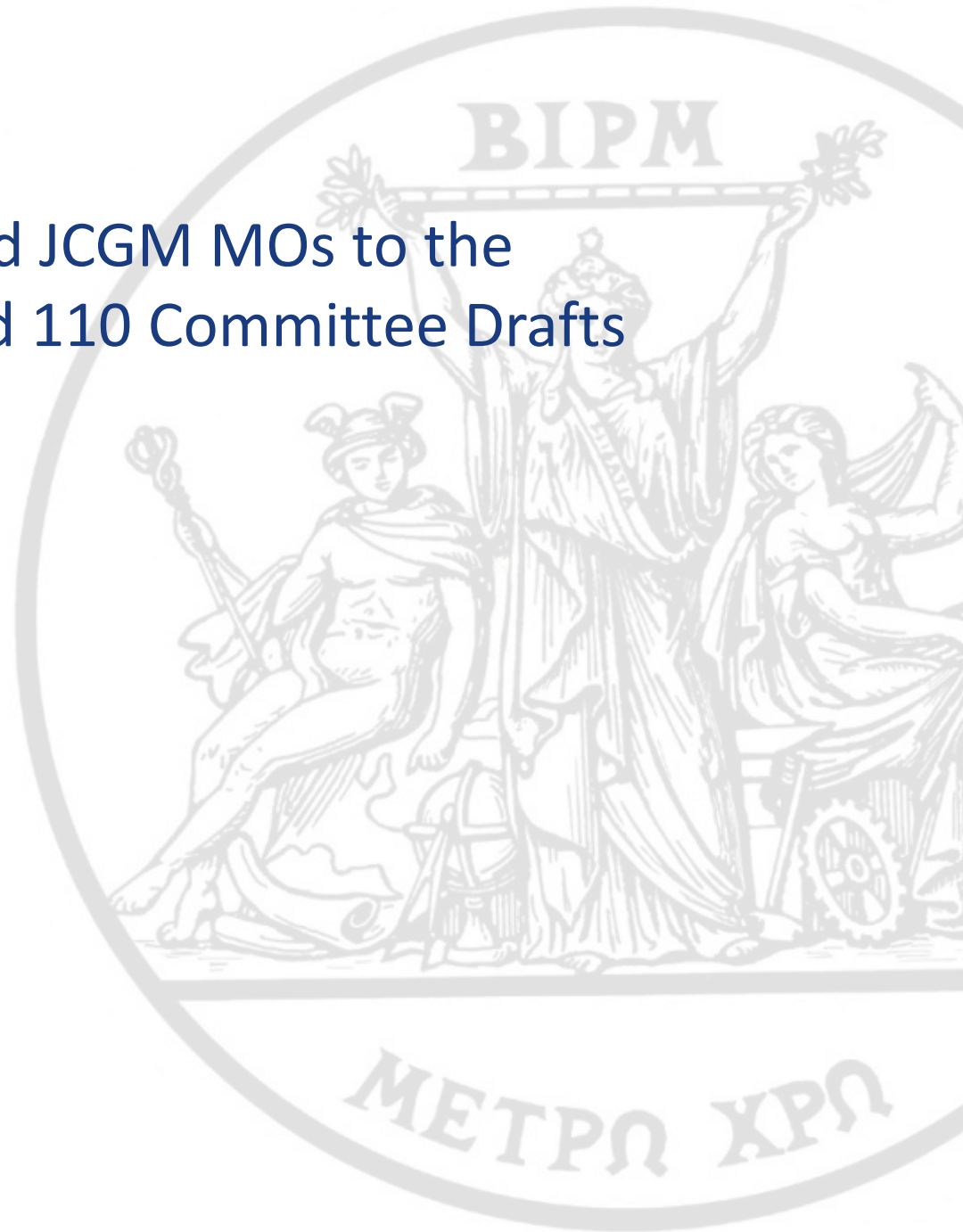


# Feedback from NMIs and JCGM MOs to the circulated JCGM 100 and 110 Committee Drafts

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# About the JCGM

## Joint Committee for Guides in Metrology:



WG1 has responsibility for maintaining the **Guide to the Expression of Uncertainty in Measurement (GUM)** and published complementary documents under the common banner “Evaluation of measurement data”.

