

LUXEMBOURG ACADEMY OF SPORTS MEDICINE, PHYSIOTHERAPY AND SCIENCE

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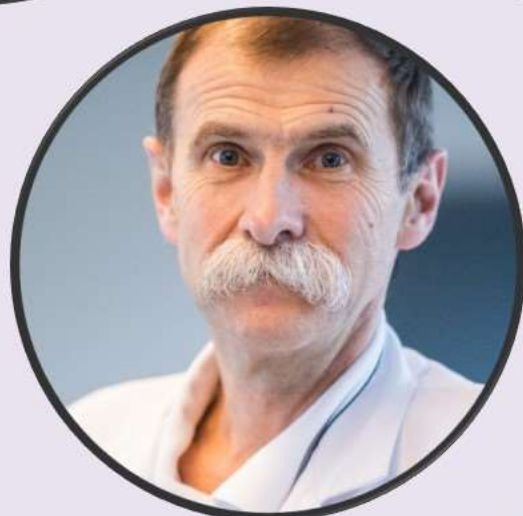
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Round table: Exercise physiology testing and sports performance

Frédéric Margue, Eric Besenius, Prof Axel Urhausen

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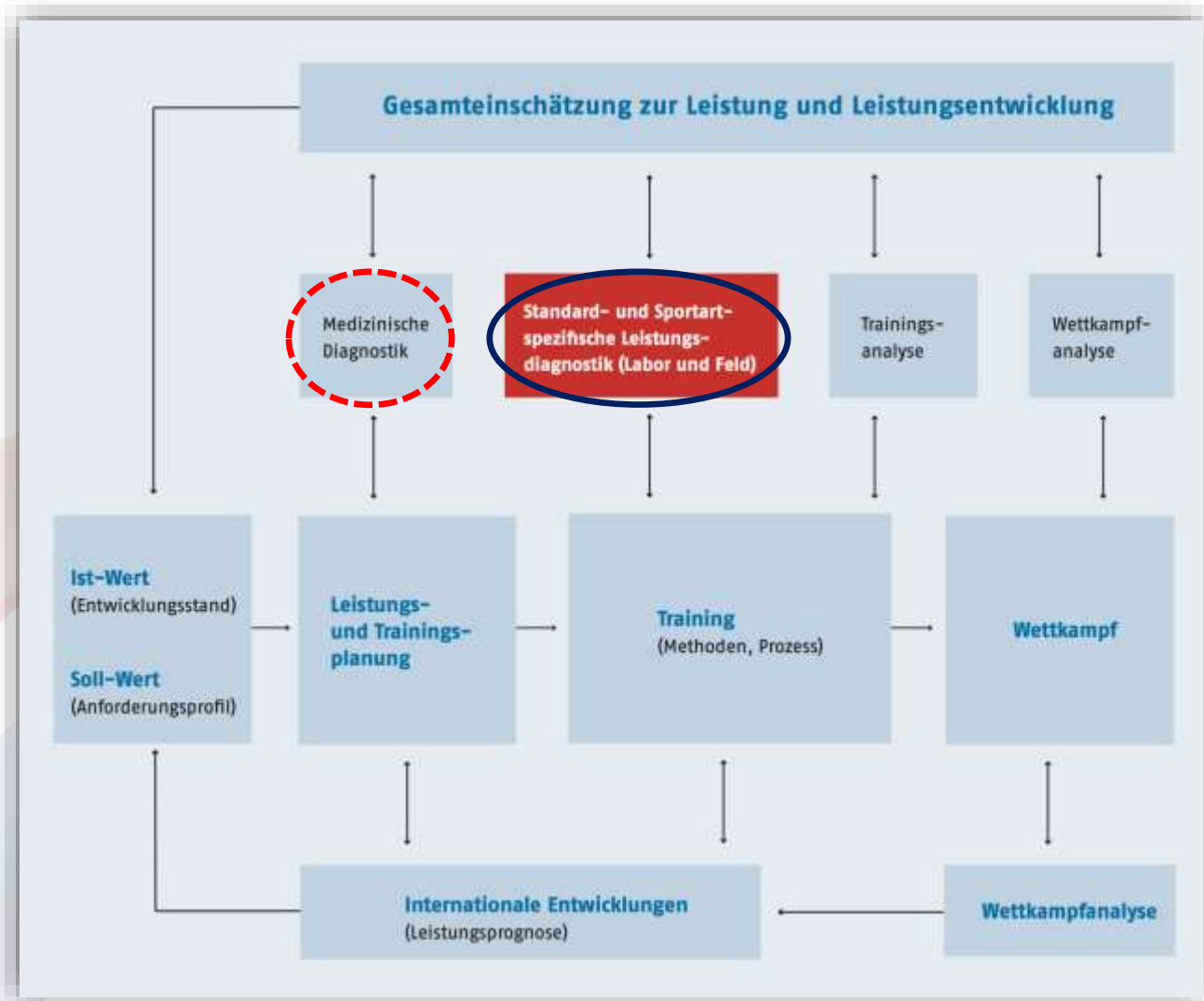
Historical Background



Salle d'examen pour sportifs d'élite I.N.S. (Institut National des Sports de Luxembourg)

