



National Physical Laboratory

ABL and ABH samples

NPL Environmental Radioactivity Comparison
Workshop

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Radionuclides in ABL and ABH

- 7 nuclides:

^{55}Fe , ^{89}Sr , ^{90}Sr , ^{238}U , ^{238}Pu , ^{239}Pu and ^{241}Am

- Two concentration levels:

ABL 1 – 20 Bq kg⁻¹

ABH 1 – 20 Bq g⁻¹

ABL and ABH composition

| | ABL (Bq kg ⁻¹) | ABH (Bq g ⁻¹) |
|-------------------|----------------------------|---------------------------|
| ⁵⁵ Fe | 15.8(3) | 6.89(12) |
| ⁸⁹ Sr | 17.8(3) | 12.83(20) |
| ⁹⁰ Sr | 8.900(19) | 10.189(16) |
| ²³⁸ U | 1.24(3) | 1.059(24) |
| ²³⁸ Pu | 15.28(5) | 2.607(9) |
| ²³⁹ Pu | 13.29(6) | 6.06(3) |
| ²⁴¹ Am | 11.99(4) | 3.691(13) |

Treatment of data

- (i) Deviation D from NPL value (%)

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

- (ii) u-test ($P = 0.01$) and relative uncertainty ratio R_R

$$u = \frac{|L - N|}{\sqrt{u_L^2 + u_N^2}} \quad R_R = \frac{N u_L}{L u_N}$$

$u < 2.58$

$u < 2.58$ but R_R is an outlier

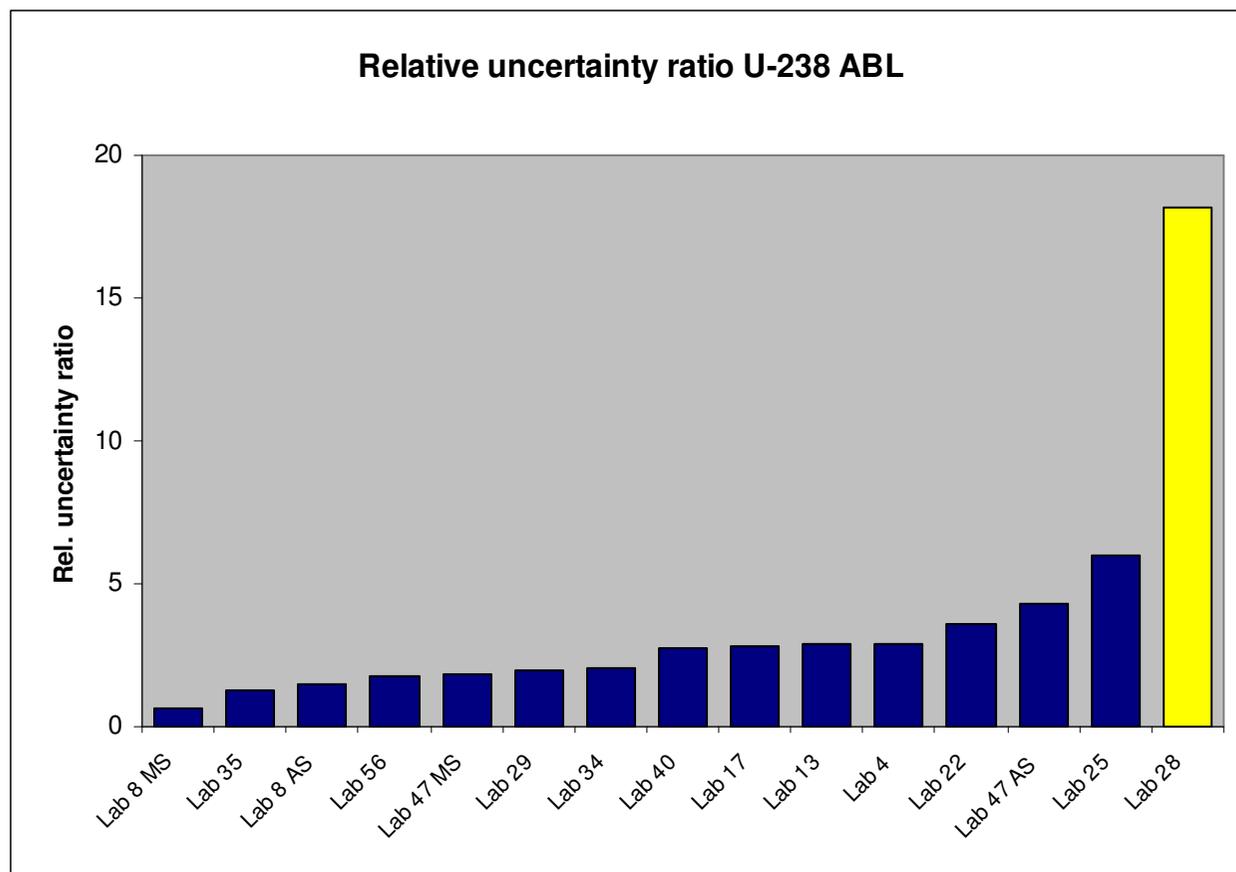
$u > 2.58$

‘in agreement’

‘possibly in agreement’

‘discrepant’

Uncertainty ratio outlier



Fe-55 results

ABL

4 results

75% of the results 'in agreement'

Deviation mean: $(10 \pm 29) \%$

Deviation median: 13%

ABH

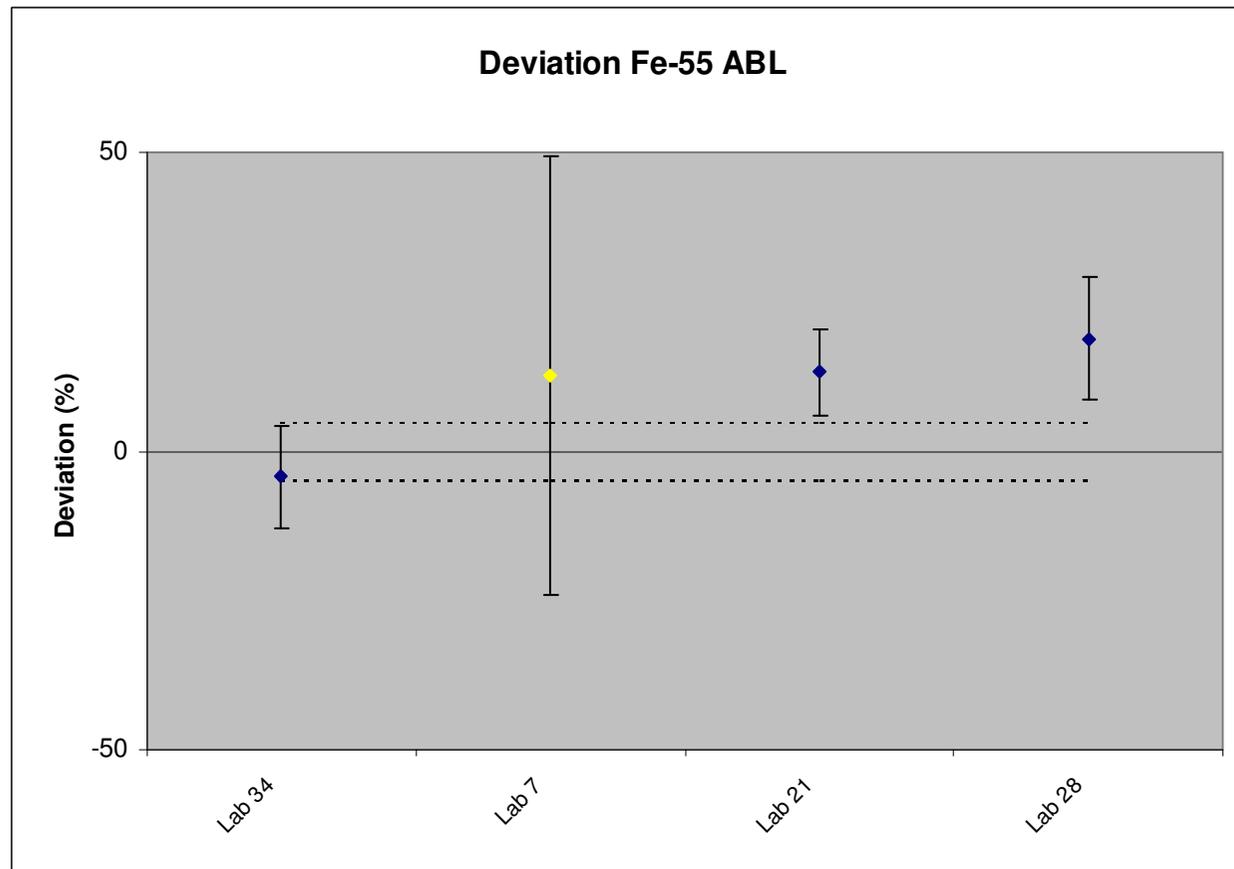
7 results

100% of the results 'in agreement'

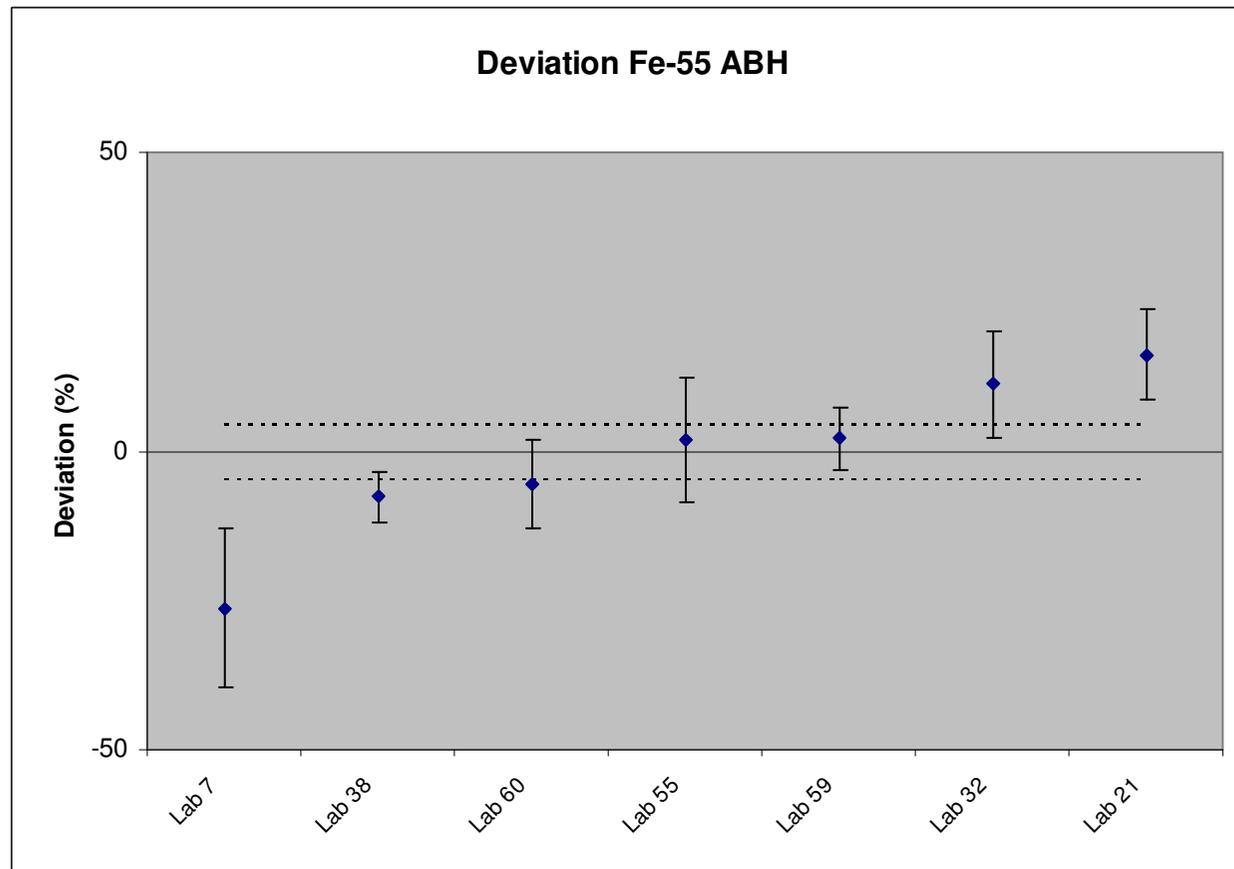
Deviation mean: $(-1 \pm 20) \%$

Deviation median: 2%

Fe-55 ABL



Fe-55 ABH



Sr-89 results

ABL

5 results

60% of the results 'in agreement'

