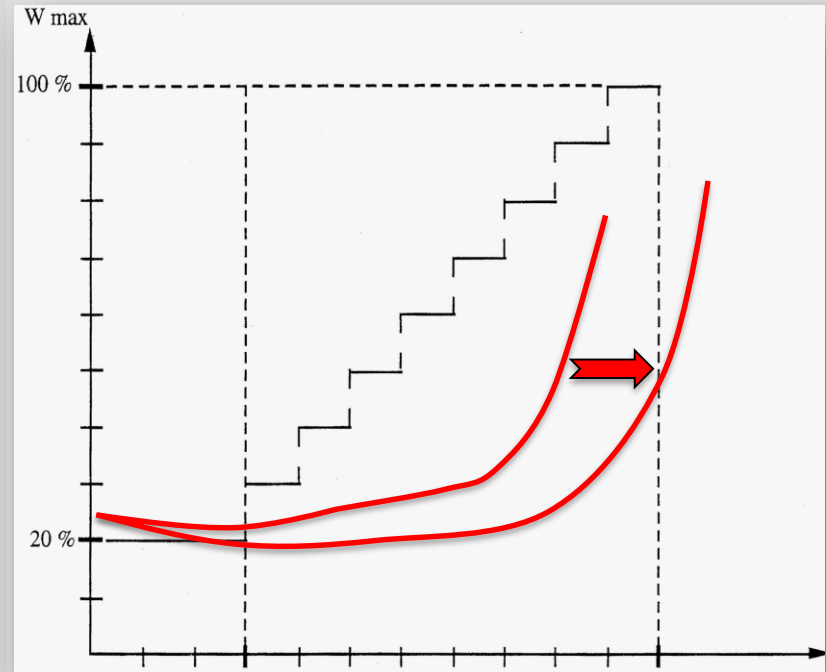


Modeling the energy metabolism of best performances in professional cycling

Sebastian Weber

Back in the days...



Model: muscular energy metabolism as a function of the power output

Metabolic recovery after exercise and the assessment of mitochondrial function in vivo in human skeletal muscle by means of 31P NMR.

Arnold J Biol Chem. 1983 Sep 10;258(17):10464-73.

Abstr: Evaluation of the relationship between the intra- and extramitochondrial [ATP]/[ADP] ratios using phosphoenolpyruvate carboxykinase.

Wilson DF, E Med Sci Sports Exerc. 1994 Jan;26(1):37-43.

muscl Abstract Factors affecting the rate and energetics of mitochondrial oxidative phosphorylation.

acid: The ratio of explain mitochondri

Wilson DF¹.

functi phosphoen + Aut PLoS One. 2012;7(3):e34118. doi: 10.1371/journal.pone.0034118. Epub 2012 Mar 28.

protoc pigeons. Mil Abstr Prediction of muscle energy states at low metabolic rates requires feedback control of mitochondrial respiratory chain activity by inorganic phosphate.

recov dehydrogen from oxaloa

Mitoch

Schmitz JP¹, Jeneson JA, van Oorschoot JW, Prompers JJ, Nicolay K, Hilbers PA, van Riel NA.

phosphoen regulat + Author information

was minima ATP sy

Abstract

Magn Reson Med. 1986 Feb;3(1):44-54.

constants fc i.e., the

The regulation of Energetics of human muscle: exercise-induced ATP depletion.

spaces. The same free n the det

Taylor DJ, Styles P, Matthews PM, Arnold DA, Gadian DG, Bore P, Radda GK.

reverse react recorded by (31

feedback control

Am J Physiol. 1999 Nov;277(5 Pt 1):E890-900.

this reaction does not

Regulation of skeletal muscle glycogen phosphorylase and PDH during maximal intermittent exercise.

Parolin ML¹, Chesley A, Matsos MP, Spriet LL, Jones NL, Heigenhauser GJ.

cytoplasmic f spectroscopy exercise con

+/- 0.04) than + Author information

Am J Physiol. 1997 Jul;273(1 Pt 1):C306-15.

energy of hyc muscle. Loss

Abstract Activation of glycolysis in human muscle in vivo.

The time cours

Conley KE¹, Blei ML, Richards TL, Kushmerick MJ, Jubrias SA.

pre-exercise was much slc

+ Author information

J Appl Physiol (1985). 1998 Dec;85(6):2140-5.

maximal isokin during bouts 1

Erratum in

Recovery of free ADP, Pi, and free energy of ATP hydrolysis in human skeletal muscle.

Am J Physiol 1999 Mar Wackerhage H¹, Hoffmann U, Essfeld D, Leyk D, Mueller K, Zange J.

