

Felt 2014 AR Wind Tunnel Test Procedures Appendix

The test:

The bicycles referenced in this document were tested at the San Diego Low Speed Wind Tunnel. This wind tunnel is considered the leading research facility for bicycle aerodynamic testing. All of the testing was performed on the same day during the same session.

Test Setup:

The test procedure was established based on our extensive experience with wind tunnel testing and included the assistance of the expert staff at San Diego LSWT. All bikes were tested with the wind speed of 30mph and the yaw angle ranging from -20° to +20°.

We understand the importance of conducting the test with the rider, but for the purpose of this test it would be very difficult to obtain consistent results. Similarly, while a pedaling mannequin could theoretically yield consistency in the results, making those results meaningful would require a very complicated mannequin apparatus that would have the ability to adapt to various bicycles without introducing additional sources of error. Furthermore, it is impossible to make a shape of the mannequin that would be representative of every possible human rider configuration and of the aerodynamic interaction between the rider and the bike. For these reasons the bikes tested were complete bicycles only, fully assembled and ready to ride.

Bicycle Setup:

All bikes tested were size name 56 cm or an equivalent, setup for the same hypothetical rider with identical stack, reach, saddle height, etc. All frames are of the same category of aero road, and of the most up-to-date designs. All components besides those specific to the bicycle were identical and transferred to each bike. The choice of components was based on a typical, high end aftermarket configuration and was entirely unbiased and not meant to influence the performance of any one bicycle frame. The specifics of the setups, such as the cable routing were optimized for improved aerodynamics and actual function. The component setup was as follows:

Wheelset – Zipp 404 Firecrest Clincher

Tires- Continental GP4000

Component Group – Shimano Dura-Ace Di2 9000

Brakes - Shimano Dura-Ace 9000 F+R (Note - the Giant Propel was tested with its proprietary integrated brakes) (Note - The AR frame utilizes Shimano 9000 direct mount rear brake) (Note - Data set "New AR w/Felt Brake" utilized a proprietary Felt design center pull front brake)

Seatpost - model specific

Saddle – Selle Italia SLR

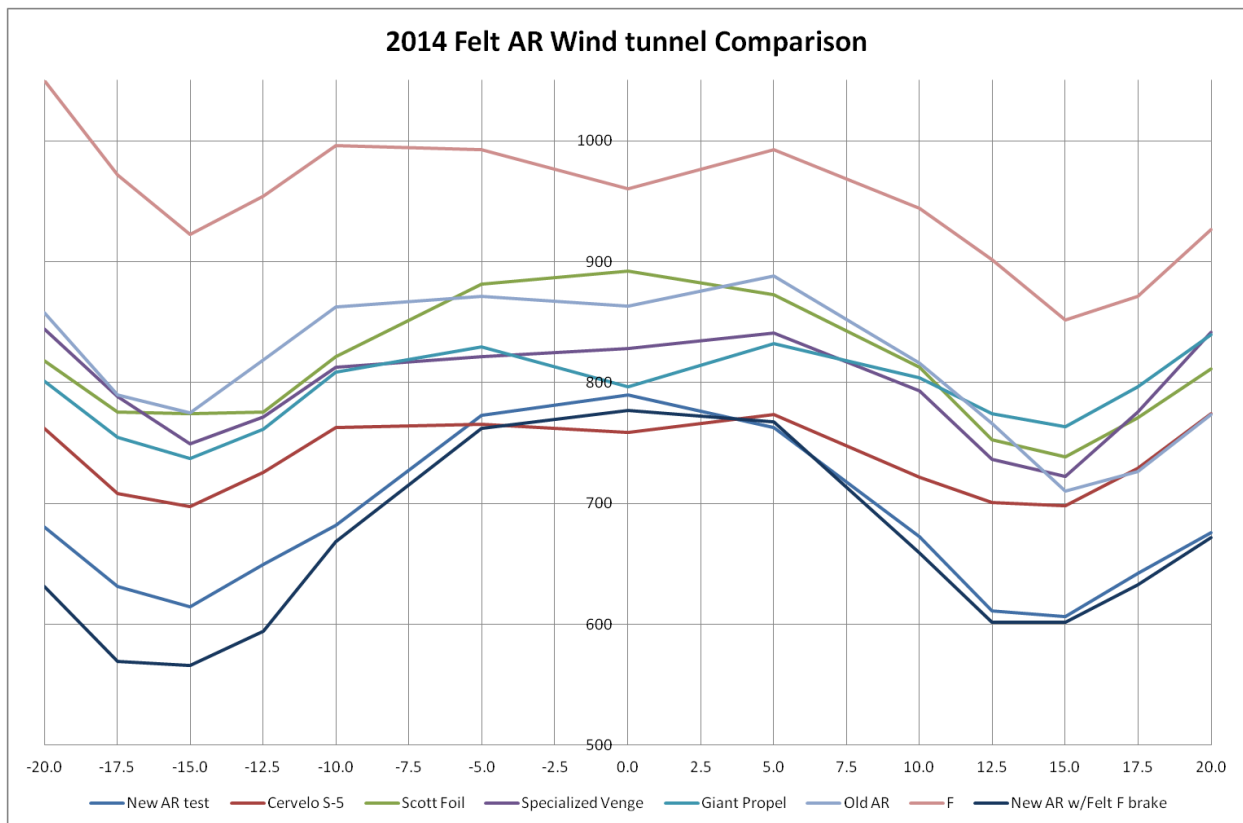
Stem – 3T Integra stem – (Note - The Giant Propel was tested with its supplied proprietary stem due to the 1/1/4 steer tube)

