AG2R LA MONDIALE | PRO CYCLING TEAM

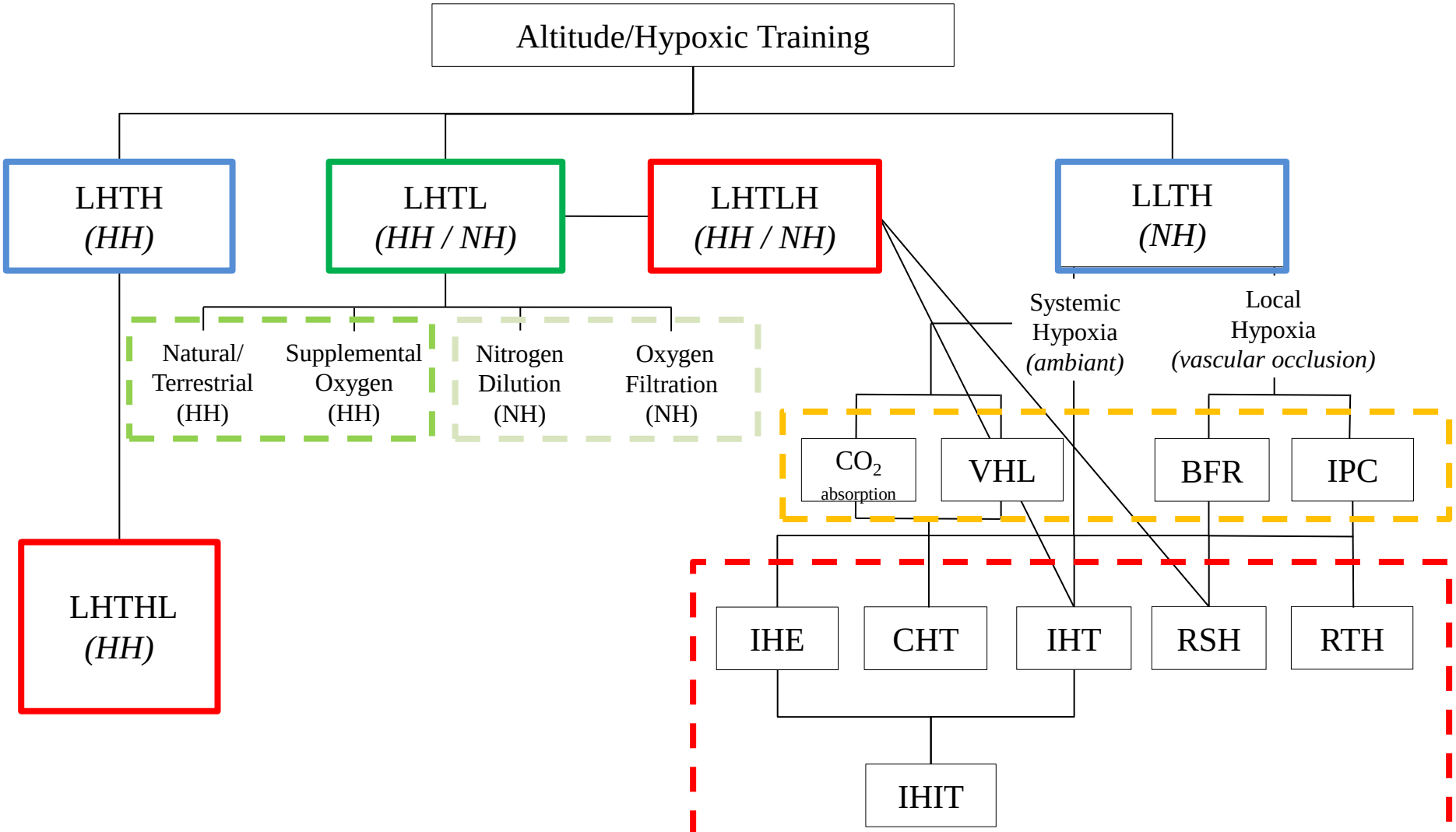
UNIL | Université de Lausanne
Institut des sciences du sport de l'Université de Lausanne

