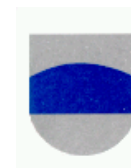




New Monitoring Approaches for Improving Athletes' Performance

Vesa Linnamo

Neuromuscular Research Center (NMRC),
Department of Biology of Physical Activity,
Vuokatti Sports Technology Unit
University of Jyväskylä, Finland









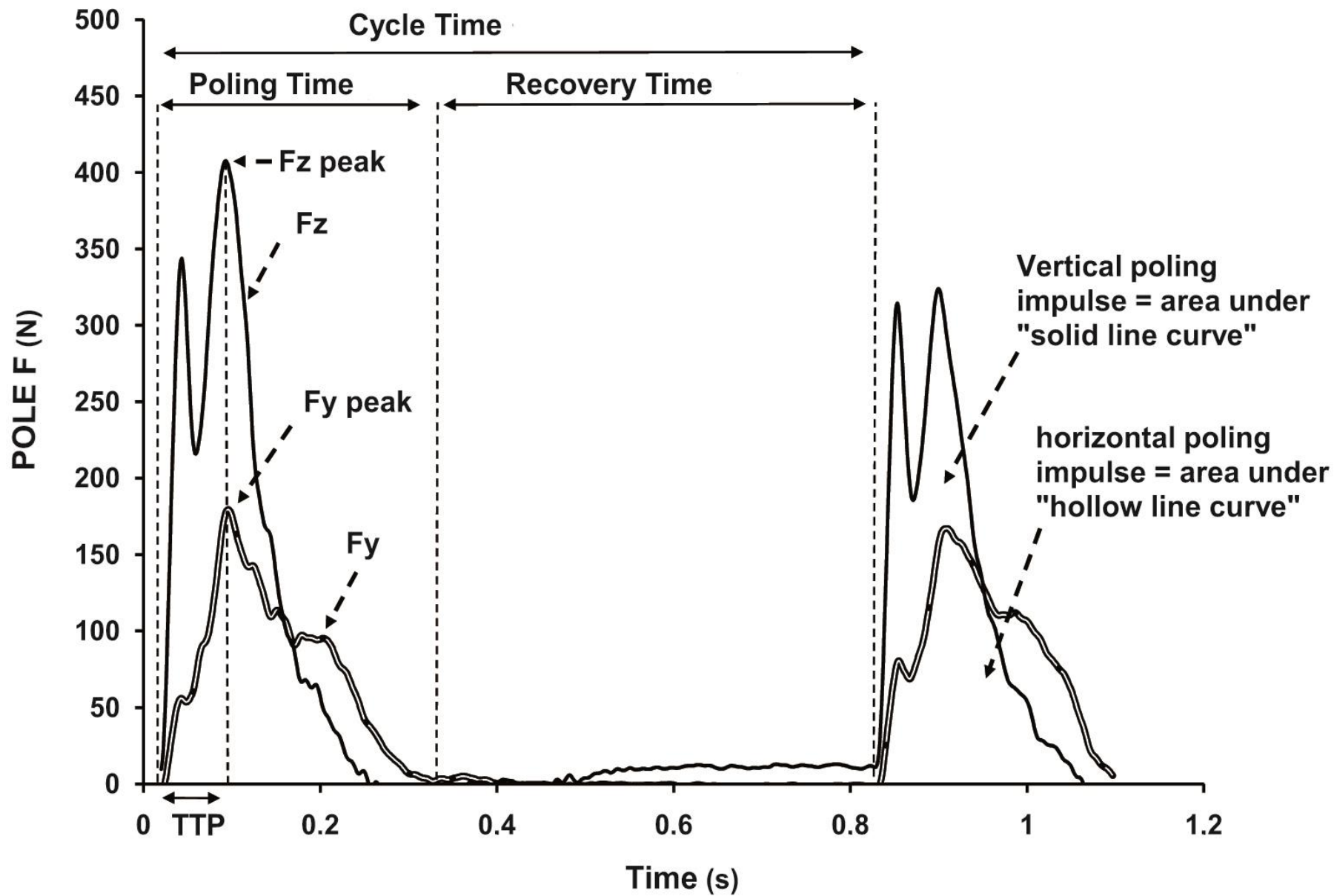




Vähäsöyrinki P., Komi P.V., Seppälä S., Kolehmainen V., Salmi J., Linnamo V. (2008) *Effect of skiing speed on ski and pole forces in cross-country skiing. Med Sci Sports Exerc. 40(6), 1111-1116, 2008.*

Mikkola J., Laaksonen M., Holmberg H-C., Nummela A., Linnamo V. (2013) *Changes in performance and poling kinetics during cross-country sprint skiing competition using the double poling technique. Sports Biomechanics. 12(4): 355-364*





Ohtonen O., Lindinger S., Linnamo V. (2013) Effects of gliding properties of cross-country skis on the force production during skating technique in elite cross-country skiers. *Int. J Sports Sci. and Coaching*. Vol 8, 2: 407-416

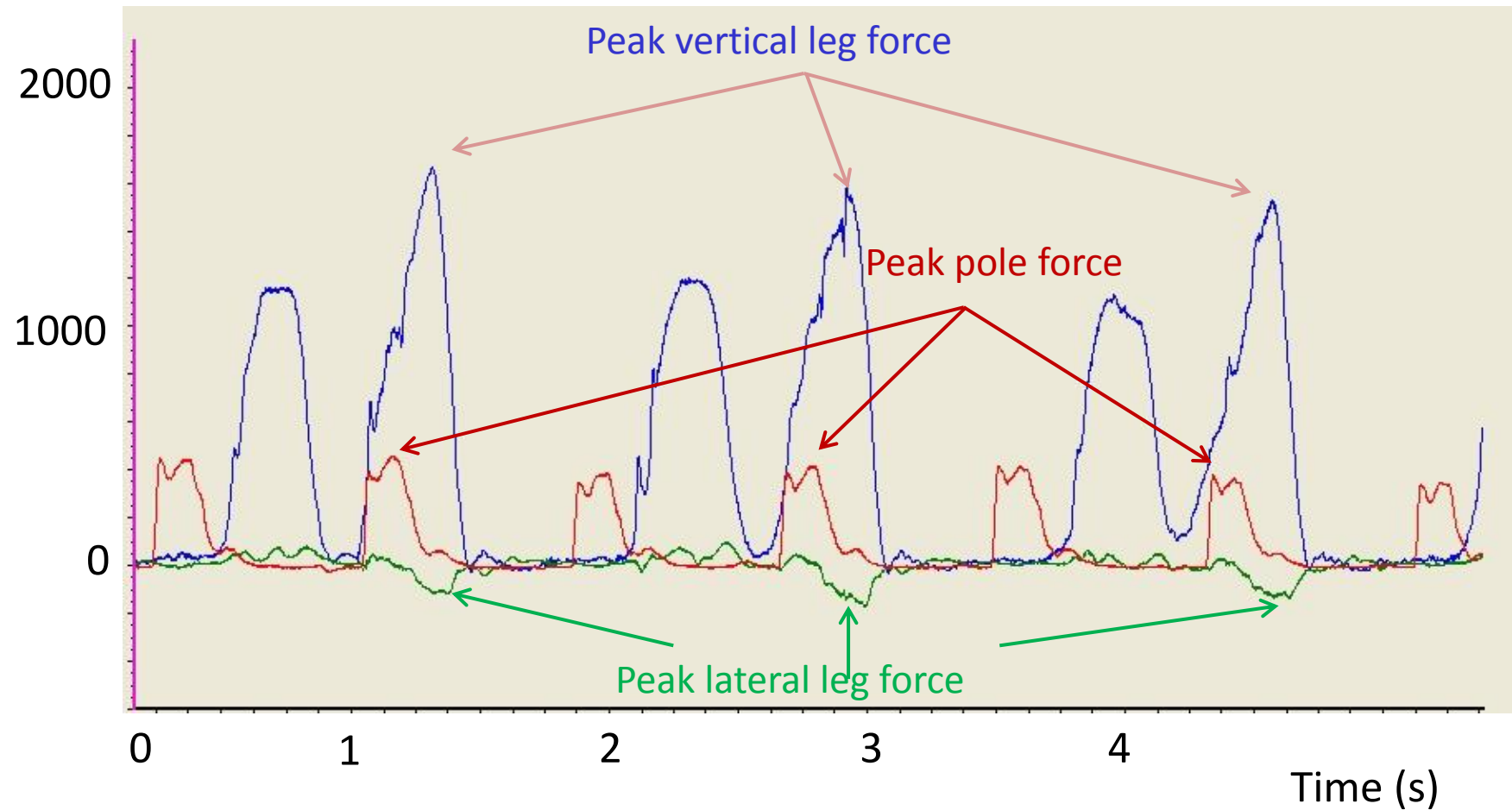
Ohtonen O., Lindinger S., Lemmettylä T., Seppälä S., Linnamo V (2013) Validation of portable 2D force binding systems for cross-country skiing. *Sports Engineering*. 16(4): 281-296

- 490 g / ski, based on strain gauges
- Vertical (z), horizontal (y) and lateral (x) direction



