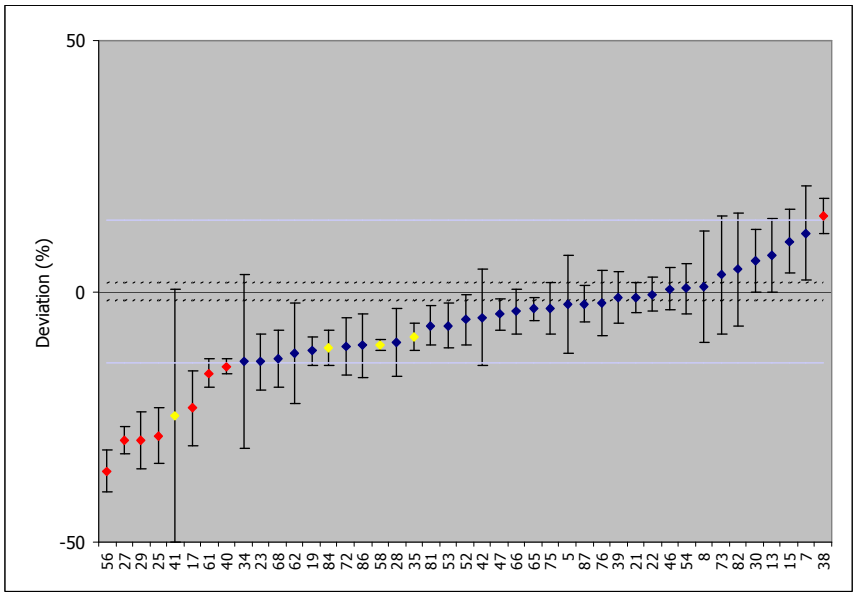
Data treatment



Arvic Harms
National Physical Laboratory
20 January 2010

NPL
National Physical Laboratory

Data evaluation (I)

(i) zeta test (past NPL)

pass if |zeta| ≤ 2.576 (99%)

$$\zeta = \frac{L - N}{\sqrt{u_{\mathrm{L}}^2 + u_{\mathrm{N}}^2}}$$

(ii) R_{L} outlier test

pass if not an outlier (IQR test)

$$R_{\mathrm{L}} = \frac{u_{\mathrm{L}}}{L}$$

(iii) z-test (ISO 13528)

pass if |z-test| ≤ 2.576 (99%)

$$z = \frac{L - N}{R_{\mathrm{med}} N}$$

Data evaluation deviates from ISO 13528:2005 standard (NPL evaluation of measurement uncertainties)

NPL National Physical Laboratory

Data evaluation (II)

Zeta test	**R_L test**	**z-test**	
pass	pass	pass	'In agreement'
pass	fail	pass	'Questionable'
fail	-	pass	'Questionable'
pass	-	fail	'Questionable'
fail	-	fail	'Discrepant'

Deviation (%) from the assigned NPL values:

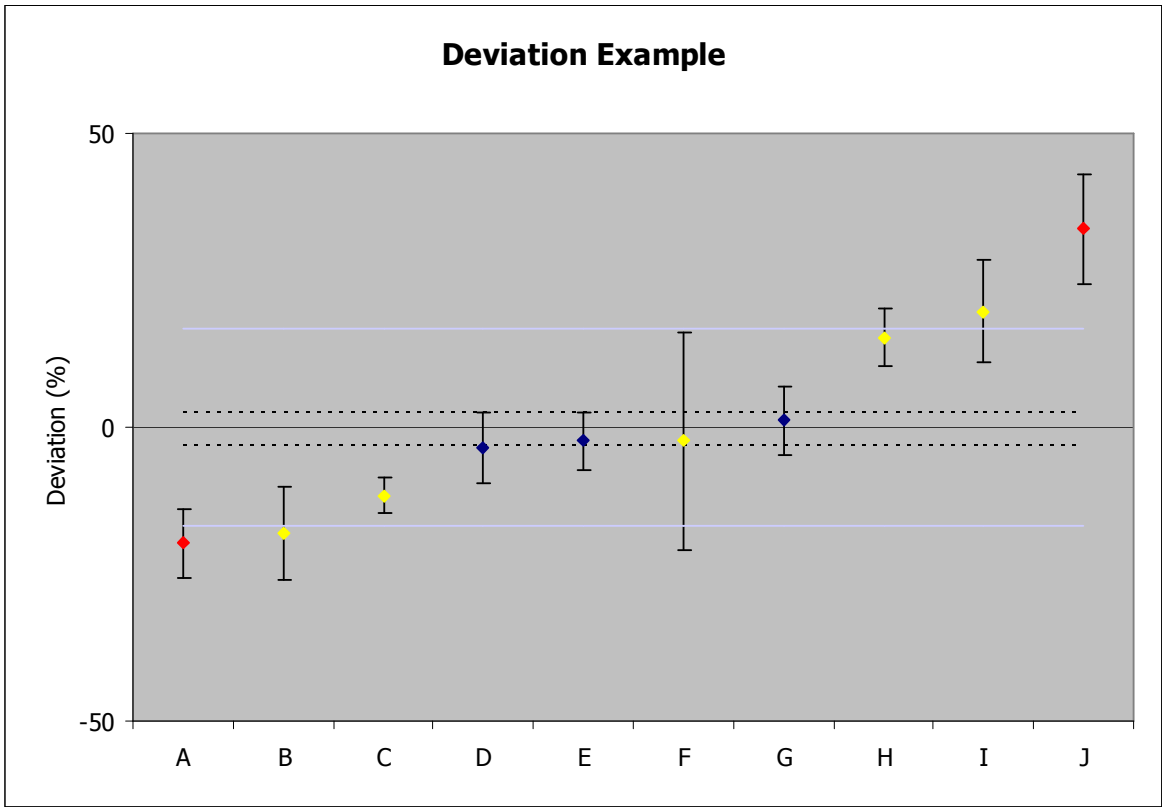
$$D = 100\frac{L-N}{N} = 100\left(\frac{L}{N} - 1\right)$$

NPL
National Physical Laboratory

Example data evaluation (deviation plot)

Results A and J 'Discrepant' D, E and G 'In agreement'

'Questionable': B and I (z test failure); C and H (zeta test failure); F (uncertainty outlier)