Altitude-induced power output increase in a Top-2 Tour de France Cyclist

BELLENOUE Samuel[1 2], QUICLET Jean-Baptiste[2], MILLET Grégoire[1]

[1]*ISSUL, University of Lausanne, Switzerland*
[2]*AG2R-La Mondiale Pro Cycling Team, La Motte-Servolex, France*

samuel.bellenoue@unil.ch



Millet et al., 2010

Sea-Level Exercise Performance Following Adaptation to Hypoxia
A Meta-Analysis

Bonetti and Hopkins, 2009

Characteristics of study groups included in the meta-analysis sorted by protocol and first author

Study	Subjects	Sample size[a]	Design	Competitive level	Training phase	Hypoxic (h/d)[b]	Exposure/ intervention days[c]	Altitude level (m)[d]	Hypoxia device
Live-high train-low									
Dehnert et al.[42]	Triathletes	6?; 10?	C	Subelite	?	~18–24	13	1956/800	
Levine and Stray-Gundersen[2]	Runners	9M, 4F; 9M, 4F	C	Subelite	Competitive	~18–24	28	2500/1200	
Stray-Gundersen and Levine[43]	Runners	6?	U	Subelite	?	~18–24	28	2500/1200	
Stray-Gundersen et al.[8]	Runners	8F, 14M	U	Elite	Competitive	~18–24	27	2500/1200	
Wehrlin et al.[44]	Orienteers	5M, 5F	U	Elite	Pre-season	~18–24	24	2456/1000	
Witkowski et al.[45]	Runners	8M, 4F	U	Subelite	?	~18–24	28	1780/1250	
	Runners	8M, 4F	U	Subelite	?	~18–24	28	2085/1250	
	Runners	8M, 4F	U	Subelite	?	~18–24	28	2454/1250	
	Runners	8M, 4F	U	Subelite	?	~18–24	28	2805/1250	

Sea-Level Exercise Performance Following Adaptation to Hypoxia
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Meta-analysis of effects on sea-level mean power output following adaptation to hypoxia

Effect	Natural altitude protocols		Artificial altitude protocols			
	live-high train-high	live-high train-low	live-high 8–18 h/d, continuous, train-low	live-high 1.5–5 h/d, continuous, train-low	live-high <1.5 h/d, intermittent, train-low	live-low train-high 0.5–2 h/d
Effect of mean protocol[a] (%); ±90% CL[b]						
Elite	(1.6; ±2.7)	**4.0; ±3.7**	(0.6; ±2.0)		(0.2; ±1.8)	
Subelite	(0.9; ±3.4)	**4.2; ±2.9**	**1.4; ±2.0**	(0.7; ±2.5)	**2.6; ±1.2**	(0.9; ±2.4)

