

# *We are not Walking, We are Rolling*

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— In collaboration with —



Jean-Paul  
Laumond

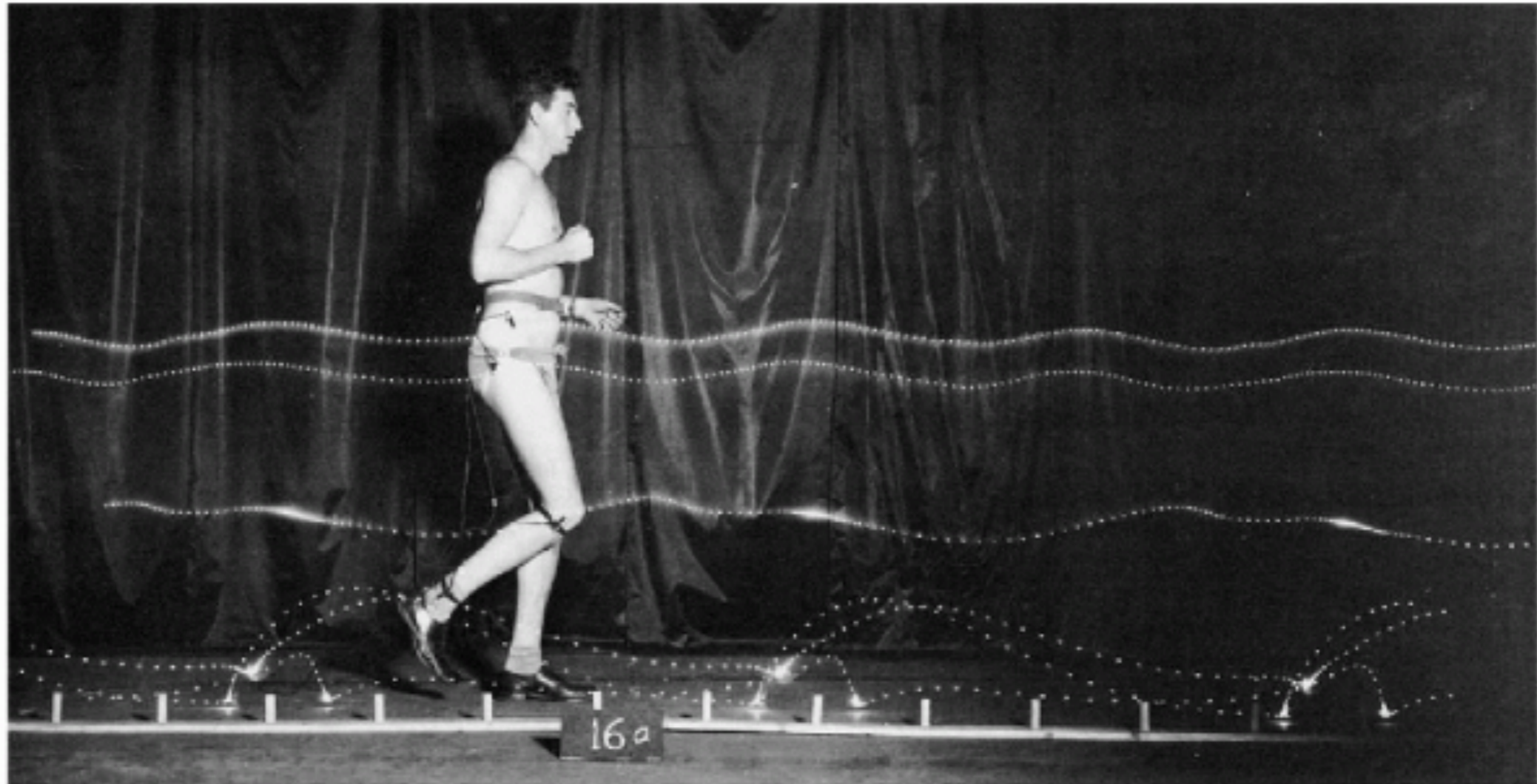


Mehdi  
Benallegue

# *What is Walking?*



# — The walking gait —

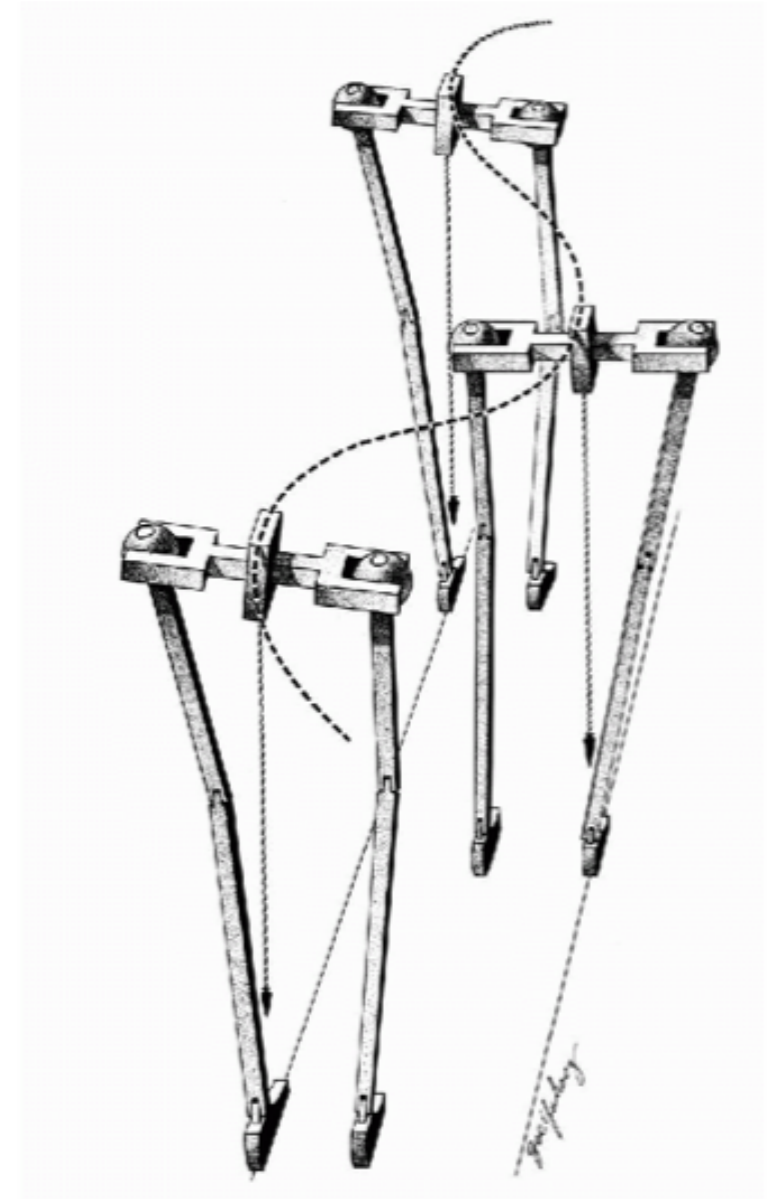


Walking is the fact to put one feet **ahead of** the other, with a succession of **single** and double **support** phases, ...