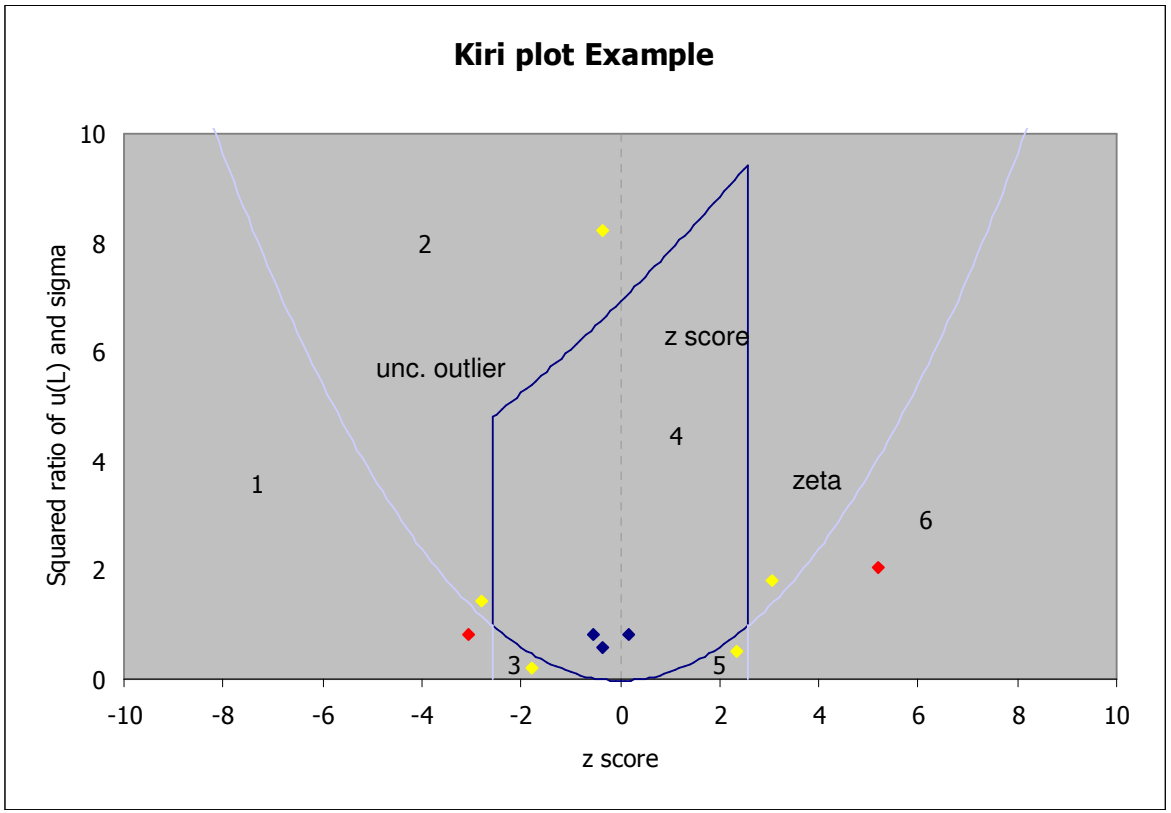


National Physical Laboratory

Kiri plot example

Visualisation of example data A – J

Defines the “in agreement” area, “questionable” areas and “discrepant” areas



National Physical Laboratory

Accred Qual Assur (2009) 14:253–261
DOI 10.1007/s00769-009-0511-1

GENERAL PAPER

A new approach for proficiency test exercise data evaluation

A. V. Harms

Received: 6 January 2009 / Accepted: 12 March 2009 / Published online: 3 April 2009

Abstract In this paper, a new data evaluation method for proficiency test exercises consisting of a combination of a z-test, a zeta test and an uncertainty outlier test is presented. This new method is compared with eight other evaluation methods (both measurement uncertainty using and measurement uncertainty ignoring) in common use and/or recommended by ISO 13528. The data set used to test the evaluation methods is real data and consists of the ^{95}Nb results of the National Physical Laboratory Environmental Radioactivity Proficiency Test Exercise 2007. The evaluation of 14 out of 32 results were affected by the choice of method.

Keywords Proficiency test exercise · Data evaluation · Uncertainty · z-test · Zeta test

Introduction

Since the late 1980s, the National Physical Laboratory (NPL) has organised 13 environmental radioactivity proficiency test exercises for a range of radionuclides. From the first exercise, participants were required to submit uncertainty values with their results. Initially, the received data was evaluated with only a zeta test, but for the 2005 and 2007 exercises a new data evaluation method was developed which combined a zeta and a z-score, while rejecting unrealistically high relative measurement uncertainty values with an outlier test [1]. In this paper, this new data evaluation method is presented and compared with eight other evaluation methods in common use and/or recommended by ISO 13528 [2] and the IUPAC Harmonized Protocol [3]. The majority of the methods consists of a variety of z-tests [4, 5], which, although endorsed by ISO 13528, ignore the uncertainty of the participants' results. This is unfortunate, because participants accredited to ISO 17025 [6] are required to provide uncertainty data with their results [7, 8]. The remainder of the methods make use of the measurement uncertainty and include the zeta test [2, 3] (which is equivalent to the E_n number test), a hybrid z/E_n number test [9], and a method in use by the IAEA which uses the zeta test, the relative uncertainties of the assigned value and the zparticipant's value and the deviation [10, 11].

The data set used to present the new NPL method and to test the various other methods is real data and originates from the ^{95}Nb results for the GH sample of the NPL Environmental Radioactivity Proficiency Test Exercise 2007 [1]. The GH samples (which was one of the eight sample types) contained ten gamma-emitting radionuclides in the range 1–20 Bq g^{-1}. The assigned specific activity values of these ten radionuclides were traceable to national standards of radioactivity.

