JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

Kelkkahiihto - tutkimusta, suorituskykyä, luokittelua…

Vesa Linnamo

Soveltavan liikunnan tutkijatapaaminen
Jyväskylä 26.11.2019

Ph.D. in MECHANICAL ENGINEERING (30th Cycle)

JYU DISSERTATIONS 101

Valeria Rosso

Biomechanics in Paralympic Cross-Country Sit Skiing

Evidence-based Tests for Classification

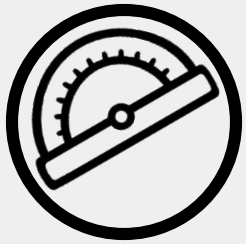
CLASSIFICATION

MEDICALLY BASED CLASSIFICATION

Classes according to disabilities. i.e. spinal cord injury and amputation

FUNCTIONAL CLASSIFICATION

Classes according to impact of impairment on performance



EVIDENCE-BASED CLASSIFICATION

Classes according to scientific evidence

Test- table-test (TTT)

From: Pernot et al. Validity of the test–table–test for Nordic skiing: in: Spinal Cord (2011) 49, 935–941.

class	% race time
LW 10	86
LW 10,5	90
LW 11	94
LW 11,5	96
LW 12	100

class	Impairment	Muscle activity (ASIA classification*)	TTT
LW 10	Lower limb and trunk	**Unable to sit** without strapping	0-2
LW 10,5	Lower limb and trunk	**sit statically** without arm support	3-6
LW 11	Lower limb and trunk	**Retained** abdominal muscles and trunk extensor	7-10
LW 11,5	Lower **limb (s)** and trunk	Near to **normal** trunk muscles activation	11
LW 12	Lower **limb (s)**	**Normal** trunk function	12

TOWARDS EVIDENCE-BASED CLASSIFICATION

Identify target sport and eligible impairment types to be classified

Define theoretical model of the determinants of sports performance

Measures of **performance, which are standardized and sport-specific** impairments, which are valid for purpose of classification

Assess association strength between measures of performance and measures of impairment

Determine minimum impairment criteria, number of classes, and class profiles

MEASURES OF PERFORMANCE

TO COMPARE

- biomechanics of skiing on snow and on the ergometer;
- trunk kinematics of sit skiers with different impact of impairment on the ergometer

TO DEVELOP

- measures of performance determinants

MEASURES OF IMPAIRMENT

TO EXPLORE

- measures of impairment of trunk control

TO DEVELOP

- measures of impairment of:
- trunk strength
- trunk control

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Biomechanics of simulated versus natural cross-country sit skiing

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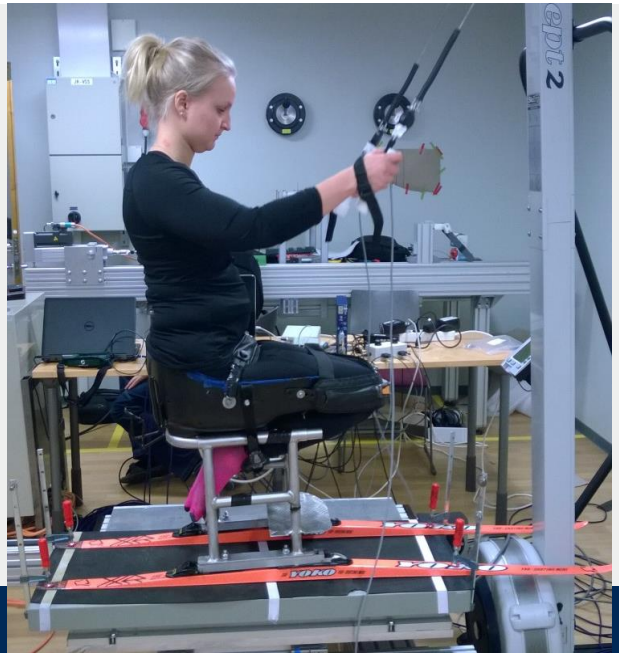
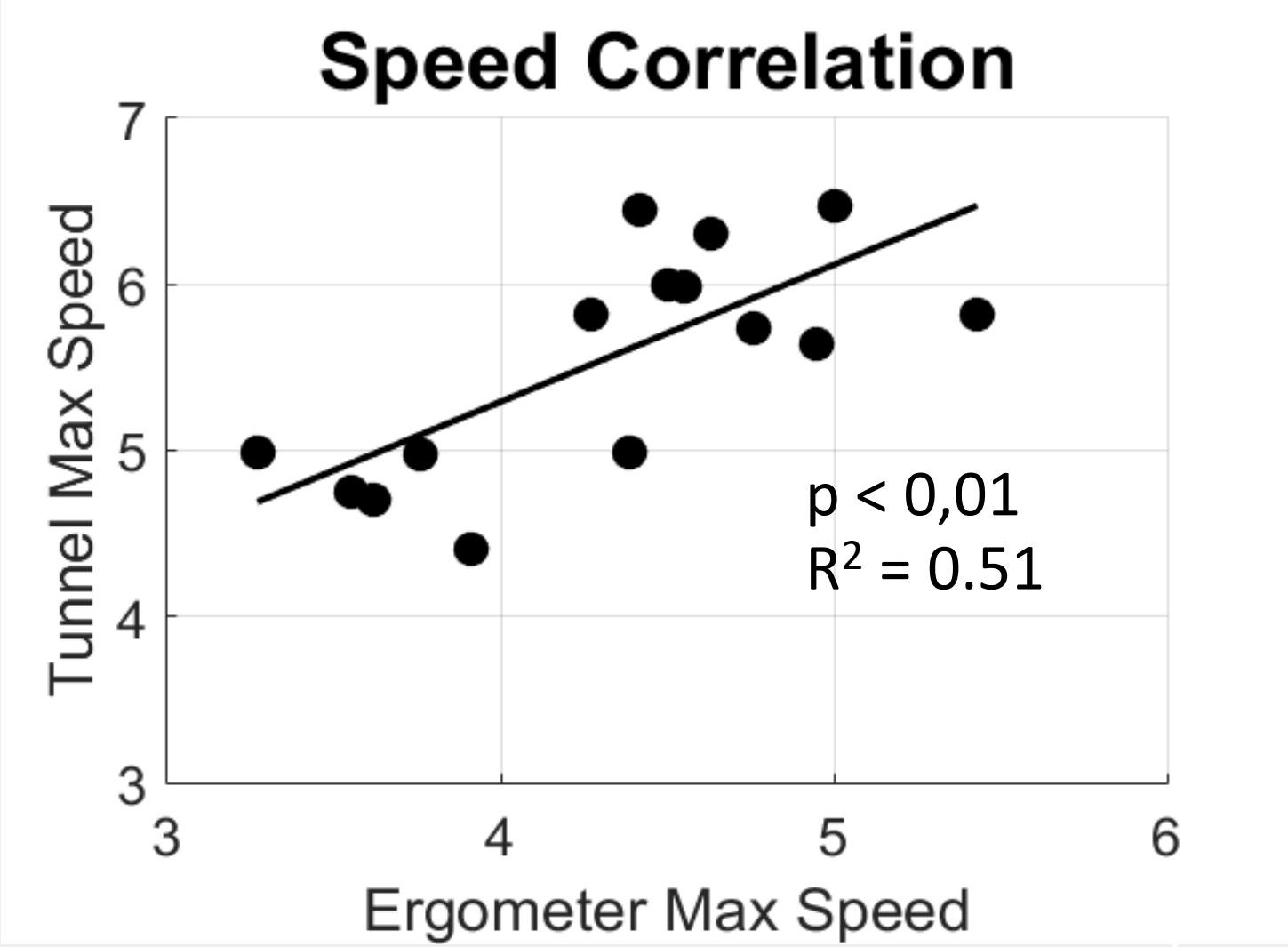
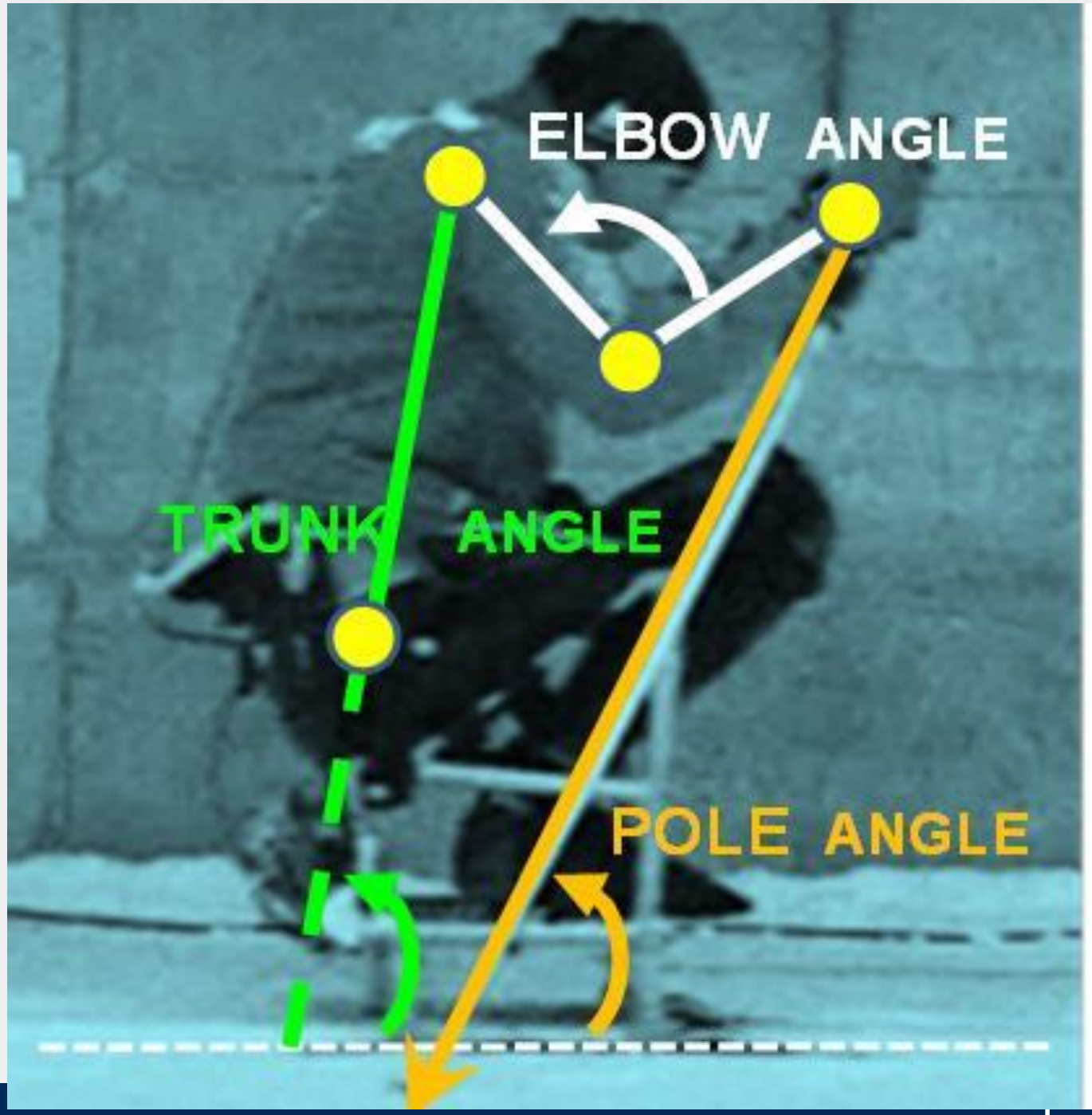


