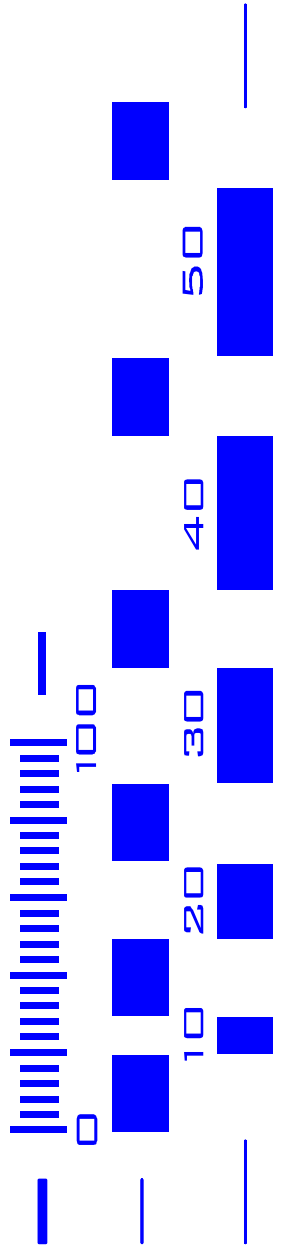
NPL Environmental Comparison Exercise 2002

Uncertainties

Mike Woods (IRMC)

May 2003



Uncertainties

The uncertainty of a measurement result expresses the reliability of that result or the confidence that we have in it

A measurement is incomplete without a statement of the corresponding measurement uncertainty

Accepted Guidance

- **GUM**

  Guide to the Expression of Uncertainty in Measurement
  ISO 1993

- **M3003**

  The Expression of Uncertainty and Confidence in Measurement
  UKAS 1997

- **MGPG 11**

  A Beginner's Guide to Uncertainty of Measurement
  NPL 2001

Rules

identify (all) sources of uncertainty

↳ quantify each (at 68% c.l.)

↳ determine effect of each on final result (at 68% c.l.)

↳ add all effects in quadrature

⇓

combined standard uncertainty (u_c)

report expanded uncertainty, $U = k \times u_c$

k = 1 (≈ 68 % c.l.) or k = 2 (≈ 95 % c.l.)

Sources of uncertainty (gamma spec)

Sampling

Background

- Counts
- Interpolation under peaks
- Reagent/Matrix blanks
- Temporal variations
- X-ray fluorescence
- Abnormal variations

Operating/Operator effects

- Editing efficiency curve
- Interpretation

Software

- Deconvolution
- Peak fitting (511, X-rays)
- Background subtraction
- Integration v. peak fitting
- Peak identification
- Nuclear data/library

Hardware

- Power supply frequency
- Cooling method
- Signal interference
- Electronic drift

Sources of uncertainty (gamma spec)

Calibration

- Uncertainty in standard
- Curve fitting
- Peak fitting
- Container
- Chemistry
- Density
- Volatility
- Random summing
- Deadtime
- Matrix effects
- Homogeneity
- Environmental Conditions
- Linearity with activity
- Linearity with energy

Assay measurement

- Sample preparation
- Sample matrix (back scatter)
- Chemical composition
- Density
- Cascade summing
- Deadtime
- Geometry
- Environmental conditions
- Homogeneity
- Positioning
- Decay data
- Peak fitting
- Escape peaks
- Random summing
- Container

^{3}H

	Participant A	Participant B
Tritium activity concentration @ 1200 GMT 01/10/02 (Bq/g)	16.753	22.9
Overall uncertainty (Bq/g)	0.282	3.86
Uncertainty due to:		
Sample count	0.007 (includes *)	11.0%
Background count	*	incl in sample count uncert
Standard count	NA	incl in chemical yield uncert
Detector efficiency	*	1.4%
Chemical yield	NA	12.70%
Decay	*	incl in sample count uncert
Quadrature sum	*0.007*	*16.6% = 3.80*