The ^{95}Nb results were much more problematic compared to the other gamma-emitting nuclides (including ^{133}Ba, ^{134}Cs and ^{152}Eu) present in the GH samples, which made this data set a particular good candidate to present the NPL method and illustrate the differences with other data evaluation methods. The data set contained 32 results, which qualified it as a 'large scheme' according to Belli et al. [12], with a relatively large range of biases and measurement uncertainty values. The calculation of ^{95}Nb specific activity was not straightforward. Apart from the usual corrections for efficiency and gamma-ray abundance, a decay correction specific for ^{95}Nb, dealing with ingrowth/decay during measurement combined with a decay correction to the reference

A. V. Harms (✉)
National Physical Laboratory, Hampton Road,
Teddington TW11 0LW, UK
e-mail: arvic.harms@npl.co.uk

Accred Qual Assur (2009) 14:307–311
DOI 10.1007/s00769-009-0512-0

GENERAL PAPER

Visualisation of proficiency test exercise results in Kiri plots

A. V. Harms

Received: 6 January 2009 / Accepted: 12 March 2009 / Published online: 31 March 2009

Abstract A novel graphical method ('Kiri plots') for the presentation of proficiency test exercise results is presented. The Kiri plot visualises the evaluation of the proficiency test results based on three statistical tests (the z score, the zeta score and the relative uncertainty outlier test) by defining six zones including a central "in agreement" zone.

Keywords Proficiency test exercise · Uncertainty · Data evaluation

Introduction

A recent paper by Spasova et al. [1] in this journal presented a novel graphical method ('PomPlots') for presentation of proficiency test exercise results. The PomPlot was originally developed for the visualisation of intercomparison results applied to the BIPM key comparison database KCDB [2]. NPL has developed a similar visualisation for proficiency test exercise results—the Kiri plot—and has used it for the presentation of recent Environmental Radioactivity Proficiency Test Exercise results [3, 4] and for the results of a recent waste-drum proficiency test exercise [5]. The development of the Kiri plot was inspired by the Naji plot [6], which is likely to have been the inspiration behind PomPlots as well. This paper describes the rationale behind the Kiri plot and compares its properties with that of a Naji plot and a PomPlot.

A. V. Harms (✉)
National Physical Laboratory, Hampton Road,
Teddington TW11 0LW, UK
e-mail: arvic.harms@npl.co.uk

Since the late 1980s, the National Physical Laboratory (NPL) has organised 13 environmental radioactivity proficiency test exercises for a range of radionuclides. In the early exercises, the participants almost exclusively originated from the UK nuclear measurement community, while in the later exercises more non-UK laboratories took part. In the most recent 2007 proficiency test exercise, which offered eight different sample types (both aqueous and solid samples) containing 28 radionuclides in total, 33 of the 65 participants represented non-UK laboratories, originating from 22 different countries [4]. In all exercises participants were required to submit uncertainty values with their results. Initially, the data evaluation consisted of only a zeta test, but this was changed in 2005 into a data evaluation consisting of three tests (the z score, the zeta score and the relative uncertainty outlier test) and a visualisation of the results with Kiri plots [3].

Data evaluation

The results in the NPL Environmental Radioactivity Proficiency Test Exercise are evaluated by three tests [3, 4]:

$$\zeta = \frac{L - N}{\sqrt{u_L^2 + u_N^2}} \tag{1}$$

$$R_L = \frac{u_L}{L} \tag{2}$$

$$z = \frac{L - N}{\sigma_P} = \frac{L - N}{R_{med} N} \tag{3}$$

where L, laboratory value; N, assigned value; u_L, standard uncertainty of the laboratory value; u_N, standard uncertainty of the assigned value; ζ, zeta score; R_L, relative uncertainty of the laboratory value; z, z score; σ_P, standard

Thank you

NPL
National Physical Laboratory