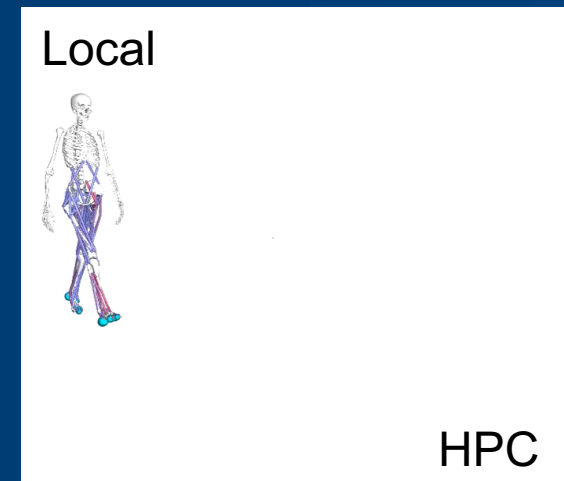


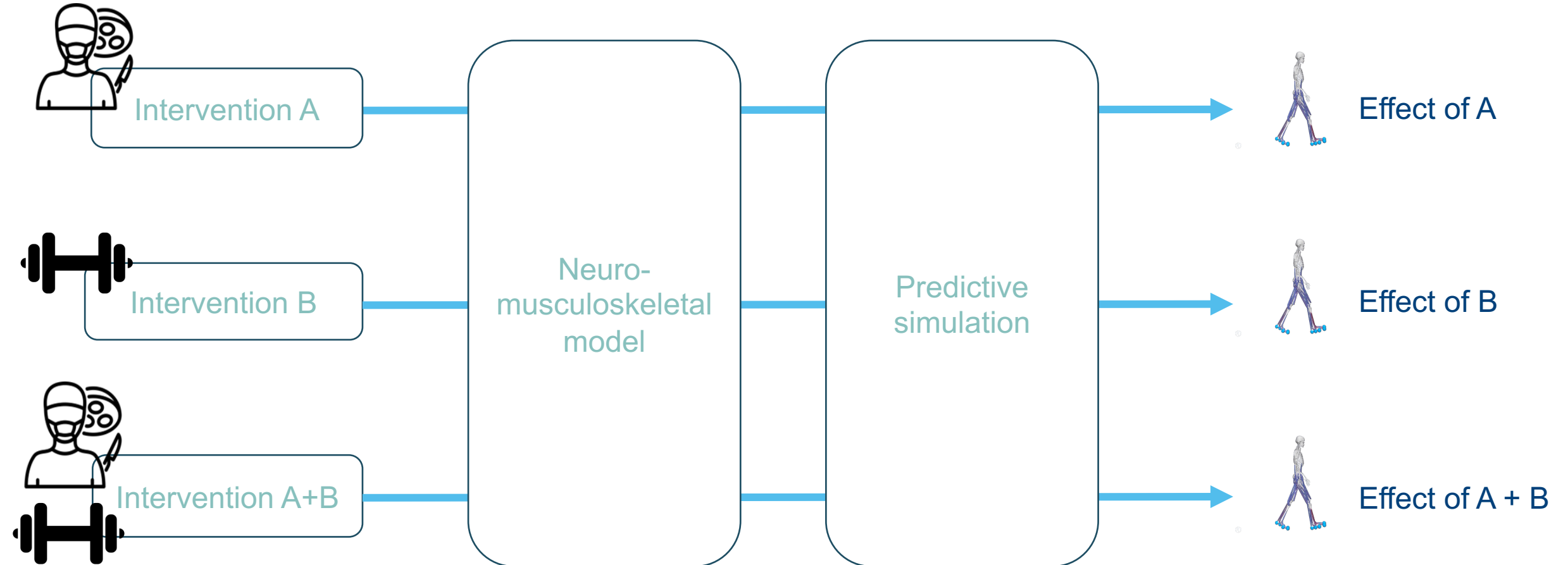
# Physics-based simulations of locomotion