# — The six major determinants of gait —

The six determinants of gait (Saunders, 1953) try to explain the shape of the **centre of gravity** trajectory:

1. pelvic rotation
2. pelvic tilting
3. knee flexion in stance phase
4. foot mechanism
5. ankle mechanism
6. lateral displacement of the pelvis

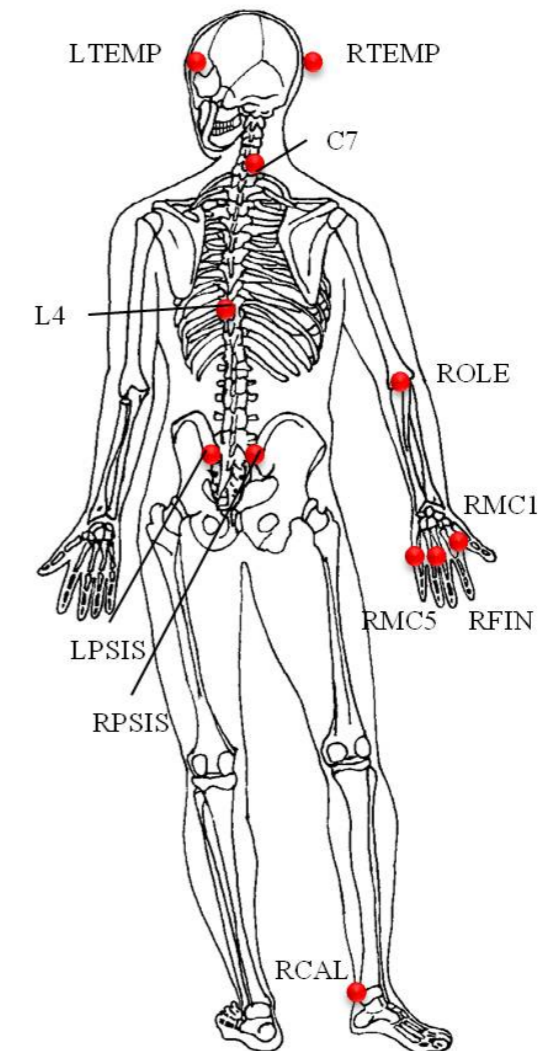
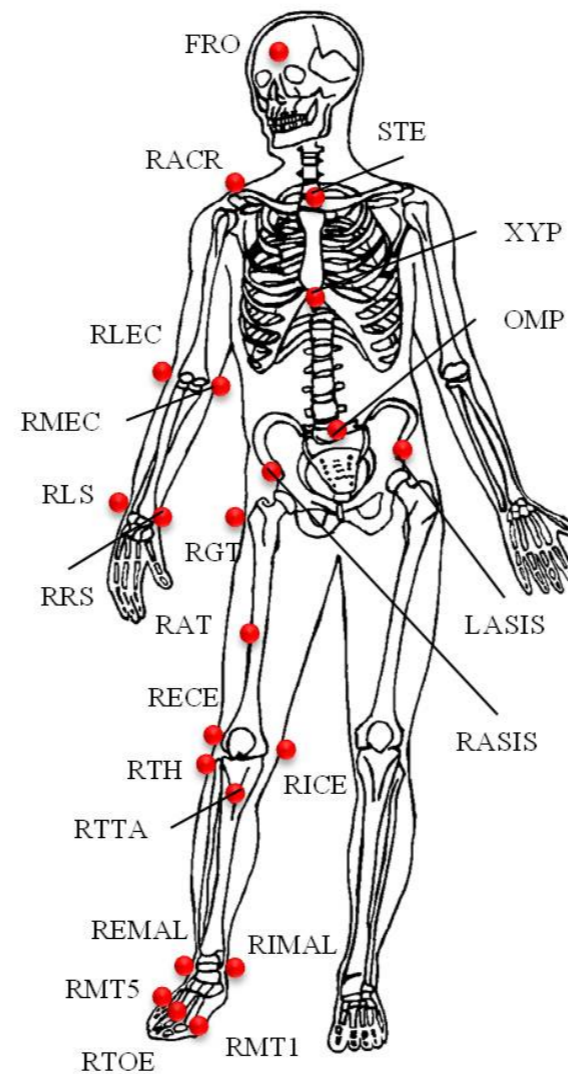
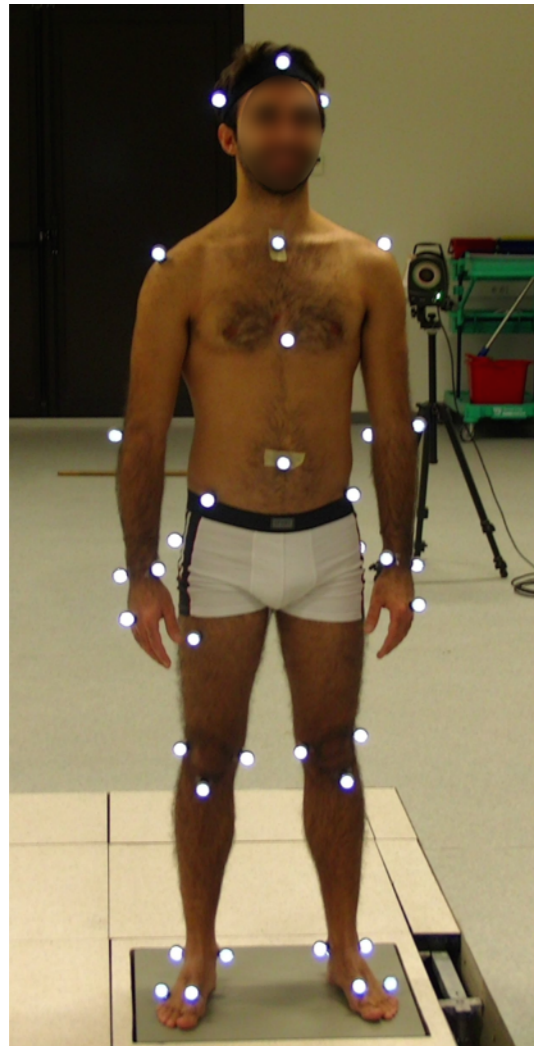