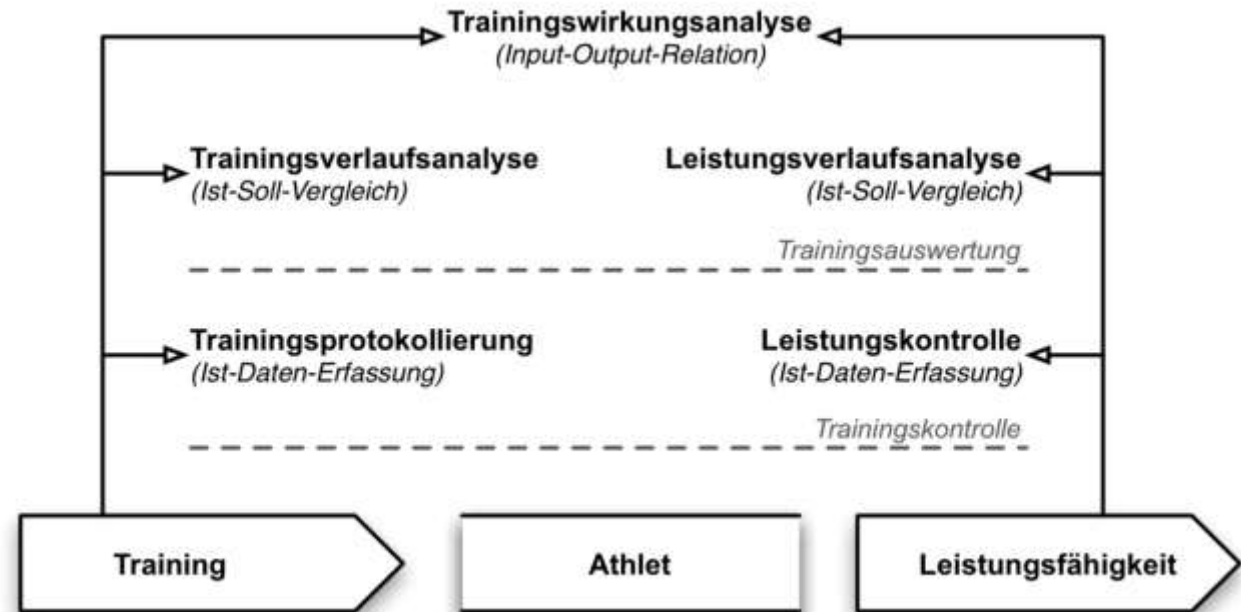


Performance Diagnostics in the Feedback Loop of Training Control

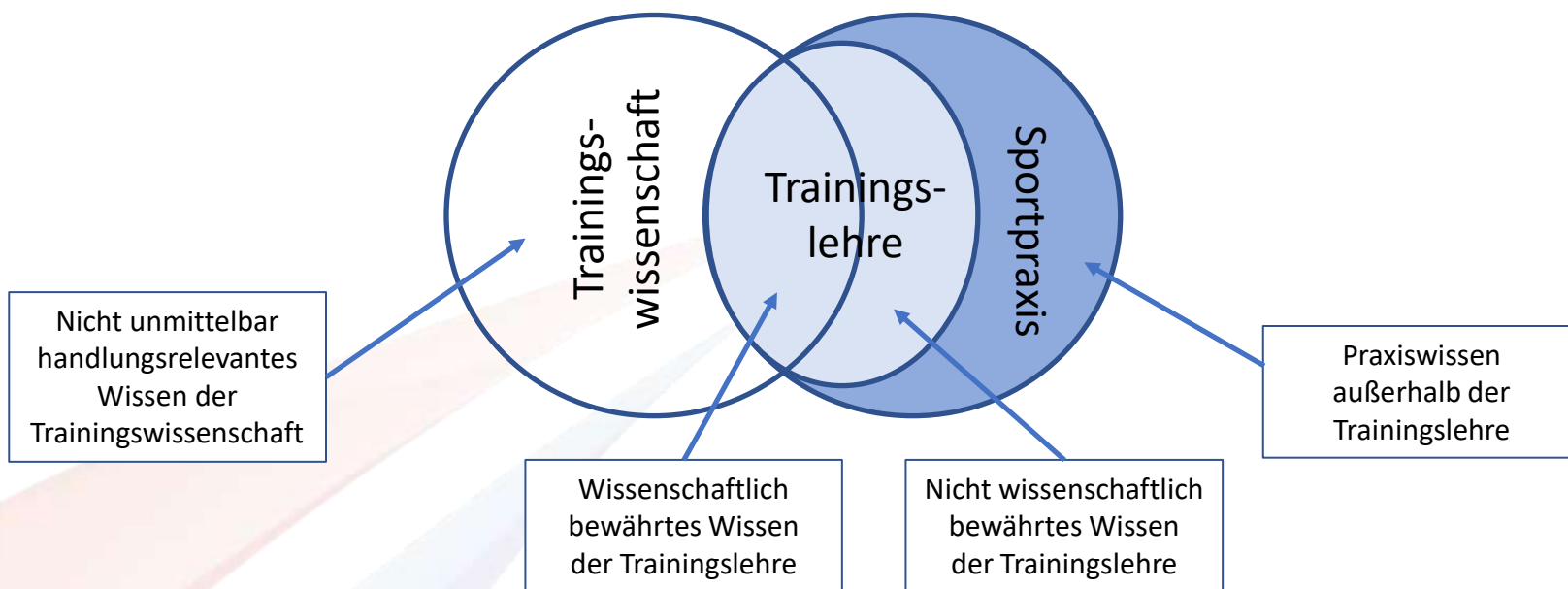


Objectives of Performance Diagnostics in the Context of Exercise Science

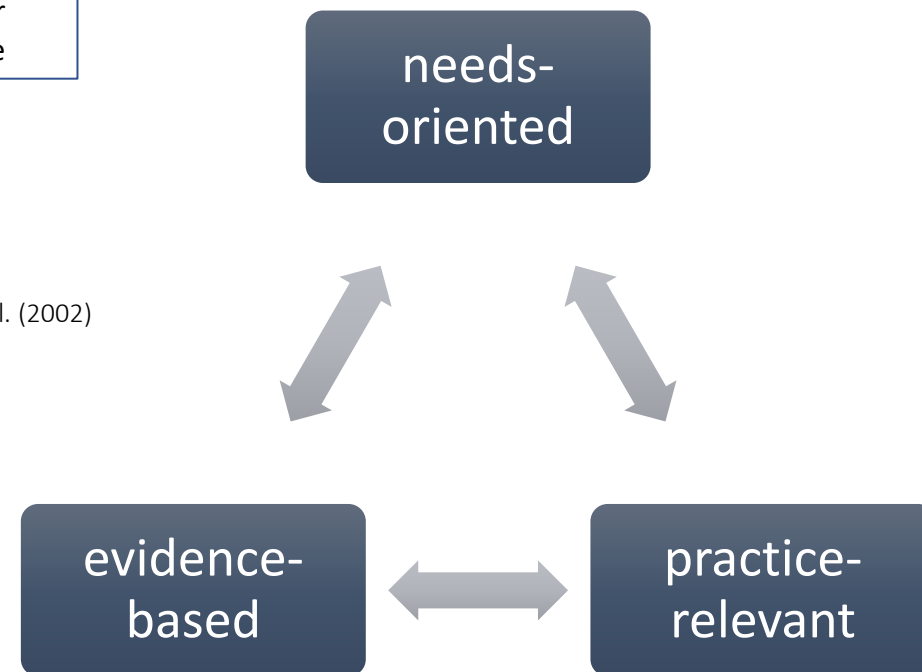
1. Assessment of the current performance level
2. Assessment of performance development
3. Optimisation of training control
4. Estimation of performance potential



Field of Tension in Elite Sports



mod. nach Hohmann et al. (2002)

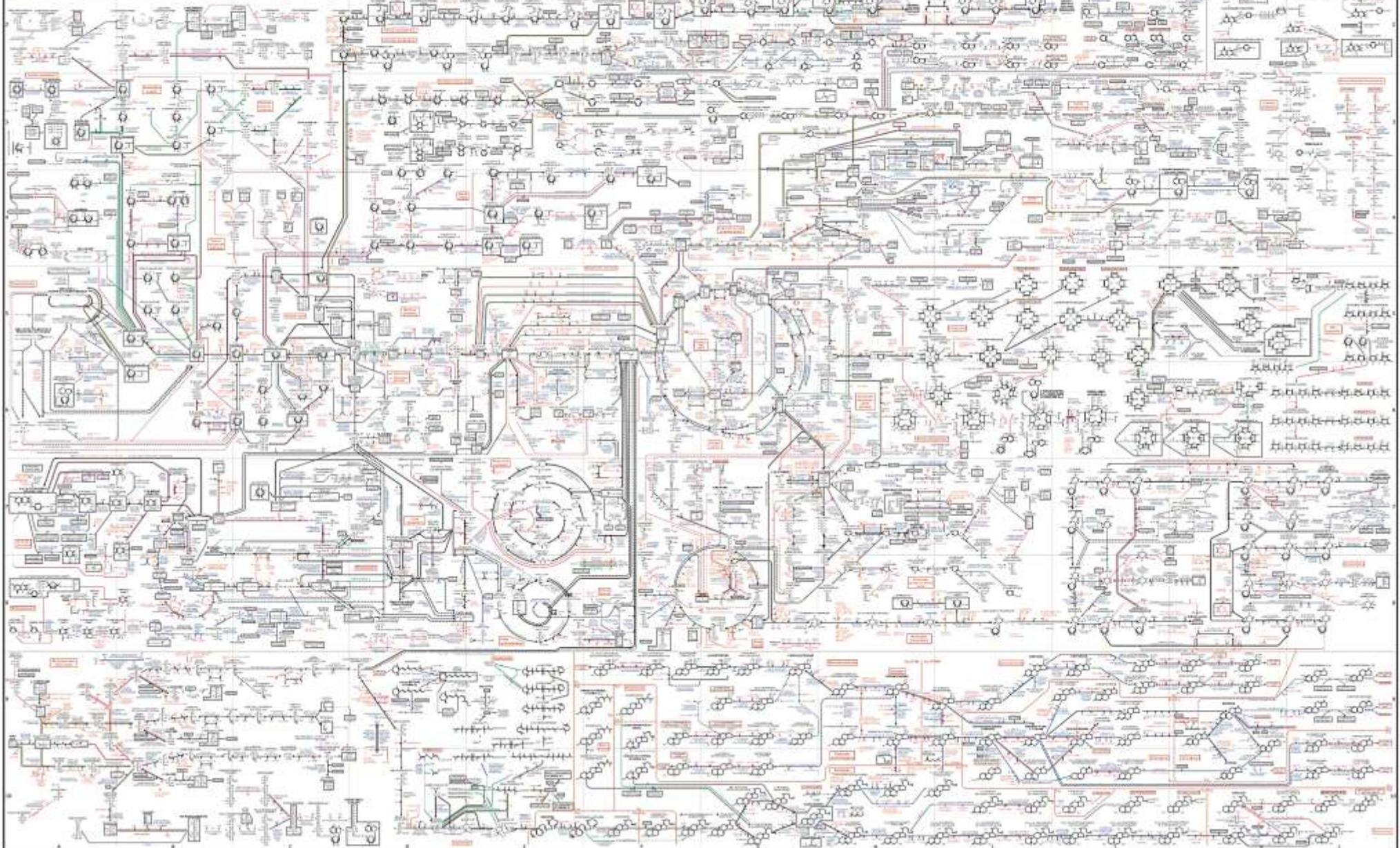


Metabolic Pathways

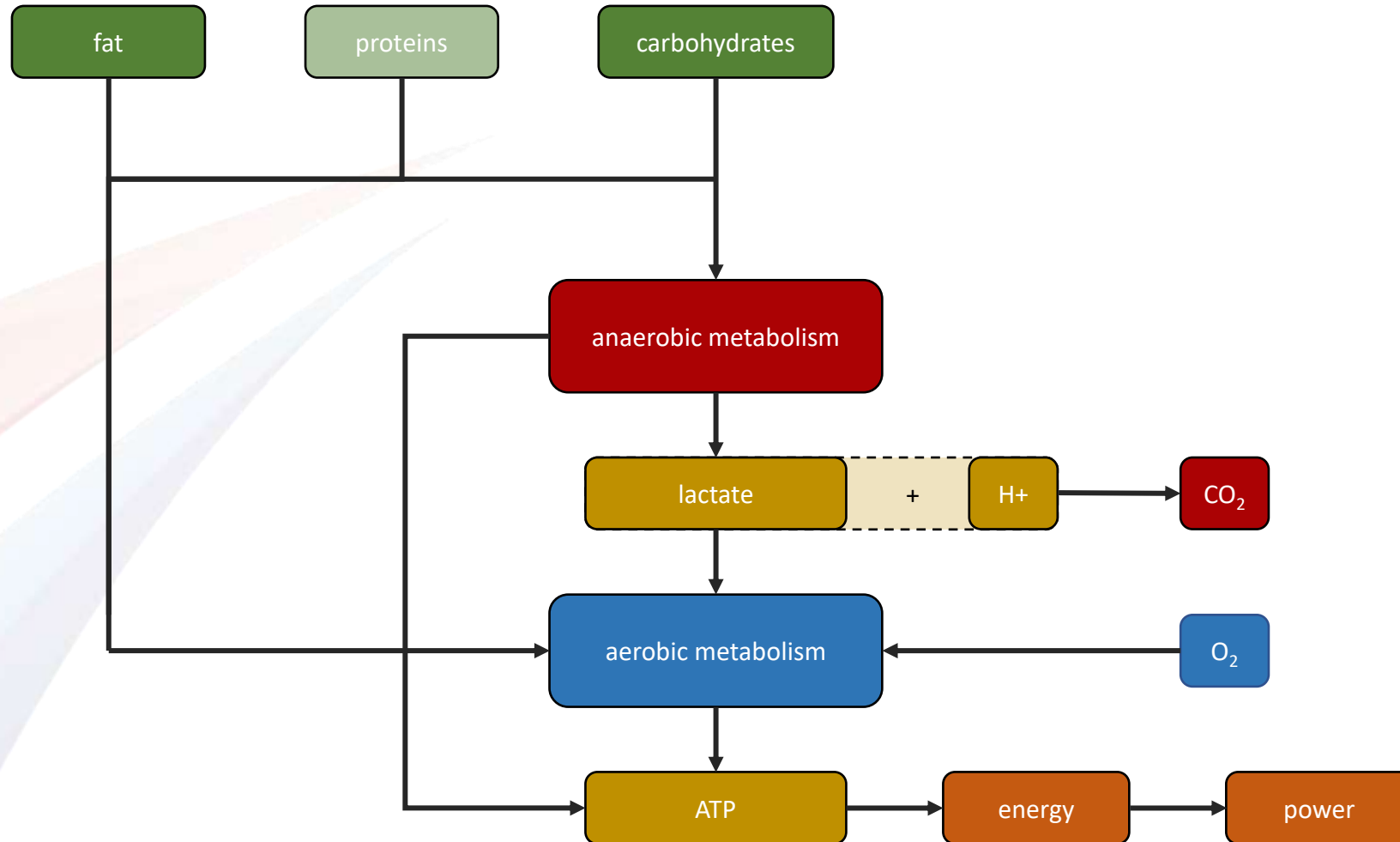
Roche Biochemical Pathways
4th Edition, Part 1 - Editor: Gerhard Michel

