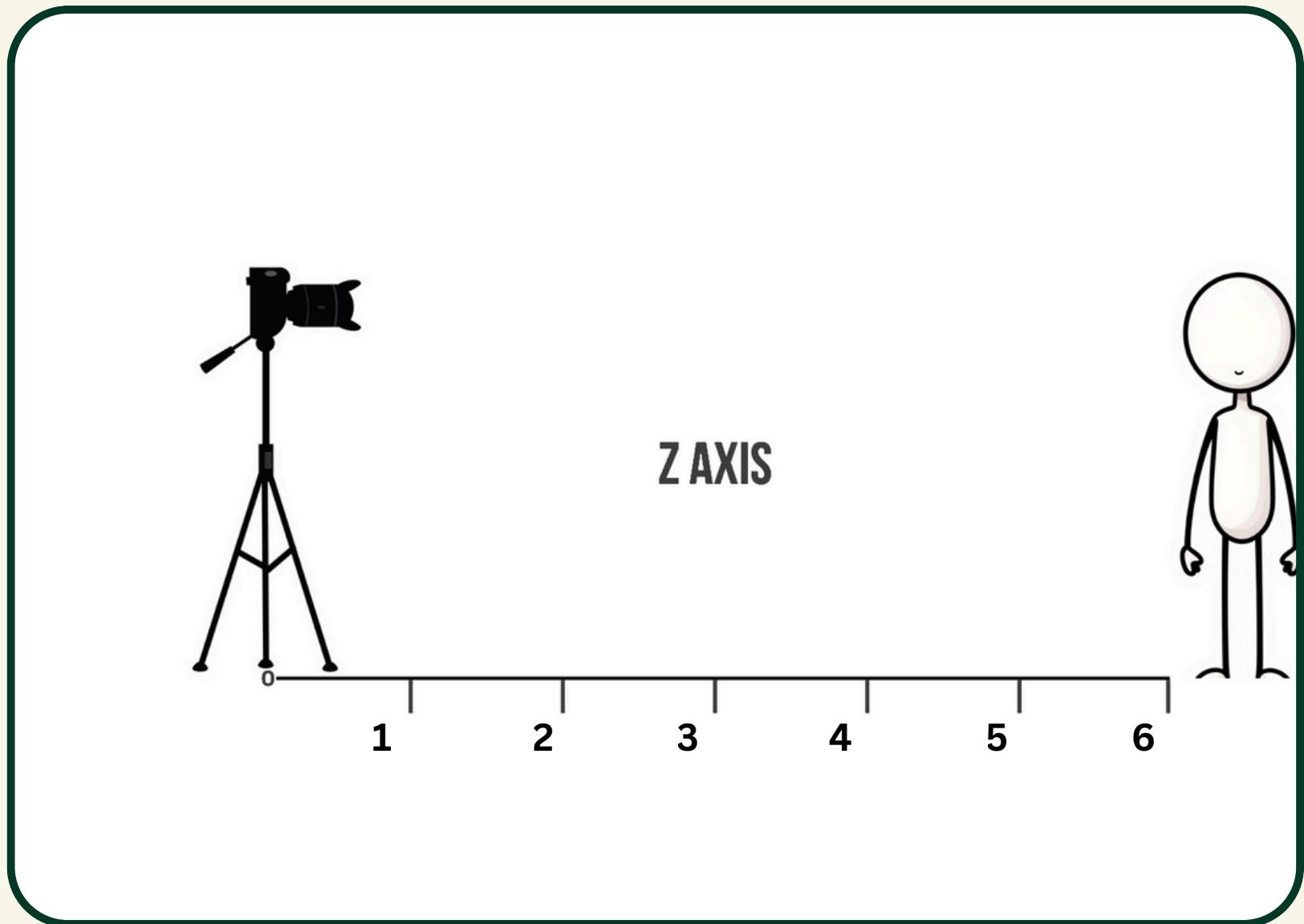
- LEARNED HOW ANATOMICAL PLANES AFFECT READINGS.
- EXPLORED HOW THE SYSTEM CAPTURES, STORES, AND STRUCTURES DATA.
- USED THIS KNOWLEDGE TO IMPROVE MEASUREMENT PRECISION.



