INSCYD

Innovationen in der Leistungsdiagnostik & Trainingssteuerung im Ausdauertraining

trainerakademie köln

seit 1974

DOSB

Wie Leistung entsteht

400m Freistil, Paris 2024, Lukas Märtens

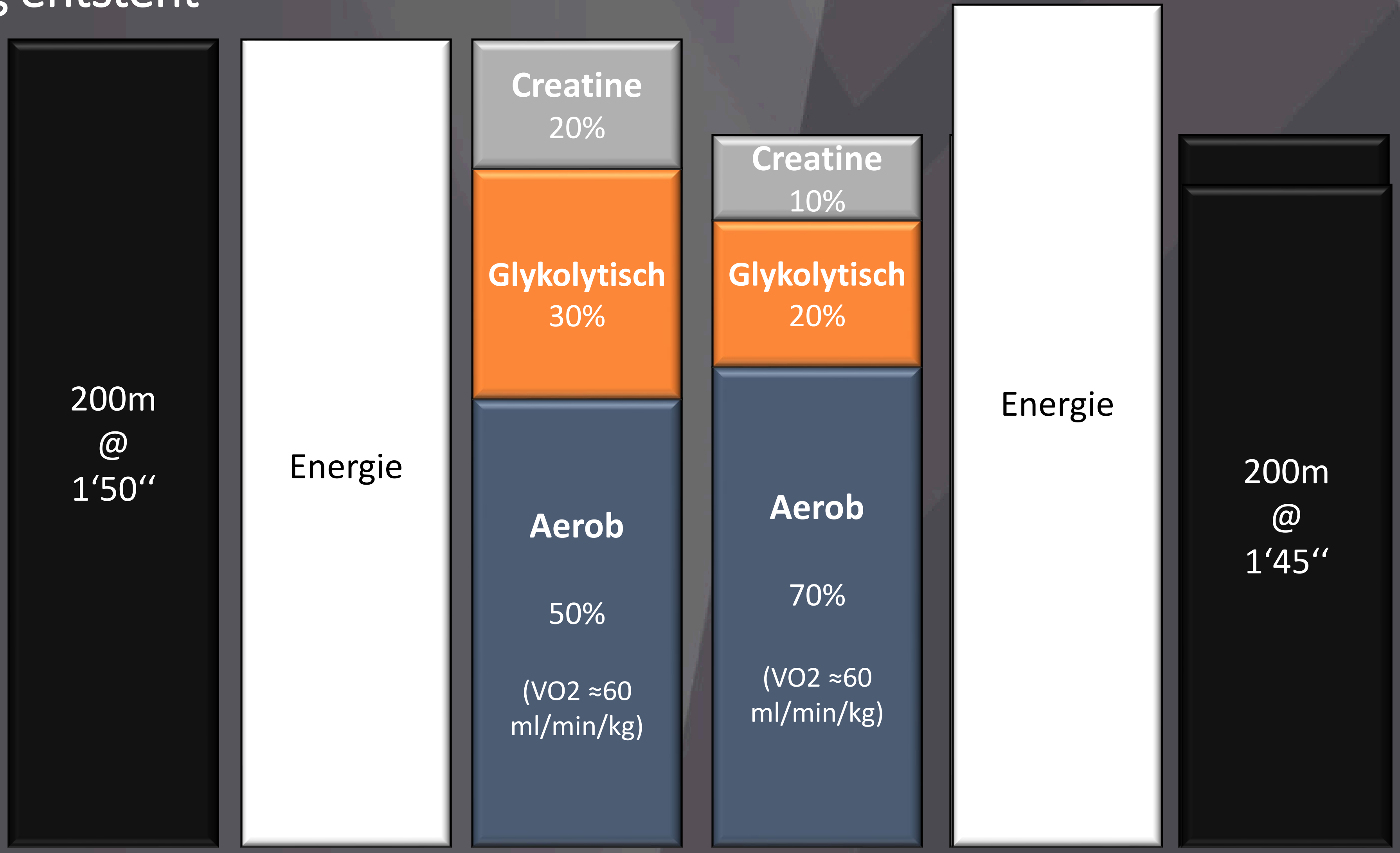
200m
@
1‘50“

Tag 1

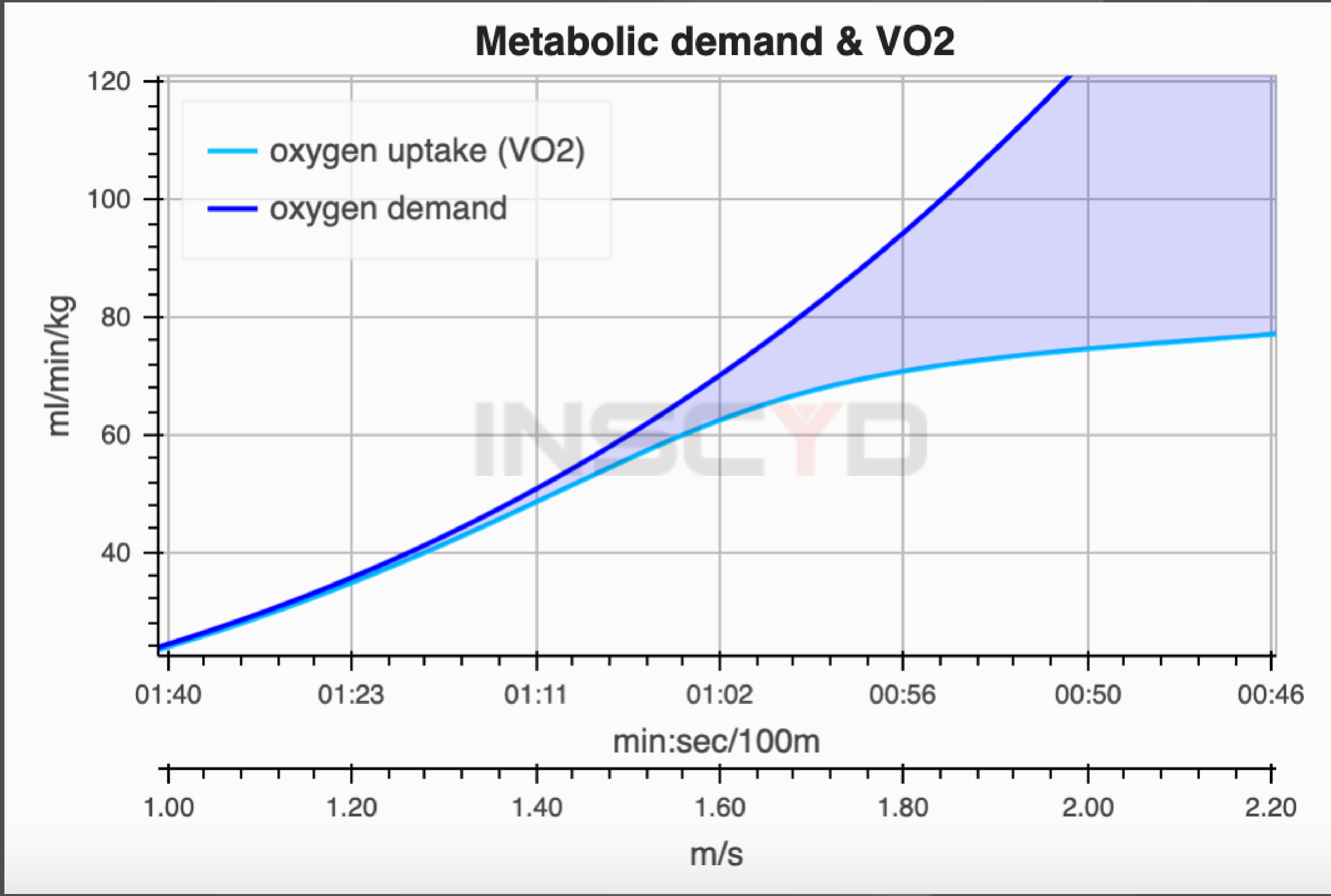
200m
@
1‘50“

Tag 2

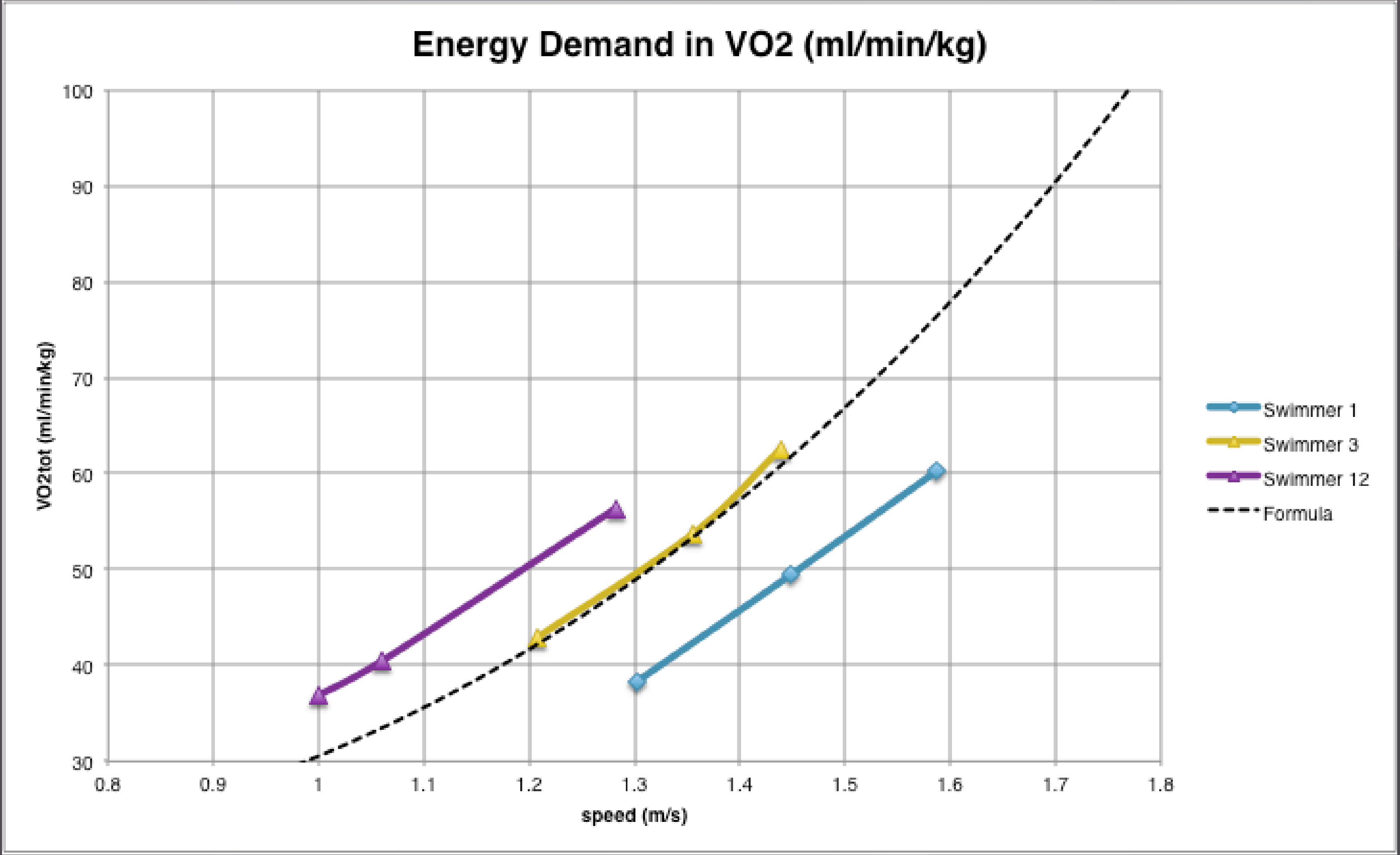
Wie Leistung entsteht



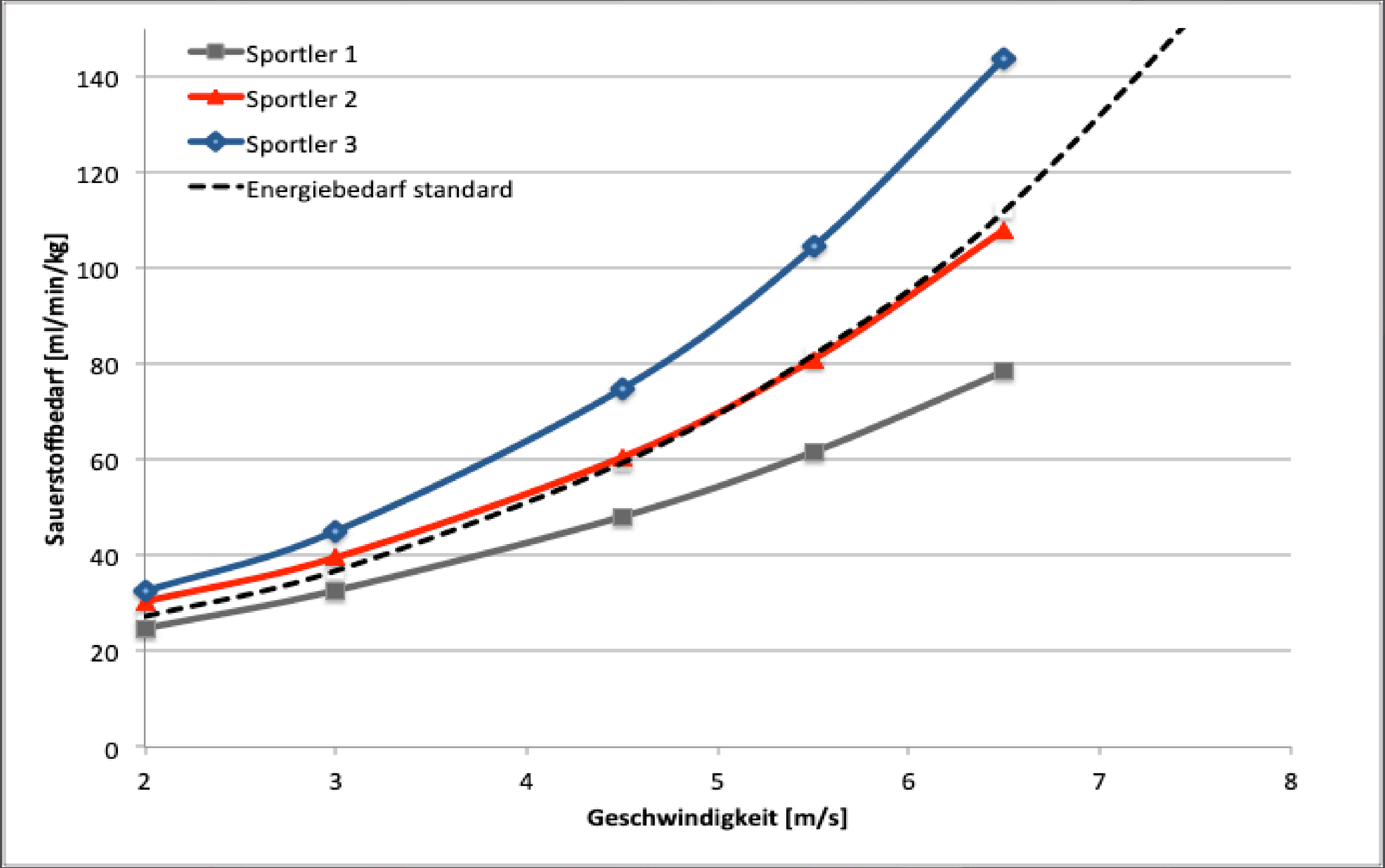
Schritt 1: $\sum(anaerobe + \text{aerobe } Leistung)$ in Geschwindigkeit „umwandeln“



Ökonomie: leistungsrelevante Unterschiede im Schwimmen



Ökonomie: leistungsrelevante Unterschiede im Ski LL



