NPL

National Physical Laboratory

NPL REPORT IR 26

Environmental Radioactivity Proficiency Test Exercise 2010

ARVIC HARMS AND CHRIS GILLIGAN

DECEMBER 2011

National Measurement System

Environmental Radioactivity Proficiency Test Exercise 2010

Arvic Harms and Chris Gilligan
Acoustics and Ionising Radiation Division

ABSTRACT

The results of the sixteenth NPL Environmental Radioactivity Proficiency Test Exercise are reported. This exercise, now UKAS accredited, included preparing 260 samples and distributing them to 73 participants. Eight different sample types were offered: an aqueous mixture of six alpha emitters (AL), an aqueous mixture of six alpha emitters (AH), an aqueous mixture of three plutonium isotopes (P), an aqueous mixture of four beta emitters (B1), an aqueous mixture of four beta emitters (B2), an aqueous mixture of eight gamma emitters at two concentration levels (GL and GH) and a synthetic solid sample containing five radionuclides (S). The level of performance was slightly worse than observed in the previous Exercise (2009); 69% of the results returned were in agreement with the assigned values.

ISSN 1754-2952

National Physical Laboratory
Hampton Road, Teddington, Middlesex, TW11 0LW

Approved on behalf of NPLML by Bajram Zeqiri, Knowledge Leader AIR.

CONTENTS

1 INTRODUCTION

This environmental radioactivity proficiency test exercise (PTE) was the sixteenth in a series of similar exercises to have been conducted by NPL since 1989. The exercises are designed to identify analytical problems, to support UKAS accreditation (ISO 17025:2005) and to provide a regular forum for discussion and technology transfer in this area. The exercises are now run on an annual basis by NPL. In 2011, UKAS granted NPL accreditation for PTE providers to the new ISO 17043:2010 standard (Conformity assessment - General requirements for proficiency testing), which replaced the previous accreditation to ISO Guide 43 parts 1 and 2:1998 and ILAC Guide G13:2007, which was obtained in 2010. The schedule of accreditation for NPL, which includes all aqueous samples of the environmental radioactivity PTE, is available on the UKAS website (www.ukas.com) under accreditation number 0016.

The range of sample types available for analysis has been mainly aqueous. In the 2010 exercise, eight samples types were available for analysis:

(i) **AL**; a 'low-level' mixture of six α-emitting radionuclides in 500 g of dilute nitric acid (1 – 20 Bq kg^{-1} per radionuclide)
(ii) **AH**; a 'high-level' mixture of six α-emitting radionuclides in 20 g of dilute nitric acid (1 – 20 Bq g^{-1} per radionuclide)
(iii) **P**; a mixture of three plutonium isotopes in 20 g of dilute nitric acid (1 – 20 Bq g^{-1} per radionuclide)
(iv) **B1**; a mixture of four β-emitting radionuclides in 500 g of very dilute NaOH solution (0.1 – 2 Bq g^{-1} per radionuclide)
(v) **B2**; a mixture of four β-emitting radionuclides in 500 g of very dilute hydrochloric acid (0.1 – 2 Bq g^{-1} per radionuclide)
(vi) **GL**; a 'low-level' mixture of eight γ-emitting radionuclides in 500 g of dilute hydrochloric acid (1 – 20 Bq kg^{-1} per radionuclide)
(vii) **GH**; a 'high-level' mixture of eight γ-emitting radionuclides in 100 g of dilute hydrochloric acid (1 – 20 Bq g^{-1} per radionuclide)
(viii) **S**; a solid SiO_2 sample containing five radionuclides (0.1 – 20 Bq g^{-1} per radionuclide)

This report describes how the exercise was carried out. As in previous years, the principal objective was to assess the performance of the participating laboratories. This required the participants to identify and/or traceably quantify the activity levels of radionuclides present in the samples, whereas the tasks of NPL were to prepare and distribute the samples to the participating laboratories, to collect, analyse and interpret the results and to compile a comprehensive report.

The assigned activity concentration values of all the radionuclides were traceable to national standards of radioactivity. The traceability to national standards in turn provides traceability at an international level to the ultimate reference point of all measurements, the SI reference value maintained by the Bureau International des Poids et Mesures (BIPM).

The measurement of samples was expected to demonstrate each participant's ability (i) to identify and quantify the activity levels of the radionuclides present in the GL and/or GH sources without prior knowledge of the radionuclide content, (ii) quantify the activity levels of the radionuclides present in the AL, AH, P, B1, B2 and/or S sources with prior knowledge of the radionuclide content, (iii) to complete the measurement in a timely manner and (iv) to provide a full uncertainty budget for each measurement.