www.biochemical-pathways.roche.com

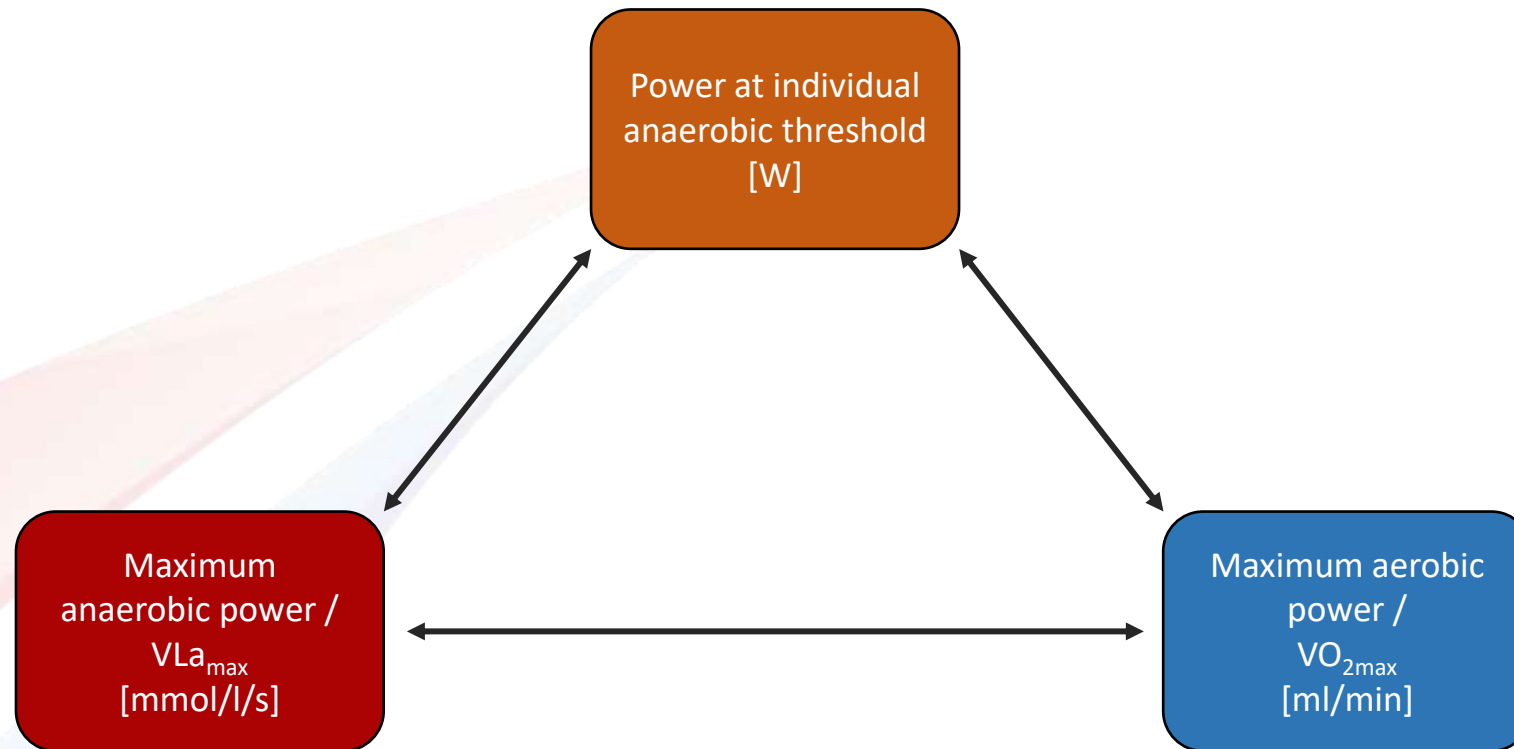
Roche



Metabolism and Performance

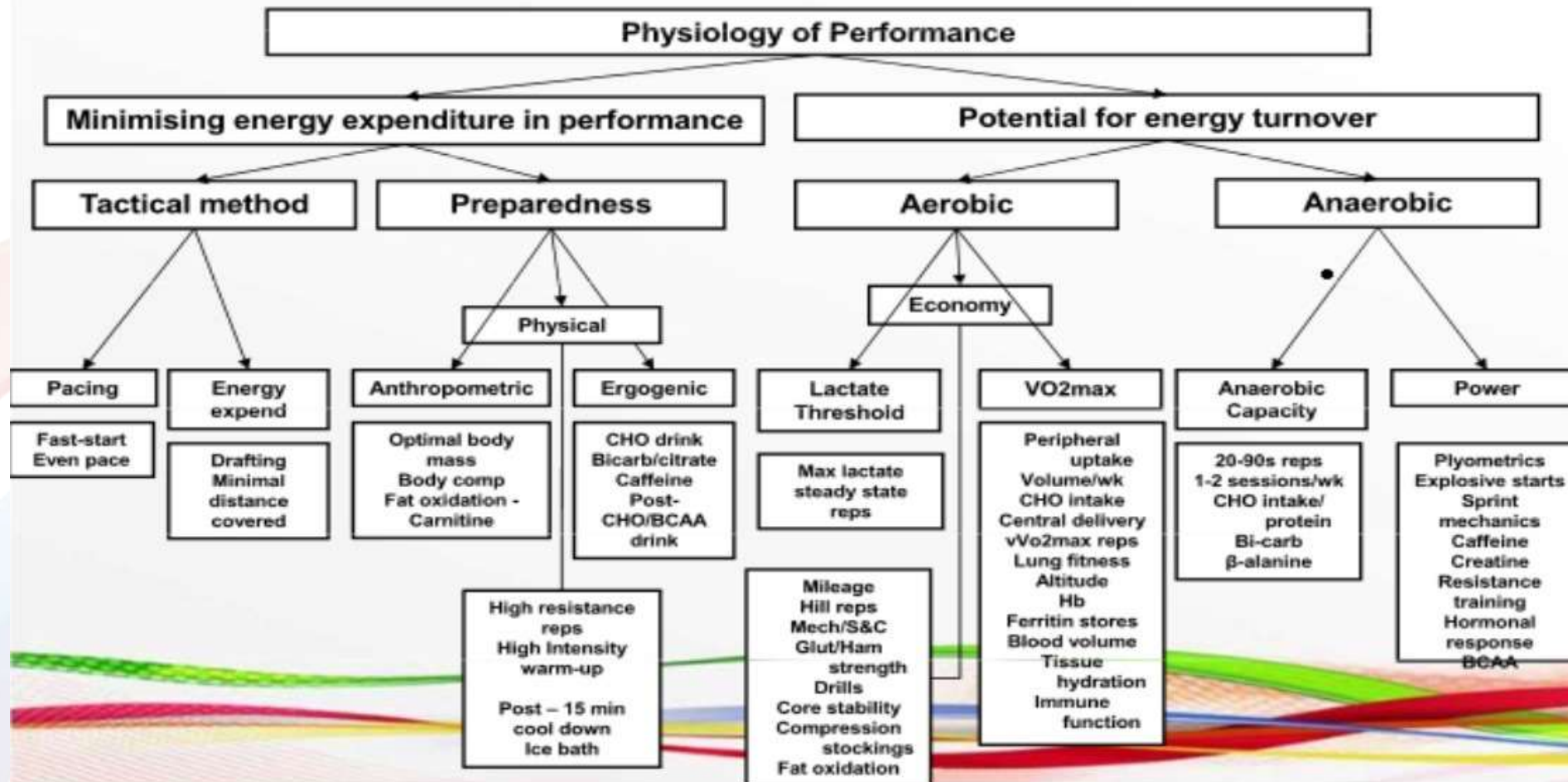


Key Parameters – Performance Diagnostics

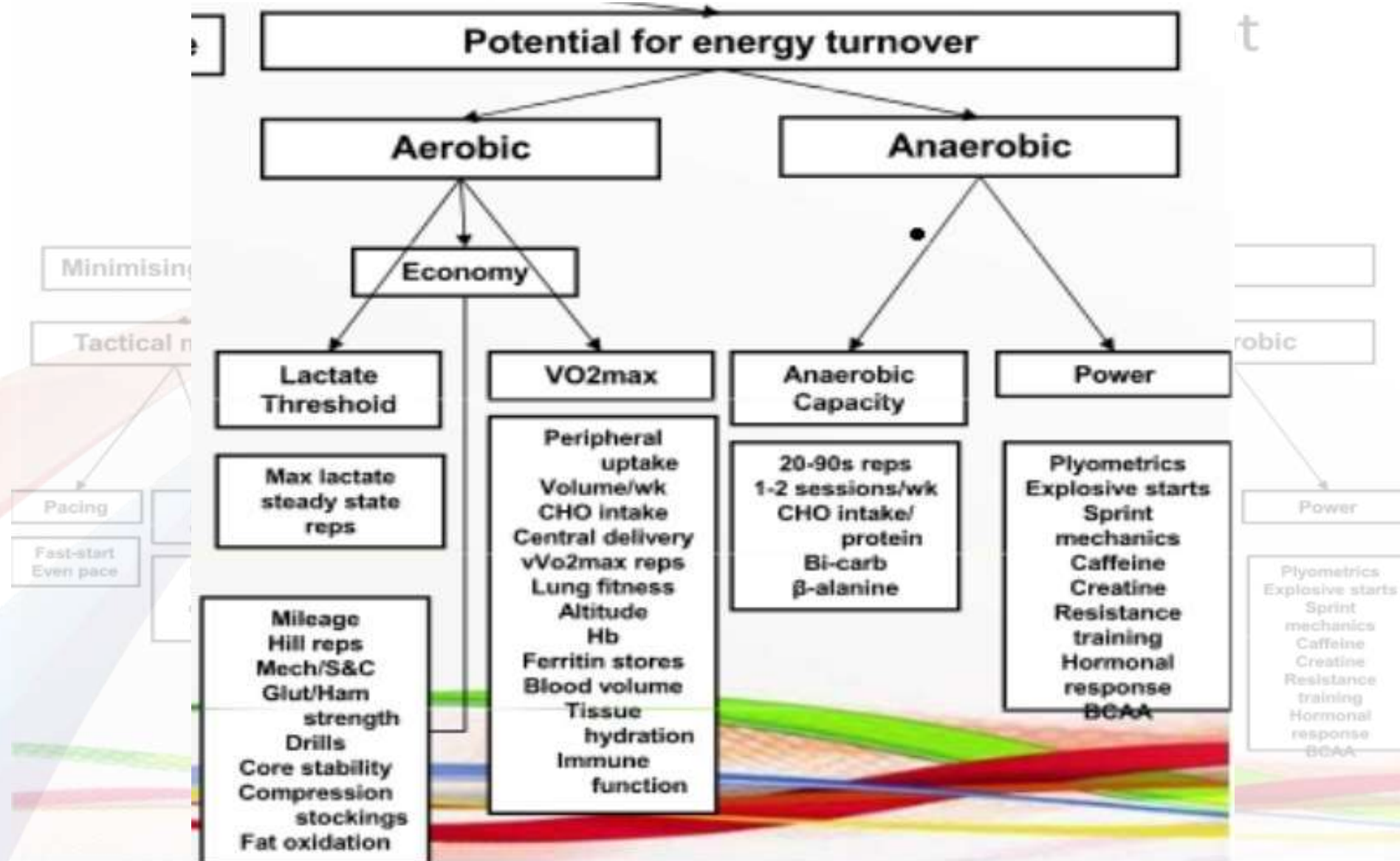


Key Parameters – Performance Diagnostics

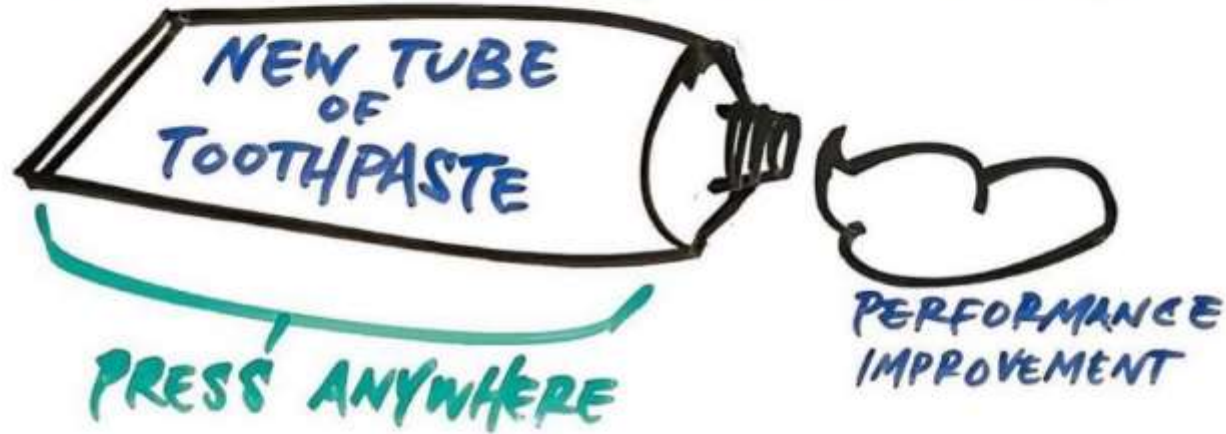
Maximum adaptation is the focus not maximum training