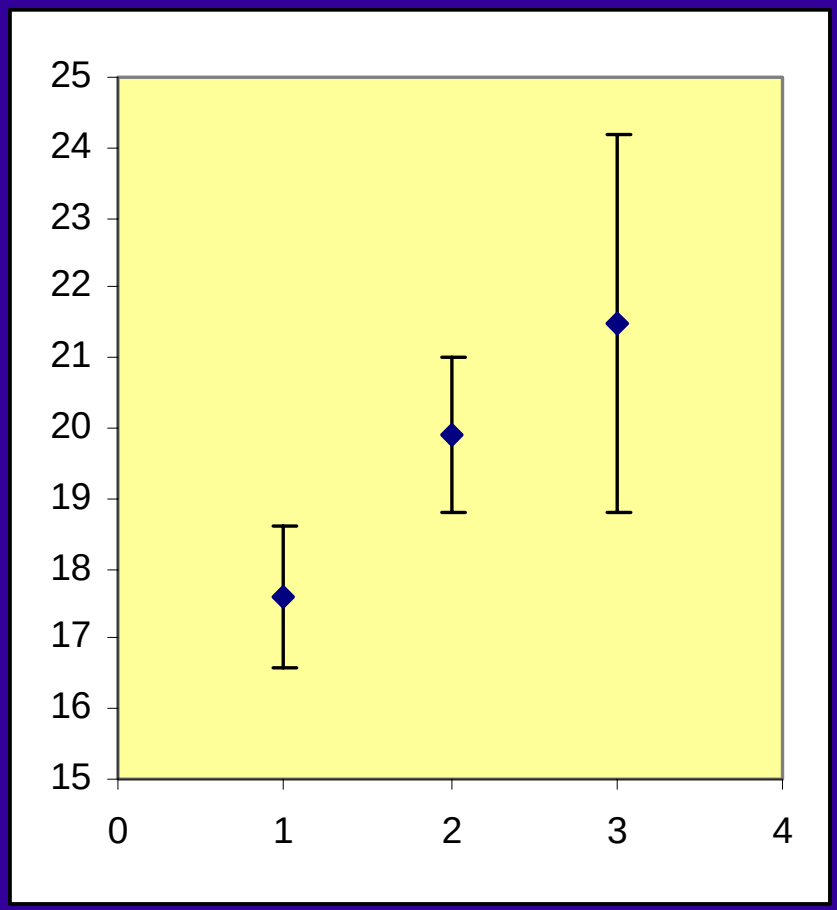
^{241}Am

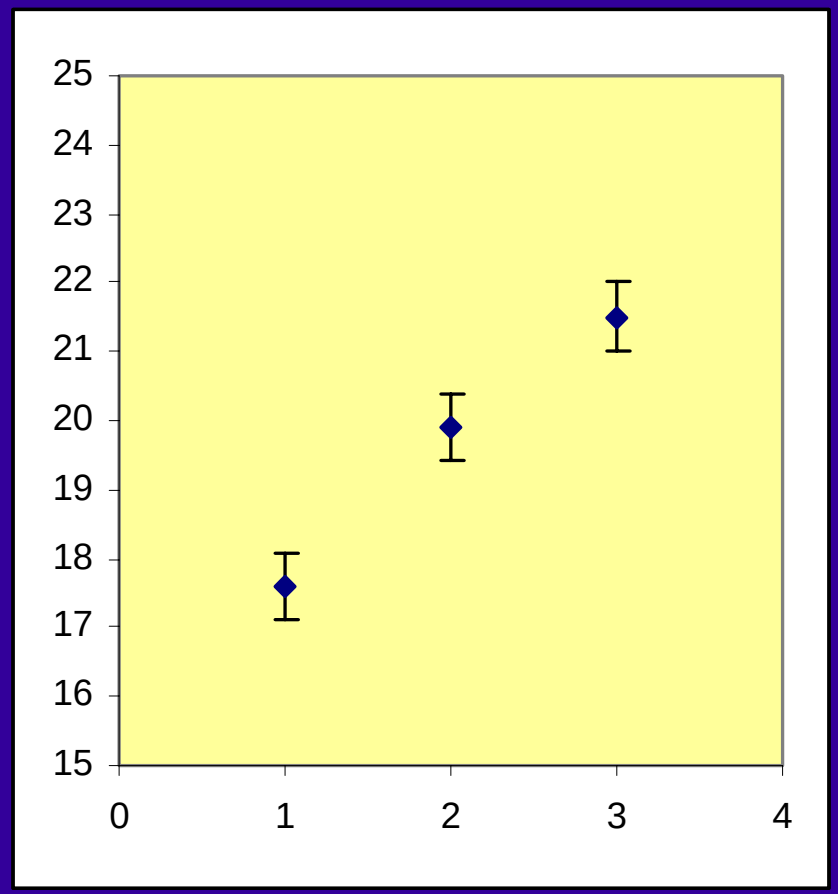
Same participant	ABH/***	ABL/***
Americum-241 activity concentration @ 1200 GMT 01/10/02 (Bq/g)	2.25	2.18
Overall uncertainty (Bq/g)	0.11 *(4.9%)*	0.19 *(8.7%)*
Uncertainty due to:		
Sample count		
Background count		
Standard count		
Detector efficiency		
Chemical yield		
Decay		