WG2 has responsibility for maintaining the **International Vocabulary of Metrology (VIM)**.

# Introductory information (WG1)

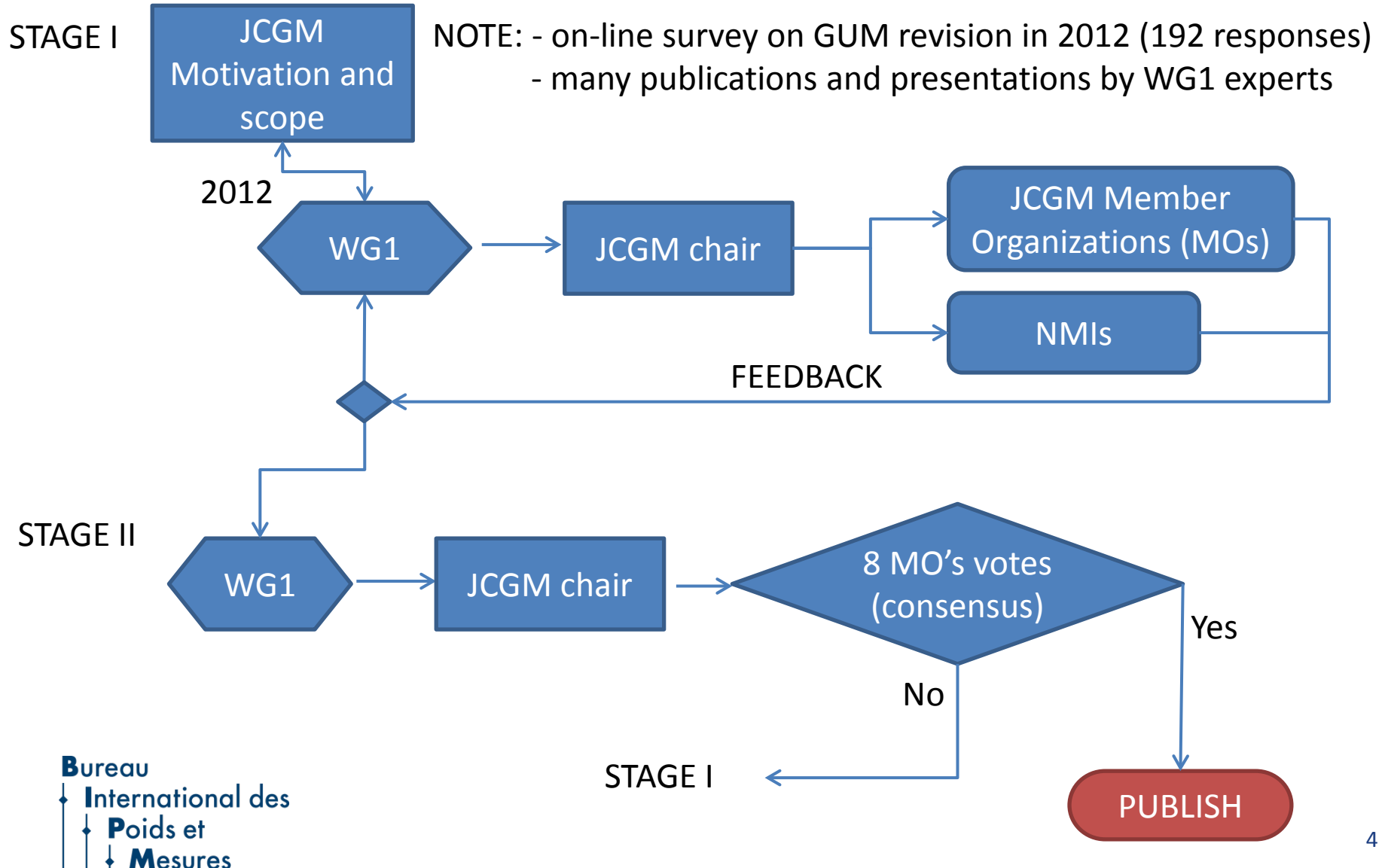
## ◆ JCGM-WG1 documents already published:

