van bon
cycling performance

SMA
Midden Nederland

Power Speed Profile

Performance model for road cycling

Marco van Bon / Guido Vroemen

M

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It’s all about *critical periods*

1. Short
5 to 60 seconds

2. Medium long
1 to 10 minutes

3. Long
10 minutes to 1 hour





Power Profile test

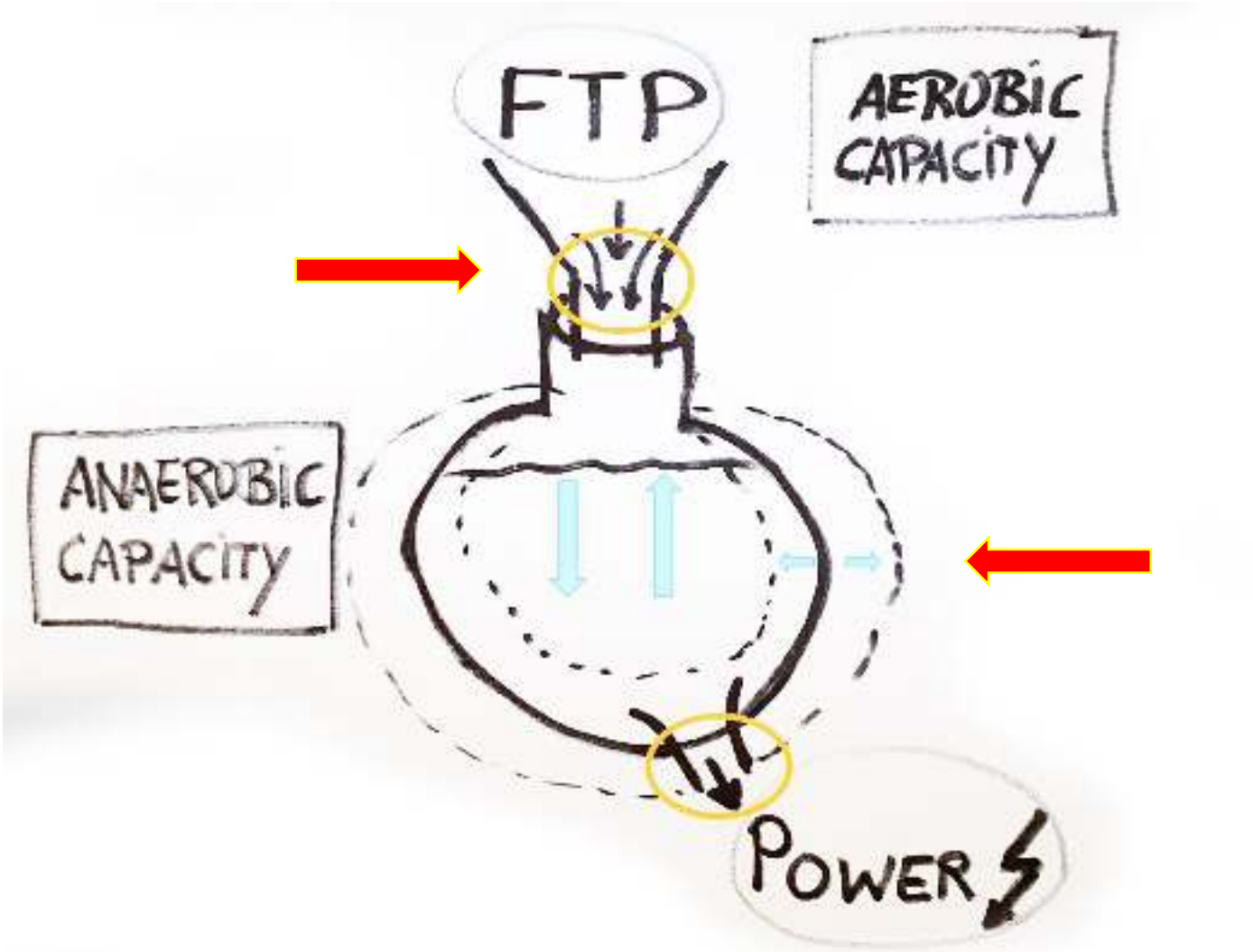
- Neuromuscular power

- Indication anaerobic glycolytic power

- Estimate of power at VO2max

- (Estimate of) FTP

Aerobic & Anaerobic Capacity



Current Power Profile tests

- Allen & Coggan
- Australian Institute of Sports
- UCI WCC
- Other ways of profiling:
  - INSCYD
  - Critical Power / W’ model

