In GPS We Trust:

Runner threatens law suit over course measurement disagreement. (True Story)

Picture yourself running your best half marathon ever, at least according to your GPS you are. You can hear the crowds welcoming now, and you are dreaming of a personal best at just under 1 hour and 44 minutes. But your time comes and goes and still you are running towards the 13 mile mark. How could this be? Your GPS is state of the art and accurate to the nth degree. Your GPS just said you finished 13.1 miles. You paid almost $200 for this device, it has to be accurate! You grit your teeth and finish strong, but your personal best has long passed by. Where's the race director you ask? This course is SO LONG! ! ! I logged 13.3 miles on my GPS.

After a fashion, you lodge your complaint and go home, but later you think again. I paid my race fee it should be the correct distance, why should race directors get away with this. I am so sure my GPS is accurate! After getting an email message from the Race Director that the course is indeed sanctioned by the USATF and certified you are still not convinced. You blast the race director and threaten to sue for the race fee, you even call the race timer up and instruct him to correct your time to the ”real” time you ran for the 13.1 mile distance. (Real story)

Which is more accurate: A certified course that is wheel measured, or your GPS? Or in truth, how far do I really have to run before I can see the Beer tent?

Read and reach your own conclusion.

USATF Certified Courses €“ How accurate are they?

The short answer is very accurate to within 1/10 of one percent

Any race worth its salt has a USATF certified course. **USATF course measurement procedures** are designed to insure that the actual distance for a race is at least the advertised distance, meaning "not short"; by USATF standards, **it should be accurate to within one tenth of one percent when compared to a known accurate course**. Over the span of 5km (16,404 feet), that would be about 16 feet. USATF certified courses also have a one tenth of one percent correction factor added (ie. 1 meter added per 1,000 meters) to insure that they are not short. The correction factor that is added to a 5km is 16.4 feet (5 meters). (USATF Site on course measurement)

So all “Accurate”€ • courses are actually a tiny bit long??? YES!

Courses can be certified as accurate when they are measured according to stringent USATF measurement criteria. Once an accurate measurement is completed, and an application is submitted to the USATF Regional Certifier, a certificate of accuracy is issued. A certified course will be assigned a specific certification code to it like**NH10030RF for our Smuttynose Rockfest half marathon.** Using the procedures developed by the USATF Road Running Technical Council (RRTC), the course measurement is done using a special (Jones/Oerth) counter that is installed on a bicycle. *Note, the manual for measuring courses is 87 pages long!*

Who pays for courses to be measured and how is it done?

(Long ago, courses used to be measured with a car's odometer, maybe that's why all my old personal records are so fast?)

Race directors pay to have race course certified according to USATF standards. Using a calibrated bicycle, the official course certifier rides the exact course multiple times and carefully takes each corner and rides each tangent. Measurement requires at least 2 rides over the entire length of the course, often more.

To measure a road race course, you cannot use a standard bike or car odometer.Instead, a highly accurate device called a Jones-Oerth device is required. This is a mechanical counter that mounts on the front wheel of a bicycle and shows a series of digits in a row, just like a car odometer reading. Each digit it registers represents only a fraction of a bicycle wheel revolution, so we call this a "high resolution" measurement: it is very sensitive. One bike wheel revolution may increment the Jones-Oerth counter 3-4 counts per foot. Since the number of counts that the device registers varies according to the wheel diameter, the certifier will see how many counts it takes to ride a known accurate course (calibration course).

How does this device work? (This part will not be on the final, but may be in a quiz later)

For example, if the Jones-Oerth device registers 4,000 counts on a 400 meter calibration course, then we calculate that it must be registering 10 counts per meter that day (4,000 divided by 400 equals 10). Further calculating tells us that we would need to show at least 10 times 5000 (50,000) counts if we were to measure out the appropriate distance for a 5000 meter race. (5000 meters is the same as 5km.) Because there is always a margin of error when measuring, USATF requires that 1 meter per km (5 meters in this case) be added onto the course, or 50 more counts on the Jones-Oerth device. Therefore, when measuring from finish to start along the intended road race course, the Jones-Oerth device should register 50,050 counts on those days when we get 4,000 counts per 400 meter calibration course ride.