Force variables - Average of 9 cycles

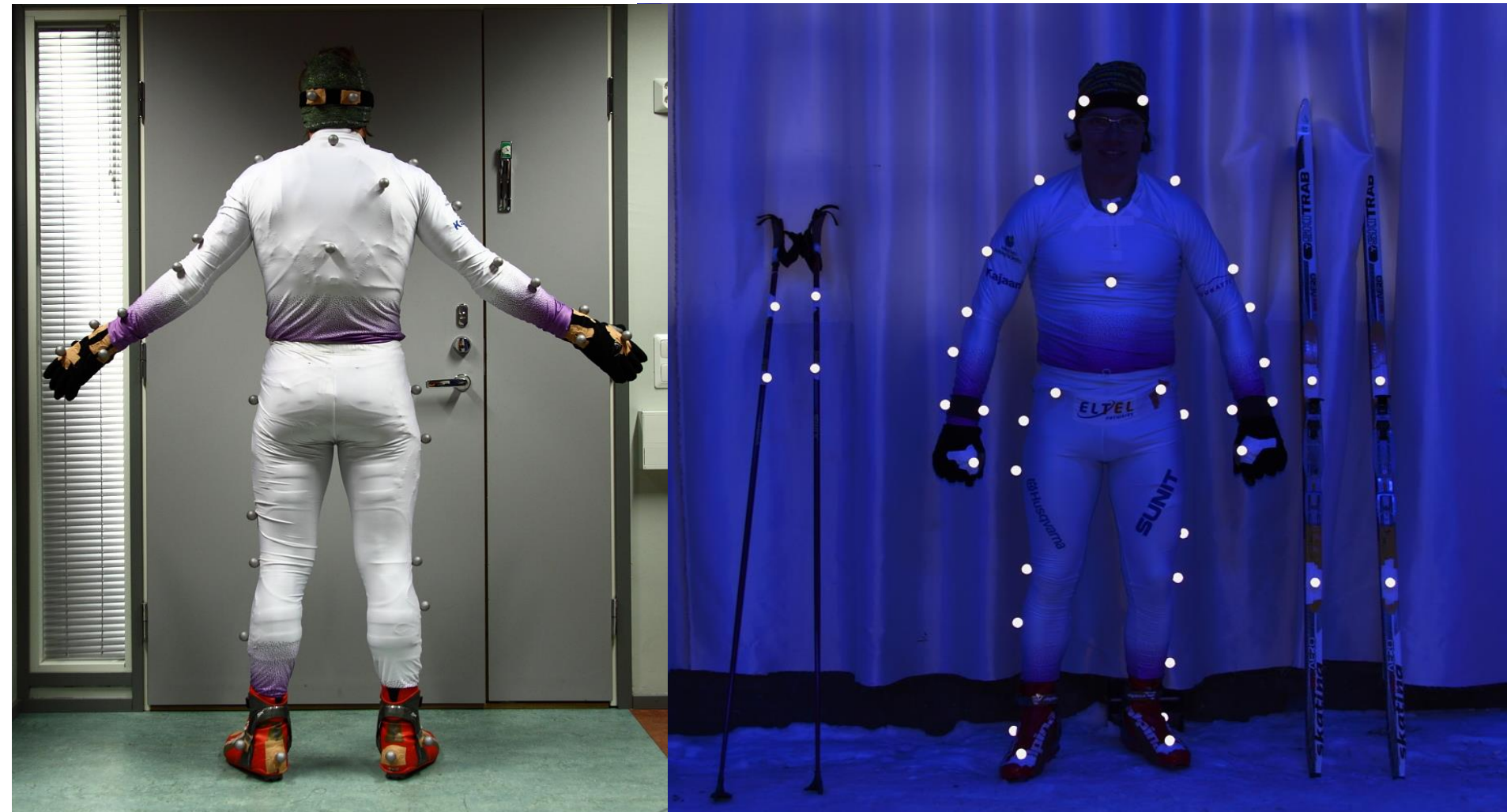
Force (N)



Forces after 20km race

- Decrease in peak leg and pole forces
- Pole forces decreased threefold compared to legs
- Emphasizes the role of upper body

Ohtonen O., Linnamo V., Pohjola M., Göpfert C., Lemmettylä T., Rapp W. Lindinger S. Usage of 3D motion analysis system on challenging field conditions and the effect of fatigue on ski skating. XIII International Symposium on 3D Analysis of Human Movement, Lausanne July 2014





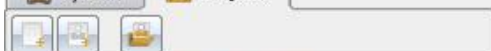


View Type: Untitled *

Resources

7_00_PostSprint Go Live

System Subjects

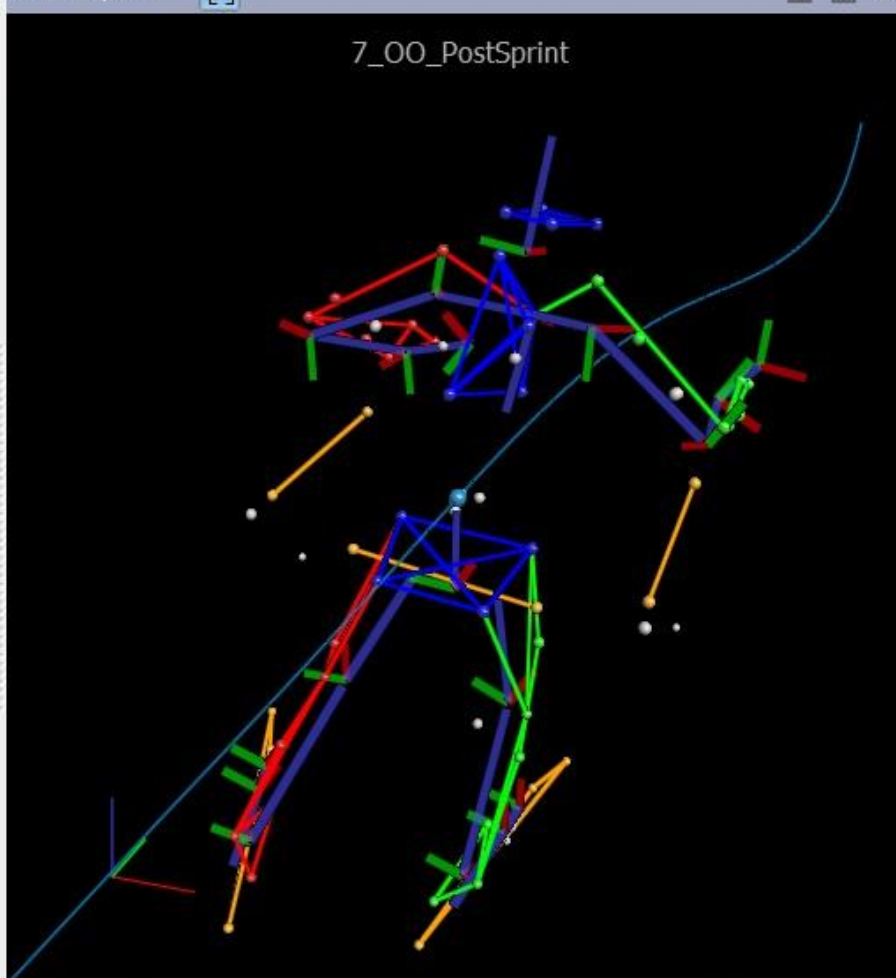


OlliO_Fatigue (Finne)

Markers

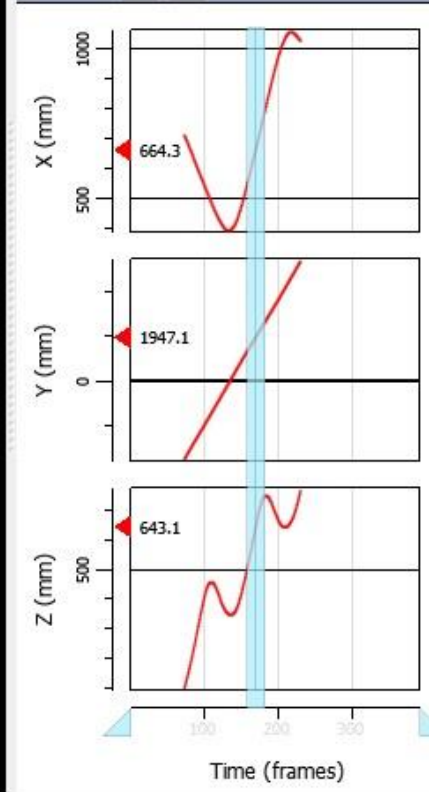
- LFHD
- RFHD
- LBHD
- RBHD
- C7
- T10
- CLAV
- STRN
- RBAK
- LSHO
- LUPA
- LELB
- LFRM
- LWRA
- LWRB
- LFIN
- RSHO
- RUPA
- RELB
- RFRM
- RWRA
- RWRB
- RFIN
- LASI
- RASI
- LPSI
- RPSI
- LTHI
- LKNE

