

# Measurement Technologies in Cross Country Skiing

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AHEAD OF ITS TIME  
FOR 150 YEARS



UNIVERSITY OF JYVÄSKYLÄ  
JYVÄSKYLÄN YLIOPISTO

100 km

FINLAND

Central Finland

Jyväskylä

Helsinki











# 20m long force plate system

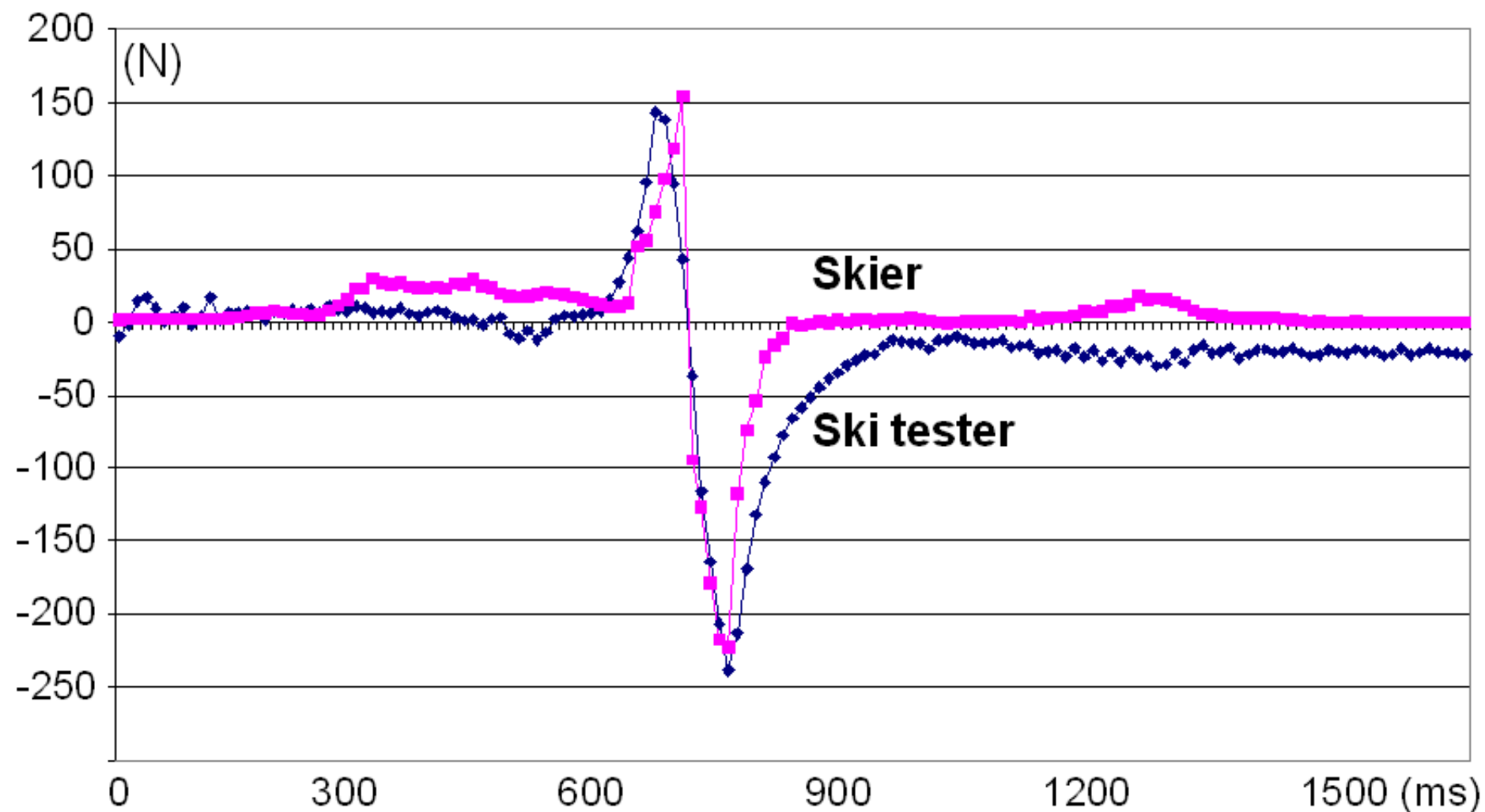


# Equipment testing

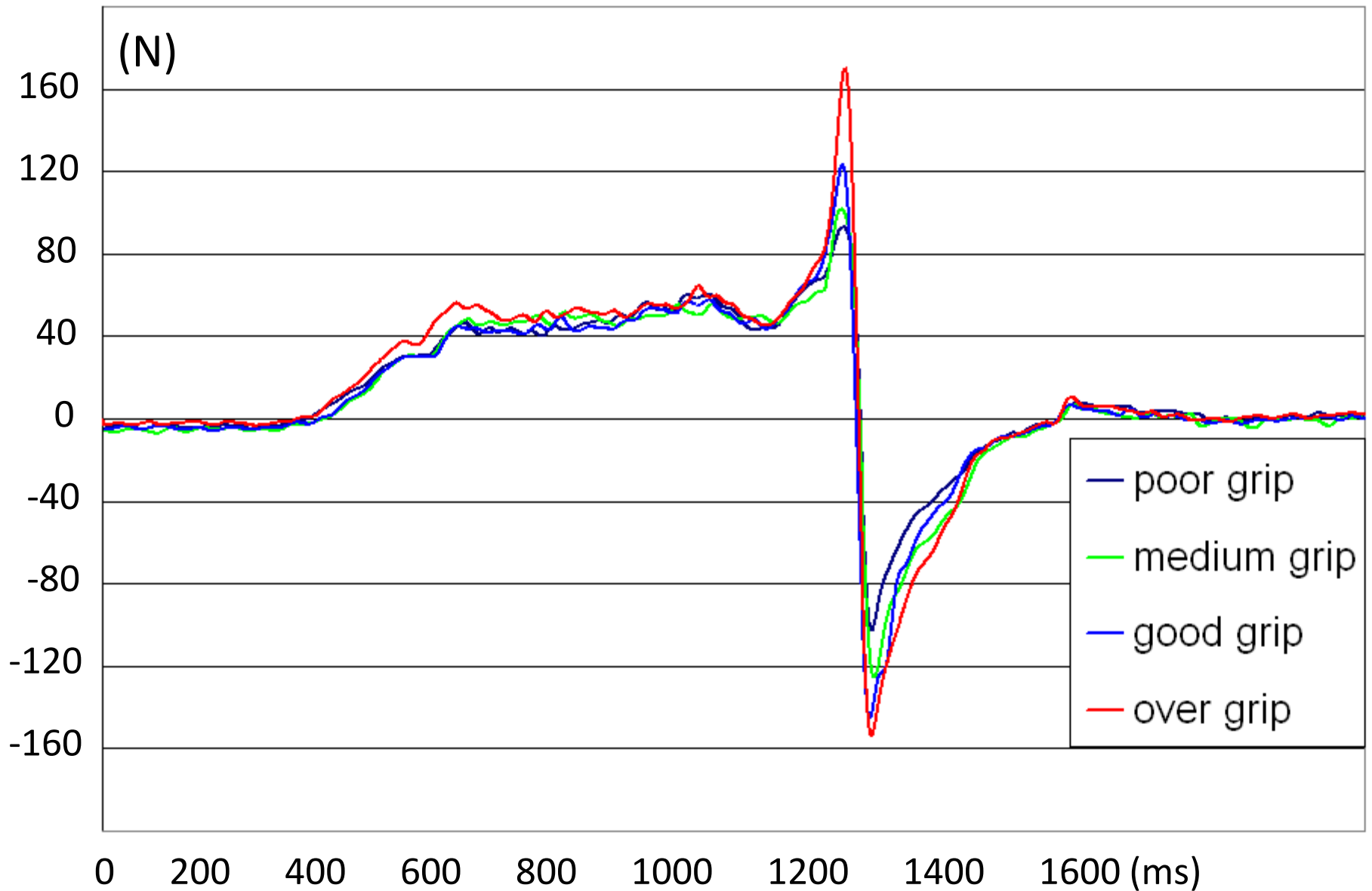




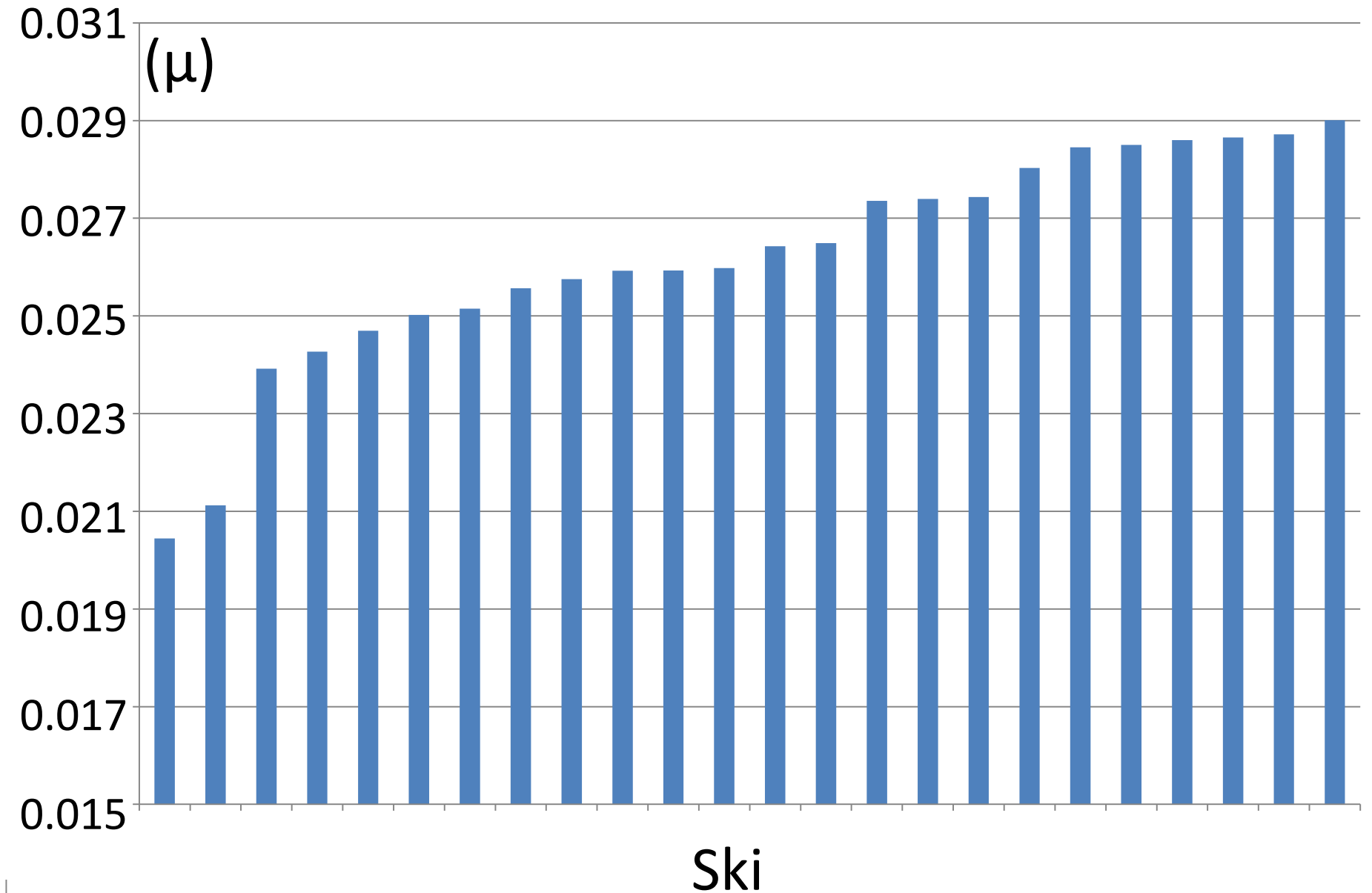
# Horizontal force



# Horizontal force Ski tester



# Coefficient of friction with 40kg pressure



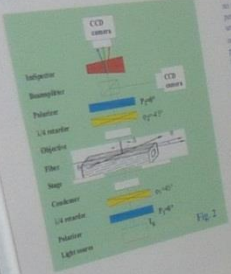
# Pressure distribution mat

...have been able for the  $\lambda$  length, width collapse