Ökonomiebestimmung: relevant in allen Sportarten

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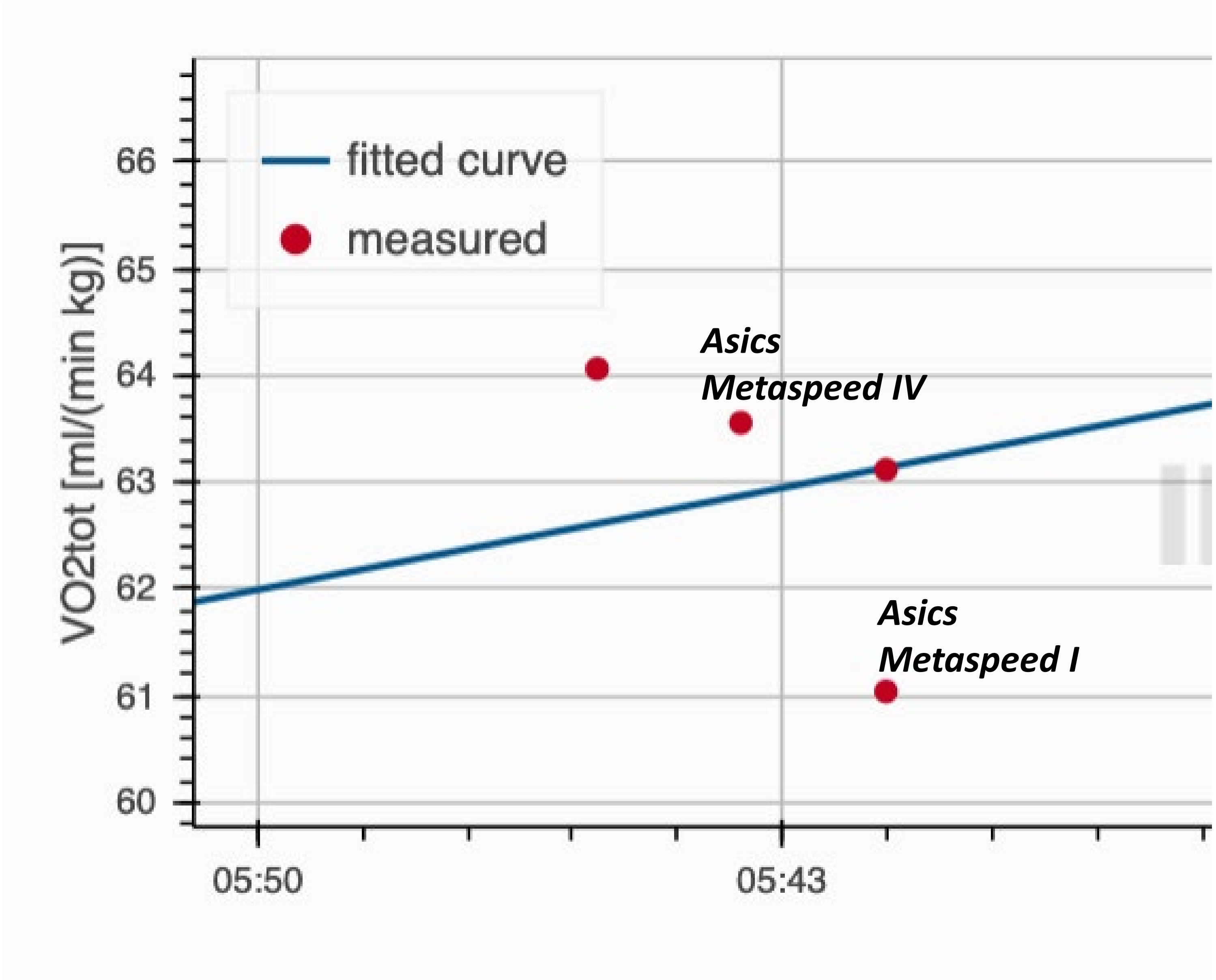
Chris Hammer

🥇 Paris 2024 Paralympics Triathlon

Tokio 2021	– 4. Platz
Rio de Janeiro 2016	– 4. Platz


fitted curve
measured
Asics
Metaspeed IV
Asics
Metaspeed I
VO2tot [ml/(min kg)]
66
65
64
63
62
61
60
05:50
05:43

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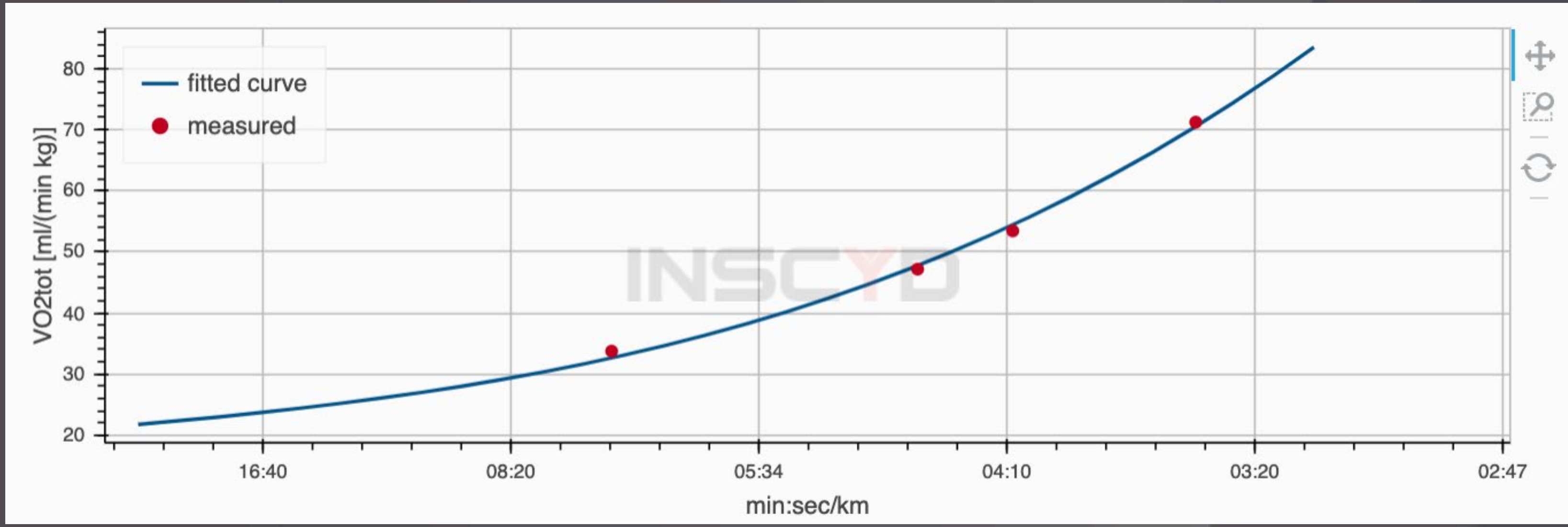
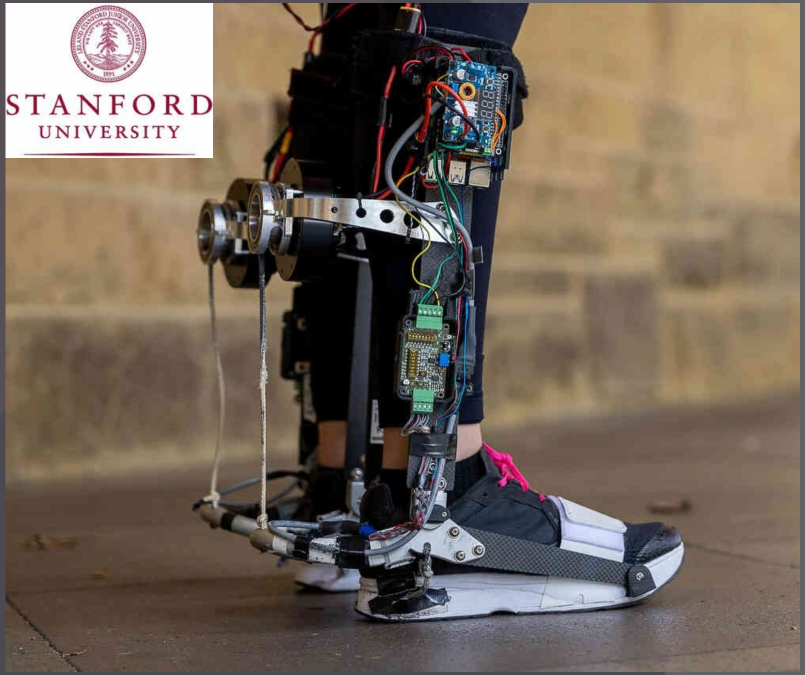
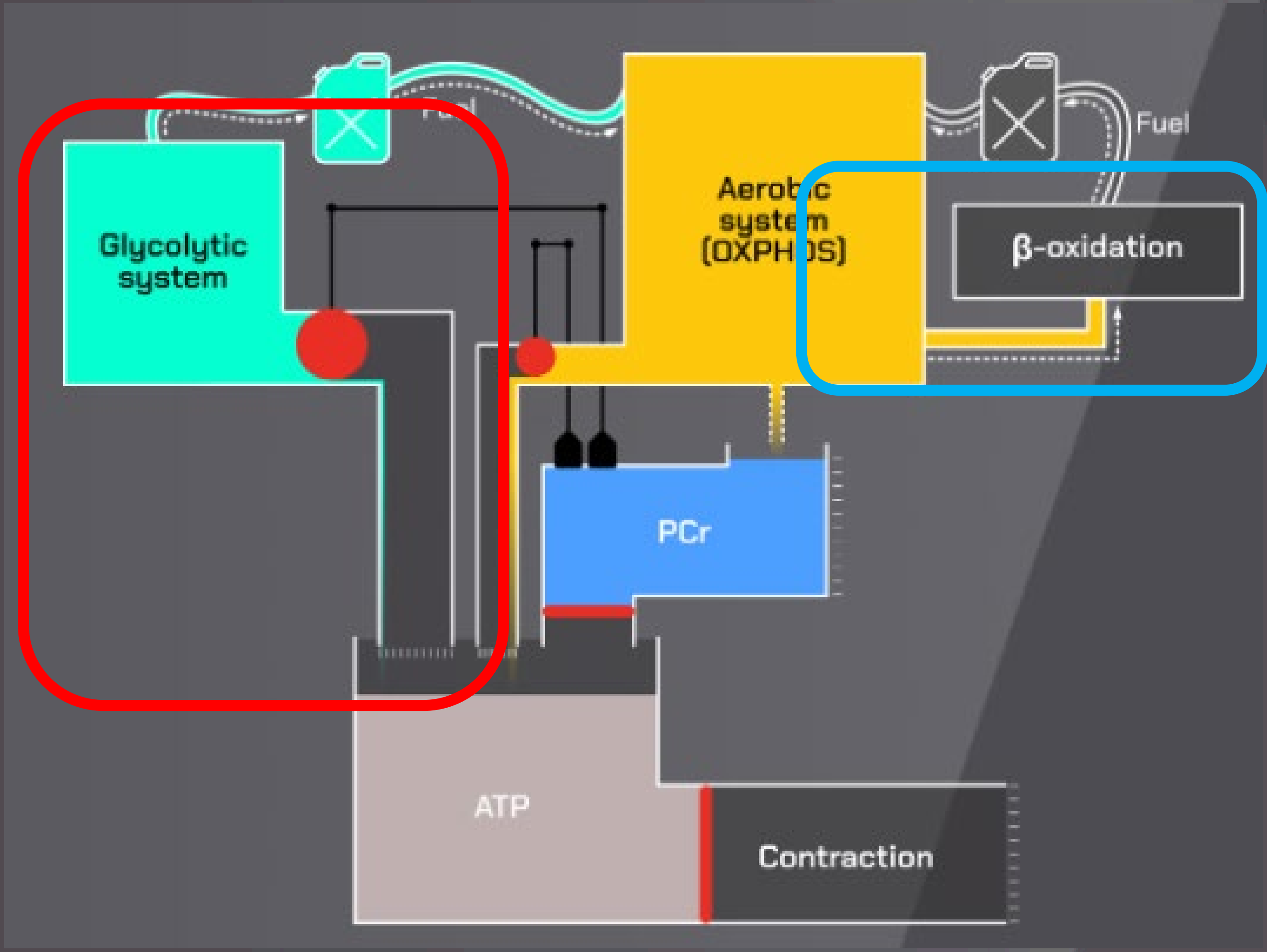
Bestimmung der Ökonomie bei unterschiedlichen Geschwindigkeiten

