# WADA External Quality Assessment Scheme (EQAS) and its new statistical framework

Eurachem’s 10th Workshop on Proficiency Testing in Analytical Chemistry, Microbiology and Laboratory Medicine

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# WADA External Quality Assessment Scheme


WADA regularly distributes urine and blood test samples to Laboratories to continuously monitor their proficiency.

The **International Standard for Laboratories (ISL)** requires satisfactory EQAS performance in order to obtain and maintain WADA accreditation.

# WADA EQAS: Main Objectives

To evaluate laboratory proficiency

To improve test result uniformity between laboratories

To provide educational opportunities

# Regular WADA External Quality Assessment Schemes

## Blind EQAS


- Labs are aware that the samples are EQAS samples
- Samples delivered by WADA EQAS sample provider
- 3 rounds of 5 samples per year

## Double-Blind EQAS

- Samples are indistinguishable from routine athlete samples
- Samples delivered by Anti-Doping Organizations
- total of 5 samples per year

## Educational EQAS

- Samples are provided in a variety of forms
- For educational purposes or data gathering
- 2-3 samples per year

Samples involving threshold substances are typically obtained from excretion studies.
These are value-assigned, tested for batch homogeneity and storage/transportation stability.

# Other WADA External Quality Assessment Schemes

## EQAS for Athlete Biological Passport (ABP) blood samples

Conducted monthly in collaboration with the Quality Control Center Switzerland

## EQAS for Laboratory accreditation decisions

Pre-probationary Test • Final Accreditation Test

Lifting of suspensions or analytical testing restrictions

## EQAS for Major Events

Olympic Games • Paralympic Games

## EQAS for Laboratory on-site assessments

## EQAS for Laboratory Investigations

# Statistical evaluation of the quantitative results from **WADA EQAS** is going to change

# Why revise the current statistical evaluation approach?

❶ Currently, the calculations rely on empirical ‘robust’ statistical methods (ISO 13528:2015) instead of explicit statistical measurement models

$$s^* = 1{,}134\sqrt{\sum_{i=1}^{p}\left(x_i^* - x^*\right)^2 / (p-1)}$$

$$s^* = \frac{1}{0{,}798 \times p}\sum_{i=1}^{p}\left|x_i - med(x)\right|$$

$$r_p = \begin{cases} \frac{1}{p}\left[1{,}6019 + \frac{1}{p}\left(-2{,}128 - \frac{5{,}172}{p}\right)\right] & p \text{ odd} \\ \frac{1}{p}\left[3{,}6756 + \frac{1}{p}\left(1{,}965 + \frac{1}{p}\left(6{,}987 - \frac{77}{p}\right)\right)\right] & p \text{ even} \end{cases}$$

# Why revise the current statistical evaluation approach?

❷ Current evaluations do not always recognize the finer structure of the reported results

Carbon isotope ratio measurements (GC/C/IRMS) are reported with the associated measurement uncertainties, which are ignored

Steroid Profile and Threshold Substance measurements have proportional errors (most standard models assume constant errors)

The rounding of the specific gravity results that is imposed on the laboratories is not taken into account

# Why revise the current statistical evaluation approach?

❸ The decision making relies on the use of maximum allowed measurement uncertainty, not the reproducibility uncertainty

The EQAS 2023-1 Round provided a total of 1350 quantitative results with **zero cases of $|z| \geq 3.0$**, indicating the conservative nature of current data evaluation methods.

# Mixed Effects Measurement Model

INSTITUTE OF PHYSICS PUBLISHING METROLOGIA
Metrologia **41** (2004) 132–136 PII: S0026-1394(04)73994-8

**Combining information from interlaboratory evaluations using a random effects model**

**Raghu N Kacker**
National Institute of Standards and Technology, Gaithersburg, MD 20899-8910, USA
E-mail: raghu.kacker@nist.gov

Computational Statistics and Data Analysis 55 (2011) 1815–1827
Contents lists available at ScienceDirect
Computational Statistics and Data Analysis
journal homepage: www.elsevier.com/locate/csda
ELSEVIER

Laplace random effects models for interlaboratory studies

Andrew L. Rukhin *, Antonio Possolo
*Statistical Engineering Division, National Institute of Standards and Technology, Gaithersburg, MD 20899, USA*

