WORKSHOP "STATISTICAL METHODS FOR SAFETY AND DECOMMISSIONING

A MEASUREMENT PROCESS IS NOT A DETERMINISTIC ALGORITHM!

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LNE: MEASUREMENTS AND STANDARDS

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Plan

- **Introduction: Video testimony**

- **Question**

- **A measurement process / measurement result**

- **Opening on the new definition of uncertainty at the JCGM**

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Introductory video

Témoignage
d'un industriel
devenu métrologue

Jean-Marc MOSCHETTA

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Is 12 different from 13 ?

❑ **The "mathematician" answers: YES**

❑ **What does the « Technician" say?**
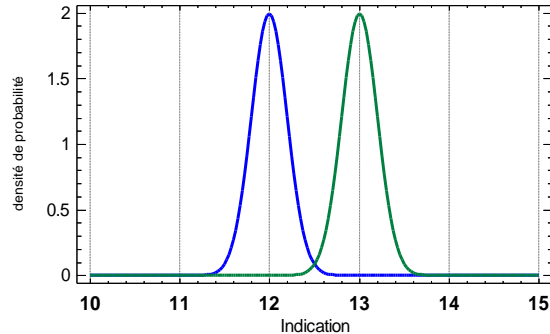
Mathematics →————————————————→ Experimentation

THE MEASURE

- units of measurement,
- measurement method,
- measurement errors,
- measurement accuracy, ...
- uncertainty of measurement

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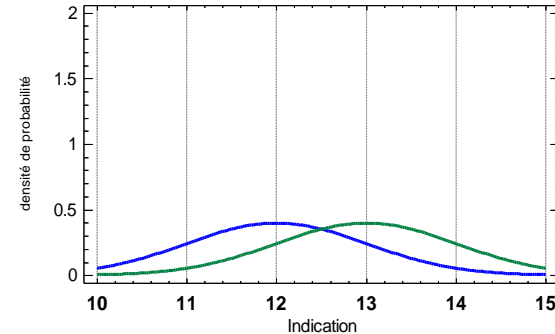
Is 12 different from 13?

Only the uncertainty makes it possible to compare 2 values

| If $u = 0.2 \Rightarrow 12.0 \neq 13.0$ |

| If $u = 1 \Rightarrow 12 = 13$ |

12 not signif. of 13

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Welcome to the land of uncertainty!

One must quantify one's knowledge or rather 'lack of knowledge' of a measured value in order to use it.

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Why assess measurement uncertainty?

➢ **Without uncertainty, measurement results cannot be compared with each other or with specifications.**

➢ **Some quantitative indication of the quality of the result is mandatory so that those who use it can assess its reliability (from introduction of GUM).**

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Is it enough to worry about dispersion?

GUM §2.2.3 measurement uncertainty
Parameter, associated with the result of a measurement, that characterises the dispersion of values that could reasonably be attributed to the measurand

NOTE 3 It is understood that the result of the measurement is the best estimate of the value of the measurand, and that all components of uncertainty , including those arising from systematic effects, such as those associated with corrections and reference standards, contribute to the dispersion

VIM 2.26 measurement uncertainty
Non-negative parameter characterising the dispersion of quantity values being attributed to a measurand, based on the information used