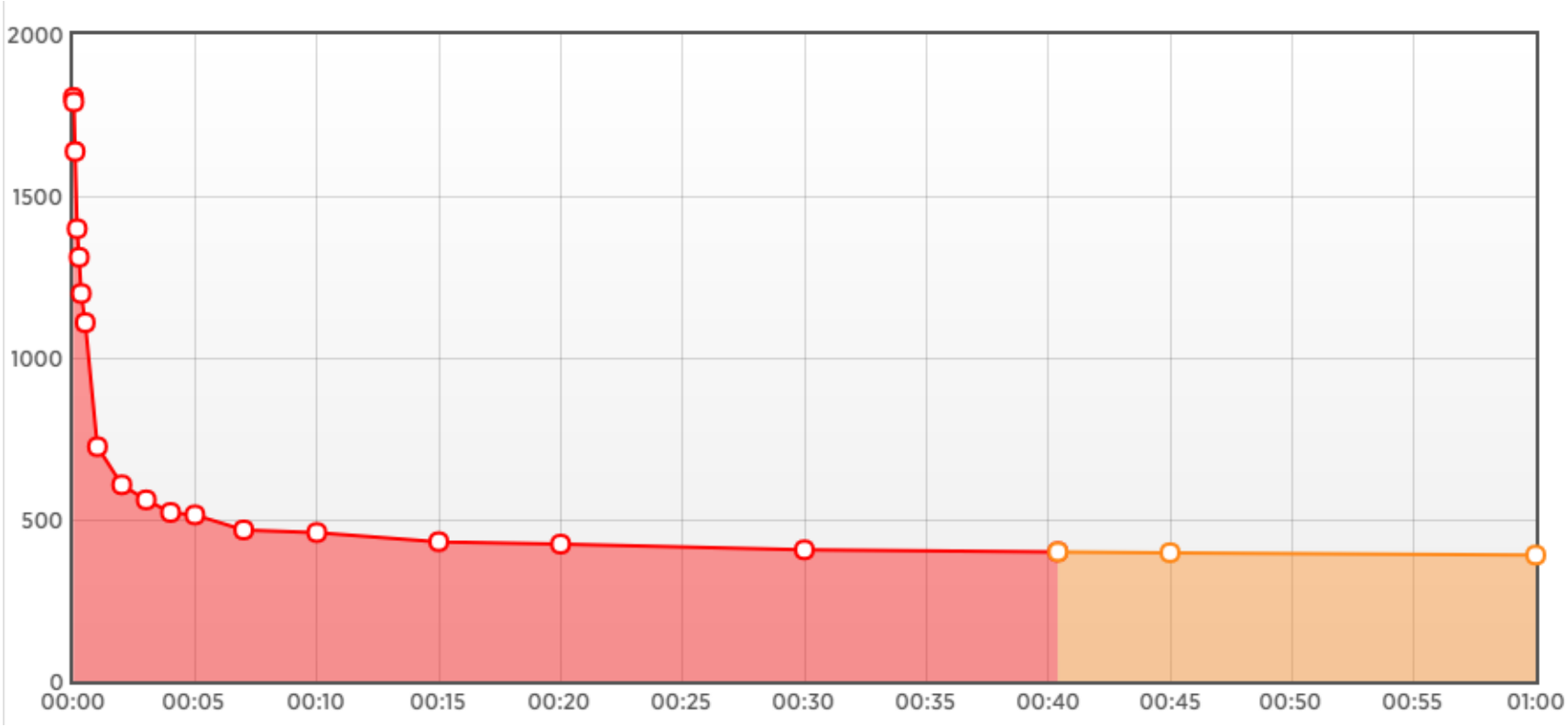
Questions :

- *Is the LHTL also effective with **cyclists**?*
- *Is it possible to expect the same range of gain with **professional** cyclists ?*
- *Is this level of gain maintained during the **competitive period**?*

Hypotheses

- Investigating **multi-expositions** in hypobaric hypoxia (Living High, Training Low) through the **use of the record power profile** (RPP) allows to assess and modellize **performance changes** in an elite cyclist.

Record Power Profile



5’’ / 30’’ / 1’ / 5’ / 10’ / 20’ / 30’

Subject

Rider

Date of birth: 9th November 1990 (26)
Nationality: France
Weight: 65 kg **Height:** 1.84 m

Points by specialty:

1379	One day races
3133	GC
147	Time trial
587	Sprint

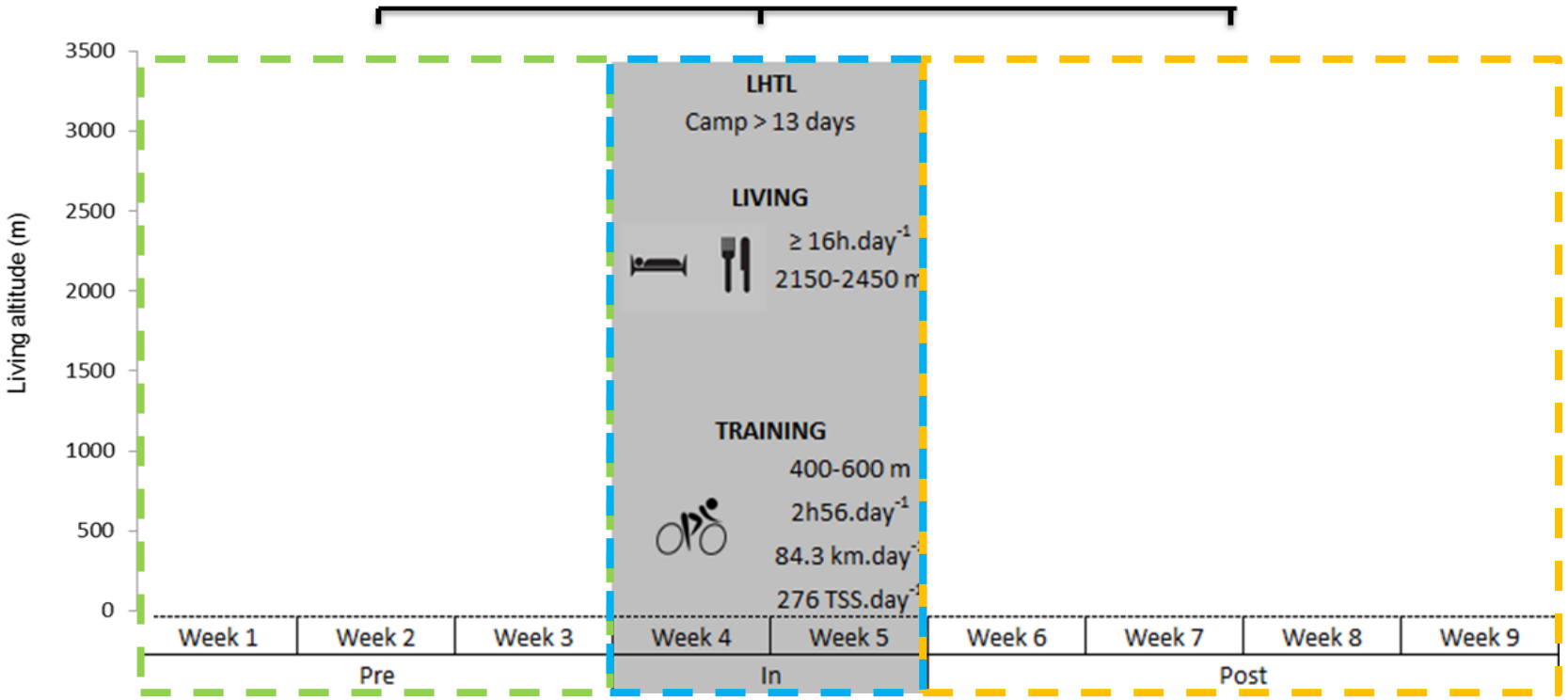
Twitter Strava

PCS Ranking: 12 **UCI Ranking:** 13

Professional cyclist since 2012

Method

- Measurement of RPP changes (%) for **5 training camps** (15-21 days) in altitude (2,150 - 2,450 m) over a period of **3 years**