- An **introduction** to the GUM and related documents JCGM 104:2009
- **Supplement 1** to the GUM – Propagation of distributions using a Monte Carlo method JCGM 101:2008
- **Supplement 2** to the GUM – Extension to any number of output quantities JCGM 102:2011
- The role of measurement uncertainty in **conformity assessment** JCGM 106:2012

## ◆ Documents in preparation *or planned*: **GUM rev. + examples**

- **Supplement 3** to the GUM — Developing and using measurement **models** JCGM 103
- **Concepts, principles and methods** for the evaluation of measurement uncertainty JCGM 105
- *Applications of the least-squares method* JCGM 107
- *Bayesian methods* JCGM 108

# Circulation process of the committee drafts (CD)



# Comments received: summary

	6 MOs	25 NMIs
JCGM 100 (GUM rev.)	530	375
JCGM 110 (exples)	83	85

Total of 1073 comments + 17 letters

(note: several comments are duplicated!)

ISO/IEC ballots: « Do you agree to the circulation of the drafts as a DIS? »

	Yes	Yes+comments	No	Abstain	Result
ISO	9	1	2	3	✓
IEC / JCGM 100	6	4	3	1	✓
IEC / JCGM 110	6	4	2	2	✓

+ many comments directly from ISO TCs

# Some statistics on the comments received in the form of templates

JCGM 100

## JCGM 100

	No. of comments received		
Clause	MOs	NMIs	Tot
General comments	68	38	106
Title ( <i>Guide to unc. in meas.</i> )	1	5	6
Foreword	10	7	17
Introduction	17	22	39
Scope	13	10	23
Summary	38	25	63
Normative reference	1	3	4
Terms & definitions	40	18	58
Conventions and notation	15	11	26
Basic concepts	61	27	88
Modelling	30	18	48
Input quantities	105	93	198
Measurand	36	50	86
Coverage interval	50	33	83
Reporting	41	12	53
Glossary, Biblio., index	4	3	7

	No. of comments received		
	MOs	NMIs	Total
Editorial	63	62	125
Vocabulary - Notation	73	21	94
Technical (minor)	210	186	396
Technical (major)	101	104	205
Proposal for additional material	23	33	56



# Main criticisms of the JCGM 100 CD

## Strategic

Highlighted in red = comment received many times

Insufficient motivation for change/ Same scope as current GUM

Current GUM does not cause major practical problems, is widely accepted and so should remain available for use when appropriate

A revision is too soon since industry has only recently started using the current GUM

Cost-benefit ratio of GUM revision not acceptable: large cost (training; update of documents and software,...) for no evident benefit, especially for the end user

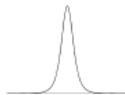


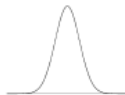

Backward compatibility and impacts on CMCs need to be addressed/  
Guidance is needed for the transition period

No compliance with several ISO standards / Deviations from VIM

# Main criticisms of the JCGM 100 CD    New approach (1/3)

- **Not fully Bayesian:** Bayesian approach (available/prior knowledge) is applied only for input quantities and not for the measurand;
- **High level change in some concepts:** the best estimate is taken as the expectation of a state-of-knowledge PDF;
- Many comments on Tables 2 and 3 (assign PDF for input quantities);



