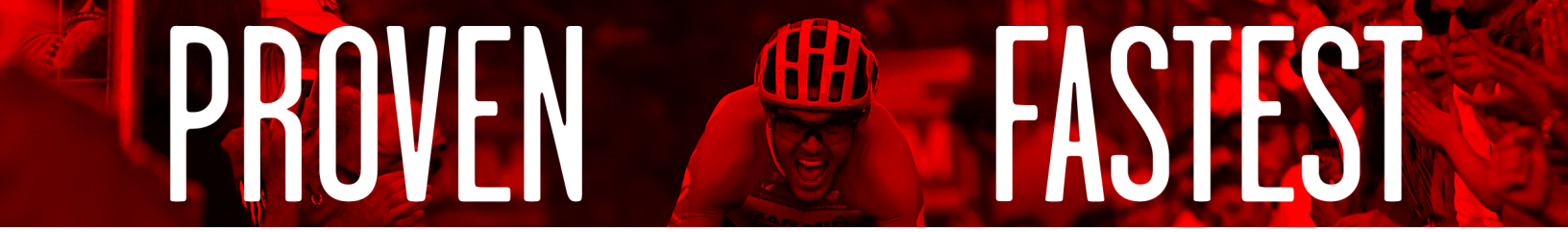


Tour Magazin has been known to put road bikes to the test. With claims about aerodynamics, weight, and stiffness throw around by many manufacturers, the German based publication attempts to sort out which road bike is best for their readers.

"Thus it is clear that, when it comes to performance of a road bike, aerodynamics beat light weight. Racers who ignore this diminish their chances of winning."
– *Tour Magazin*

To serve this purpose, they recently asked the question 'aerodynamic or classic road bike; which one is faster?' And, 'do aerodynamics really matter?' The results are telling, and may help you decide which bike is best for you.

Who was invited?

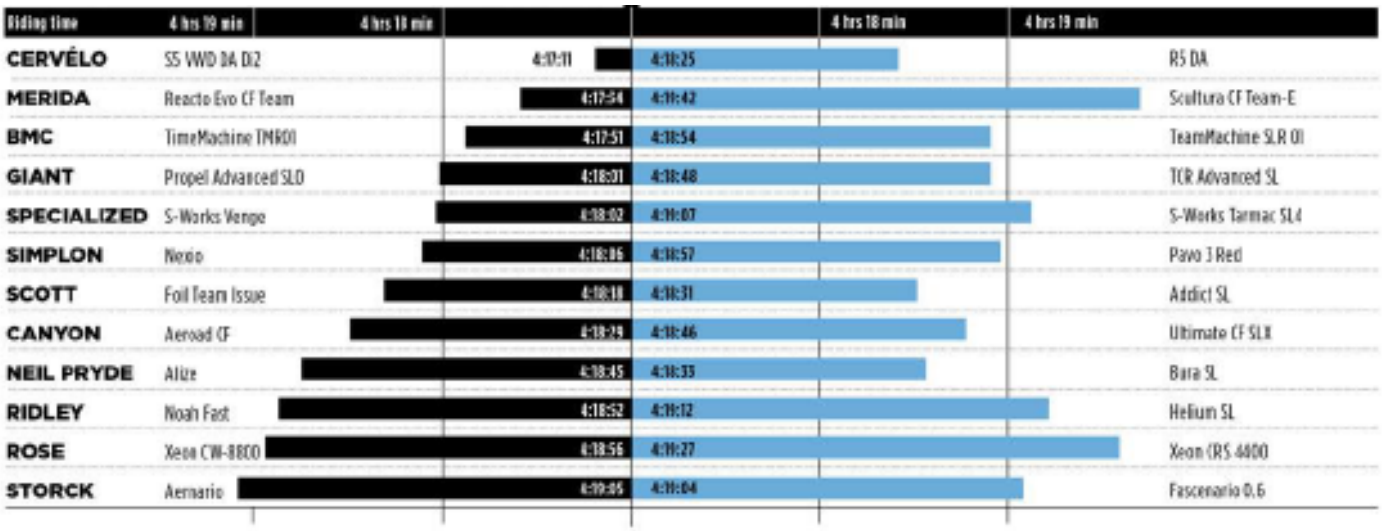
Tour invited 12 manufacturers, all of whom have a claim to fastest or lightest bike. To put the value of weight and aerodynamics in context, and to see how each manufacturer applied these design goals, all 12 manufacturers entered two bikes in the test: their most aero and their lightest. When *Tour* approached Cervélo, we jumped at the chance to have an independent third party put us to the test against the rest. The Cervélo S5 VWD and R5 were entered.