As in previous exercises, a list of the radionuclides present in the AL (containing a mixture of ^{226}Ra, ^{232}Th, ^{238}U, ^{239}Pu, ^{241}Am and ^{244}Cm) and AH sources (containing a mixture of ^{210}Pb/^{210}Po, ^{237}Np, ^{238}Pu, ^{239}Pu, ^{241}Am and ^{244}Cm), the B1 sources (containing a mixture of ^{3}H, ^{14}C, ^{36}Cl and ^{99}Tc), the B2 sources (containing a mixture of ^{3}H, ^{55}Fe, ^{89}Sr and ^{90}Sr) and the S sources (a solid SiO_2 sample containing a mixture of ^{60}Co, ^{137}Cs, ^{152}Eu, ^{154}Eu and ^{241}Am) was provided in advance of the exercise. A similar list was not provided for the GL and GH mixtures, since the measurement technique is non-invasive and readily enables unambiguous identification of the nuclides present, although the following candidate list of possible gamma-emitters was provided:

^{7}Be, ^{22}Na, ^{40}K, ^{46}Sc, ^{51}Cr, ^{54}Mn, ^{59}Fe, ^{56}Co, ^{57}Co, ^{58}Co, ^{60}Co, ^{65}Zn, ^{85}Sr, ^{88}Y, ^{91}Y, ^{95}Zr, ^{95}Nb, ^{103}Ru, ^{106}Ru, ^{109}Cd, ^{110m}Ag, ^{111}Ag, ^{113}Sn, ^{123m}Te, ^{124}Sb, ^{125}Sb, ^{125}I, ^{129}I, ^{134}Cs, ^{137}Cs, ^{133}Ba, ^{140}Ba, ^{139}Ce, ^{141}Ce, ^{144}Ce, ^{147}Nd, ^{152}Eu, ^{154}Eu, ^{155}Eu, ^{153}Gd, ^{160}Tb, ^{166m}Ho, ^{170}Tm, ^{192}Ir, ^{203}Hg and ^{207}Bi.

The data treatment was similar compared to the previous 2009 exercise. A result was only classified as 'in agreement' when three tests (the zeta test, the relative uncertainty outlier test and the *z*-test) were passed. A failure to pass one of these tests resulted in a classification 'questionable'. Failure of both the zeta test and the *z*-test resulted in a classification 'discrepant'. The graphical representation of the data is similar to that used in the 2009 exercise: (i) the colour-coded deviation plots (dark blue points = results in agreement with NPL; yellow points = questionable results; red points = discrepant results); (ii) 'zeta score' plots, (iii) relative uncertainty plots and (iv) 'Kiri plots'.

2 MATERIALS AND METHODS

2.1 PARTICIPANTS

A total of 70 participants took part in the exercise (37 from the United Kingdom and 33 from overseas organisations). A full listing is given in Appendix O. The majority of the samples taken were the GL and GH (45 and 35 participants, respectively). Uptake for the AL, AH, P, B1, B2 and S samples was 29, 20, 16, 30, 29 and 26, respectively (for details see Appendix E).

2.2 COMPOSITION OF SAMPLES

To prepare the sources, a number of standardised single radionuclide solutions were combined and diluted as necessary. This was performed in accordance with established procedures that have been independently accredited by the United Kingdom Accreditation Service (UKAS) for the production of solution standards of radioactivity. The final activity concentration for each radionuclide was determined by dividing the initial single-radionuclide activity concentration by the dilution factors as determined from weighing (i.e., the Gravimetric Dilution Factors, or 'GDFs'). Sets of mixed-radionuclide sources were prepared and counted at each dilution stage in order to derive 'Radiometric Dilution Factors' (RDFs) to confirm those derived gravimetrically. The radionuclides included were all derived from existing stocks of radioactive sources at NPL. The radionuclides were standardised as follows:

^{7}Be, **^{95}Zr**, **^{95}Nb, ^{154}Eu, ^{210}Pb**

^{134}Cs, **^{137}Cs**, **^{152}Eu**, **^{226}Ra** and **^{237}Np** – standardised in an ionisation chamber that had been calibrated by solutions previously standardised by coincidence counting techniques.

^{60}Co, **^{239}Pu**, **^{241}Am** and **^{244}Cm** – standardised by absolute counting techniques.

^{36}Cl, ^{89}Sr, **^{90}Sr**, and **^{99}Tc** – standardised by liquid scintillation counting (using the CIEMAT / NIST efficiency tracing method with ^{3}H).

^{55}Fe – standardised by a medium-pressure proportional counter.