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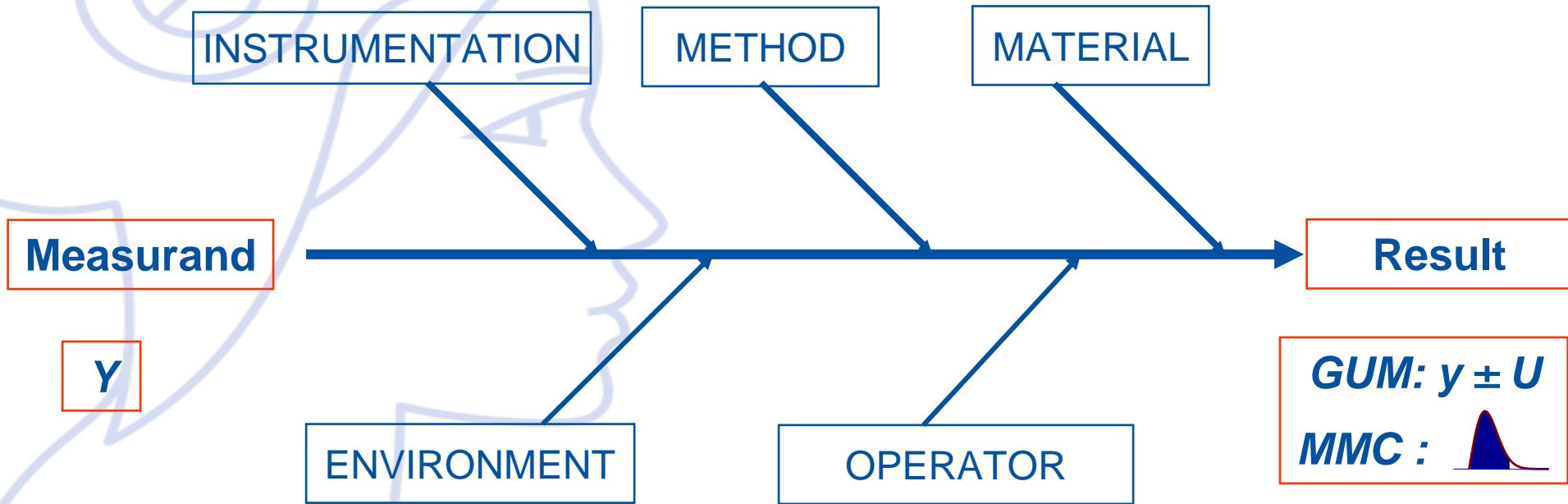21/11/22

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It is necessary to look <u>first</u> at errors

A measurement or a measurement process usually has imperfections that cause an error in the measurement result.

The errors come from :

- ► **instrumentation (standards, instruments, etc.)**
- ► **the method**
- ► **the environment**
- ► **the operator**
- ► **the object being measured**

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Analysis of the measurement process

INSTRUMENTATION

METHOD

MATERIAL

Measurand

Y

Result

ENVIRONMENT

OPERATOR

GUM: y ± U

MMC :

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The different types of errors

▶ **measurement error** (VIM § 2.16)

Measured quantity value minus and a reference quantity value.

différence entre la **valeur mesurée** d'une **grandeur** et une **valeur de référence**

▶ **systematic error** (VIM § 2.17)

Component of the measurement error that in replicate measurements remains constant or varies in a predictable manner

composante de l'erreur de mesure qui, dans des mesurages répétés, demeure constante ou varie de façon prévisible

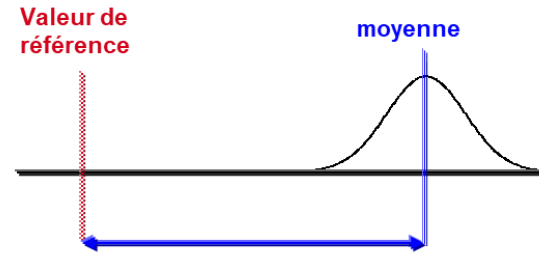▶ **random error** (VIM § 2.19)

Component of the measurement error that in replicate measurements varies in an unpredictable manner

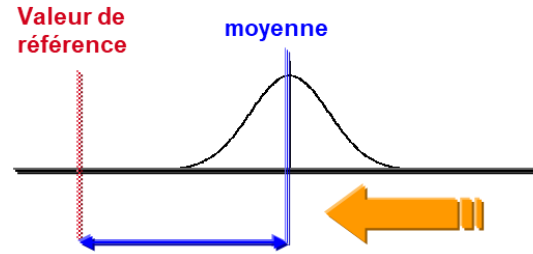composante de l'erreur de mesure qui, dans des mesurages répétés, varie de façon imprévisible