## *Our transition to HPC*

B. Van Den Bosch, PhD student  
Neuromechanics Lab, Department of Movement Sciences



# Our dream: personalized computational models to predict intervention effects on movement

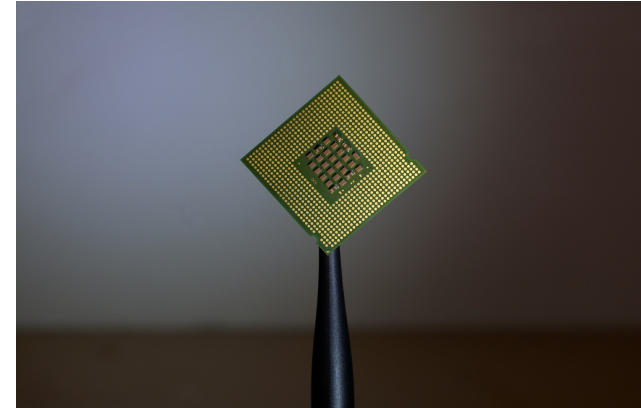


# We aim at developing predictive simulations of motion for personalized optimization of human movement

- Model-based optimal treatment or training design is challenging due to

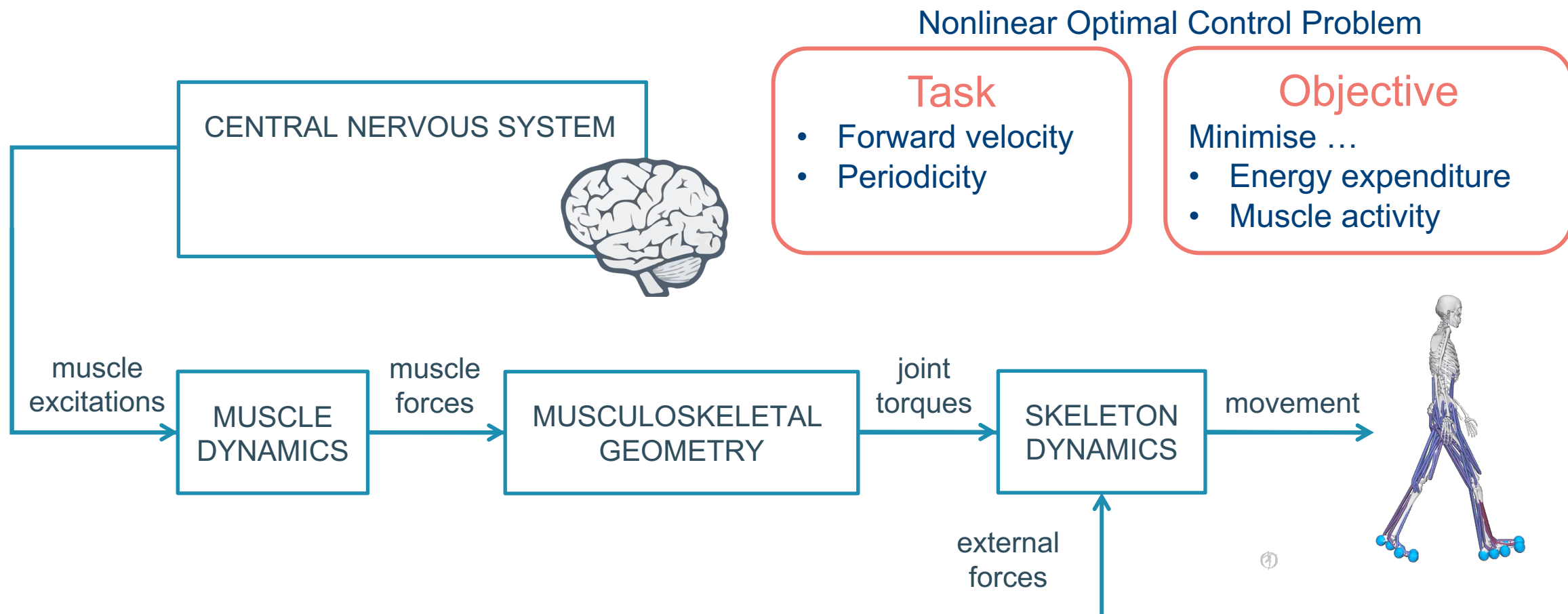


the difficulty to capture the complexity and inter-subject variability of the neuromusculoskeletal system in a model