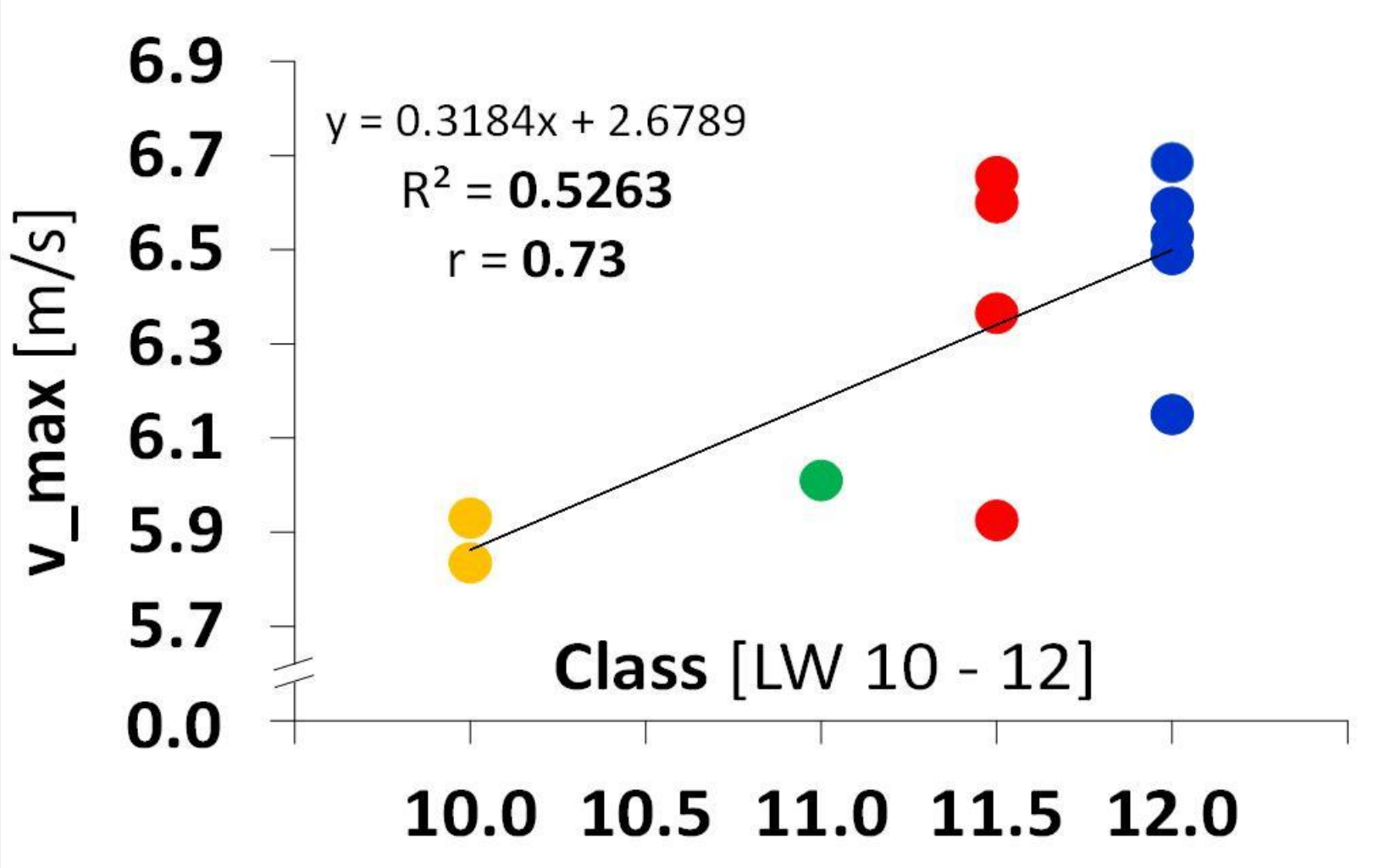
Maximal speed

- Ergo 4.3 ± 0.6m/s
- Tunnel 4.6 ± 0.7 m/s (P<0,05)