# *Experimental Setup*

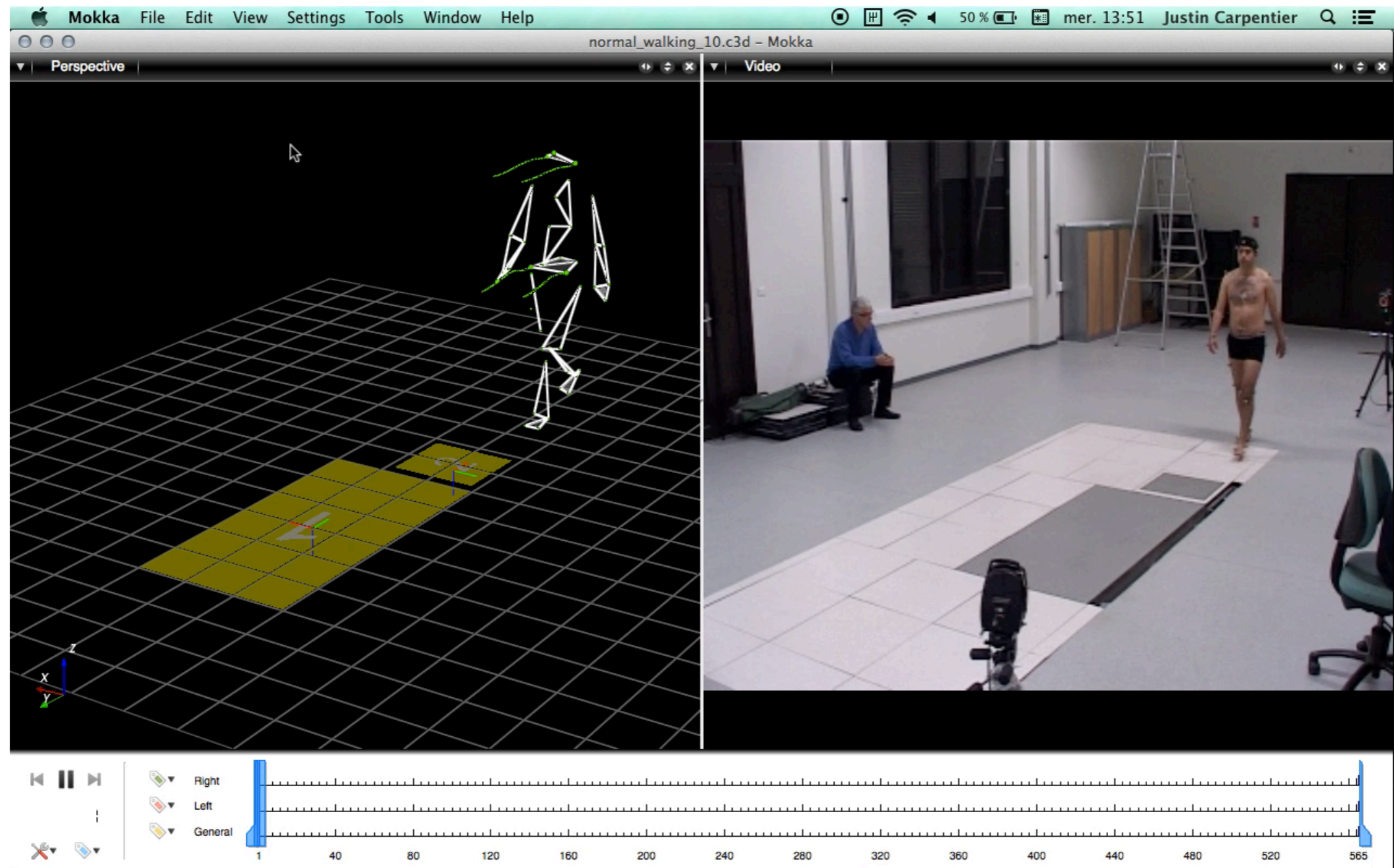




# — Marker placements —



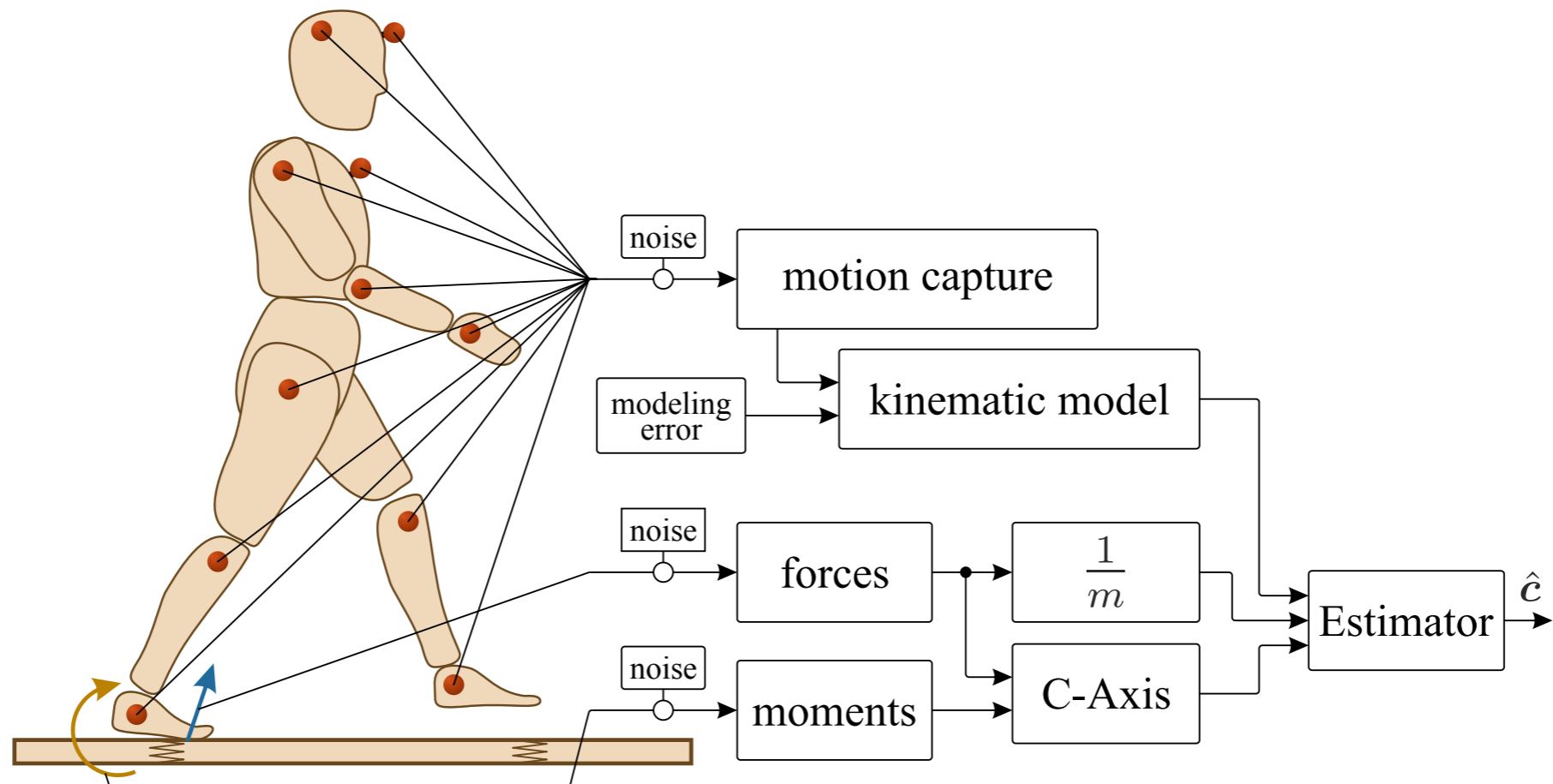
# — Motion Capture recording —





# *Reconstruction of the Centre of Mass trajectory*

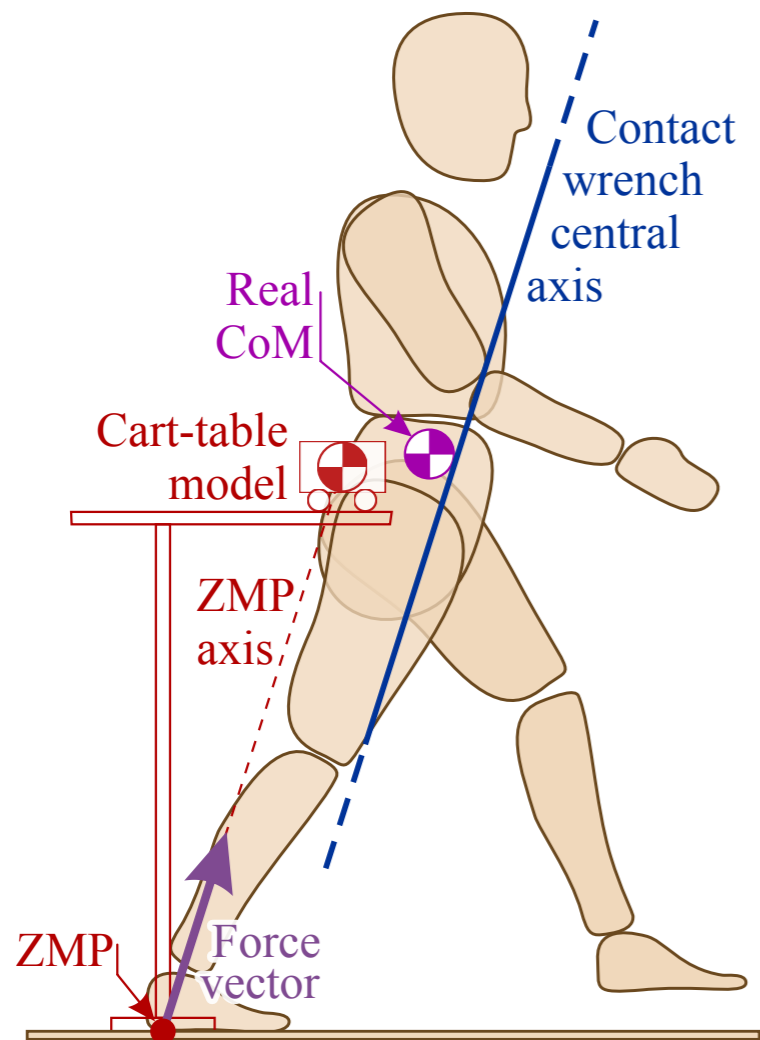