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Systematic errors

Trueness

Pour être juste, on cherche donc à réduire les erreurs systématiques en appliquant des corrections.
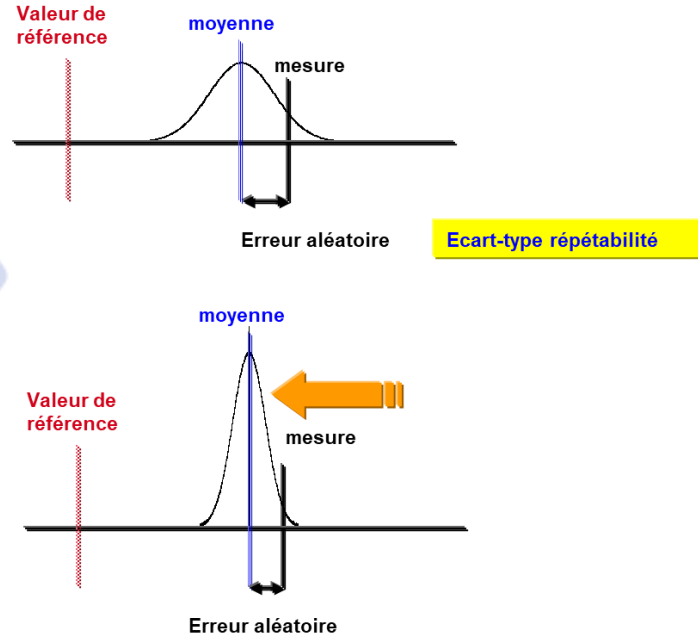
Valeur de référence — moyenne

Erreur systématique

biais

Valeur de référence — moyenne

Erreur systématique

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Random errors

Precision (in english)

Fidelité (en français)

Valeur de référence   moyenne   mesure

Erreur aléatoire   Ecart-type répétabilité

moyenne   mesure

Valeur de référence

Erreur aléatoire

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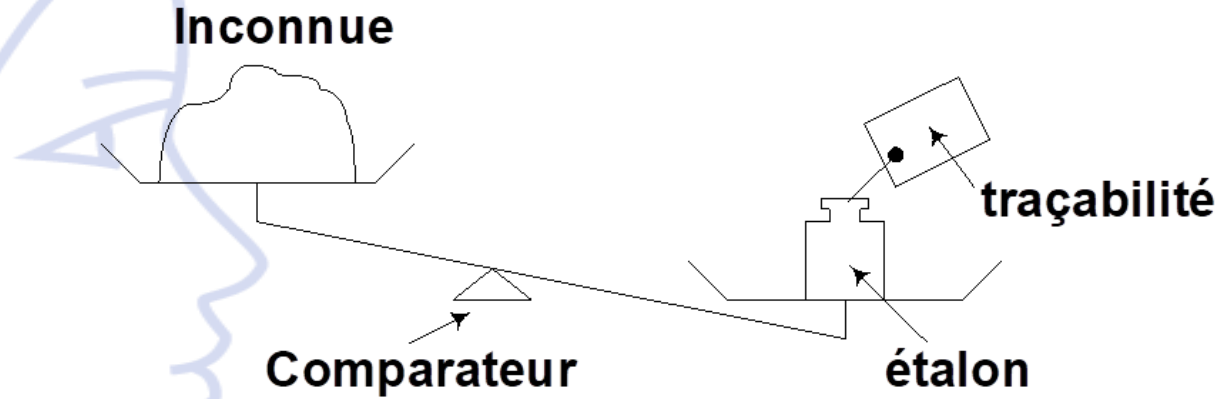
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How can we reduce errors?

Random errors are usually reduced by increasing the number of independent observations and taking the average of these values.
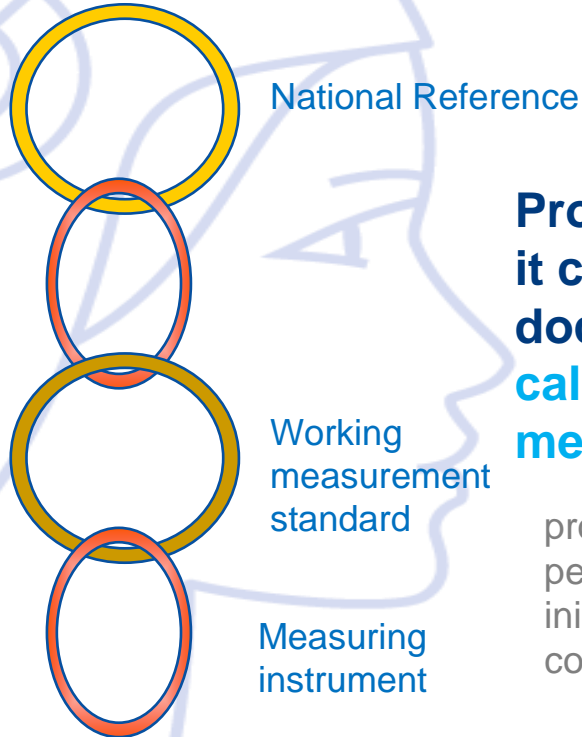
Systematic errors are reduced by applying corrections.