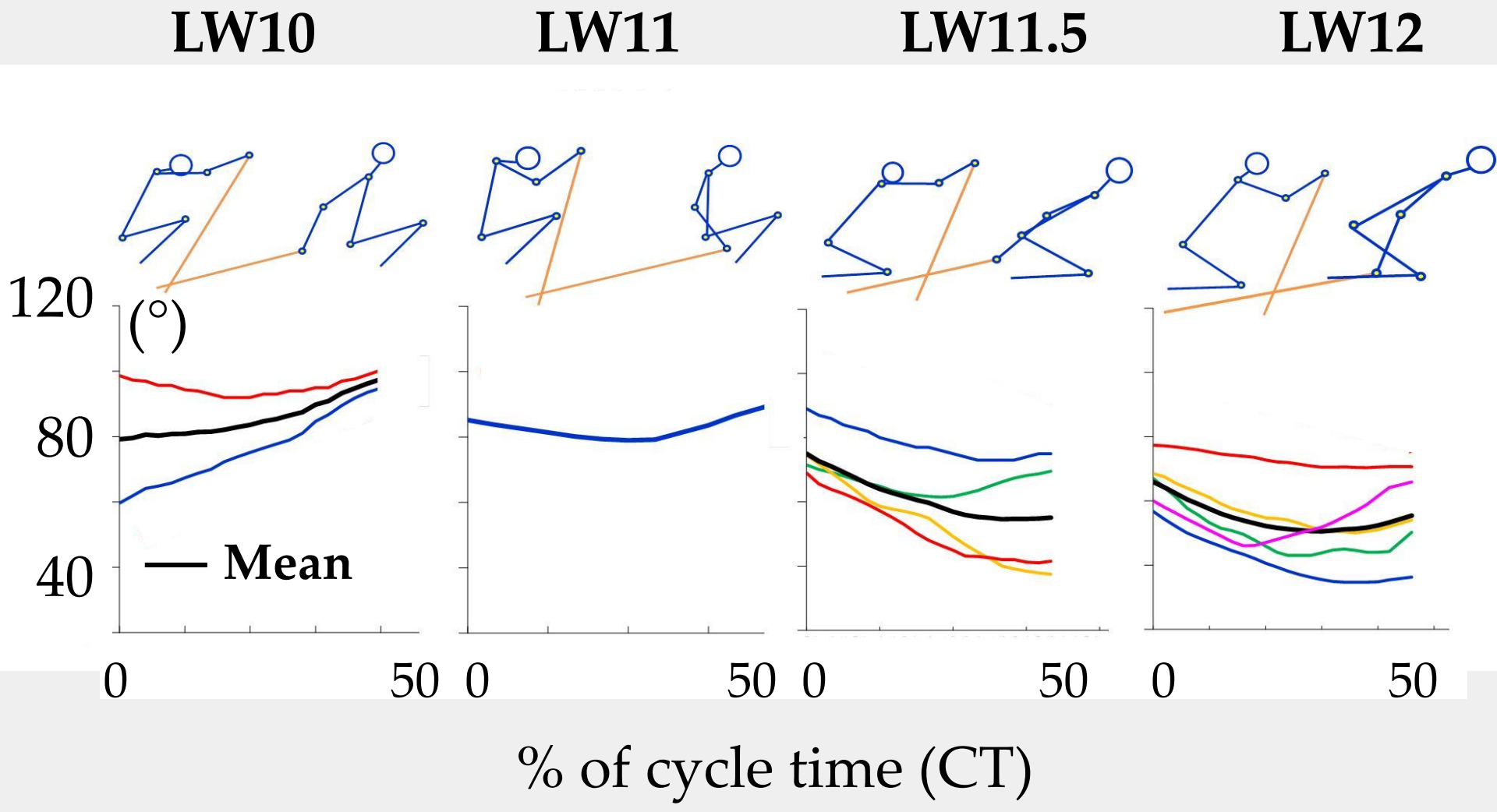

ELBOW ANGLE
TRUNK ANGLE
POLE ANGLE

12 male skiers on flat terrain

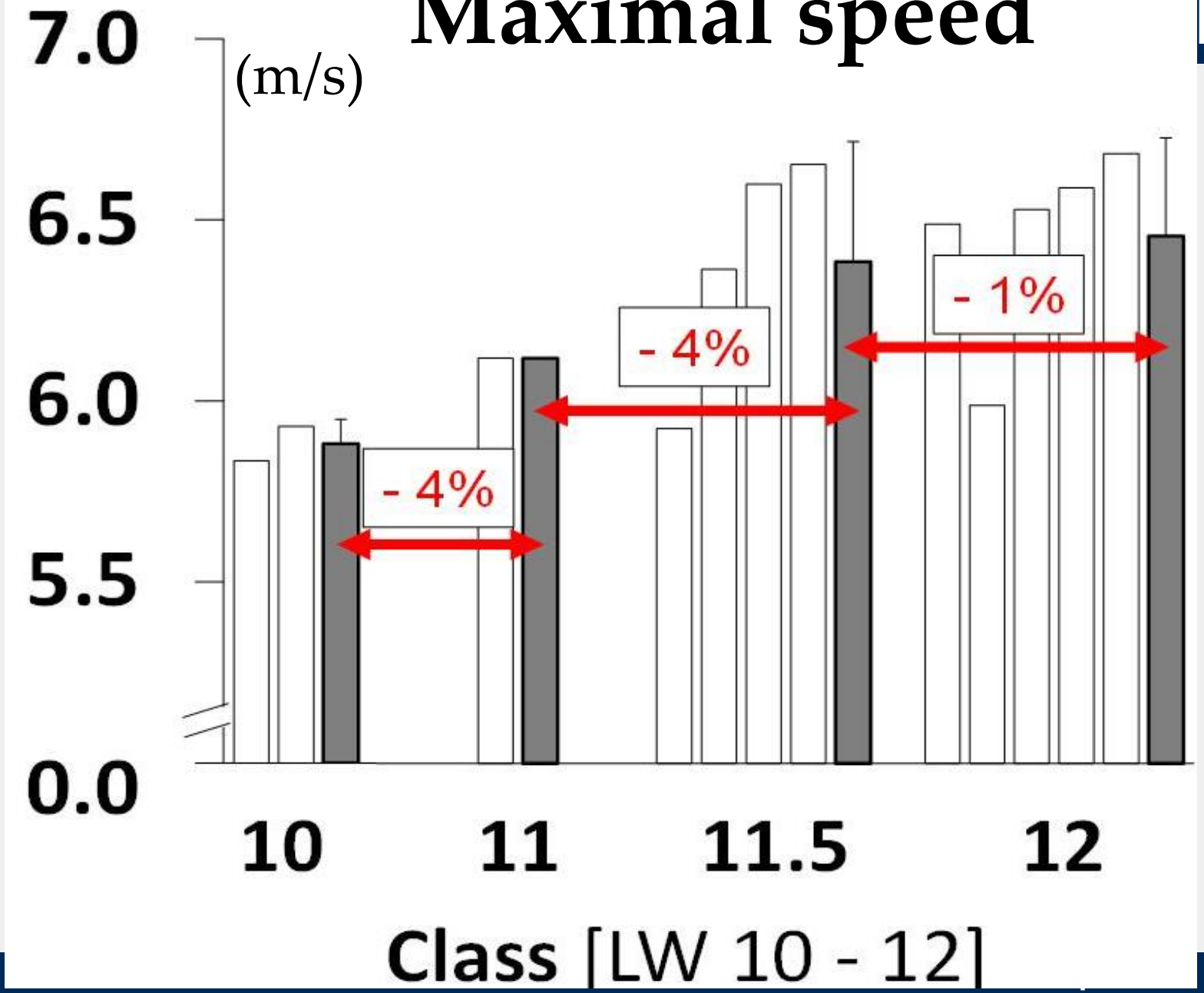


(Karczewska-Lindinger et al. 2016)

Trunk angle during poling phase



Maximal speed



Adapted Physical Activity Quarterly, 2019, 36, 61–76
https://doi.org/10.1123/apaq.2017-0161

Human Kinetics
ORIGINAL RESEARCH

Balance Perturbations as a Measurement Tool for Trunk Impairment in Cross-Country Sit Skiing