Available knowledge	PDF and illustration (not to scale)	$x$ and $u(x)$
$n$ indication values having average $\bar{\xi}$ and standard deviation $s$ drawn independently from Gaussian PDF with unknown expectation and variance	Scaled and shifted $t$ : $t_{n-1}(\bar{\xi}, s^2/n)$	 $x = \bar{\xi}$ , $u(x) = \left(\frac{n-1}{n-3}\right)^{1/2} \frac{s}{\sqrt{n}}$
$n$ counts having average $\bar{q}$ drawn independently from Poisson distribution with unknown expectation	Gamma: $G(n\bar{q} + 1/2, 1/n)$	 $x = \bar{q} + \frac{1}{2n}$ , $u(x) = \left(\frac{\bar{q}}{n} + \frac{1}{2n^2}\right)^{1/2}$
Lower and upper limits $a, b$	Rectangular: $R(a, b)$	 $x = \frac{a+b}{2}$ , $u(x) = \frac{b-a}{\sqrt{12}}$
Best estimate $x$ and standard uncertainty $u(x)$	Gaussian: $N(x, u^2(x))$	 $x$ , $u(x)$
Best estimate $x$ , expanded uncertainty $U_p$ , coverage factor $k_p$ and effective degrees of freedom $\nu_{\text{eff}} (> 2)$ obtained by applying JCGM 100:2008	Scaled and shifted $t$ : $t_{\nu_{\text{eff}}}(x, \sigma^2)$ , $\sigma^2 = \left(\frac{U_p}{k_p}\right)^2$	 $x$ , $u(x) = \left(\frac{\nu_{\text{eff}}}{\nu_{\text{eff}}-2}\right)^{1/2} \sigma$

...

# Main criticisms of the JCGM 100 CD    **New approach (1/3)**

- **Not fully Bayesian:** Bayesian approach (available/prior knowledge) is applied only for input quantities and not for the measurand;
- **High level change in some concepts:** the best estimate is taken as the expectation of a state-of-knowledge PDF;
- Many comments on Tables 2 and 3 (assign PDF for input quantities);

$u(x_i) = \left( \frac{n-1}{n-3} \right)^{1/2} \frac{s_i}{\sqrt{n}}$   $\sqrt{(n-1)/(n-3)}$  implies more measurements and larger  $u$   
=> what to do if limited test material and historical knowledge ( $\sigma_{\text{pooled}}$ ) of the instrument not relevant because e.g. the std deviation highly depends on the material measured?

- What to do if not Gaussian population?

# Main criticisms of the JCGM 100 CD    New approach (2/3)

- a) Gaussian PDF:  $k = 1.96$
- b) conservative intervals from Chebyshev inequality:  $k = 2.98$  or  $k = 4.47$   
depending on available knowledge
- c) GUM Supplement 1 (MCM)

=> no more harmonised method world wide, which is potentially dangerous

“The wide range of coverage factors discussed in clause 11 will provide ample opportunity to document whether a company is being “conservative” in its methodology or not – and is the feedstock for litigation.”

$k = 2$  has proven to be adequate in practice

Central Limit Theorem no more mentioned: is there something wrong with it?

“The results provided by Gauss and Chebyshev inequalities are too much conservative and would lead to too many changes in decision making, calibration certificates and conformity assessment. Such a choice to provide a coverage interval is then unrealistic for many users in different disciplines.”

# Main criticisms of the JCGM 100 CD New approach (3/3)

**11.3.2** Confirmation of the adequacy of linearization and that the PDF for  $Y$  can be regarded as Gaussian can be extremely difficult to obtain

“In practice, these approximations work well in the vast majority of cases.”

Confirming validity of linearization using GUM-S1 is too hard requirement and anyway would not confirm the validity of the PDFs; use higher-order terms in LPU as an easy alternative

Not applicable in chemistry labs (16) and in calibration, accreditation and testing labs (30)

Need of more explanations and short&easy examples to illustrate the new approach and its impact (when the results of the current and revised GUM are significantly different?)