SFE method (3) is developed based on microscopic transmission spectroscopy (optometry), capability of real-time measurement of a fiber for  $n$  and  $\lambda$ .

### Measurement principle and demonstration

- SFE method uses an optical arrangement (Fig.2) sensitive to the orientation of the fiber sample, determined only by the fiber's  $q$  and  $\lambda$ .



**Conclusion**

- SFE method requires no sample preparation and periodic quantitative measurement of mean pore fibers oriented randomly in the measured angle  $\theta$  and calculates a pressure proportional to the cell wall thickness. It is suitable for on-line measurement of fibers. It is suitable to conduct continuous quality for use not only in laboratory but also under on-line condition based on the method for measurement of  $n$  and  $\lambda$  in addition to other parameters such as the fiber's length, width and shape.

**References**

- [1] C.M. Cundy, et al., *Journal of Control & Technology*, 6, 161-169 (2002).
- [2] B.A. C. Tang, *World Science*, 8, 133-139 (1977).
- [3] T.C. Li, "Microscopic imaging observation on-line measurement of single strand wool fibers", *unpublished* for publication in *Text. Res. J.* (2005).
- [4] T.C. Li, "Measurement of the microfiber angle and pore thickness of fiber pulp fibers by microscopic imaging observation", *submitted to be published in Textile Prog. & Paper Electron. Journal*, 223 (2005).

