At its core, cycling is an equation: forces for, and forces against. Subtract that which seeks to slow you down — rolling resistance, wind, gravity, grinding bearings and all the rest — from the amount of power the human engine is churning out. The result? Speed.

There are two ways to go faster: improve the engine, or reduce resistance. The former involves sweat and tears. All other things being equal, reducing resistance anywhere on your bike or body will result in a faster ride. Yes, you can buy speed. It takes a decent pile of cash, and a willingness to accept a few minor drawbacks, but it is possible. And that’s where these aero wheels come in.

A NEW BREED
Compared to a standard 32-spoke aluminum wheel, the 50-70mm deep wheelsets in this test will reduce drag by between 158 and 224 grams at 30 miles per hour. What does that mean for you? That roughly equates to 15 to 23 watts. It might not sound like much, but it takes a hell of a lot of sweat to become 23 watts stronger.

The use of computational fluid dynamics (CFD) to help refine rim shape — which has the most dramatic effect on aerodynamics and control — has allowed for an exponential increase in aerodynamic refinement over a very short period of time.

The result has been a surge of new rim shapes, all of which attempt to increase a wheel's stall angle, or the wind angle at which most of the aerodynamic benefit is lost. All use a similar theme: wider than ever at the brake track, between 24 and 28mm, and wide all the way to a rounded spoke bed. Though no two are identical, all have more in common with each other than with the narrow V-shaped profile used for most of the last decade. All claim to be faster, and offer vastly improved crosswind stability.

For this test, we included a classic V-shaped carbon rim, plus blunt-tailed options from Rolf, Hed, Enve and Bontrager. All five are tubulars, though most come in a clincher version. Zipp opted out of the test.

We put each set through extensive wind tunnel and inertia testing, plus real-world ride time, and ranked them in a number of objective and subjective categories, including brake performance and crosswind stability. In the wind tunnel, we tested various tire sizes on each wheel, since the tire/rim interaction is vital to overall aerodynamics.

In the end, each company took a slightly different approach toward the same goal: a fast, light and stable set of race wheels. Read on to find out which was most successful.

METHODS
IN THE WIND TUNNEL
We tested all five sets of wheels on a complete bike, in an attempt to create the same environment in which they are expected to perform in real life. While this may seem like an obvious choice, it is in fact much less common than one would expect. Why? Just as rims and tires interact in unique and often unpredictable ways, the relationship between wheels and frames is also highly variable. That means that the fastest wheels in one frame may not be the fastest in another.

That said, a wheel that tests very well without any frame at all may not, in fact, be fastest in any frame. We feel that our method, while not absolute, provides enhanced insight into how these wheels perform in the real world. Specifically, our protocol places additional emphasis on the aerodynamics of the front wheel, just as the real world does.

We tested all five sets across a full yaw angle sweep from -20° to 20°. The negative yaw angles represent wind hitting the drive side of the bike, and positive yaw the non-drive side. As the data show, the various components on the drive side can have an impact on wheel aerodynamics, so we felt it was important to gain drag figures from both positive and negative yaw angles.

ROTATIONAL INERTIA (OR MOMENT OF INERTIA)
Rotational inertia is the rotational equivalent of mass. Because this calculation offers insight into the amount of energy required to accelerate (through pedaling) and decelerate (through braking), a wheel with a lower inertia will perform better on both fronts. We can measure the mass of the wheel easily enough, but it is not necessarily the case that the lightest wheel will have the lowest moment of inertia, or vice versa. So, we used a torsional pendulum setup created by Lennard Zinn to measure a wheel’s rotational inertia.
“A frequent racer’s dream.”

Within this test, the Psimet wheels act as a stand-in for an older generation of narrow V-shaped aero rims. We were intrigued to see how this shape matched up against the current crop of fat, blunt-tailed options. The wheels were hand built by popular Chicago-based wheelbuilder Rob Curtis, so we were confident of the build quality. But we weren’t so sure about the rims, which are generic, open-mold carbon tubulars that can be found under a dozen different brand names. Curtis built the pair with a 50mm front and 60mm rear rim. How would these significantly cheaper hoops, based loosely on popular rims from half a decade ago, stack up against the cutting-edge options?

Turns out, they did quite well. In terms of pure performance they do lag behind the latest round of blunt-tail rims, but Psimet still fares much better than our 32-spoke control in the wind tunnel, and the sprightly, super-stiff feel we noticed on the road was backed up by our inertia testing. In most conditions, the wheels were an absolute pleasure to ride. Plus, they are less than half the price of the next cheapest wheel, and you could buy three sets for the price of this test’s winner. That’s some serious value, and makes them a frequent racer’s dream.