^{3}H

	Rep 1	Rep 2	Rep 3
Tritium activity concentration @ 1200 GMT 01/10/02 (Bq/g)	17.6	19.9	21.5
Overall uncertainty (Bq/g)	1.0	1.1	2.7
Uncertainty due to:			
Sample count	2.3 %	2.3 %	2.3 %
Background count			
Standard count	1.3 %		
Detector efficiency	0.1 %		
Chemical yield (fractionation)	1 %		
Decay	0.2 %		
Quadrature sum	*2.83 % = 0.5*	*2.83 % = 0.6 or 2.3 % = 0.5*	*2.83 % = 0.6 or 2.3 % = 0.5*

^{3}H


25
24
23
22
21
20
19
18
17
16
15
0
1
2
3
4


25
24
23
22
21
20
19
18
17
16
15
0
1
2
3
4

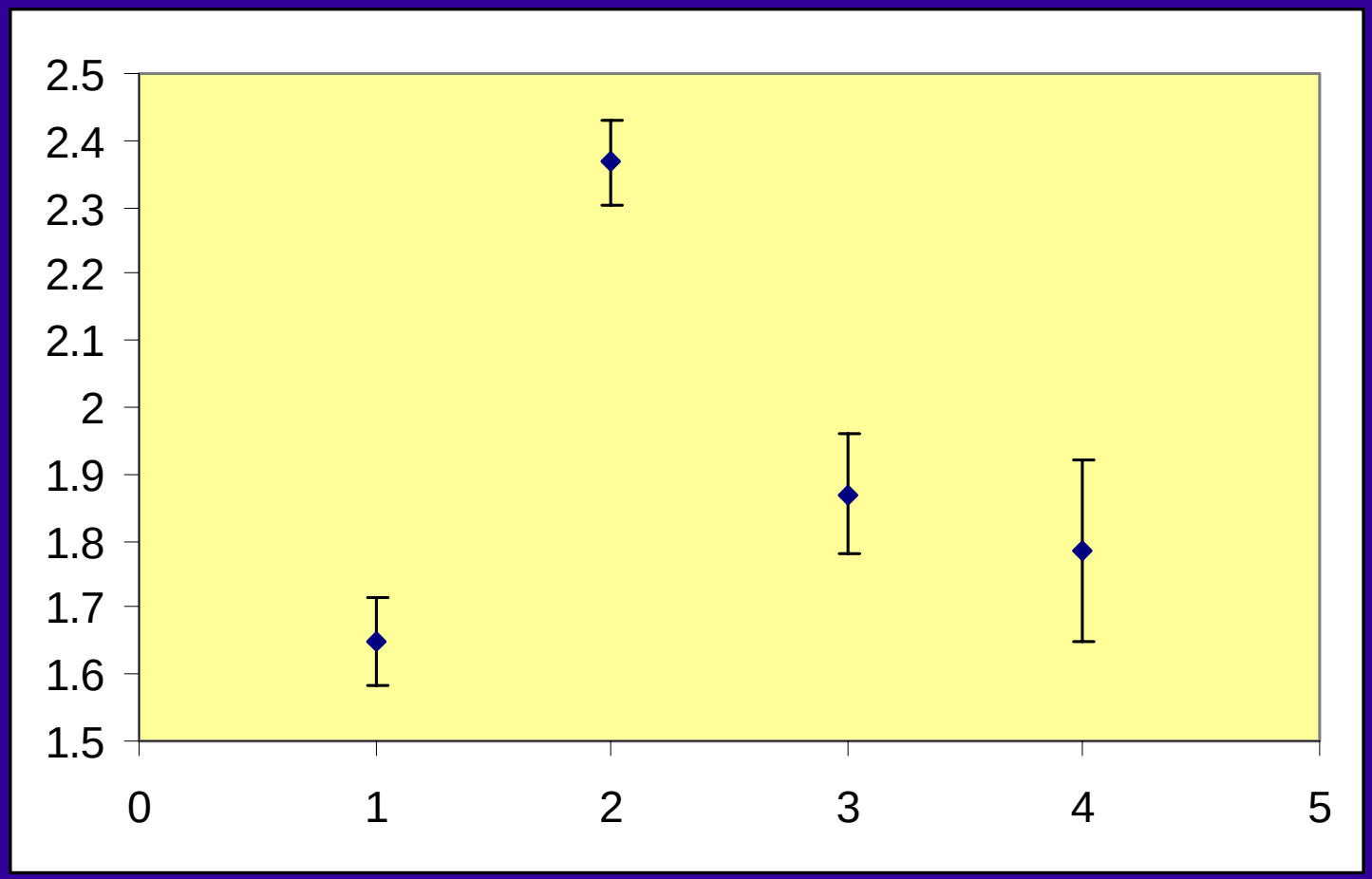
NPL

IRMC

^{95}Zr

Detector	Bq/g	± Bq/g
1	1.650	0.065
2	2.367	0.063
3	1.87	0.091
4	1.785	0.137

^{95}Zr



NPL

IRMC

NPL

National Physical Laboratory