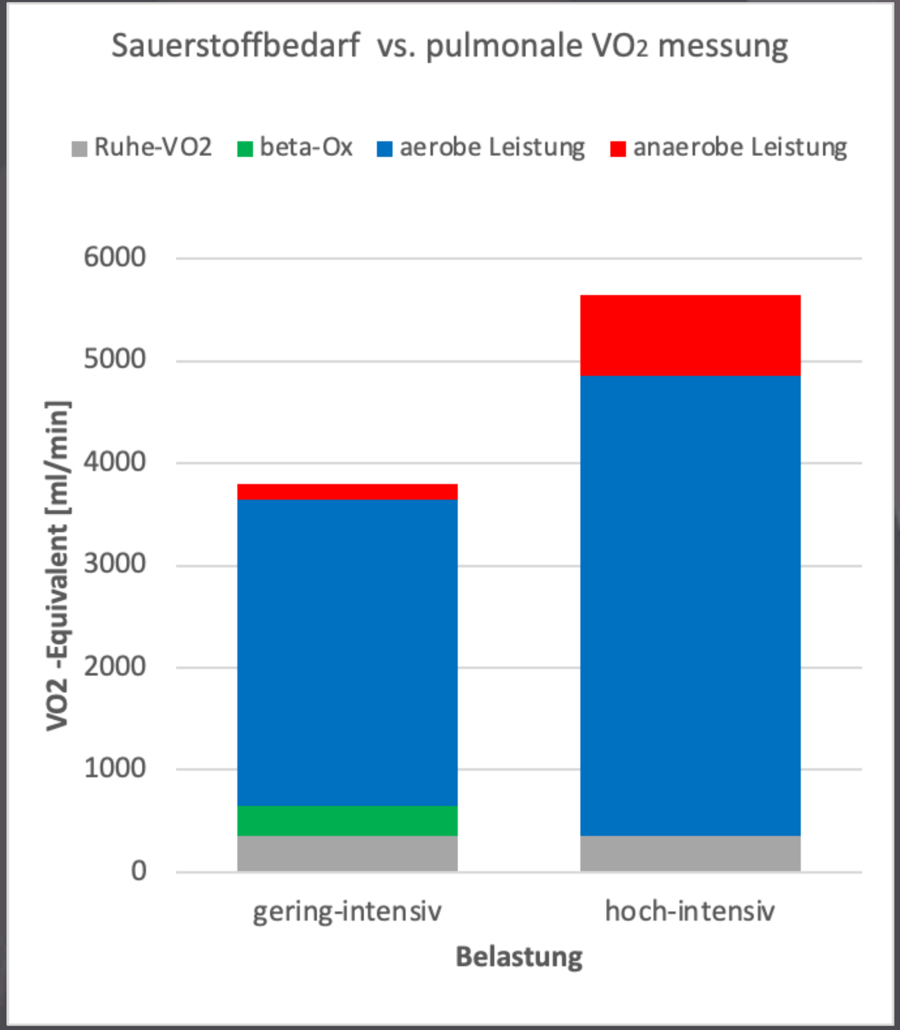


Measured Values							
Run	Distance [m]	Time [mm:ss]	Pace [min:sec/km]	Max Lactate [mmol/l]	Heart rate [bpm]	VO2 [ml/min/kg]	VO2tot [ml/min/kg]
1	867	06:00	06:55	1.4	0	40.60	33.75
2	1311	06:00	04:34	3.4	0	47.20	47.18
3	1449	06:00	04:08	5.6	0	51.90	53.45
4	1143	04:00	03:30	15.8	0	61.90	71.24



Berücksichtigung des Substratstoffwechsels





Laktat – Marker für glykolytische Energie

frontiers in NEUROSCIENCE
PERSPECTIVE ARTICLE
published: 27 February 2015
doi: 10.3389/fnins.2015.00022

Lactate is always the end product of glycolysis

Matthew J. Rogatzki[1], Brian S. Ferguson[2], Matthew L. Goodwin[3] and L. Bruce Gladden[4]*

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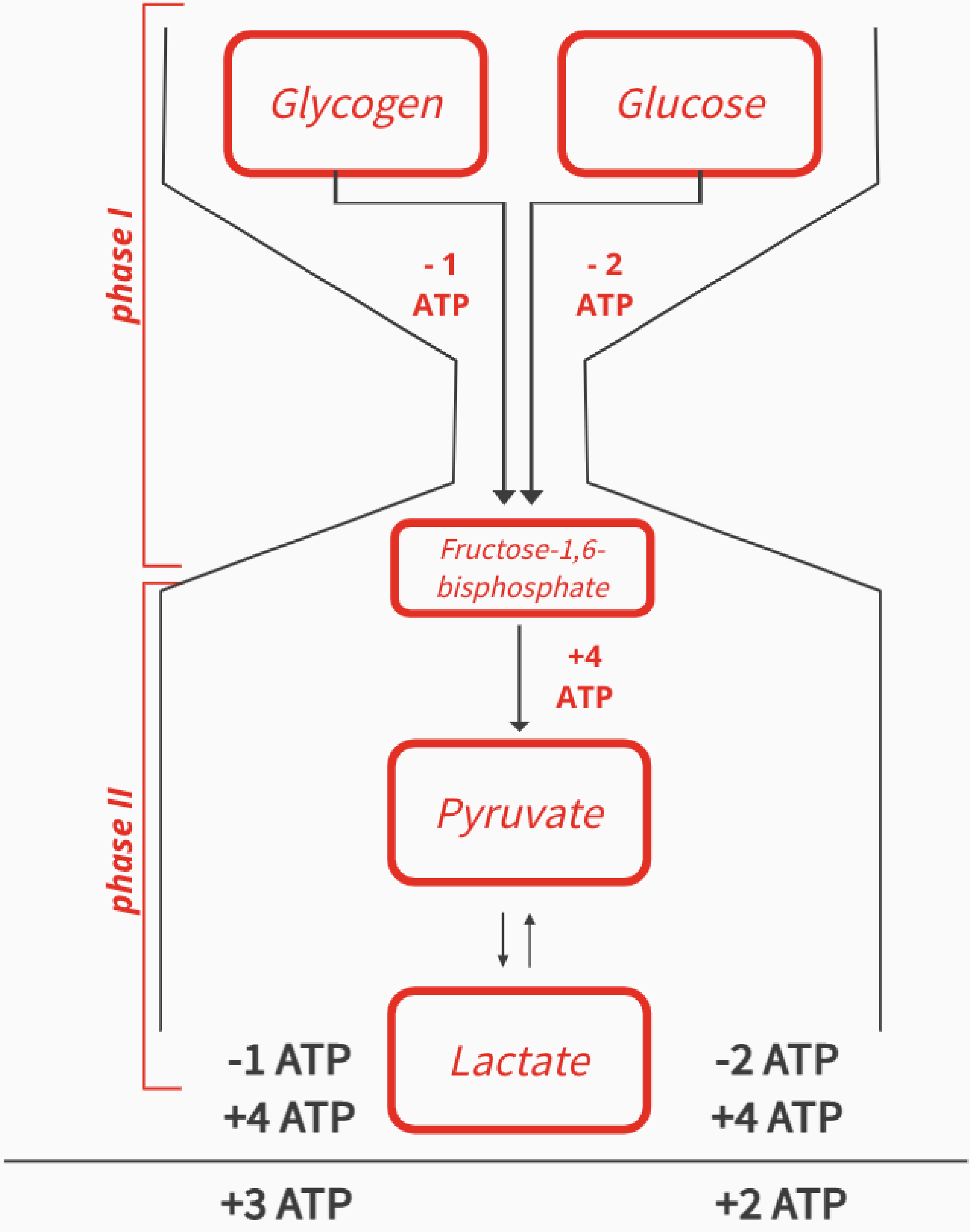
[2] Department of Biomedical Sciences, University of Missouri, Columbia, MO, USA
[3] Department of Orthopaedics, and Huntsman Cancer Institute, University of Utah, Salt Lake City, UT, USA
[4] School of Kinesiology, Auburn University, Auburn, AL, USA

"Further reflection on the activity of the LDH enzyme and the equilibrium constant of its reaction advance the proposition that La– is the primary end product of glycolysis under most, if not all metabolic conditions in most cells."

$$\text{Laktatproduktion}\left[\frac{mmol}{t}\right]$$

$$\sim$$

$$glykolytische\ ATP\ Produktion\left[\frac{mmol}{t}\right]$$



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Maximale glykolytische Leistung – VLa_{max} – wozu braucht man das ?

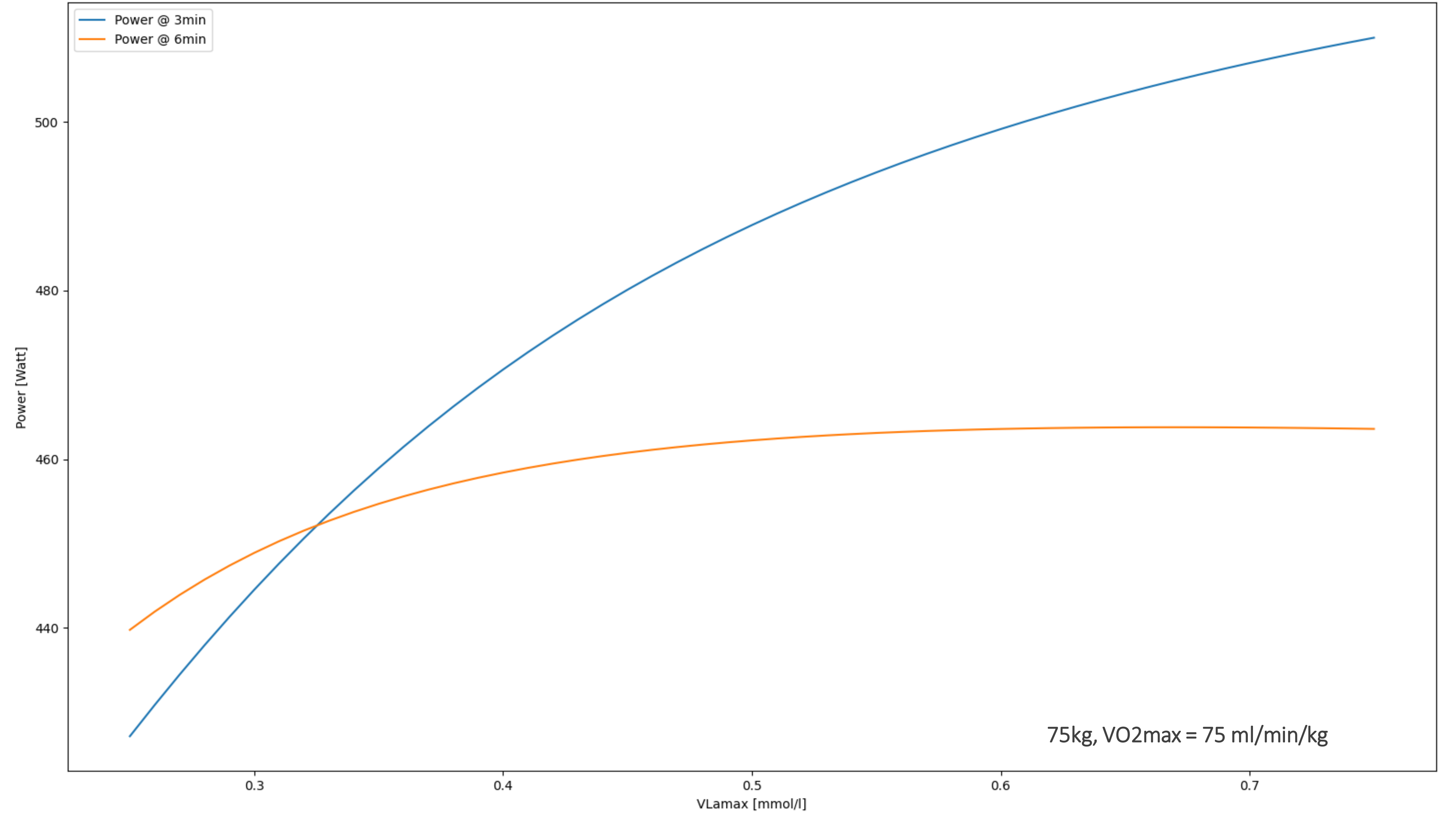
$$1\ \mathrm{mmol\ Laktat} = 1.0\ -\ 1.5\ mmol\ ATP$$