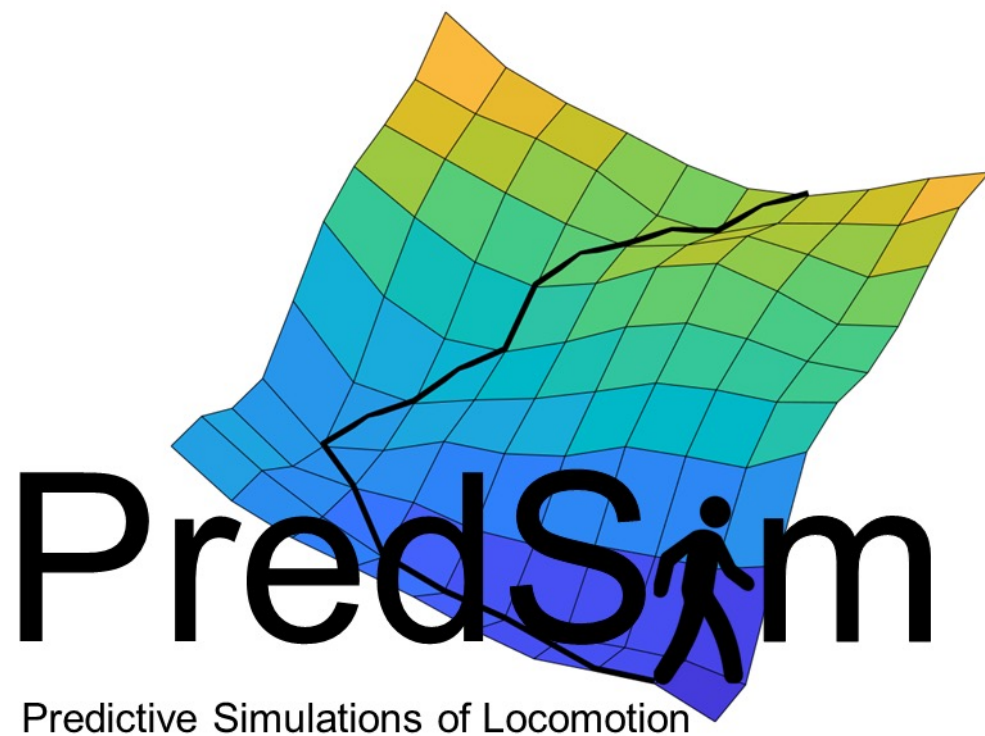


the high computational cost of numerical methods that account for the complexity of the neuromusculoskeletal system.

