Meten aan Sport

Rutger Ockhorst (Northgo College)
Martin Mollema (Vlietland College)

Martin Mollema (Vlietland College)

Biofysica

- Keuzeonderwerp
- Geen harde eisen
- Leefwereld leerling

dus...SPORT

Sport in examens

- Powerskips (2017)
- Sprong bij Volleybal (2015)
- Strategiebepaling bij Wielrennen (2014)
- Highland Games (2014)
- Kogelstoten (2014)
- Sprint (2013)

Workshop

Onderwerp 1: Wielrennen
Onderwerp 2: Schaatsen

Daarna: zelf aan de slag
Ontwerpen van een sportopdracht!

Fietsen

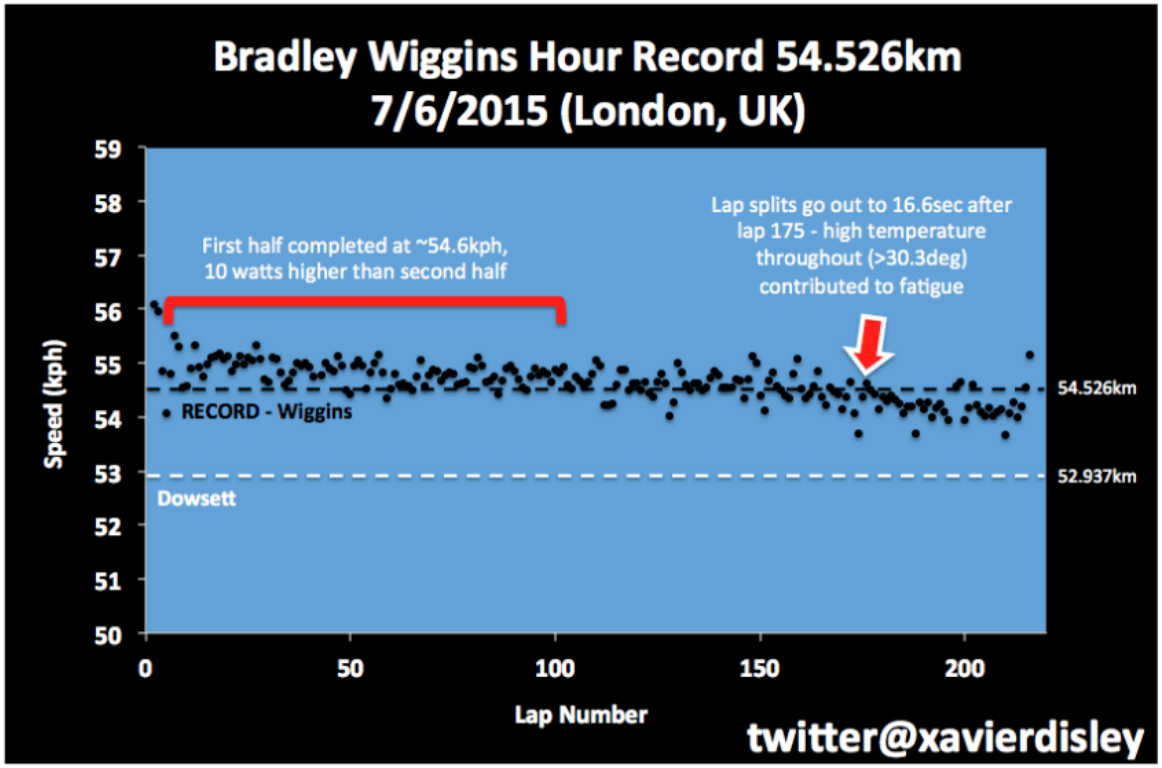
$$P = F \cdot v$$

$$F_{rol} = \mu \cdot F_N = \mu \cdot mg$$

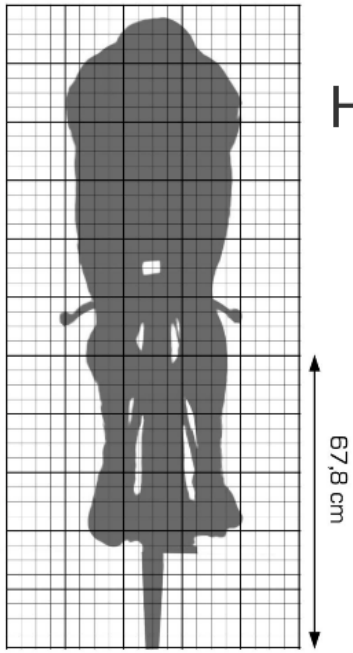
$$F_{lucht} = \frac{1}{2} \rho C_d A \cdot v^2$$

Zie ook: *The Bicyclist's Paradox*
Randy Knight, Phys. Teach 46 (2008)