Deviation mean: $(-27 \pm 71) \%$

Deviation median: -10%

ABH

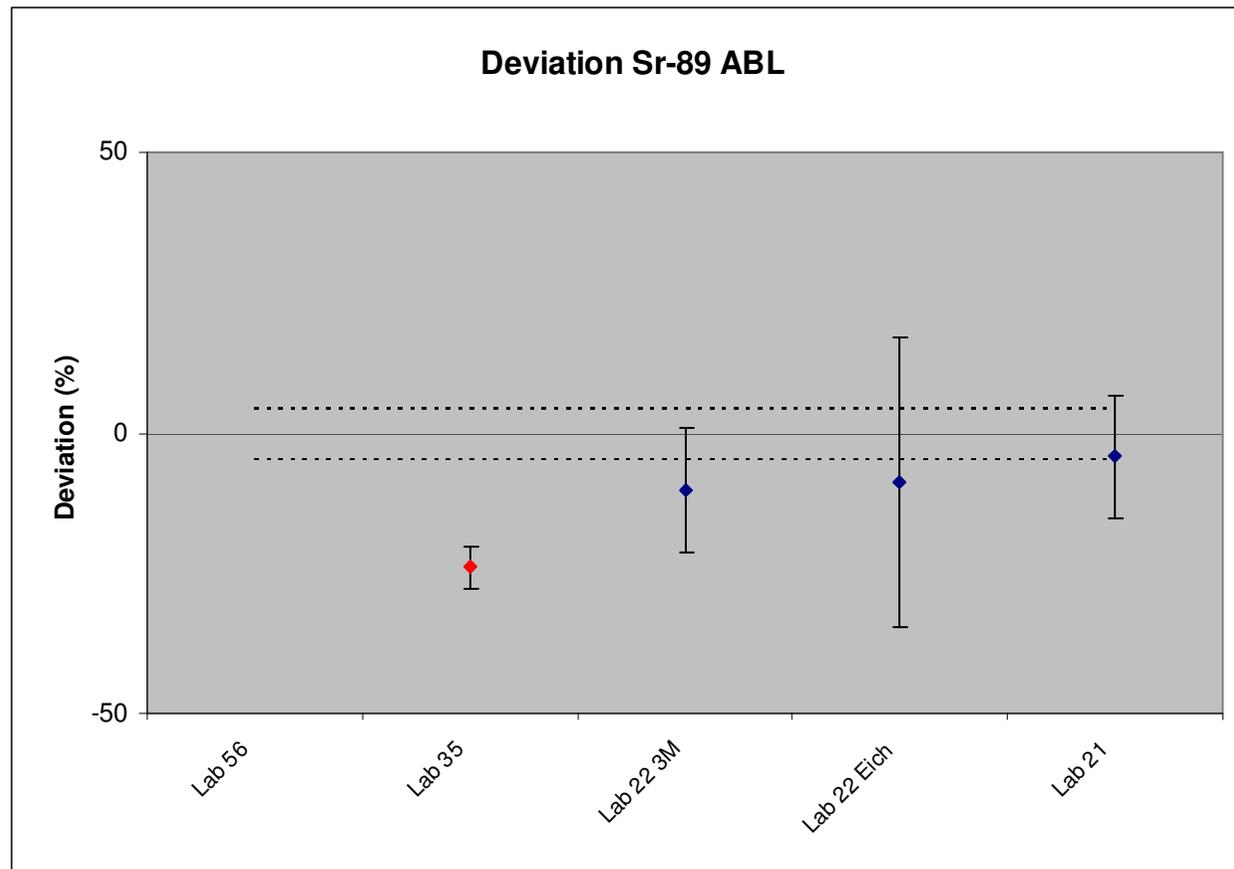
6 results

50% of the results 'in agreement'

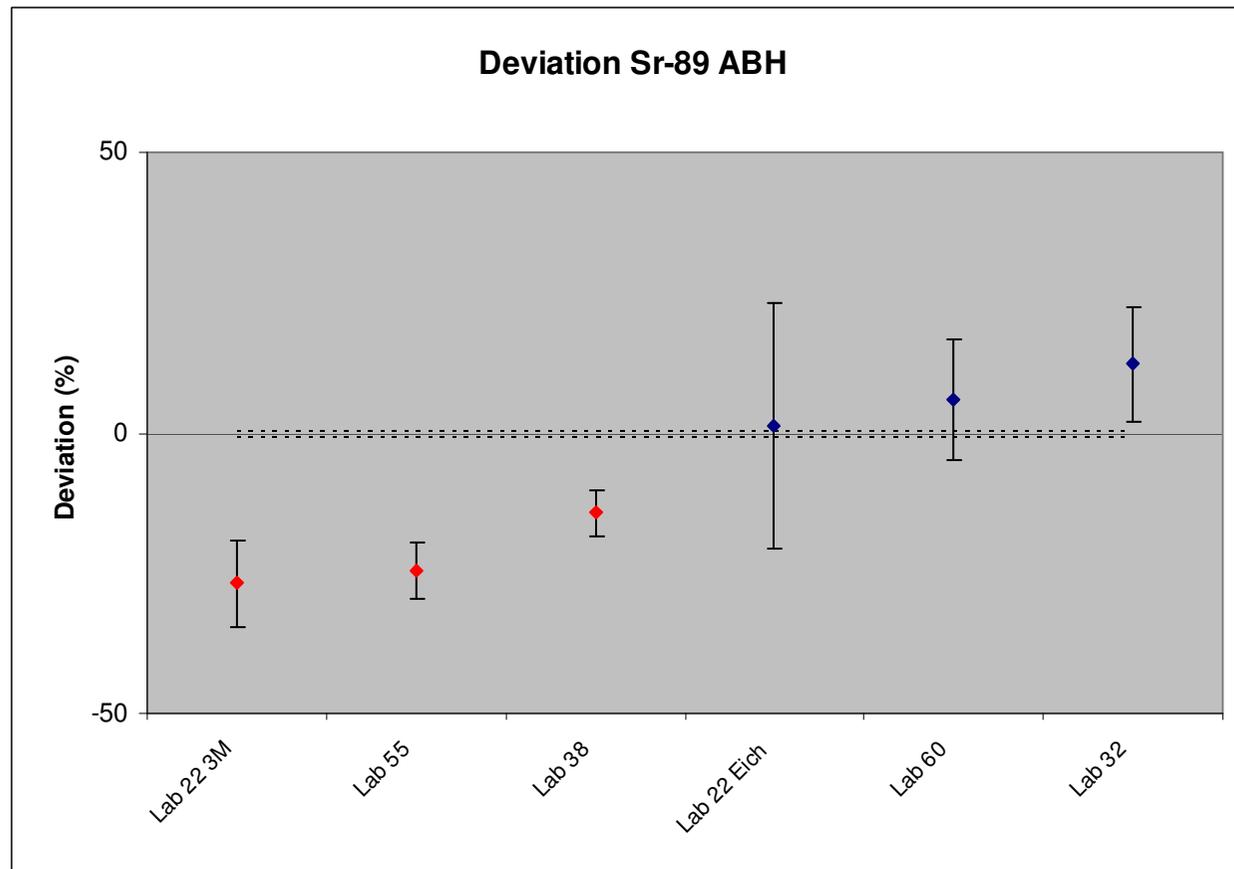
Deviation mean: $(-8 \pm 27) \%$

Deviation median: -6%

Sr-89 ABL



Sr-89 ABH



Sr-90 results

ABL

13 results

46% of the results 'in agreement'

Deviation mean: $(1 \pm 39) \%$

Deviation median: -5%

ABH

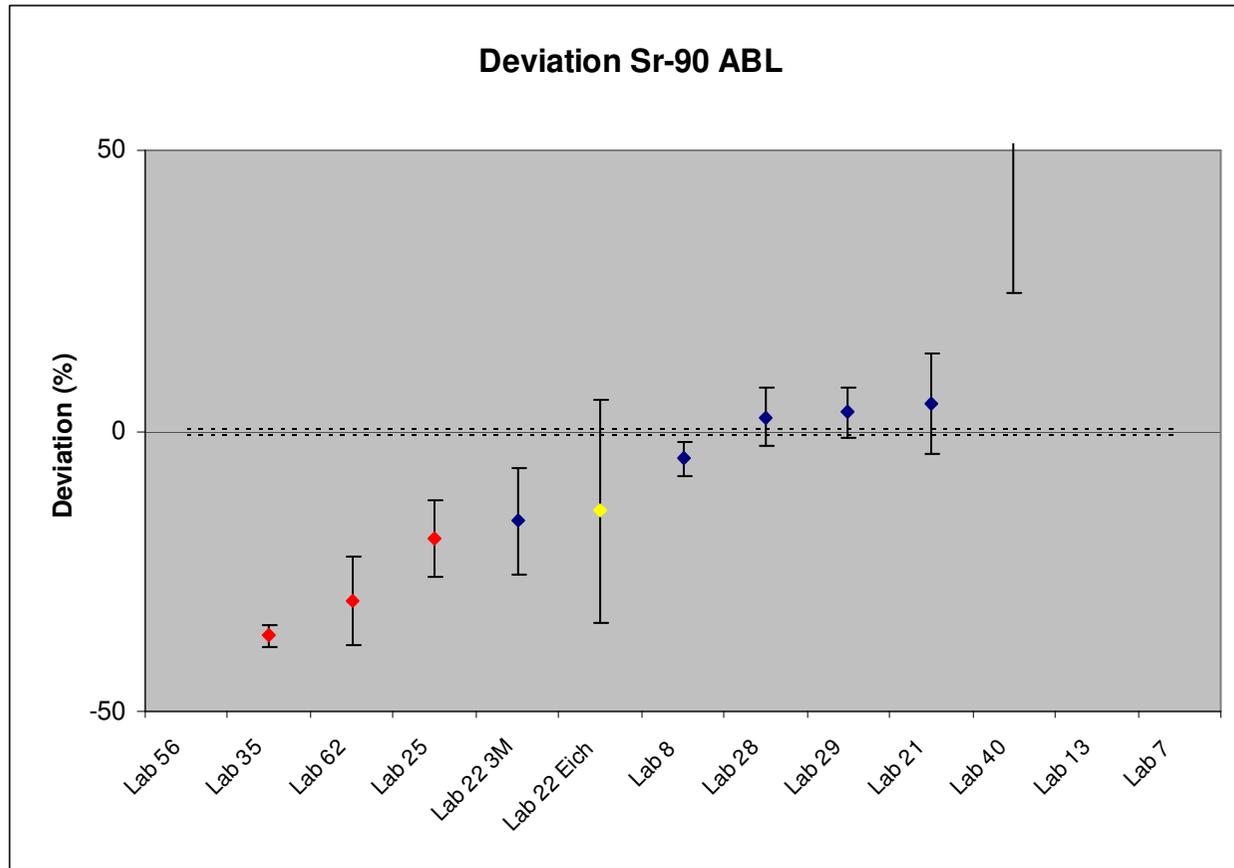
13 results

54% of the results 'in agreement'