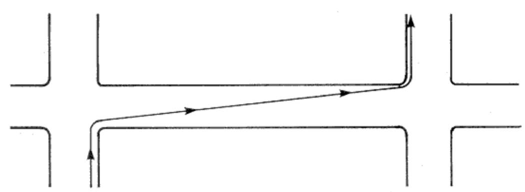
Why is this so accurate?

What makes the use of the Jones-Oerth device significantly different from a bike or car odometer or even GPS is that the Jones-Oerth device has to be calibrated every day that it is used or else it is not official and accurate. One issue with the Jones-Oerth device is that it usually register more counts on a cool day than it would on a hot day. On a hot day, the bicycle tires expand enough to increase the wheel diameter (and consequently the circumference, the distance of one wheel revolution). This causes the Jones-Oerth device to register fewer counts per 400 meters on those hot days. The amount of air pressure in the tires, a high pressure or low pressure weather system, direct sun, cloudiness, and road temperature will all affect the number of counts which the Jones-Oerth device registers that day on the calibration course. The weight of the rider and his or her equipment on the bike will also affect the number of counts which the Jones-Oerth device registers. The certifier must calibrate and check the device on a track or with a steel tape measure **before AND after the course** measurement to remove any chance of errors caused by changes in the atmosphere or tire pressure.

How is the measurement performed?

Measuring the course is a painstaking, labor intensive and sometimes dangerous process that can take hours. Normally, the certifier drives the course first with the race director to become familiar with the curves and sections of the course. After surviving that drive, two or more rides are done of the course using the calibrated bike and riding the tangents on the road. (Many thanks to our certifiers who risk life and limb to do this)

The first ride lays out the length, and the second ride verifies and checks the length. **The length measured for each ride must compare to less than 0.08 percent to be a valid measurement.**If they don't compare, additional rides must be done until a valid course length can be established.



Each ride must also follow the shortest possible path that an experienced runner would follow. This means staying within 1 foot of the edge at corners and curves and following tangents to take the shortest path between opposite (“S”€ •) curves.

Certainly, on some courses, restrictions are applied that determine the edges of the course. For example, runners are often limited to one side of a roadway and the measurement takes that into consideration. But, you're not done yet. After measuring the course, the bicycle must be calibrated again. This accounts for temperature changes, which affect the tire pressure and the accuracy

NO RESTRICTIONS —
RUNNERS MAY USE ENTIRE ROAD

RIGHT SIDE ONLY — RUNNERS
MAY NOT CROSS CENTER LINE.
-CONES AND MONITORS REQUIRED

of the measurement. If the count per foot is greater for this second calibration, then the course needs to be adjusted for the new count.

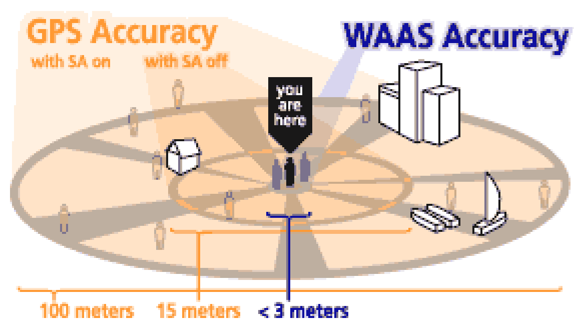
Conclusions:

A certified course provides an accurate course that runners can rely on to compare times and efforts against. Performed in a professional manner, course certifiers insure that you are running an accurate course from week to week and race to race. The objective of a course measurement is to provide the most accurate measurement of a course taking the shortest possible course using a procedure that can be repeated for accuracy and consistency to within a very small margin of error.

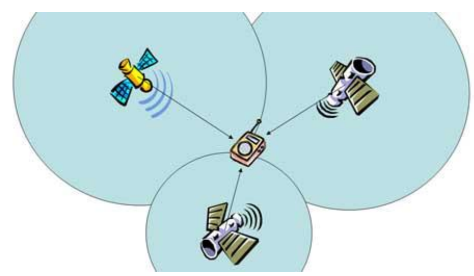
GPS Accuracy Fact, Fiction and Common Sense.