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Politecnico di Torino

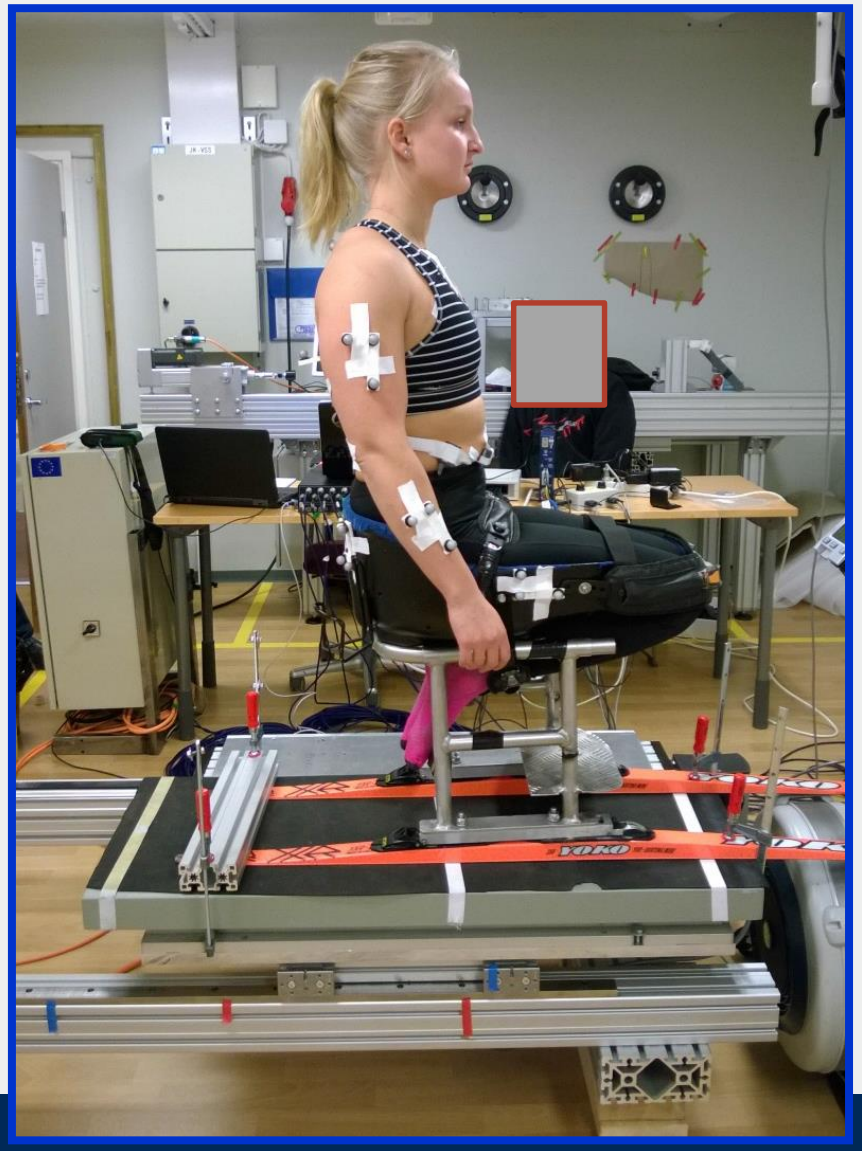
Walter Rapp
University of Freiburg

Stefan Lindinger
University of Gothenburg

Yves Vanlandewijck
KU Leuven

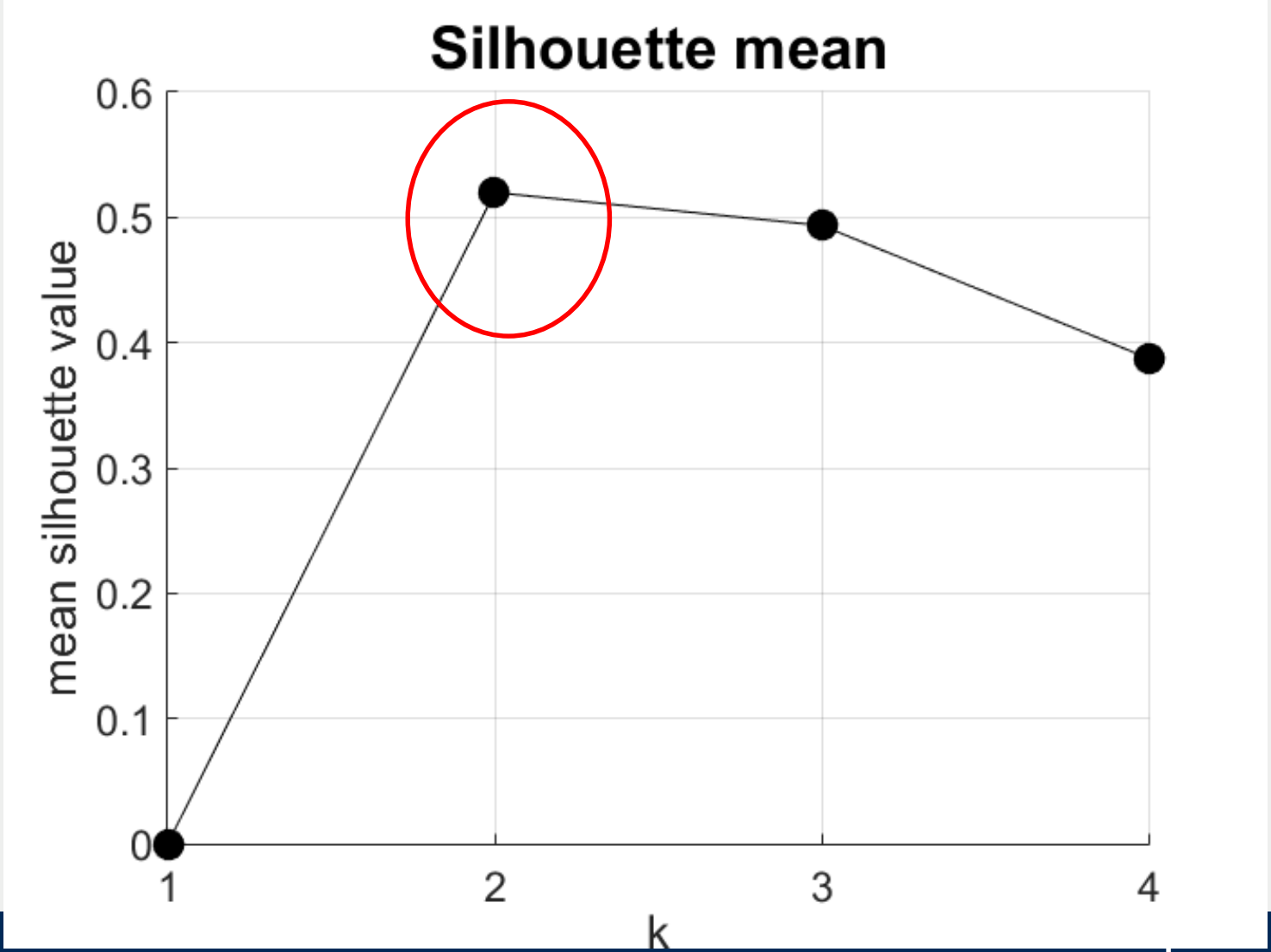
Sami Äyrämö and Vesa Linnamo
University of Jyväskylä

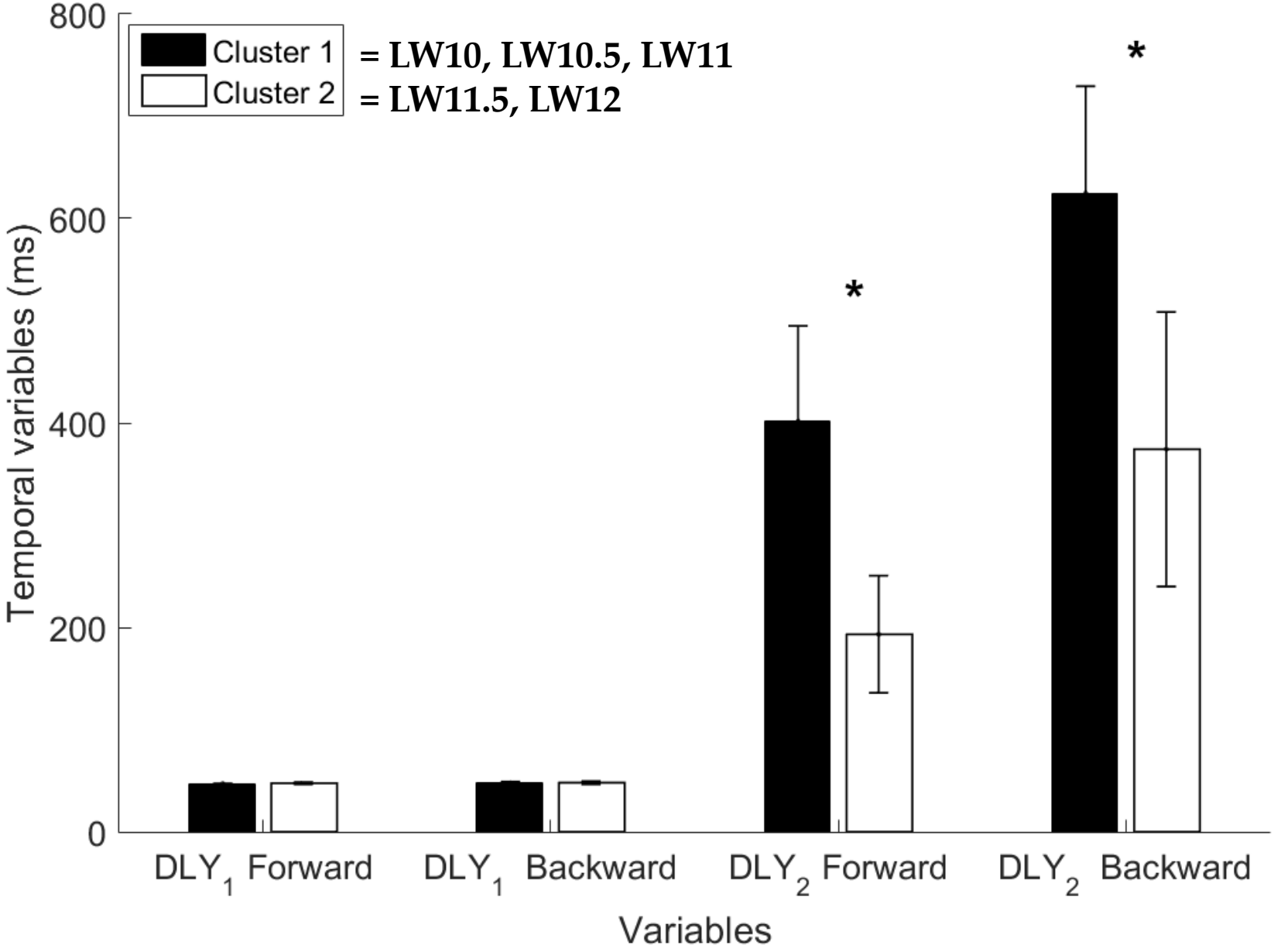
Balance perturbations as a measurement tool for trunk impairment in cross-country sit skiing