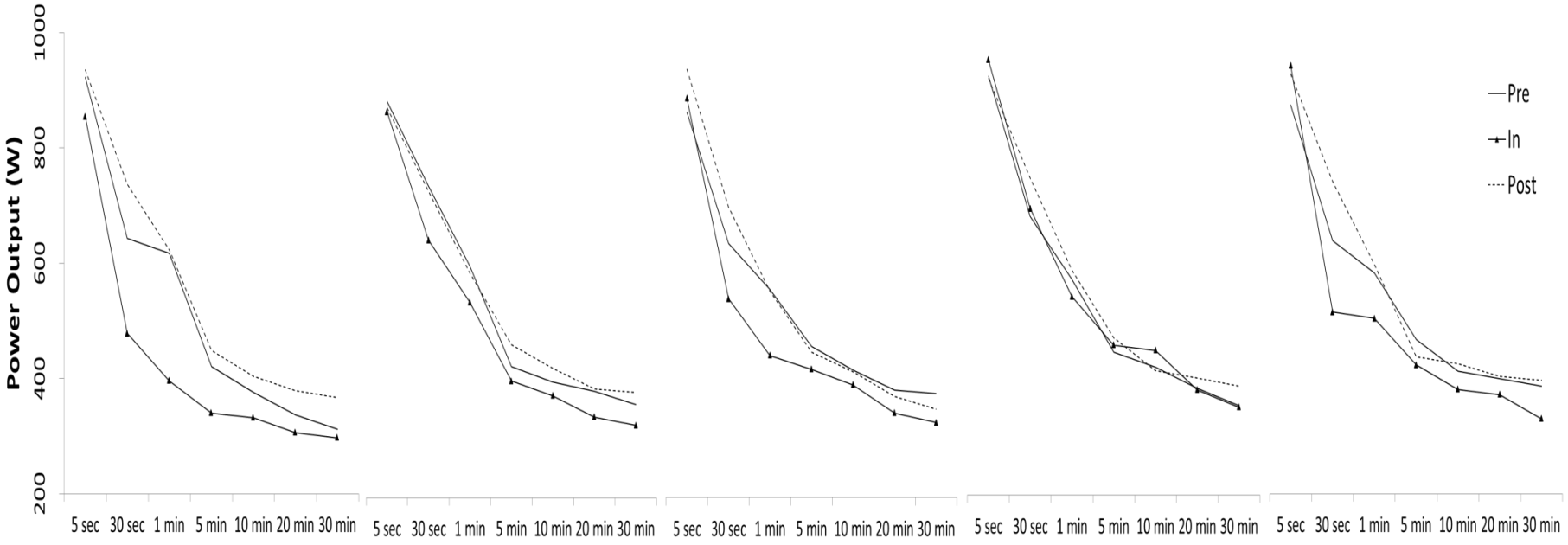
Training

- Duration : 3:02 ± 00:12 h/day
- Distance : 89 ± 5 km/day
- Slope : 1 754 ± 211 m/day