3D Perspective

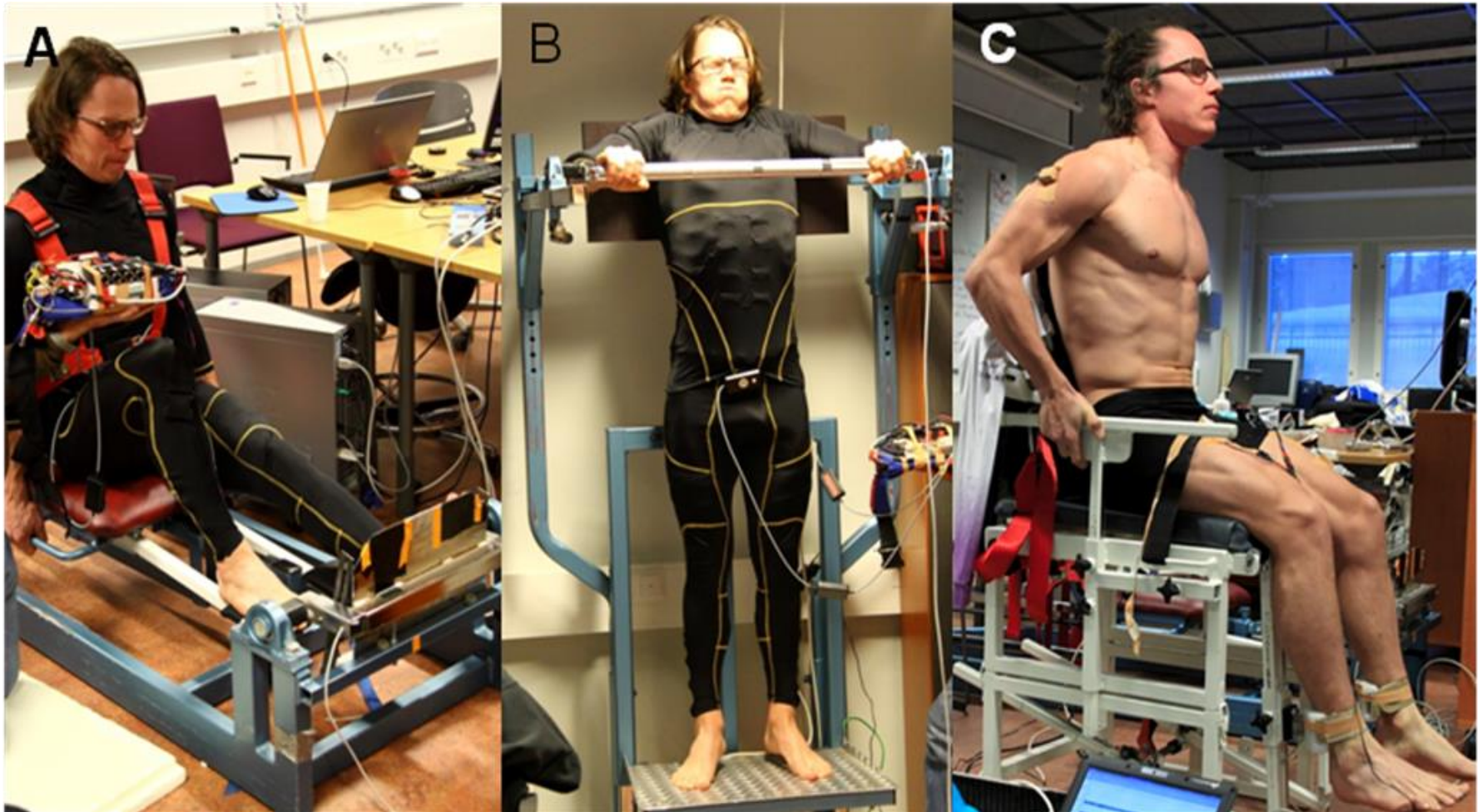


Graph

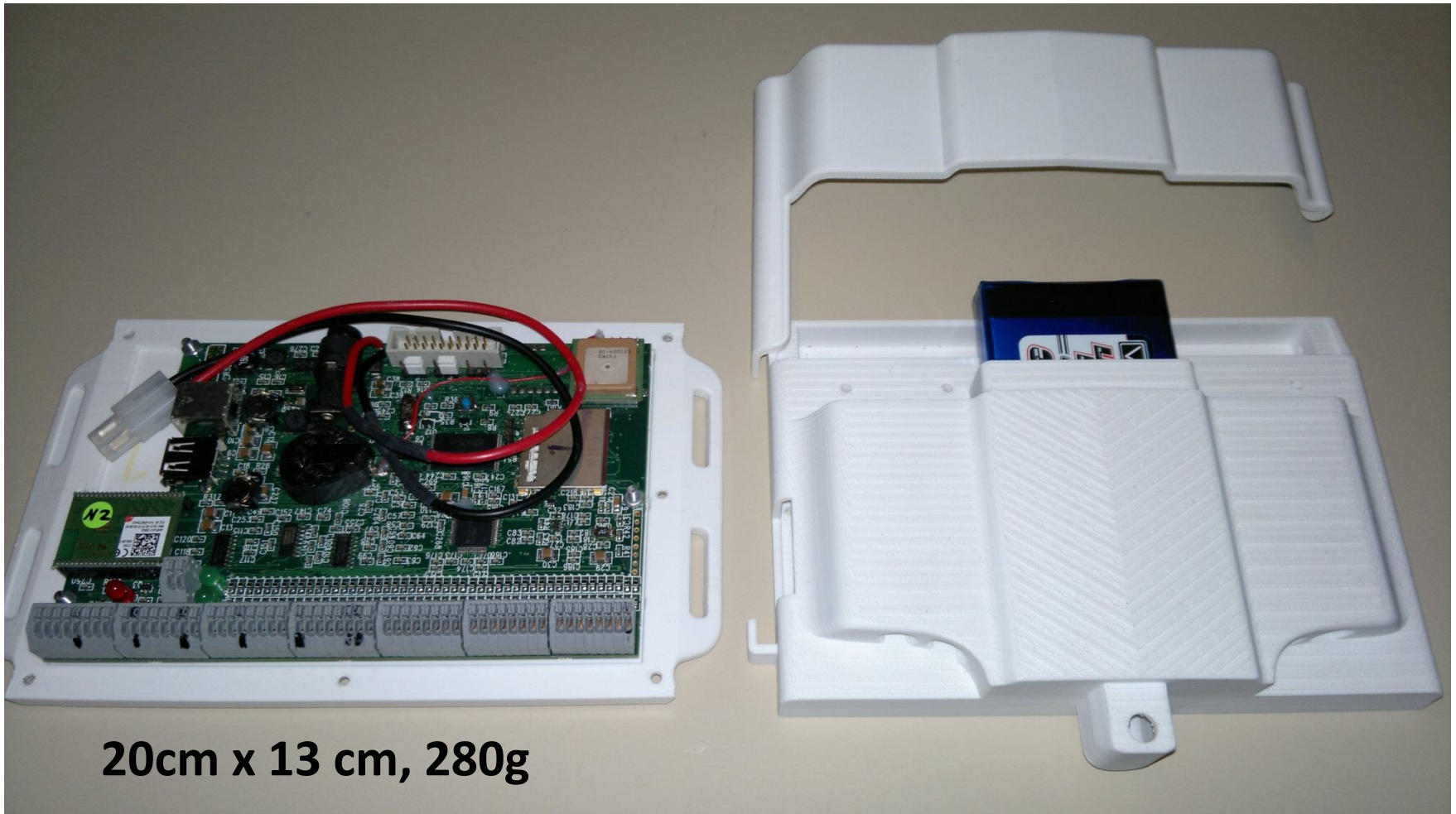
Components



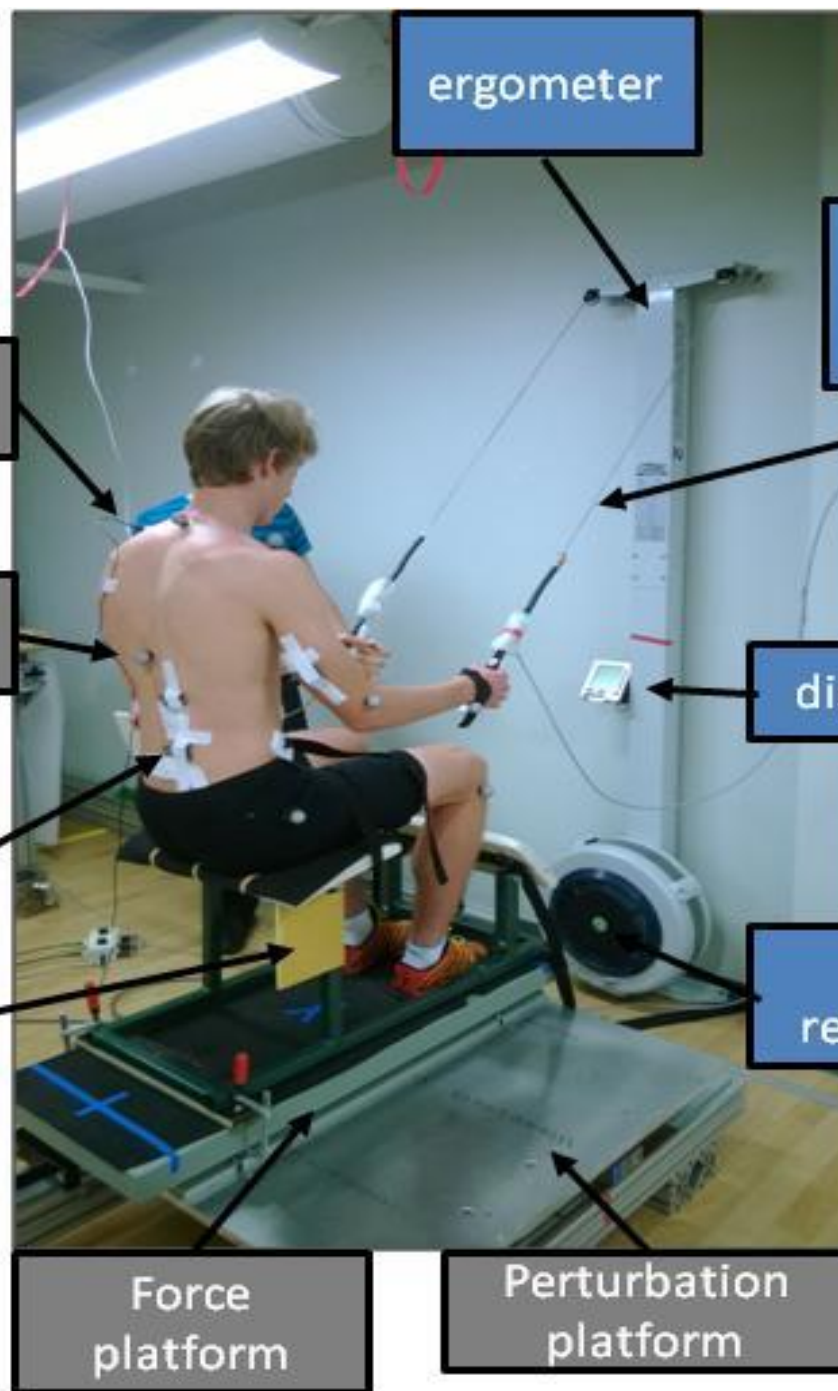
EMG suit (Myontec)