increased from whereas PDH

+ Author information

We tested the cytoplas

nearly complet first bout and ir

Abstract

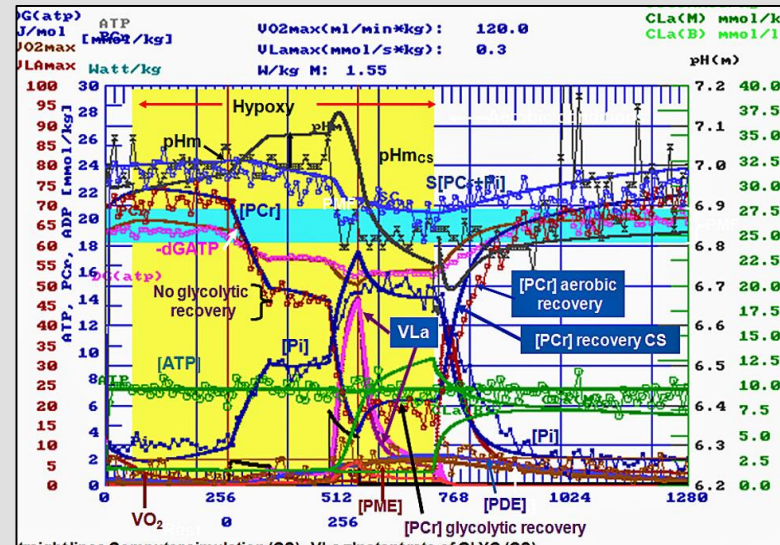
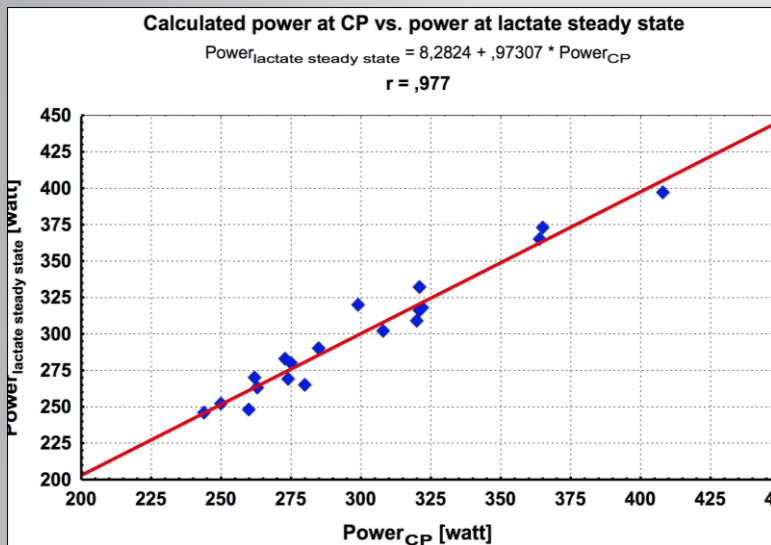
We measured significant undershoots of the concentrations of free ADP ([ADP]) and Pi ([Pi]) and the free energy of ATP hydrolysis

marked in the

ischemic and activated phosphocreatine, Pi, Al

intervals. Proton produ 30 and 50 stimulations, [Pi], [ADP], or [AMP] in We measured significant undershoots of the concentrations of free ADP ([ADP]) and Pi ([Pi]) and the free energy of ATP hydrolysis (DeltaGATP) below initial resting levels during recovery from severe ischemic exercise with 31P-nuclear magnetic resonance spectroscopy in 11 healthy sports students. Undershoots of the rate of oxidative phosphorylation would be predicted if the rate of oxidative phosphorylation would depend solely on free [ADP], [Pi], or DeltaGATP. However, undershoots of the rate of oxidative phosphorylation have not been reported in the literature. Furthermore, undershoots of the rate of oxidative phosphorylation are unlikely because there is evidence that a balance between ATP production and consumption cannot be achieved if an undershoot of the rate of oxidative phosphorylation actually occurs. Therefore, oxidative phosphorylation seems to depend not only on free [ADP], [Pi], or DeltaGATP. An explanation is that acidosis-related or other factors control oxidative phosphorylation additionally, at least under some conditions.

Validation & Application



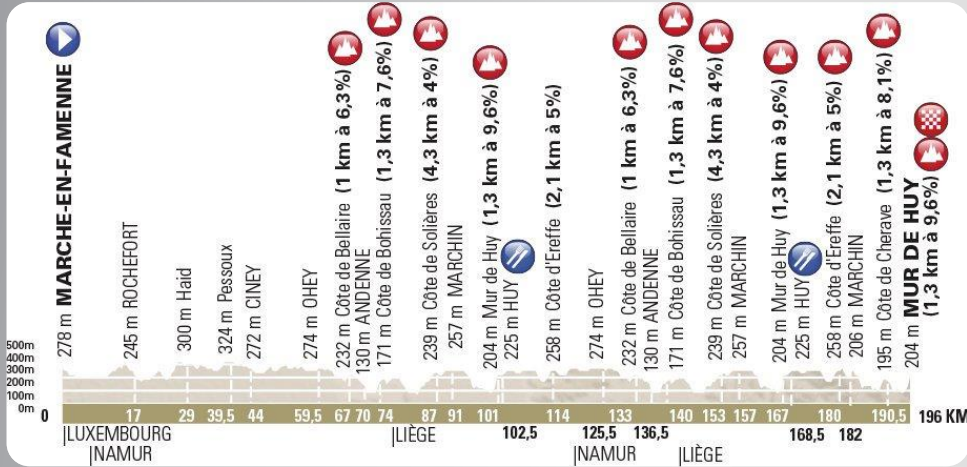
Applications

- Pacing in TT
- Analyze energy sources for given CP data
- Estimate capacities of the competition
- Metabolic demands of a race
- Data manipulation to understand margins
- Metabolic kinetics in interval training



La Flèche Wallonne ...?

...unique final climb!



...8 years of working experience!