**We employ linear mixed effects measurement model which provides a coherent statistical framework for all results of a given analyte**

**– across all Laboratories and all EQAS Samples**

# Mixed Effects Measurement Model Example

## Specific Gravity of Urine

Reported result by each laboratory (*lab*) for each sample (*s*)

Laboratory bias

Measurement error *

Rounding error

$$X_{lab,s} = \mu_s + L_{lab} + E_{lab,s} + R_{lab,s}$$

Sample-specific consensus value

* Estimated by combining the results from multiple samples

Laplace distribution

Gaussian distribution

Uniform distribution

# Bayesian Framework for Interlaboratory Comparisons

IOP Publishing | Bureau International des Poids et Mesures Metrologia
Metrologia 54 (2017) S34–S62 https://doi.org/10.1088/1681-7575/aa6c0e

**Consensus building for interlaboratory studies, key comparisons, and meta-analysis**

Amanda Koepke[1], Thomas Lafarge[2], Antonio Possolo[2] and Blaza Toman[2]

[1] National Institute of Standards and Technology, US Department of Commerce, Boulder, CO, United States of America
[2] National Institute of Standards and Technology, US Department of Commerce, Gaithersburg, MD, United States of America

Accred Qual Assur (2017) 22:1–19
DOI 10.1007/s00769-017-1247-y

GENERAL PAPER

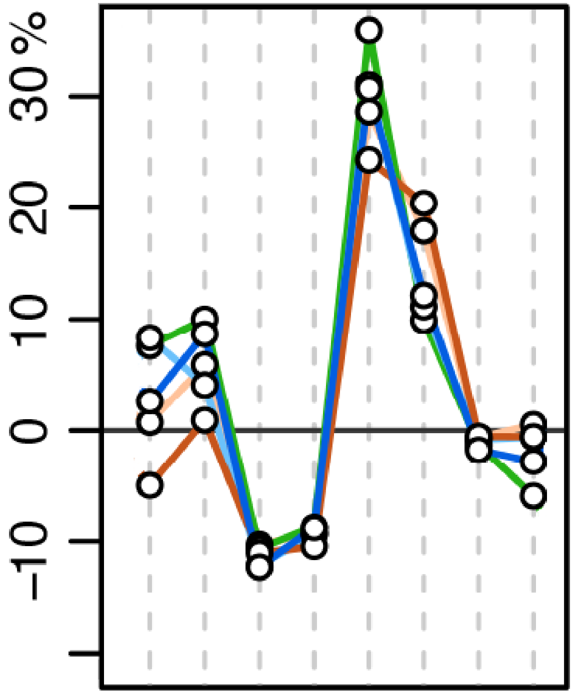
**Bayesian framework for proficiency tests using auxiliary information on laboratories**

Séverine Demeyer[1] · Nicolas Fischer[1]

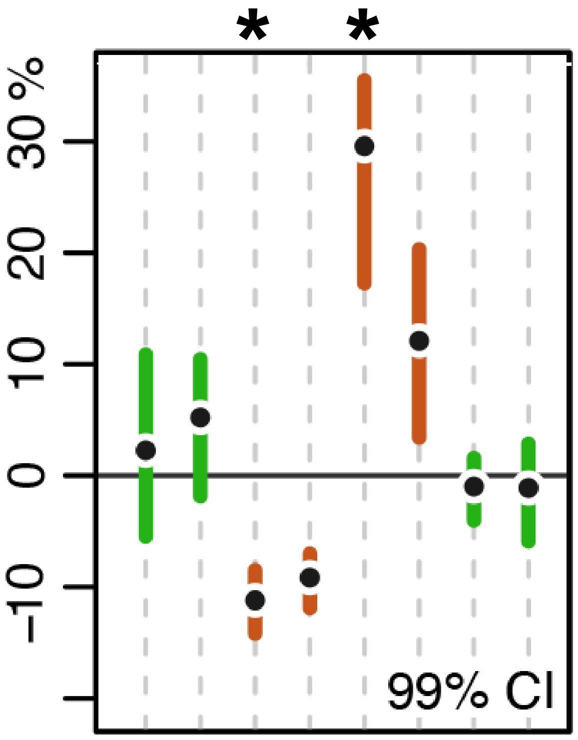
1. provides flexible, model-based approach to data reduction
2. allows to incorporate the expected measurement uncertainties ($u_c < u_{c\_Max}$)
3. provides uncertainty distributions for all model parameters
4. naturally recognizes correlations between model parameters, for example, when evaluating the Laboratory bias