How was the test conducted?

"To answer the fascinating question of which frame is really the fastest, we entered the windtunnel data along with the lab's weights into a simulation over an assumed riding distance of 100km (62 miles) with a total elevation gain of 2000 m (6562 ft)."
– *Tour Magazin*

Tour built each of the 24 bikes "as uniformly as possible." Each bike was weighed and then taken to the GST Windtunnel in Immenstaad. In the tunnel, each bike was tested with a rider 'dummy' with pedaling legs through various yaw angles. The bikes were also tested in *Tour Magazin's* independent lab for weight, ride stability, lateral fork stiffness, power transmission, fork comfort, frame comfort, and even paint.

With all of the data collected, each bike was run through a simulated hilly road ride. The simulation was based on a solo rider pedaling at 200 watts over a 100km course with a net 2000m of elevation gain. The simulated rider and conditions were the same in each case.



The bar graph shows the absolute ride times of the aerodynamic and lightweight bikes, paired by make and sorted according to the times of the aerodynamic road bikes. The shorter the bar, the faster the bike is on the simulated 100 km (62 mile) route with a total elevation gain of 2000 m (6562'). Under these conditions, the Cervélo S5 is the fastest bike with a ride time of 4 hours, 17 minutes and 11 seconds. The rider of the Merida Scultura would require 4 hours, 19 minutes and 11 seconds for the same route. Aerodynamic drag and weight are factored into the equation. Calculations are based upon a constant power output of 200 watts pedaling in a static, brake hood position; a rider weight of 75 kg (165 lbs) and a maximum bike weight of 7.5 kg (16.5 lbs). It's also assumed that all frames are ridden with the same equipment as utilized in the aerodynamics test.

The results.

"Test results show that the fastest bike, by far, is the Cervélo S5."
– *Tour Magazin*

Simply put, the Cervélo S5 VWD is fastest. Period. The independent results confirmed what we have been seeing ourselves, both in the wind tunnel and on the scale. So if speed is your number 1 priority, your choice is easy.

However, the test is about more than just speed. And maybe your needs are too. When we start comparing the light weight frames, the results really start to get interesting. The Cervélo R5 finished first among the light frames, but also finished in 8th place overall, beating more than a third of the aerodynamic bikes, a mere 24 seconds behind the Giant Propel. In fact, *Tour Magazin* heralds the R5 as not only fast, but stable and comfortable as well.

So, what is best for you?

Your ideal bike depends on your ideal ride. If weight and stability are your priorities, then the R5 is a great option. And of course, among light bikes, why not choose the fastest one? If finishing ahead, or finishing with less effort is your priority, the S5 VWD can't be beat.

THE NUMBERS GAME

Aerodynamic or classic road bikes? More speed or lightweight and more comfortable? Current top-of-the-line models leave racing cyclists with a difficult choice. TOUR's test of 24 road bikes helps to inform your decision

TEXT
Manuel Jekel & Robert Kühnen

PHOTOS
Markus Greber

TRANSLATION
Kai Hilbertz

Being able to raise your arms at the end of a race to celebrate your victory is dependent on many factors. Your physique, tactical understanding and having an eye for the decisive moments of the race are all important factors. Among professionals, it's also important to have a powerful team. Very often, good or bad luck will tip the scales. In addition to the many unpredictable factors, there are also concrete measures which you can take to improve your competitive chances. This includes carefully choosing your material. The outcome of the 2011 World Cycling Championships in Copenhagen amply demonstrated this: Mark Cavendish won the road race by half a bike length ahead of Matt Goss. Cavendish rode an aerodynamically optimized S-Works Venge from Specialized, Goss was on the conventional S-Works Tarmac SL4 from the same manufacturer.