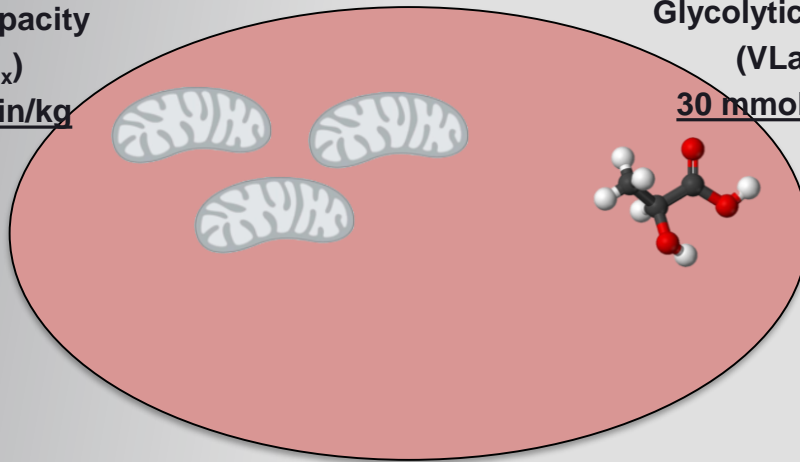


Finale: Power & Speed



Athlete “Top-10-Joe”: measured metabolic capacities

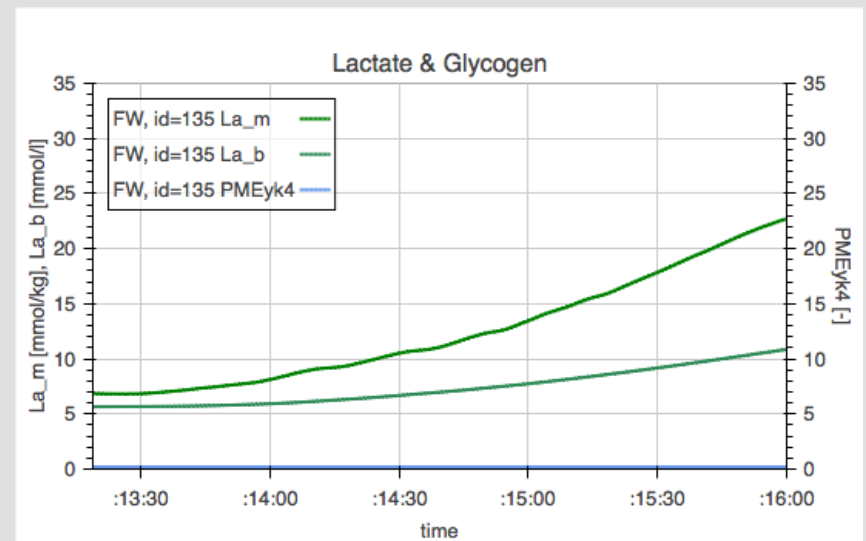
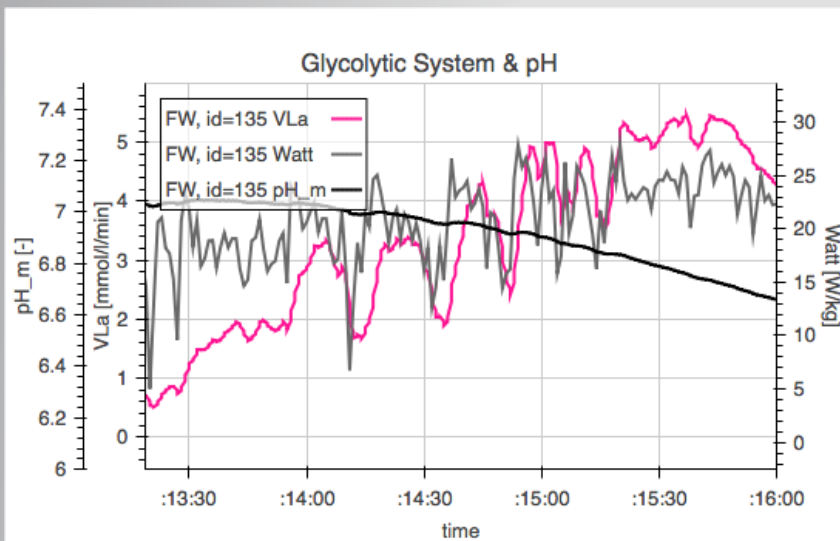
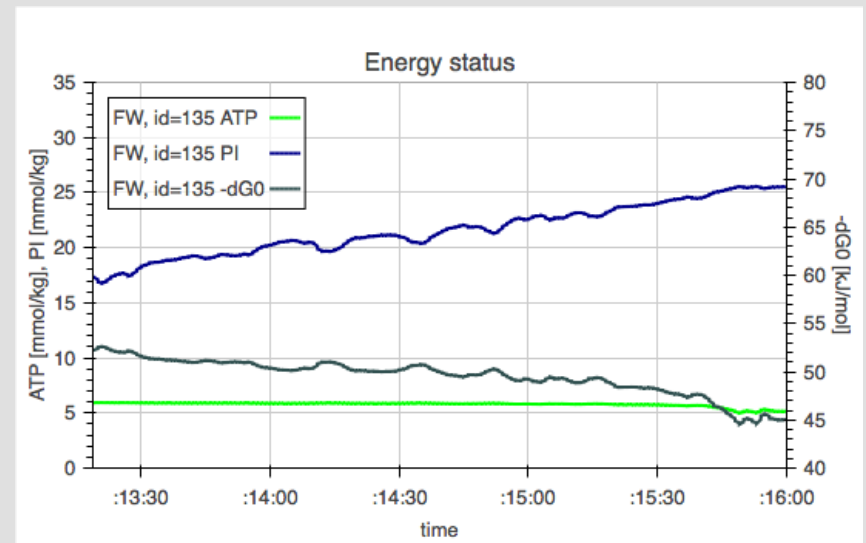
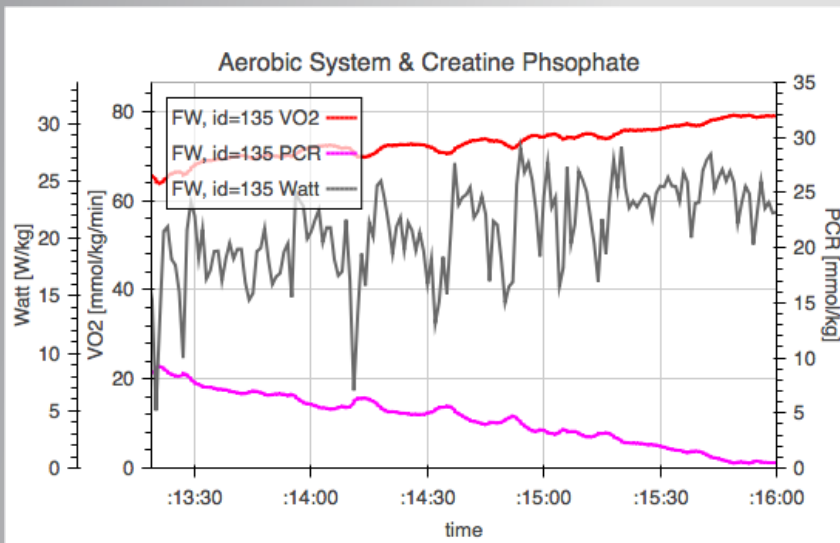
Aerobic capacity
(VO_{2max})
80.5 ml/min/kg