# KINETISENSE

## ANATOMICAL PLANES & ORIENTATION

- KINETISENSE USES ANATOMICAL PLANES AS POINTS OF ORIGIN OF AXES .
- THE SAGITTAL PLANE IS THE X-AXIS ORIGIN FOR EACH BODY SEGMENT.
- THE TRANSVERSE PLANE SETS THE Y-AXIS ORIGIN FOR THE ENTIRE BODY LENGTH.
- HOWEVER, FOR THE Z AXIS THE CAMERA IS THE POINT OF ORIGIN.
- Z VALUES INCREASES AS A PERSON MOVES AWAY FROM THE CAMERA.



## WHAT WE OBSERVED

- FORCEDECKS RECORDED ~23 SECONDS → INCLUDES A 3-SECOND COUNTDOWN.
- KINETISENSE RECORDS AT A MAXIMUM OF 60 Hz.
- FORCEDECKS RECORDS AT A MINIMUM OF 100 Hz.
- THIS MEANS FORCEDECKS HAS MORE DATA POINTS OVER THE SAME DURATION.
- THE LAST ~3 SECONDS OF KINETISENSE DATA WAS REPEATED.

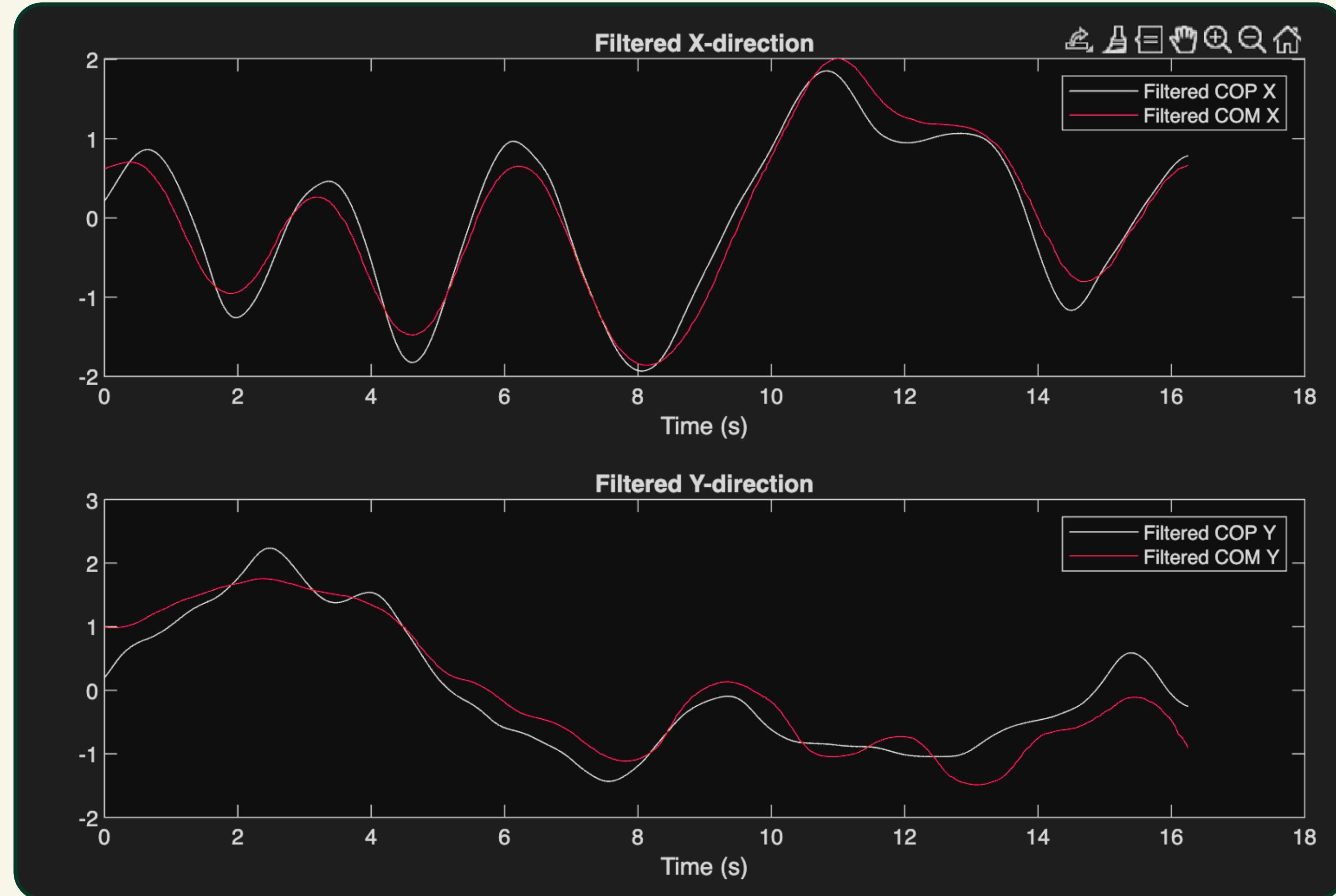
# STATIC FRAMES

669.9126	2.8164	-0.1169	-0.8479	3.0420	0.0917	-0.8599	2.9686	0.0000	-4.19	137,656,545.0000
670.9132	2.8194	-0.1171	-0.8478	3.0451	0.0922	-0.8604	2.9709	0.0000	4.09	137,656,588.0000
671.9142	2.8207	-0.1171	-0.8479	3.0454	0.0922	-0.8609	2.9752	0.0000	4.02	137,656,612.0000
672.9140	2.8218	-0.1171	-0.8478	3.0464	0.0922	-0.8607	2.9755	0.0000	4.46	137,656,629.0000
673.9143	2.8216	-0.1167	-0.8478	3.0424	0.0919	-0.8607	2.9753	0.0000	6.22	137,656,680.0000
674.9145	2.8219	-0.1169	-0.8478	3.0423	0.0921	-0.8606	2.9755	0.0000	6.80	137,656,705.0000
675.9145	2.8224	-0.1171	-0.8476	3.0406	0.0922	-0.8607	2.9759	0.0000	6.33	137,656,734.0000