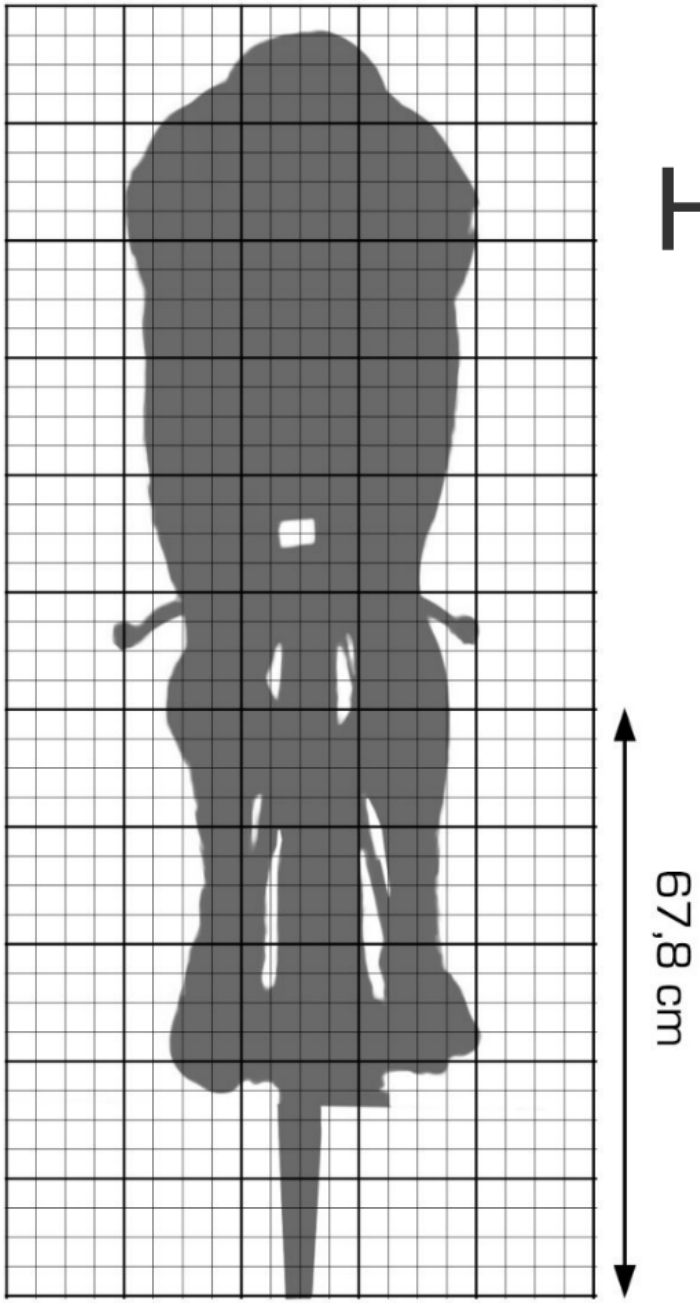
Constant Vermogen?