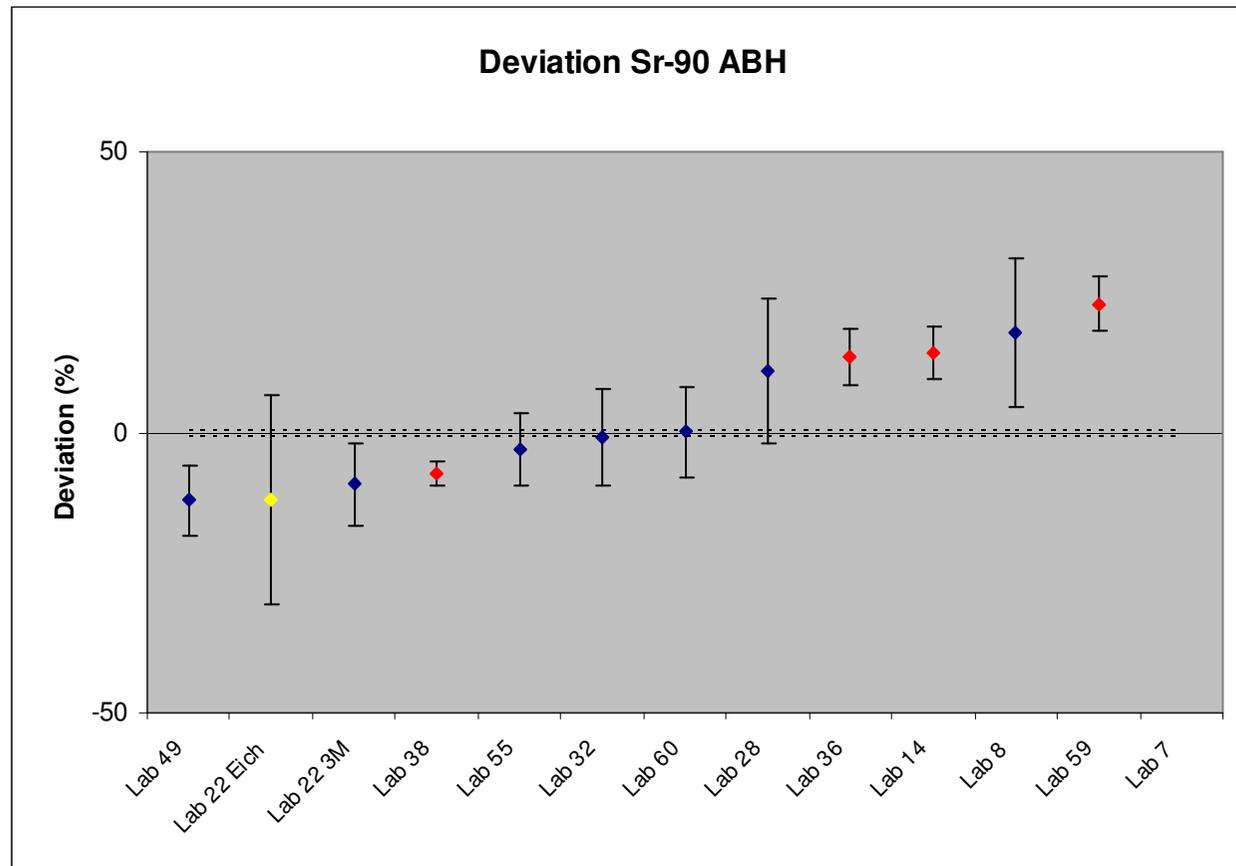
Deviation mean: $(3 \pm 11) \%$

Deviation median: 0%

Sr-90 ABL



Sr-90 ABH



U-238 results

ABL

15 results

80% of the results 'in agreement'

Deviation mean: $(0 \pm 7) \%$

Deviation median: -3%

ABH

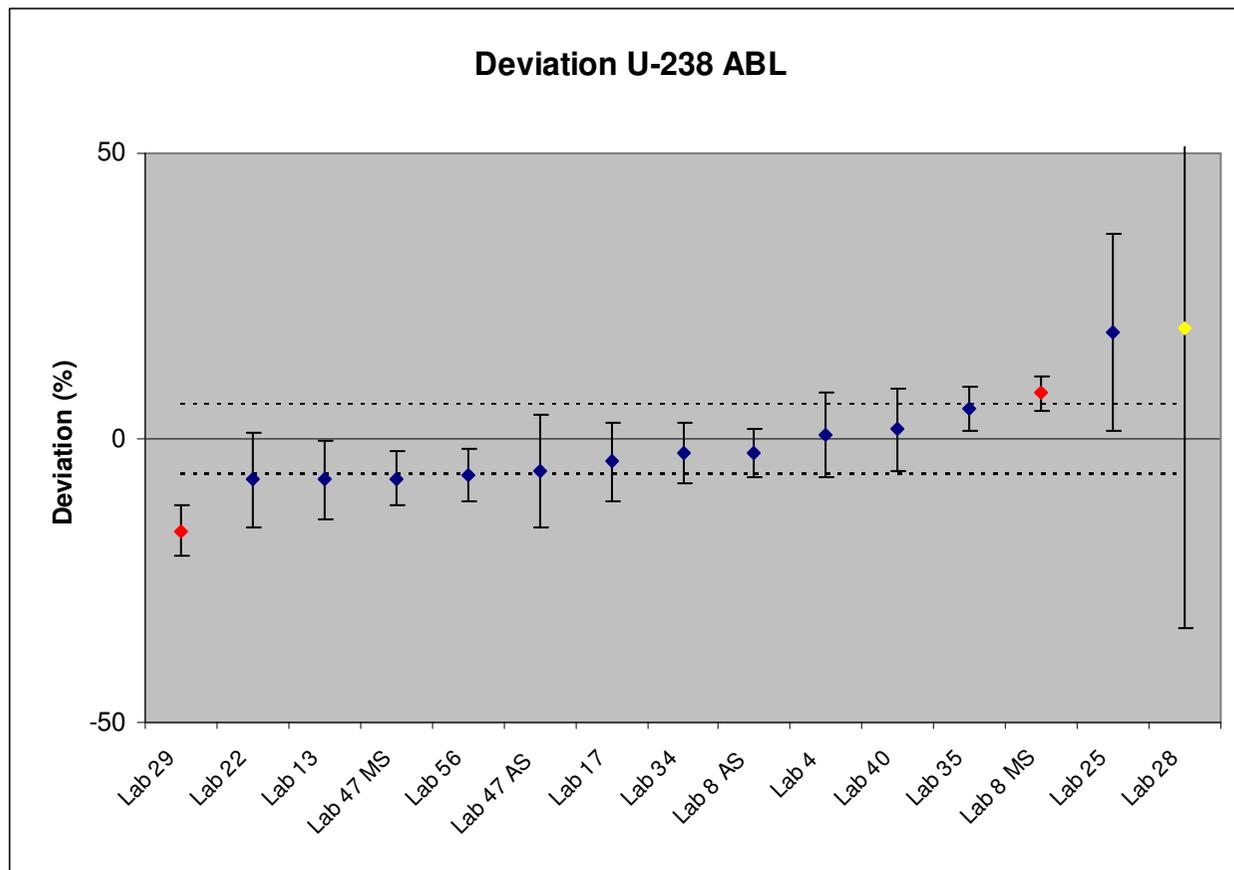
13 results

85% of the results 'in agreement'

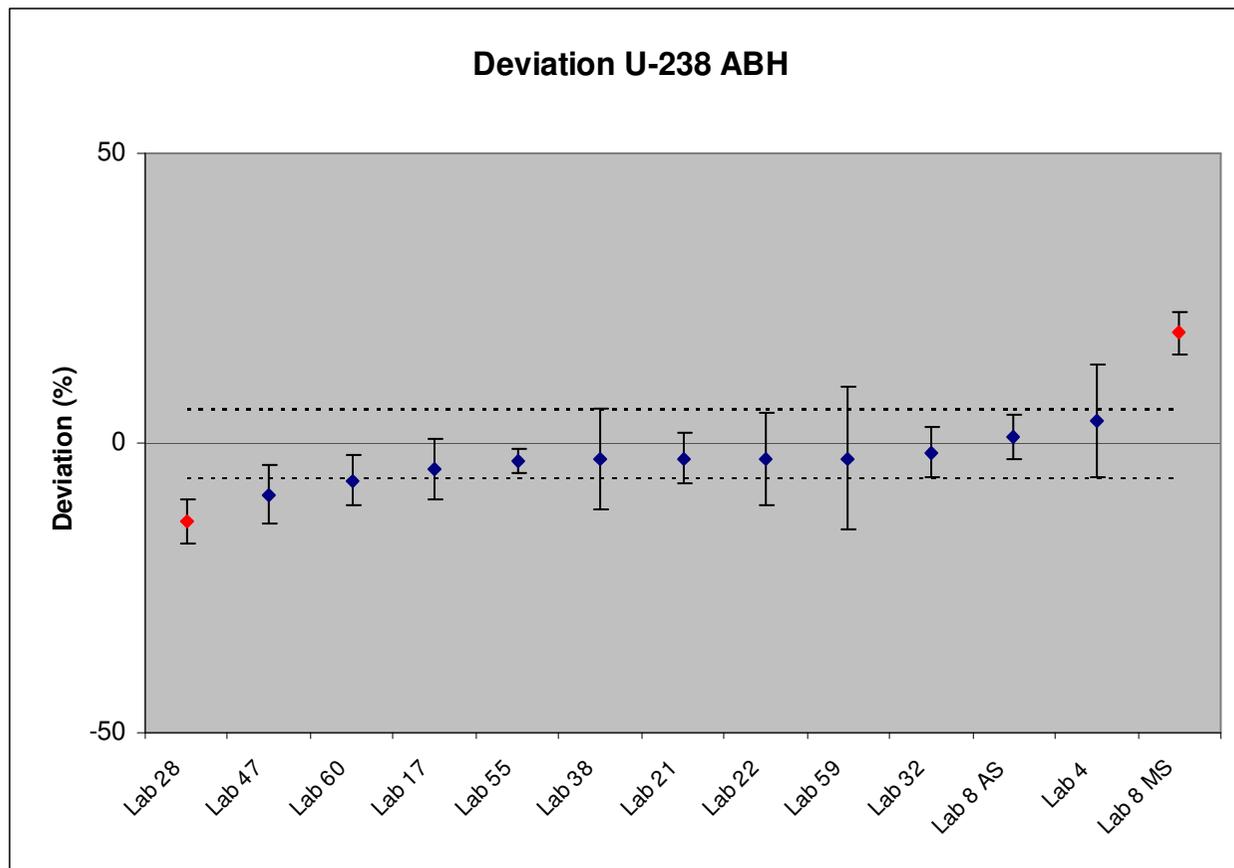
Deviation mean: $(-2 \pm 6) \%$

Deviation median: -3%

U-238 ABL



U-238 ABH



Pu-238 results

ABL

16 results

88% of the results 'in agreement'