**MILA**  
Mikrostruktur  
Laboratory



# Pole testing

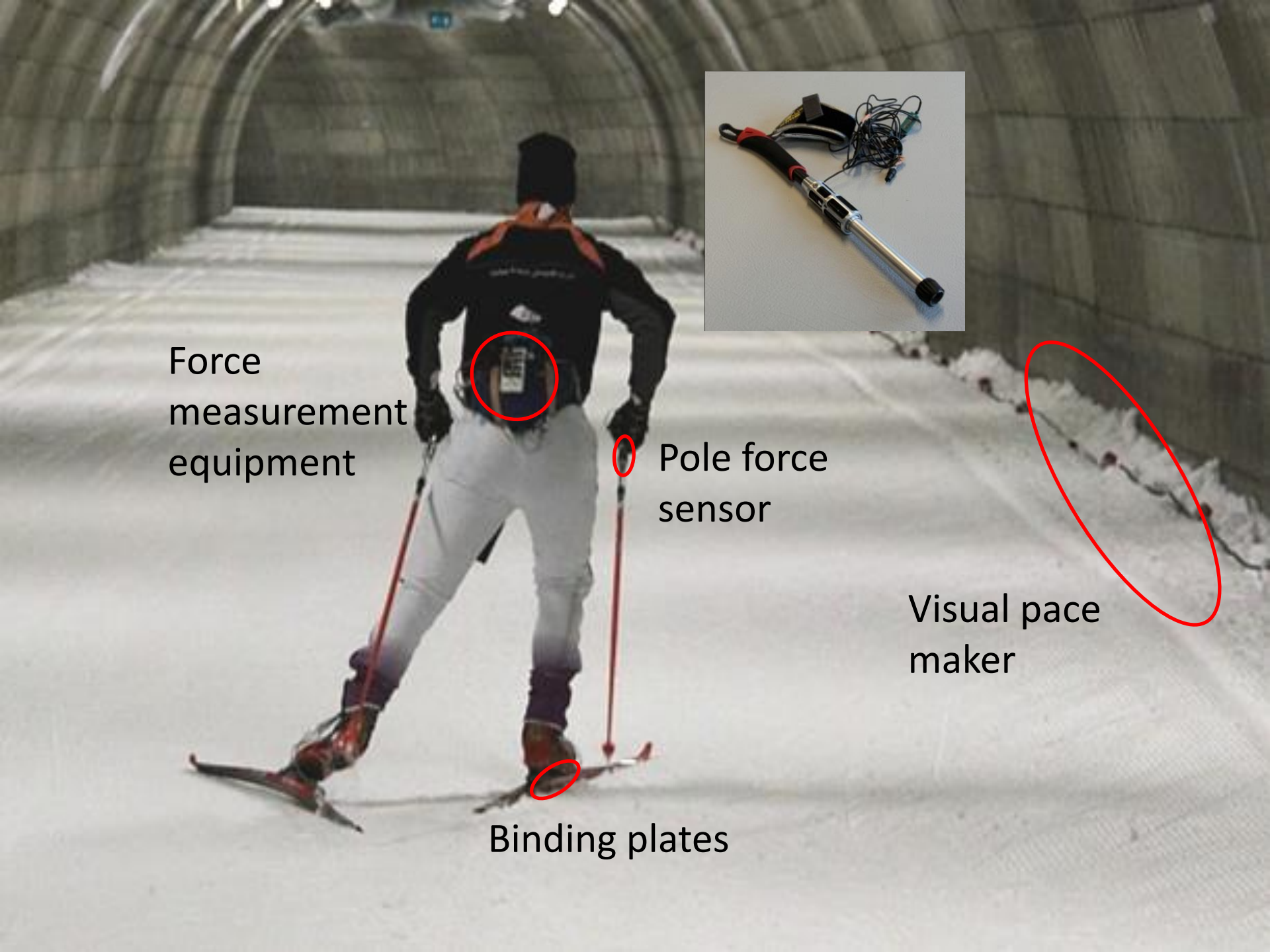


## Custom made binding plate pair

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





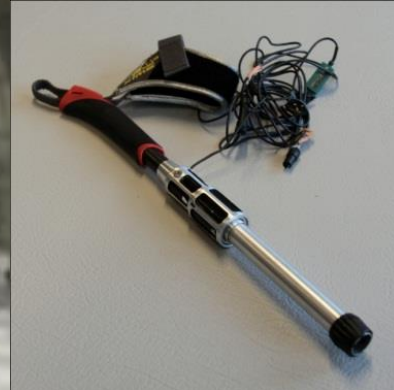