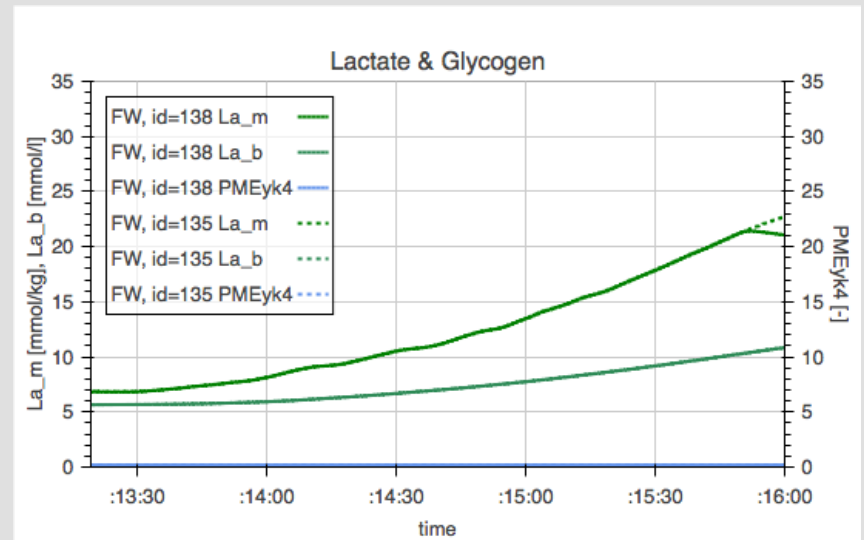
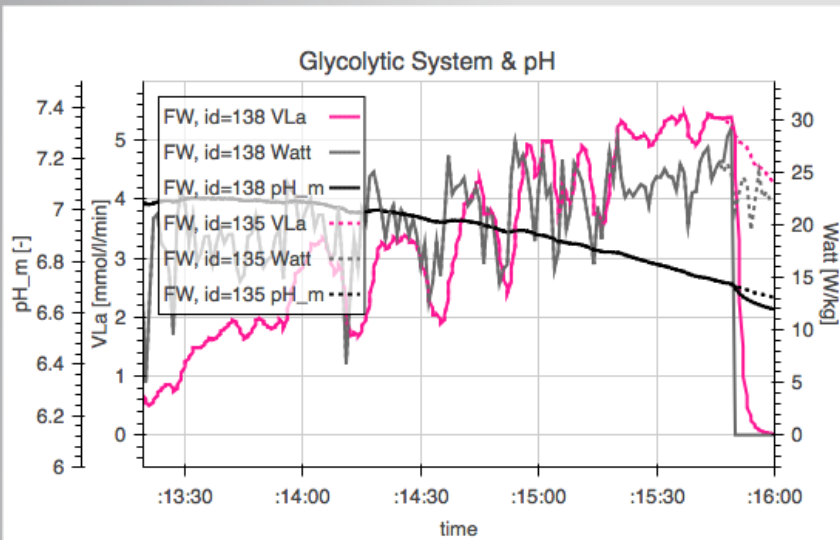
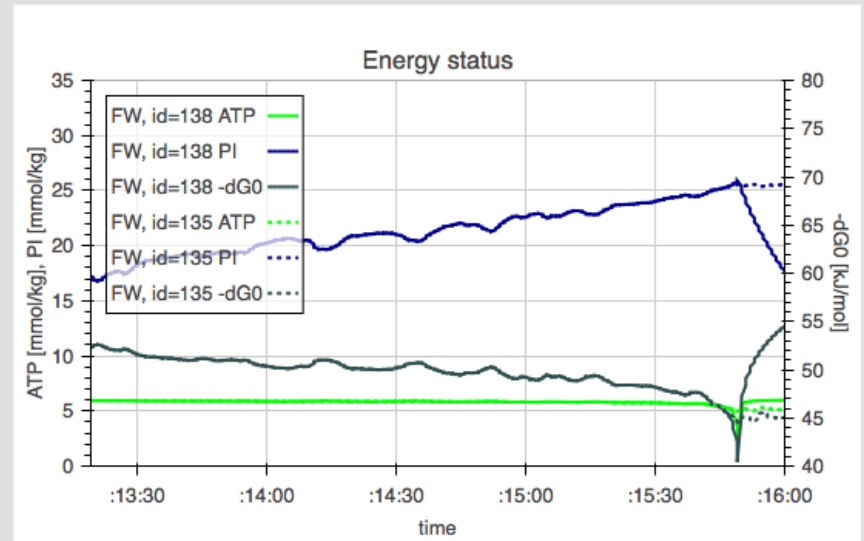
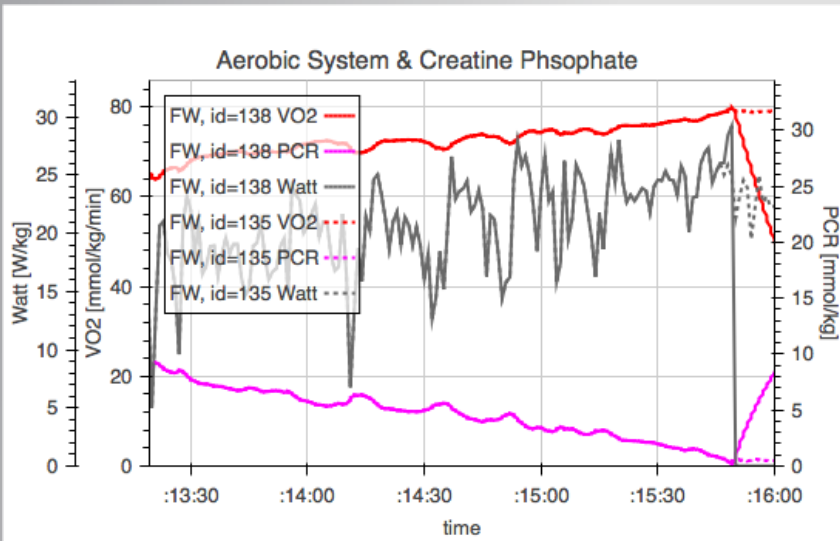
Glycolytic capacity
(VLa_{max})
30 mmol/min/kg