Deviation mean: $(-5 \pm 7) \%$

Deviation median: -3%

ABH

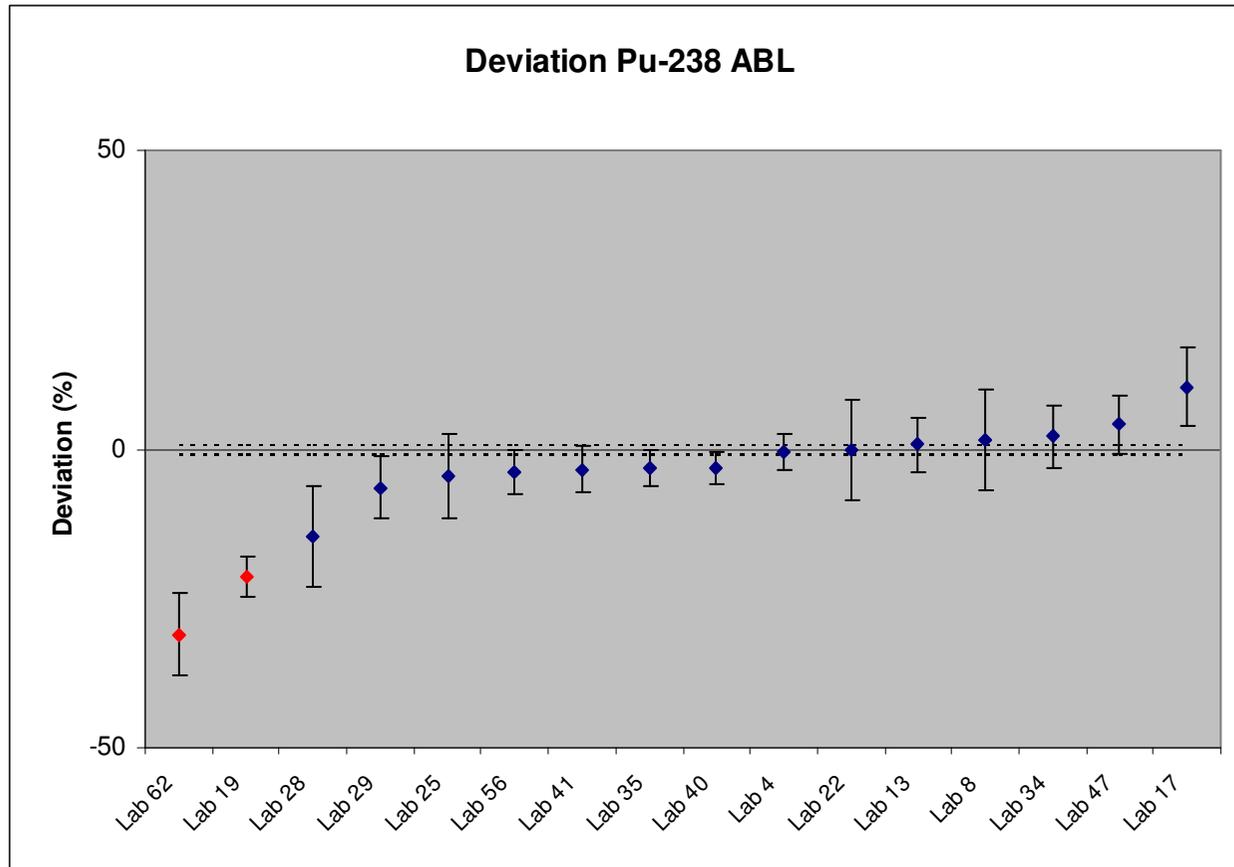
14 results

79% of the results 'in agreement'

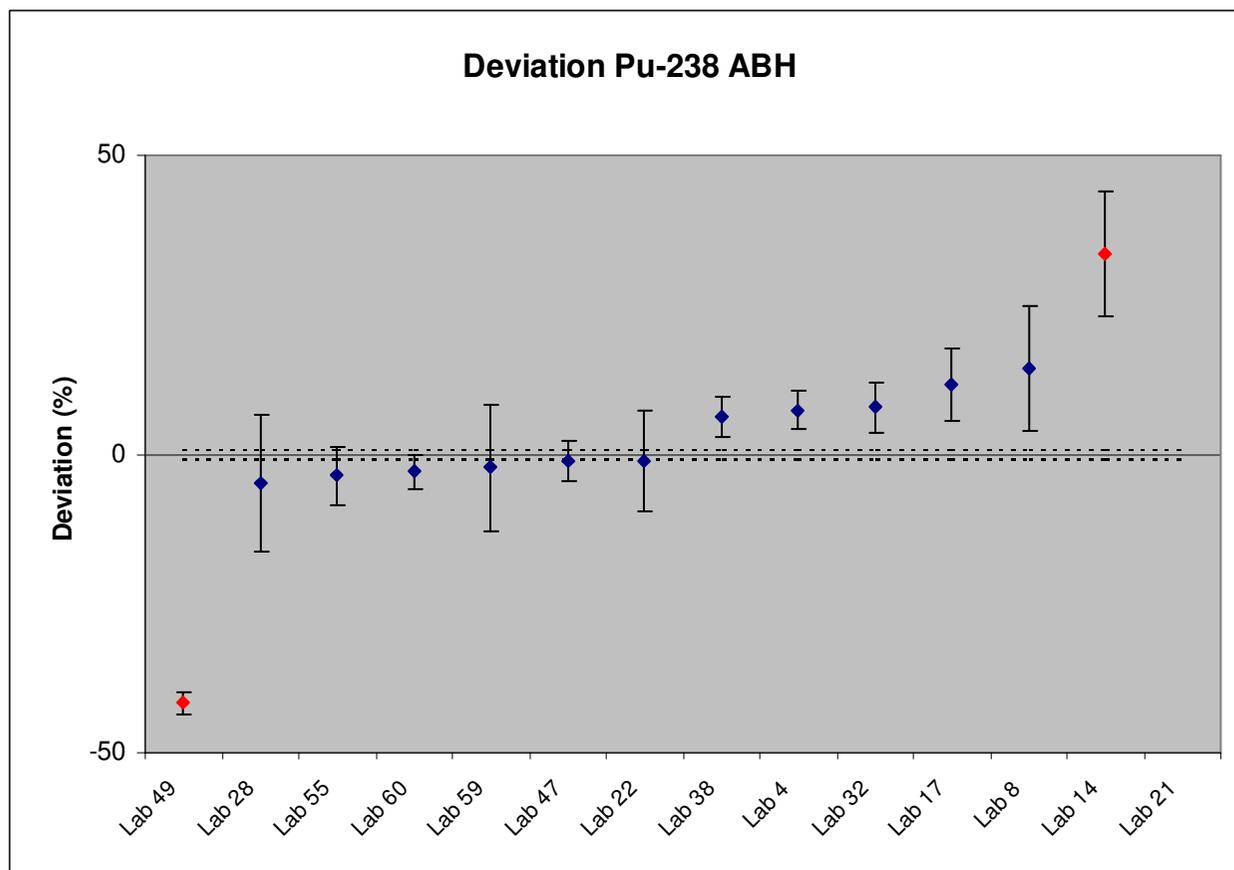
Deviation mean: $(5 \pm 10) \%$

Deviation median: 3%

Pu-238 ABL



Pu-238 ABH



Pu-239 results

ABL

17 results

82% of the results 'in agreement'