# — The general idea —



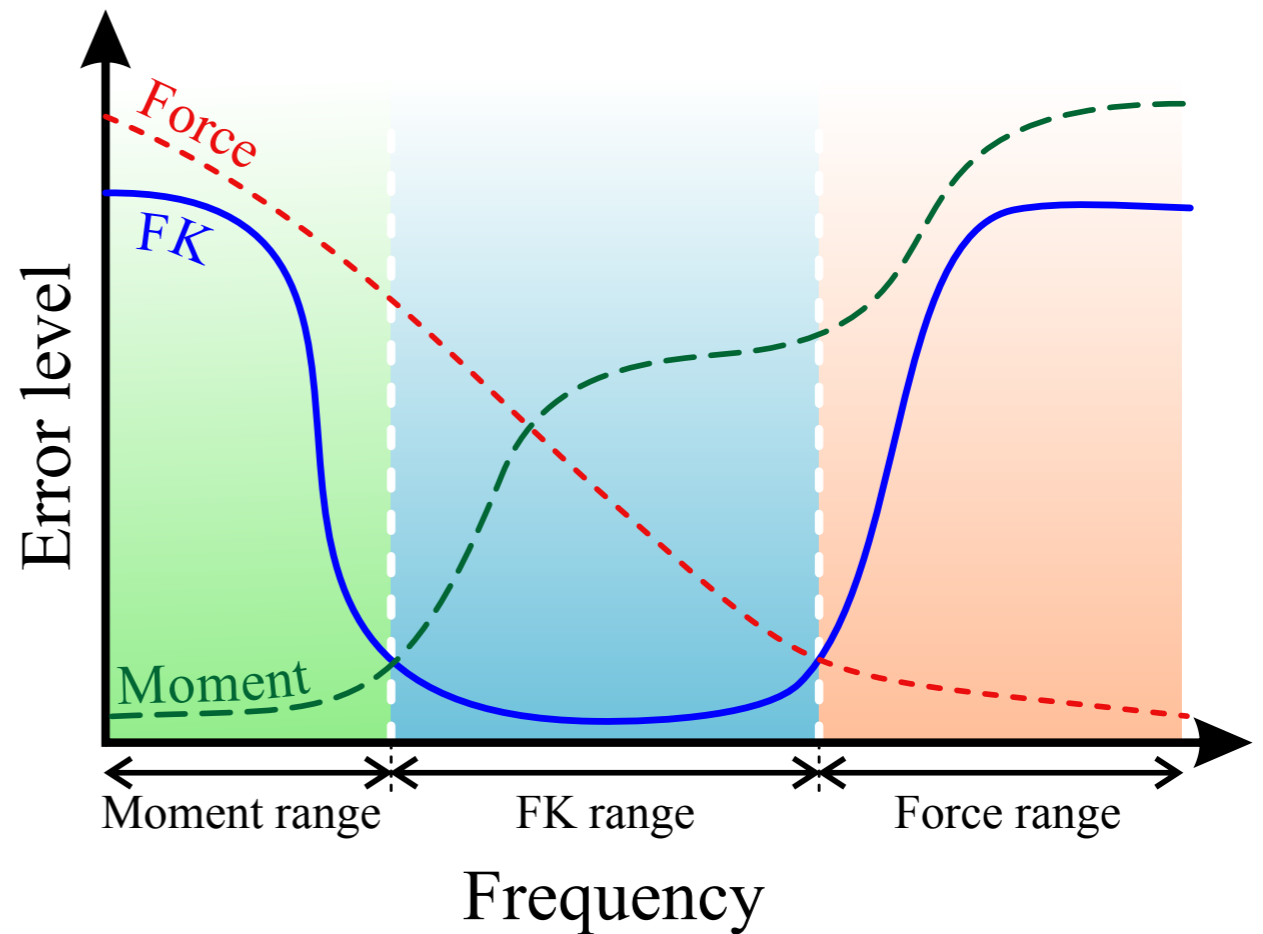
*Center of Mass Estimation for Polyarticulated System in Contact - A Spectral Approach*, Carpentier et al., to appear in IEEE Transactions on Robotics.