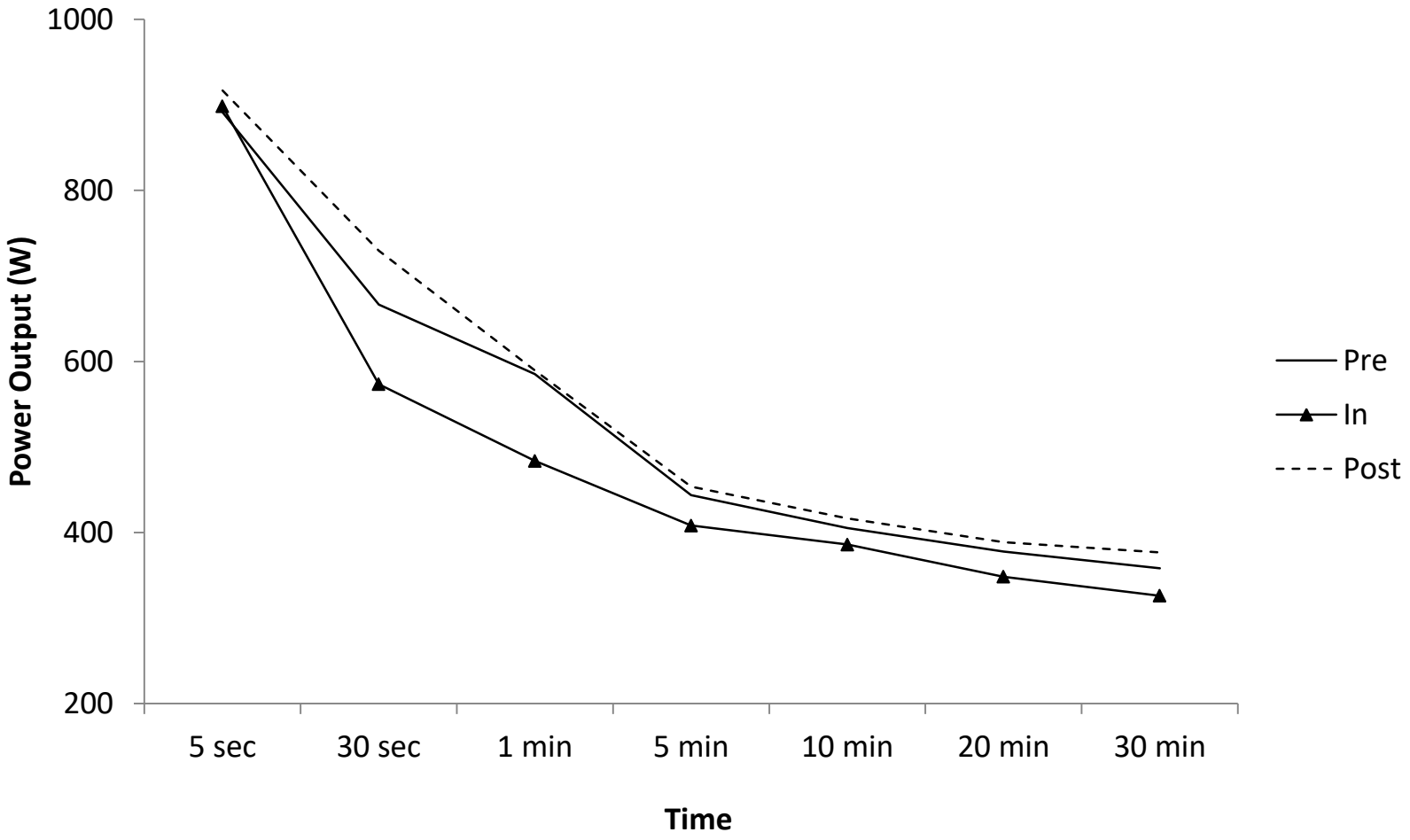
	Camp 1	Camp 2	Camp 3	Camp 4	Camp 5	Mean	Standard deviation
	2014 May	2015 April	2015 Mai	2016 April	2016 Mai		
Low	87.2	76.9	79.9	74.1	75.4	78.7	5.2
Moderate	10.3	15.0	13.5	17.1	15.4	14.3	2.6
Hight	2.5	8.1	6.6	8.8	9.2	7.0	2.7

Pourcentage of time spent at low, moderate, and high intensity during the 5 training camps

Evolution of the RPP during the 5 training camps



Evolution of the RPP during the 5 training camps



Performance changes from Pre to Post altitude training camp (%)

	Camp 1	Camp 2	Camp 3	Camp 4	Camp 5	Mean	CV
	2014 May	2015 April	2015 May	2016 April	2016 May		
	19 days	17 days	18 days	15 days	21 days		
5 sec	1.4	-1.2	8.7	-0.4	6.2	2.9	1.5
30 sec	14.6	-1.2	9.8	9.7	16.0	9.8	0.7
1 min	1.0	-2.0	-0.5	2.7	2.6	0.7	2.7
5 min	6.7	8.9	-2.2	5.4	-6.4	2.5	2.6
10 min	7.4	6.0	-0.7	-1.4	3.2	2.9	1.4
20 min	12.5	1.0	-2.8	4.5	1.0	3.2	1.8
30 min	17.6	5.8	-3.1	9.7	2.6	6.5	1.2

Year to year performances changes from Post- altitude training camp

	Gain per year		Mean Gain per year
	2014-2015	2015-2016	
5 sec	1.4	-2.5	-0.6
30 sec	-1.2	1.4	0.1
1 min	-5.6	1.4	-2.2
5 min	3.3	0.4	1.9
10 min	4.7	0.2	2.5
20 min	2.4	3.6	3.0
30 min	4.1	3.4	3.8

⇒ For this elite cyclist, as previously demonstrated in endurance athletes (Millet et al., 2010), **altitude (LHTL) induced a significant increased** in power output, around 3-4 % for the aerobic part, and 4-5% for the anaerobic.