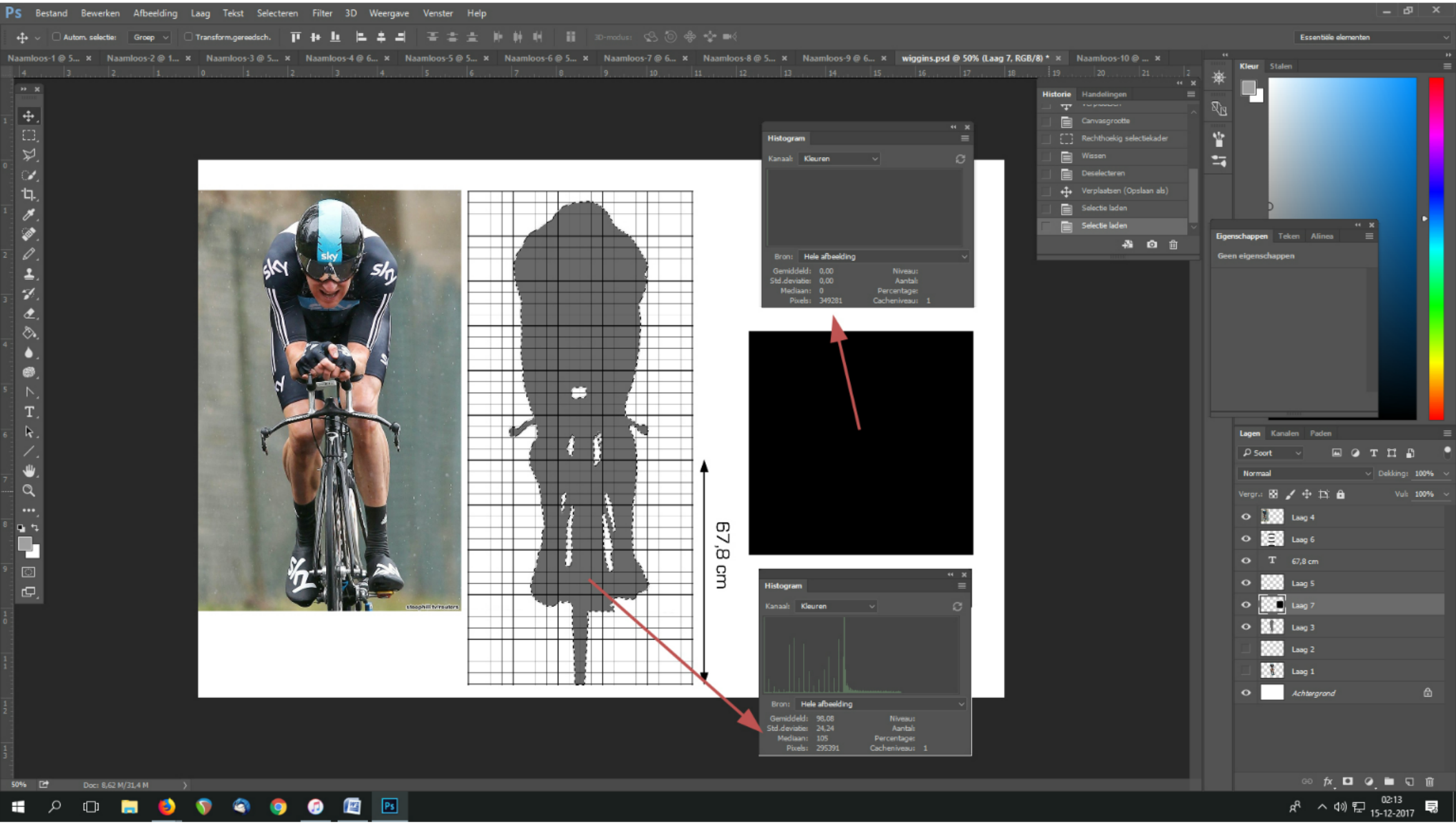
Frontaal Oppervlak



Old School
Hokjes Tellen



Old School Hokjes Tellen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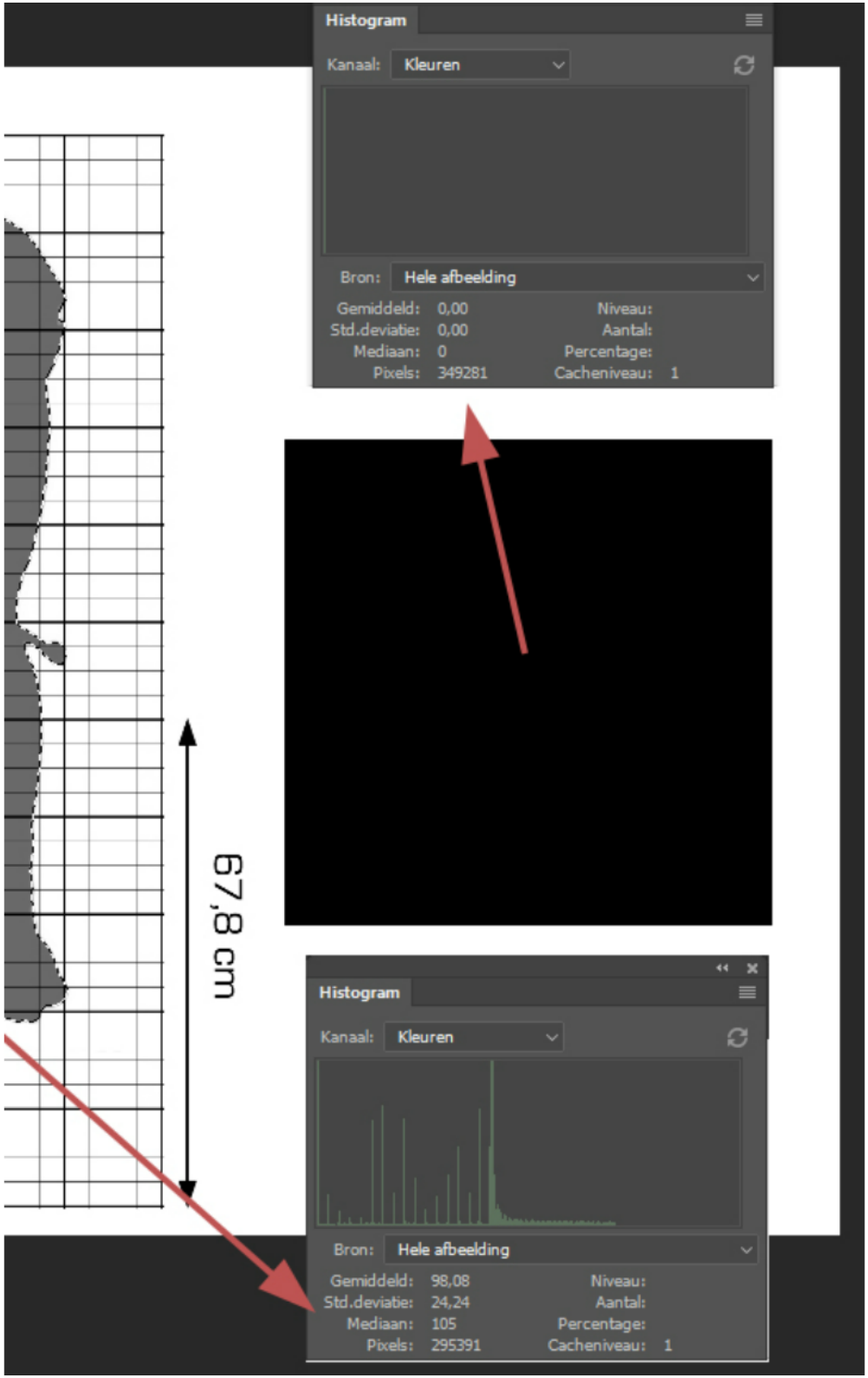
wiggins.psd @ 50% (Laag 7, RGB/8) *
Histogram
Kanaal: Kleuren
Bron: Hele afbeelding
Gemiddeld: 0,00
Std.deviatie: 0,00
Mediaan: 0
Pixels: 349281
Niveau:
Aantal:
Percentage:
Cacheniveau: 1
67,8 cm
Gemiddeld: 98,08
Std.deviatie: 24,24
Mediaan: 105
Pixels: 295391
Cacheniveau: 1
Historie
Handelingen
Canvasgrootte
Rechthoekig selectiekader
Wissen
Deselecteren
Verplaatsen (Opslaan als)
Selectie laden
Kleur
Stalen
Eigenschappen
Teken
Alinea
Geen eigenschappen
Lagen
Kanalen
Paden
Normaal
Dekking: 100%
Laag 4
Laag 6
67,8 cm
Laag 5
Laag 7
Laag 3
Laag 2
Laag 1
Achtergrond
50%
Doc: 8,62 M/31,4 M
02:13
15-12-2017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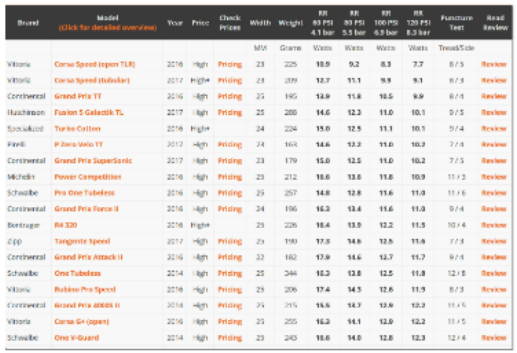
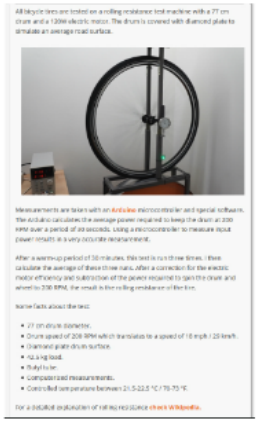
Gemiddeld: 98,08
Std.deviatie: 24,24
Mediaan: 105
Pixels: 295391
Niveau:
Aantal:
Percentage:
Cacheniveau: 1