100m Sprint – 9.8 s
≈ 1.00 mmol/l/s
(≈ 1000 Watt)

VLa_{max}: ≈ 0.6 mmol/l/s
=> 11.8s

VLa_{max}: ≈ 0.25 mmol/l/s
=> 16.5 s

Einfluss der VLa_{max} auf die Leistung in kurzen Belastungen



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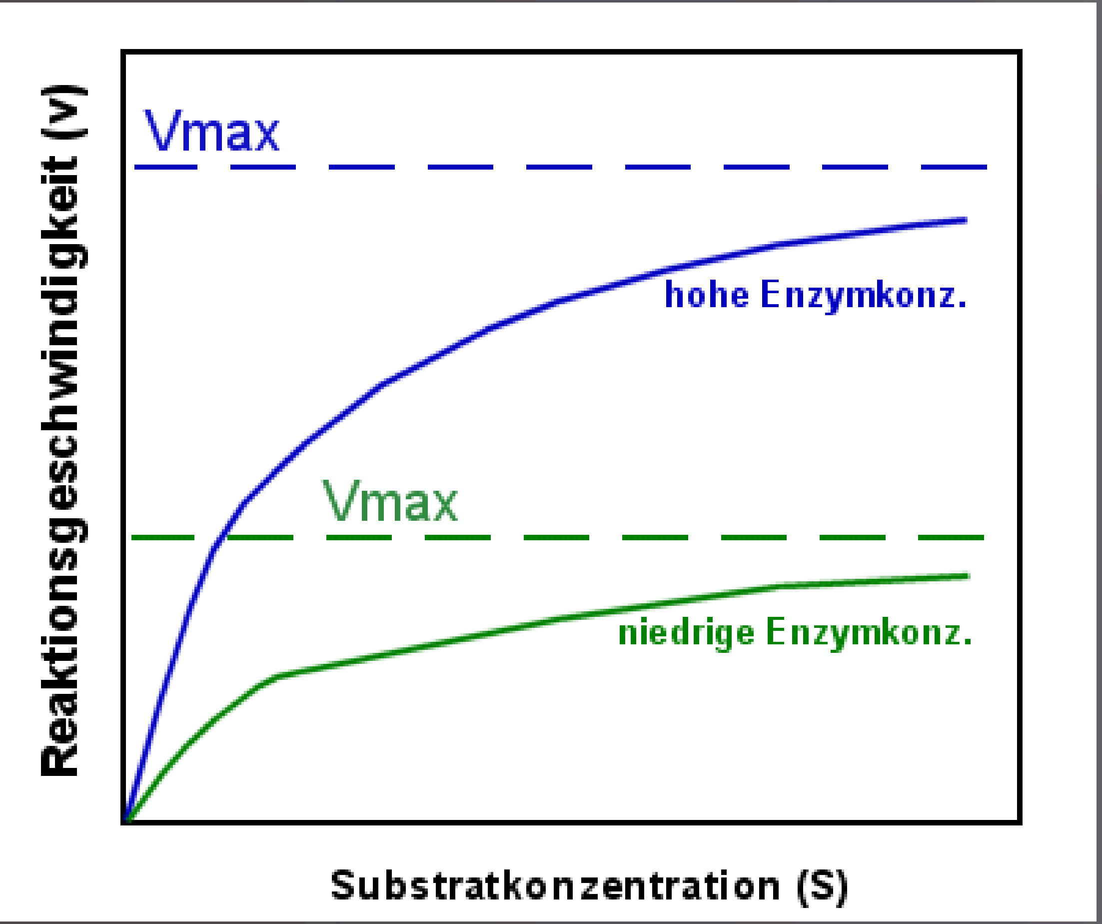
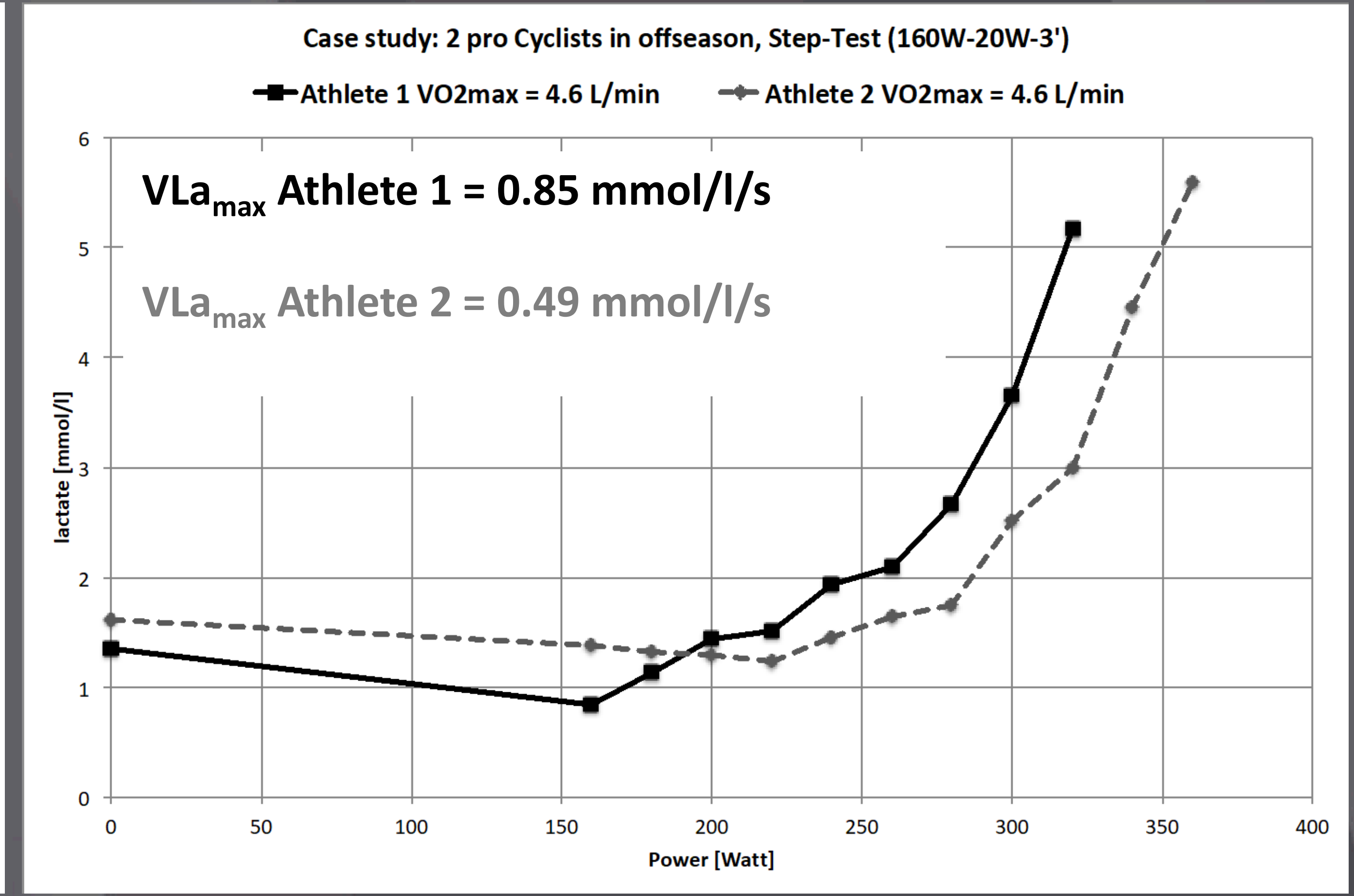
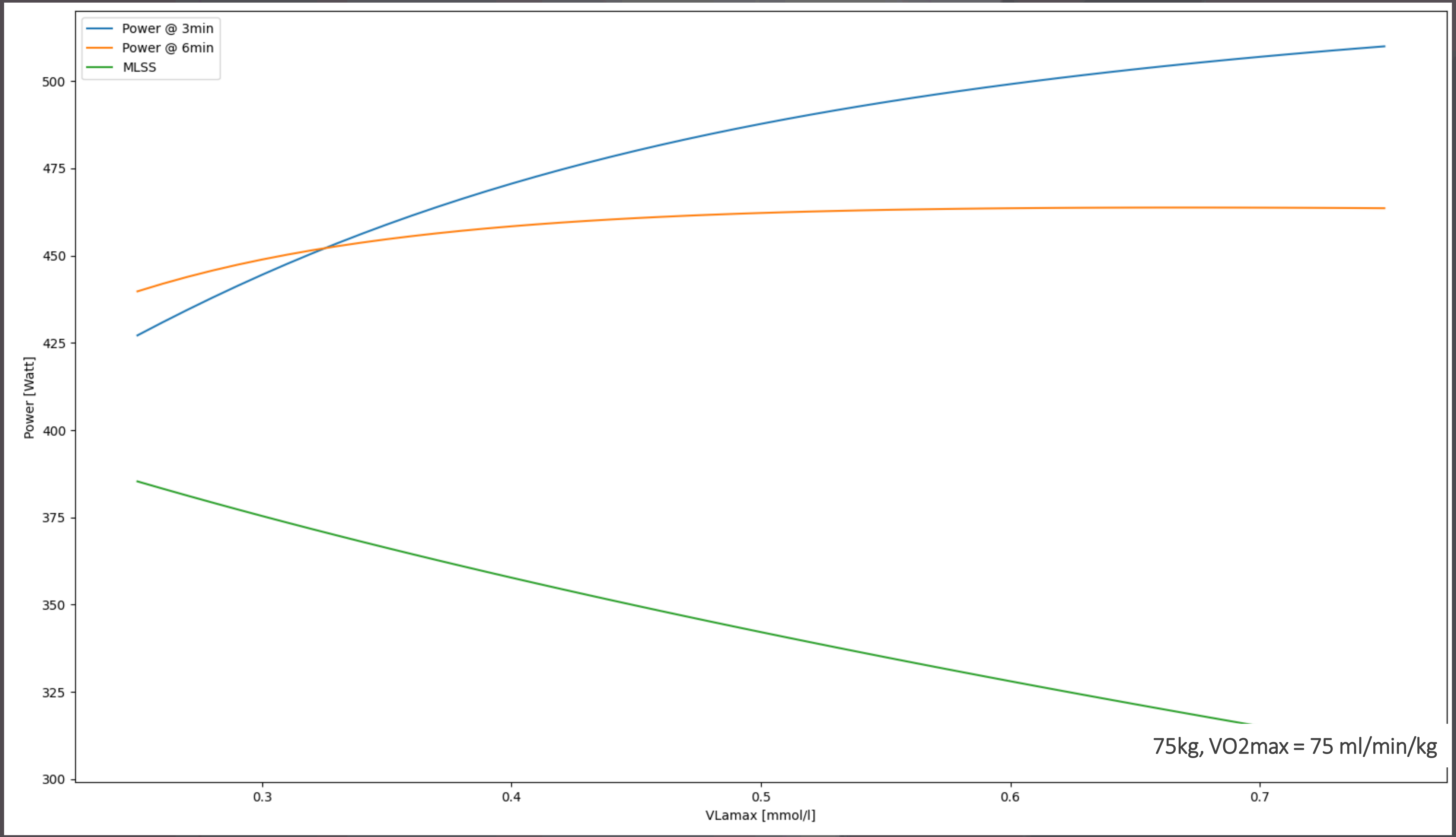
VLa_{max} in submaximalen Ausdauerbelastungen