# The neuro-musculoskeletal model describes the relation between neural commands and movement

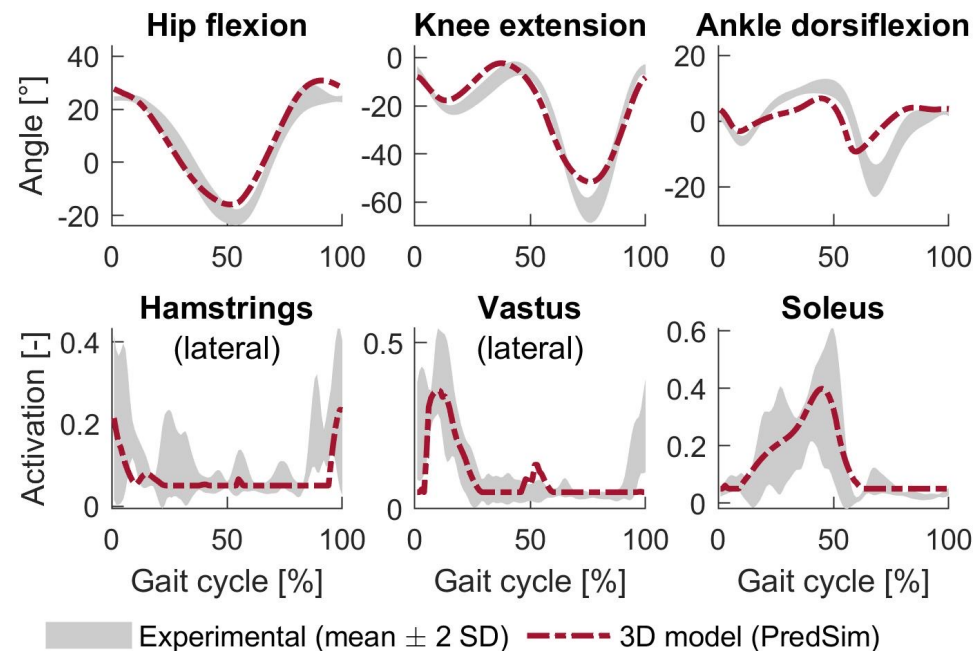
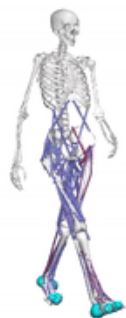


# PredSim: A Framework for Rapid Predictive Simulations of Locomotion



IPOPT

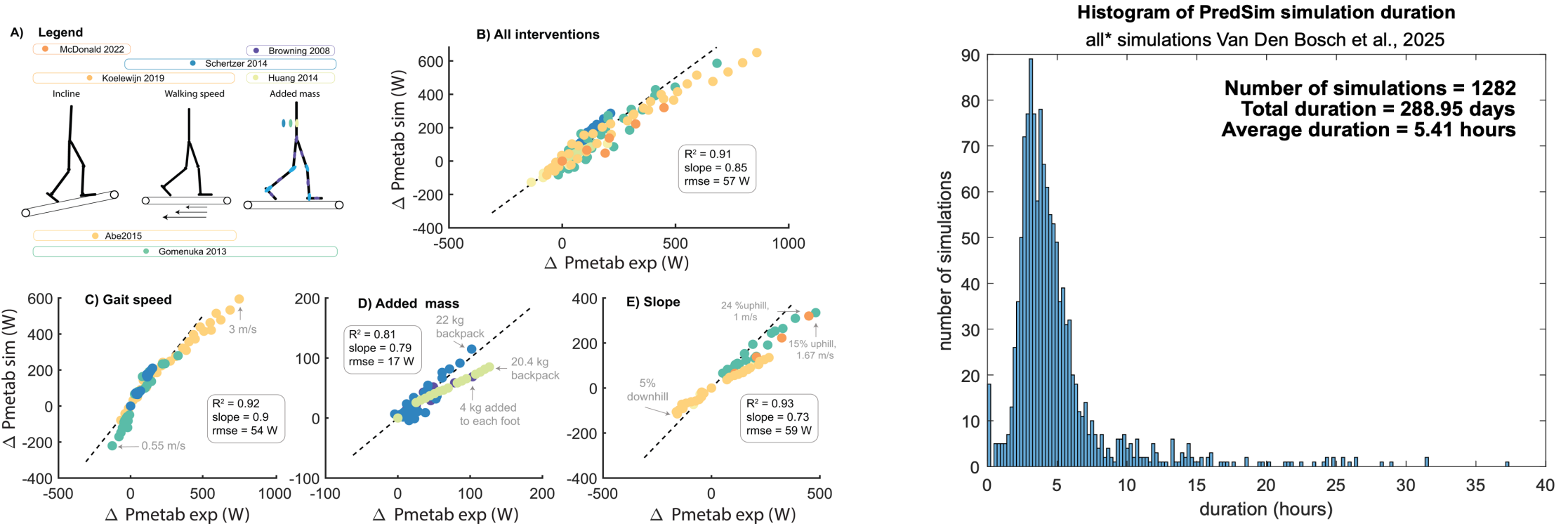
# Our models and simulations capture main features of healthy walking