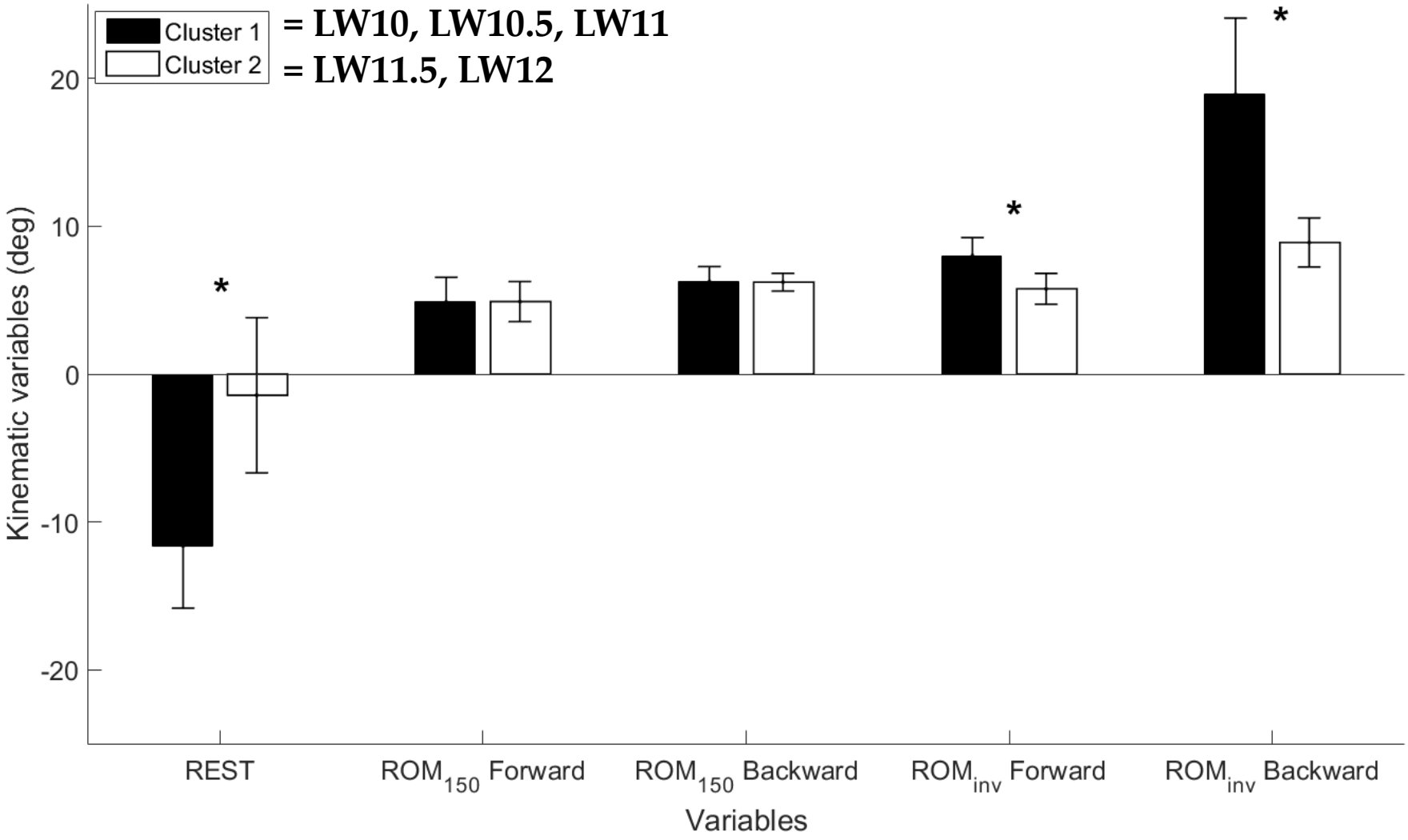


Cluster method

- the k-means using the squared Euclidean distance




800
600
400
200
0
Temporal variables (ms)
Cluster 1
Cluster 2
= LW10, LW10.5, LW11
= LW11.5, LW12
*
*
DLY1 Forward
DLY1 Backward
DLY2 Forward
DLY2 Backward
Variables


Cluster 1
Cluster 2
= LW10, LW10.5, LW11
= LW11.5, LW12
Kinematic variables (deg)
20
10
0
-10
-20
*
*
*
REST
ROM150 Forward
ROM150 Backward
ROMinv Forward
ROMinv Backward
Variables