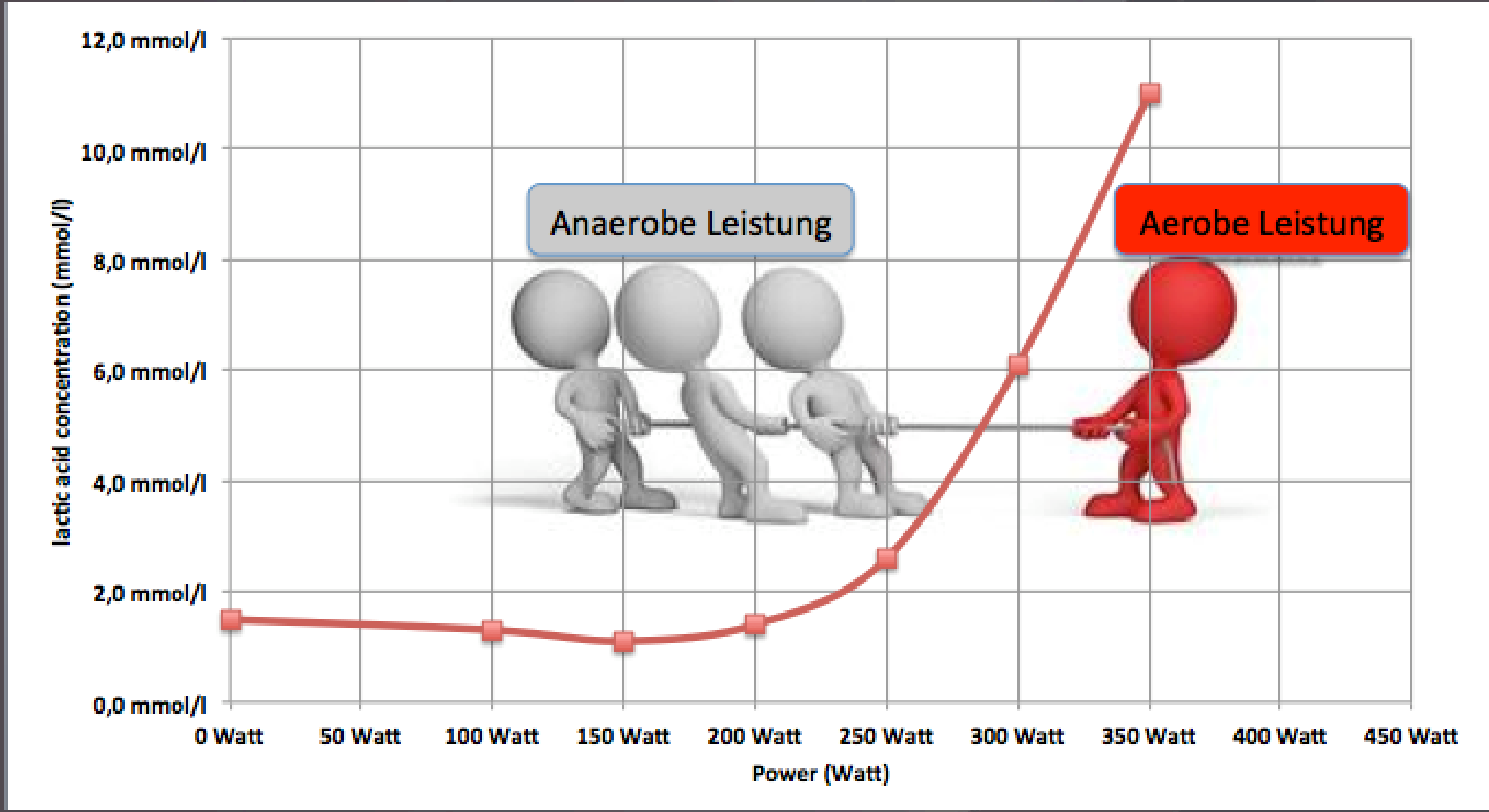




VLa_{max} in kurzen maximalen – vs. Ausdauerleistung



Die Lage der Laktatleistungskurve



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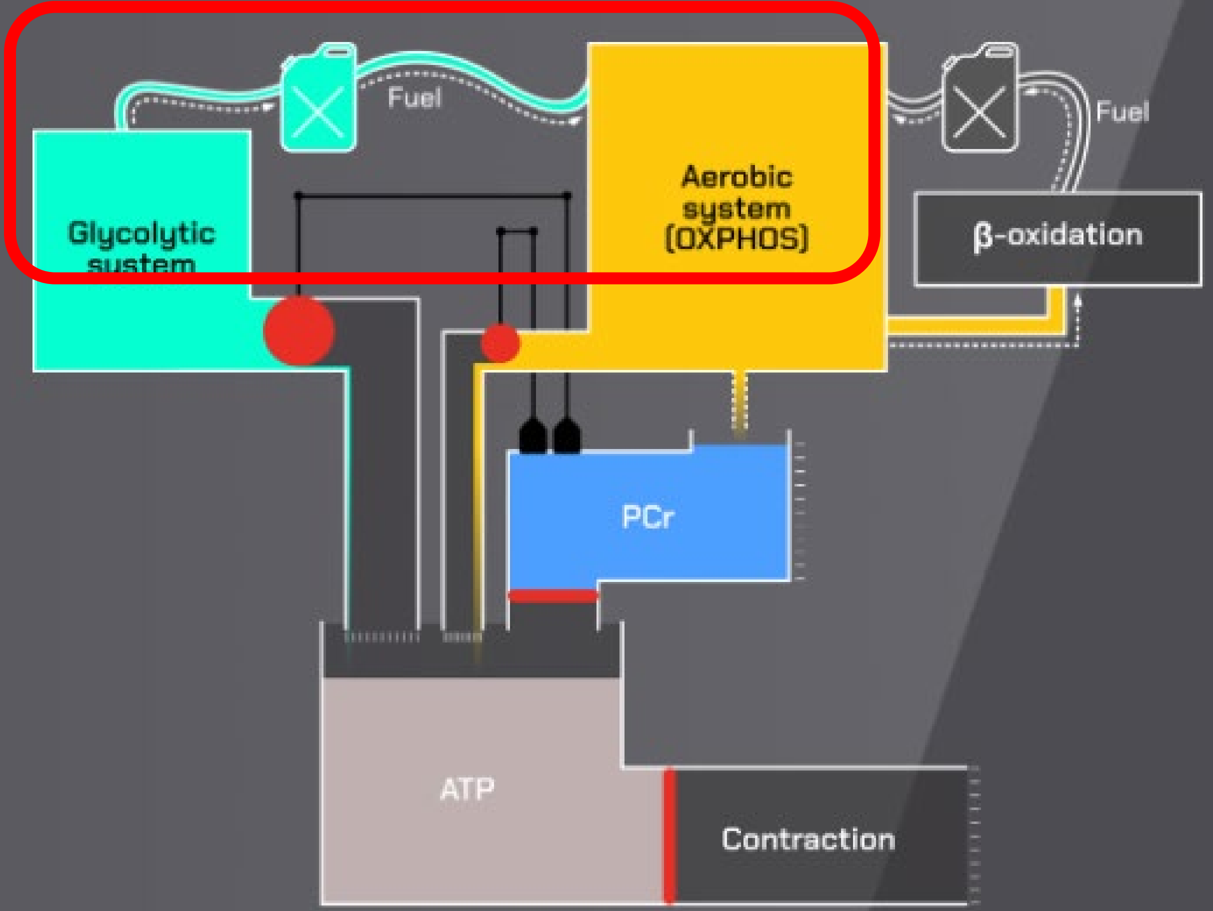
Laktat =
Brennstoff für den aeroben Stoffwechsel



Lactate: Glycolytic End Product and Oxidative Substrate During Sustained Exercise in Mammals – The "Lactate Shuttle"

G.A. BROOKS[1]

Lactate turnover and oxidation have been found to have a direct, positive relationship to metabolic rate (VO_2) during prolonged, steady state exercise by dogs (Depocas et al. 1969; Issekutz et al. 1976), rats (Donovan and Brooks 1983), and humans (Mazzeo et al. 1982; Brooks et al. 1984). In rats (Donovan and Brooks 1983), lactate oxidation was a linear function of VO_2 up to an intensity of 75% of maximal O_2 consumption ($VO_{2\,max}$) (Fig. 1).

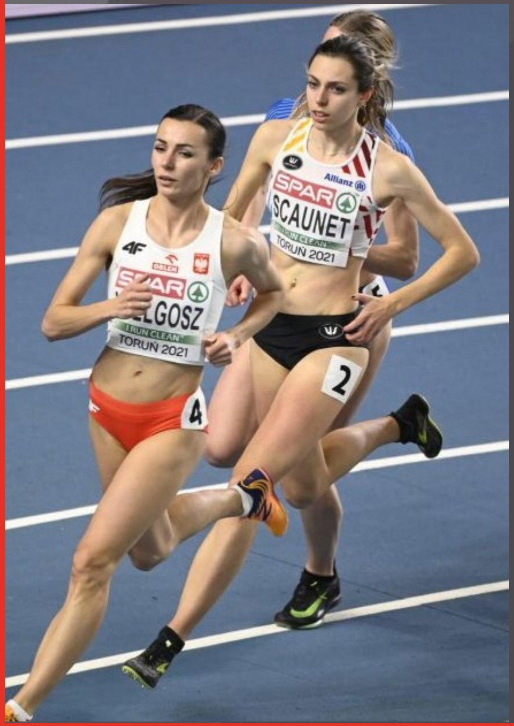
VO_{2max} – direkter Bezug zur Leistung

Je 1 Watt $\approx \mathbf{12.5 \frac{ml}{min}}$

100 Watt $\approx 1.25 \frac{L}{min}$

200 Watt $\approx 2.5 \frac{L}{min}$

500 Watt $\approx 6.25 \frac{L}{min}$



Je 1 m/s $\approx \mathbf{7.7 \frac{ml}{min}/kg}$

$10km/30' \approx 71 \frac{ml}{min}/kg$

Marathon/1:59h $\approx 77.5 \frac{ml}{min}/kg$

800m/ 1‘44“$\approx 118 \frac{ml}{min}/kg$

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Metabolisches Profil erklärt Trainingsanpassungen ?!

	VO_{2max}	VLa_{max}	Ökonomie
1	85 ml/min/kg,	0.8 mmol/l/s,	4.7 kcal/kg/km;
2	80 ml/min/kg,	0.4 mmol/l/s,	4.3 kcal/kg/km

Max. Leistung:
200m @ 1’48”

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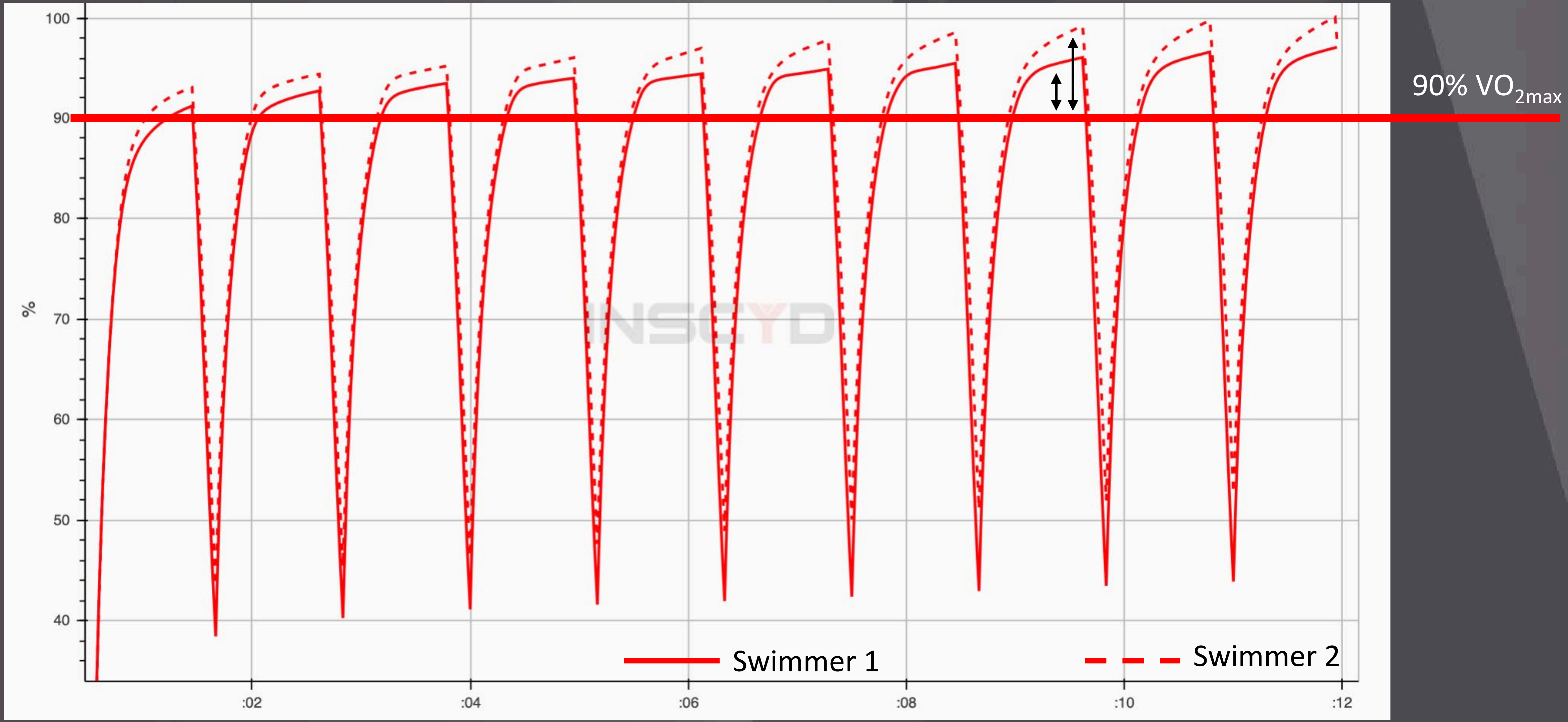
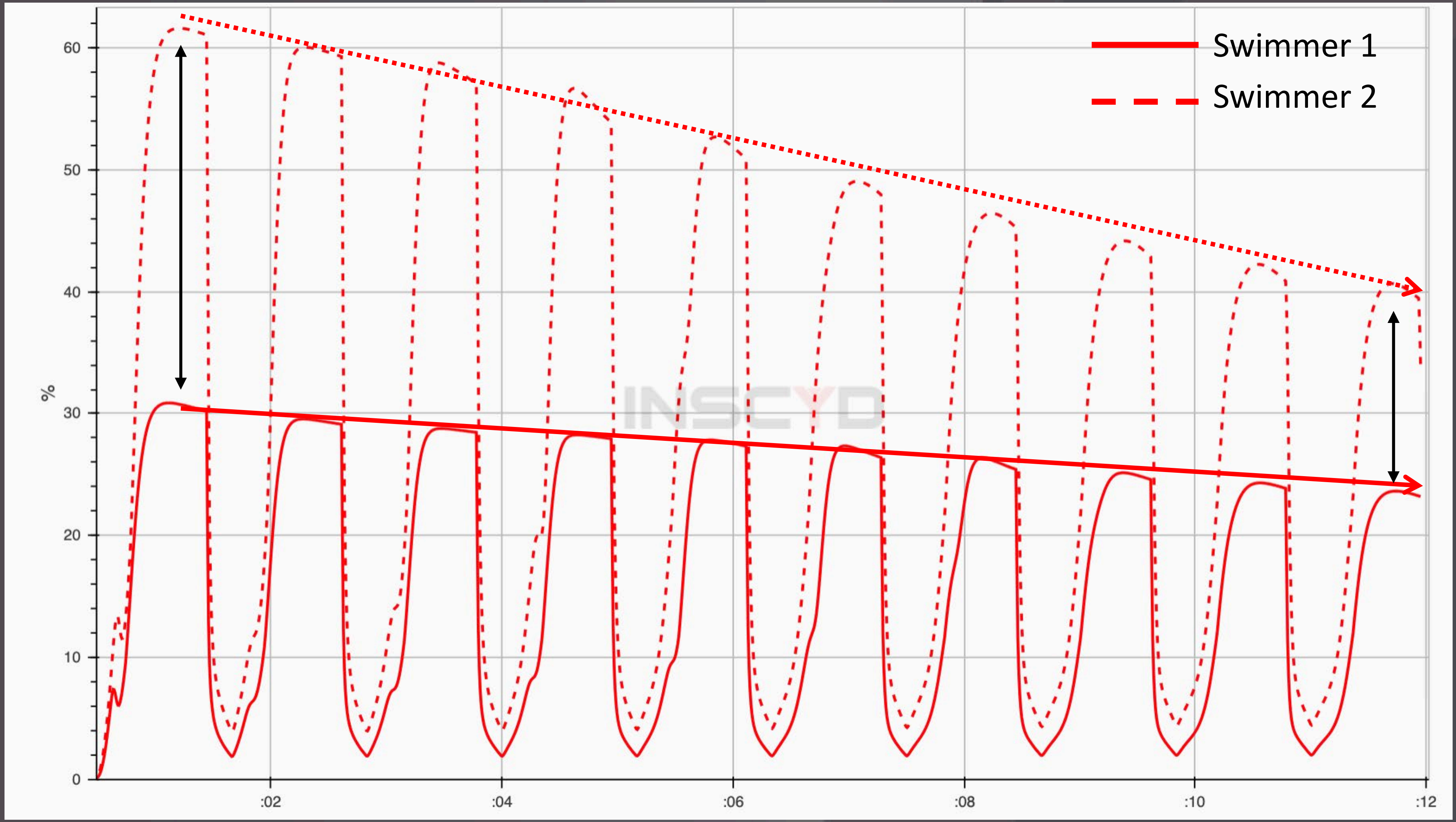
Metabolisches Profil erklärt Trainingsanpassungen ?!