Handlebars – Zipp Vuka Sprint

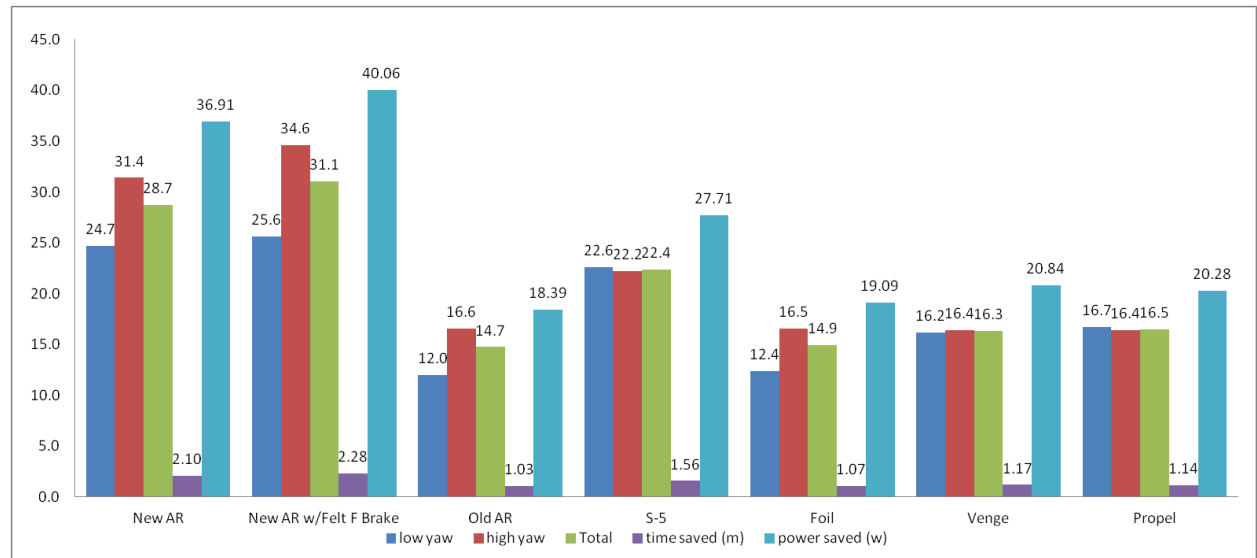
Data Analysis:

We believe that not all wind tunnels are equivalent and while testing trends should correlate, the actual force measurements will not be the same in tests conducted at different facilities. For that reason, rather than present the force measurements obtained, we chose to present the time savings calculated from those measured aerodynamic forces relative to the baseline- which, for the purposes of this test, was chosen as a Felt F1 road bicycle with an identical setup as outlined above. Remember, wind tunnel testing should be considered a tool for basic comparison of a given set-up or configuration, and not the end all determining factor of real world conditions.