… and more

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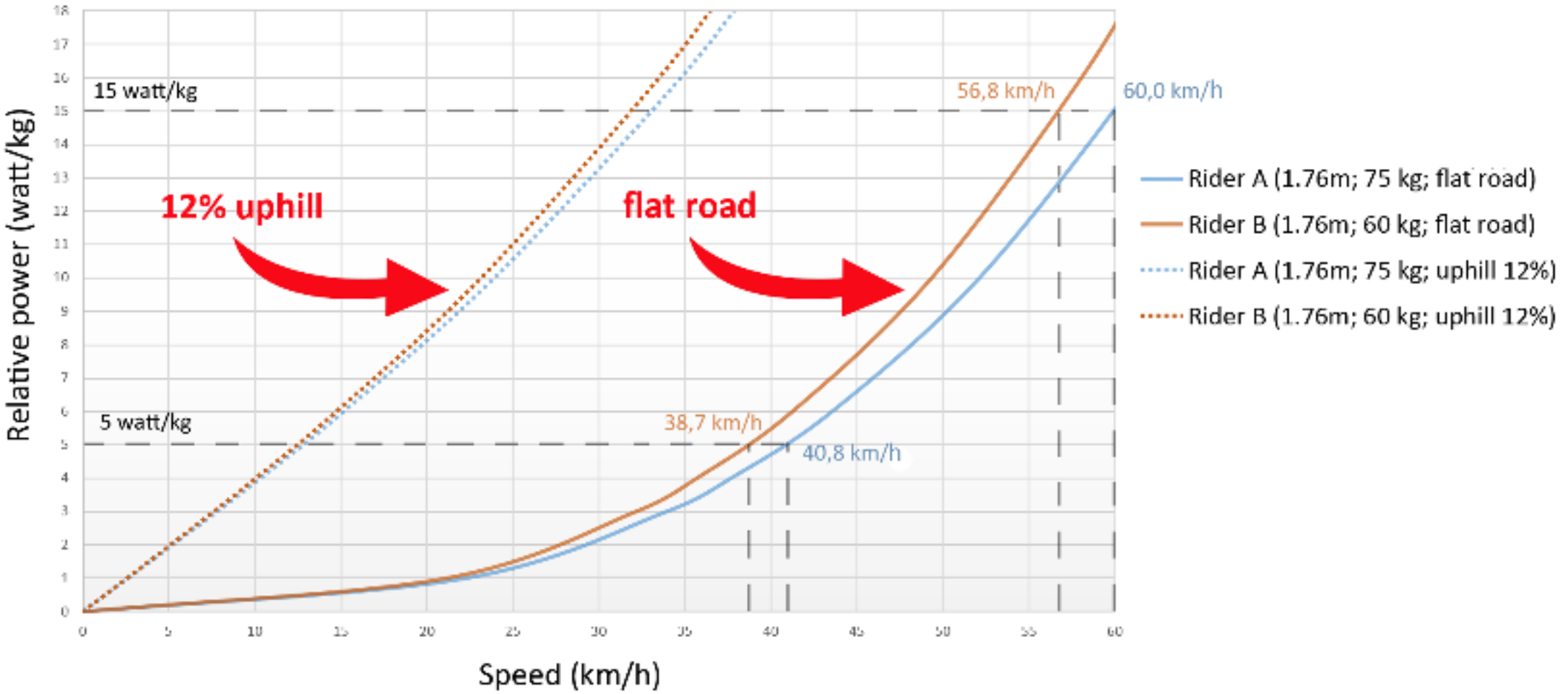
Power Speed Profile test

Why do we need a new model?



Solution: Power Speed Profile

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Let's put all the variables that determine speed in one formula*:

1. Aerodynamic drag
2. Gravity
3. Rolling resistance / friction

…and calculate the **Performance Index**

* Dijk H van, Vroemen, G et al. (2016). The secret of cycling. NedRUN.