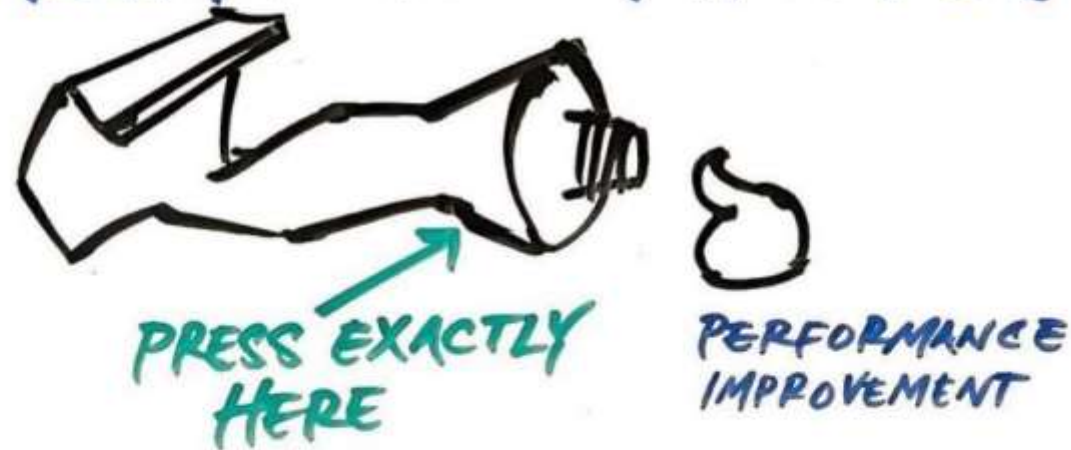
Key Parameters – Performance Diagnostics



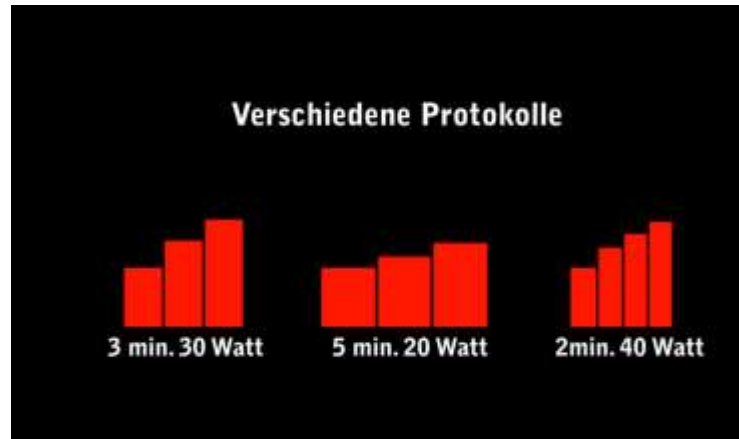
NOVICE ATHLETES



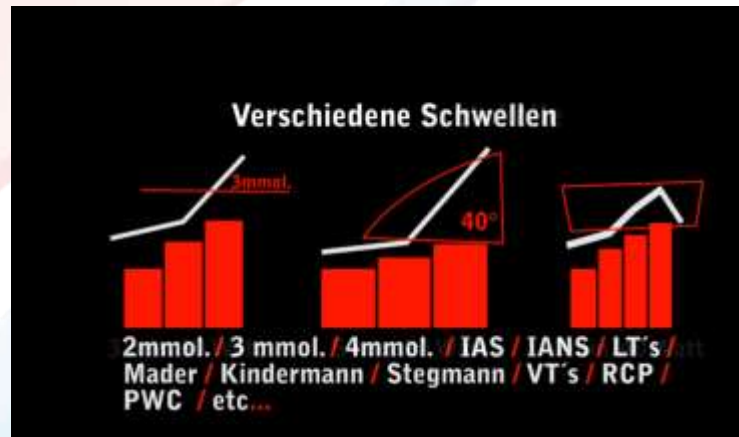
ADVANCED ATHLETES



Lactate Threshold Tests

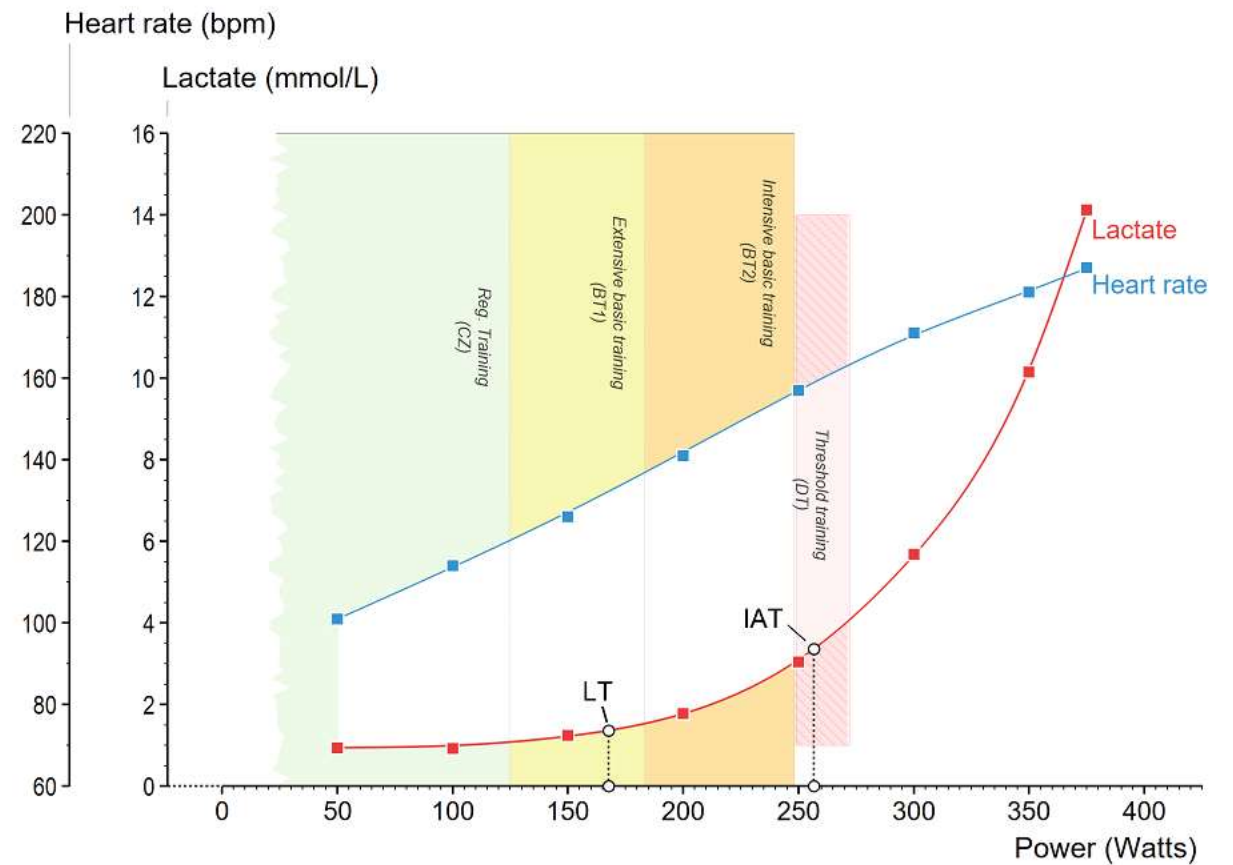


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© INSCYD

Lactate-to-performance-curve:



© Ergonizer; LIHPS

Spiroergometrie

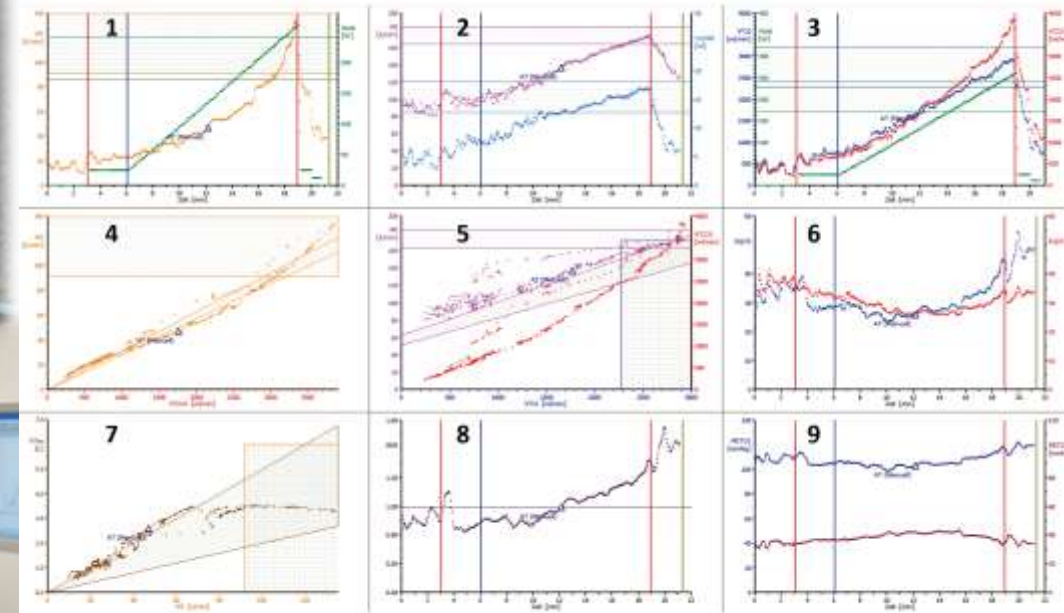
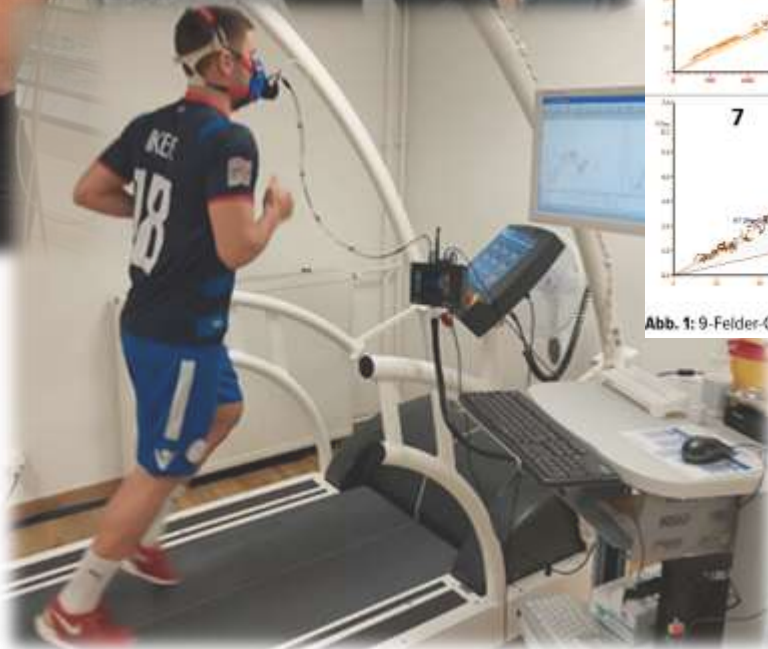
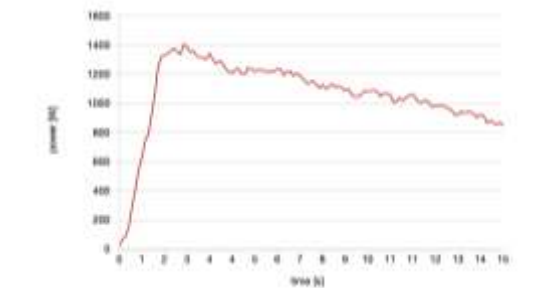
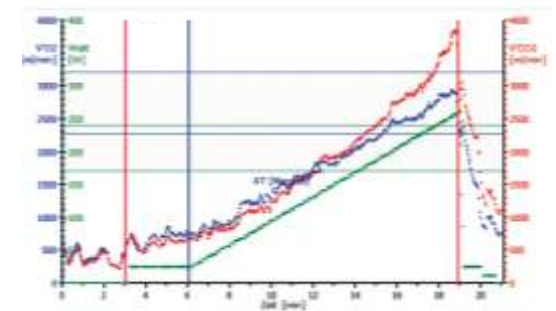
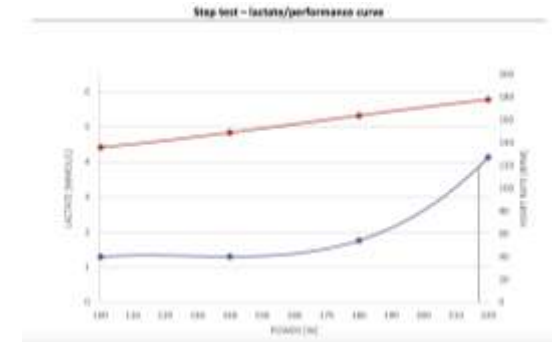
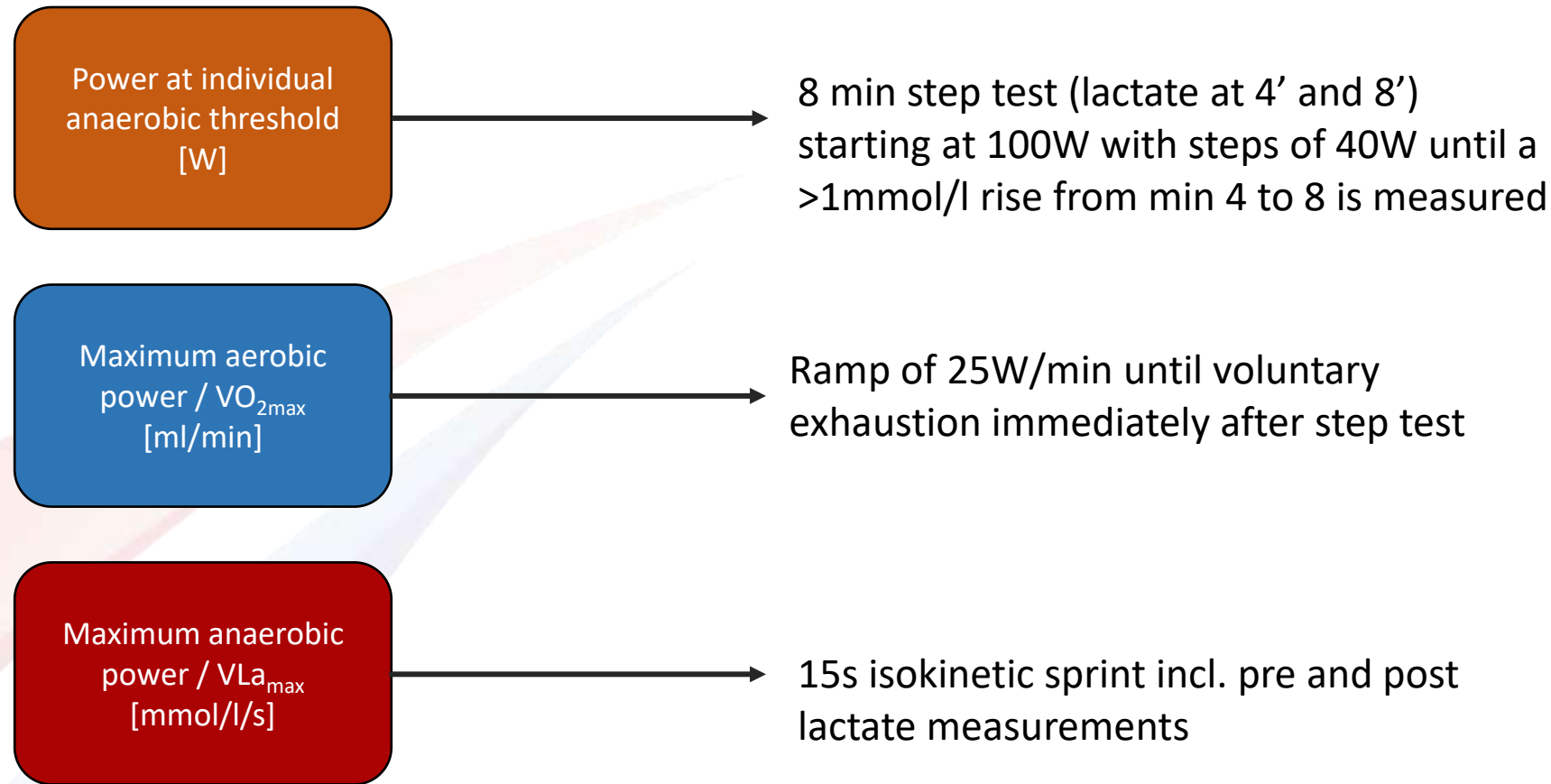