Deviation mean: $(-0.5 \pm 2.8) \%$ Deviation median: 0%

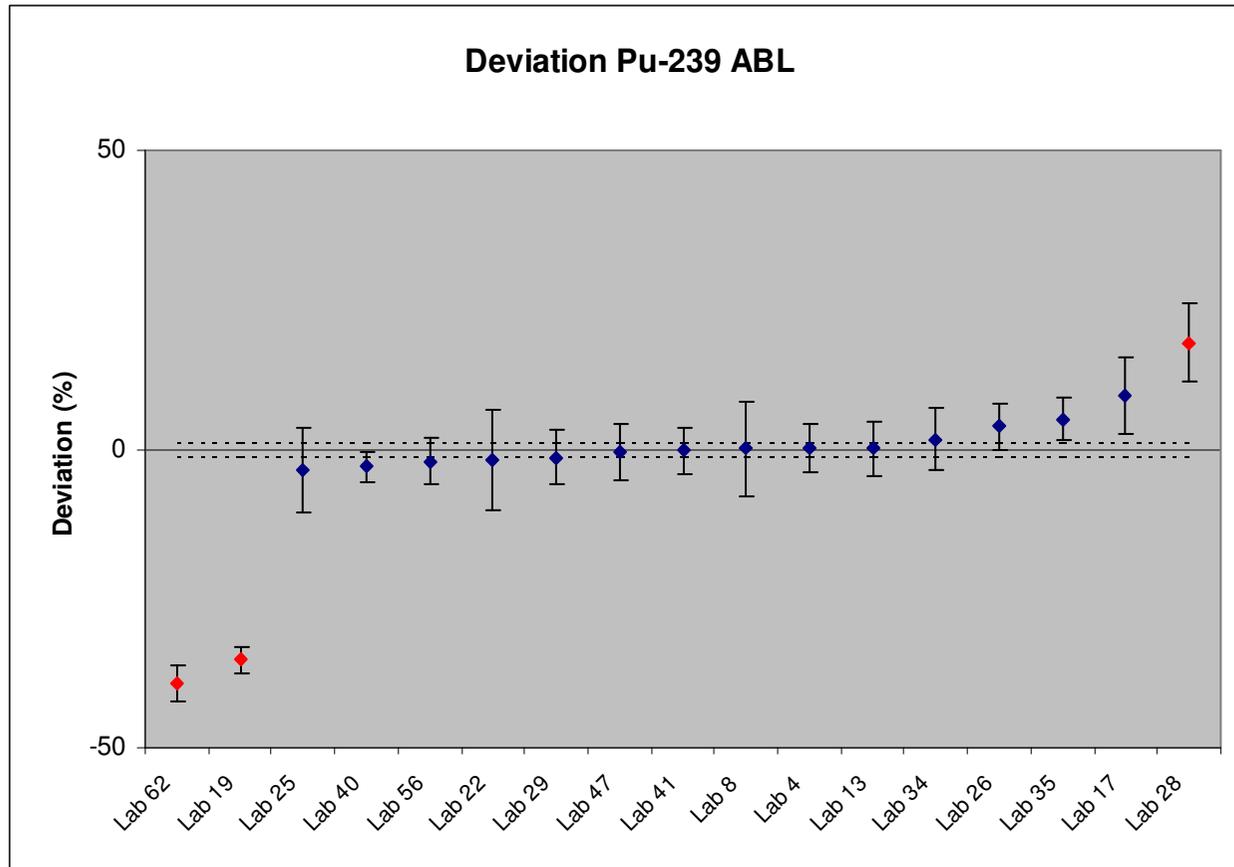
ABH

13 results

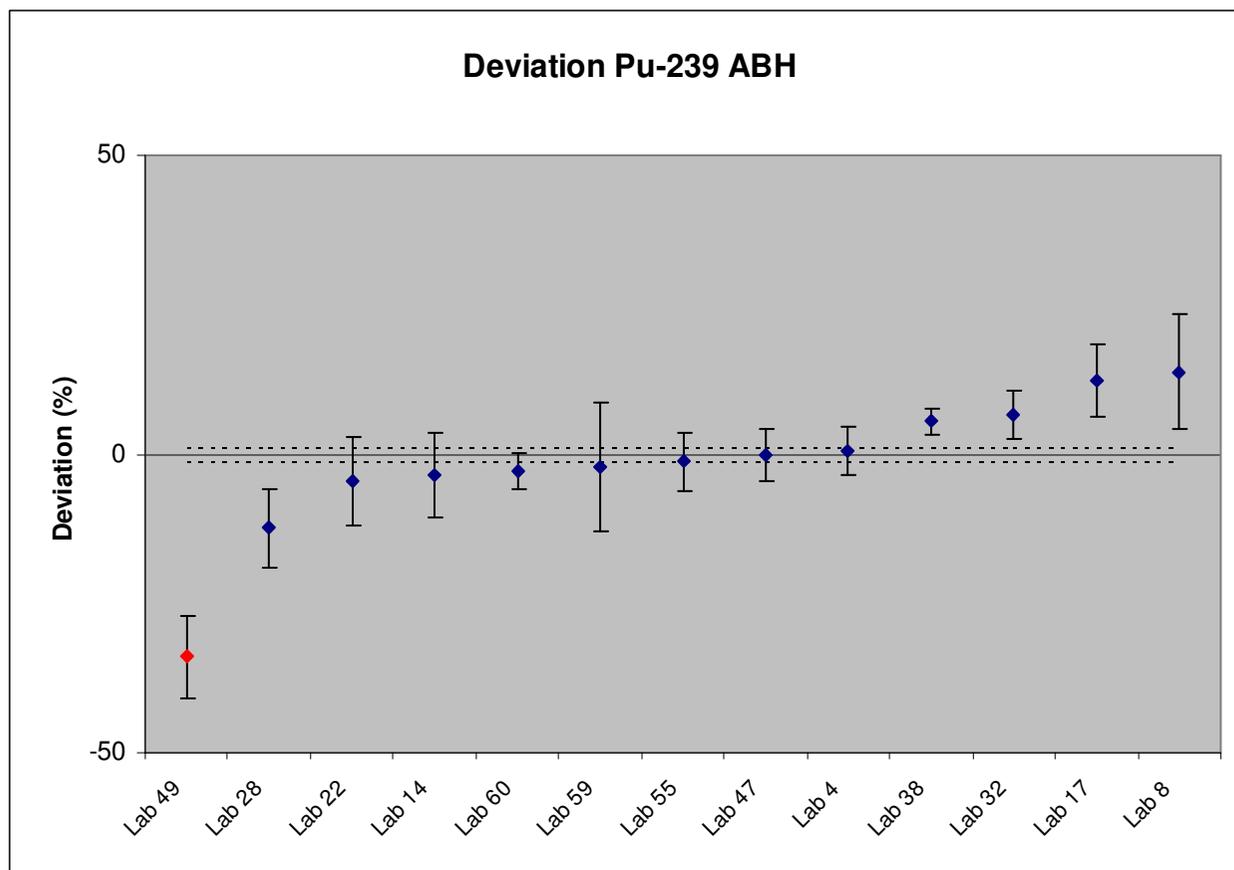
92% of the results 'in agreement'

Deviation mean: $(-2 \pm 10) \%$ Deviation median: -1%

Pu-239 ABL



Pu-239 ABH



Am-241 results

ABL

14 results

86% of the results 'in agreement'

Deviation mean: $(3.5 \pm 3.8) \%$

Deviation median: 3%

ABH

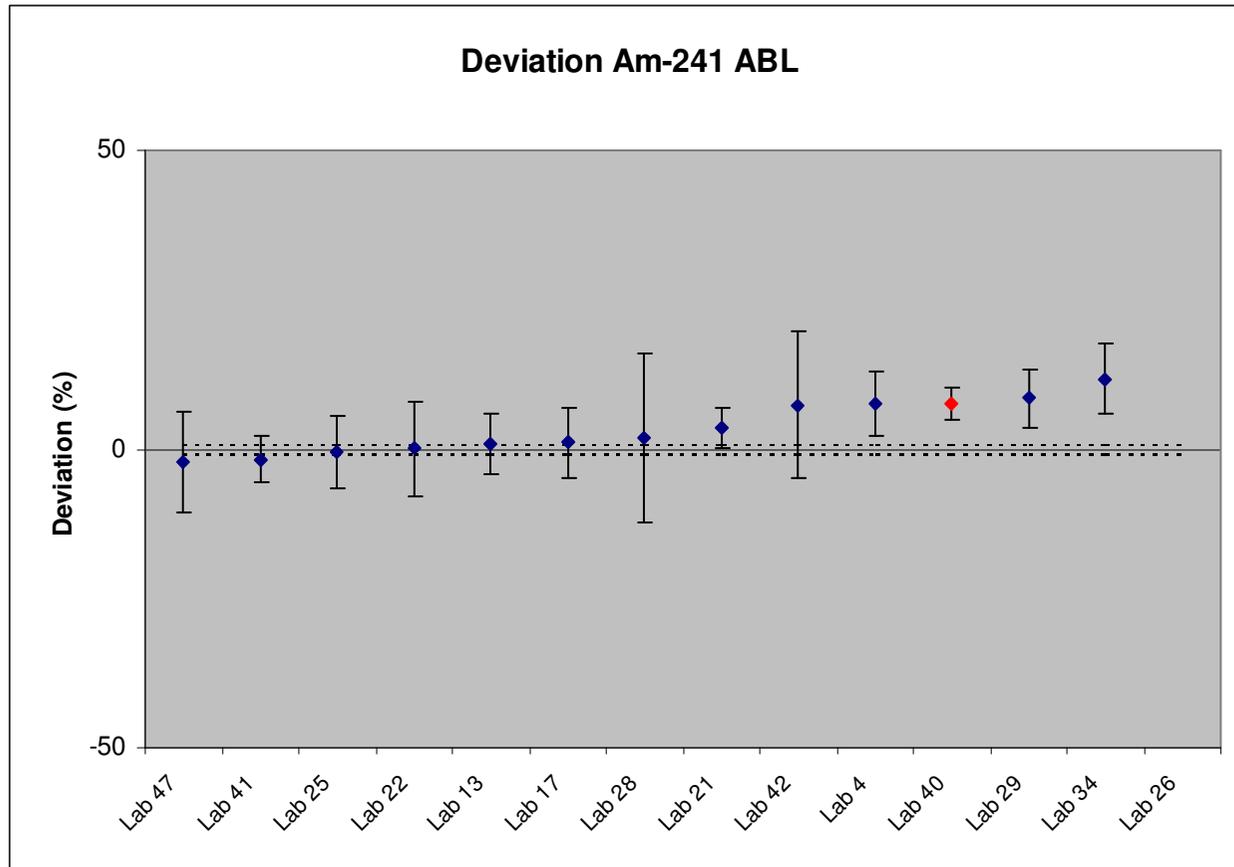
16 results

88% of the results 'in agreement'

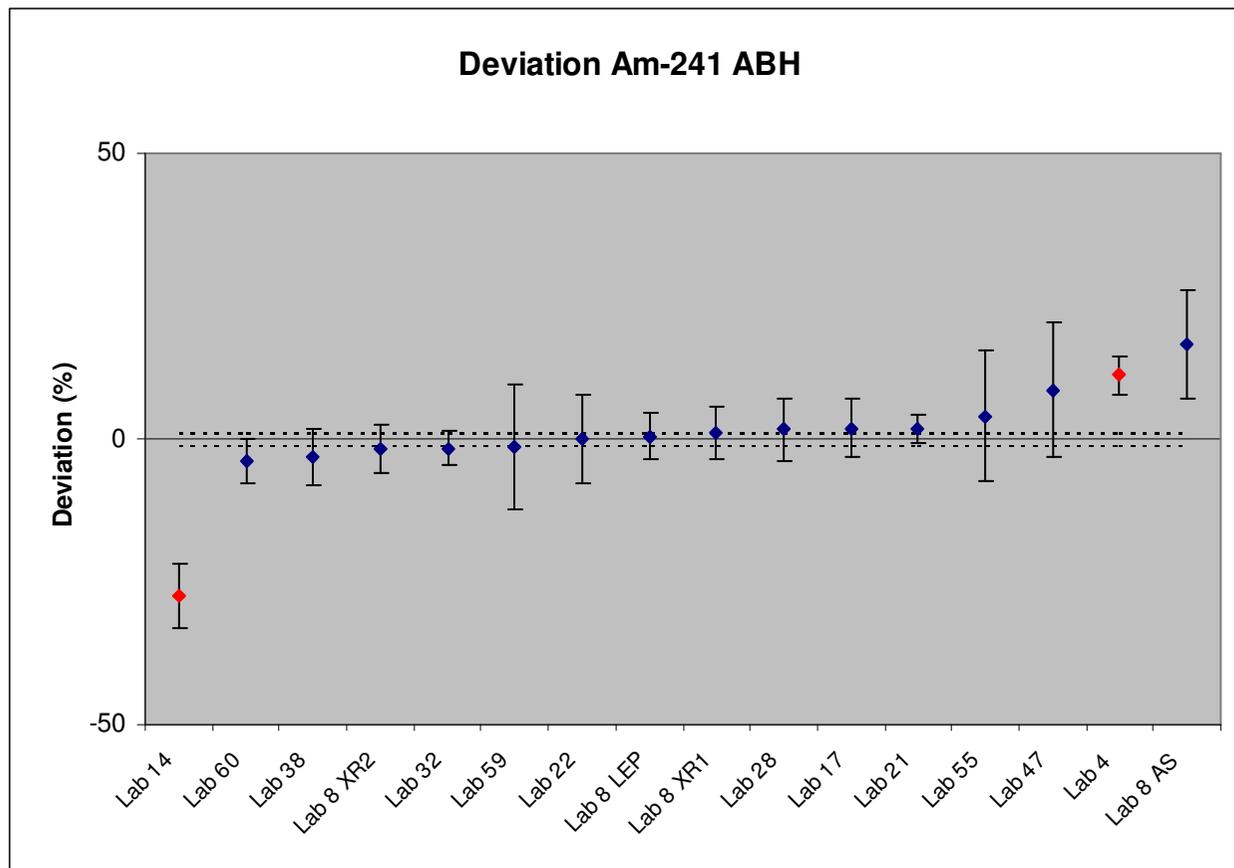
Deviation mean: $(2.3 \pm 4.4) \%$

Deviation median: 1%

Am-241 ABL



Am-241 ABH



ABL summary

Results

76%

'in agreement'

4%

'probably in agreement'

20%

'discrepant'

Problematic nuclides:

^{89}Sr and ^{90}Sr

Less problematic:

^{55}Fe , ^{238}U , ^{238}Pu , ^{239}Pu and
 ^{241}Am

ABH summary

Results

79%

'in agreement'

1%

'probably in agreement'

20%

'discrepant'