⌚ speed x 0.5

Model	# dof	# muscles	Simulation time
2D human	10	18	1-2 minutes
3D human	33	94	75 minutes

# Growing number of simulations and complexity of the models increase the need for computing resources



$n_{\text{models}} \times n_{\text{parameters}} \times n_{\text{locomotion\_types}}$

# Local hardware\* has advantages, but also limitations

## The PROS

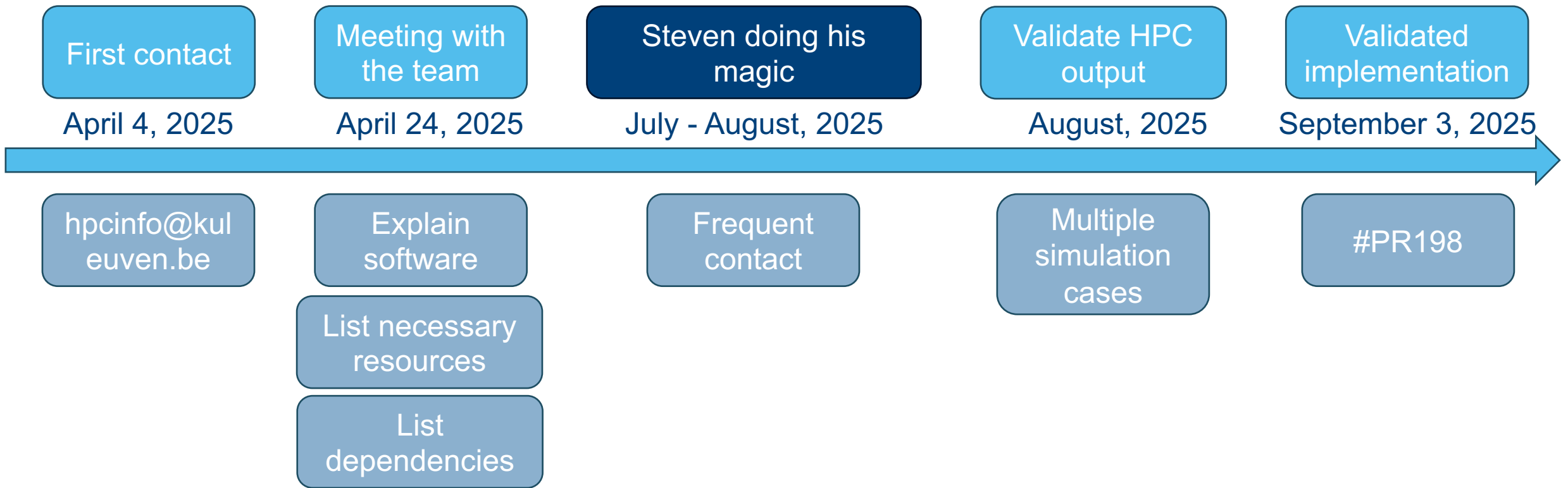
- Familiar (runs Windows)
  - Easy deployment
  - Quick onboarding
- Direct access

## The CONS

- Overcrowding
- Limited computation resources
- Unreliable (automatic restarts, updates, power interruptions)
- Expensive (upfront cost)