Force, EMG, Air pressure, GPS data



20cm x 13 cm, 280g



ergometer

Rope with force transducers

display

Air resistance

Perturbation platform

Force platform

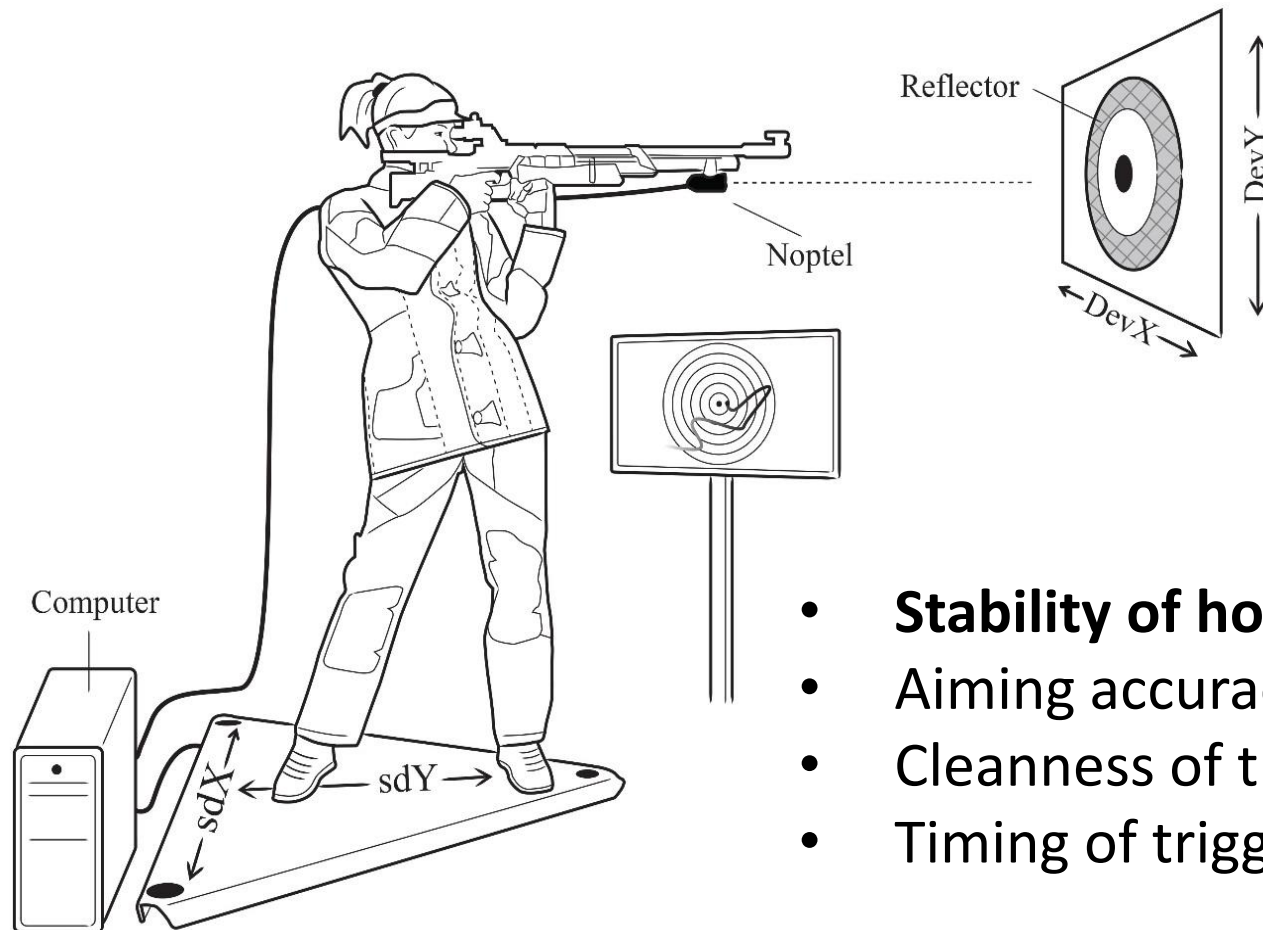
Adjustable chair

EMG

Reflecting marker

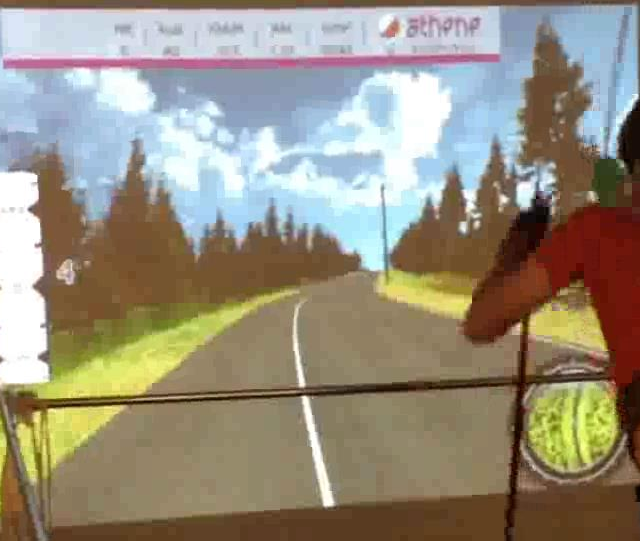
accelerator

Ihalainen S., Kuitunen S., Mononen K., Linnamo V (2015) Determinants of elite level air rifle shooting performance. Scandinavian Journal of Medicine and Science in Sports. In print

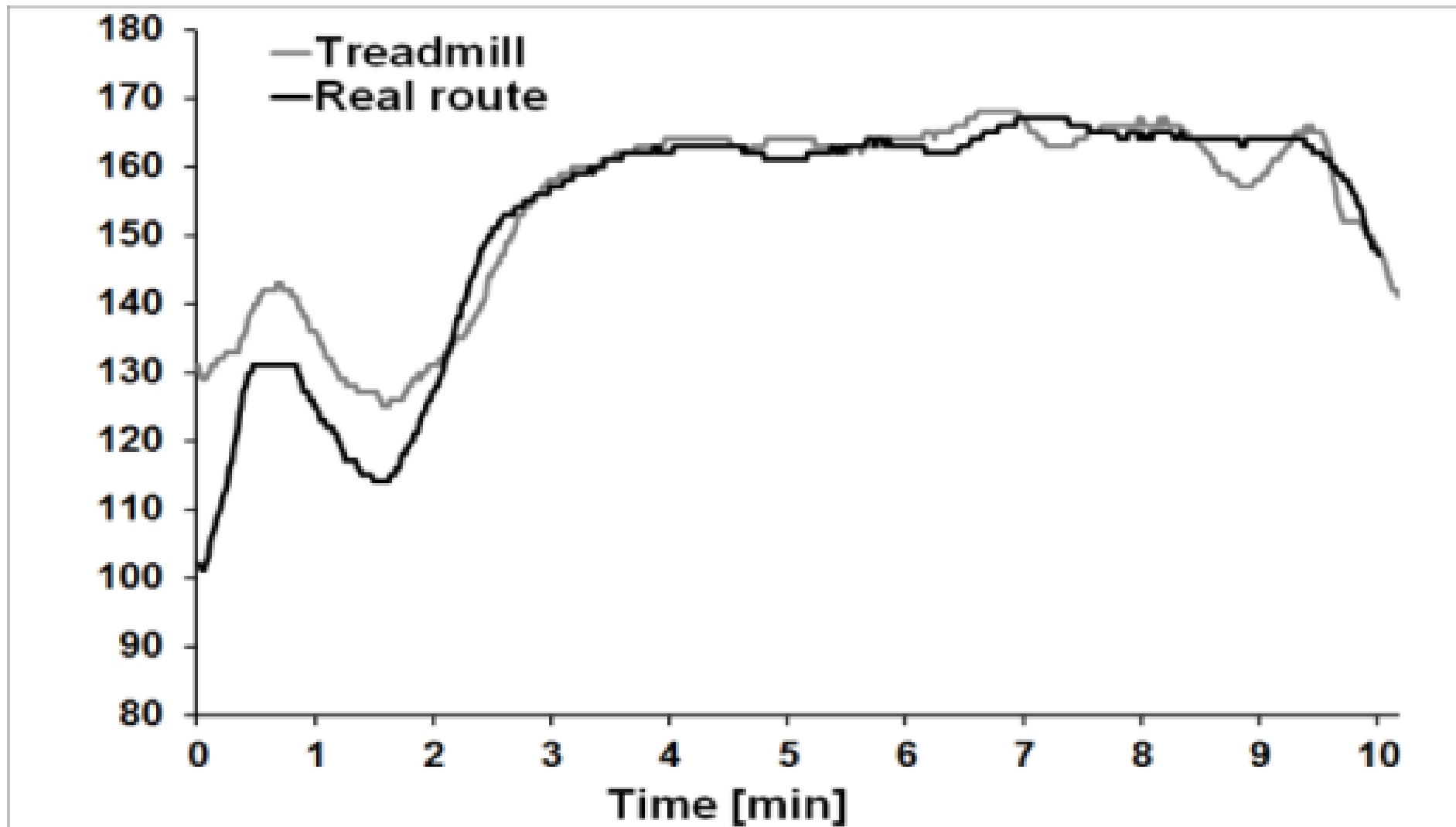


- **Stability of hold**
- Aiming accuracy
- Cleanness of triggering
- Timing of triggering