QUANTITATIVE TESTING
Wind tunnel testing showed Psimet bunched closely with the rest of the aero wheels in this test, though still the slowest of the five. Nonetheless, the set is faster than the 32-spoke control wheels by about 15 watts at 30mph.

It is important to note, though, that while the blunt-tail wheels all are fastest around 10° yaw, the Psimets are slowest. They stall out far earlier than the others, and drag increases quickly once they tip over the edge. The most common yaw angles encountered in the real world sit between 5° and 15°, meaning that the Psimets lose quite a bit where it matters most. Though they are only 2 watts slower in a direct headwind, the Psimets lose a full 11 watts to the Enve 6.7s at 10° of yaw.

SUBJECTIVE TESTING
Wind gusts buffet the front Psimet wheel with reckless abandon. Despite the 50mm front wheel depth, the wheels are more difficult to control in the wind than the 60mm HED or Enve options. The classic, V-shape rims are to blame.

Brake performance is a bit disappointing as well. We experienced low absolute power and slight pulsation, particularly at low speeds. “Erratic modulation, at best,” noted Nick Legan during our test runs. Oddly enough, the slight pulsation actually seemed to diminish as the pads and rims heated. After a few hard downhill switchbacks, the brake performance actually improved.

VALUE
The Psimet wheels can be picked up for just under $1,000, and similar sets under different brand names can be had for similar prices. They lose some in the wind tunnel, but spin up faster than many more expensive wheels. To us, the message is clear: if you race a lot and don’t want to worry about breaking hyper-expensive wheels when you inevitably crash, go for these. Buy three pair for the price of one set of Enve 6.7s.

WEIGHT
Four more points go to the Psimets for being the second lightest in this test.

PSIMET/WHITE INDUSTRIES CUSTOM $1,000 1,423g
WIDTH: 21mm  FRONT DEPTH: 50mm  REAR DEPTH: 60mm
QUANTITATIVE TESTING: 31 OUT OF 50
WIND TUNNEL 30  ROTATIONAL INERTIA 20
SUBJECTIVE TESTING: 12 OUT OF 30
CROSSWIND PERFORMANCE 20  BRAKING 10

“A frequent racer’s dream.”

Just as subtle changes in the shape of each rim’s spoke bed proved vital to both overall aerodynamics and crosswind performance, tire selection can have a dramatic impact on the same. Vittoria provided us with 21, 23 and 25mm Corsa CX tires to help us find the best combination for each wheel. Rim and tire are a system, and one impacts the other. In fact, we saw changes of as much as 97 grams of drag, or nearly 10 watts at 30mph, with the same wheel simply by swapping from a 21 to 25mm tire.

On average, a 21mm was the fastest option for all the wheels tested. But the impact of tire size was not consistent across all of them. On the Psimets, for example, tire size had very little effect — less than 10 grams difference at most yaw angles. On the Bontragers, a 21mm tire saw a sharp drop down to 953 grams of drag at -10° yaw, while a 25mm tire saw a sharp spike up to 1050 grams. In other words, the wheels were stalling out at -10° with a 25mm tire, but not with a 21mm tire. The 23mm tire was right in the middle.

Of course, numerous other factors need to be taken into account regarding tire selection. The rolling resistance associated with a 25mm tire will usually be lower than that of a 21mm, and both 23mm and 25mm will corner and handle much better than their skinny sibling. Racing a technical criterion on a 21mm tire for the sake of a few grams of drag isn’t a great idea, but throwing 21mm tires on for a time trial will likely save a few seconds. As with most equipment selection, there is no right answer for every situation.
Rolf Prima has a long history in carbon tubulars, and the company’s hallmark paired spoke design has a proven track record. Nonetheless, we were a bit skeptical of the low front and rear spoke counts — both get only 16. Stiffness was never an issue, though, and the wheels felt light and nimble under acceleration. Rather, it was braking performance and high-yaw wind tunnel results that were Rolf’s downfall.

Hed helped lead the charge toward wider wheels, and has had more time to perfect its stabilizing shape than any other brand in this test; the rest are all first-generation products. So we were not the least bit surprised when the Stinger 6s were confident taking the Stinger 6s out in some crosswinds, and are easier to control at the same time. It might sound like marketing jargon, but the shape truly does work. We were confident taking the Stinger 6s out in some truly nasty, spring winds.

Brake performance was low on absolute power and high on modulation. Braking was exceptionally predictable, but Hed’s blue cork pads did not provide much initial bite, decreasing outright power. The surface area of the pad is also very large — too large, in fact, as we had issues with the pads hitting the rim decals.