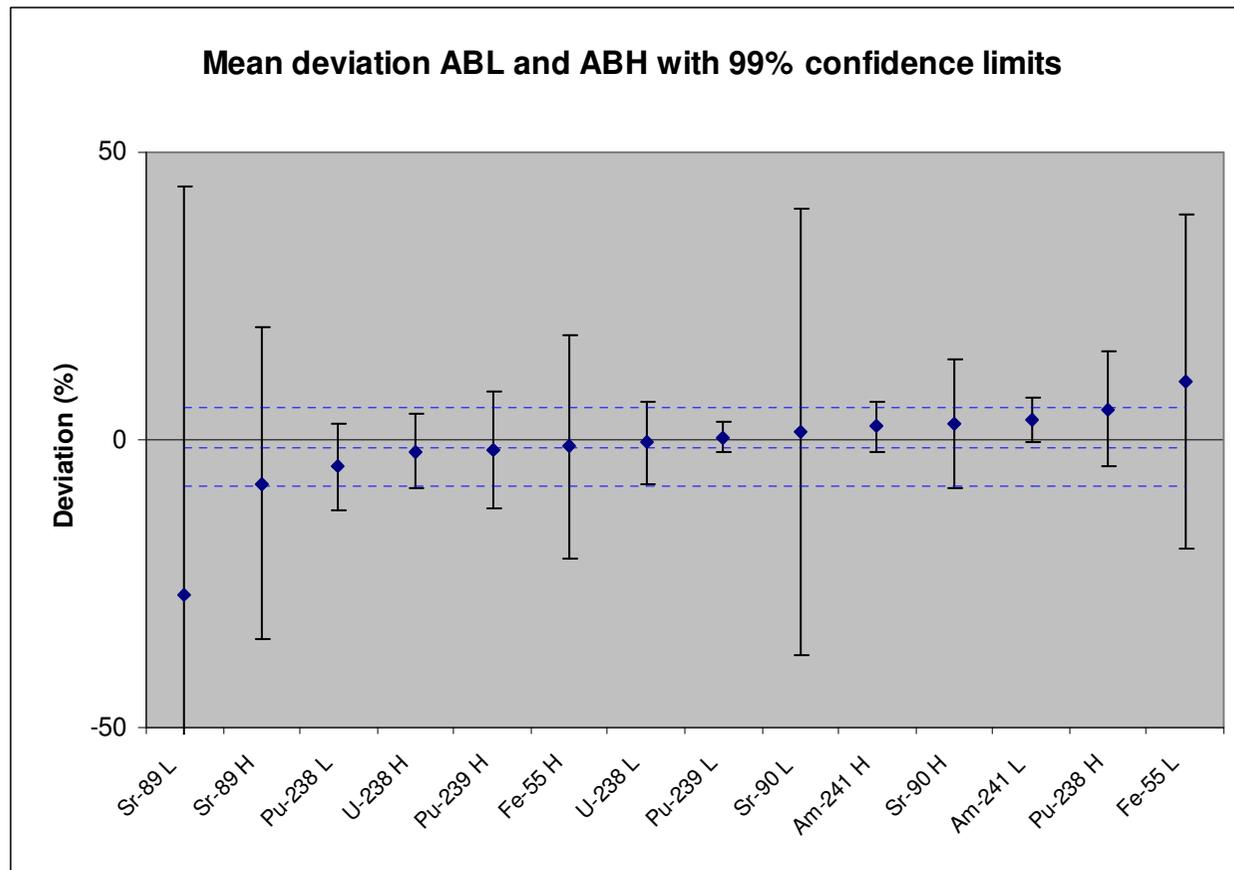
Problematic nuclides:

^{89}Sr and ^{90}Sr

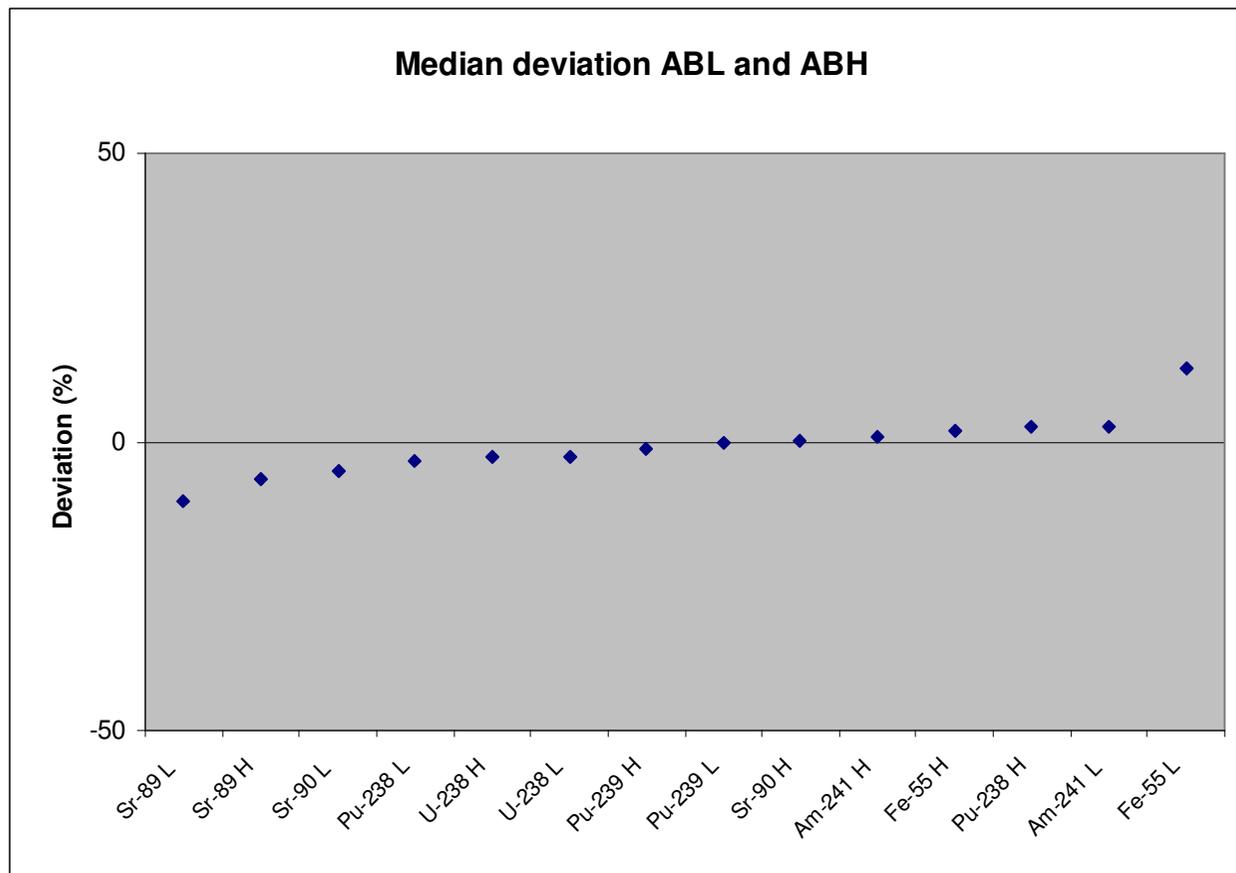
Less problematic:

^{55}Fe , ^{238}U , ^{238}Pu , ^{239}Pu and ^{241}Am

Mean deviation ABL and ABH with 99% confidence limits



Median deviation ABL and ABH



Naji plot

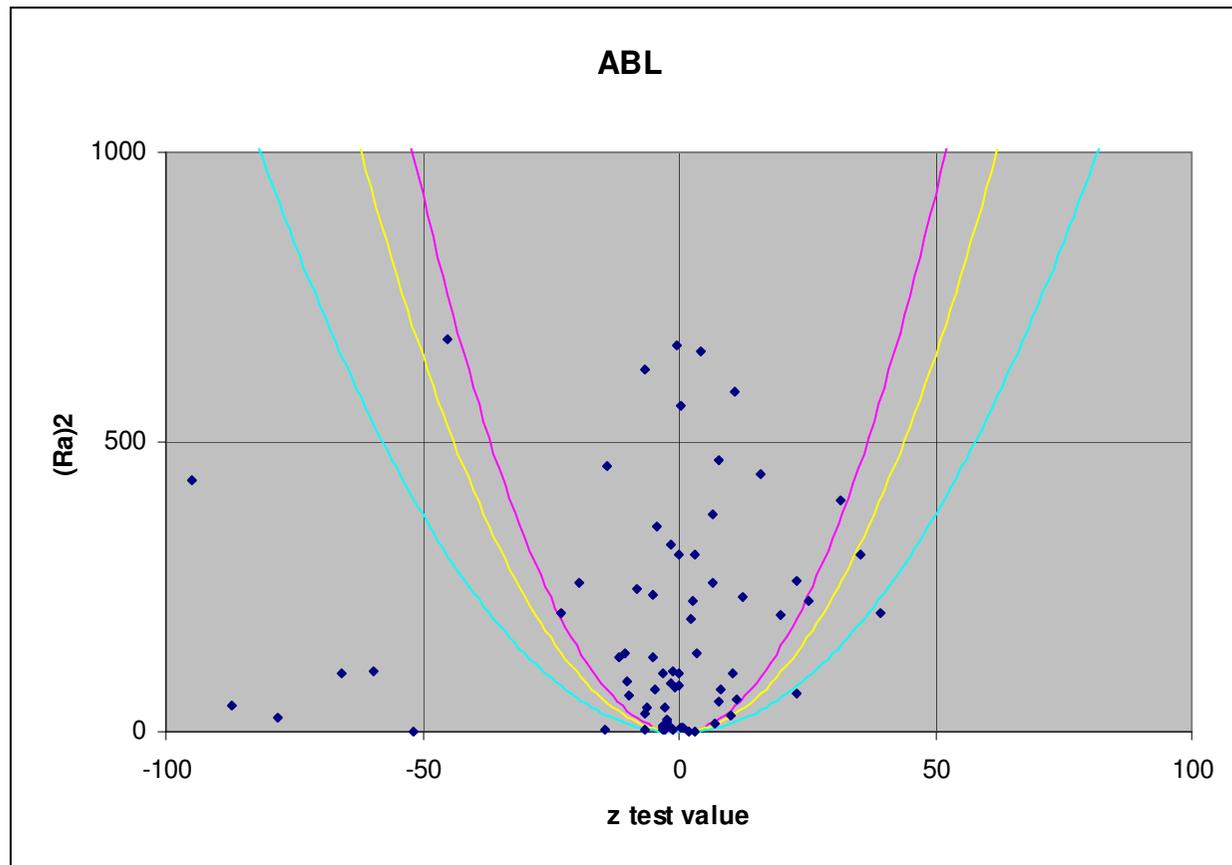
Square of the absolute uncertainty ratio versus the z-score