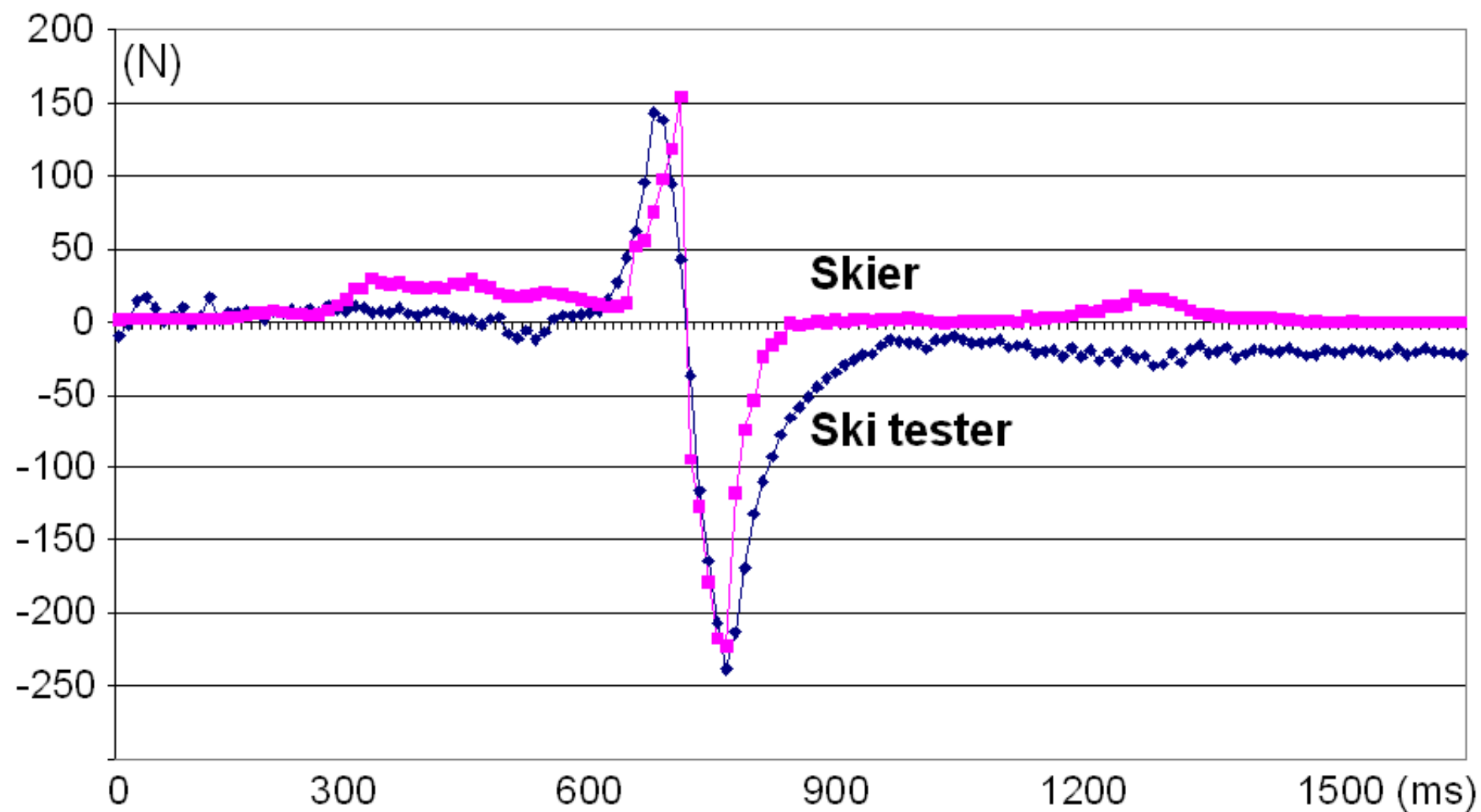
Heart rate



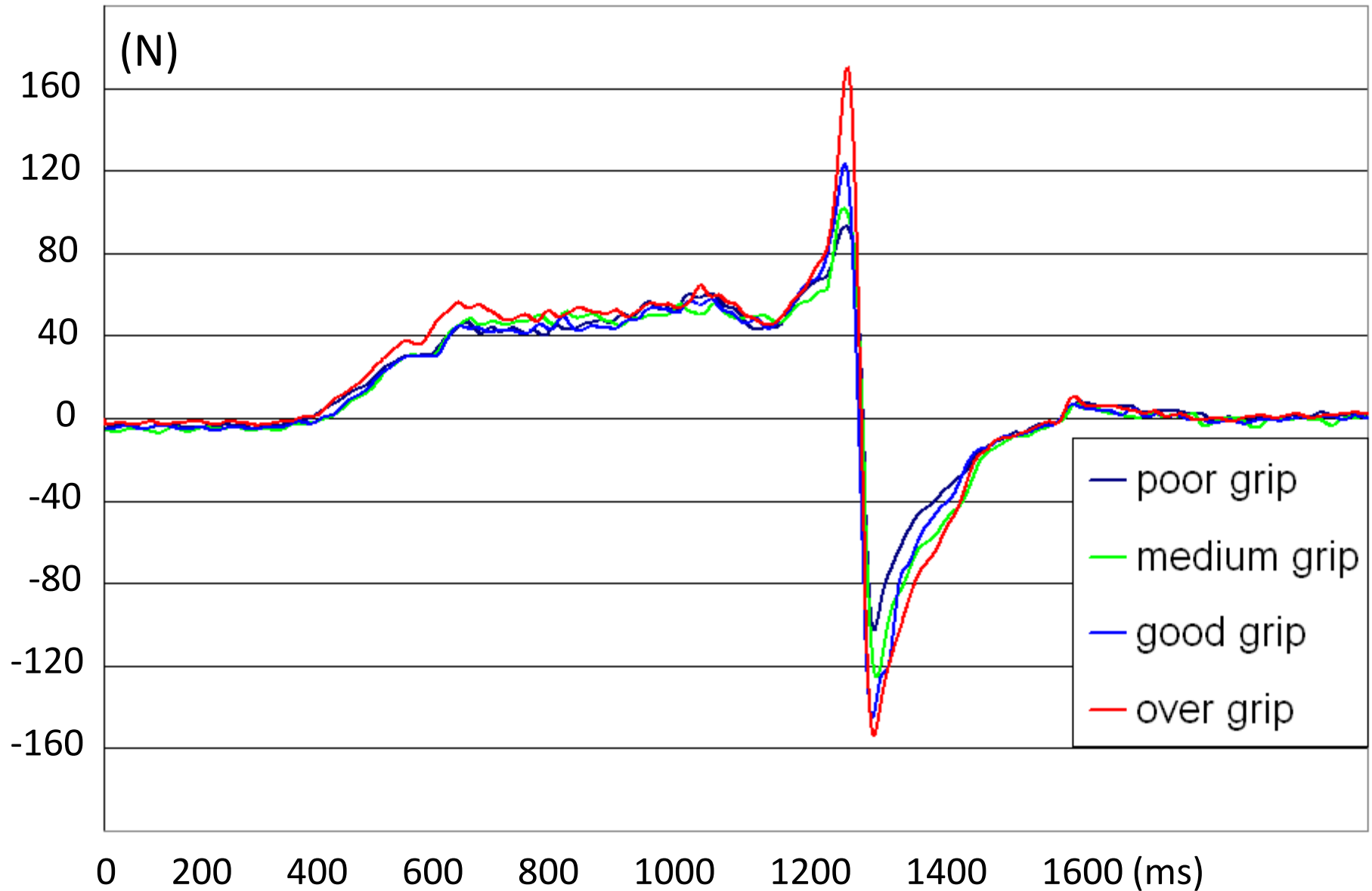
Linnamo V., Kolehmainen V., Vähäsöyrinki P., Komi P (2008)
Simulation of classical skiing using a new ski tester.
Science and Skiing IV. ISBN 978-1-84126-255-0, p. 615-620



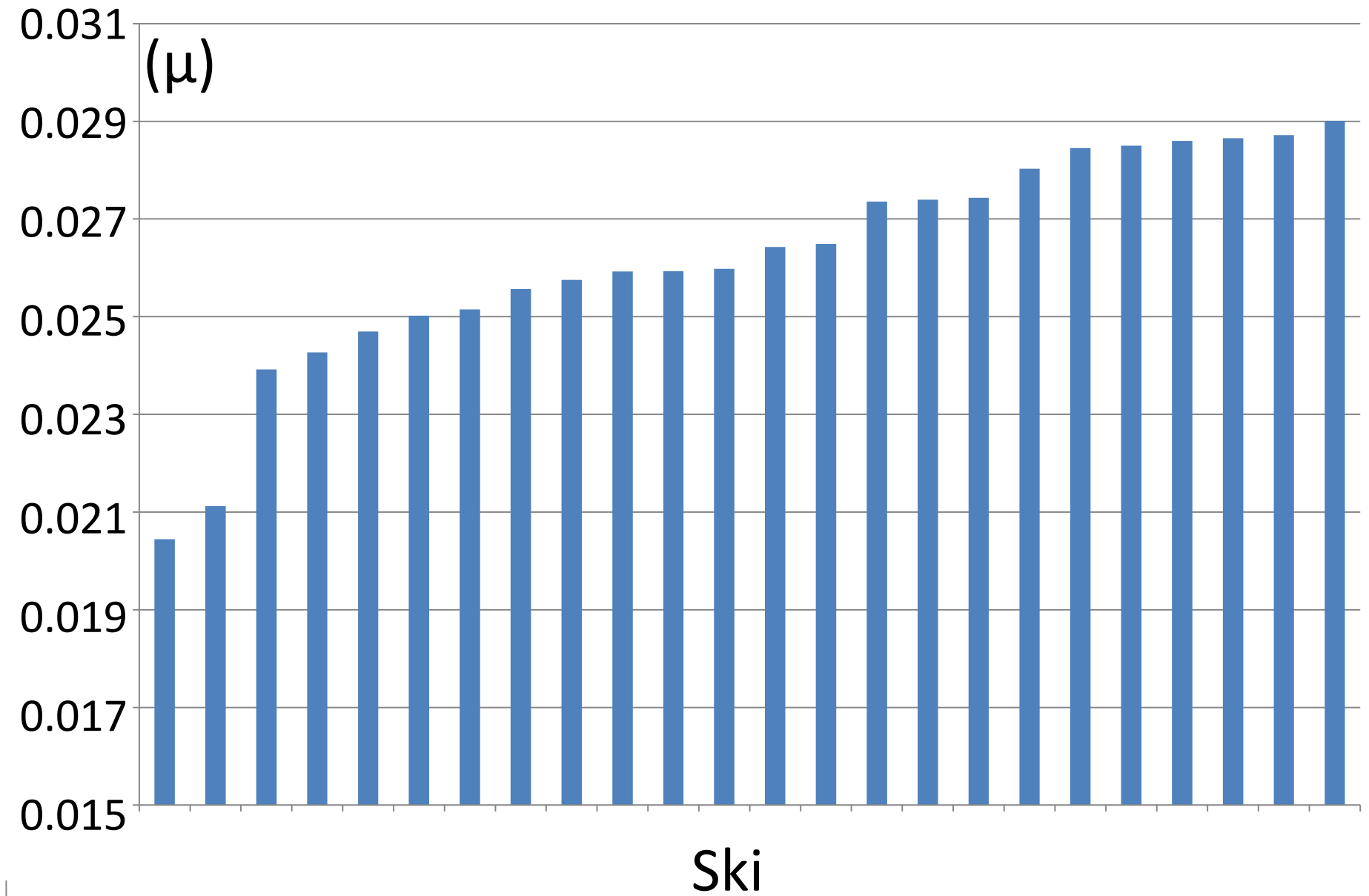
Horizontal force



Horizontal force Ski tester



Coefficient of friction with 40kg pressure



- Science

- Need for several subjects
- Comprehensive consideration of results
- “Unlimited” time resource
- No need for instant feedback