Rolweerstand

www.bicyclerollingresistance.com



Brand	Model (Click for detailed overview)	Year	Price	Check Prices	Width	Weight	RR 60 PSI 4.1 bar	RR 80 PSI 5.5 bar	RR 100 PSI 6.9 bar	RR 120 PSI 8.3 bar	Puncture Test	Read Review
					MM	Grams	Watts	Watts	Watts	Watts	Treads/Side	
Vittoria	Corsa Speed (open TLR)	2016	High	Pricing	23	225	10.9	9.2	8.3	7.7	8 / 5	Review
Vittoria	Corsa Speed (tubular)	2017	High+	Pricing	23	209	12.7	11.1	9.9	9.1	8 / 5	Review
Continental	Grand Prix TT	2016	High	Pricing	25	195	13.9	11.8	10.5	9.9	8 / 4	Review
Hutchinson	Fusion 5 Galactik TL	2017	High	Pricing	25	200	14.6	12.3	11.0	10.1	9 / 5	Review
Specialized	Turbo Cotton	2016	High+		24	224	15.0	12.5	11.1	10.1	9 / 4	Review
Pirelli	P Zero Velo TT	2017	High	Pricing	24	164	14.6	12.3	11.0	10.2	7 / 4	Review
Continental	Grand Prix SuperSonic	2017	High	Pricing	23	179	15.0	12.5	11.0	10.2	7 / 5	Review
Michelin	Power Competition	2016	High	Pricing	23	212	10.6	13.6	11.8	10.9	11 / 3	Review
Schwalbe	Pro One Tubeless	2016	High	Pricing	25	257	14.8	12.8	11.6	11.0	11 / 6	Review
Continental	Grand Prix Force II	2016	High	Pricing	24	196	16.3	13.4	11.6	11.0	9 / 4	Review
Bontrager	R4 320	2016	High+		25	226	18.4	13.9	12.2	11.5	10 / 4	Review
Zipp	Tangente Speed	2017	High	Pricing	23	190	17.5	14.6	12.5	11.6	7 / 5	Review
Continental	Grand Prix Attack II	2016	High	Pricing	22	182	17.9	14.6	12.7	11.7	9 / 4	Review
Schwalbe	One Tubeless	2014	High	Pricing	25	244	16.3	13.8	12.5	11.8	12 / 8	Review
Vittoria	Rubino Pro Speed	2016	High	Pricing	23	206	17.4	14.3	12.6	11.9	8 / 3	Review
Continental	Grand Prix 4000S II	2014	High	Pricing	25	215	16.6	14.7	13.0	12.2	11 / 5	Review
Vittoria	Corsa G+ (open)	2016	High	Pricing	25	255	16.3	14.1	12.9	12.2	11 / 5	Review
Schwalbe	One V-Guard	2014	High	Pricing	23	243	18.6	14.0	12.8	12.3	12 / 4	Review



All bicycle tires are tested on a rolling resistance test machine with a 27 cm drum and a 1200W electric motor. The drum is covered with diamond plate to simulate an average road surface.

Measurements are taken with an Arduino microcontroller and special software. The Arduino calculates the average power required to keep the drum at 200 RPM over a period of 20 seconds. Using a microcontroller to measure input power results in a very accurate measurement.

After a warm-up period of 10 minutes, this test is run three times. I then calculate the average of these three runs. After a correction for the electric motor efficiency and subtraction of the power required to spin the drum and wheel to 200 RPM, the result is the rolling resistance of the tire.

Some facts about the test:

- 27 cm drum diameter.
- Drum speed of 200 RPM which translates to a speed of 18 mph / 29 km/h.
- Diamond plate drum surface.
- 42 a kg load.
- Tubyl to be.
- Computerized measurements.
- Controlled temperature between 21.5-22.5 °C / 70-73 °F.

For a detailed explanation of rolling resistance check Wikipedia.

Rolling Resistance Test Results

Rolling Resistance Test Results (Speed: 29 kmh / 18 mph, Load: 42.5 kg)	
Inner Tube	Conti Race28 (100gr butyl)
Rolling Resistance 140 psi / 9.7 Bar	Not Tested
Rolling Resistance 120 psi / 8.3 Bar	12.2 Watts
Rolling Resistance 100 PSI / 6.9 Bar	12.9 Watts
Rolling Resistance 80 PSI / 5.5 Bar	13.7 Watts
Rolling Resistance 60 PSI / 4.1 Bar	15.5 Watts
Rolling Resistance Coefficient (Cr) 140 psi / 9.7 Bar	Not Tested
Rolling Resistance Coefficient (Cr) 120 psi / 8.3 Bar	0.00366
Rolling Resistance Coefficient (Cr) 100 psi / 6.9 Bar	0.00387
Rolling Resistance Coefficient (Cr) 80 psi / 5.5 Bar	0.00411
Rolling Resistance Coefficient (Cr) 60 psi / 4.1 Bar	0.00465

Performance in the rolling resistance test is great. At an air pressure of 120 psi, rolling resistance is a low 12.2 watts, which is excellent for a Tour / Race type tire. Dropping air pressure to 100 psi results in a rolling resistance of 12.9 watts. Lowering air pressure even lower results in a rolling resistance of 13.7 watts at an air pressure of 80 psi.

Noteworthy is the very flat rolling resistance graph of this tire. dropping air pressure to 80 psi increases rolling resistance by only 1.5 watts per tire. This is a great feature because rider comfort will increase greatly at 80 / 90 psi at a very low cost.

