Ms. Particular Presents: Accurate vs. Precise

Celia M. Elliott
Department of Physics
University of Illinois

Careful writers make a distinction between “accurate” and “precise” when describing physical measurements.

"Accurate" refers to the extent to which a measurement correctly reflects the true size of what is being measured

"Precise" refers to the extent to which a measurement gives the same results, time after time

Suppose you excite a fluophore with a laser and measure the time between excitation and quench (the time the fluophore "turns on" and "turns off"). You get the following results: 42.7 ms, 42.6 ms, 42.8 ms, 42.6 ms, 42.7 ms, 42.7 ms, 42.5 ms, 42.8 ms, 42.6 ms, 42.9 ms. Your results are very "precise" (you get the same results time after time). But if your timing device is mis-calibrated by 12 ms, your results are not "accurate" (close to the true value of 54.7 ms).

Or suppose you want to measure the pH of your lawn to determine if you need to fertilize it. You lay out a 1-m grid and take soil samples at the intersection of each grid line. You know that the expected pH for suburban lawns in central Illinois is 6.7. When you get back to the lab and measure the pH of each sample, you get the following results: 6.8, 6.7, 6.8, 9.3, 6.6, 6.4, 9.7. 6.7, 6.5, 8.9, 6.7, 9.1. The first, second, third, fifth, sixth, eighth, ninth, and eleventh measurements are "accurate" (close to the expected value of 6.7) but your results (all twelve measurements) are not "precise." (Your dog has "fertilized" some spots in your lawn.)

Some scientists make further distinctions between "repeatability" and "reproducibility" of precise measurements.

"Repeatability" refers to obtaining precise measurements using the same instrument and the same operator over a relatively short time period.

"Reproducibility" refers to obtaining precise measurements using the same measurement process among different operators and different instruments over a longer time period.