- Coaching

- One athlete and need for individual feedback
- Limited amount of known variables
- Informative and practical packet of results
- Instant delivery of results (seconds)

The COACHTECH project

- Feedback tool for coaching
 - Combining video(s) and analog signals
 - Not sport specific
 - Real time feedback
 - Easy to use
 - Web analyzing and storage
 - Academic information to coaches in easy form

Ohtonen O., Ruotsalainen K., Mikkonen P., Heikkinen T., Hakkarainen A., Leppävuori A., Linnamo V. Online feedback system for athletes and coaches. 3rd International Congress on Science and Nordic Skiing June 5-8.2015, Vuokatti, Finland, p 35

Coachtech - Principal

- Wireless Nodes (40 x 28 x 92 mm, 58g)
 - Analog signal acquiring
 - 8 channels, 16bits
 - +/-5V signals
 - +/- 200mV (EMG)
 - Accelerometer
 - Measurement frequency up to 1000Hz
 - One or several (max 13)
- Cameras, GoPro Hero 3 (4)
 - 100Hz
 - HD (720p)
- Access points and server computer
- **System collects and synchronizes all the data (videos, analog signals) automatically**



switch back to normal mode

Play

previous frame

next frame

Video speed: 0.1x

1x

Current video speed: 1.00x

2012-06-20 16:04:00 IN_TT_24

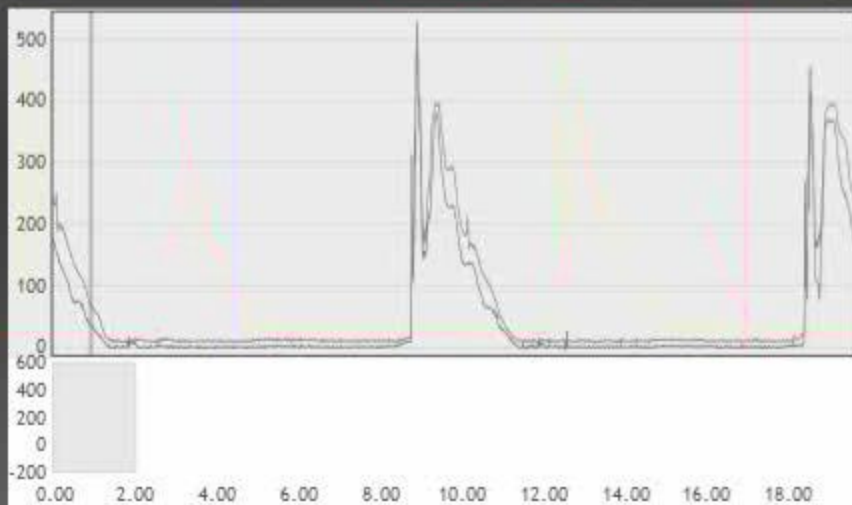
Manage

OIKEA SAUTYA: Syklin kesto [s]:1.00 Syklin mitta [m]:0.63 Nopeus [m/s]:0.60 Kulma: [deg]1.94 Huippuvoimien k.a [N]:371.15 Impulssien k.a: 41.04 VASEN SAUTYA: Huippuvoimien k.a [N]412.90 Impulssien k.a 52.28



Cameras: rear side
nopeus: 23.99 kulma: 1.84

☒ oikea ☒ vasen



2012-06-20 16:04:00 IN_TT_24

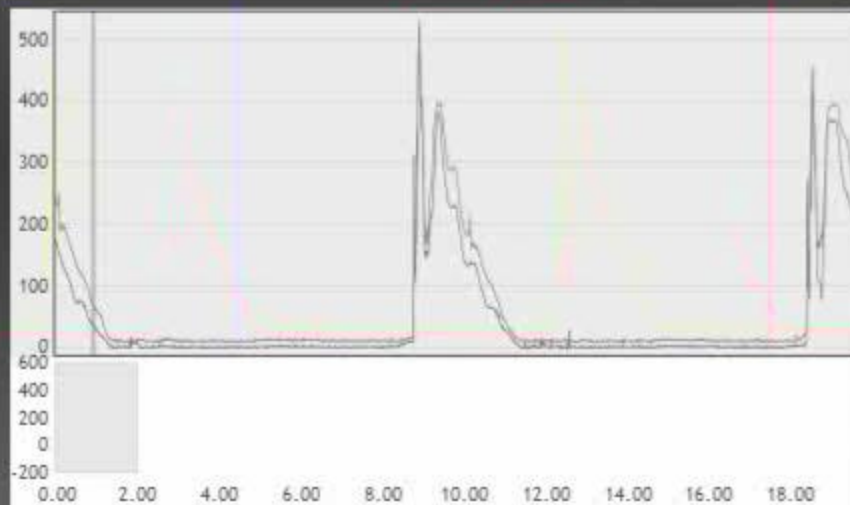
Manage

OIKEA SAUTYA: Syklin kesto [s]:1.00 Syklin mitta [m]:0.63 Nopeus [m/s]:0.60 Kulma: [deg]1.94 Huippuvoimien k.a [N]:371.15 Impulssien k.a: 41.04 VASEN SAUTYA: Huippuvoimien k.a [N]412.90 Impulssien k.a 52.28



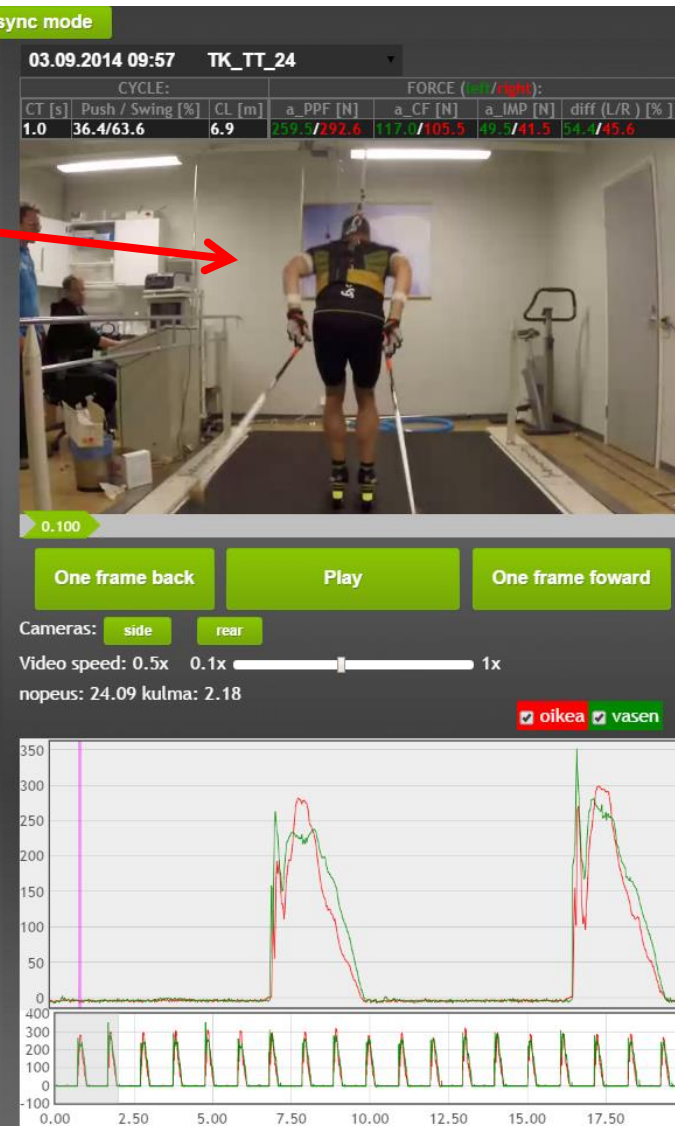
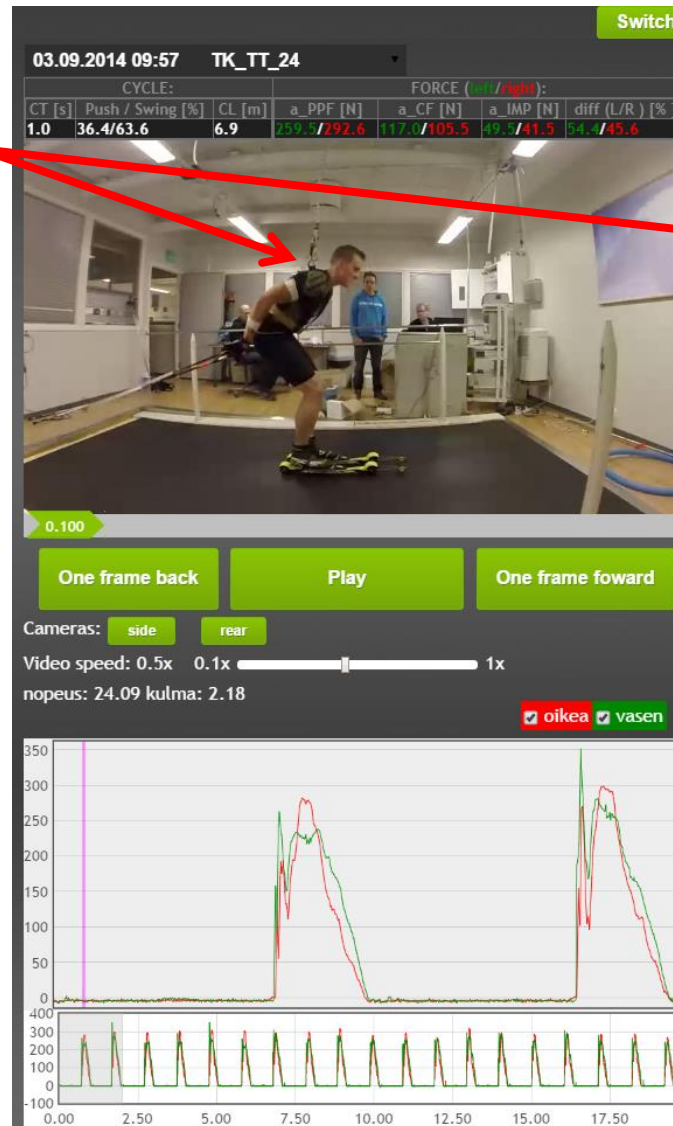
Cameras: rear side
nopeus: 23.99 kulma: 1.84