How does a GPS compare when measuring race courses.:

The short answer is: A GPS measurement is often not nearly as accurate as a wheel measured course. The normal wrist-held or recreational devices are accurate to anywhere from 3 meters to 10 meters 95% of the time causing them to often report longer distances on an accurate measured course. There are many other issues that prevent a GPS measurement to be as accurate.



There is a tremendous amount of information on the web related to GPS accuracy and very long descriptive accuracy statements made by different manufacturers. **One would think that with all the technology of satelites and computers and software algorythms that the GPS is far more accurate than the old fashioned bike measurement method. Think again.**



A little background: To determine an object's location, the GPS system must receive a radio signal from at least three satellites, preferably four.. Since each satellite emits a unique signal, the receiver can then match the signal to the satellite and its orbital position. This is called triangulation. Distance from the receiver is then calculated (for each satellite), and from that data, the receiver accurately calculates its geographic position.

What affects the accuracy of a GPS?

A comprehensive comparision of all commercially available GPS devices is beyond the scope of this article. However, many runners use a leading brand, Garmin and the stated current specification using the latest WAAS is 3-5 meters. However that is only for 95% of the time. the other 5% of the time your GPS may be off as much as 10 meters or more.

10 Meters off, that doesn't seem like a lot.

(Check again - Thats as much as 30 FEET PER READING)

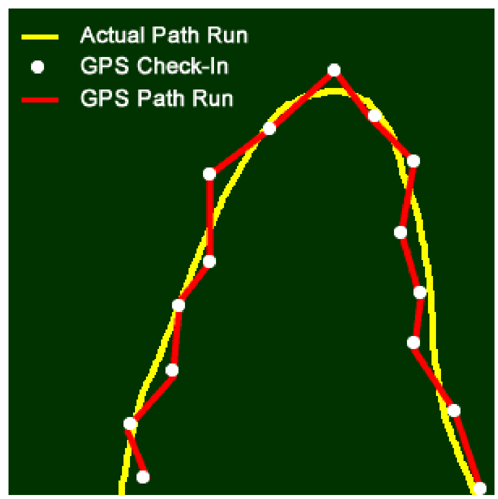
There is a general misunderstanding of what a GPS device is. People have a picture in their mind that it follows your path like a traditional wheel. The image being of a consistent and continuous line being drawn along the path that you run.

FICTION: Your GPS measures the same path you are running.

Not so. Instead your GPS records a series of reading that can be plotted on a chart. So instead of a constant line it is a reading every 1 to 20 seconds. These dots are to the left or right or you or front or back. See chart below. According to the MANUFACTURERS Spec... 95% of the time that dot is within 10 feet or 3 meters. (not that close really when you think about it.)

To better illustrate, let's just say your GPS is very special Border Collie that will run with you anytime, anywhere. Like any well trained dog they run right next to you, or within 10 feet 95% of the time, but 5% of the time, they see a squirrel and chase it just for a short time. Or they run through a large puddle up to 30 feet away. But like a good dog they start and finish right with you.

GPS - Connect the Dots if you can



The reality is that your GPS plots all those points of the Collie's path. This series of dots are connected make lines. To measure distance it simply plays connect-the-dots and adds up the total difference between those points.

The second (and bigger) problem is the accuracy of those dots. Garmin's web site itself states the following: "Garmin® GPS receivers are accurate to within 10 meters on average."

The image to the right shows what happens 95% of the time. So the result is that your GPS can read your path as weaving 10 meters in either direction, when you are actually moving in a straight line.

More Issues with Accuracy: Skip this part if you are already convinced!

GPS accuracy is affected by a number of factors, including satellite positions, noise in the radio signal, atmospheric conditions, and natural barriers to the signal. Noise can create an error between 1 to 10 meters and results from static or interference from something near the receiver or something on the same frequency. Objects such a mountains or buildings between the satellite and the receiver can also produce error, sometimes up to 30 meters. The most accurate determination of position occurs when the satellite and receiver have a clear view of each other and no other objects interfere.