Brand	Model (Click for detailed overview)	Year	Price	Check Prices	Width	Weight	RR 60 PSI 4.1 bar	RR 80 PSI 5.5 bar	RR 100 PSI 6.9 bar	RR 120 PSI 8.3 bar	Puncture Test	Read Review
					MM	Grams	Watts	Watts	Watts	Watts	Tread/Side	
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Continental	Grand Prix TT	2016	High	Pricing	25	195	**13.9**	**11.8**	**10.5**	**9.9**	8 / 4	Review
Hutchinson	Fusion 5 Galactik TL	2017	High	Pricing	25	288	**14.6**	**12.3**	**11.0**	**10.1**	9 / 5	Review
Specialized	Turbo Cotton	2016	High+		24	224	**15.0**	**12.5**	**11.1**	**10.1**	9 / 4	Review
Pirelli	P Zero Velo TT	2017	High	Pricing	23	163	**14.6**	**12.2**	**11.0**	**10.2**	7 / 4	Review
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Schwalbe	One Tubeless	2014	High	Pricing	25	344	**16.3**	**13.8**	**12.5**	**11.8**	12 / 8	Review
Vittoria	Rubino Pro Speed	2016	High	Pricing	25	206	**17.4**	**14.3**	**12.6**	**11.9**	8 / 3	Review
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3	Review
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/ 8	Review
3	Review
/ 5	Review
/ 5	Review
/ 4	Review

All bicycle tires are tested on a rolling resistance test machine with a 77 cm drum and a 120W electric motor. The drum is covered with diamond plate to simulate an average road surface.

Measurements are taken with an **Arduino** microcontroller and special software. The Arduino calculates the average power required to keep the drum at 200 RPM over a period of 30 seconds. Using a microcontroller to measure input power results in a very accurate measurement.

After a warm-up period of 30 minutes, this test is run three times. I then calculate the average of these three runs. After a correction for the electric motor efficiency and subtraction of the power required to spin the drum and wheel to 200 RPM, the result is the rolling resistance of the tire.

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- Butyl tube.
- Computerized measurements.
- Controlled temperature between 21.5-22.5 °C / 70-73 °F.

For a detailed explanation of rolling resistance **check Wikipedia.**

Rolling Resistanc

Rolling Resistan
Inner Tube
Rolling Resistance 140 p
Rolling Resistance 120 p
Rolling Resistance 100 P
Rolling Resistance 80 PS
Rolling Resistance 60 PS
Rolling Resistance Coeffi
Rolling Resistance Coeffi
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Rolling Resistance Coeffi
Rolling Resistance Coeffi

Performance in the ro
rolling resistance is a
tire. Dropping air pres
Lowering air pressure
an air pressure of 80 p

Noteworthy is the ver
pressure to 80 psi incr
great feature because
low cost.

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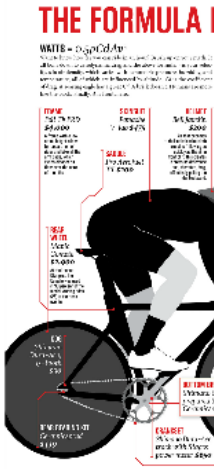
En Cd dan?

$$P = F \cdot v$$

$$F_{rol} = \mu \cdot F_N = \mu \cdot mg$$

$$F_{lucht} = \frac{1}{2}\rho C_d A \cdot v^2$$



THE FORMULA FOR SPEED

"TRACKULATOR"
Check out the online tool that will do the math for you, so you can ignore everything on this page: analyticcycling.com

WATTS = $0.5\rho CdAv^3$

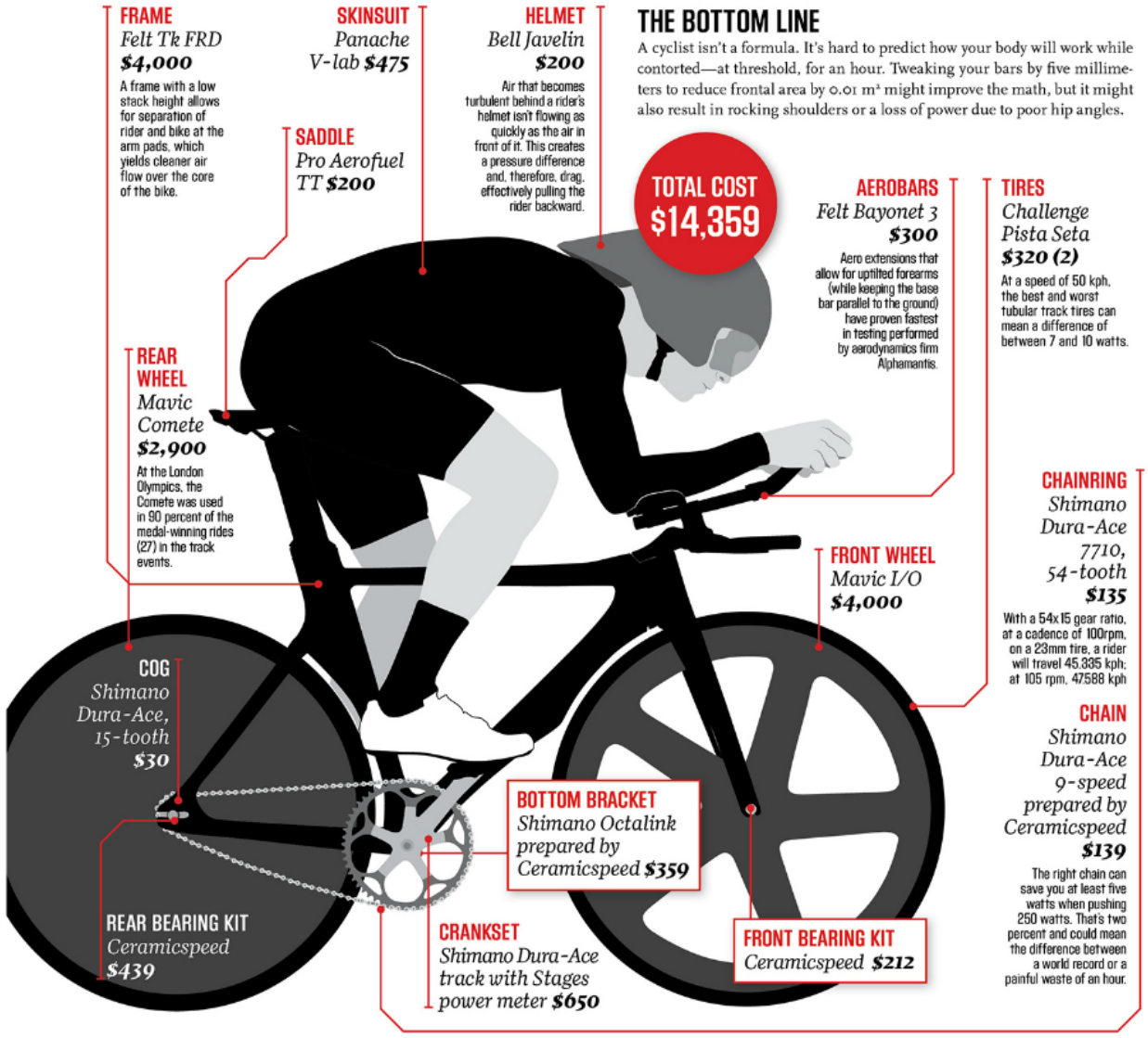
Want to know how far you can ride in an hour? Brush up on your math. It all boils down to aerodynamic drag and the above formula. v is your velocity. ρ is air density, which varies with barometric pressure, humidity, and temperature, all of which are influenced by altitude. *Cd* is the coefficient of drag. A soaring eagle has a great *Cd*. A brick doesn't. Humans are more like the brick. Finally, *A* is frontal area.