☒ oikea ☒ vasen

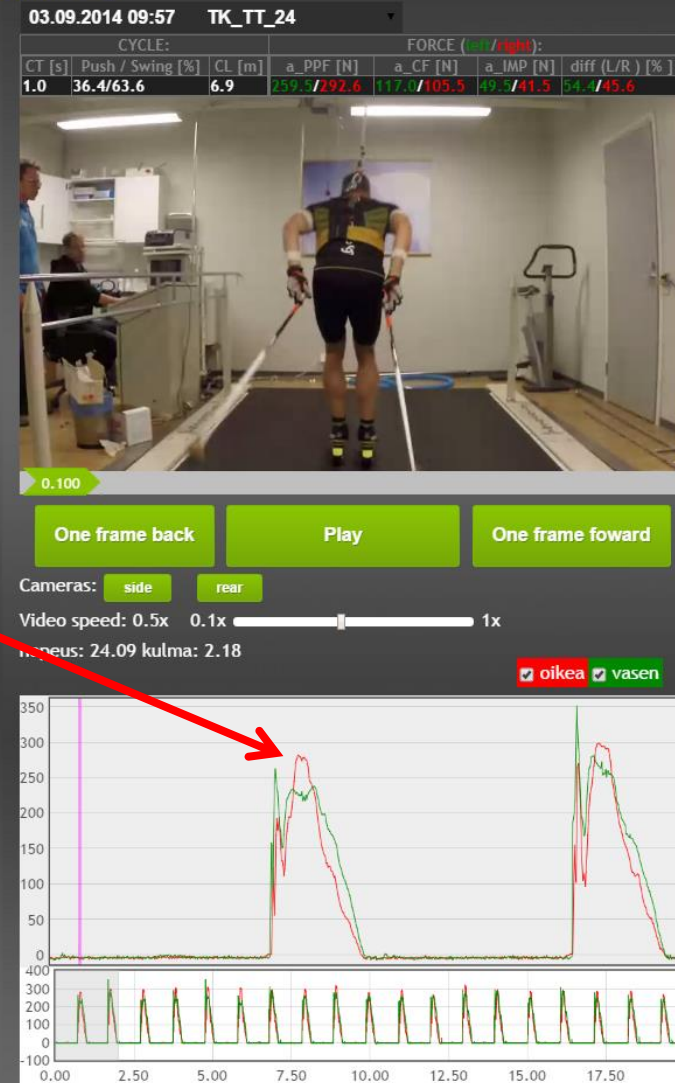
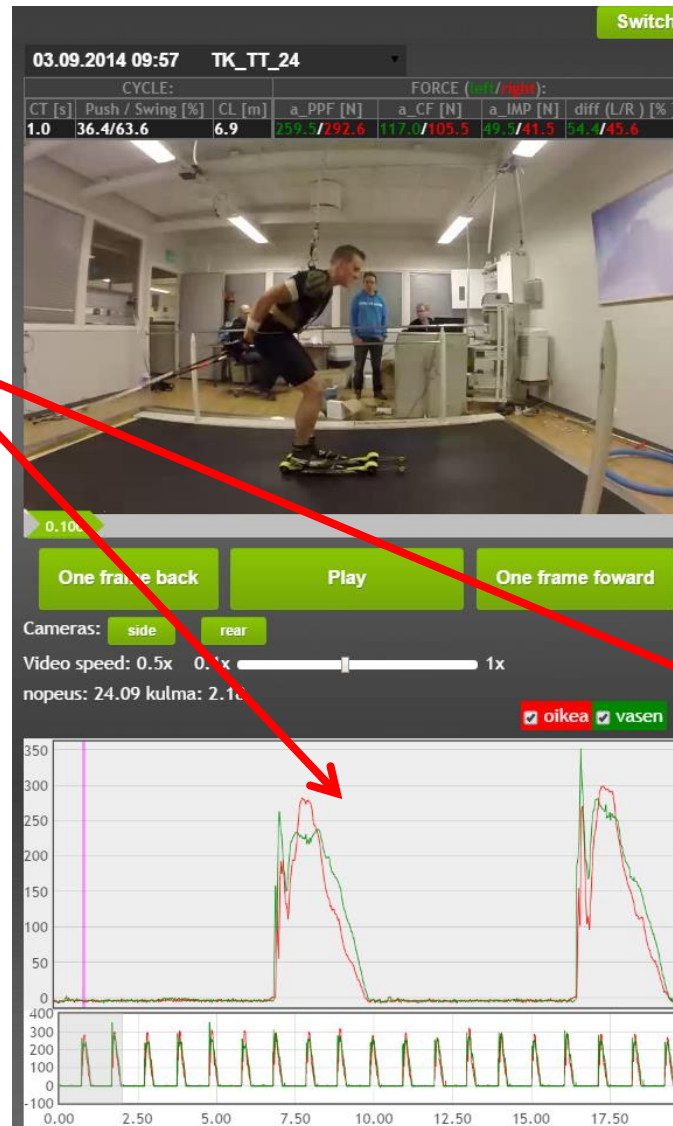


Data *almost* online after trial

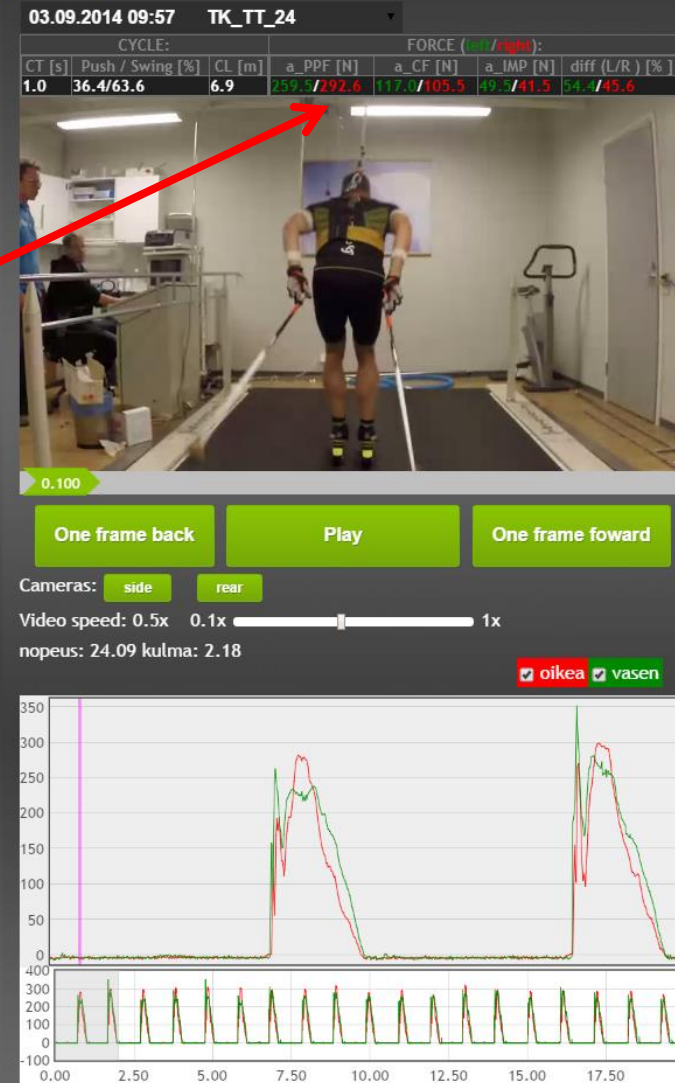
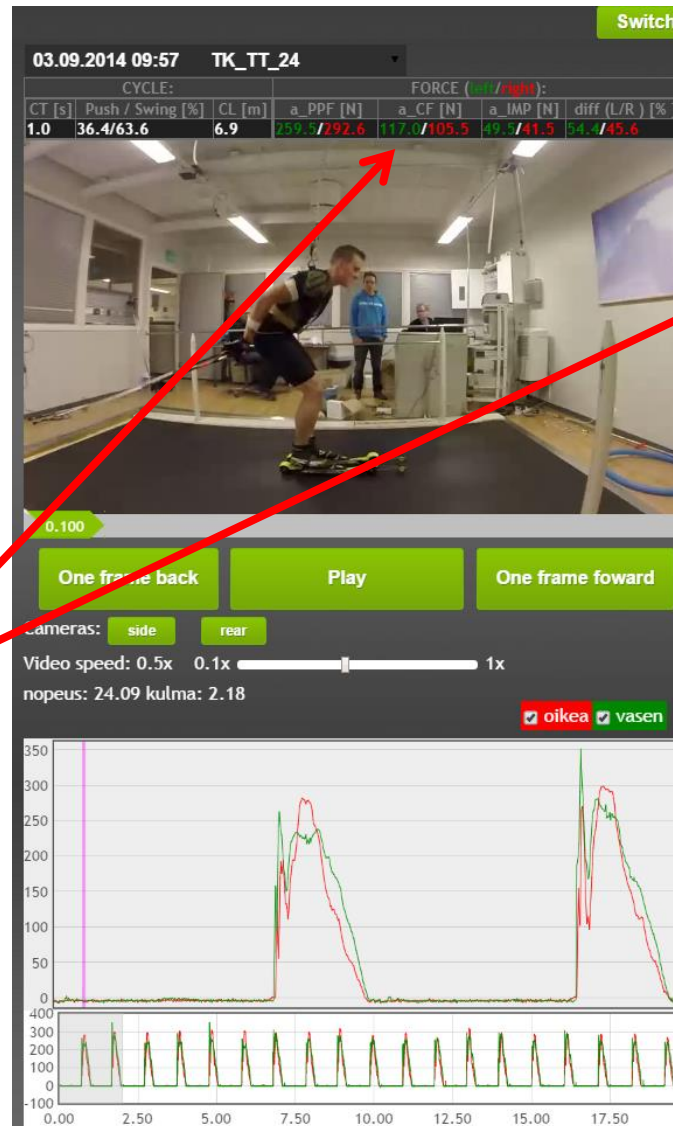
- Videos from one or several angle