^{3}H, **^{232}Th**, **^{238}U**, **^{238}Pu** and **^{14}C** – traceable to a national standard of radioactivity.

Each radionuclide was checked for impurities either by alpha spectrometry, gamma-ray spectrometry or by reference to the original calibration certificate. The following impurities were found: ^{240}Pu and ^{241}Pu (in the ^{239}Pu source) and ^{85}Sr (in the ^{89}Sr source). Negligible amounts of ^{239}Pu, ^{240}Pu, ^{241}Pu and ^{242}Pu were present in the ^{238}Pu source. The ^{244}Cm source contained a small amount of its daughter ^{240}Pu and negligible amounts of contaminants (^{245}Cm, ^{246}Cm, ^{247}Cm and ^{248}Cm). A detailed overview of the source preparation and dilution checks can be found in Appendices C and D.

2.3 REFERENCE TIME

The reference time for all activity concentrations was 1 October 2010 12:00 UTC.* The deadline for the submission of results was 1 December 2010. In some cases, an extension of the deadline was granted (see Appendix E for details).

2.4 DETECTOR SYSTEMS

2.4.1 Gamma-ray spectrometry

"Maggie" is a calibrated detector with a high purity germanium n-type crystal with a relative efficiency of 11.1% at 1332 keV. It has a beryllium end cap to allow measurements at low energies. It is calibrated for aqueous solution, the geometry being 1 ml in a 2 ml ampoule. Calibration is achieved via ampoules containing single nuclide solutions which either a) have been directly measured on the NPL ionisation chambers or b) contain solutions standardised by absolute techniques at NPL. In this way, the calibration is linked as closely to NPL primary standards as practicable. Impurity determinations of solutions assayed by ionisation chamber were performed on this detector.

"Sir Robin" and "Galahad" are detectors with a high purity germanium p-type crystal with relative efficiencies of 70% at 1332 keV. The crystal sits inside a low background lead shield consisting of an outer layer of 11 cm 'contemporary' lead at 500 Bq kg^{-1} ^{210}Pb and an inner layer of 9 cm 'old' Tudor lead at 5-10 Bq kg^{-1} ^{210}Pb. There is no copper/cadmium grading as the sources assayed are typically not active enough to produce large amounts of X-rays. Neither layer of lead contains any antimony. "Sir Robin" and "Galahad" were used to perform measurements on selected samples taken from batches prepared for the participants. These measurements were required for QA purposes.

All systems use commercially-available analogue electronics to condition and analyse the signals from the detectors. Top-end spectroscopy amplifiers (Canberra 2025 or Ortec 672) are used throughout to maximise stability and resolution. The data acquisition system consists of Canberra ADC/MCAs connected via an Ethernet network to three workstations running the Canberra Genie 2000 v2.1 software. The commercial software is used to control data acquisition and to determine peak areas only, with all subsequent calculations being performed by NPL staff. The calibrated detector "Maggie" uses the established pulser technique to perform dead time and pulse pile-up corrections. A high stability BNC PB5 pulser unit is used to provide tail pulses to the test input of the preamplifier such that an additional peak appears in the spectrum at 2.3 MeV. The pulse frequency is controlled by a calibrated NPL pulser unit which produces trigger pulses at a well-defined frequency of 10 Hz. The fraction of pulses observed in the spectrum is used to make an estimate of the losses due to dead time and pulse pile-up. A further correction is required to take account of the non-random nature of the pulses from the pulse generator, however this is usually insignificant, being of the order of 0.01%. The standard live time correction is applied on the environmental-level detectors "Sir Robin" and "Galahad". This technique has been demonstrated to work well when the amplifier and ADC are matched and when the input count rate is not high. A well-type NaI(Tl) gamma-ray detector was used to determine Radiometric Dilution Factors and thus confirm Gravimetric Dilution Factors (for the GL and GH samples; see Appendix D for more details).

2.4.2 Liquid scintillation counting

A Packard (Packard Instrument Co., Meriden, CT, USA) Tri-Carb model 2700 TR scintillation spectrometer (with range 0-2000 keV), 20-ml low-potassium glass vials and EcoScint A, EcoScint H and Ultima Gold AB liquid scintillation cocktails were used to standardise ^{89}Sr, ^{90}Sr and ^{99}Tc using the CIEMAT/NIST method. Each vial contained 10 g of liquid scintillation

* Universal Time, Coordinated, which replaced GMT in 1972.

cocktail and 1.0 g of aqueous phase (containing either the ^{89}Sr, ^{90}Sr and ^{99}Tc or the ^{3}H standard source) resulting in a total volume of approximately 11 ml for all samples. Subsequently, the vials were swirled thoroughly and placed in the counter to cool and dark-adapt. Quenching was measured using the tSIE parameter (transformed Spectral Index of the External standard), which has a range of 0-1000, where 0 indicates a completely quenched sample and 1000 an unquenched sample. All count rates were corrected for background. The computer programmes CN2004 (PTB, Braunschweig, Germany), Matlab and Axum-7 were used to calculate the activities.
The same counter was also used to confirm Gravimetric Dilution Factors for the AL, AH, B1 and B2 samples using Cerenkov counting and liquid scintillation counting; (see Appendix D for more details).