FORCES AGAINST YOU

About 90 percent of your aerodynamic drag is a function of pushing air out of the way of your body. Aero gear will help, but for the most part, humans are bad at cheating the wind. What you can alter is how much is hitting the wind, by changing your position. There's a great primer on using Photoshop to calculate your frontal area here: cyclingpowerlab.com/CyclingAerodynamics.aspx.

THE BOTTOM LINE

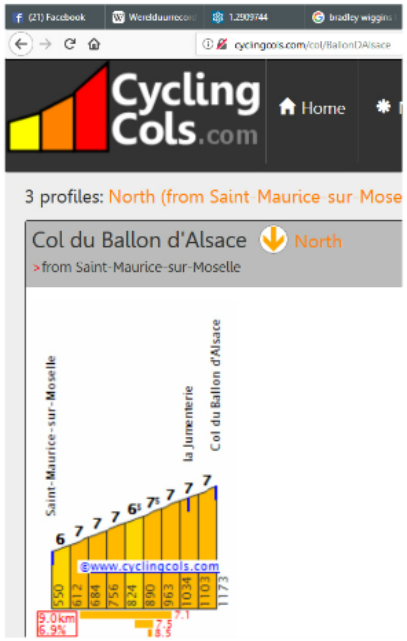
A cyclist isn't a formula. It's hard to predict how your body will work while contorted—at threshold, for an hour. Tweaking your bars by five millimeters to reduce frontal area by 0.01 m² might improve the math, but it might also result in rocking shoulders or a loss of power due to poor hip angles.

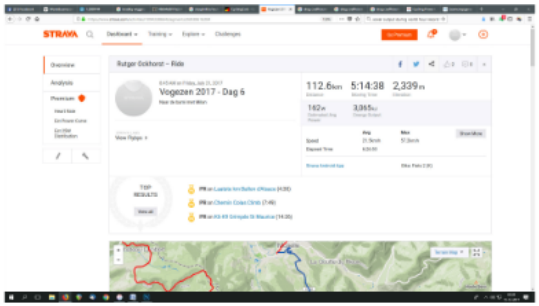


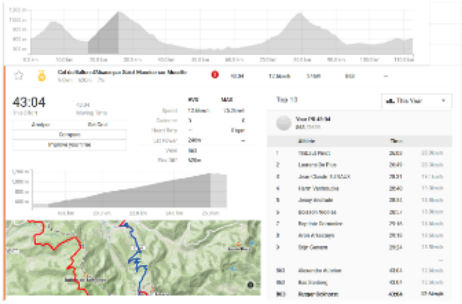
Eigen Prestatie Meten

- Constante hartslag = constant vermogen
- Geen wind, weinig luchtweerstand
- Geijkt traject