WORLD CHAMPION THANKS TO A FASTER BIKE?

The difference between the two models can be determined in a wind tunnel. At a speed of 45 km/h (28 mph), a rider has to produce 12.5 more watts to compensate for the Tarmac's aerodynamic disadvantage compared to the Venge. Because the force needed to overcome the wind's resistance increases threefold as velocity increases - doubling speed requires eight times the power - the difference in power ouput during the final sprint at 70 km/h

TEST

Aerodynamics versus Lightness

(43 mph) becomes considerably larger. Considering this evidence, one of the reasons that Cavendish became World Champion in 2011 is that he rode the faster bicycle.

Specialized is hardly the only manufacturer now offering more than one top model. The differentiation in aerodynamic and lightweight models is becoming the norm, especially for manufacturers who equip Pro Tour teams. Therefore amateur riders, who have to decide on only one bike, are presented with a choice. Do I take the lighter, and presumably also more comfortable frame? Or should I select the faster aero model? And exactly how great are the differences between aerodynamic and lightweight models? To find out, we invited manufacturers to this test who offer both an aerodynamic road bike and a light model built according to conventional criteria . In order to participate, the condition was that both models had to be submitted.

In the end, twelve manufacturers with 24 models accepted our invitation. The test's first stop was in TOUR's lab, where, besides the weights, we also measured riding stability, suspension comfort and power transmission. Then we took all the framesets to Lake Constance in order to quantify their aerodynamics in the GST wind tunnel. The exclusive new feature was our wind tunnel dummy with rotating legs. The new test dummy allows us to measure aerodynamic interactions between the legs and the framesets. Thus, current results are more realistic than previous results we measured with our old, rigid dummy. Since the new test dummy was designed without an upper body, the proportion of total aerodynamic drag caused by the dummy was significantly lower than in previous wind tunnel tests.

To ensure that measurements truly resulted from the frames' forms without being ob-

SHORT & SWEET

FACTS

25.1

watts
are saved by the fastest frame in the test compared to the slowest frame at 45 km/h (28 mph)

2:31

minutes:
This is the theoretical time difference between the fastest and the slowest frame over a simulated distance of 100 km (62 miles) with 2000 m (6562') total elevation gain.

All results start on
PAGE 12

GRADES: 1 = VERY GOOD, 2 = GOOD, 3 = SATISFACTORY, 4 = SUFFICIENT, 5 = FAILING
GERMAN PRICES; THE PRICE IN YOUR COUNTRY MAY VARY

LEADERBOARD

Wind tunnel

CERVELO
S5 VWD

MERIDA
REACTO EVO CF TEAM

Best overall

STORCK
AERNARIO

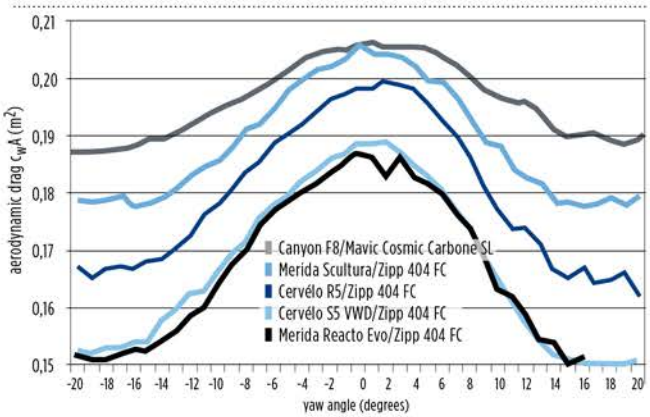
CANYON
ULTIMATE CF SLX

VENGE BEATS TARMAC
Mark Cavendish won the 2011 World Championship in Copenhagen by half a bike length ahead of Matt Goss. "Cav" rode the aerodynamic Specialized Venge, Goss rode the conventional Specialized Tarmac