- Intervall set
- 10x 100m @57”
- passiver Erholung: @13”

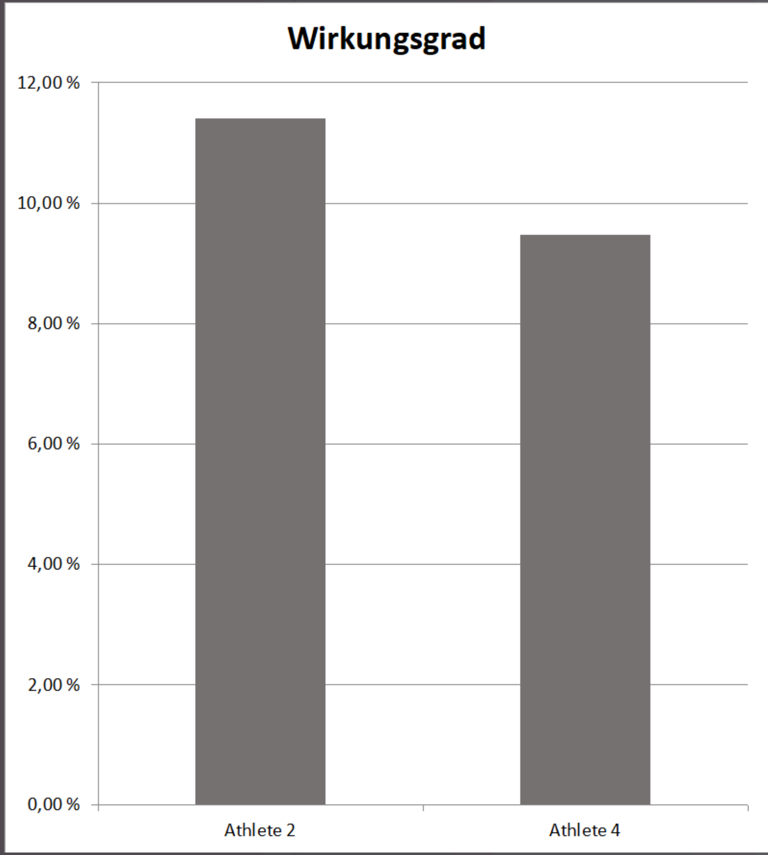
% Belastung des aeroben Systems (VO_{2max})

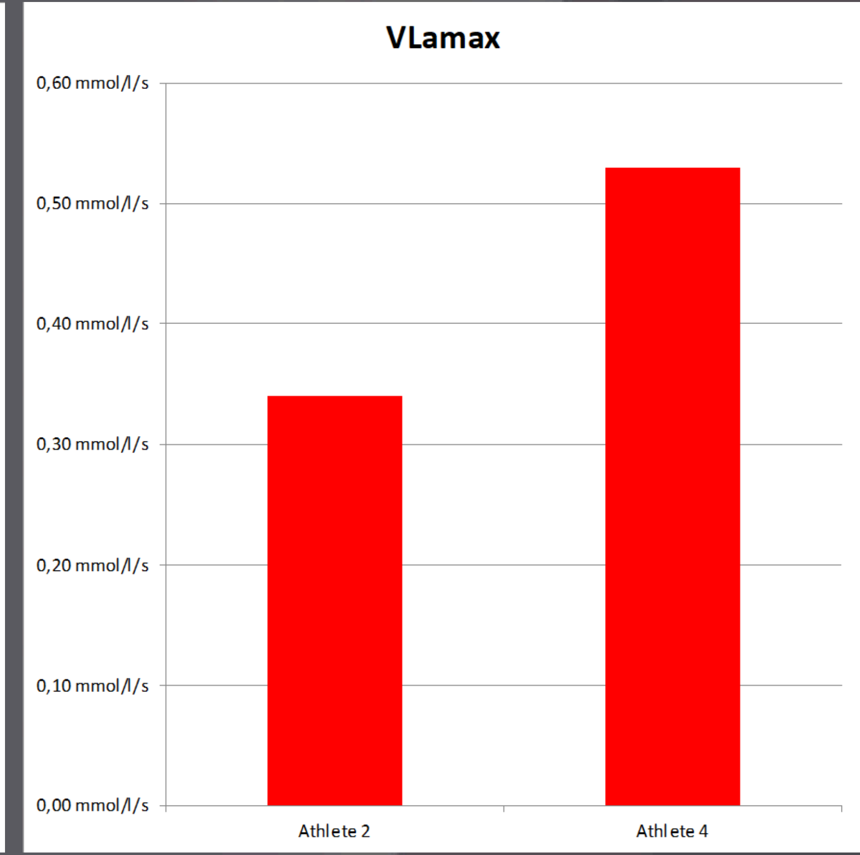


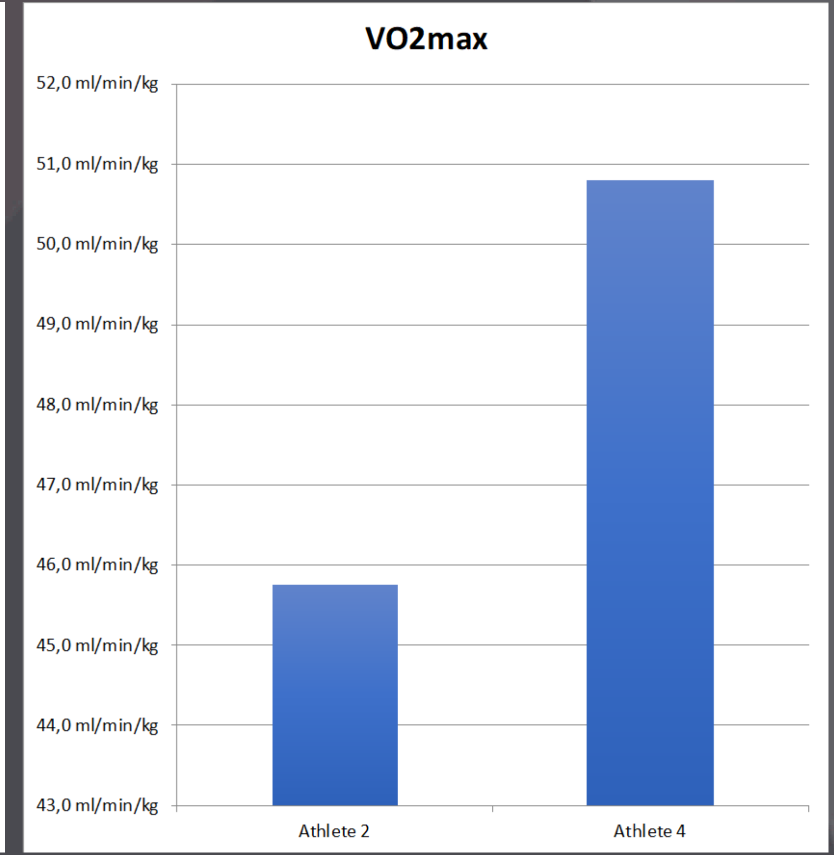
% Belastung des glykolytoschen Systems (VLa_{max})



Metabolisches Profil -
Leistungspotentiale erkennen







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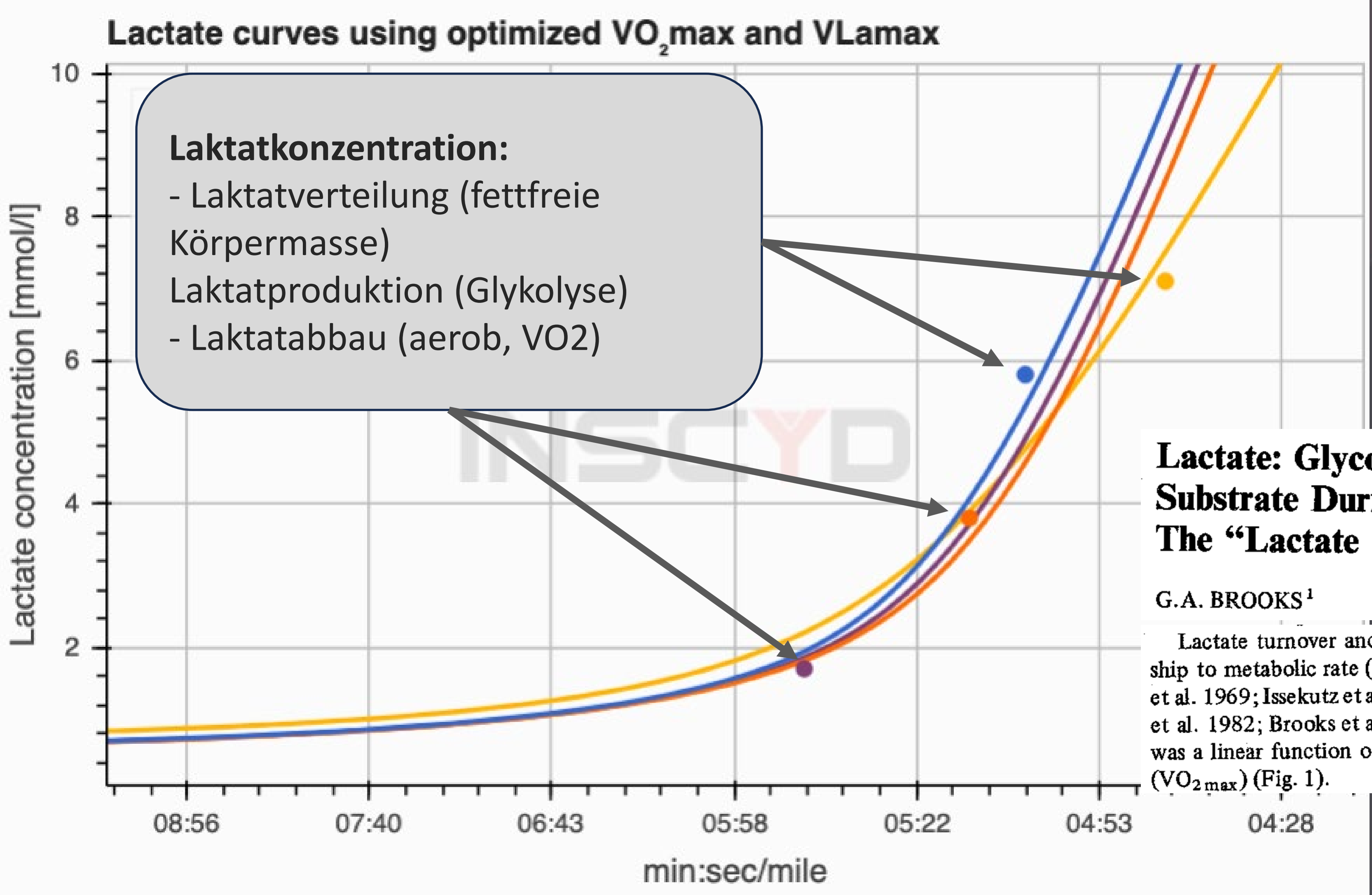
Raus aus dem Labor !