# Example Analysis: Steroids in Urine

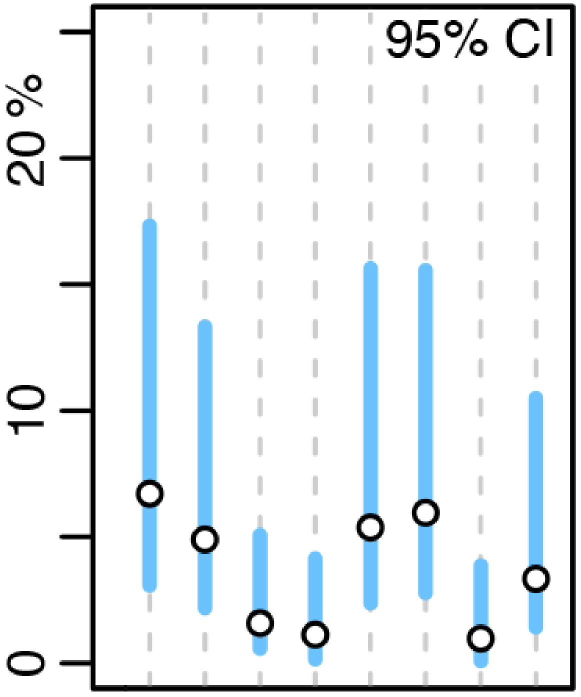
**EQAS 2023-1**
**5β-androstanediol**




**RESULTS FROM FIVE SAMPLES**
(median centered)




**LABORATORY BIASES**
(4 Labs show significant bias)




**MEASUREMENT ERRORS**

Results of 8 out of 30 Labs are shown here

* Only 2 of these Labs are flagged by the conventional Rank Sum analysis

Conventional analysis does not provide MU evaluation

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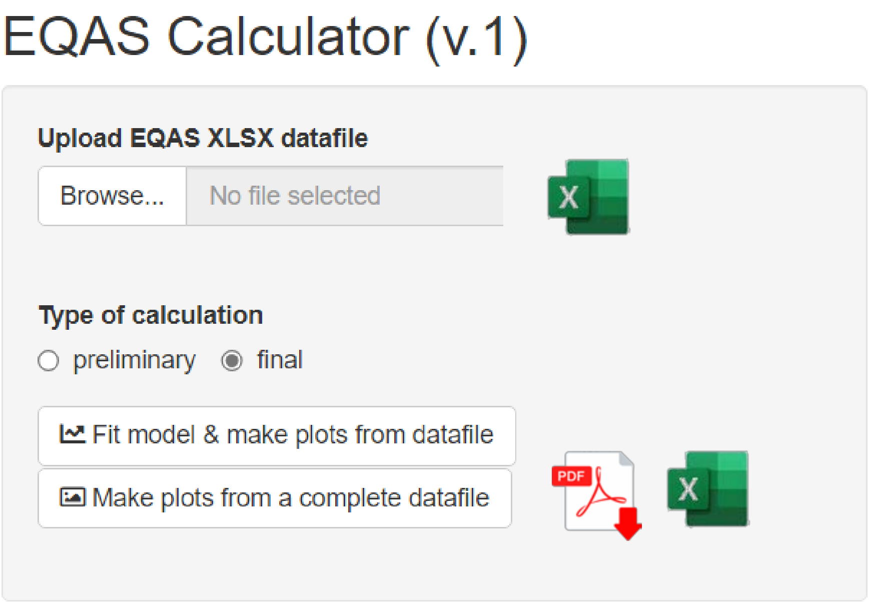
# Custom Software for EQAS Data Reduction