scured by different equipment, the framesets were built up as uniformly as possible. Where possible, brakes, cranks and front derailleurs from SRAM's Red group were mounted. Zipp 404 wheels, equipped with Continental Grand Prix 4000S tires, were employed as our wheel standard. Our standard handlebar was a Zipp VukaSprint with aerodynamic top, mounted with Shimano Dura-Ace Di2 levers and brake cables, which were placed at the same height above the bottom bracket of each frame with millimeter precision. Exceptions to uniformity were made when there were technical reasons for that decision. The aerodynamic frames from BMC, Giant, Merida and Ridley, as well as Storck's Fascenario 0.6, were measured with their integrated brakes. Bikes from Cervélo and Specialized were tested with their special cranksets. The Giant Propel was measured with its aerodynamic handlebar-stem unit, which was specifically developed for that frame.

Test results show that the fastest bike, by far, is the Cervelo S5. Back in February 2012, this frame also placed first in TOUR's wind tunnel test. The Time Machine from BMC confirmed its very good aerodynamic results from the TOUR test in February 2013. Merida's new Evo Reacto pushed into second place of the aero rating, between Cervelo and BMC. Giant's Propel, tested for the first time, landed right behind the BMC. The Specialized Venge followed close behind. These five frames comprise the top group in the wind tunnel. Some of the other models improved compared to previous tests, whereas others fell behind. Canyon's Aeroad CF and Simplon's Nexio are both significantly better than previously tested. On the other hand, in last year's test the Storck Aernario was on par with the Nexio. In this test it fell behind and was even a little bit worse in the wind tunnel than the conventional Fascenario 0.6.

AERO VERSUS LIGHT FRAMES



The graph shows wind resistance curves of two aerodynamic road bicycles compared to two light weight bikes with the same setup. In addition, a round-tubed frame (Canyon F8, 2010 model) with Mavic Cosmic Carbone wheels is shown as a reference and as a comparison to previous tests. The two Merida frames represent the extremes within the test field - no other pair measured further apart. Due to its slower wheelset, the reference frame has a flatter curve.

NEW TEST PROCEDURE

How is it possible that the very same frame does passably in one aerodynamics test, then does better or not so well in the next? What at first glance seems to be contradictory - suggesting inaccurate measurements - actually becomes plausible once you look at the data. When we last tested in February 2013, we carried out the wind tunnel test with Mavic Cosmic Carbone SL wheelsets, which are now aerodynamically outdated. This was to facilitate comparisons with the previous test results. To explore possible improvement with fast wheels, all frames were also measured with Zipp 808 wheels which are currently considered to be the gold standard of aerodynamic wheelsets. At the time, results with the 808 wheels already hinted that some bikes such as the Simplon Nexio would benefit more from fast wheels than others. That a gap has now grown between the Nexio and the Aernario can be explained mainly through the mounting of the Zipp 404 wheels. Aerodynamically, they're clearly better than the Cosmic Carbone SL.