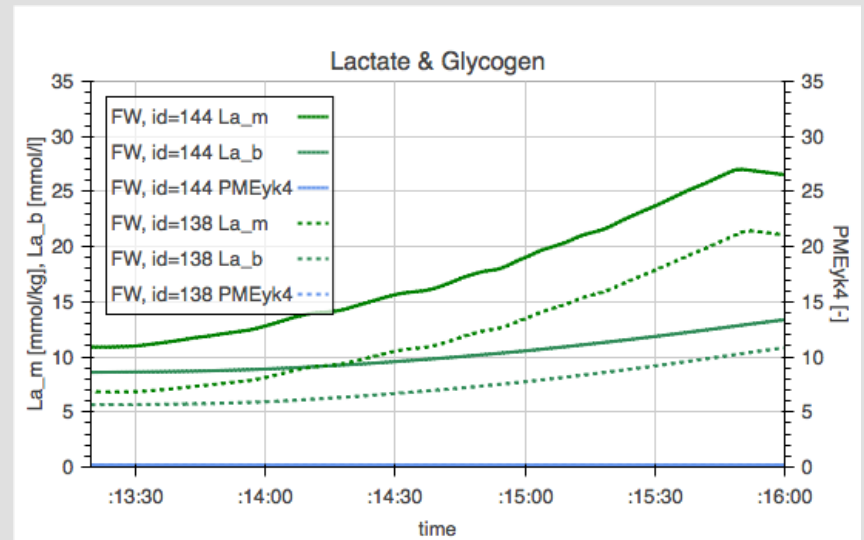
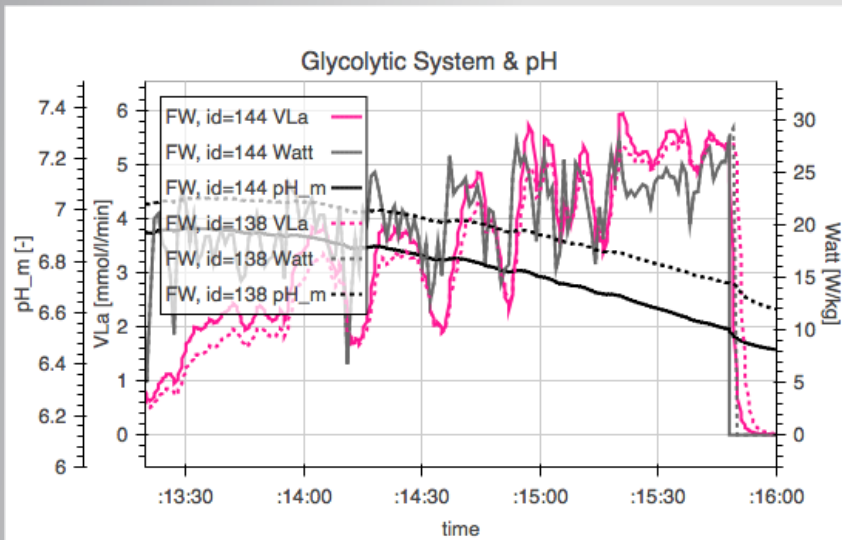
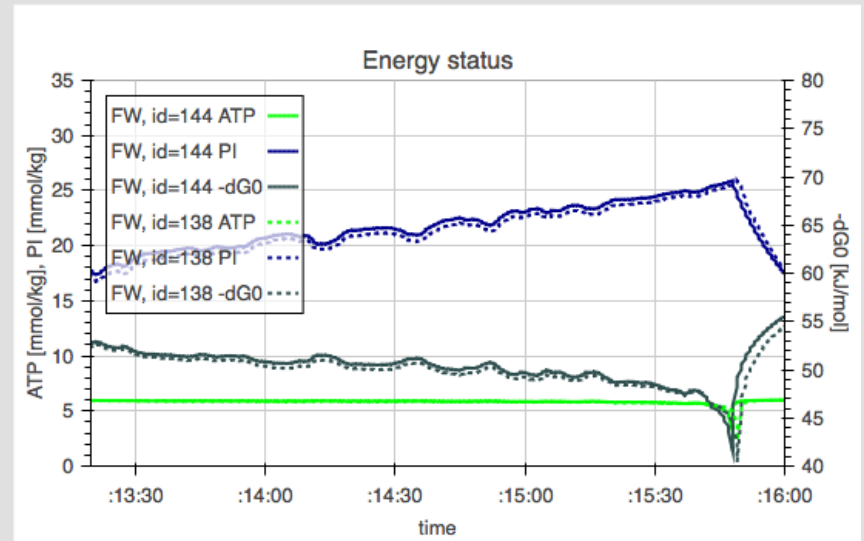
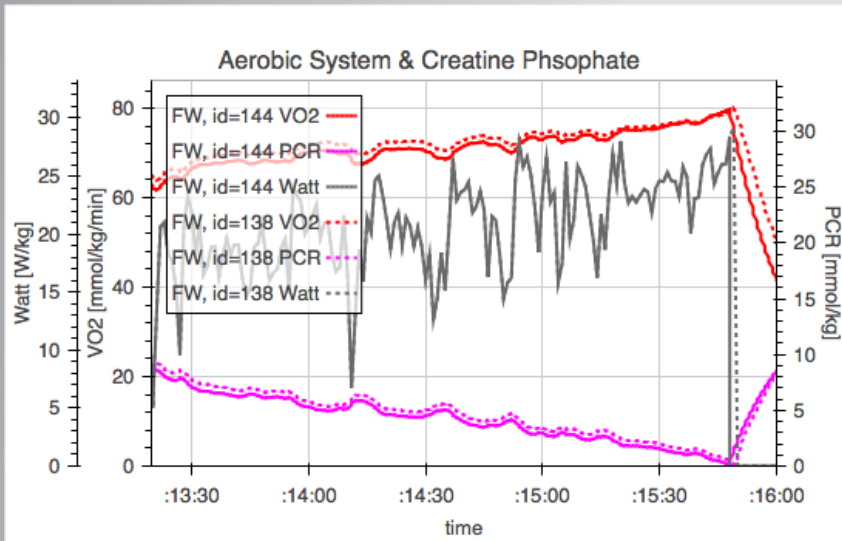
Muscle Energetics in the final 3': Mur de Huy



