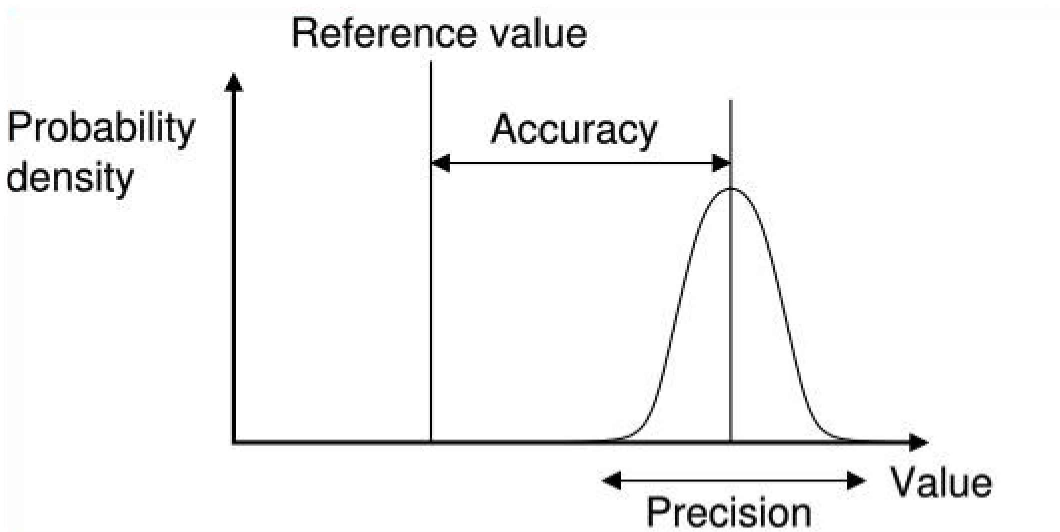
Part III

The meanings of precision and accuracy in respect to the measurement itself are to be found in the under lying mathematics. First, a single measurement isn't statistically significant, no experiment would base conclusions on a single data point which is, by definition an inexact value. What is needed is a series of measurements which can be analyzed using statistical methods. If we preform such a measurement experiment we'll have a cluster of data points around some mean value. This suggests a Normal distribution. Every Normal distribution has 2 defining quantities, the mean, and the deviation, we need only define accuracy and precision in terms of these quantities.

Accuracy refers to how well your measurement agrees with the actual quantity. Without a predetermined value to compare to, accuracy is a meaningless term. If your given a stick with an unknown length you can measure it to within a micron, but you cannot discuss the accuracy of the measurement. Nor, if you only made single measurement, can you discuss it's precision, as precision is related to the deviation and deviation is meaningless in relation to a single measurement.



The figure clearly shows the accuracy in relation to a reference value. Accuracy, in a lab for instance, is usually given as percentage error.

$$\delta = \frac{|v_{\text{approx}} - v|}{|v|} \times 100\%.$$

The precision is shown here as the spread of the data. In statistics this would be the deviation, but in science and engineering the uncertainty of a measurement is usually given by a tolerance, +/- 0.01, or by the number of significant figures. If no reference value is available, we can calculate the percentage difference between measurements, which is an indication of precision.

$$\%Diff = \frac{2 \times |x_1 - x_2|}{x_1 + x_2} \times 100$$