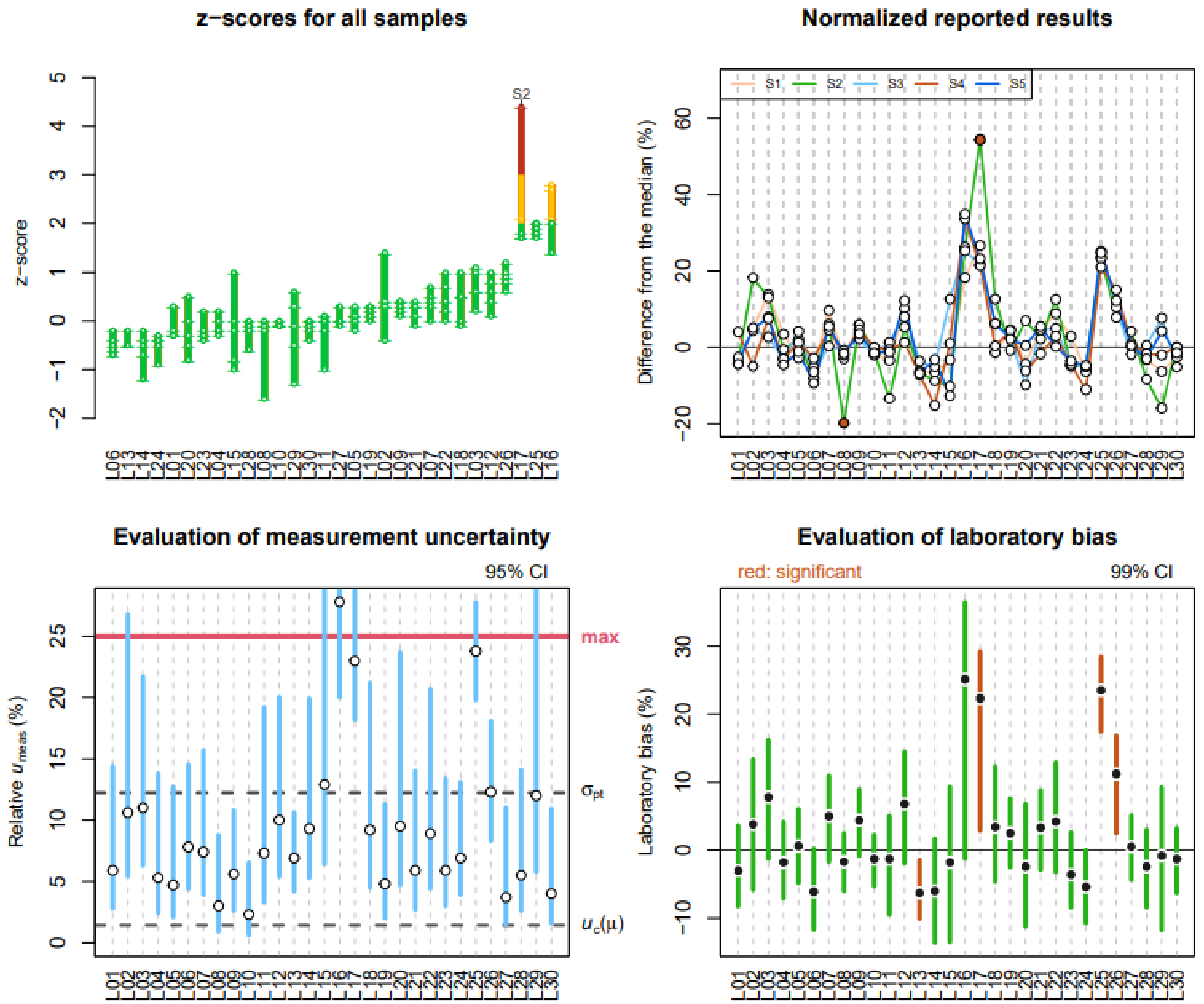



WADA EQAS Calculator (2023), v.1

wada ama

Canada
NRC·CNRC

1. $z$-scores are calculated using model-based predictive standard deviations of the results
2. PDF and XLSX reports are generated programatically



# Outlook

**The use of modern statistical methods and tools provides**

**more information from the same data**
**more advanced statistical modelling**
**more realistic uncertainty evaluations**

play true

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