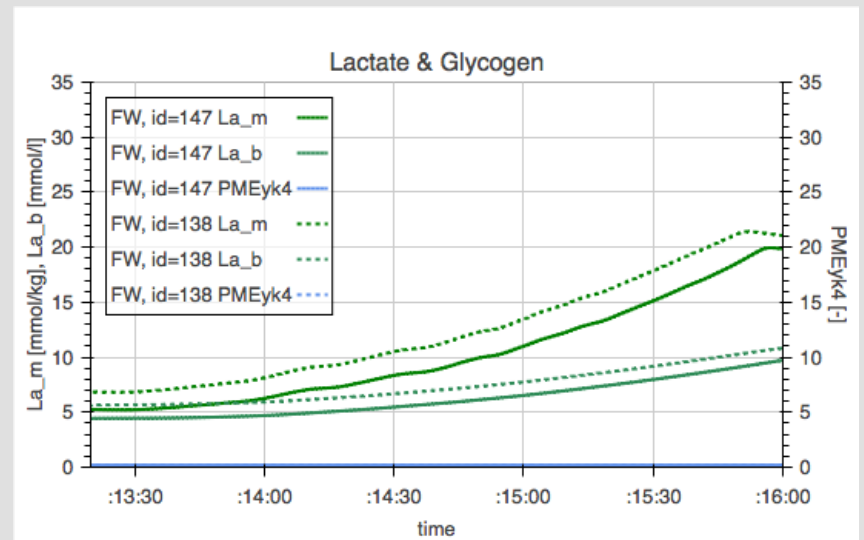
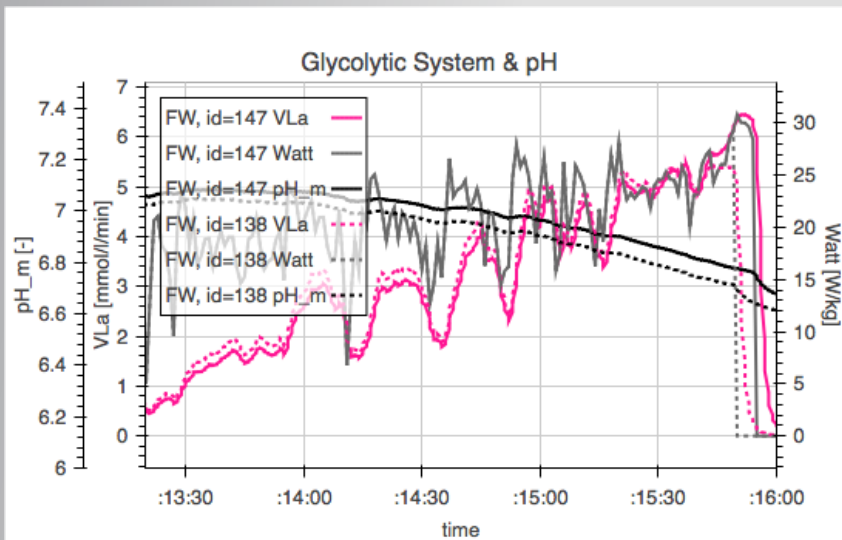
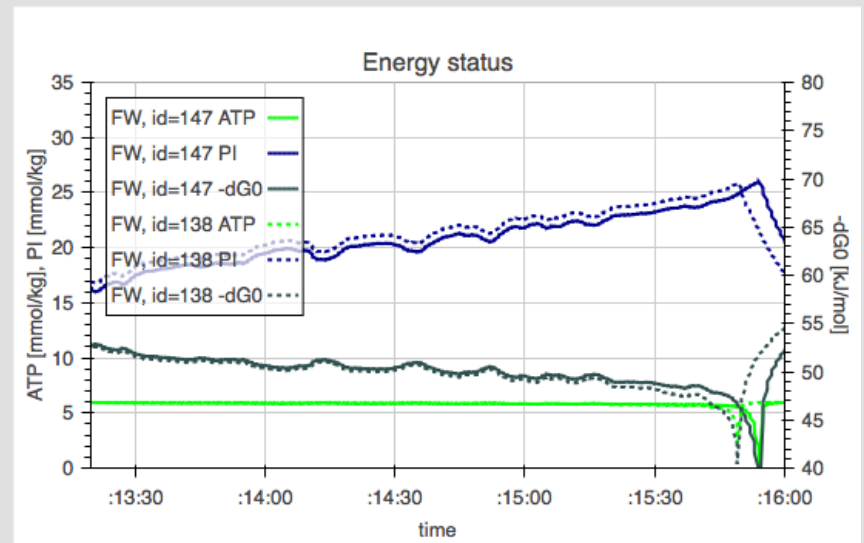
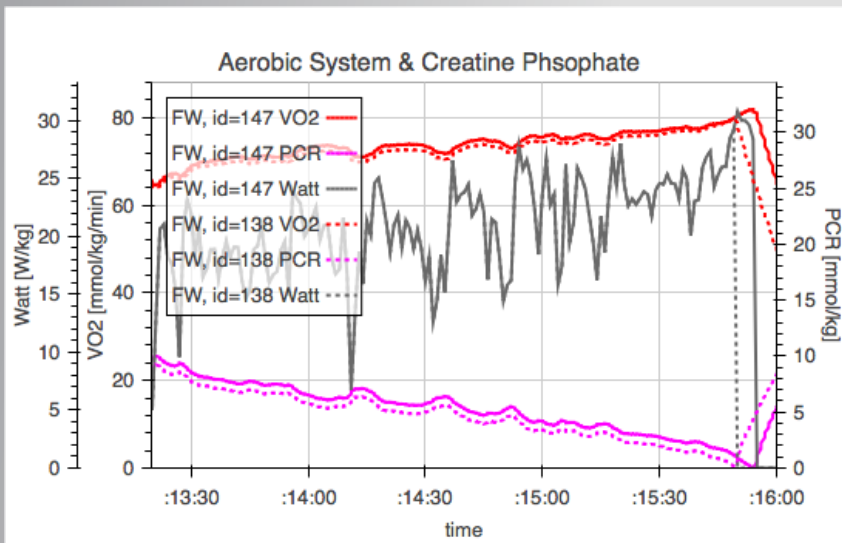
Lets try a sprint ...!