Optie 1: Berg Fietsen







(21) Facebook | Werelduurrecord | 1.2909744 | bradley wiggins

cyclingcols.com/col/BallonDAlsace

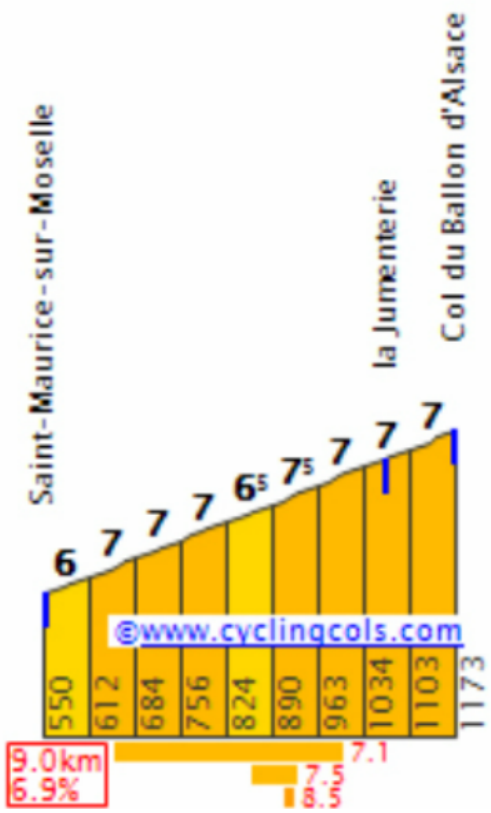
CyclingCols.com

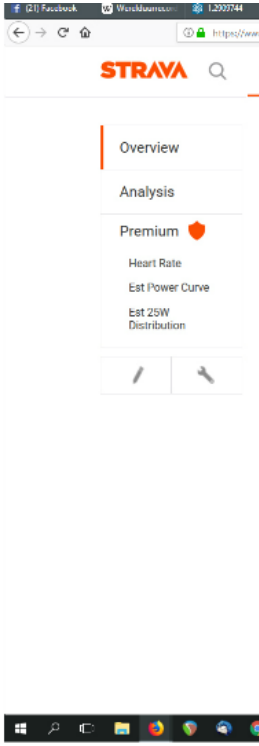
Home

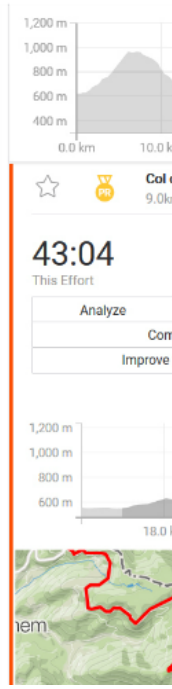
3 profiles: North (from Saint-Maurice-sur-Mose