Power Speed Profile

What are critical periods we testing?

critical period	time	critical periods	performance indicator
short (5 t/m 60 seconds)	6 seconds	5 seconds	Neuromuscular / anaerobic a-lactic power
	30 seconds	15 seconds	Anaerobic a-lactic capacity
		30 seconds	Anaerobic lactic power
	1 minute	1 minute	Anaerobic lactic capacity
medium long (>1 up to 10 minutes)	4 minutes	4 minutes on time trail bike	Aerobic power / Anaerobic lactic capacity
		4 minutes uphill (slope 12%)	
long (10 minutes up to and including 1 hour)	20 minutes	60 minutes on time trail bike	Aerobic power / capacity
		60 minutes uphill (slope 8%)	

Day 1 Anaerobic Assessment: 6 seconds + 30 seconds (15'' + 30'') + 1 minute

Day 2 Aerobic Assessment: 4 and 20 minutes (used to estimate FTP)

Power Speed Profile

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Example calculating benchmark for 5 second sprint

Avg. height & weight of top sprinters
1.78 meter
71.5 kg

Top sprinters of 2018 (procyclingstats.com): Sagan, Viviani, Groenwegen

Calculate CdA
0,372

Bassett JD et al. (1999). Comparing cycling world hour records, 1967-1996: modeling with empirical data

Use highest avg. power
1800 watts
25.2 W/kg

Allen & Coggan (2010), World Cycling Centre Power Profile test

Calculate speed
70,66 km/h

Fomula by Van Dijk & Vroemen (2016). *The secret of cycling.*

Power Speed Profile

G

Benchmarks for men

Critical period	Power (w)	Watts/kg	Height (cm)	Weight (kg)	CdA	Speed (km/u)
5 secs. sprint	1800	25.2	178.4	71.5	0.372	70.660
15 secs. sprint	1350	18.9	178.4	71.5	0.372	64.037
30 secs. sprint	1080	15.1	178.4	71.5	0.372	59.309
1 min. effort	825	11.5	178.4	71.5	0.372	54.037
4 mins. effort (on time trail bike)	569	7.7	186.0	74.0	0.243	54.460
4 mins. effort (12% climb)	490	7.7	177.5	63.7	0.360	18.503
60 mins. effort (on time trail bike)	448	6.4	181.4	70.0	0.234	50.665
60 mins. effort (8% climb)	420	6.4	179.6	65.7	0.365	21.499

Benchmarks for women

Critical period	Power (w)	Watts/kg	Height (cm)	Weight (kg)	CdA	Speed (km/u)
5 secs. sprint	1160	19.4	168.0	59.8	0.346	62.372
15 secs. sprint	870	14.5	168.0	59.8	0.346	56.502
30 secs. sprint	700	11.7	168.0	59.8	0.346	52.413
1 min. effort effort	555	9.3	168.0	59.8	0.346	48.351
4 mins. effort (on time-trail bike)	408	6.8	170.0	60.1	0.214	50.693
4 mins. effort (12% climb)	393	6.8	167.9	57.8	0.343	16.361
60 mins. effort (on time-trail bike)	342	5.7	170.0	60.1	0.214	47.597
60 mins. effort (8% climb)	306	5.7	163.4	53.9	0.334	18.978

Power Speed Profile

M

How much power does a rider need to equal speed of top cyclist?

Speed to match
70,66 km/h

Height & weight of tested rider
1.76 meter
62 kg

Calculate CdA
0.356

Calculate power needed to equal speed
1713 watt
27.6 W/kg

M

Power Speed Profile

$$\textit{Performance Index (PI)} = \left(\frac{\text{Power generated by tested rider}}{\text{Power needed equal top performance}} \right) * 100$$

Tested rider
1.76 meter
62 kg

Tested 5 sec. power
1200 watt

Power needed to equal top performance
1713 watt

Performance Index
1200/1713 x 100 =
70.1

Power Speed Profile

Performance Index

performance index	pro-tour	elite	amateur / master
90-100	Very good to exceptional	Exceptional	Exceptional
80-90	Good	Good to very good	
70-80	Moderate to fair	Moderate	Good to very good
60-70	Bad	Fair	Moderate to good
50-60	Very bad	Bad	Fair to bad
< 50	-	Very bad	Very bad