Abb. 1: 9-Felder-Grafik nach Wasserman

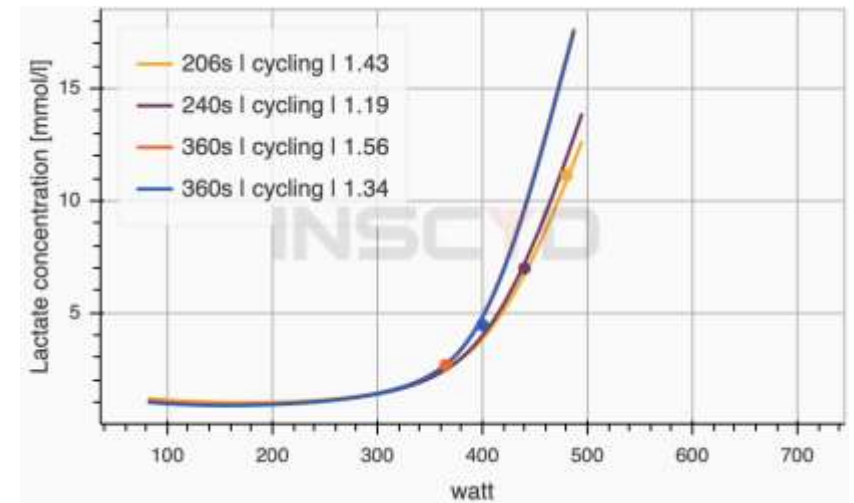
Example: Combined Test Protocol



+ validation using calculations according to Weber (2003) and Hauser (2012)

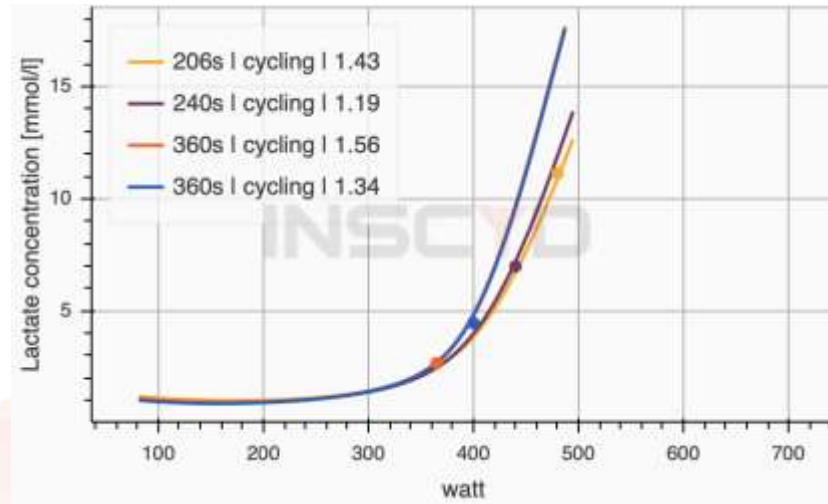
Metabolic Simulations

„2-Kompartiment-Modell nach Mader“
(cf. Heck et al. 2022)



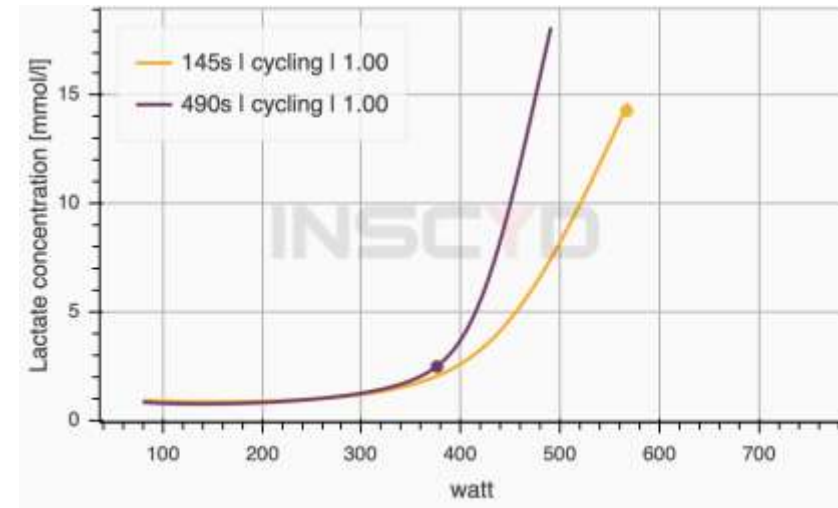
Run	Power [watt]	Time [mm:ss]	Max Lactate [mmol/l]
1	365	06:00	2.7
2	400	06:00	4.5
3	440	04:00	7.0
4	480	03:26	11.1

Metabolic Simulations – Re-Test



Run	Power [watt]	Time [mm:ss]	Max Lactate [mmol/l]
1	365	06:00	2.7
2	400	06:00	4.5
3	440	04:00	7.0
4	480	03:26	11.1

$VO_{2\max}$ [ml/min/kg]	VL_{\max} [mmol/l/s]	Anaerobic threshold [W]
73,45	0,39	393



Run	Power [watt]	Time [mm:ss]	Max Lactate [mmol/l]
1	376	08:10	2.5
2	567	02:25	14.3

$VO_{2\max}$ [ml/min/kg]	VL_{\max} [mmol/l/s]	Anaerobic threshold [W]
80,55	0,43	408

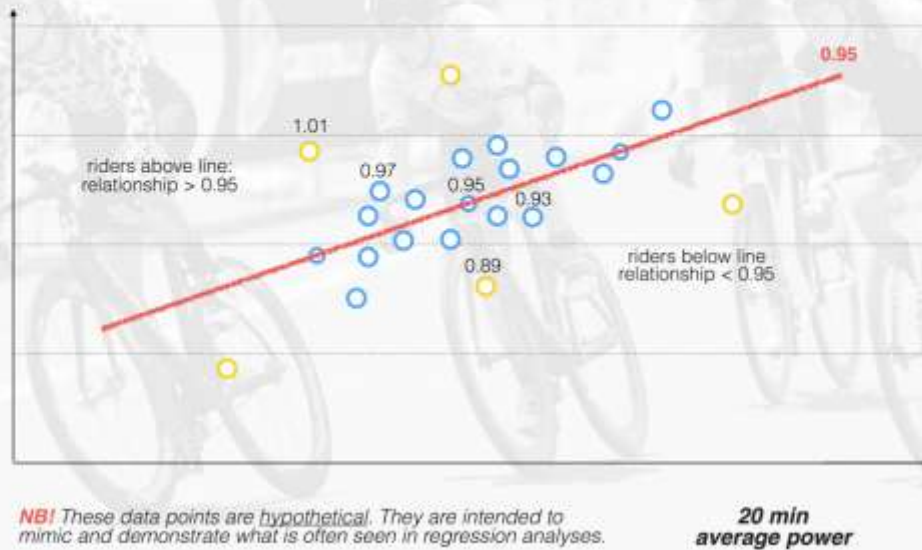
Functional threshold power (FTP)

FTP60 and FTP20 relationship

model development by regression analysis

60 min average power

With several data points (riders), a trend line is added to best fit all the data points. Note that most riders do not lie exactly on the line, but close to it (blue). Some outliers are far from the line (yellow). These riders will deviate significantly from the 0.95 relationship between 60 and 20 min power outputs.



NB! These data points are hypothetical. They are intended to mimic and demonstrate what is often seen in regression analyses.

wattkg.com

Individual differences

in threshold power estimates by...

- A: FTP60 and FTP20 (60min avg W - 20min avg W x 0.95)
- B: FTP20 and lactate profile test (FTP20 - LPT)

E.g. I: 6 riders had a 60 min avg power that was 5-15 W lower than threshold power estimated by 20 min avg x 0.95

E.g. II: 3 riders had an FTP estimated by 20 min avg x 0.95 that was 40-50 W higher than their estimate by lactate profile testing.



adapted from Borszcz et al 2018

wattkg.com

Functional threshold power (FTP)

LIMITATION OF FTP

FTP IS NOT A GOOD MEASURE FOR PROGRESS



FTP

- ✘ **Unclear Progress Indicators:** Increases in FTP don't specify improvements in aerobic or anaerobic power.
- ✘ **Misleading Metric:** FTP changes might not align with athletes' specific training goals.

FTP DOESN'T PREDICT PERFORMANCE



FTP

- ✘ **Limited Race Insight:** Mainly reflects time trial performance, not diverse racing conditions.
- ✘ **Lacks Comprehensive Analysis:** Doesn't account for endurance or sprint dynamics in races.