676.9146	2.8222	-0.1167	-0.8476	3.0400	0.0922	-0.8606	2.9754	0.0000	6.39	137,656,764.0000
677.9142	2.8214	-0.1167	-0.8471	3.0401	0.0926	-0.8605	2.9748	0.0000	6.11	137,656,790.0000
678.9142	2.8214	-0.1167	-0.8471	3.0401	0.0926	-0.8605	2.9748	0.0000	6.11	137,656,815.0000
679.9142	2.8214	-0.1167	-0.8471	3.0401	0.0926	-0.8605	2.9748	0.0000	6.11	137,656,848.0000
680.9142	2.8214	-0.1167	-0.8471	3.0401	0.0926	-0.8605	2.9748	0.0000	6.11	137,656,874.0000
681.9142	2.8214	-0.1167	-0.8471	3.0401	0.0926	-0.8605	2.9748	0.0000	6.11	137,656,898.0000
682.9142	2.8214	-0.1167	-0.8471	3.0401	0.0926	-0.8605	2.9748	0.0000	6.11	137,656,915.0000
683.9142	2.8214	-0.1167	-0.8471	3.0401	0.0926	-0.8605	2.9748	0.0000	6.11	137,656,942.0000
684.9142	2.8214	-0.1167	-0.8471	3.0401	0.0926	-0.8605	2.9748	0.0000	6.11	137,656,991.0000
685.9142	2.8214	-0.1167	-0.8471	3.0401	0.0926	-0.8605	2.9748	0.0000	6.11	137,657,042.0000
686.9142	2.8214	-0.1167	-0.8471	3.0401	0.0926	-0.8605	2.9748	0.0000	6.11	137,657,066.0000
687.9142	2.8214	-0.1167	-0.8471	3.0401	0.0926	-0.8605	2.9748	0.0000	6.11	137,657,083.0000
688.9142	2.8214	-0.1167	-0.8471	3.0401	0.0926	-0.8605	2.9748	0.0000	6.11	137,657,125.0000
689.9142	2.8214	-0.1167	-0.8471	3.0401	0.0926	-0.8605	2.9748	0.0000	6.11	137,657,150.0000
690.9142	2.8214	-0.1167	-0.8471	3.0401	0.0926	-0.8605	2.9748	0.0000	6.11	137,657,167.0000