Force measurement equipment

Pole force sensor

Binding plates

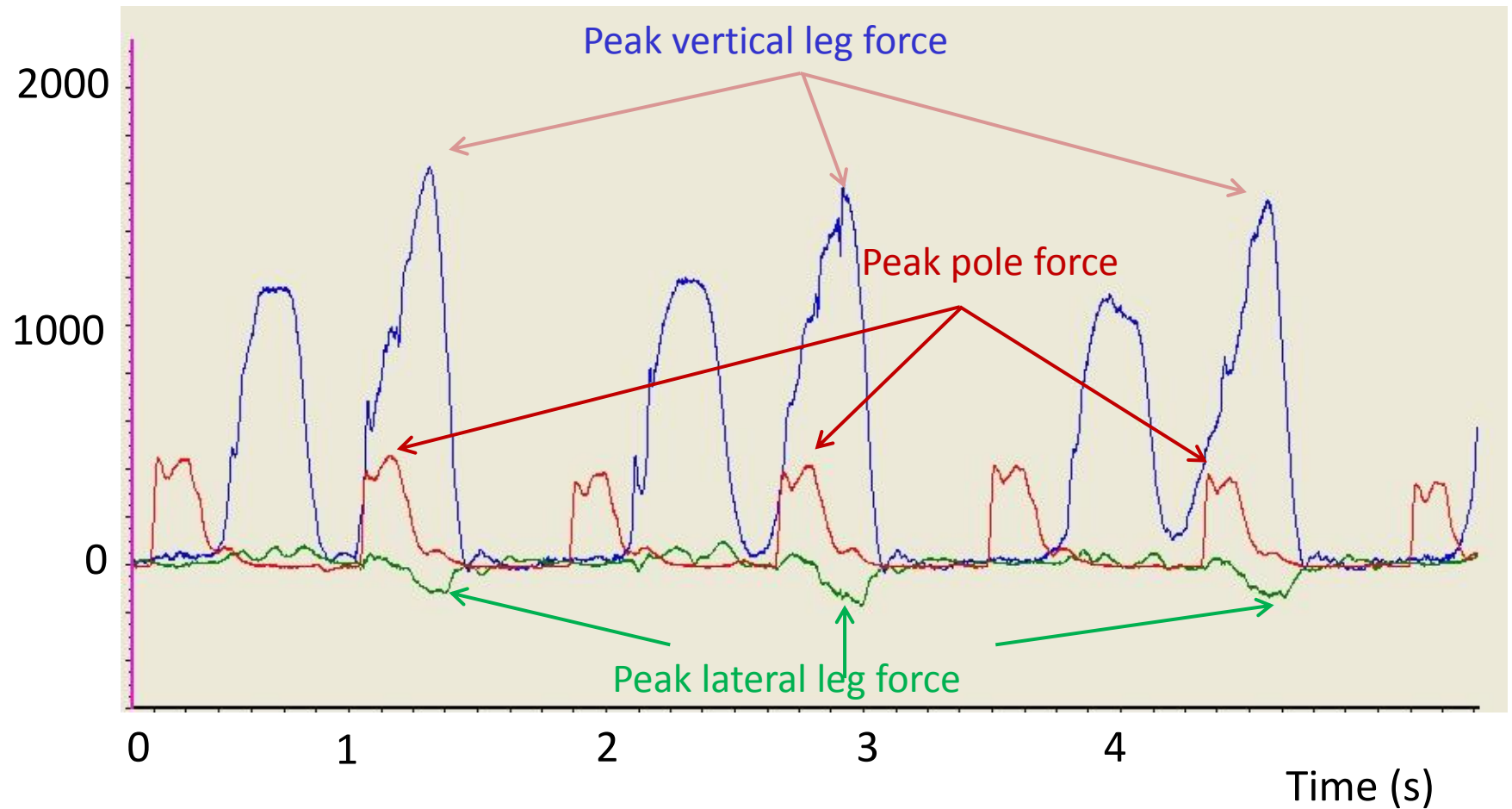
Visual pace maker



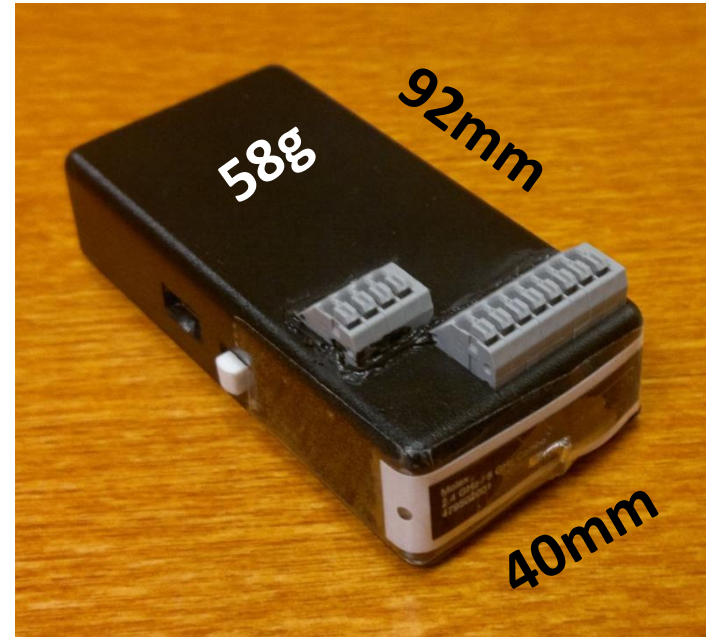


## Force variables - Average of 9 cycles

Force (N)