<https://hal.archives-ouvertes.fr/hal-01182734>

# — The general idea —

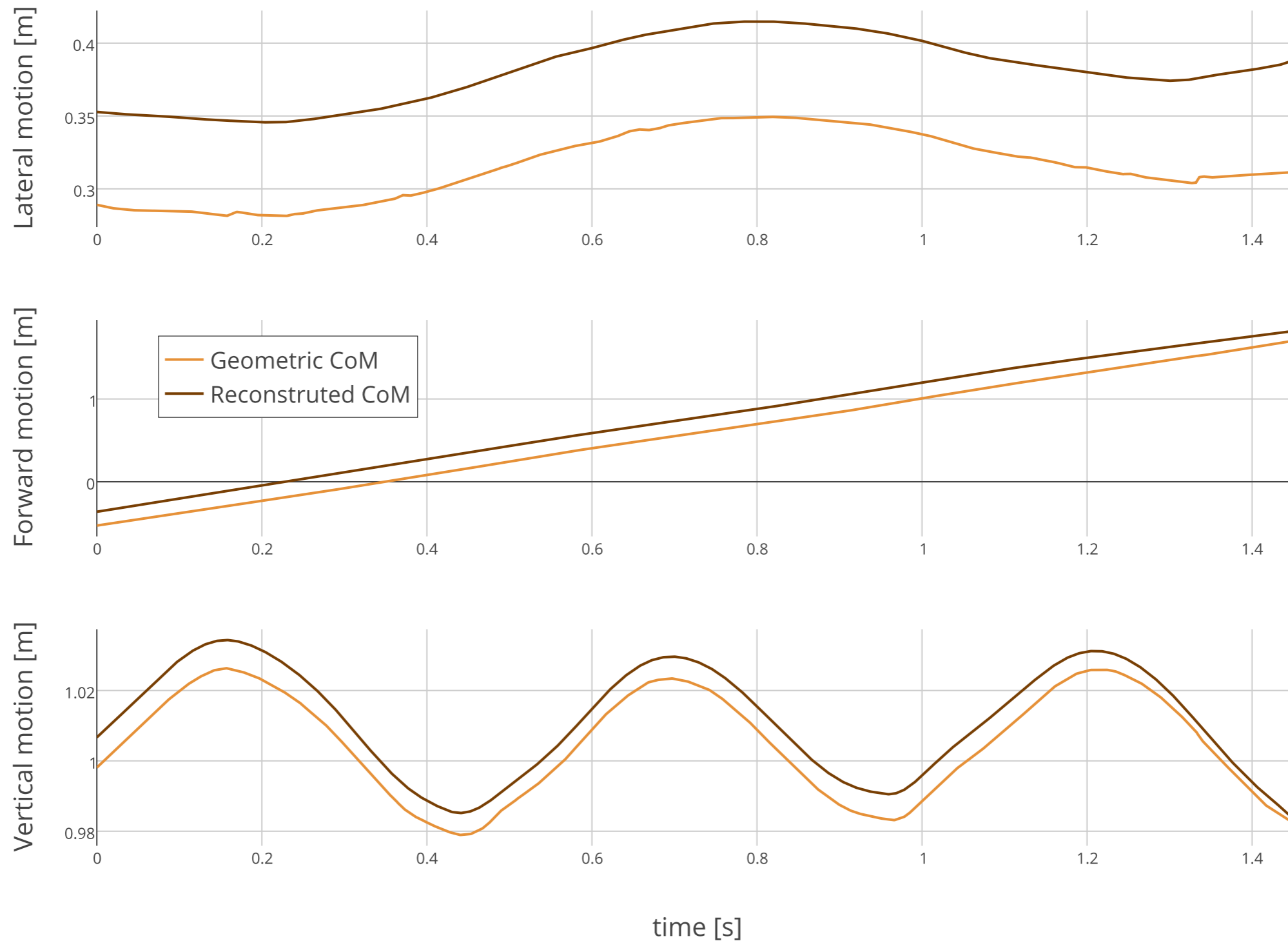


Projection of the CoM  
on the Central Axis of  
contact wrench



Error level on the different bandwidths

# — The reconstructed trajectory —

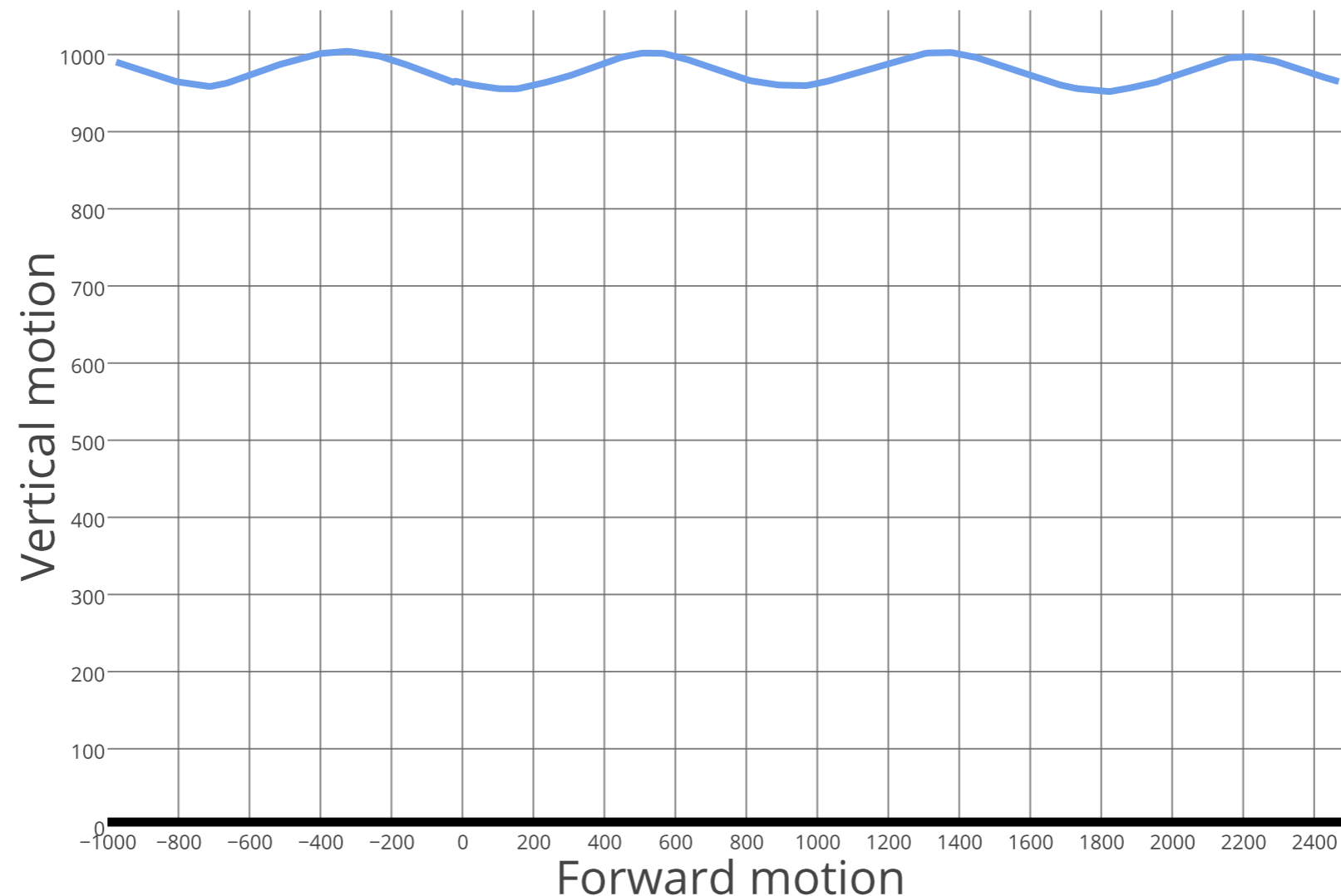




# *The Geometric Nature of the Centre of Mass trajectory*

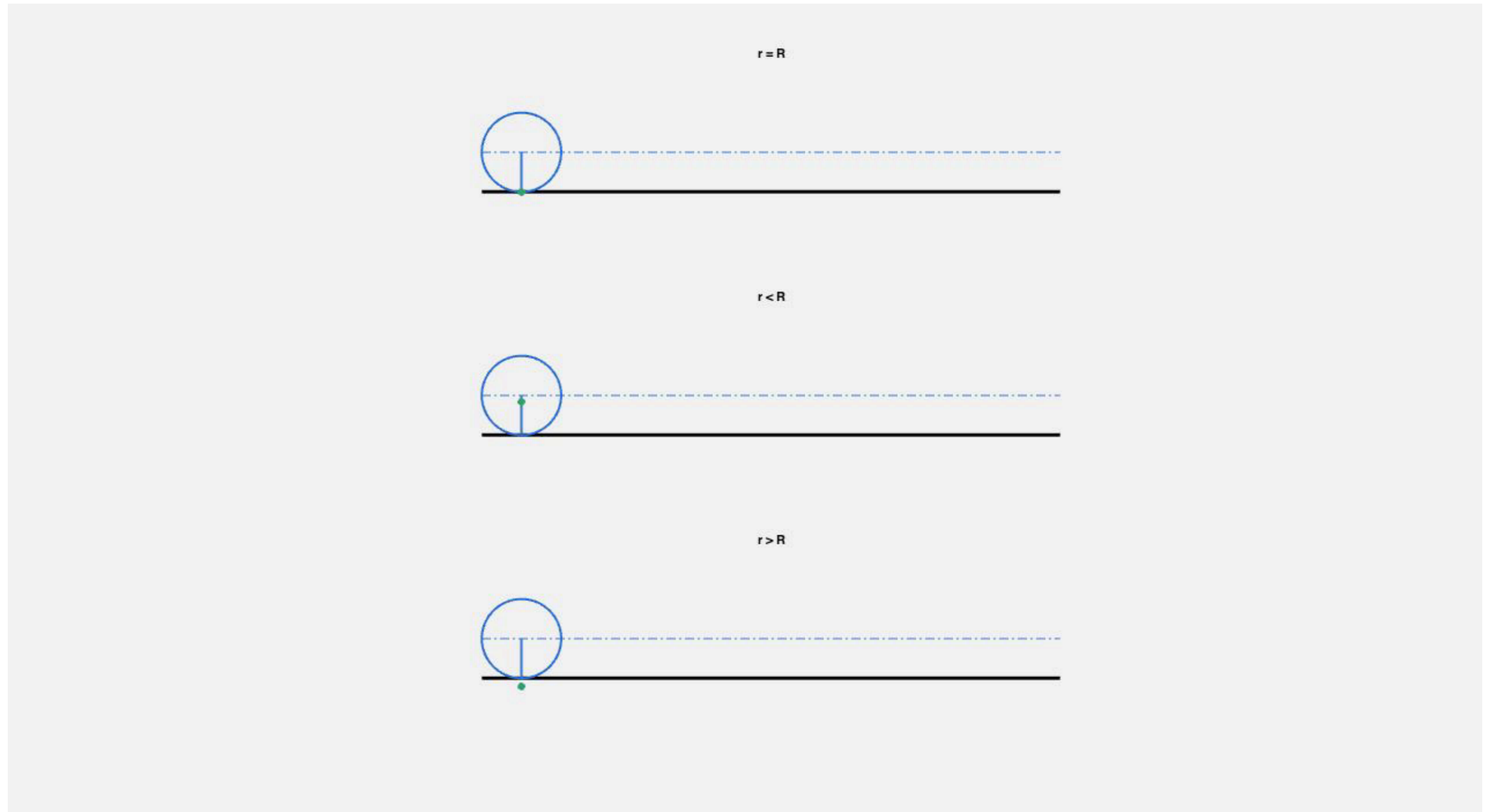