Bestimmung VLa_{max} & VO_{2max} aus simplen Laktattests



Laktatkonzentration:
- Laktatverteilung (fettfreie Körpermasse)

Laktatproduktion (Glykolyse)
- Laktatabbau (aerob, VO2)

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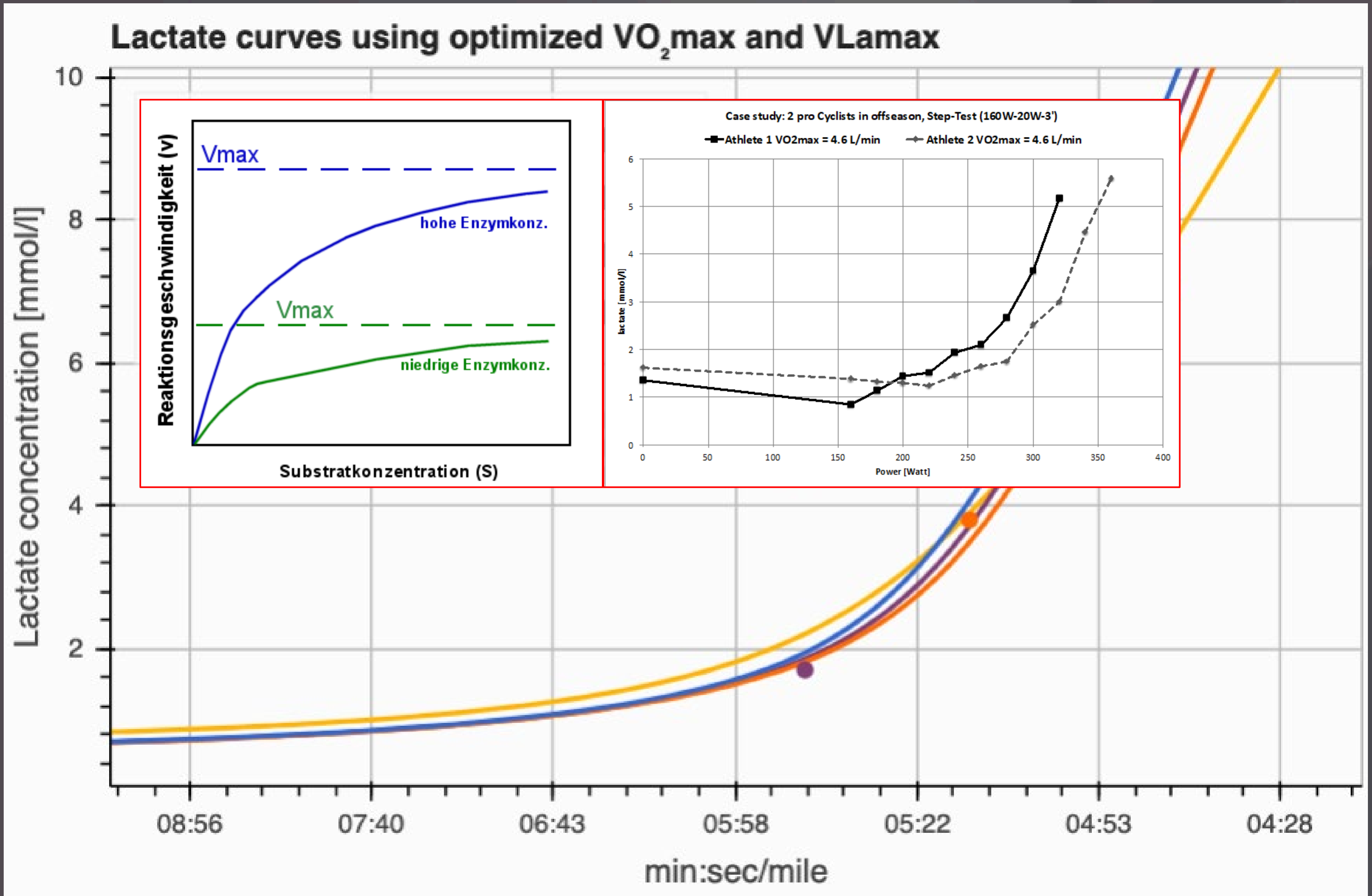
Bestimmung VLa_{max} & VO_{2max} aus simplen Laktattests



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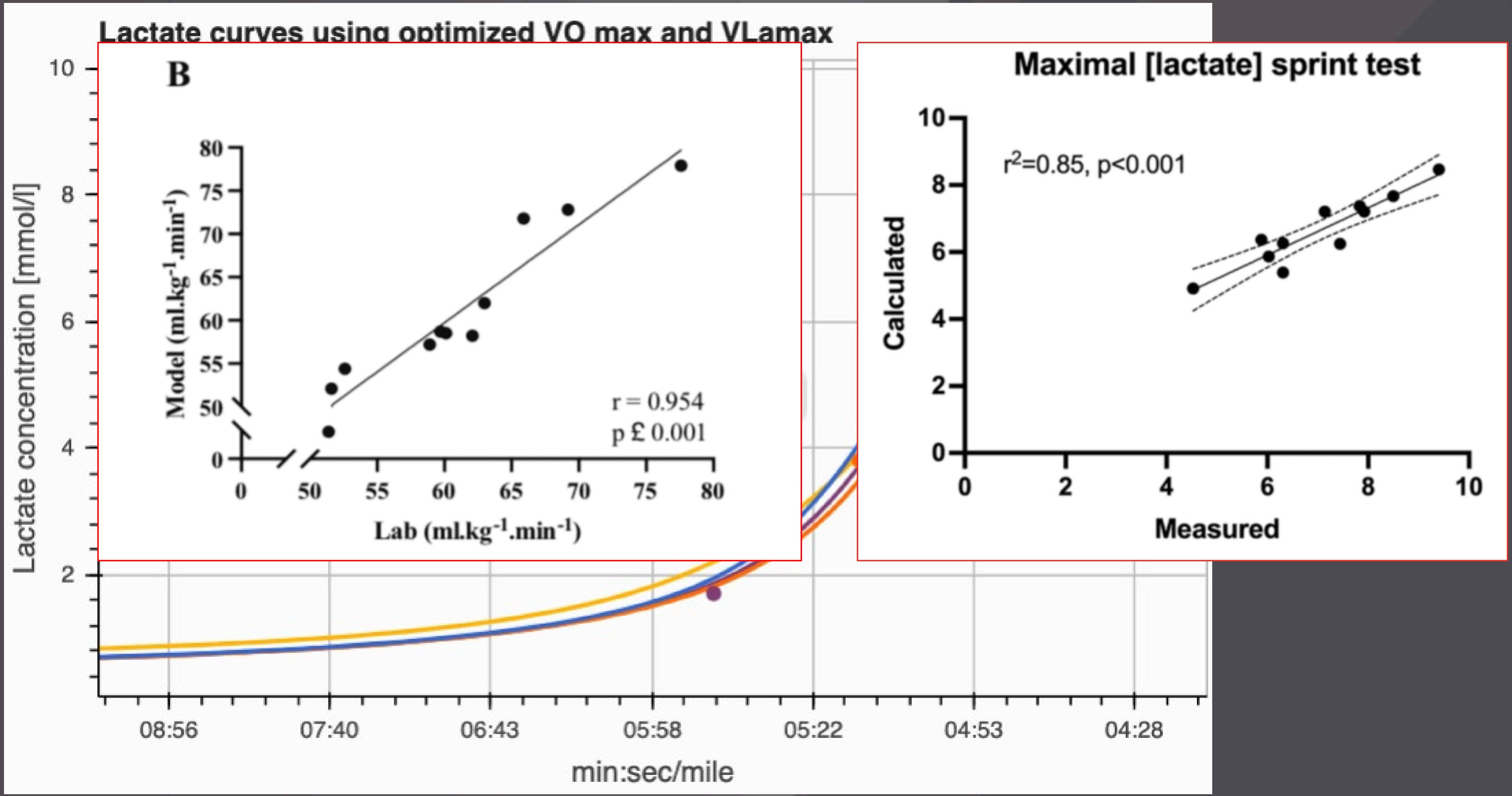
Bestimmung VLa_{max} & VO_{2max} aus simplen Laktattests



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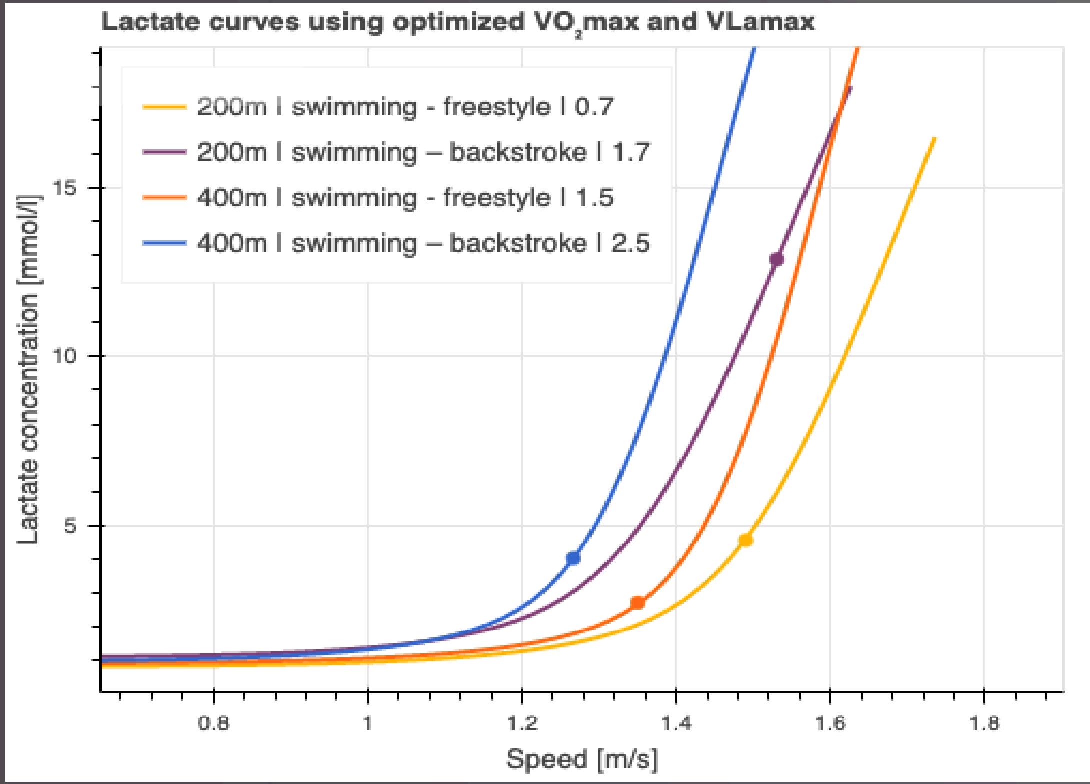
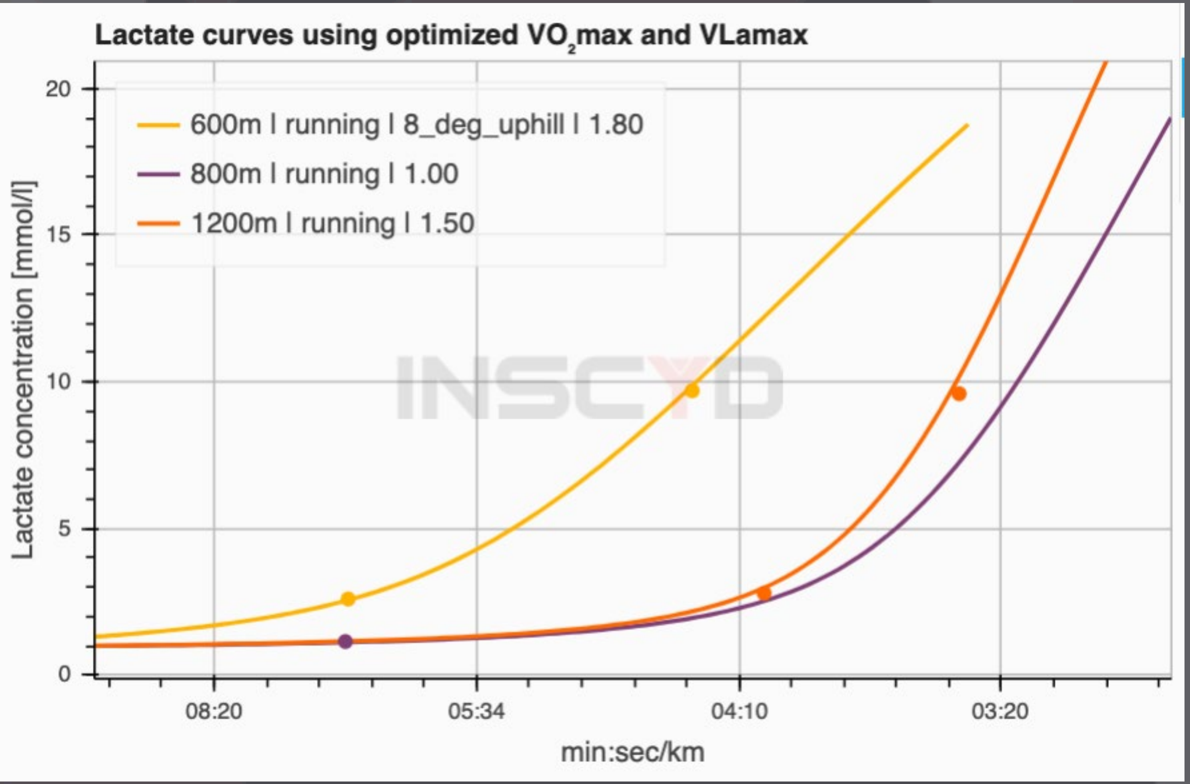
Keines oder jedes Testprotokoll