2.4.3 Ionisation Chamber

A TPA MkII ionisation chamber, which contains a counting gas of argon at 2 MPa, was used. This chamber has been monitored daily for almost 30 years using the same radium test source, and its variation in response has been found to be less than 0.1% over that period. The chamber converts ionising radiation into electrical current, which is measured using a voltage integrator circuit; the important components of which are calibrated in a manner traceable to national standards every six months. The conversion from current to source activity in Becquerels is nuclide-dependent, and is derived by measuring a source that has been standardised using primary standardisation methods. The chamber is linear over a large dynamic range (sub-pA equivalent activities up to micro-amps) and is intrinsically free from dead-time. Operation at the high end of the current range is only limited by space-charge recombination effects, where the density of ions in the chamber approaches a level where ions recombine before they are swept by the applied high voltage to the charge collection wires, thus diminishing the measured current and introducing a non-linear component into the chamber response.
The geometry of the source affects the response of the chamber, and so sources are typically decanted into standard vials of known composition and suspended inside the chamber using a special holder; corrections for source volume are also applied, as the depth of liquid in the standard vial also has a small effect on the overall response. Analysis of results is exceptionally simple – the accumulated charge in the feedback capacitor is derived from the voltage drop across it, and an average current is worked out based on the elapsed time of the measurement. The average current is then converted to source activity by applying the appropriate calibration factor. If the source is discovered to be contaminated (deduced from gamma-spectroscopy measurements, or half-life determinations) then it may be necessary to analyse the result using a multi-component model for the source; this does not introduce any significant complexity into the analysis.

2.5 NUCLIDES

2.5.1 AL, AH and P samples

The nuclides listed below were the principal radionuclides present in the AL, AH and P samples. The composition of the AL and AH samples was different from the AL and AH samples offered in the last exercise: (i) ^{237}Np was omitted from the AL samples, whilst ^{226}Ra was added and (ii) ^{226}Ra was omitted from the AH samples, whilst $^{210}Pb/^{210}Po$ was added.

2.5.1.1 Lead-210 (AH)

This naturally-occurring nuclide decays mainly by emission of beta minus particles (E_{max} = 63.5 keV) to the short-lived radionuclide ^{210}Bi and is part of the uranium-radium decay series. It occurs widely in the environment. Lead-210 was standardised using X.

2.5.1.2 Polonium-210 (AH)
This naturally-occurring nuclide decays by emission of alpha particles to stable ^{206}Pb and is part of the uranium-radium decay series. It occurs widely in the environment. It was assumed that ^{210}Po was in equilibrium with ^{210}Pb.

2.5.1.3 Radium-226 (AL)
This naturally-occurring nuclide decays by emission of alpha particles to the short-lived radionuclide ^{222}Rn and is part of the uranium-radium decay series. It occurs widely in the environment. The ^{226}Ra source was standardised using an ionisation chamber. The ^{226}Ra source contained ^{210}Pb, ^{210}Bi and ^{210}Po (each ingrown to ~37% of the ^{226}Ra activity).

2.5.1.4 Thorium-232 (AL)
This naturally occurring primordial nuclide decays by emission of alpha particles to ^{228}Ra. It occurs widely in the environment. The ^{232}Th source was traceable to a national standard of radioactivity. The ^{232}Th source was in equilibrium with its daughters.

2.5.1.5 Neptunium-237 (AH)
This nuclide is produced by the decay of short-lived ^{237}U, which is formed by a ^{238}U (n,2n) reaction. It decays mainly by emission of alpha particles to relatively short-lived ^{233}Pa which subsequently undergoes beta minus decay to ^{233}U. The ^{237}Np source was standardised using an ionisation chamber.

2.5.1.6 Uranium-238 (AL)
This naturally occurring primordial nuclide decays mainly by emission of alpha particles to relatively short-lived ^{234}Th. It occurs widely in the environment. The ^{238}U source was traceable to a national standard of radioactivity.