Original Article

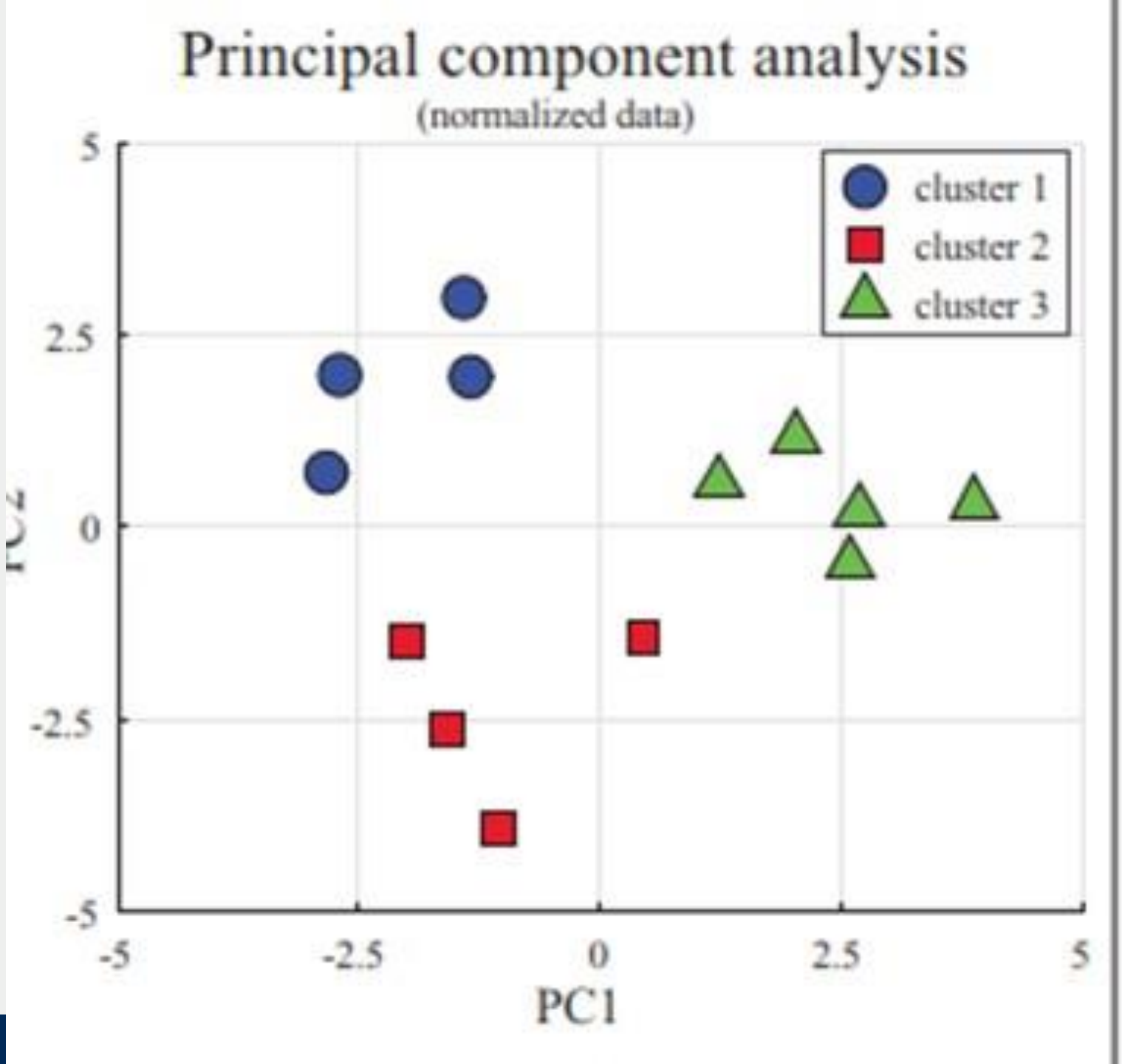
Institution of MECHANICAL ENGINEERS

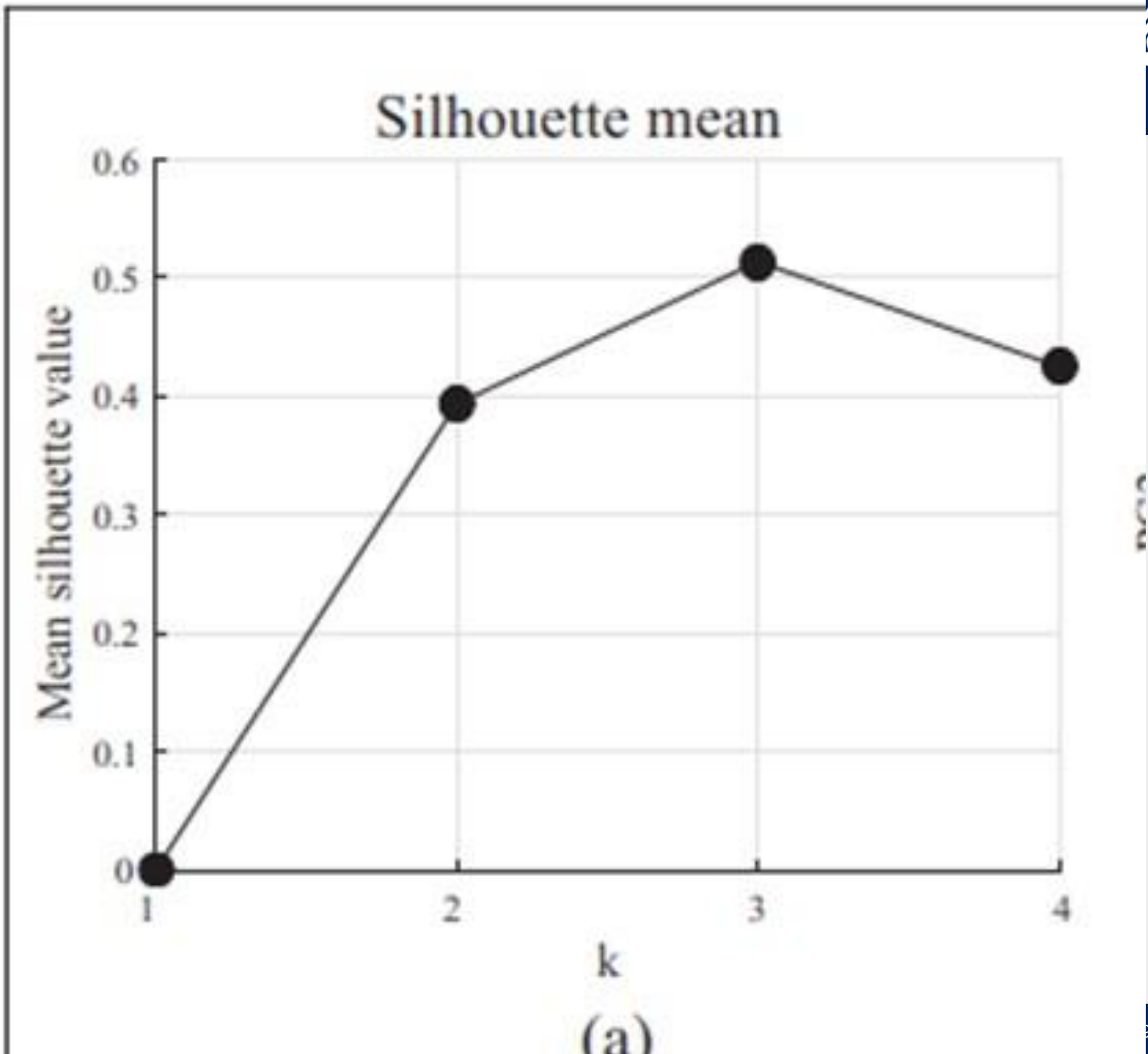
Simulated skiing as a measurement tool for performance in cross-country sit-skiing

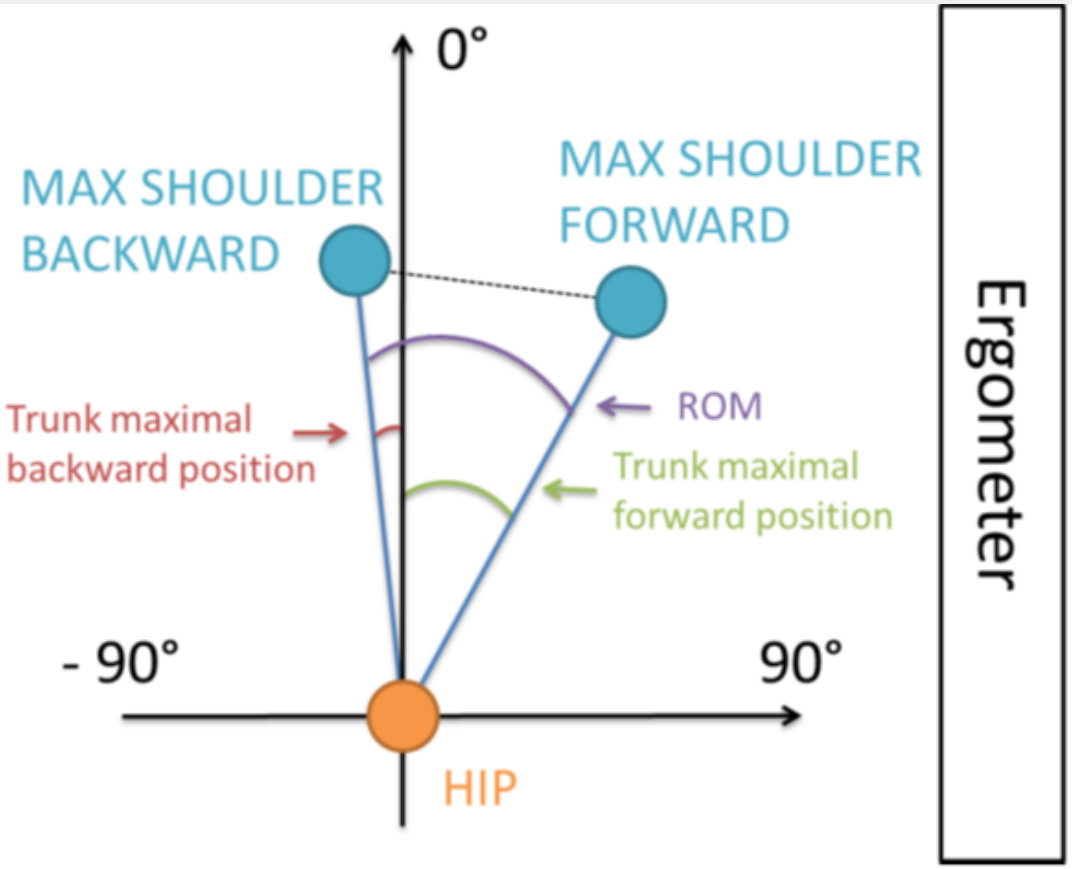
Valeria Rosso[1,2], Vesa Linnamo[2], Walter Rapp[3], Stefan Lindinger[4], Magdalena Karczewska-Lindinger[5], Yves Vanlandewijck[6] and Laura Gastaldi[7]

Journal of SPORTS ENGINEERING AND TECHNOLOGY

Proc IMechE Part P:
J Sports Engineering and Technology
1–12


Principal component analysis
(normalized data)
cluster 1
cluster 2
cluster 3
5
2.5
0
-2.5
-5
-5
-2.5
0
2.5
5
PC1


Silhouette mean
Mean silhouette value
0.6
0.5
0.4
0.3
0.2
0.1
0
1
2
3
4
k
(a)



Group (6 females, 10 males)	LW10, 10.5 **(N=3)**	LW 11, 11.5 **(N=7)**	LW12 **(N=6)**
Max backward [°]	-4.6 ± 4.4	7.9 ± 6.4	14.4 ± 11.6
Max forward [°]	17.8 ± 6.0	40.2 ± 15.0	52.5 ± 8.2
ROM [°]	22.4 ± 8.9	32.3 ± 13.9	38.1 ± 14.2

IV

TOWARDS EVIDENCE-BASED CLASSIFICATION IN CROSS-COUNTRY SIT SKIING: MEASURES OF IMPAIRMENT OF STRENGTH AND TRUNK CONTROL

by

Rosso V., Linnamo V., Vanlandewijck Y., Rapp W., Fasel B., Karczewska-Lindinger M., Lindinger S., Gastaldi L.