Table 5. *Performance Index linked to competition level*

Power Speed Profile: World Tour (M)

Results

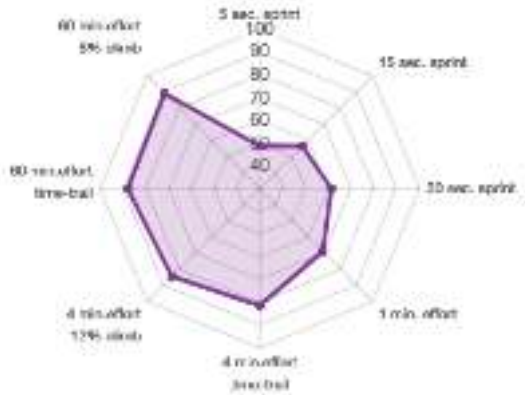
Name of Cyclist	World Tour Pro
Test date	2017
Length	189 cm
Weight	79 kg

Critical period	Power (W)	Watt/kg	Speed (km/h)	Performance index
1 sec. peak	1724	21.8	N/A	N/A
5 secs. sprint	1561	19.8	66.1	82.3
15 secs. sprint	1271	16.1	61.6	89.4
30 secs. sprint	1021	12.9	57.1	89.7
1 min. effort	794	10.1	52.4	91.3
4 mins. effort (on time-trail bike)	537	6.8	52.7	91.4
4 mins. effort (12% climb)	537	6.8	17.0	90.9
60 mins. effort (on time-trail bike)	439	5.5	48.9	90.8
60 mins. effort (8% climb)	439	5.5	19.5	88.8

Power Speed Profile: Elite level TT (M)

Results

Name of Cyclist	NC TT
Test date	30 June 2019
Length	172 cm
Weight	66 kg



Critical period	Power (w)	Watt/kg	Speed (km/h)	Performance index
1 sec. peak	911	13.8	N/A	N/A
5 secs. sprint	847	12.8	55.3	48.9
15 secs. sprint	734	11.1	52.6	56.5
30 secs. sprint	638	9.7	50.1	61.4
1 min. effort	548	8.3	47.5	69.2
4 mins. effort (on time-trial bike)	426	6.5	50.7	81.6
4 mins. effort (12% climb)	426	6.5	15.9	84.4
60 mins. effort (on time trial bike)	374	5.7	48.3	87.7
60 mins. effort (8% climb)	374	5.7	19.5	88.8

Power Speed Profile: NC RR Amateur (M)

Results

Name of Cyclist	NC Road Race Amateur
Test date	2018
Length	181 cm
Weight	76 kg

Critical period	Power (w)	Watt/kg	Speed (km/h)	Performance index
1 sec. peak	1573	20.7	N/A	N/A
5 secs. sprint	1411	18.6	64.5	76.6
15 secs. sprint	1120	14.7	59.6	81.1
30 secs. sprint	867	11.4	54.5	78.4
1 min. effort	639	8.4	49.0	75.6
4 mins. effort (on time trail bike)	394	5.2	47.8	69.5
4 mins. effort (12% climb)	394	5.2	53.1	69.1
60 mins. effort (on time trail bike)	302	4.0	43.4	65.2
60 mins. effort (8% climb)	302	4.0	34.5	63.6

Power Speed Profile: Cyclo winner (F)

Results

Name of Cyclist	Cyclo winner
Test date	2018
Length	184 cm
Weight	63 kg

Critical period	Power (w)	Watt/kg	Speed (km/h)	Performance index
1 sec. peak	1142	18.1	N/A	N/A
5 secs. sprint	938	14.9	56.9	76.7
15 secs. sprint	660	10.5	50.4	72.0
30 secs. sprint	507	8.0	46.0	68.7
1 min. effort	422	6.7	43.1	72.2
4 mins. effort (on time-trail bike)	334	5.3	46.2	77.0
4 mins. effort (12% climb)	334	5.3	13.1	78.8
60 mins. effort (on time trail bike)	297	4.7	44.2	81.6
60 mins. effort (8% climb)	297	4.7	16.5	84.9

Power Speed Profile: world class XCE (m)