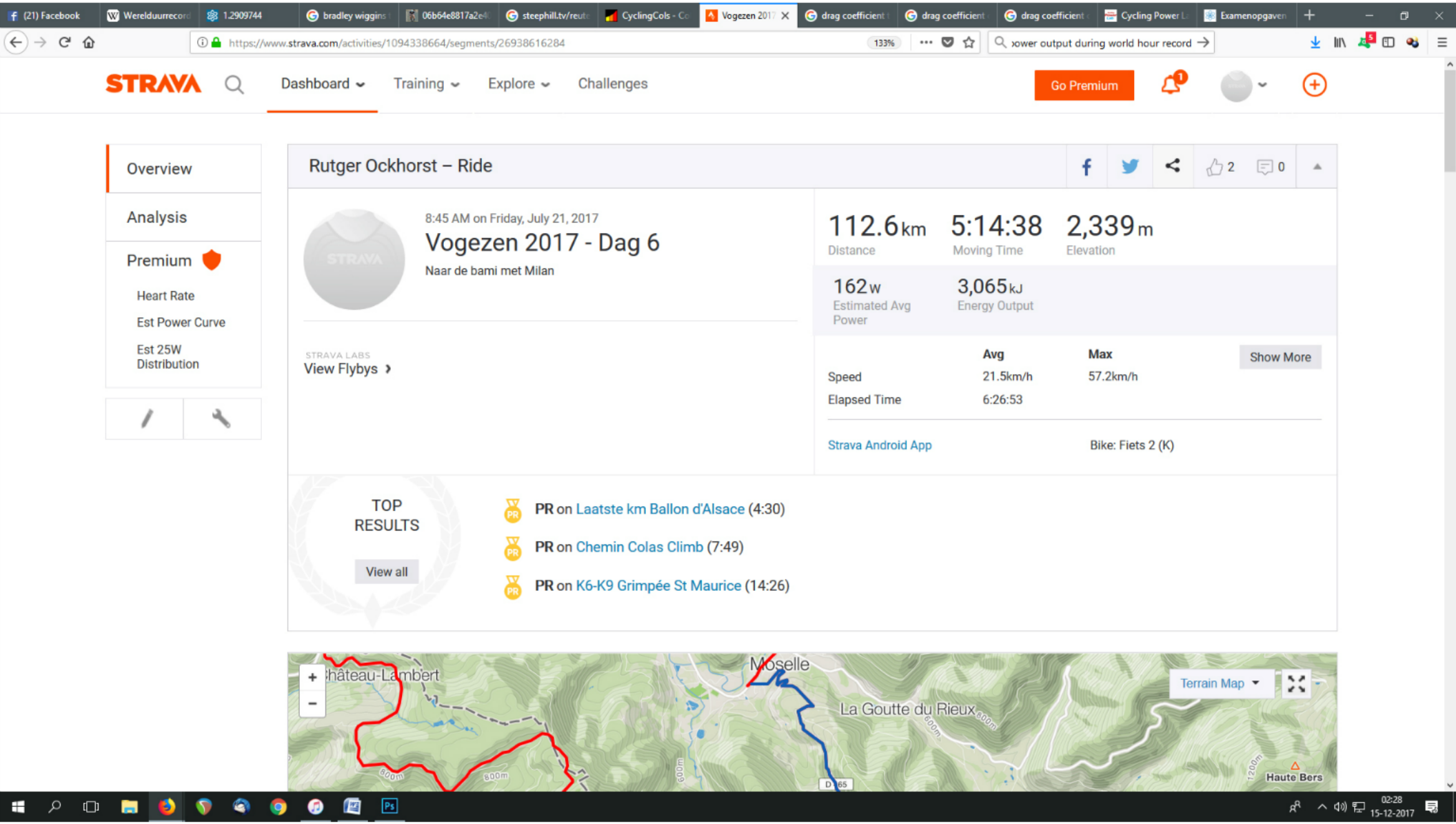
Col du Ballon d'Alsace North

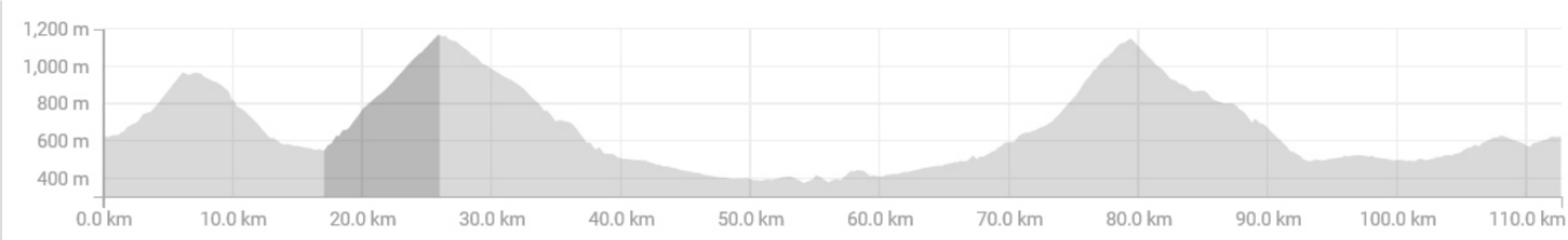
>from Saint-Maurice-sur-Moselle








(21) Facebook
https://www.strava.com/activities/1094338664/segments/26938616284
power output during world hour record
STRAVA
Dashboard
Training
Explore
Challenges
Go Premium
Overview
Analysis
Premium
Heart Rate
Est Power Curve
Est 25W Distribution
Rutger Ockhorst – Ride
2
0
8:45 AM on Friday, July 21, 2017
Vogezen 2017 - Dag 6
Naar de bami met Milan
112.6 km
Distance
5:14:38
Moving Time
2,339 m
Elevation
162 w
Estimated Avg Power
3,065 kJ
Energy Output
STRAVA LABS
View Flybys
Avg
Max
Show More
Speed
21.5km/h
57.2km/h
Elapsed Time
6:26:53
Strava Android App
Bike: Fiets 2 (K)
TOP RESULTS
View all
PR on Laatste km Ballon d'Alsace (4:30)
PR on Chemin Colas Climb (7:49)
PR on K6-K9 Grimpée St Maurice (14:26)
Moselle
La Goutte du Rieux
Terrain Map
Haute Bers
02:28
15-12-2017



☆	PR	**Col du Ballon d'Alsace par Saint-Maurice-sur-Moselle** 9.0km 620m 7%	2	43:04	12.6km/h	246W	863	–

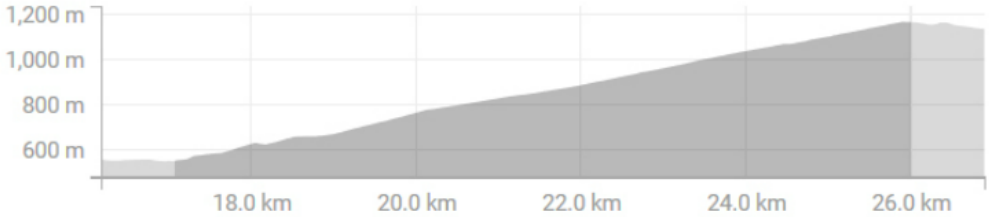
43:04

This Effort

43:04
Moving Time

Analyze	Set Goal
Compare	
Improve your time	

	AVG	MAX
Speed	12.6km/h	25.2km/h
Cadence	0	0
Heart Rate	–	0 bpm
Est Power	246W	–
VAM	863	
Elev Diff	620m	



Top 10

This Year

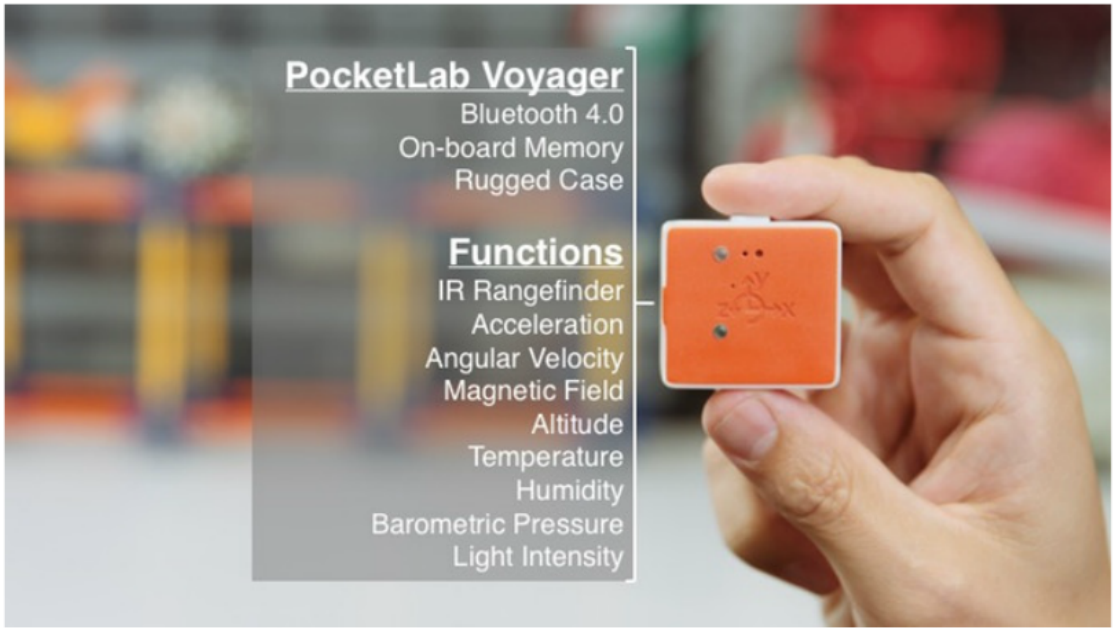
Your PR 43:04
863 /2699

	Athlete	Time	
1	Thibaut Pinot	26:08	20.8km/h
2	Laurens De Plus	26:49	20.3km/h
3	Jean-Claude TUTIAUX	28:31	19.1km/h
4	Harm Vanhoucke	28:40	19.0km/h
5	Jessy Andrade	28:54	18.8km/h
6	Boisson Nicolas	28:57	18.8km/h
7	Baptiste Domanico	29:16	18.6km/h
8	Aron Arkesteyn	29:18	18.6km/h
9	Stijn Geneyn	29:24	18.5km/h
			...
863	Alexandre Aubrion	43:04	12.6km/h
863	Bas Sanberg	43:04	12.6km/h
863	**Rutger Ockhorst**	**43:04**	**12.6km/h**

Optie 2: Proefopstelling

over naar Martin...

Voor straks



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