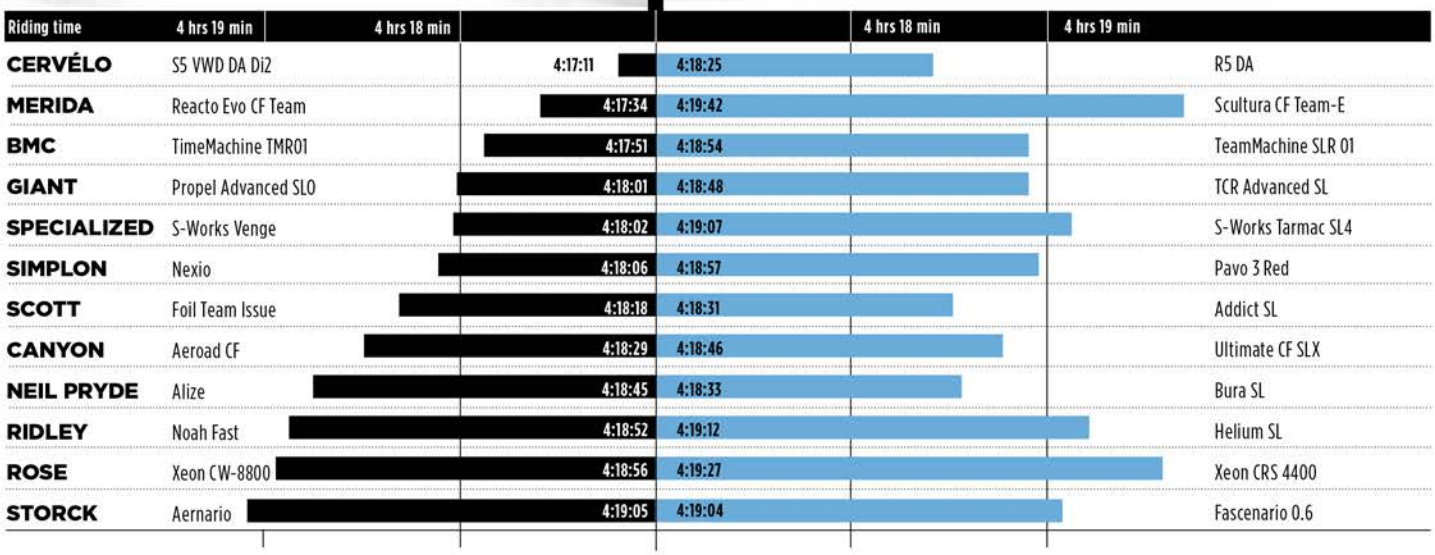
As a general rule, the new test setup with 404 wheels and VukaSprint handlebars seems to largely exploit the frames' aerodynamic potential. That the Nexio would advance in the rankings of the new setup was to be expected. The Aernario's falling back in the overall standings was also no great surprise.

If you only look at the wind tun-

photo: Roth

AERODYNAMIC FRAMES

LIGHTWEIGHT FRAMES



The bar graph shows the absolute ride times of the aerodynamic and lightweight bikes, paired by make and sorted according to the times of the aerodynamic road bikes. The shorter the bar, the faster the bike is on the simulated 100 km (62 mile) route with a total elevation gain of 2000 m (6562'). Under these conditions, the Cervélo S5 is the fastest bike with a ride time of 4 hours, 17 minutes and 11 seconds. The rider of the Merida Scultura would require 4 hours, 19 minutes and 11 seconds for the same route. Aerodynamic drag and weight are factored into the equation. Calculations are based upon a constant power output of 200 watts pedaling in a static, brake hood position; a rider weight of 75 kg (165 lbs) and a maximum bike weight of 7.5 kg (16.5 lbs). It's also assumed that all frames are ridden with the same equipment as utilized in the aerodynamics test.

nel test, eleven of the twelve aero frame are at the front of the rankings. But it'd be rash and incorrect to conclude that these eleven frames are the fastest under all conditions. Even if weight isn't as important as speed in most riding situations, it's hardly irrelevant. To answer the fascinating question of which frame is really the fastest, we entered the wind tunnel data along with the lab's weights into a simulation over an assumed riding distance of 100 km (62 miles) with a total elevation gain of 2000 m (6562'). You can see the results in the diagram above. Once you base the rankings on this premise, a few minor changes occur in the order of the 24 frames. Some very lightweight models do slightly better, others fall behind a little. However, the main trend doesn't change much. Over the 100 km distance, the aerodynamic models remain clearly faster despite the fact that they weigh more. After completing the distance, the rider of the S5 is theoretically about two and a half minutes in front of the rider of the slowest bike in the test (Merida Scultura). Thus, it's clear that, when it comes to the performance of a road bike, aerodynamics beat light weight. Racers who ignore this diminish their chances of winning.