Submitted for publication.


HH

Simulated bench press without backrest

Simulated poling

Simulated bench press with backrest

TOWARDS EVIDENCE-BASED CLASSIFICATION

Identify target sport and eligible impairment types to be classified

Define theoretical model of the determinants of sports performance

Measures of **performance, which are standardized and sport-specific** impairments, which are valid for purpose of classification

Assess association strength between measures of performance and measures of impairment

Determine minimum impairment criteria, number of classes, and class profiles

Race analysis

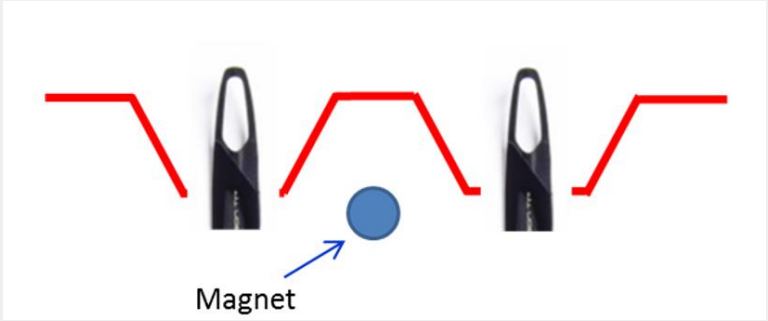
TECHNOLOGY:

MINI-MAGNETO-SENSORS (RECEIVER) + MAGNETS (SENDER) IN SNOW

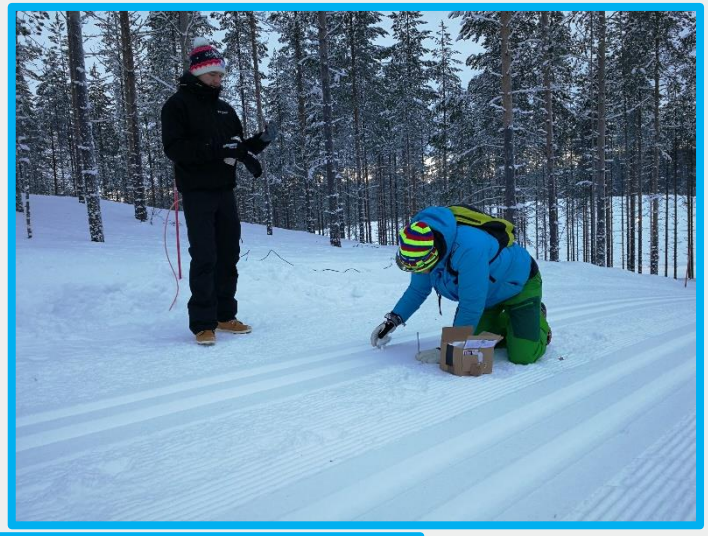
SparkFun 9DoF Razor IMU M0

SEN-14001

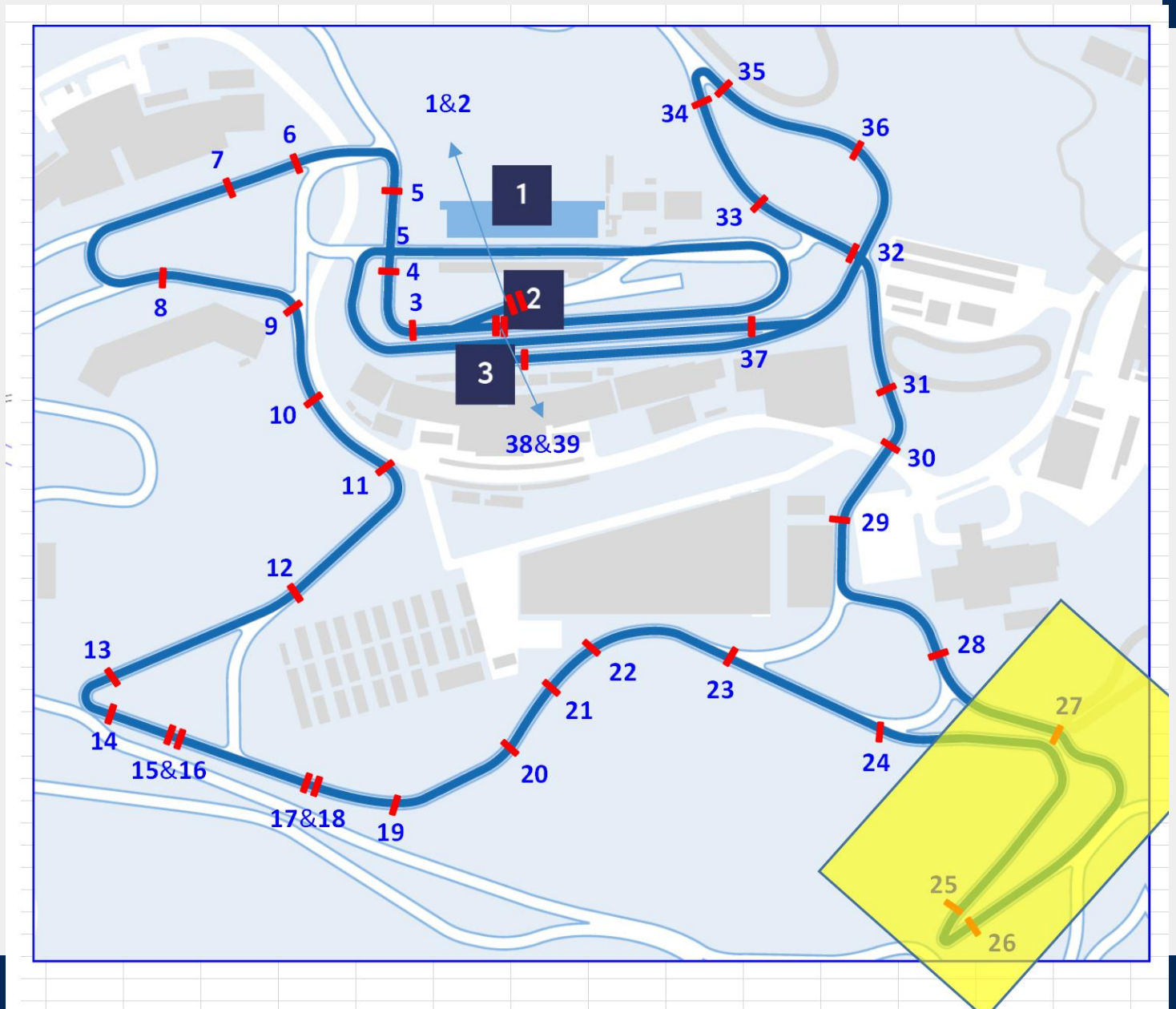
*„No“ weight (15g)
*Small
*Easy to mount
(plastic band fixed)
*„No“ interference with athlete
*100 Hz