These two rules form the basis of the metrologist's approach, which seeks to give the best possible estimate of the measurand.

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Measuring is comparing!

Inconnue

Comparateur

étalon

traçabilité

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Metrological traceability (VIM § 2.41)

National Reference

Working
measurement
standard

Measuring
instrument

Property of a measurement result whereby it can be related to a reference through an documented unbroken chain of calibrations, each contributing to the measurement uncertainty

propriété d'un résultat de mesure selon laquelle ce résultat peut être relié à une référence par l'intermédiaire d'une chaîne ininterrompue et documentée d'étalonnages dont chacun contribue à l'incertitude de mesure

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Demonstration Metrological traceability

cofrac

Traçabilité des résultats de mesure –
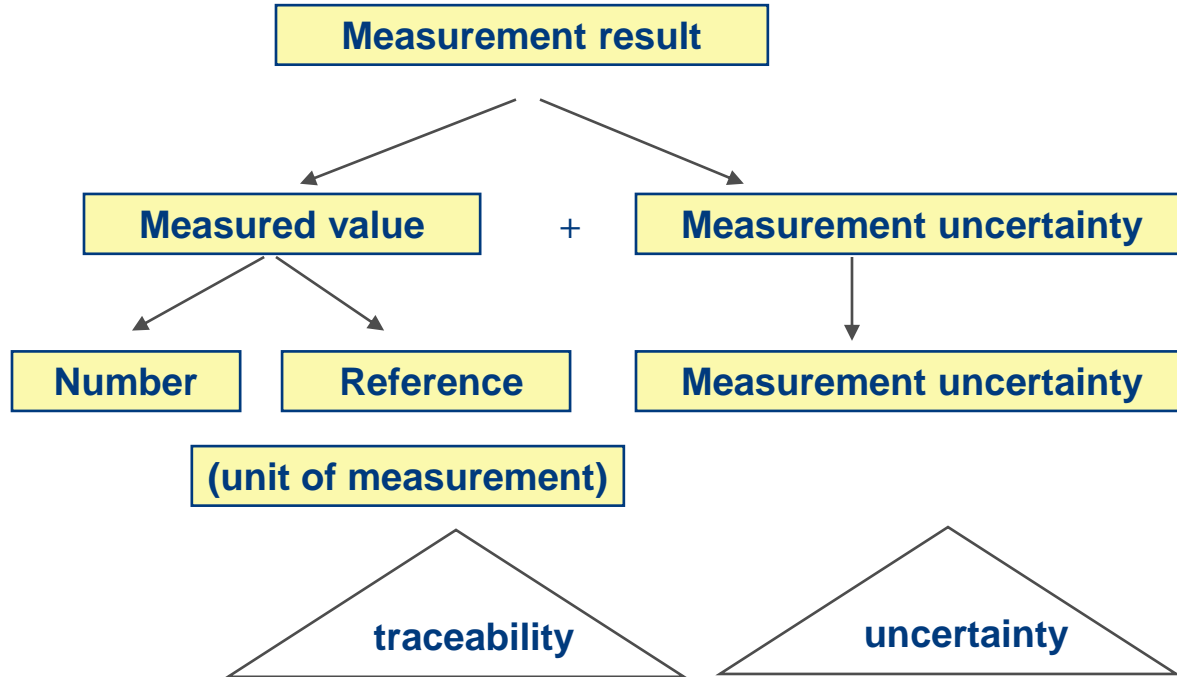Politique du Cofrac et modalités d'évaluation

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Composition of a measurement result

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In conclusion

A measurement result is the output of a measurement process:

- **The truesness of the measurement is not automatic: the validity of the results is important (comparison with standards, CRMs, participation in inter-laboratory comparisons...).**

- **The measurement uncertainty must include :**
  - ➤ **doubts that remain after corrections have been made**
  - ➤ **measurement precision from random errors**

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Opening: Towards a new definition of uncertainty

This information is from Walter Bich's conference in Mathmet 2 Nov. 2022
It presents the position of the JCGM-WG1

Measurement uncertainty :

doubt about the true value of the measurand that remains after making a measurement

MU is the concept, not a measure of the concept

The true value, for a long time demonised as an idealised concept,

The doubt is about the measurand (given its estimate), not about the estimate

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Thank you,
questions ?

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