Of course, not everyone on a road bike wants to win races. Comfort and riding stability are also important criteria that can make the difference when deciding on a purchase. Seen against this backdrop, it's ironic that the mechanical values measured in the lab tests turn the wind tunnel results on their head. The Cervélo S5, the fastest bike in the test field, ranks dead last in the laboratory test, far behind the others. Its undoing is its relatively low stability and low levels of comfort. Conversely, the Storck Aernario and Canyon Ultimate CF SLX are, in this order, the best frames to have ever gone through TOUR's laboratory.

INCOMPATIBLE?

This seems to confirm that good aerodynamics and good handling characteristics, which depend largely on comfort and riding stability, don't go together. Or is it sometimes possible to successfully combine them? Two new models from Cervélo and Scott are the best at resolving the seeming contradiction. The R5 and the Addict SL both pursue an "aerodynamic + light" concept - similar to Trek's Madone 7.9. Both are very light and comfortable, but also have tubing that is at least partially aerodynamically shaped. So while these frames aren't as streamlined as the aerodynamic specialists, they are measurably faster than your typical frame with round tubing.

The R5 and the Addict are the best at bringing together different requirements under one roof. They are light, have a stable ride, are comfortable and a bit aerodynamic. In the future, it's likely that more manufacturers will adopt this approach. Although it may be fascinating to ride a bicycle that's faster than other bikes right out of the box, a lightweight road bike that tracks reliably in every situation and dampens road buzz is, in the end, also quite nice.