“Fastest of the bunch at 0° yaw.”

The TDF 60s were third fastest in the wind tunnel, just 13 grams of drag (a little over 2 watts at 30mph) slower than the Enve 6.7 set. They fell nicely in line with the top two performances between 5° and 15° yaw, but drag rose quickly as the wheels stalled around 15°. Perhaps due to the low spoke count, the TDF 60s were actually the fastest of the bunch at 0° yaw.

The front wheel had a moment of inertia of 1.75 seconds, placing it second behind Bontrager, and the rear managed a score of 1.77 seconds, enough for third behind Bontrager and Psimet.

“For $2,200, it’s impossible to go faster.”

Hed pulled ahead at -15° yaw, dropping precipitously down to 890 grams of drag while every other wheel rose to between 950 and 1,000 grams. So, in the Venge frame we used for testing and with a 21mm tire, a pair of Stinger 6s is faster than Enve 6.7s if the wind is coming from your right side. This odd advantage disappears with a 23 or 25c tire.

Our inertia testing was not so kind. Hed came in last, losing out to the deeper and slightly heavier Enve 6.7 set — by quite a bit, in fact. The Rolf, Psimet and Enve wheels were all closely packed at 1.75 and 1.76 seconds, while Hed fell far behind at 1.80.

Hed and Enve effectively tied in the wind tunnel, with the Stinger 6s generating only one extra gram of drag across a full sweep of yaw angles. That’s within the tunnel’s margin of error. The two sets tied down to the gram at 0° and remained tightly packed across all positive yaw angles (with wind hitting the non-drive side of the bike). However, the rear set 13 grams of drag and a heap of crosswind performance worth $1,200? That’s a question we can’t answer for you.

Hed’s SCT (Stability Control Tuning) shape, which keeps the stall angle high in crosswinds. That means the wheels stay quick even with hefty crosswinds, and are easier to control at the same time. It might sound like marketing jargon, but the shape truly does work. We were confident taking the Stinger 6s out in some truly nasty, spring winds.

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“Powerful, but in a shuddery, disconcerting way.”

We tried the TDF 60s with another set of carbon-specific brake pads, but the problem persisted.

At $2,300, Rolf has placed the TDF 60 smack dab in the middle of the carbon tubular market. Enve’s 6.7 is more expensive, but also faster. More importantly, a pair of Hed Stinger 6s is $100 cheaper and, though a bit slower to spin up, is a better wheelset overall.

As the third lightest in our test, the Rolf TDF 60s get 3 points.

Crosswind performance with the Stinger 6 is simply phenomenal. The rims use Hed’s SCT (Stability Control Tuning) shape, which keeps the stall angle high in crosswinds. That means the wheels stay quick even with hefty crosswinds, and are easier to control at the same time. It might sound like marketing jargon, but the shape truly does work. We were confident taking the Stinger 6s out in some truly nasty, spring winds.

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If aero performance is your highest priority, the Stinger’s $2,200 price tag is worth every penny, particularly when compared to the Enve at $600 more. However, we had to lop a few points off because significantly cheaper options (like the Psimetts in this test) still perform very well. Is 65 grams of drag and a heap of crosswind performance worth $1,200? That’s a question we can’t answer for you.

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VALUE

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WEIGHT

As the third lightest in our test, the Rolf TDF 60s get 3 points.
The Aeolus 5 D3 stepped into this test with a slight disadvantage. The set of 50mm rims are shorter than all but the front Psimet rim, and in a trial against the wind, size does matter. While the wheels did lose a bit in the wind tunnel, where they placed fourth out of five, their low rotational inertia and weight helped make up some of the difference. We found the Aeolus 5 to be hyper-versatile: light, stable, and aero enough. If we could only have one set of wheels, Bontrager would get our money.

**QUANTITATIVE TESTING**

Though they were fourth in the wind tunnel, the Bontragers were exceptionally consistent across the full sweep of yaw angles, with the smallest peaks and valleys of the bunch. We didn’t see a big dip at 15°, as we did with the rest of the blunt-tailed wheels. Overall, the wheels ended up only 26 grams of drag slower than the winner in the tunnel.

Thanks to their low rim weight, the inertia test was an easy victory for Bontrager. While the rest all sat between 1.75 and 1.83 seconds, the front Bontrager pulled a 1.66 and the rear a 1.68 second moment of inertia. This difference was also noticeable on the road.

**SUBJECTIVE TESTING**

Despite their lower height, the Bontragers were not quite as stable as the Hed and Enve wheels. Sharp crosswinds grabbed at the bike more than we expected them to. That said, we still found them on par with Rolf, and miles ahead of Psimet. Relative to anything available a few years ago, the Bontragers are rock solid.

