Measurement uncertainty:
What and Why

Science
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Measurement uncertainty

- What is it?
- Why is it important?
- When and in what form will it be required?
- How is measurement uncertainty quantified?
- What contributes to measurement uncertainty?

Measurement uncertainty

ISO definition

"A parameter, associated with the result of a measurement, that characterises the dispersion of the values that could reasonably be attributed to the measurand"

The part of the result after the ±

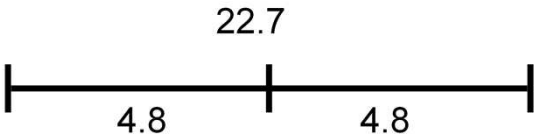
ISO/IEC Guide 98-3:2008 Uncertainty of measurement - Part 3: Guide to the expression of uncertainty in measurement (GUM:1995).

The 'GUM' is also available as a free download from www.bipm.org, reference JCGM 100:2008.

What information does it give?

22.7 ± 4.8 g

"The amount is between 17.9 and 27.5"



A RANGE containing the TRUE VALUE

In general, x±y is interpreted by the analyst as 'the true value is in here somewhere'. Uncertainty estimation, done well, permits that interpretation.

When will the customer be able to interpret in this way?

Error vs uncertainty

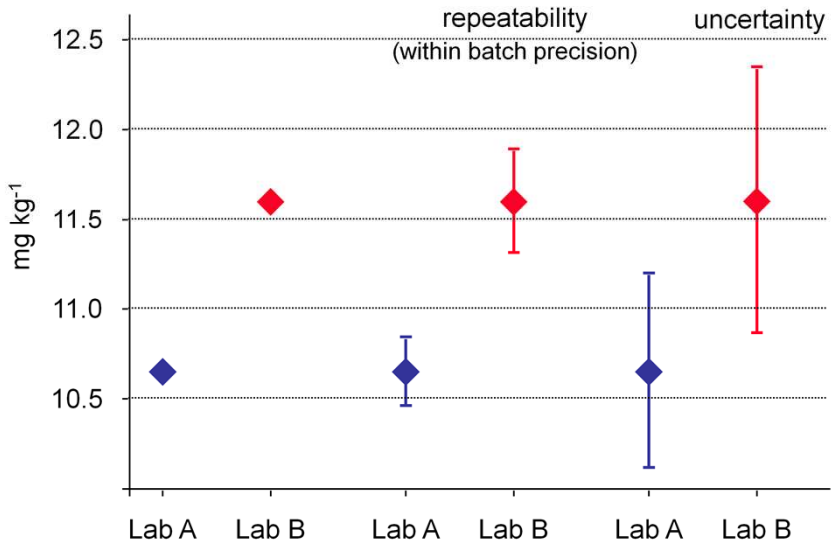
- ERROR is a DIFFERENCE
  - measured value - true value
- UNCERTAINTY is a RANGE
- ERROR - need to know a true value
- UNCERTAINTY - true value need not be known

Why is it important?

It enables you to:

- Assess the reliability of the result
- Assess the confidence that can be placed in any decision based on the result
  - e.g. compliance judgements
- Assess the ‘fitness for purpose’ of the result
- Compare measurement results

Comparison of results



Without any indication of the likely spread of results for each laboratory it is difficult to judge whether there is any real difference between them.

Using an estimate of repeatability (i.e. within batch precision) for each laboratory indicates that their results are different, as the error bars do not overlap. However, repeatability underestimates the likely spread of results as it does not cover the full variability of the method. Measurement uncertainty, when evaluated correctly, gives a more realistic estimate of the true spread of results. In this example, when the measurement uncertainty is taken into account, we can see that there is in fact no significant difference between the results.

Uncertainty evaluation allows the customer to make informed decisions as to whether sets of results are significantly different or whether limits have been breached.