OVERVIEW OF ALL RESULTS

COMPANY MODEL	FRAME										GRADE		
	weight (frame + fork), grams[1]	ride stability, Nm/degree	lateral fork stiffness, N/mm	power transmission, N/mm	frame comfort, N/mm	fork comfort, N/mm	paint	finish	instruction manual[2]	guarantee[3]	Grade frame	Aerodynamics (45 km/h)	Final frame grade w/ aerodyn.
Percentage of the final grade[4]	25	15	15	10	10	10	5	5	2.5	2.5	100/80	20	100
BMC TimeMachine TMR01	1604	95	42	69	322	80	1	1	1	2		205	
	2.7	1.3	3.0	1.0	3.7	3.0	1.0	1.0	1.0	2.0	**2.3**	**1.3**	**2.1**
BMC TeamMachine SLR 01	1296	101	56	68	132	86	1	1	1	2		220	
	1.3	1.0	1.0	1.0	1.7	3.7	1.0	1.0	1.0	2.0	**1.4**	**3.0**	**1.8**
CANYON Aeroad CF 9.0 SL	1538	85	54	58	140	106	1	1	1	1		212	
	2.3	2.3	1.0	1.3	1.7	5.0	1.0	1.0	1.0	1.0	**2.0**	**2.3**	**2.1**
CANYON Ultimate CF SLX 9.0 SL	1233	101	54	68	92	77	1	1	1	1		220	
	1.3	1.0	1.0	1.0	1.0	2.7	1.0	1.0	1.0	1.0	**1.3**	**3.0**	**1.6**
CERVÉLO S5 VWD DA Di2	1468	72	38	50	373	123	1	1	1	1		201	
	2.0	3.7	3.3	2.7	4.3	5.0	1.0	1.0	1.0	1.0	**2.9**	**1.0**	**2.5**
CERVÉLO R5 DA	1253	93	51	63	138	116	1	1	1	1		216	
	1.3	1.7	1.3	1.0	1.7	5.0	1.0	1.0	1.0	1.0	**1.7**	**2.7**	**1.9**
GIANT Propel Advanced SL0	1588	92	52	63	135	118	1	1	1	2		207	
	2.3	1.7	1.3	1.0	1.7	5.0	1.0	1.0	1.0	2.0	**2.0**	**1.7**	**1.9**
GIANT TCR Advanced SL	1479	105	53	69	142	99	1	1	1	2		216	
	2.0	1.0	1.0	1.0	1.7	5.0	1.0	1.0	1.0	2.0	**1.7**	**2.7**	**1.9**
MERIDA Reacto Evo CF Team	1573	94	44	64	216	91	1	1	1	2		203	
	2.3	1.7	2.3	1.0	2.3	4.3	1.0	1.0	1.0	2.0	**2.1**	**1.3**	**2.0**
MERIDA Scultura CF Team-E	1360	110	49	63	144	79	1	1	1	2		226	
	1.7	1.0	1.7	1.0	1.7	3.0	1.0	1.0	1.0	2.0	**1.6**	**3.7**	**2.0**
NEIL PRYDE Alize	1551	98	43	58	240	90	1	2	1	1		215	
	2.3	1.0	2.7	1.3	2.7	4.3	1.0	2.0	1.0	1.0	**2.2**	**2.3**	**2.2**
NEIL PRYDE Bura SL	1273	85	53	60	109	112	1	2	1	1		217	
	1.3	2.3	1.0	1.0	1.3	5.0	1.0	2.0	1.0	1.0	**1.8**	**2.7**	**1.9**
RIDLEY Noah Fast	1757	96	59	70	373	103	1	1	1	3		213	
	3.0	1.3	1.0	1.0	4.3	5.0	1.0	1.0	1.0	3.0	**2.3**	**2.3**	**2.3**
RIDLEY Helium SL	1249	88	46	57	127	89	1	2	1	3		223	
	1.3	2.0	2.0	1.7	1.3	4.0	1.0	2.0	1.0	3.0	**1.9**	**3.3**	**2.2**
ROSE Xeon CW-8800	1611	92	46	57	192	129	1	1	1	1		215	
	2.7	1.7	2.3	1.7	2.3	5.0	1.0	1.0	1.0	1.0	**2.3**	**2.7**	**2.4**
ROSE Xeon CRS 4400	1459	100	61	66	154	90	1	1	1	1		222	
	2.0	1.0	1.0	1.0	1.7	4.0	1.0	1.0	1.0	1.0	**1.6**	**3.3**	**2.0**
SCOTT Foil Team Issue	1514	96	45	60	194	98	1	1	1	3		211	
	2.3	1.3	2.3	1.0	2.3	5.0	1.0	1.0	1.0	3.0	**2.2**	**2.0**	**2.1**
SCOTT Addict SL	1154	90	40	50	129	78	1	1	1	3		218	
	1.0	2.0	3.3	2.7	1.3	3.0	1.0	1.0	1.0	3.0	**2.0**	**3.0**	**2.2**
SIMPLON Nexio	1480	96	49	68	191	90	1	1	1	1		210	
	2.0	1.3	1.7	1.0	2.3	4.3	1.0	1.0	1.0	1.0	**1.9**	**2.0**	**1.9**
SIMPLON Pavo 3 Red	1242	96	46	65	137	73	1	1	1	1		221	
	1.3	1.3	2.0	1.0	1.7	2.3	1.0	1.0	1.0	1.0	**1.5**	**3.3**	**1.9**
SPECIALIZED S-Works Venge	1559	89	37	52	357	110	1	1	1	3		208	
	2.3	2.0	3.7	2.3	4.0	5.0	1.0	1.0	1.0	3.0	**2.8**	**1.7**	**2.5**
SPECIALIZED S-Works Tarmac SL4	1399	119	47	67	151	115	1	1	1	3		220	
	1.7	1.0	2.0	1.0	1.7	5.0	1.0	1.0	1.0	3.0	**1.8**	**3.0**	**2.1**
STORCK Aernario	1190	106	53	58	133	59	1	1	1	3		223	
	1.0	1.0	1.0	1.3	1.7	1.0	1.0	1.0	1.0	3.0	**1.2**	**3.3**	**1.6**
STORCK Fascenario 0.6	1212	106	56	70	186	88	1	1	1	3		223	
	1.3	1.0	1.0	1.0	2.0	4.0	1.0	1.0	1.0	3.0	**1.5**	**3.3**	**1.9**

At a glance Grades of 4.0 or worse are in red. You can immediately see which bikes have weaker individual scores and thus might fall out of contention.