Braking was the second best in this test. Power was a bit on the low side with Bontrager’s cork pads, but modulation was excellent. We experienced no pulsing or other irregularities, and heat had little effect on performance.

**VALUE**

While they miss a bit in pure aerodynamics, the Bontragers’ low inertia and excellent brake performance make it unquestionably the most versatile in this test. The jack-of-all-trades mentality behind the design is immediately evident. However, once again we had to take points off because the Psimet wheels are nearly as good everywhere except in a nasty crosswind, for less than half the price.

**WEIGHT**

As the lightest in this test by nearly half a pound, the Bontragers get all five points.
While Bontrager entered this test with a rim-height disadvantage, the Enve entered with the opposite. A 60mm front rim is even with both Hed and Roelf, but the 70mm rear rim is the tallest in this test. We fully expected the wheels to do well in the wind tunnel.

They didn’t disappoint, taking a narrow but unsurprising victory over Hed by a single gram of drag. What did surprise us was the incredible crosswind control the wheels offered and the reasonable inertia figures. The deepest wheels in this test still spin up quickly, and crosswind performance was in a class of its own.

Unlike the other blunt-tailed sets here, the 6.7s don’t simply decrease the pressure felt on the handlebars as crosswinds kick up. They seem to actually smooth out gusts, drastically improving predictability. The sensation is almost odd at first — as if the front wheel is being pulled to the side by a rubber band, which serves to remove all the harsh inputs. Combined with phenomenal braking, excellent wind tunnel results, and acceptable inertia figures, the Enve 6.7s were the clear overall winner.

**Quantitative Testing**

The Enve 6.7s have the lowest overall drag across the full yaw angle sweep, but, more importantly, they were exceptionally quick all the way from 5° to 20°. They did fall behind Hed at -15°, where they seem to stall, but regained their composure as the angle tilted out towards -20°.

Despite being a few grams heavier than the Heds, Enve managed to keep the rotational inertia low. The wheels ended up tightly paired with the lighter Psimet and Roelf sets, and well ahead of Hed.

**Subjective Testing**

Enve provides the best crosswind performance in this test, smoothing out gusts and offering exceptionally predictable handling in all but the worst conditions. Hed is quite close, but did not offer the same damping of sudden gusts.

Braking performance was flawless. With the new SMART System wheels, Enve has updated its brake track technology with a surface treatment that works very well in both wet (they offered the most initial grip of any wheel in the test) and dry conditions. Gone is the pulsation we had experienced with Enve rims in the past.

**Value**

At $2,900, the 6.7s are $600 more expensive than any other wheel here. You could essentially buy three pairs of Psimets for the same price. Despite their excellent performance, that’s a big chunk of change, and hurts the overall value score.

**Weight**

As the heaviest in this test, Enve only gets 1 point.
RESULTS

Wide rims are here to stay, and we couldn’t be happier about it. For those with the funds, deep carbon wheels can now be seriously considered as everyday wheels — perhaps not the tubulars in these pages, but the same technology applies to clincher options from most of the top brands. Crosswinds are not the issue they once were, and impact resistance has increased dramatically. Versatility is the hallmark of the latest generation.

MORE IMPORTANT THAN WEIGHT — ROTATIONAL INERTIA

In time trials, the moment of inertia may matter very little, due to the steady speeds and minimal braking involved. Heavy wheels with lots of mass around their edges will take more energy to get started, but once in motion, they will not require any more energy to keep moving than a lower-inertia wheel, in the absence of frictional forces. However, wind is a big frictional force on a bike, and if a wheel is more aerodynamic at the expense of higher rotational inertia and higher mass, you still come out ahead if there is no braking to be done on the course. If there are lots of turns that require hard braking, though, the mass and rotational inertia both matter considerably more, and at a certain point, a less aero wheel with lower rotational inertia will outperform a more aero one with higher rotational inertia. When climbing, a rider benefits from lower wheel mass, and as long as he or she does not use the brakes, it does not matter how the mass is distributed (as long as it is uniform) around the wheel. — Lennard Zinn

As you can see, the Bontrager wheels have the lowest weight and the shortest period of oscillation. Its rotational inertia is the same as if it weighed 380 grams, all concentrated at its outer edge. Compare this to the Hed rear wheel, which weighs less than the Enve but which has a larger moment of inertia.

If you are interested in the full story behind these equations, go to velonews.com and look under Tech for Wheel/Moment of Inertia.

THE TUNNEL DOESN’T LIE

THE FINAL TALLY

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