# — Centre of Mass trajectory —



The CoM trajectory follows a **cycloidal** pattern.

# — What is a cycloid? —



## — What is a cycloid? —

The geometric formula of a cycloid:

$$y(\theta) = R\theta - r \sin(\theta + \phi)$$

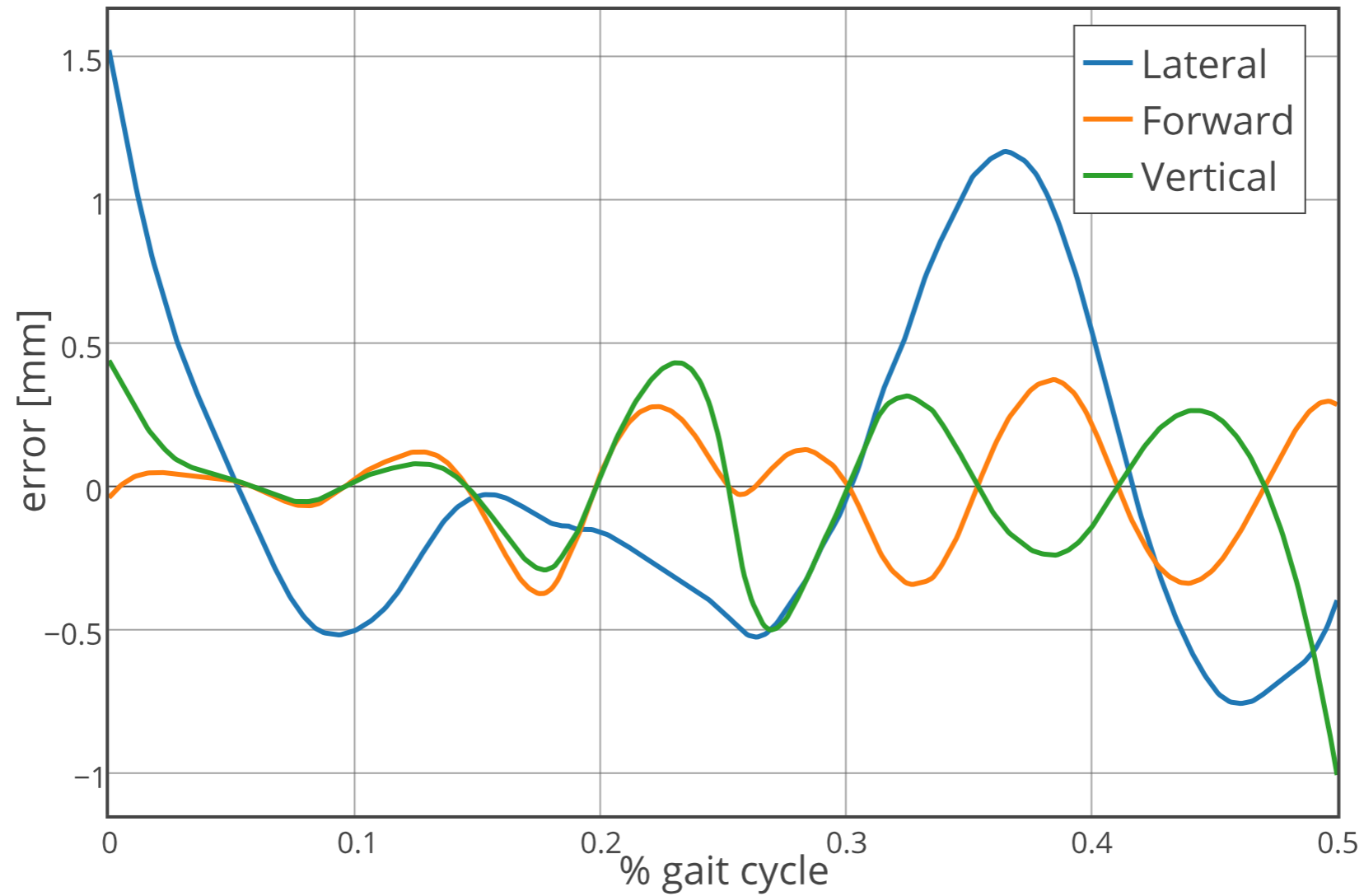
$$z(\theta) = z_0 - r \cos(\theta + \phi)$$