Higher glycolytic capacity: 30 (dotted) → 66 (bolt) mmol/min/kg



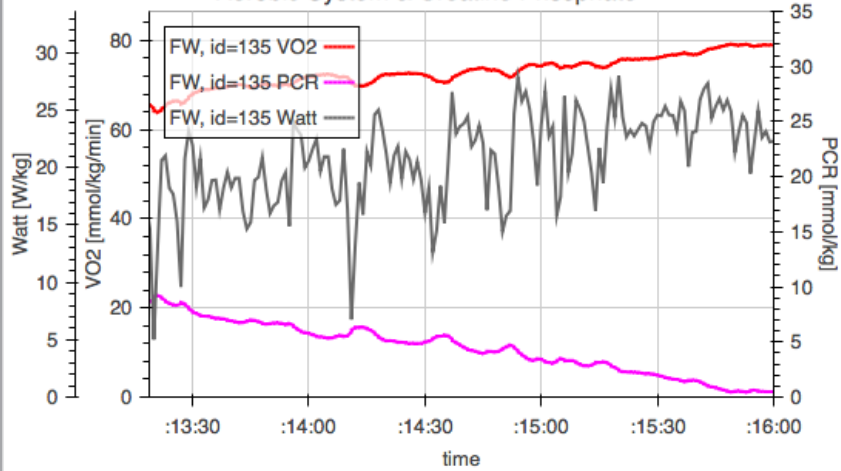
Influence of higher aerobic capacity: 80.5 (dotted) → 82.5 (bolt) mmol/min/kg