- *Is the LHTL also effective with **cyclists**?* ✓
- *Is it possible to expect the same range of gain with **professional** cyclists*? ✓
- *Is this level of gain maintained during the **competitive period***? ✓

Thank you for your attention !

Post3-4

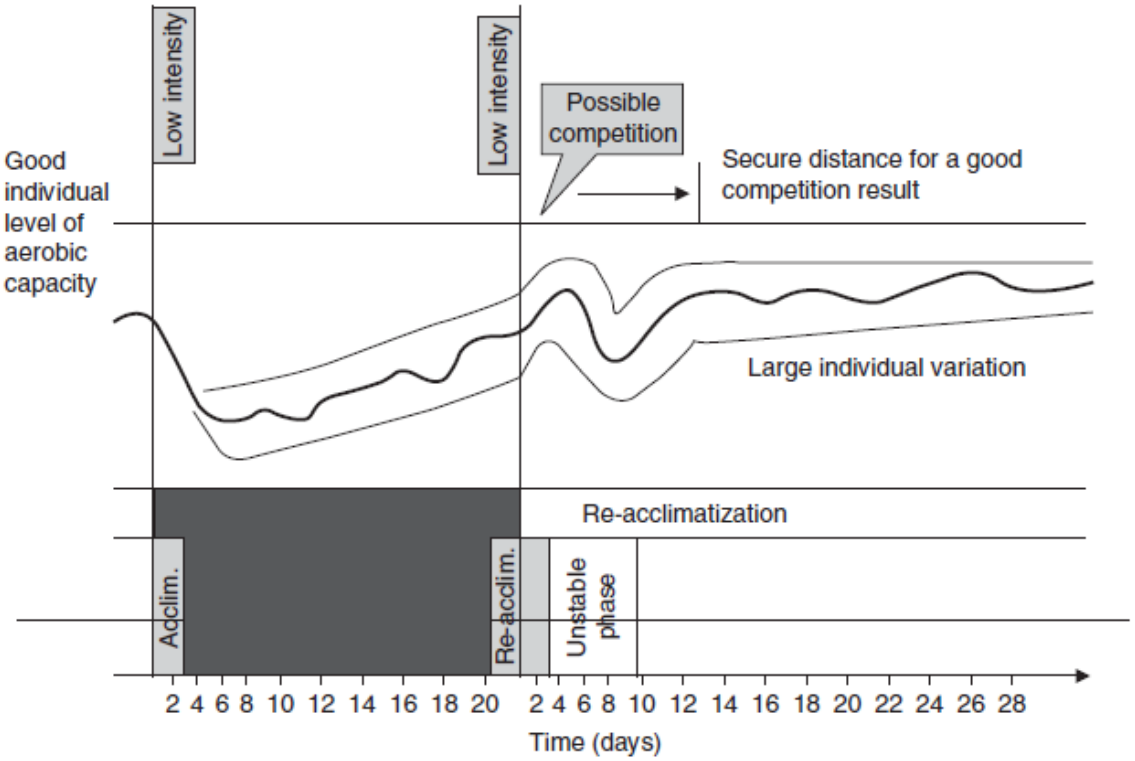


Fig. 2. Schematic view of the development of the aerobic capacity during and after 'live-high train-high' (LHTH) training (adapted from Fuchs and Reiss[3]). **Acclim.** = acclimatization.

Millet et al., 2010