\*Intel core i9-10980XE 3.00 GHz (up to 4.6 GHz), 256GB DDR4 2666MHz ECC RAM

# We had no experience with HPC or Linux: HPC-team to the rescue!



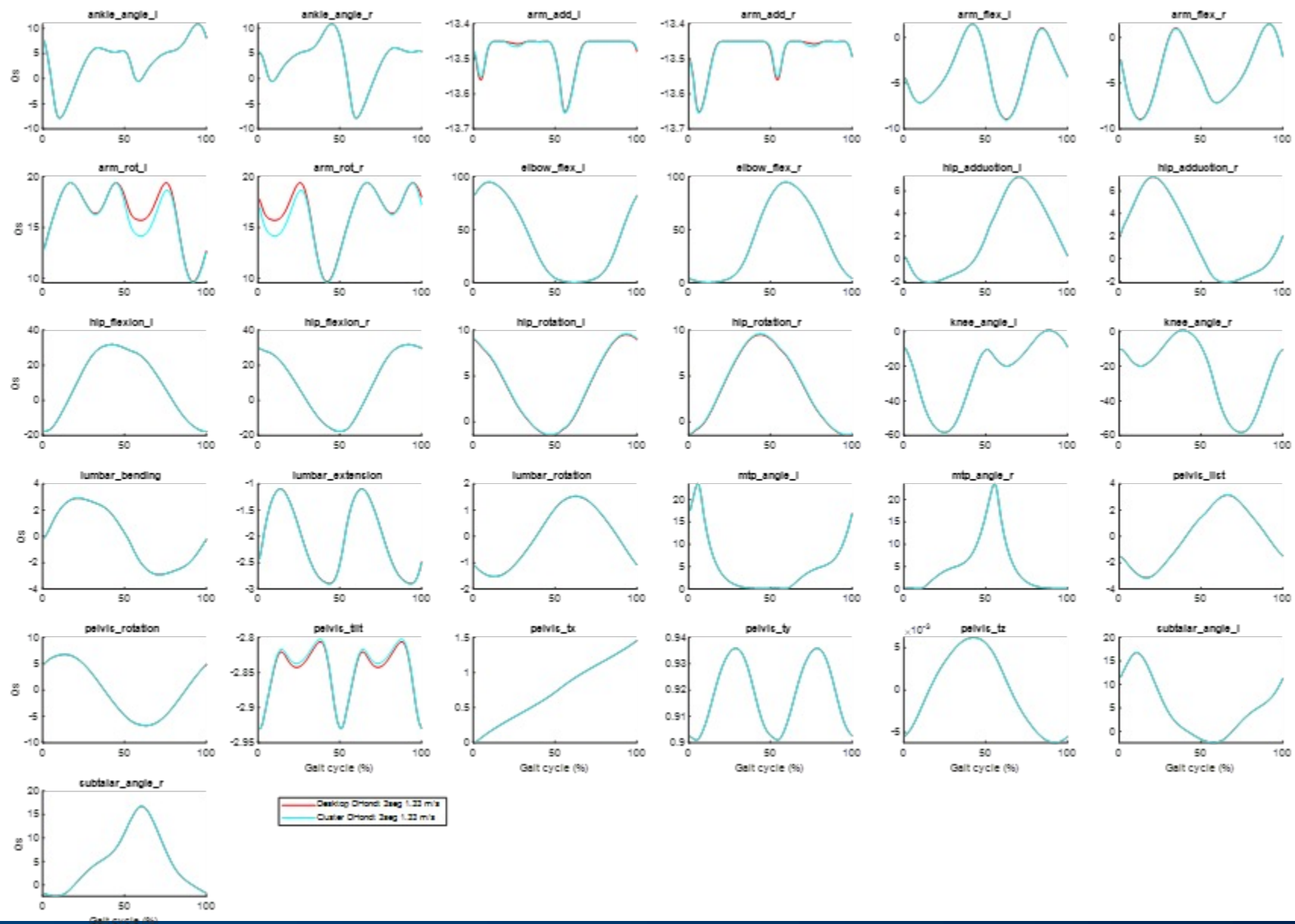
# Local machine vs. VSC Genius (example)

Local machine (4x6 matlab-cluster)

	0.5 m/s	1.33 m/s	2.2 m/s
Iterations	2146	1612	1107
Cost	294,13	360,02	788,30
total time	43686,04	33330,93	21574,61

Genius (1 node, 18 ntask per node)

	0.5 m/s	1.33 m/s	2.2 m/s
Iterations	1343	1673	1323
Cost	294,45	359,87	788,09
total time	7459,77	8948,72	6628,72



# A glimpse into the future

- Sensitivity analyses
- More in parallel > faster complete results
- More complex models
  - More degrees of freedom (e.g. trunk)
  - More (complex) muscles
  - Complex motor control (e.g. force-dependend muscle feedback)



## PI Neuromechanics Lab



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## Run PredSim yourself



## PredSim contributors

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