2018

Results

Name of Cyclist	World class MTB XCE
Test date	2018
Length	179 cm
Weight	78 kg

Critical period	Power (W)	Watt/kg	Speed (km/h)	Performance index
1 sec. peak	1826	24.1	N/A	N/A
5 secs. sprint	1709	21.9	68.6	92.5
15 secs. sprint	1393	17.9	64.1	100.0
30 secs. sprint	1095	14.1	59.1	98.8
1 min. effort	800	10.3	52.9	94.3
4 mins. effort (on time-trail bike)	462	5.9	50.5	81.0
4 mins. effort (12% climb)	462	5.9	14.9	79.2
60 mins. effort (on time-trail bike)	336	4.3	45.0	72.1
60 mins. effort (8% climb)	336	4.3	15.7	69.3

2019

Results

Name of Cyclist	World class MTB XCE
Test date	2019
Length	179 cm
Weight	78 kg

Critical period	Power (W)	Watt/kg	Speed (km/h)	Performance index
1 sec. peak	1936	24.8	N/A	N/A
5 secs. sprint	1833	23.5	70.5	99.2
15 secs. sprint	1611	20.7	67.4	100.0
30 secs. sprint	1354	17.4	63.5	100.0
1 min. effort	1024	13.1	57.7	100.0
4 mins. effort (on time-trail bike)	527	6.8	53.0	92.4
4 mins. effort (12% climb)	527	6.8	16.9	90.3
60 mins. effort (on time trail bike)	330	4.2	44.7	70.8
60 mins. effort (8% climb)	330	4.2	15.4	68.0

Power Speed Profile: world class XC (F)

2017

Results

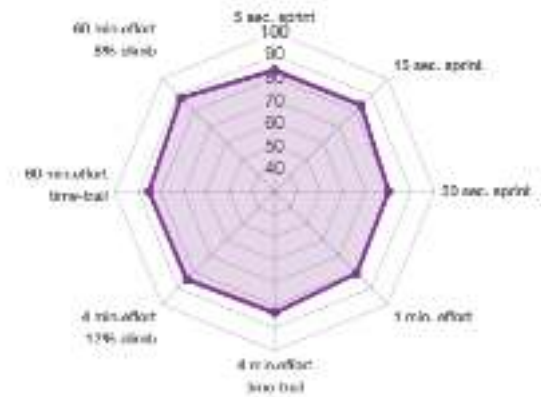
Name of Cyclist	World class MTB XCO
Test date	2017
Length	165 cm
Weight	57 kg

Critical period	Power (w)	Watt/kg	Speed (km/h)	Performance index
1 sec. peak	1025	17.9	N/A	N/A
5 secs. sprint	936	16.4	58.3	82.2
15 secs. sprint	777	13.6	54.7	91.1
30 secs. sprint	632	11.1	50.9	92.1
1 min. effort	492	8.6	46.7	90.4
4 mins. effort (on time-trail bike)	327	5.7	47.4	83.0
4 mins. effort (12% climb)	327	5.7	14.0	84.2
60 mins. effort (on time-trail bike)	262	4.6	43.8	79.3
60 mins. effort (8% climb)	262	4.6	16.0	81.8