[1]**Weight corrected** for a standard frame size of 57 cm (22.5") and fork shaft length 225 mm.

[2]**Instruction manual (IM)**: IMs with racing bike specific details, illustrations and safety instructions are graded as very good = 1.0. A generic IM gets a grade of 3.0, whereas a missing IM is graded as failing = 5.0.

[3]**Guarantee**: A frame and fork guarantee of more than five years merits a good = 2.0. A three to five year guarantee = 3.0, less than three years is a 4.0. If the guarantee excludes the fork or racing use, the grade drops by one level. If the guarantee offers a crash replacement, the grade improves by one level.

[4]**Percentage of the final grade:** The grade for the frameset is calculated from the weighted individual grades of the frame's various mechanical properties, which together comprise 100%. When the aerodynamics grade is also factored in, the frame comprises 80% and the aerodynamics grade 20% of the final grade (100%)

Grades: 1 = VERY GOOD, 2 = GOOD, 3 = SATISFACTORY, 4 = SUFFICIENT, 5 = FAILING

HOW TOUR TESTS

The aerodynamics tests were conducted in the GST wind tunnel in Immenstaad. All frames were measured with rotating wheels at yaw angles ranging from -20 to +20 degrees at speeds of 45 km/h (28 mph). 130 individual measurements per bike were included in calculating total aerodynamic drag. The frequency of various yaw angles during an actual ride was factored in through a probability equation. A new rider dummy was mounted with its legs pedaling at 88 revolutions per minute. A normal, full-bodied dummy would have caused about 75% of the bike and rider's total aerodynamic drag. For that reason and because, to a great degree, only the legs interact with the bicycle, we omitted the torso, the arms and the head to achieve a higher degree of measurement resolution. The seating position of the legged dummy was identical during all measurements.

All measurements were taken with framesets that were ordered in addition to the test bikes themselves. For test measurements, the frames were built up enough to be almost ready to run. To minimize distortions due to components and different parts, equipment was made as uniform as possible. As our standard, we used Zipp 404 wheels mounted with 23 mm wide Continental Grand Prix 4000S tires. Our standard handlebar was a Zipp VukaSprint with aerodynamic top, mounted with Shimano Dura-Ace Di2 levers and brake cables, installed at the same height above the bottom bracket of each frame with millimeter precision. Where possible, SRAM Red brakes, front derailleurs and cranks were mounted. Exceptions to uniformity were made when a frame required certain equipment, such as models with integrated brakes. Each frame was tested with one 0.5 liter bottle mounted on the down tube. Because of our new dummies and other changes compared to previous testing procedures, the numerical watt values of this test are not comparable with previous wind tunnel tests. Measurement accuracy of the test is ± 0.35 watts.

Final grades are derived from the frame measurements in TOUR's laboratory and the wind tunnel results. In our lab, framesets were subjected to the usual tests. Weight (25% of the frame grade), riding stability (15% of the frame grade), lateral stiffness of the fork (15%), power transmission (10%), comfort of the frame (10%), fork comfort (10%) and the quality of the paint (5%) were measured. In addition, build quality (finish, 5%), the instruction manual (2.5%) and the warranty coverage (2.5%) all figured into the frame grade.

The lab and wind tunnel test results are graded separately for each frameset. In addition there's the overall, final grade. The frame comprises 80% and the aerodynamics make up 20% of the final grade.

Important! The watt values and grades derived thereof result from the frames being set up to be measured in the uniform manner described. Results aren't transferable to the complete test bikes as shown. But they are clear indicators of the respective frame's aerodynamic potential.