$$z = \frac{L - N}{u_N} \quad R_A^2 = \left(\frac{u_L}{u_N} \right)^2$$

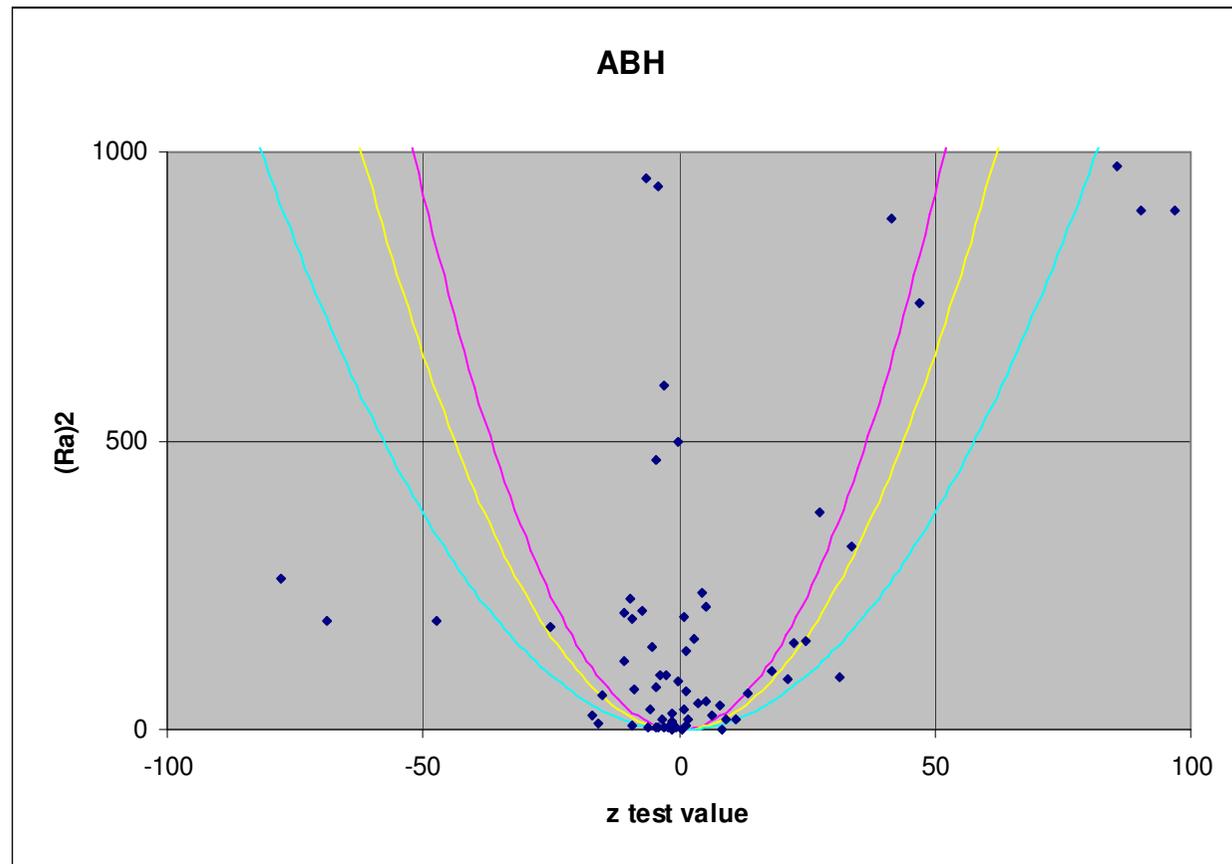
The parabolae represent u-test values of 1.64, 1.96 and 2.58, (P = 0.10, 0.05 and 0.01, respectively)