- Fast beliebige Kombination von Stufendauer und Höhe
- Variable Stufenlängen innerhalb eines Tests
- Unabhängig von Material und äußeren Bedingungen

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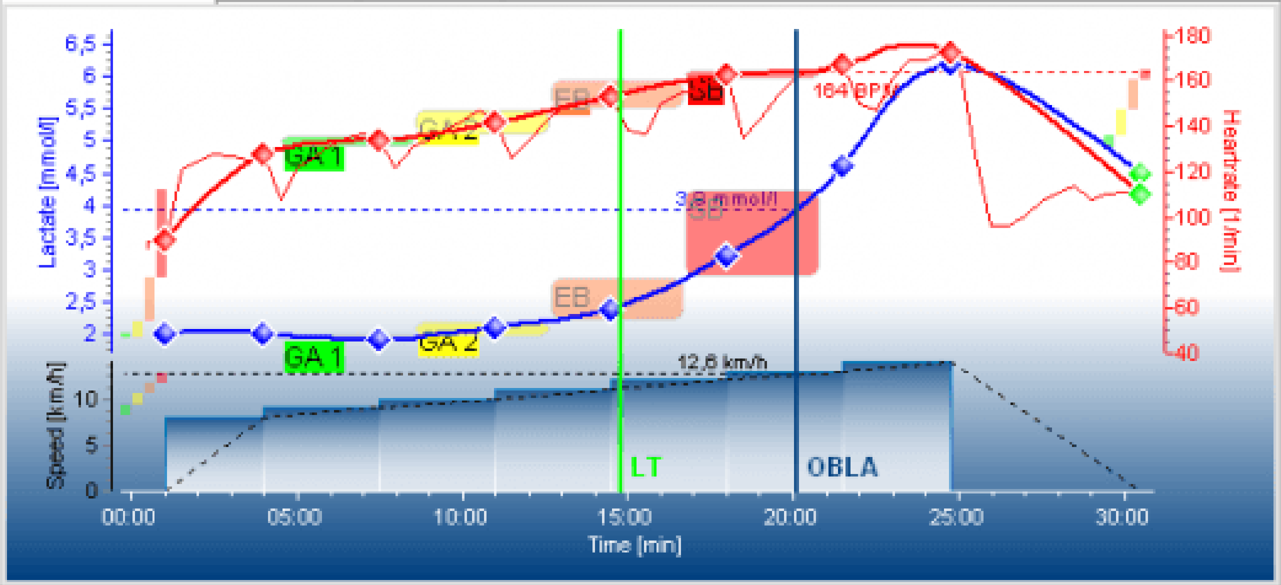
Laktat-Stufentest 2.0

Single analysis | Training calendar | Compare tests

Lactate diagnostics | Load display | Assessment



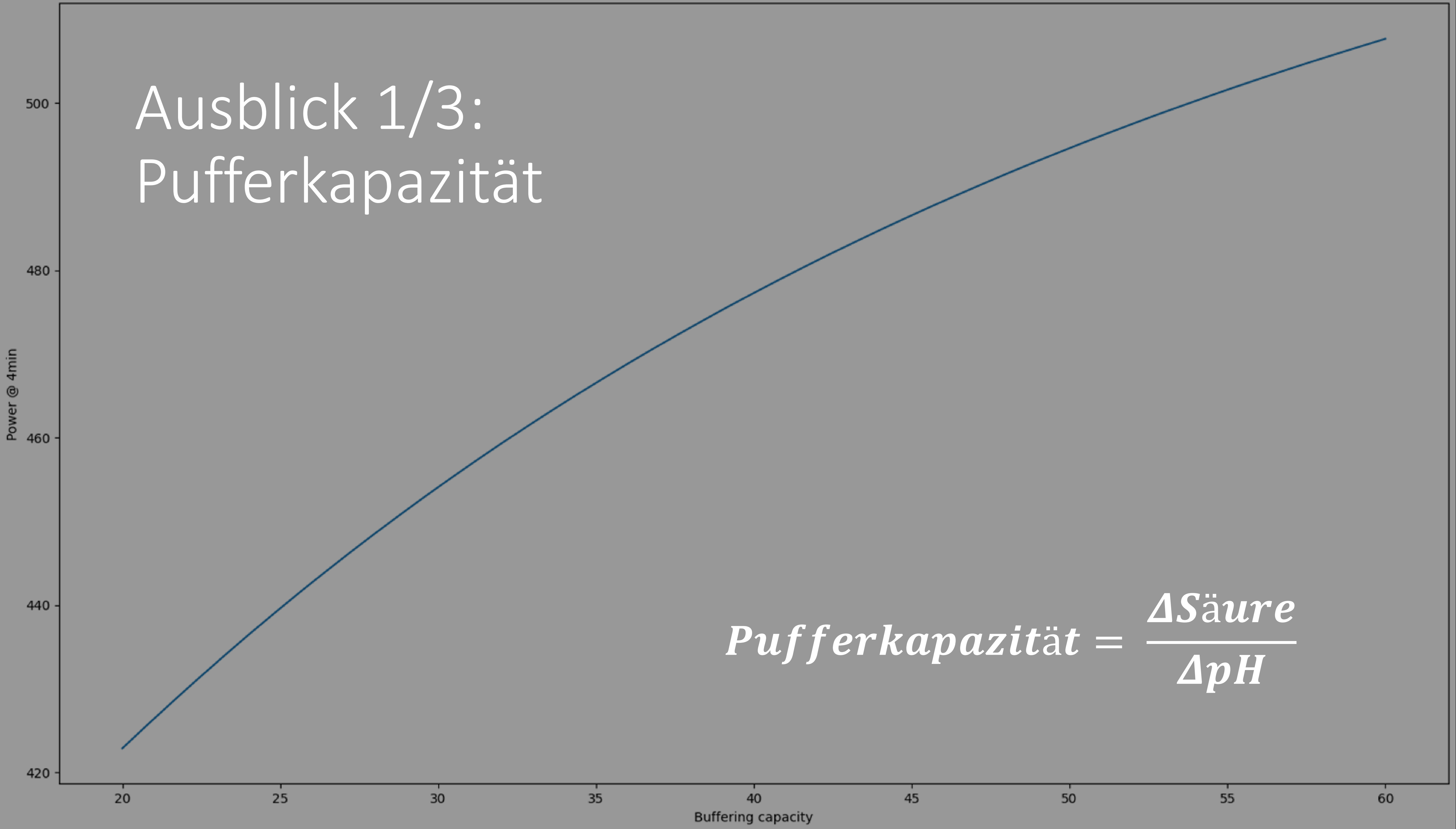
3. Thresholds   OBLA model: LT + 1,5 mmol/l (run)

	2 mmol/l	4 mmol/l	6 mmol/l	LT	OBLA	MAX
km/h	9,6	12,7	13,7	11,1	12,6	14,0
Lactate	2,0	4,0	6,0	2,4	3,9	6,2
HR	138	164	176	154	164	173
% max.	68,5	90,4	97,7	79,2	90,0	100,0
1000 m	00:06:15	00:04:44	00:04:23	00:05:24	00:04:45	00:04:17

4. Training areas   with training plan: from test

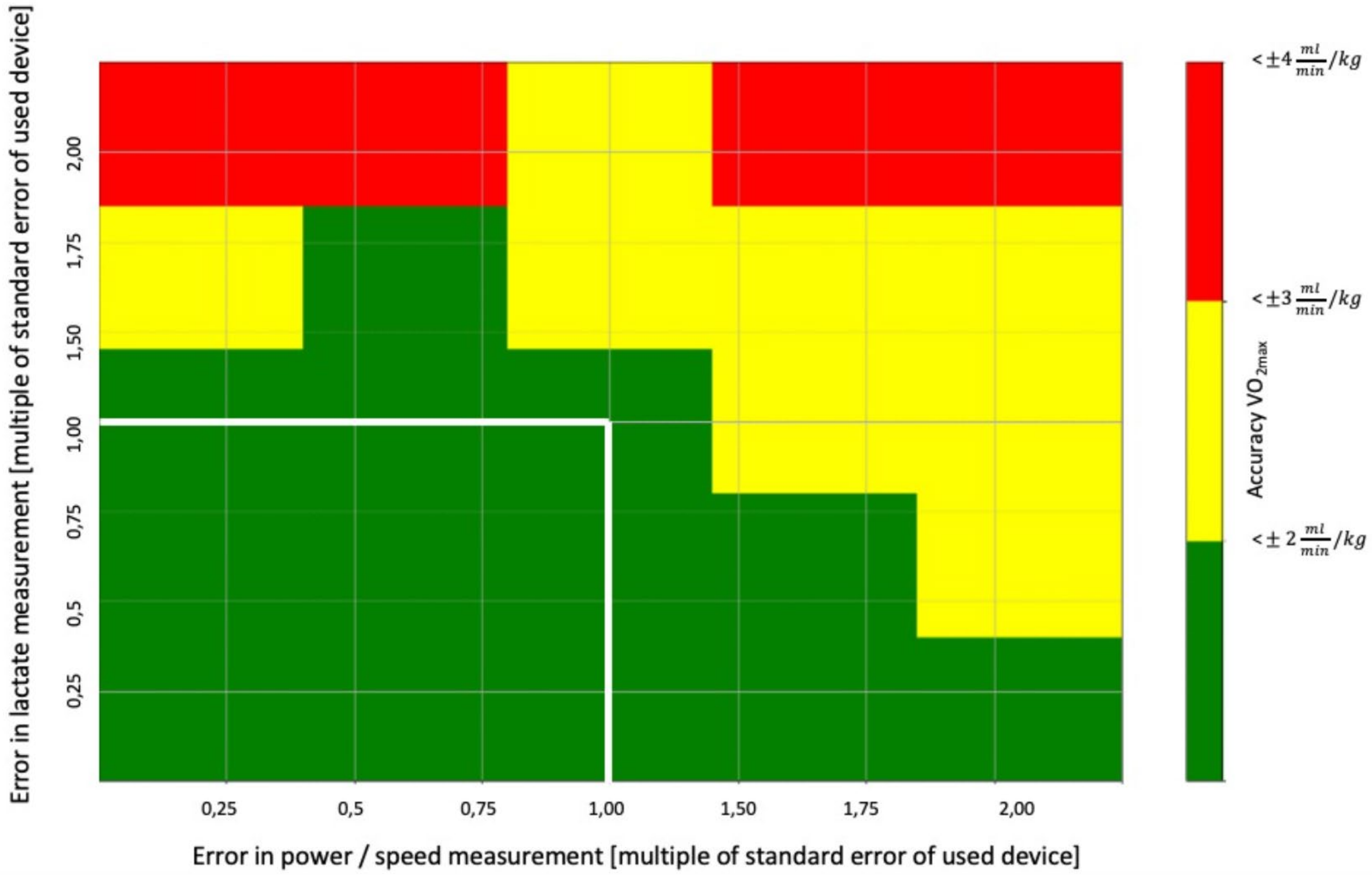
	GA 1	GA 2	EB	SB
km/h	8,2 - 9,3	9,3 - 10,5	10,5 - 11,6	11,6 - 12,8
Lactate	2,0 - 1,9	1,9 - 2,2	2,2 - 2,9	2,9 - 4,2
Heartrate	131 - 136	136 - 147	147 - 160	160 - 165
1000 m	7:21 - 6:26	6:26 - 5:43	5:43 - 5:09	5:09 - 4:41

Ausblick 1/3: Pufferkapazität



$$Pufferkapazität = \frac{\Delta Säure}{\Delta pH}$$

Ausblick 2/3: Berechnung von Messgerät-basierten Fehlern



Ausblick 3/3: Real-time Laktat Sensoren (CLM)

Vielen Dank für Ihre Aufmerksamkeit

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