# Wireless data transmission

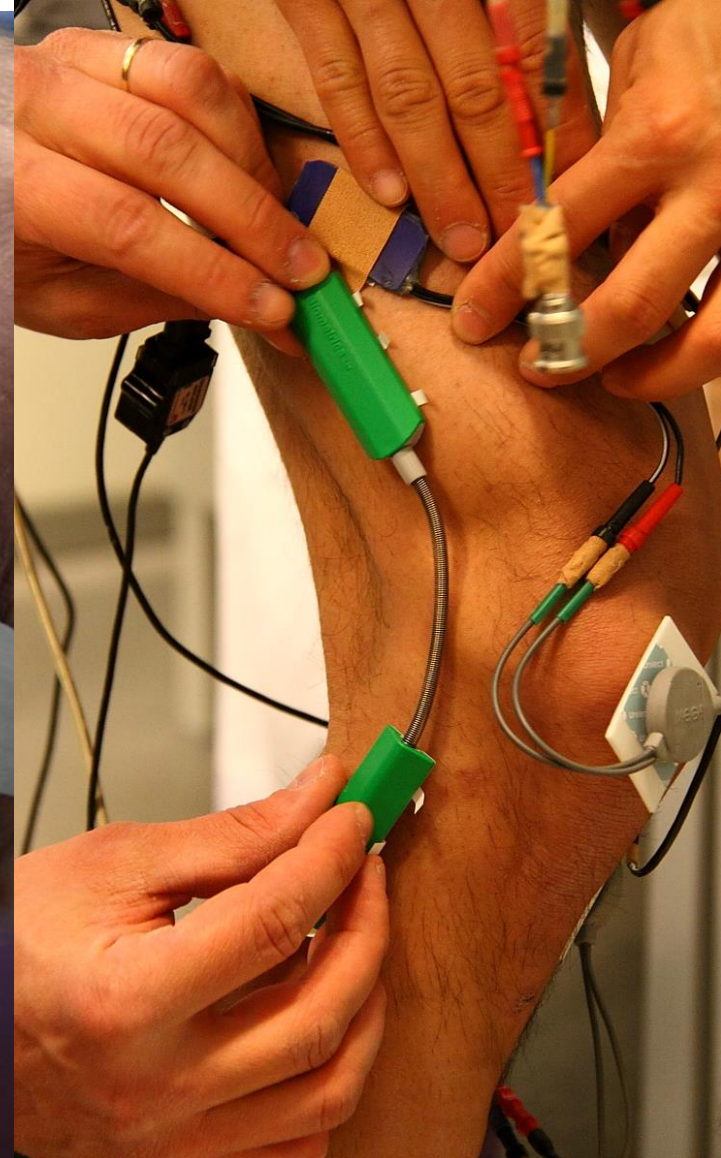
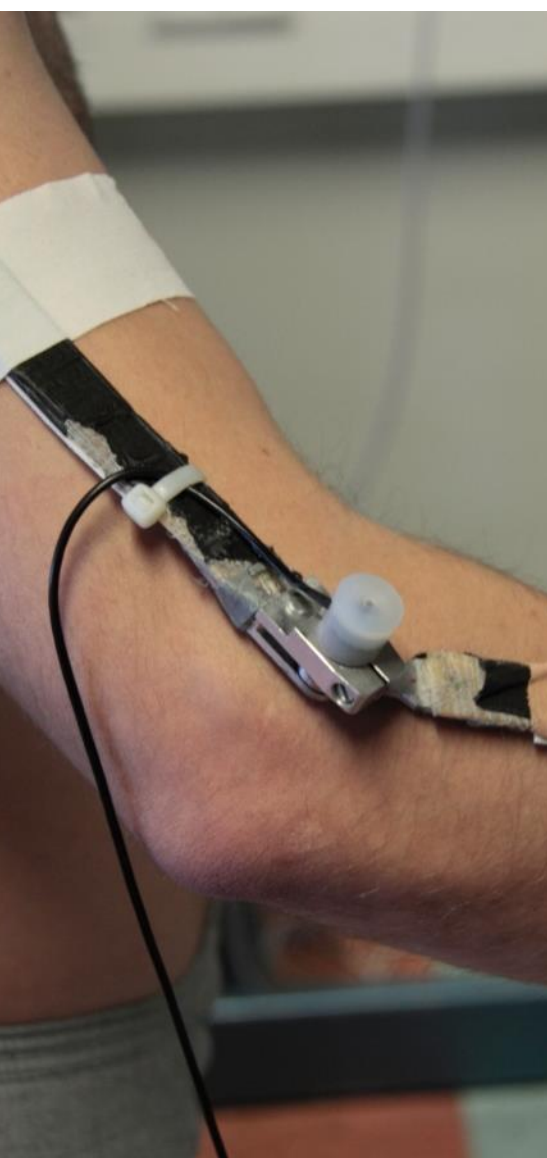