“Top-10-Joe:

aerobic: 80.5 ml/min/kg & glycolytic: 30 mmol/min/kg

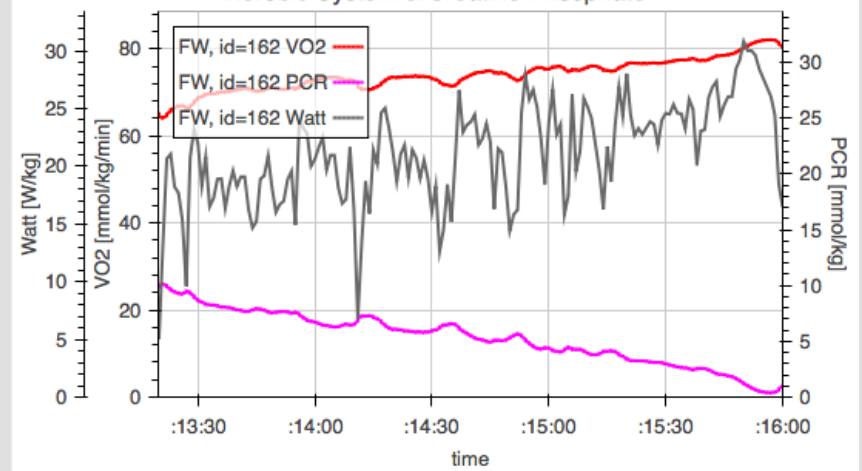
Aerobic System & Creatine Phosphate



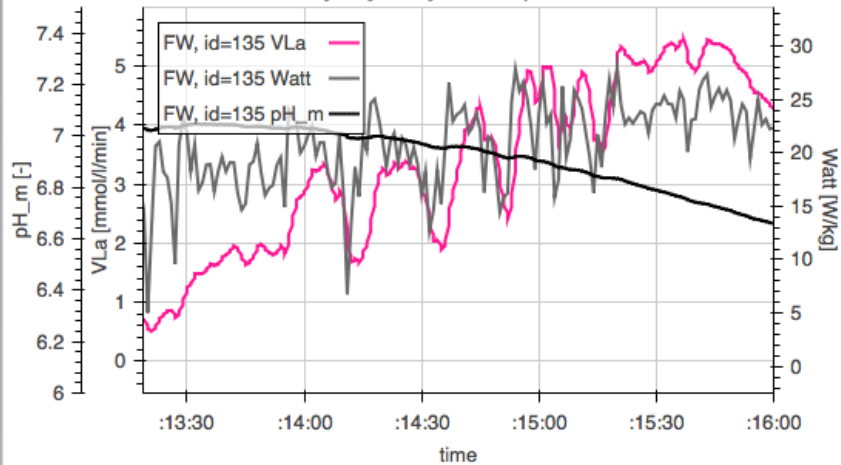
“Winning-Joe:

aerobic: 83.0 ml/min/kg & glycolytic: 39 mmol/min/kg

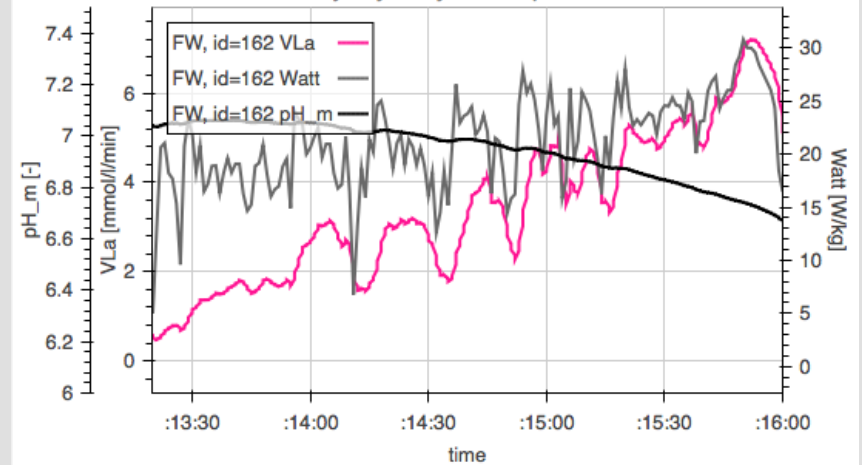
Aerobic System & Creatine Phosphate



Glycolytic System & pH



Glycolytic System & pH



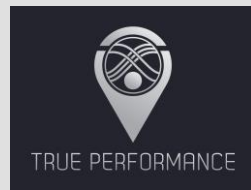
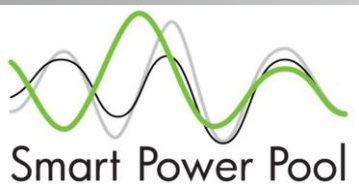
Thank you!

Sebastian Weber

Cannondale Drapac Pro Cycling Team

Sebastian@true-performance.com

www.true-performance.com



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 **Generalitat
de Catalunya**