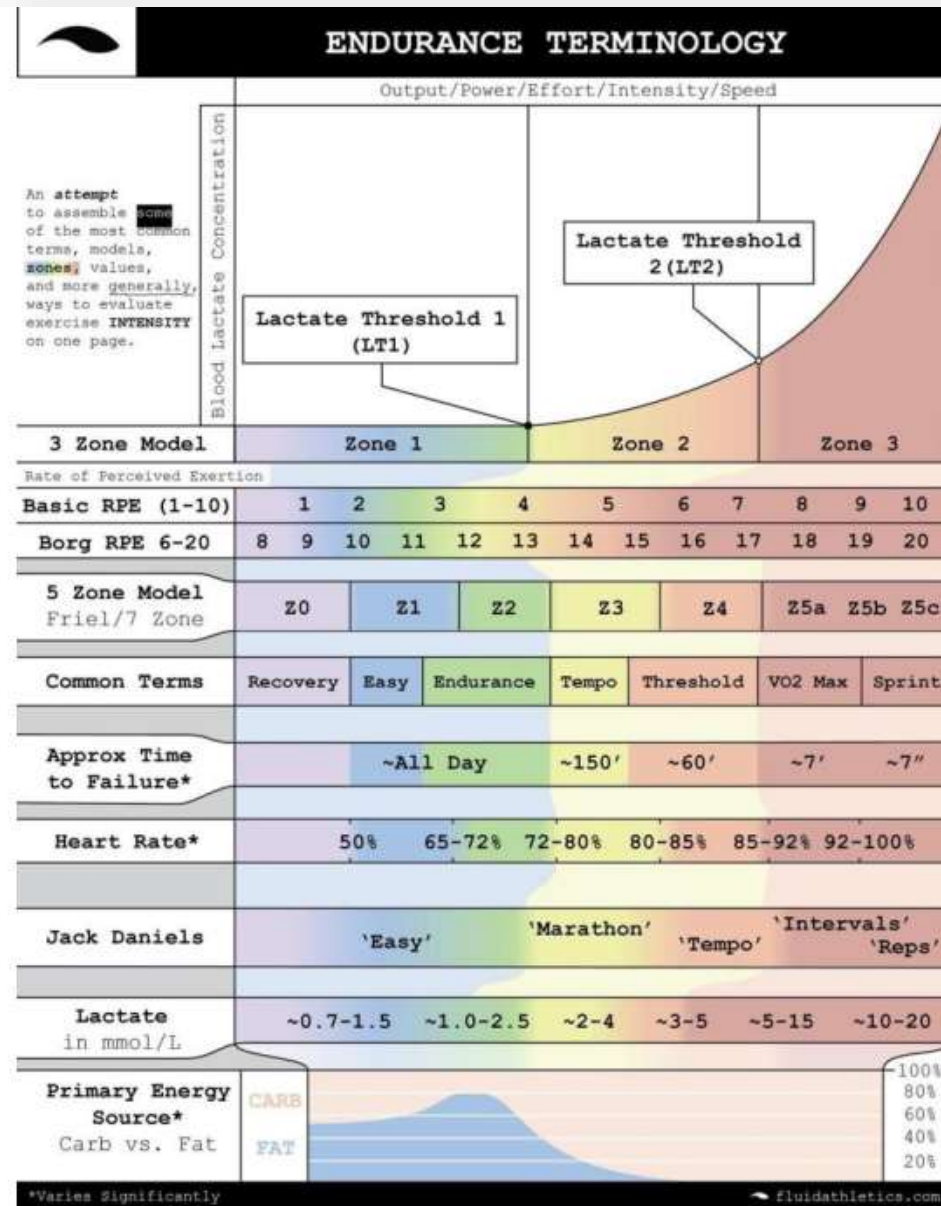
FTP CANNOT BE USED FOR TRAINING ZONES



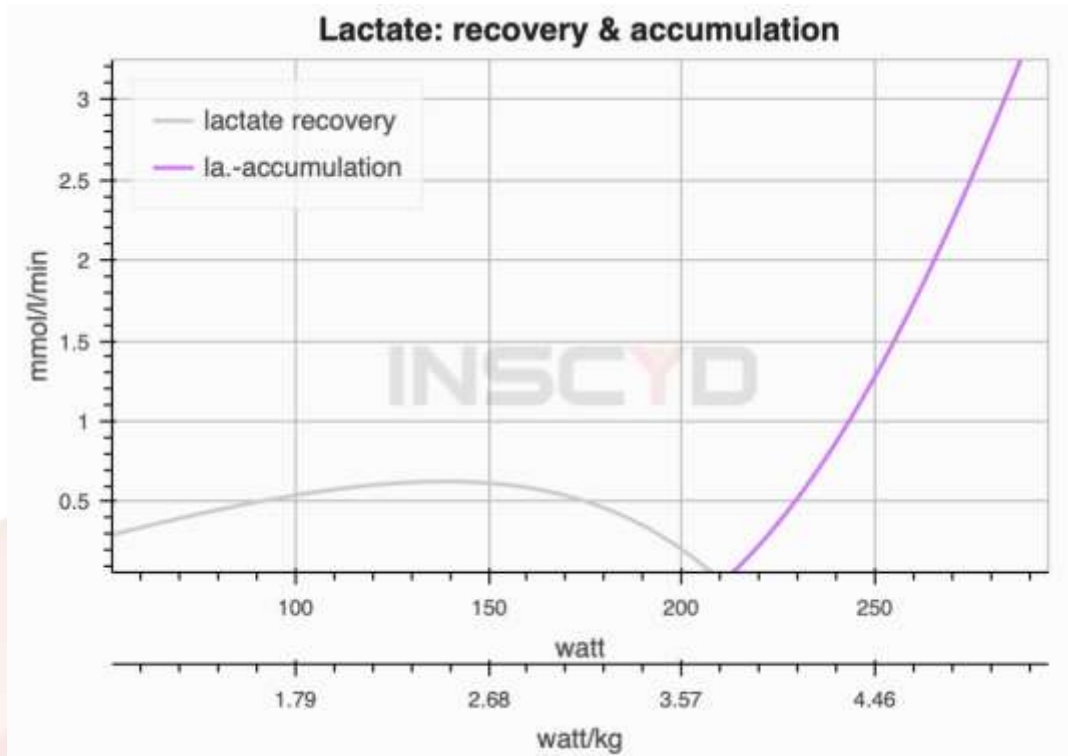
FTP

- ✘ **Inaccurate Training Zones:** FTP-based zones may not reflect individual metabolic differences.
- ✘ **Limited Training Application:** Not suitable for diverse training needs, especially high-intensity and sprint training.

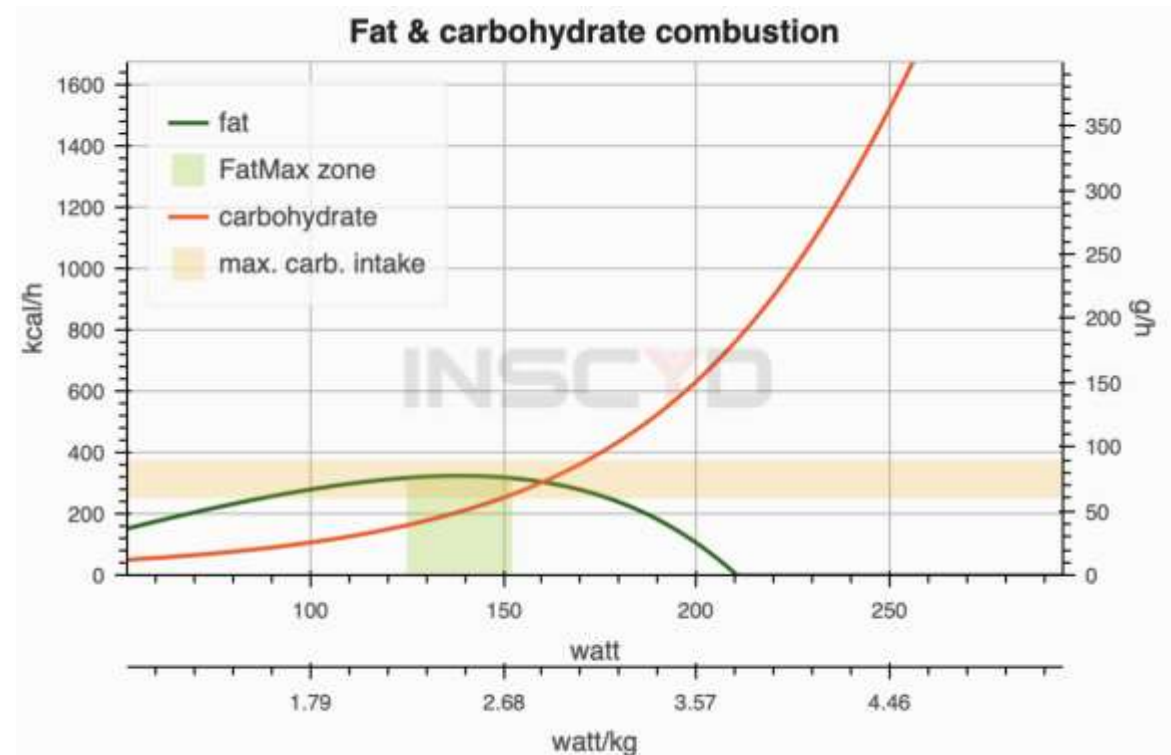
Metabolic Diagnostics → Transfer to Training Routine