# Motion analysis

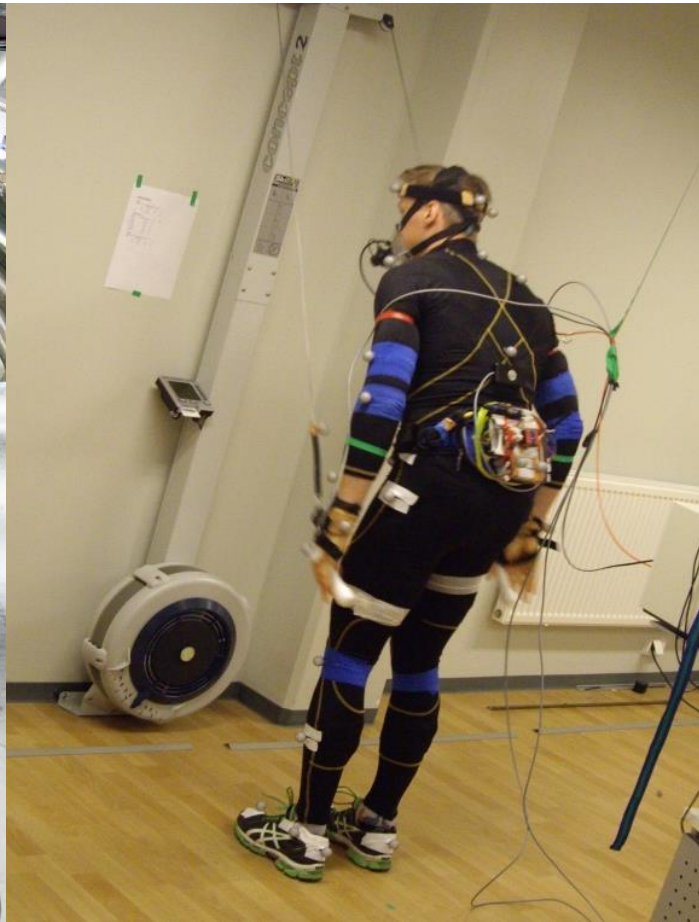




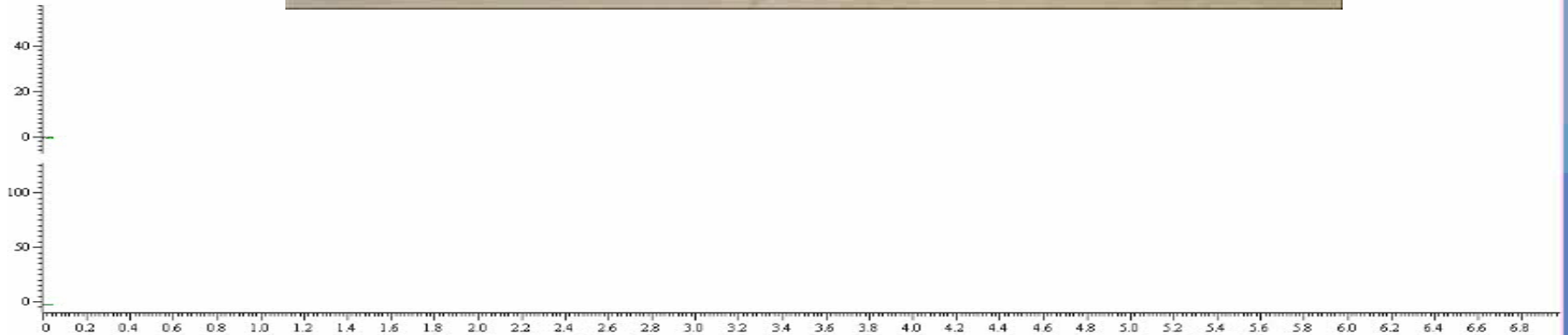
# Goniometers



# Double poling vs. ergometer

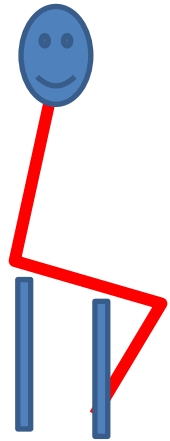


# Paralympic research

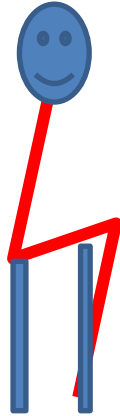


# Classification project

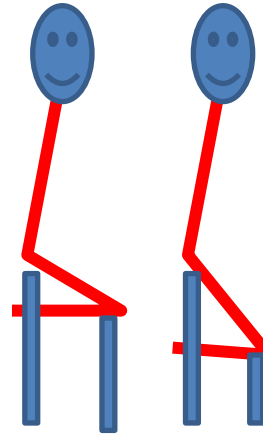
Position 1 „neutral“



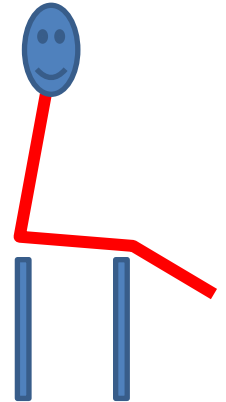
Position 2 „Max hip flexion“



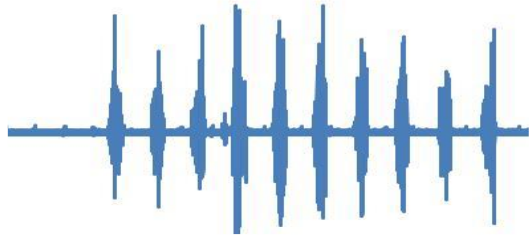
Position 3 A, B „hip extension“



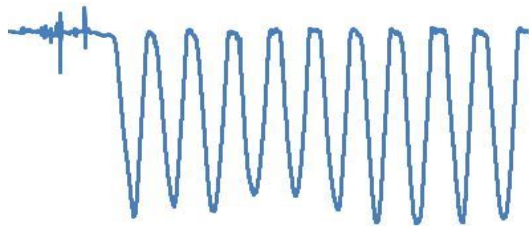
Position 4 „long seat“







EMG  
Rectus abd.