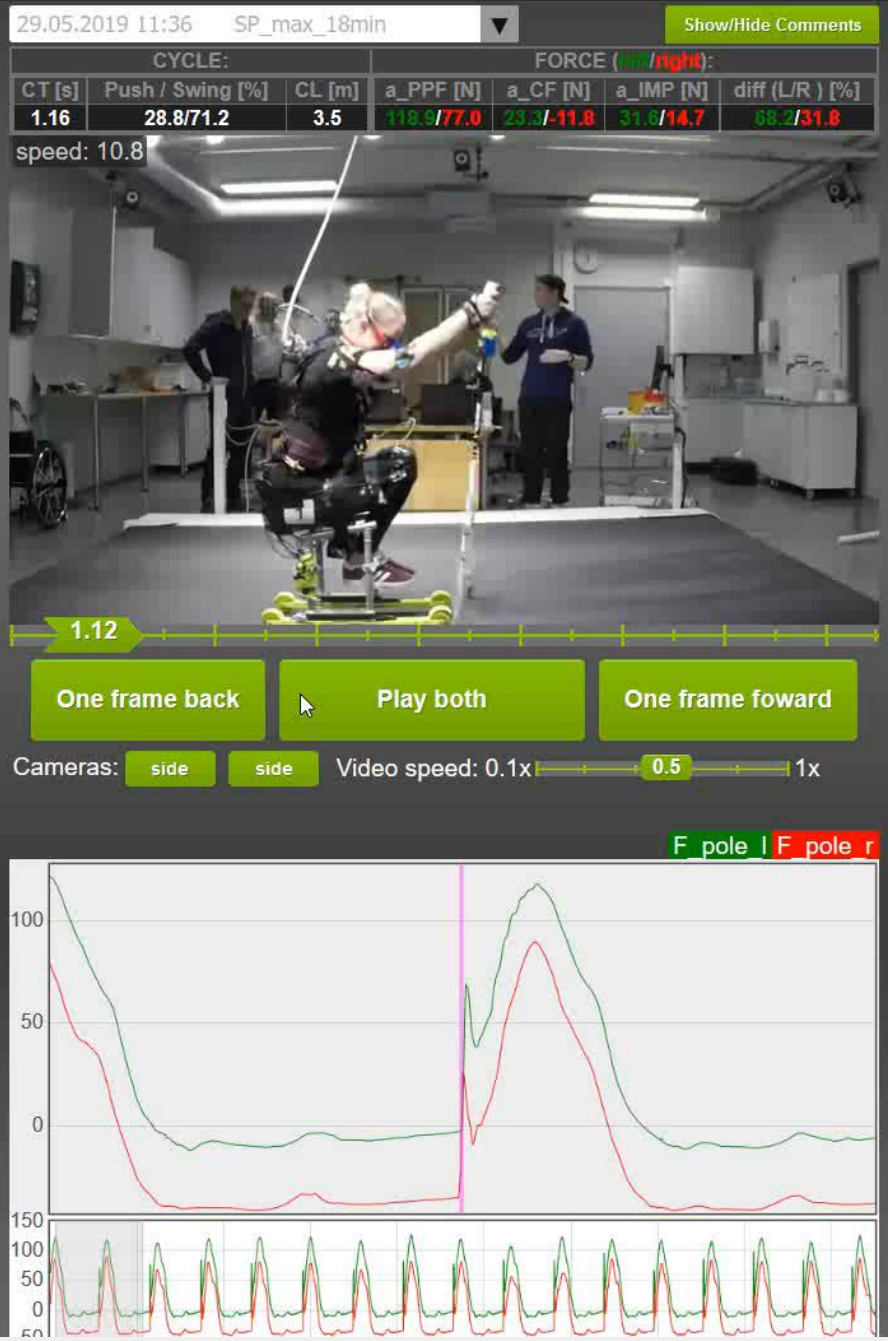


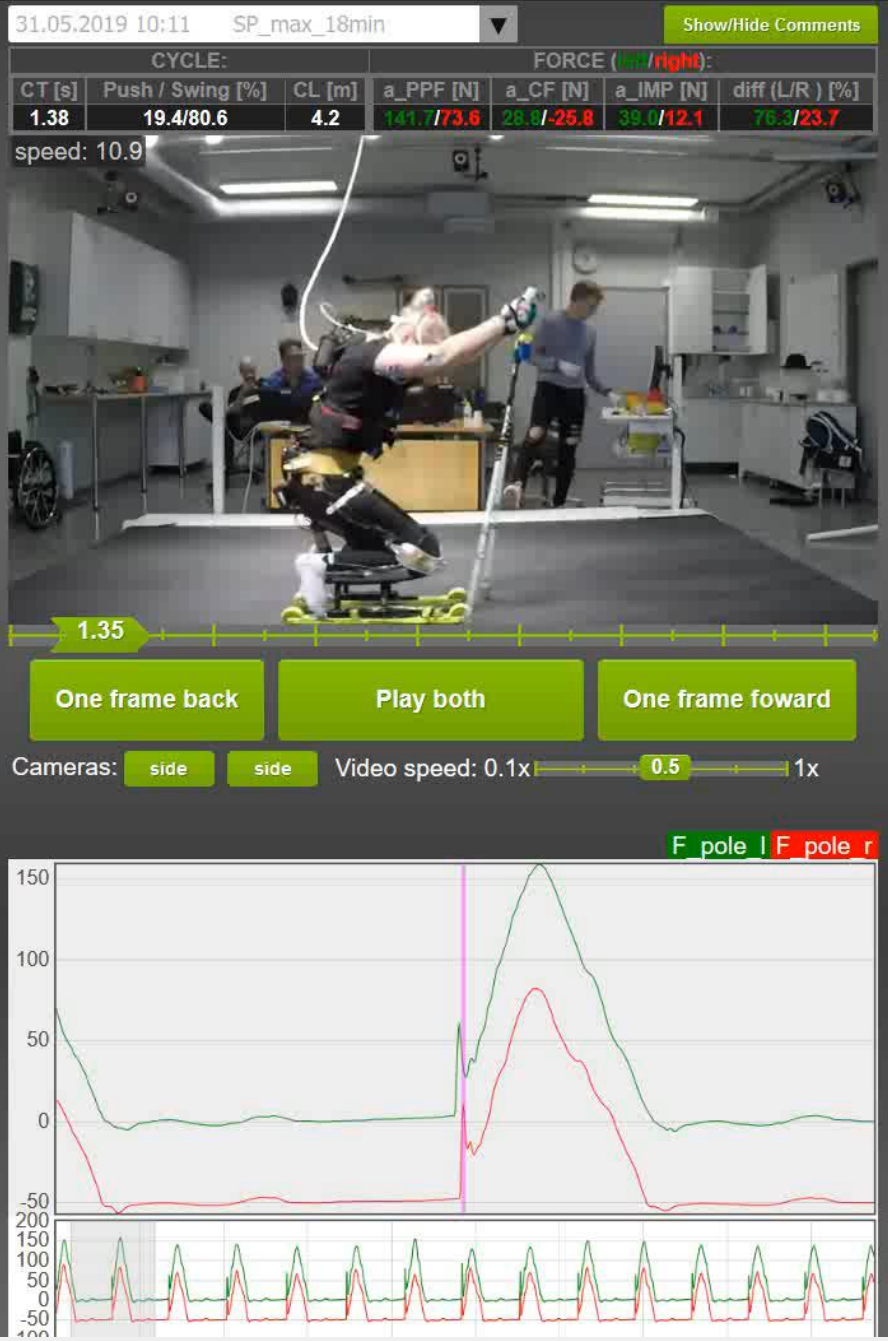
EARLY MORNING MAGNET INSTALLATIONS



Sit-ski men 7.5km




29.05.2019 11:36 SP_max_18min
Show/Hide Comments
CYCLE:
FORCE (left/right):
CT [s] | Push / Swing [%] | CL [m] | a_PPF [N] | a_CF [N] | a_IMP [N] | diff (L/R) [%]
1.16 | 28.8/71.2 | 3.5 | 118.9/77.0 | 23.3/-11.8 | 31.6/14.7 | 68.2/31.8
speed: 10.8
1.12
One frame back
Play both
One frame foward
Cameras: side side
Video speed: 0.1x 0.5 1x
F_pole_l F_pole_r
100
50
0
150
100
50
0


31.05.2019 10:11 SP_max_18min
Show/Hide Comments
CYCLE:
FORCE (left/right):
CT [s] | Push / Swing [%] | CL [m] | a_PPF [N] | a_CF [N] | a_IMP [N] | diff (L/R) [%]
1.38 | 19.4/80.6 | 4.2 | 141.7/73.6 | 28.8/-25.8 | 39.0/12.1 | 76.3/23.7
speed: 10.9
1.35
One frame back
Play both
One frame foward
Cameras: side side
Video speed: 0.1x 0.5 1x
F_pole_l F_pole_r
150
100
50
0
-50
200
150
100
50
0
-50

Kiitos!