With a linear dependency with time:

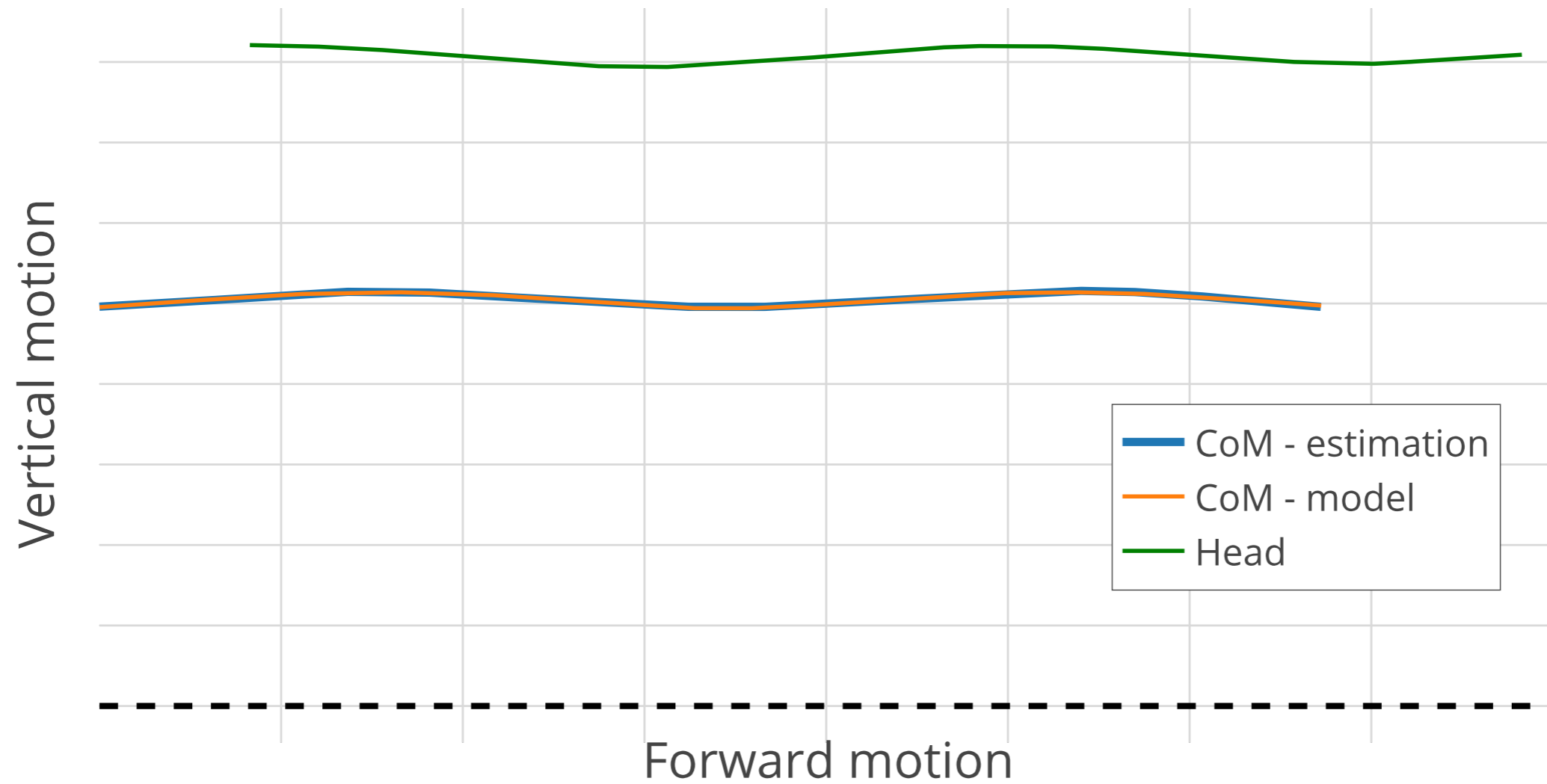
$$\theta(t) = \theta_0 + \omega_1 t$$



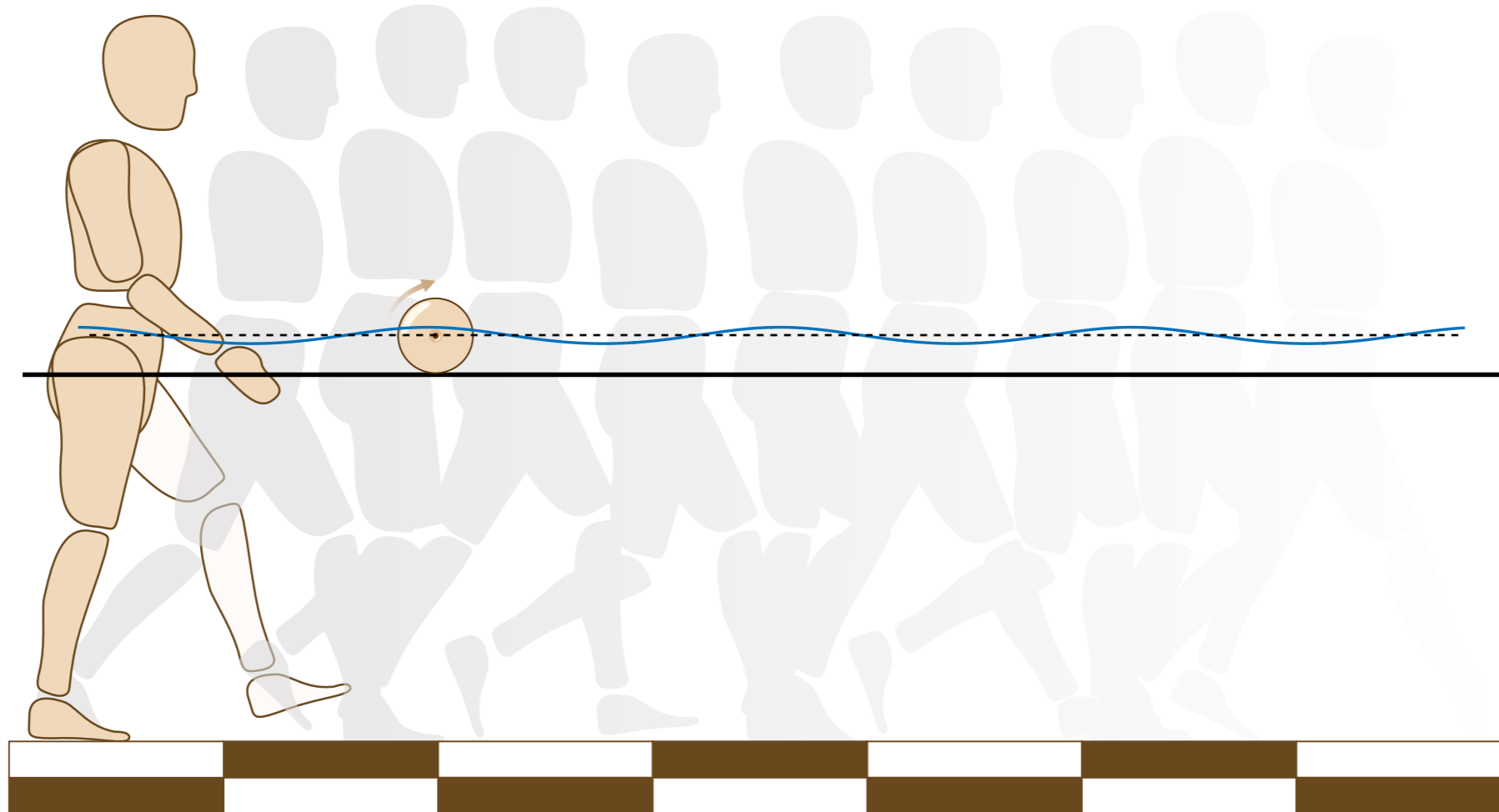
# — Fitting results —



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# — The Yoyo-Man —



*The Yoyo-Man*, Laumond et al., in International Symposium on Robotics Research, Sept 2015, Sestri Levante, Italy.

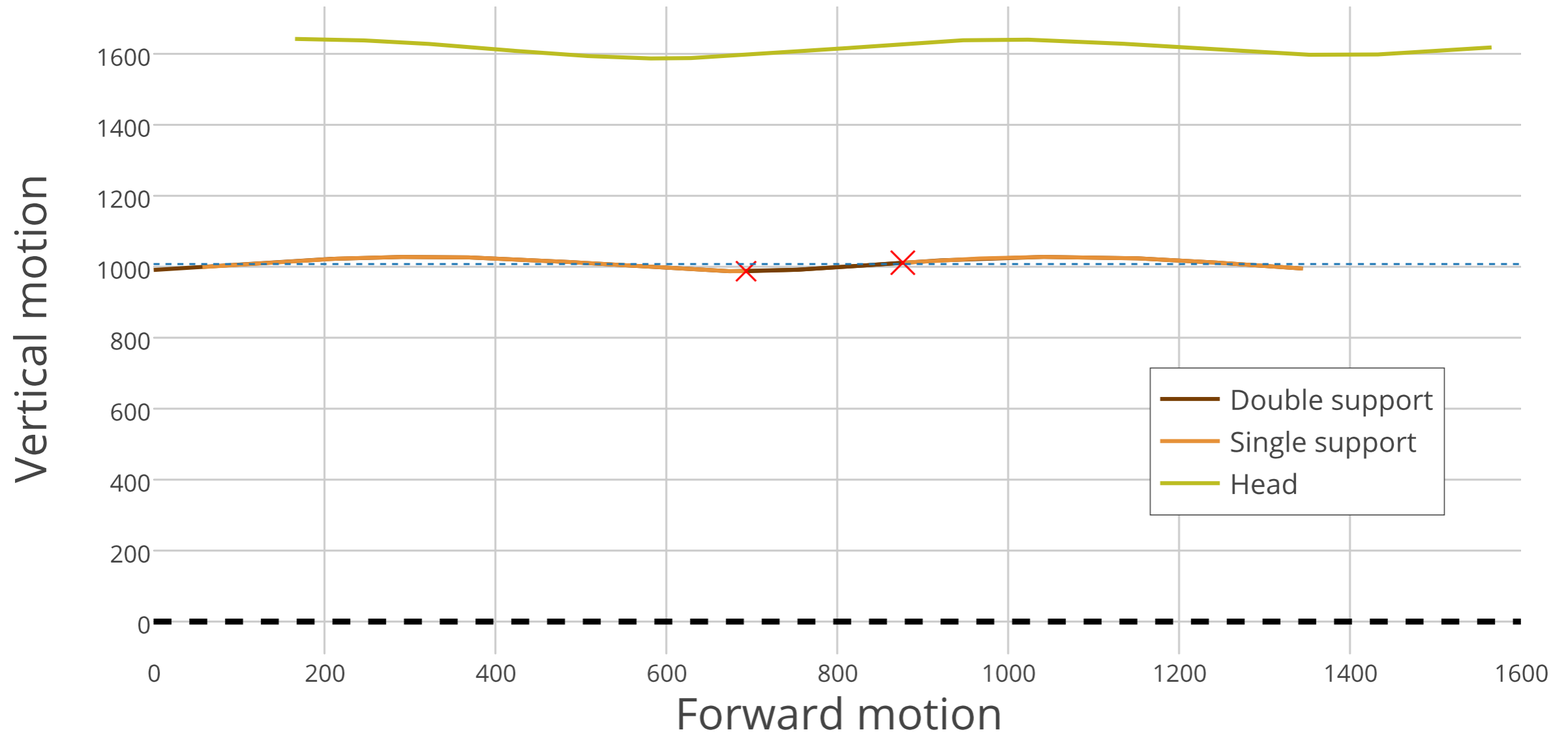
<https://hal.archives-ouvertes.fr/hal-01175591>

***Where is the segmentation?***

***Does this Geometry encompass the natural  
segmentation?***



# — The segmentation is hidden in the model —



The **segmentation of trajectories** does not necessarily imply **segmented control**.

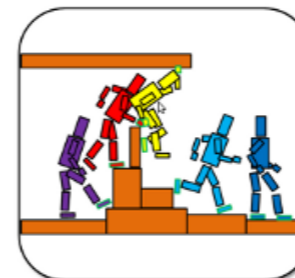
# — Acknowledgment —



Koroibot



Actanthrope



ANR Entracte