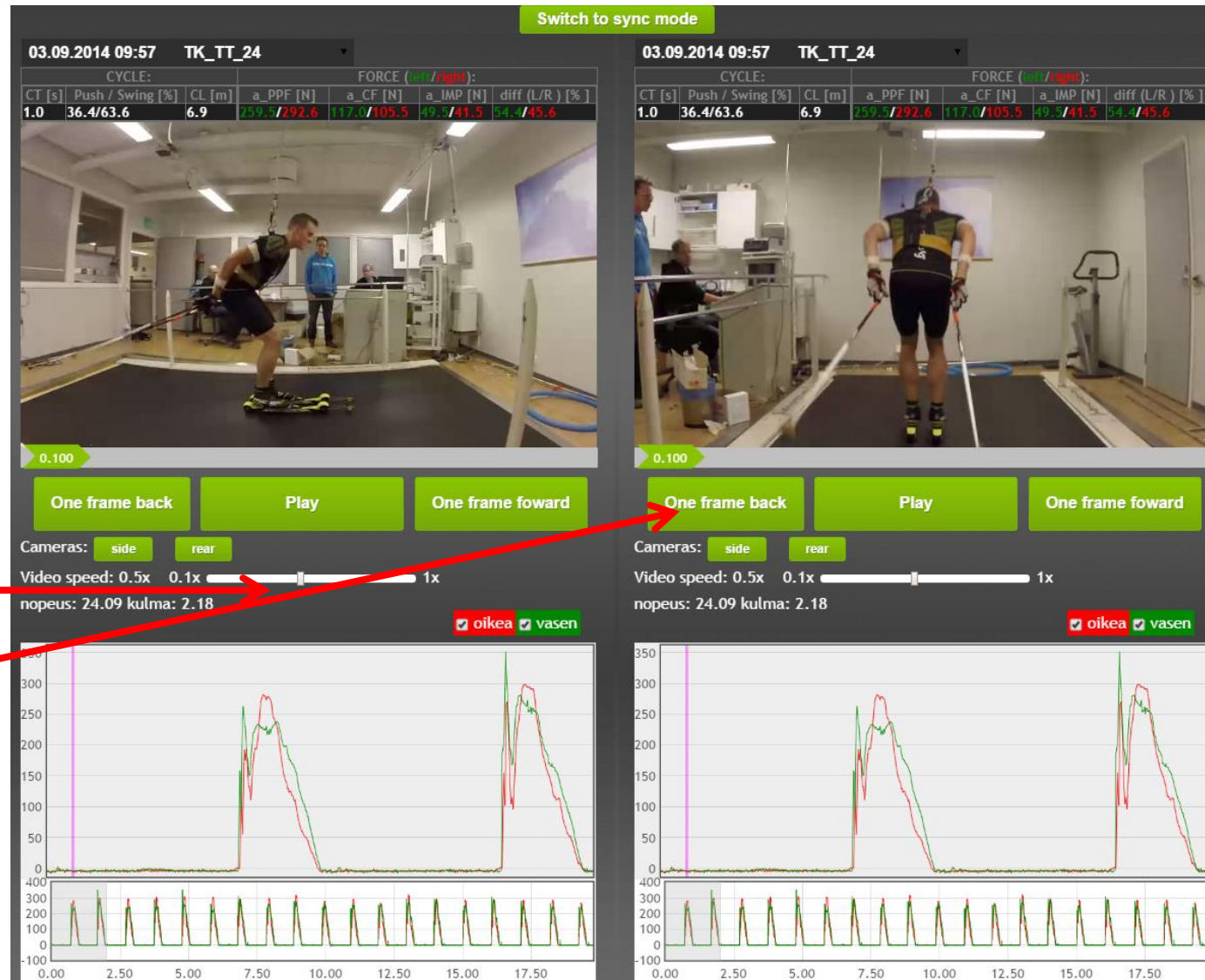
- Videos from one or several angle
- Force or other signal as curve



- Videos from one or several angle
- Force or other signal as curve
- **Desired parameters calculated**



- Videos from one or several angle
- Force or other signal as curve
- Desired parameters calculated
- **Video**
 - **Slow motion**
 - **Frame by frame**
 - **Comparing to other trials**



Switch to normal mode

20.03.2015 10:18 RÄ_

avg Fx (L/R) [N]		Net Impulse [Ns]		Jump			balance (L/R) [%]	
static	dynamic	Fy	inrush	time [s]	angle [°]	height [cm]	static	dynamic
45/47	30/51	48.5	5.07	0.68	62.1	26.5	50/50	48/52



0.34

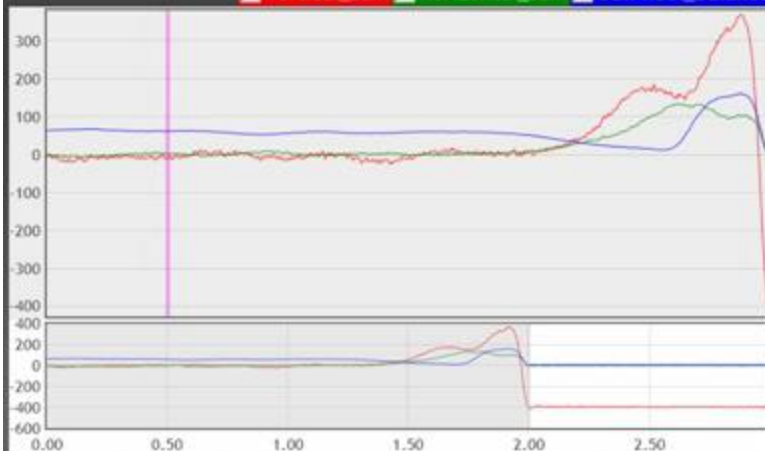
One frame back

Pause both

One frame forward

Cameras: ☒ side ☒ back Video speed: 0.1x 0.25 1x

☒ vertical_sum ☒ horizontal_sum ☒ ball-heel_balance



20.03.2015 10:18 RÄ_

avg Fx (L/R) [N]		Net Impulse [Ns]		Jump			balance (L/R) [%]	
static	dynamic	Fy	inrush	time [s]	angle [°]	height [cm]	static	dynamic
45/47	30/51	48.5	5.07	0.68	62.1	26.5	50/50	48/52



0.34

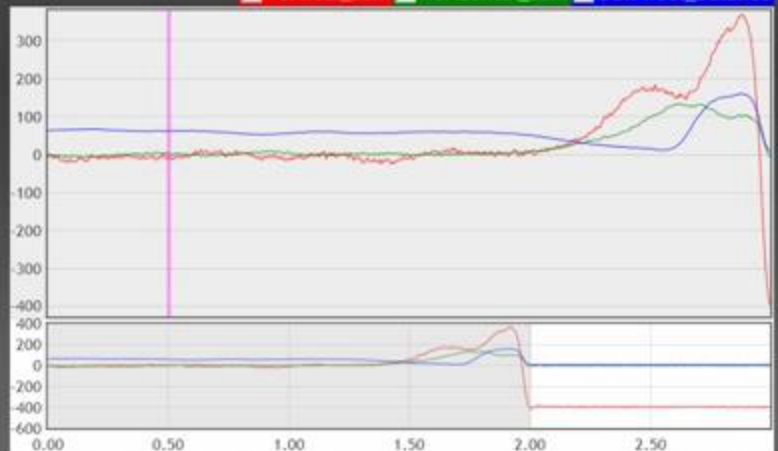
One frame back

Pause both

One frame forward

Cameras: ☒ side ☒ back Video speed: 0.1x 0.25 1x

☒ vertical_sum ☒ horizontal_sum ☒ ball-heel_balance



Switch to normal mode

30.10.2015 13:36 VK_3

ShowHide Comments

GATES			CONTACT	FLIGHT	STEPS	
speed [m/s]	split [s]	time [s]	time [ms]	time [ms]	freq [Hz]	length [m]
9.04	1.106	1.106	91 / 88	143 / 114	4.55	2.11 / 1.83
-	-	-	92 / 89	141 / 112	4.63	2.11 / 1.82

Time: 0.0



0.00

One frame back

Play both

One frame forward

Cameras:

cam 1

cam 2

Video speed: 0.1x

0.5

1x

☒ gates ☒ contacts



30.10.2015 13:36 VK_3

ShowHide Comments

GATES			CONTACT	FLIGHT	STEPS	
speed [m/s]	split [s]	time [s]	time [ms]	time [ms]	freq [Hz]	length [m]
9.04	1.106	1.106	91 / 88	143 / 114	4.55	2.11 / 1.83
-	-	-	92 / 89	141 / 112	4.63	2.11 / 1.82

Time: 0.0



0.00

One frame back

Play both

One frame forward

Cameras:

cam 1

cam 2

Video speed: 0.1x

0.5

1x

☒ gates ☒ contacts



The one who says: "It cannot be done", should never interrupt the one who is doing it