The time savings are calculated using the average of aerodynamic drag measured at different yaw angles. Such approach is adequate, but in order to try and improve the correlation with the real world situation, we used a weighted average with an emphasis placed on more common angles of attack such as 10, 12.5 and 15 degrees. The weights were derived from our experience of aerodynamic testing in the wind tunnel and real world. To remove the suspicion of bias, below is the compilation of the actual aerodynamic force measured for all bicycles tested.



% Faster than F	Range	New AR	New AR w/Felt F Brake	Old AR	S-5	Foil	Venge	Propel
low yaw	+10° to -10°	24.7	25.6	12.0	22.6	12.4	16.2	16.7
high yaw	+12.5° to +20° and -12.5° to -20°	31.4	34.6	16.6	22.2	16.5	16.4	16.4
Total	+20° to -20°	28.7	31.1	14.7	22.4	14.9	16.3	16.5
time saved (m)	weighted +20° to -20°	2.10	2.28	1.03	1.56	1.07	1.17	1.14
power saved (w)	weighted +20° to -20°	36.91	40.06	18.39	27.71	19.09	20.84	20.28

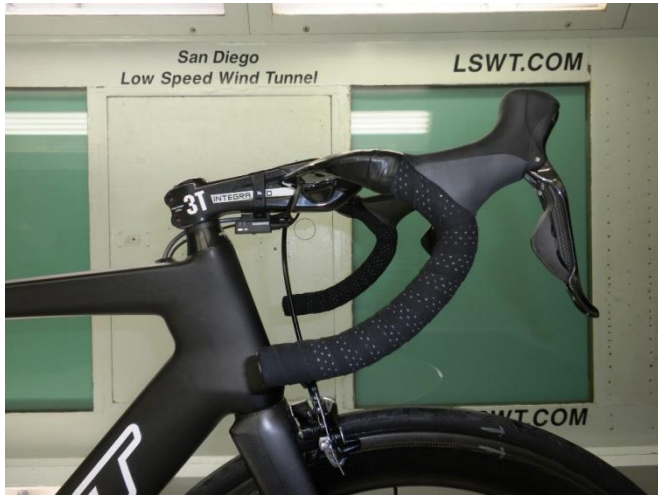


Below are Pictures of the Individual test set-up

2014 Felt AR



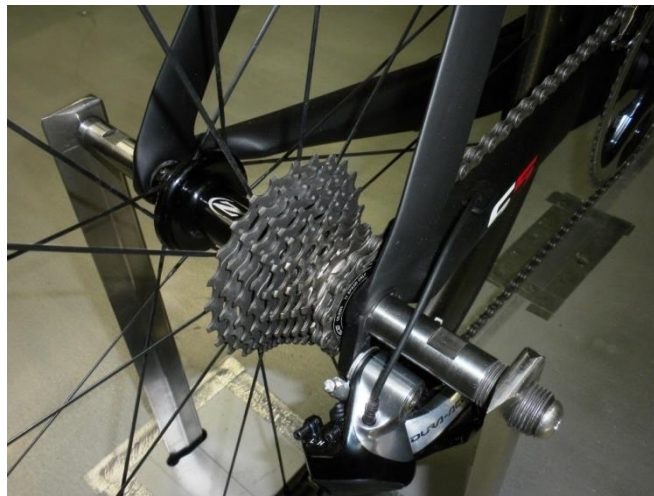








Cervelo S-5











Scott Foil







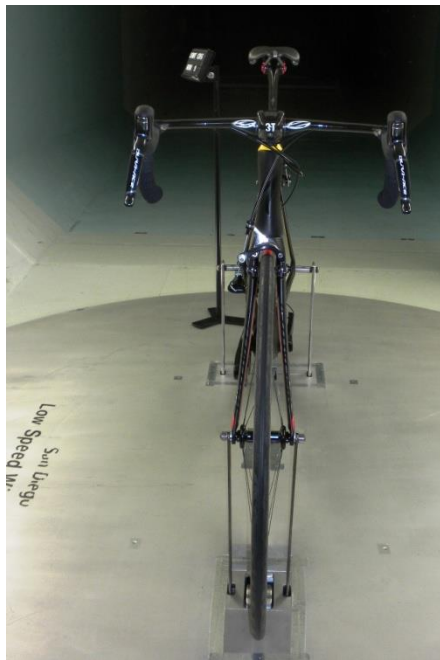




Specialized Venge











Giant Propel