Data points outside the area bounded by the $u = 2.58$ parabola are discrepant

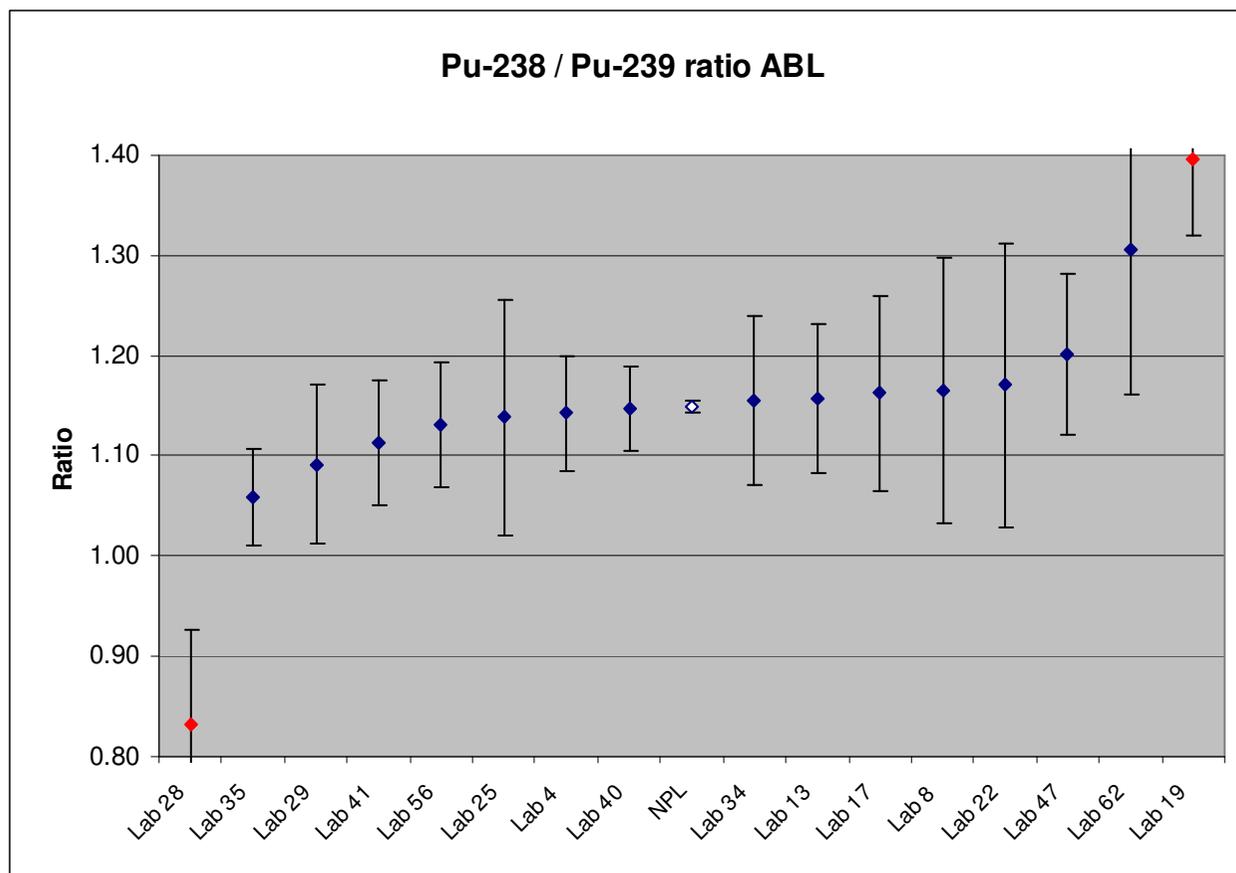
Naji plot ABL



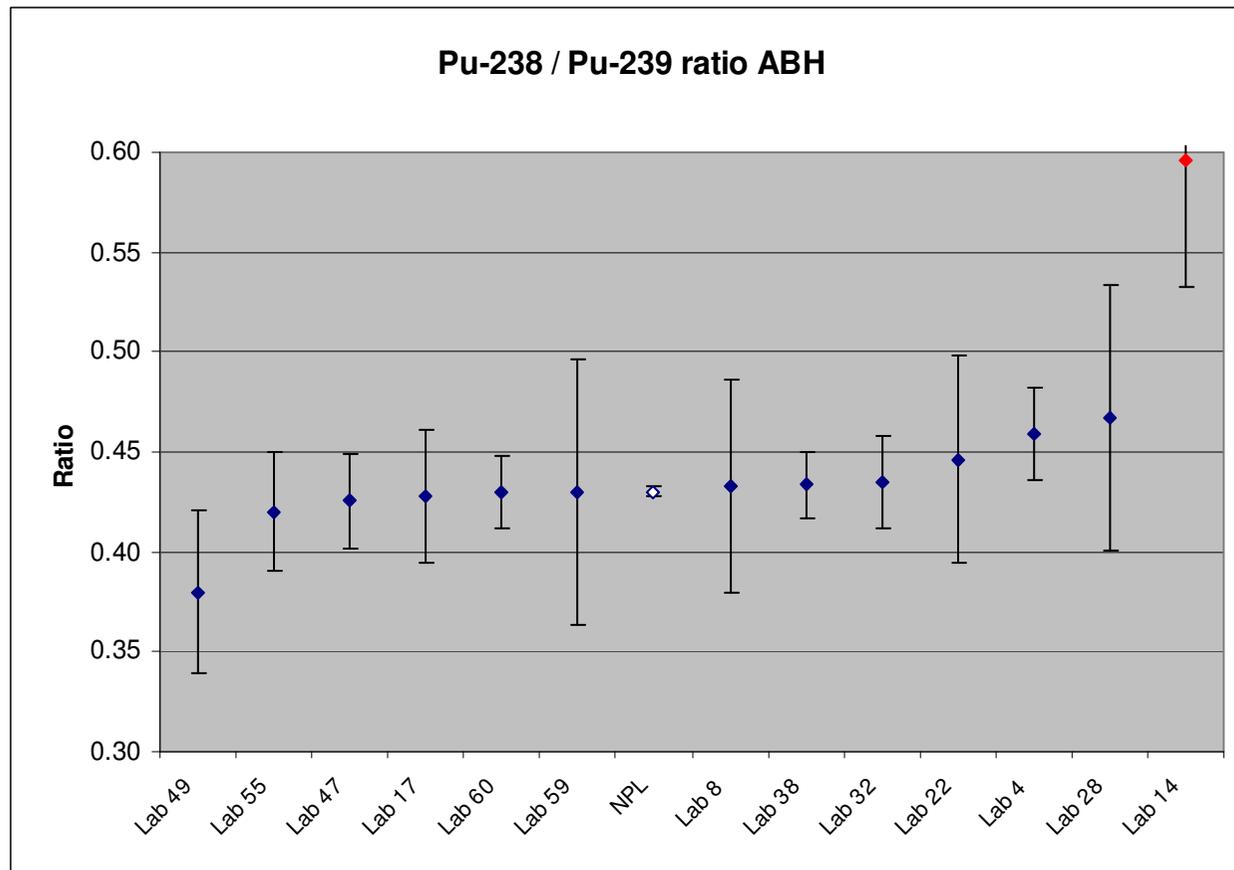
Naji Plot ABH



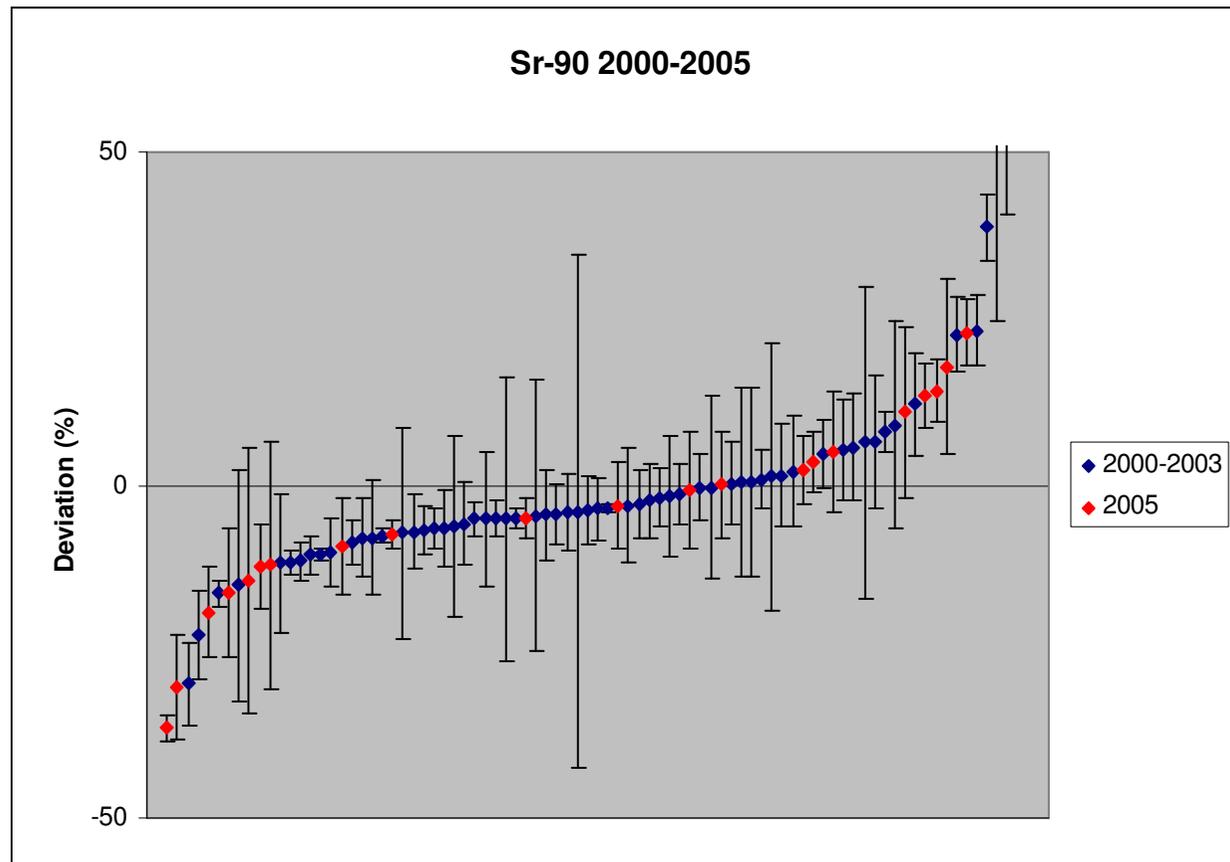
Pu-238 / Pu-239 ratio ABL



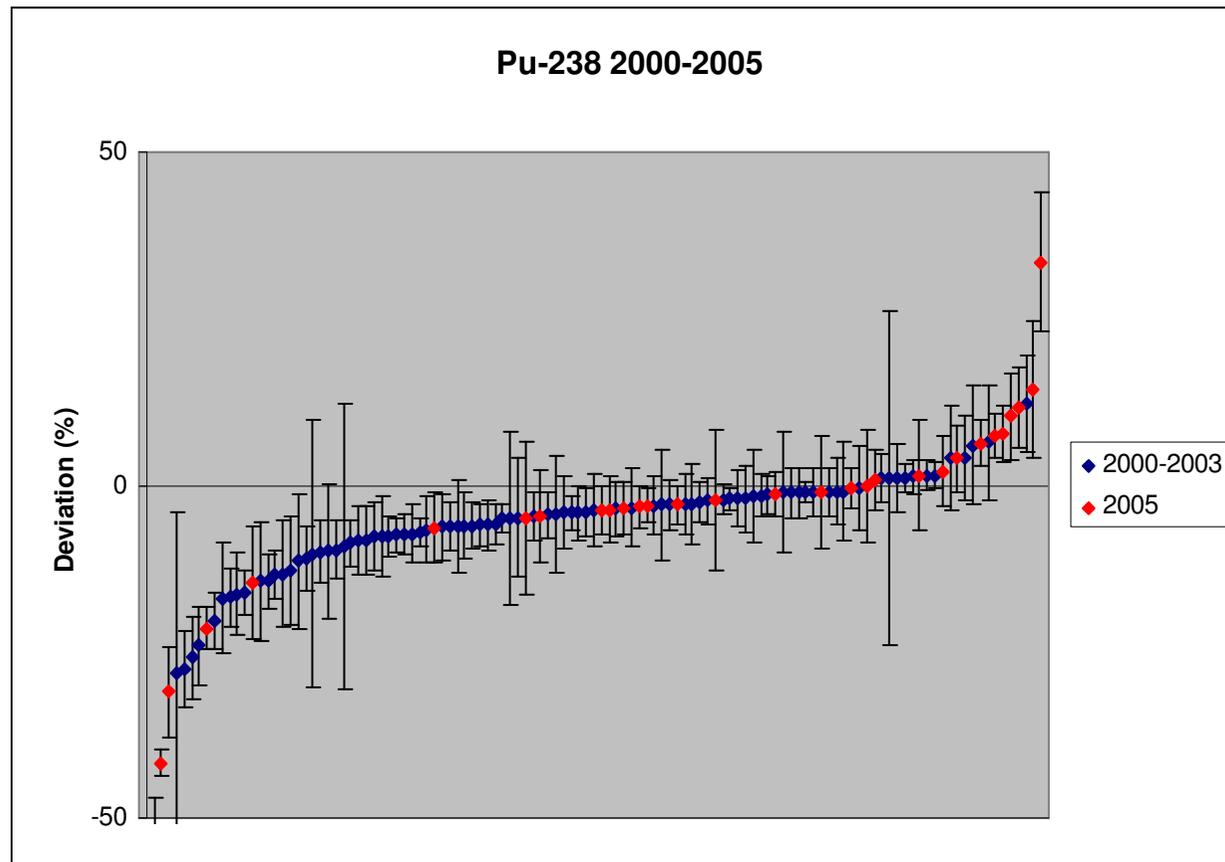
Pu-238 / Pu-239 ratio ABH



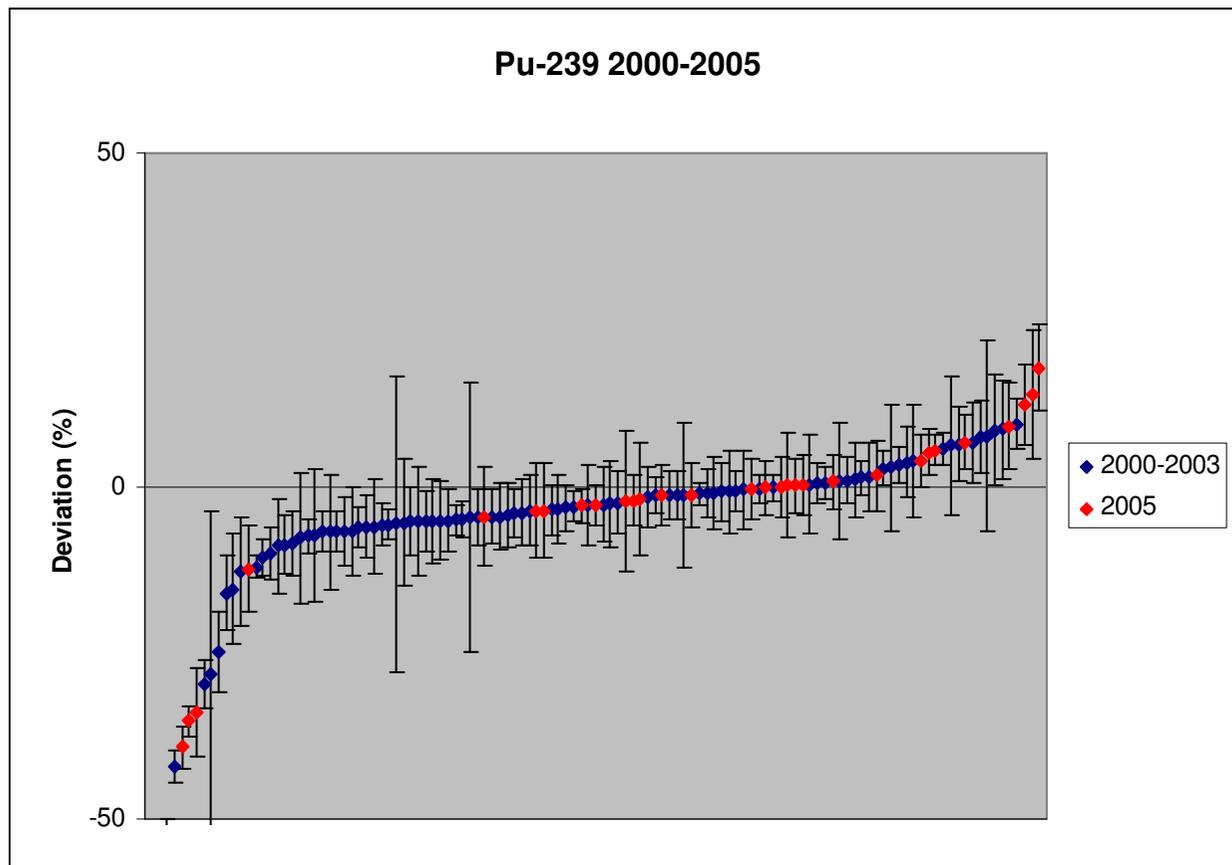
Sr-90 2000-2005



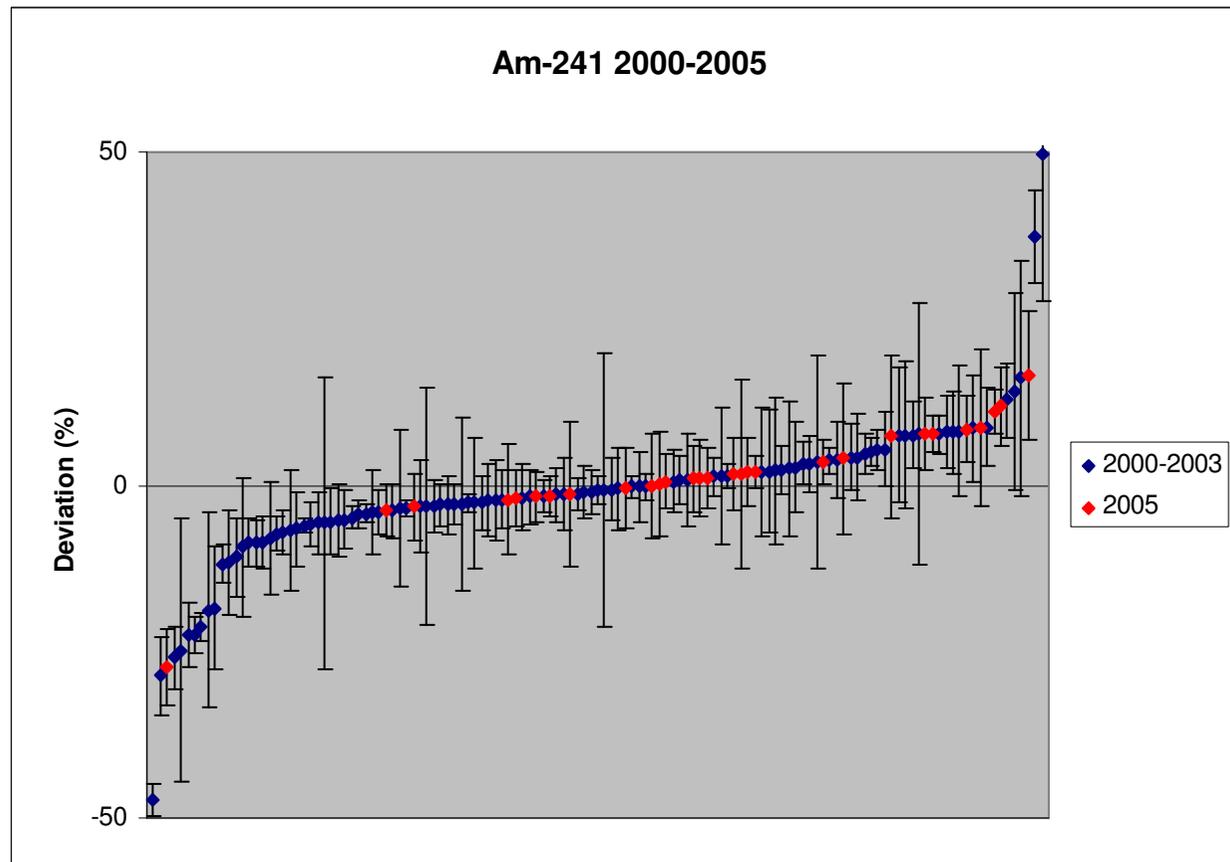
Pu-238 2000-2005



Pu-239 2000-2005



Am-241 2000-2005



Thank you