Future supporting software would be a black box with all the inherent dangers/ Safety issues

ANOVA and regression analysis ( >< Too high level document! )

Definitional uncertainty, modelling uncertainty, target uncertainty and uncertainty budget  
(sensitivity analysis)

Guidance to objectively decide if a PDF is symmetric, single-peaked or gaussian

How to handle observed variation that is not explained by the measurement model  
(see Eurachem guide: dummy variable)

Nominal and ordinal scales (example of Rockwell Hardness C scale)

# Supporting views and suggestions (1/2)

Positive statements:

“The draft is more accessible than the current GUM”

“The draft includes several significant improvements over the current GUM”

“We welcome the improved consistency in evaluating standard uncertainty and the clear structure of the document”

“The clause *Other modelling approaches* is very positive”

...

- Publish the JCGM 100 CD as Supplement to current GUM
- Publish a 4-page summary separately
- Promote publication of easier applied documents (like EA-4/02, EURACHEM/CITAC...)
- Coordination with the present revision of ISO 17025

## Supporting views and suggestions (2/2)

### **Go further in the Bayesian approach :**

- full Bayesian treatment; add the derivation of formulae
- Tables 2 and 3: indicate the priors used to obtain the PDFs; add the chi-squared distribution/ Add guidance on elicitation of joint distribution
- Encourage the use of Bayesian methods for constrained quantities (e.g. concentration)
- Give more prominence to Monte-Carlo method; recommend its use in case of complicated model

Add guidance for discrete cases, cases of implicit models and cause-and-effect diagram

Add guidance on how to combine results obtained from several methods/ Include the analysis of international comparison results (and the use of statistical models) and the identification of outliers



# Some statistics on comments received in the form of templates

JCGM 110

## JCGM 110

	No. of comments received		
Clause	MOs	NMIs	Tot
General comments	14	8	22
Title	0	1	1
Foreword	2	0	2
Introduction	0	0	0
Scope	0	1	1
Normative reference	1	0	1
Conventions and notation	1	3	4
Gauge block	18	29	47
Resistance and reactance	2	9	11
Celsius temperature	19	17	36
Molecular weights	7	1	8
Gravimetric mixture	19	15	34
Bibliography	0	1	1

# JCGM 110 CD: Pros and Cons (1/3)

## Criticisms on examples

Too high level / Too simplistic / Not realistic (gauge block; thermometry) / Not suitable for practitioners

Gauge block:

- double counting of uncertainty contributions
- need more explanations on assignment of PDFs for input quantities
- what happens if less information on calibration certificate?

« Molecular weight »:

- conflict with IUPAC recommendation
- correlation issues to clarify
- overly complex, not useful to most practicing chemists

Gravimetric mixture: is the check of linearity missing?

Need to indicate for each example whether the MCM validation is mandatory

Rounding issues

Need review from the CIPM Consultative Committees

# JCGM 110 CD: Pros and Cons (2/3)

## Missing topics

Need more simple and illustrative examples (see Eurachem Guide)

Need more examples strictly following JCGM 100 recommendations (including reporting) and covering all domains of metrology

Need explanations on how to derive the model; on how to calculate regression coefficients

Comparison of GUM, MCM and Bayes approaches for examples of linear and non-linear models

# JCGM 110 CD: Pros and Cons (3/3)

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Positive statements:

“A separate document which ‘evolves’ independently from JCGM 100  
is a progressive improvement”

“The provision of examples is a good idea and will be of benefit”

# Conclusion

- Largely negative reactions
- Part of the criticisms would also apply to current GUM
- Part of criticisms would be solved by the planned JCGM documents (modelling; concepts; Bayesian approach; least squares)
- JCGM-WG1 will discuss the strategy to apply along the following lines
  - Simplify the draft
  - Demonstrate the advantage of the GUM revision with practical examples
  - Consider a possible transition period
  - ...
- Please remember: the GUM is a guide, not a « push-button » procedure

Thank you for your  
attention.



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