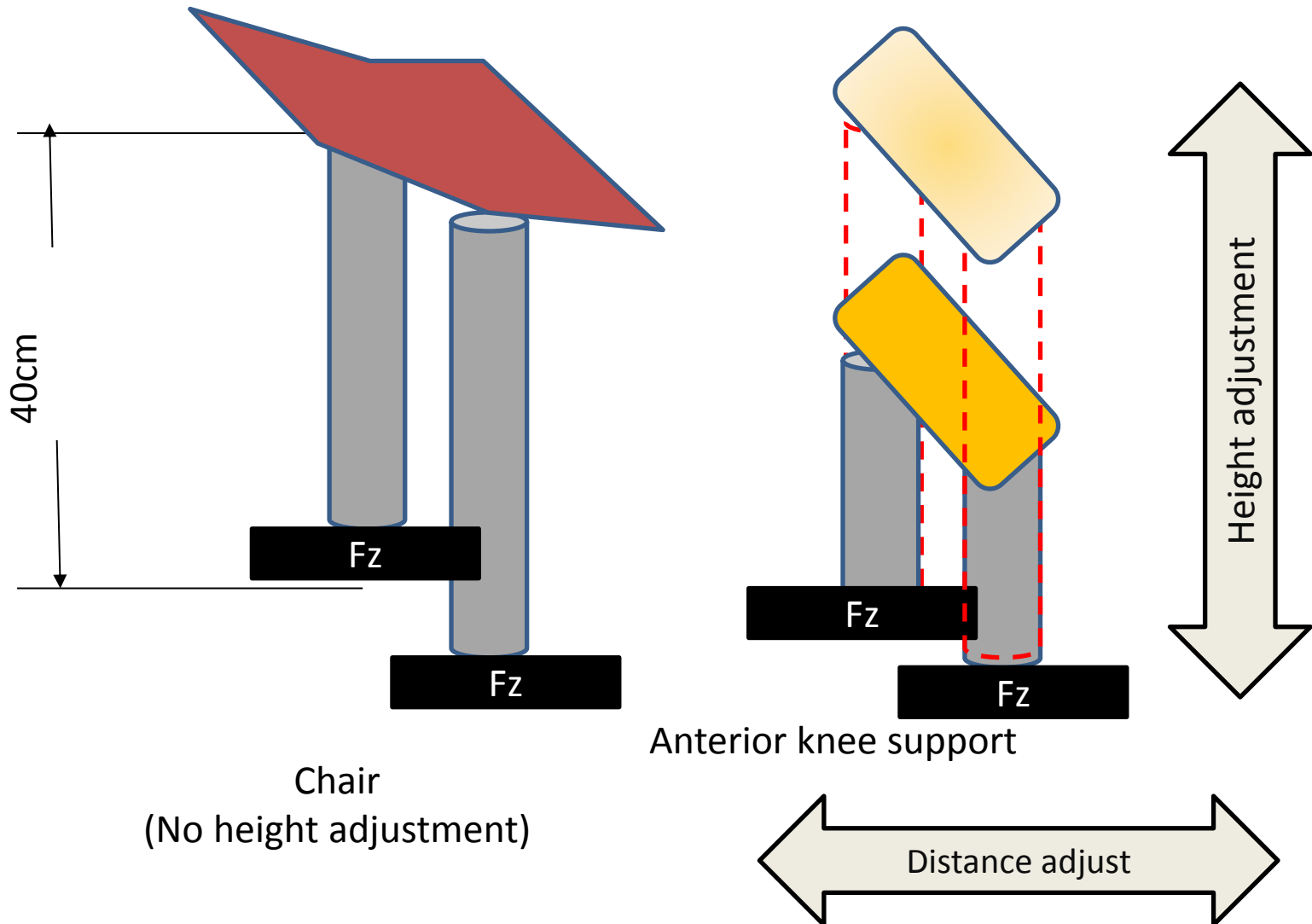


Force





# Sitting platform (to be constructed)





- Sudden perturbation on a dynamic force platform to check the response; EMG, acceleration, center of pressure



# Effect of arm swing

- With mathematical modeling to determine what is the effect of the level of arm amputee to performance



- wrist
- elbow
- shoulder



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## “Tunnel people”





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