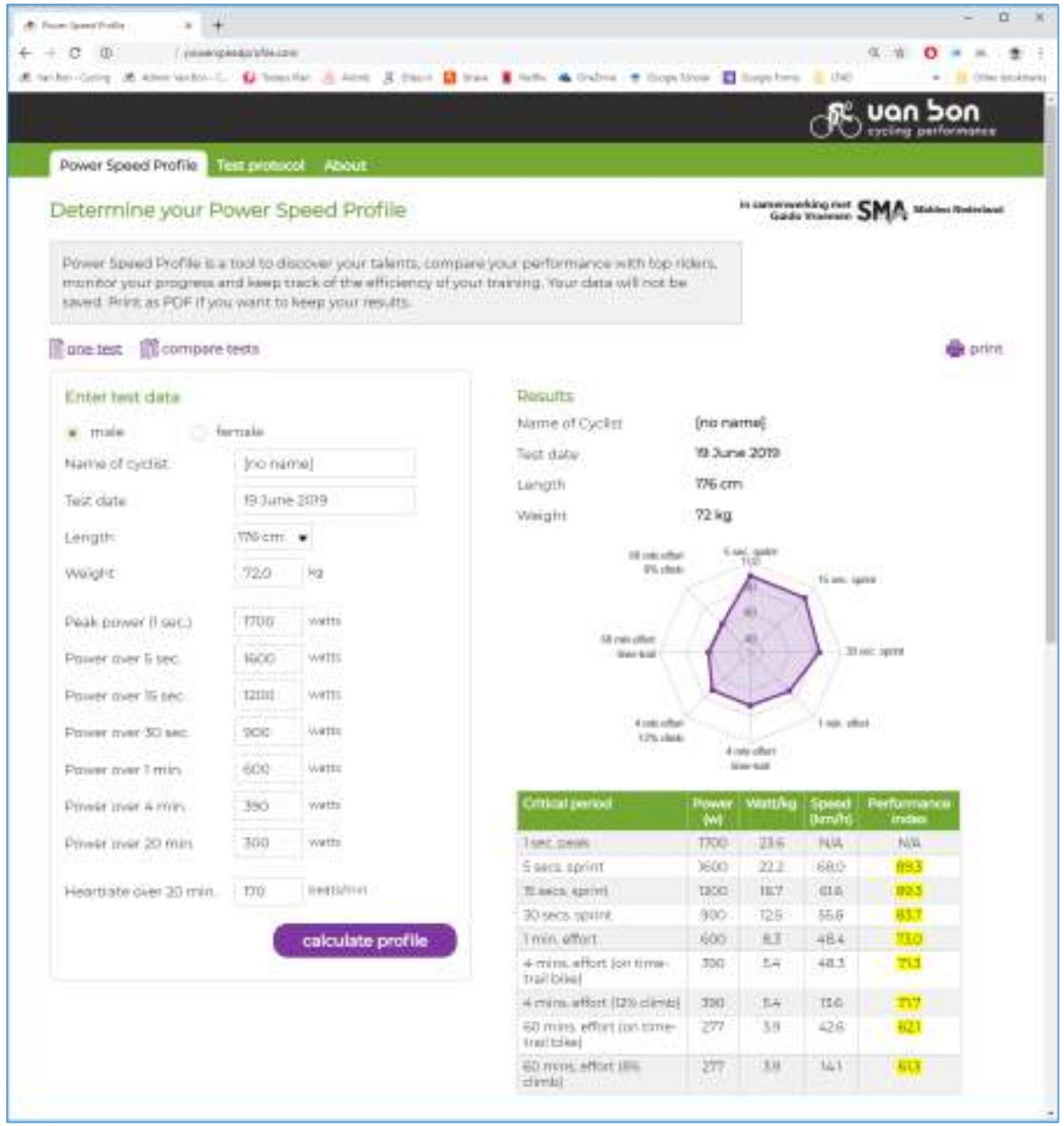
2019

Results

Name of Cyclist	World class MTB XCO
Test date	30 June 2019
Length	165 cm
Weight	56 kg



Critical period	Power (w)	Watt/kg	Speed (km/h)	Performance index
1 sec. peak	1097	19.6	N/A	N/A
5 secs. sprint	945	15.9	58.6	83.6
15 secs. sprint	709	12.7	53.1	83.6
30 secs. sprint	548	9.8	48.6	80.3
1 min. effort	438	7.8	44.9	81.0
4 mins. effort (on time-trail bike)	324	5.8	47.4	85.1
4 mins. effort (12% climb)	324	5.8	14.0	84.7
60 mins. effort (on time-trail bike)	278	5.0	44.9	85.0
60 mins. effort (8% climb)	278	5.0	17.0	88.0



Power Speed Profile

Use it yourself:

www.powerspeedprofile.com

- Protocol
- Power Speed Profile
- FTP
- W’
- HRM & Power zones

Power Speed Profile

Any questions?

Power Speed Profile: Performance model for road cycling (1)
https://www.researchgate.net/publication/329389879_Power_Speed_Profile_Performance_model_for_road_cycling_1

Power Speed Profile: Performance model for road cycling (2)
https://www.researchgate.net/publication/330441547_Power_Speed_Profile_Performance_model_for_road_cycling_2

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