# **FIXES IMPLEMENTED**

- TRIMMED FORCEDECKS DATA TO REMOVE COUNTDOWN PERIOD.**
- CROPPED KINETISENSE AND FORCEDECKS TO EXCLUDE REPEATED DATA (E.G., 0S–16.5S).**
- INTERPOLATED COM DATA TO MATCH COP SAMPLING FREQUENCY.**
- CLEANED AND ALIGNED TIMESTAMPS FOR SYNCHRONIZED CORRELATION.**

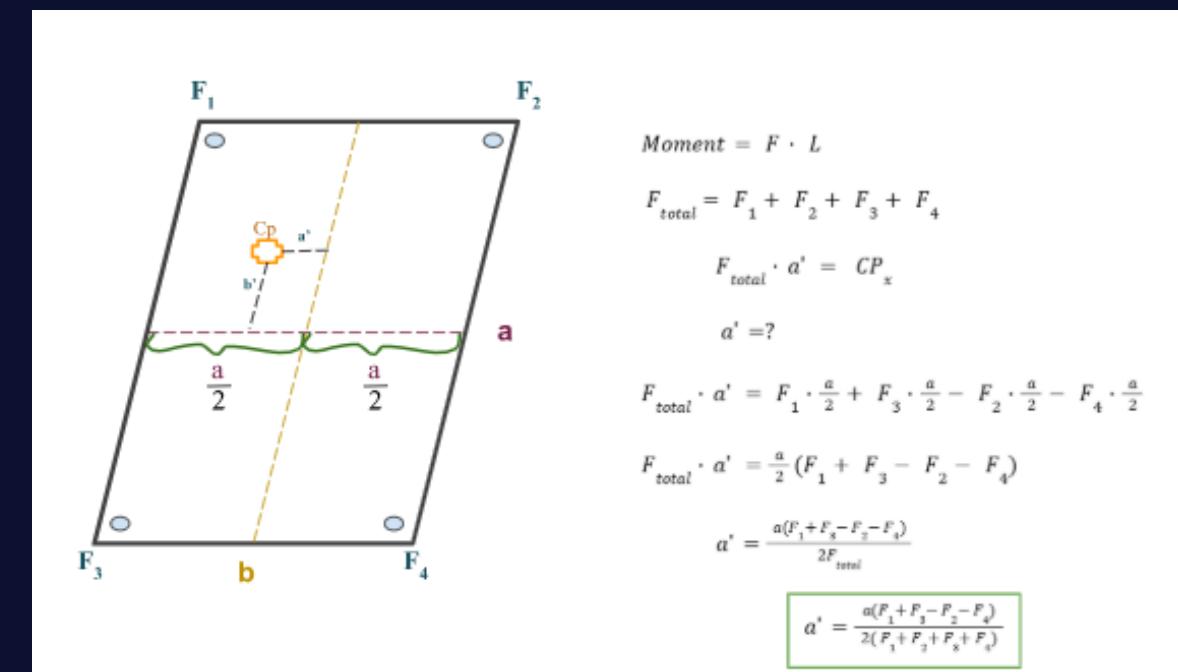
# RESULTS



# NEXT STEPS



COMPLETE ANALYSIS



REPORT WRITE-UP  
AND  
POLISH



VALIDATION COMPLETE!

# ACKNOWLEDGMENTS



Sponsors and Supporters

Principal Investigator

Lab Coordinator

The team



THANK YOU