Time trial – Pacing Recommendations

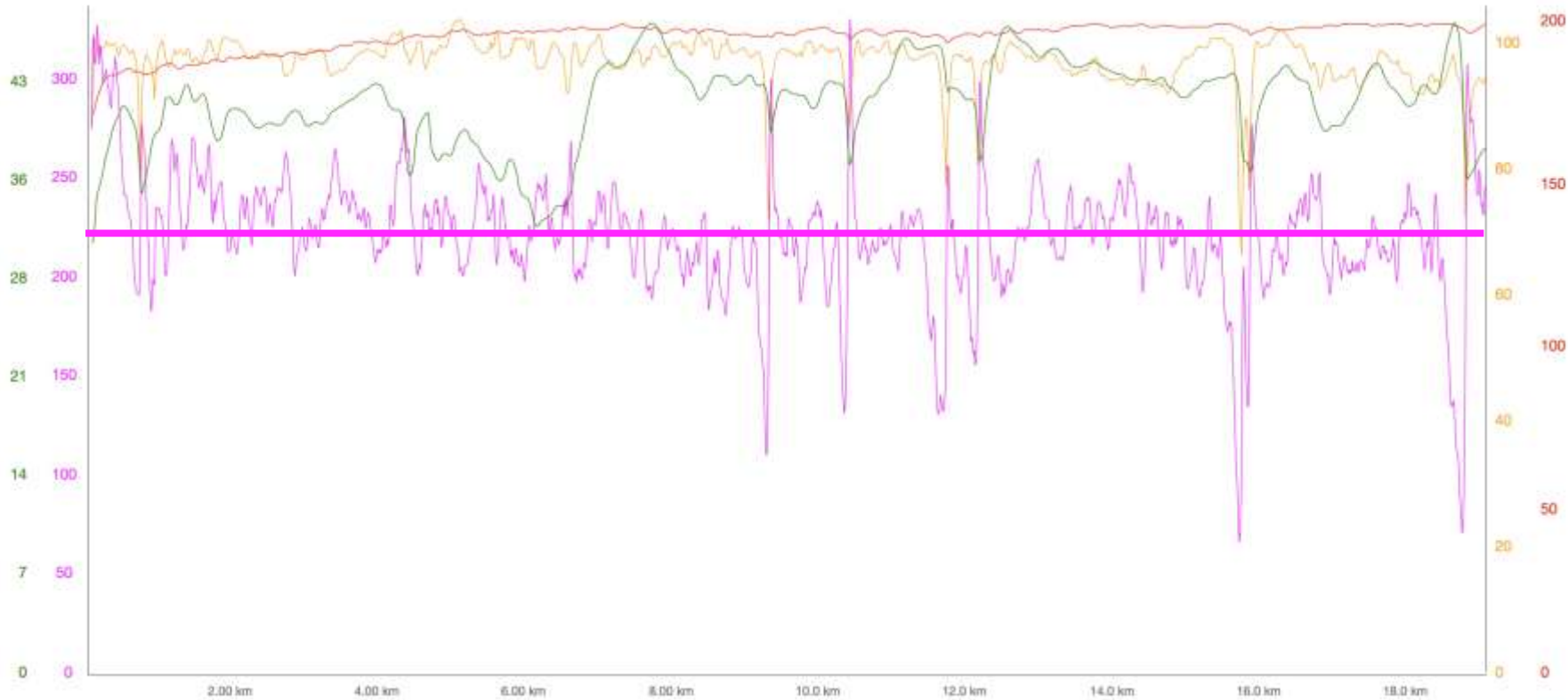


Run	Power [watt]	Time [mm:ss]	Max Lactate [mmol/l]
1	210	15:00	5.3
2	231	10:00	9.0
3	273	05:00	12.6



Recommendation: 220 W

Time Trial – Competition Results

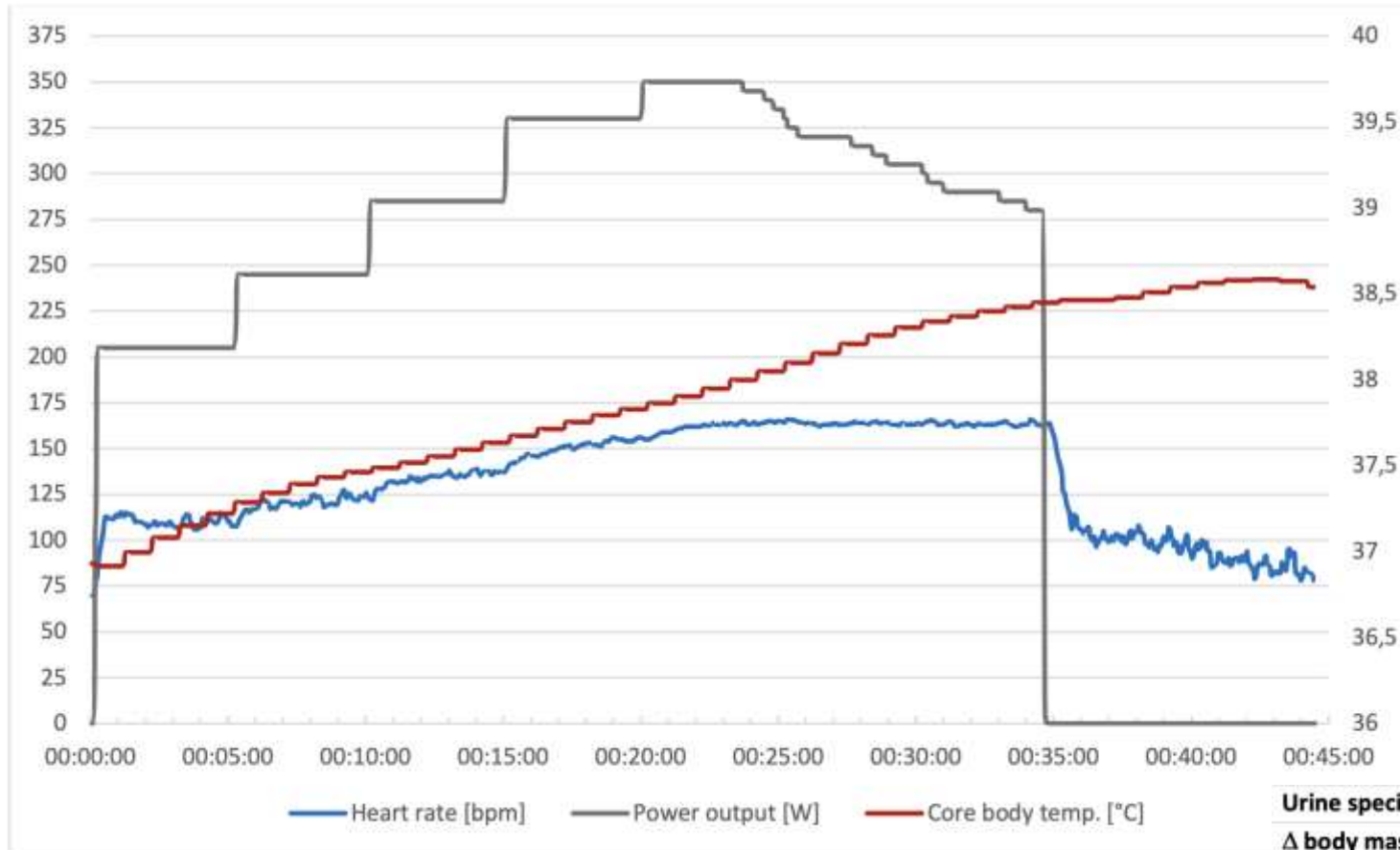


Duration **27:14** Distance **19.0 km** TSS **46**

Work	362 kJ	IF	1.01
NP	223 W	VI	1.01
Pw:Hr	9.07%	EF	1.14
El. Gain	10 m	Grade	--
El. Loss	10 m	VAM	22 m/h
W/kg	4.27		

	MIN	AVG	MAX	
Power	0	221	516	W
Heart Rate	169	195	200	bpm
Cadence	9	97	109	rpm
Speed	30.2	41.8	48.0	kph
Pace	01:59	01:26	01:15	min/km
Elevation	13	19	27	m
Temperature	16	17	18	C

Heat Ramp Test



© greenTEG AG

© LIHPS

Urine specific gravity before test	1,0144
Δ body mass pre / post test	1.100 g
Heart rate at the end of ramp-up phase [bpm]	163
Power Output at the end of ramp-up phase [W]	350
Time during test (constant heart rate) phase [min]	11:30
Power output at the end of test (constant heart rate) phase [W]	280
Core body temp. at the end of test (constant heart rate) phase [°C]	38,45
Max. core body temp. post test [°C]	38,58
Recommended heat training zone [°C]	37,95 - 38,15

Power measurement



© SRM



© Stryd



© Rowing in Motion



© SRM



© cyclingweekly



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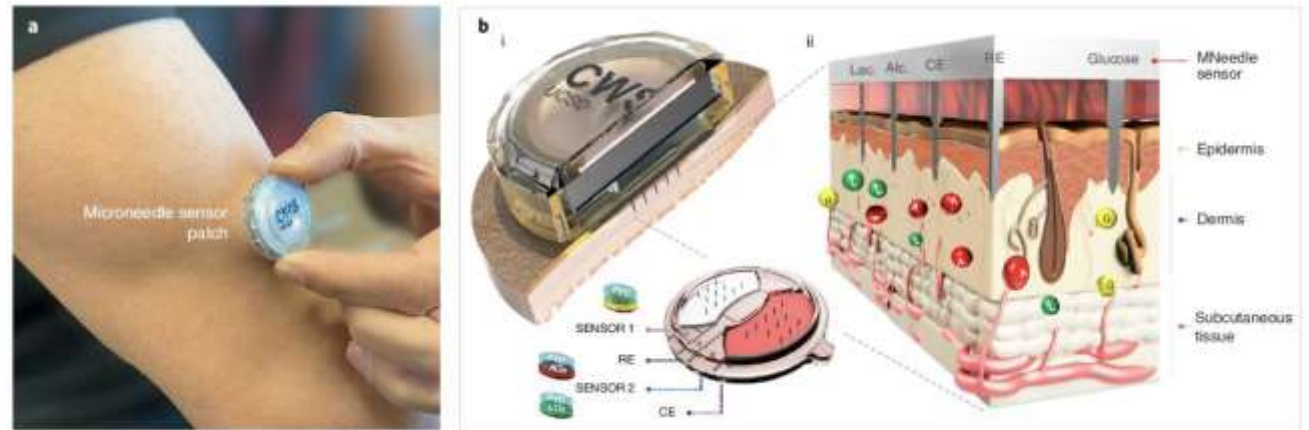


© Catapult

Continuous Lactate Measurement



© clearsafeproducts



Tehrani et al. (2022)

Questions?



Next lectures:

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13/12/2023
(17h30-19h30, Loc A)

**Physical activity at work - What is it? And what should we do
with it? (EN)**

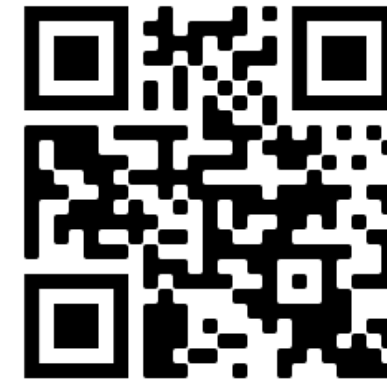
Pieter Coenen, PhD - Amsterdam University, NL

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