Obviously, mountains and clouds cannot be controlled or moved, nor can interference and blockage from buildings always be prevented. These factors then, will affect GPS accuracy. To overcome or get around these factors, other technology, AGPS, DGPS, and WAAS, has been developed to aid in determining an accurate location. The net result can be best described by a study by Michael D. Londe PHD summary below.

"It could be conservatively stated that at best these types of receivers are accurate to 8m to10 m at 95% confidence. This set of tests has concentrated on Garmin recreational receivers. Tests that have been run on other brands of recreational receivers have yielded similar results." (1)

Runners just run....race and have fun.. stop checking your GPS every tenth of a mile! ! !

What other factors affect measurements using a GPS

Not only is the GPS not accurate enough for a true reading but runners on a course are not able to run the exact shortest distance due to a number of factors including:

1. Courses with lots of turns often create longer GPS readings. Runners in a race can try to run the tangent or the shortest possible line on a corner, but often other runners are in the way, or traffic prohibits them from doing this safely.

2. Water stops and other excursions from the course will make your GPS report a longer difference
3. Not starting the GPS at the start line, often the runner starts the GPS before the start in the corral
4. Inexperience with the course. If you are running a course for the very first time, you are not able to pick the best tangent or shortest line since you have limited knowledge of the course
5. Runners often choose to run on the softer side of the road, or on the cant of the road that feels best.
6. Runners almost never run in a straight line, they make hundreds of small adjustments in a race left and right. Try this test, run 10 miles hard on the roads, now go to a track and try to run following exactly on the white line for 3 miles. You will find yourself wandering ever so slightly.
7. Runners are more focused on “running the race” • and over time become tired and more focused on finishing. Professional certifiers ride smoothly along on a bike with little of no discomfort to distract them.

So, I just bought this $200 GPS and you are saying it’s not accurate??

Your GPS is a great tool for workouts, for figuring out approximately where you are in a race and for elevation and pacing charts. The object of this site is to contrast the two measuring means, a wheel measured certified course and a recreational GPS device.

"So, whereas the phenomenon of GPS technology has added some unique, valuable and fun aspects to running, and races**, they are not as accurate** at measuring a course as the standard wheel measuring method, especially when the course has lots of turns." Dave McGillivray (Ask the Race Director, BAA Boston Marathon RD)

Here's a standard of proof anyone can try.

Find a good track at a University. Set your GPS and go for a 5K run. Remember to run precisely next to the white line in the first lane. The actual measurement of 400 meter track That would be a boring 12 and a half laps. (Start at the 200 meter mark and run to the start line, now do 12 more laps)

You have just run the most accurate 5K course you can find. Now go to your computer and pull down the results. Check your results. Now plot your points on a chart. This is a 5K course with 25 corners, your chart will not show a perfect oval. It will show an oval with points going way inside the track and way up in the bleachers.

Common Sense

If it were just so easy to certify a course by running or biking on it using a GPS, race directors worldwide would be adopting this method. Alas, it is not that easy or accurate. Some certifiers in the UK are actually trying to do this. but so far no luck. Certified professions whose sole job is to measure and certify a course using stringent calculated methods developed over tens of years have a much better chance at getting extremely close to the actual race course distance required.

Math being my strong point, lets look at a final ingredient, That 1:44 marathoner ran for about 6,240 seconds. Over that period if his GPS samplied every 5 seconds that will provide 1,248 samples over a half marathon course. The certifier will record 211,290 points or clicks on the counter over the same course - or almost 200 times as many.

Courses measuring short: Note from our great course measurer Ron "I've used a GPS while measuring and found that tree cover will affect the distance measured. When running a path with several turns in a heavily wooded area, the GPS looses satelite information, and when out from under the trees, and satelite info is again available, the GPS assumes that you traveled a straight line from where satelites were lost and regained-- hence a shorter route."

(1) Baseline Accuracy Assessments of Garmin Recreational GPS Receivers
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