2.5.1.7 Plutonium-238 (AH and P)
This nuclide is produced by neutron activation of ^{237}Np (after decay of short-lived ^{238}Np). It decays mainly by emission of alpha particles to ^{234}U. It occurs in the environment as a result of discharges from the nuclear industry. The ^{238}Pu source was traceable to a national standard of radioactivity. It contained a small amount of contaminants (^{239}Pu, ^{240}Pu, ^{241}Pu and ^{242}Pu; together these amounted to approximately 0.01% of the total activity).

2.5.1.8 Plutonium-239 (AL, AH and P)
This nuclide is produced by neutron activation of ^{238}U (after decay of the short-lived radionuclides ^{239}U and ^{239}Np). It decays mainly by emission of alpha particles to ^{235m}U which subsequently decays by isomeric transition to ^{235}U. It occurs widely in the environment as a result of weapon tests and discharges from the nuclear industry. The ^{239}Pu source was standardised by absolute counting techniques. The source contained small amounts of contaminants (^{240}Pu, ^{241}Pu and ^{241}Am: together these amounted to about 1% of the total activity).

2.5.1.9 Plutonium-241 (P)
This nuclide is produced by neutron activation of ^{240}Pu. It undergoes mainly beta minus decay (E_{max} = 20.8 keV) to ^{241}Am. It occurs in the environment as a result of discharges from the nuclear industry. It contained a small amount of contaminants (^{238}Pu, ^{239}Pu, ^{240}Pu, ^{242}Pu and ^{244}Pu; together these amounted to 0.067% of the total activity).

2.5.1.10 Americium-241 (AL, AH and S)
This nuclide is produced by the decay of ^{241}Pu. It decays mainly by emission of alpha particles to ^{237}Np. It occurs widely in the environment as a result of weapon tests and discharges from the nuclear industry. The ^{241}Am source was standardised by absolute counting techniques.

2.5.1.11 Curium-244 (AL and AH)
This nuclide is produced by multiple neutron activation of ^{238}U, ^{239}Pu and ^{243}Am. It decays by emission of alpha particles to ^{240}Pu. It occurs in the environment as a result of weapon tests and discharges from the nuclear industry. The ^{244}Cm source was standardised by absolute counting techniques. The ^{244}Cm source contained small amounts of contaminants (^{240}Pu: 0.21%; ^{245}Cm, ^{246}Cm, ^{247}Cm and ^{248}Cm: together these amounted to <0.002% of the total activity).

2.5.2 B1 samples

The nuclides listed below were the principal radionuclides present in the B1 samples. The composition of the B1 sample was different from the B1 sample offered in the last exercise: ^{129}I was omitted, whilst ^{36}Cl was added.

2.5.2.1 Hydrogen-3 (Tritium)
This nuclide is produced by neutron activation of deuterium and neutron induced fission and spallation. It occurs widely in the environment as a result of cosmic ray interactions, releases from nuclear weapon tests and discharges from the nuclear industry. It undergoes beta minus decay (E_{max} = 18.6 keV) to ^{3}He. The chemical form of ^{3}H in the B1 samples was tritiated water. The ^{3}H source was traceable to a national standard of radioactivity.

2.5.2.2 Carbon-14
This nuclide is formed by interaction of ^{14}N with neutrons produced in the upper atmosphere by cosmic-ray interactions. It undergoes beta minus decay (E_{max} = 156 keV) to ^{14}N. It occurs widely in the environment as a result of the natural process mentioned above and as a result of releases from nuclear weapon tests and discharges from the nuclear industry. The chemical form of ^{14}C in the B1 samples was sodium carbonate. The carbon-14 source was traceable to a national standard of radioactivity.

2.5.2.3 Chlorine-36
This long-lived nuclide is produced by neutron activation of ^{35}Cl. It decays by beta minus emissions (E_{max} = 709 keV) to ^{36}Ar (98.1%) and by electron capture (1.9%) and beta plus emissions (0.0015%) to ^{36}S. It occurs in some environmental samples, due to discharges from the nuclear industry. Chlorine-36 was standardised by liquid scintillation counting (using CIEMAT / NIST efficiency tracing with ^{3}H).

2.5.2.4 Technetium-99
This long-lived nuclide is produced by neutron induced fission of ^{235}U and ^{239}Pu. It undergoes beta minus decay (E_{max} = 294 keV) to ^{99}Ru. It occurs widely in the marine environment as a result discharges from the nuclear industry. The ^{99}Tc source was standardised by liquid scintillation counting (using CIEMAT / NIST efficiency tracing with ^{3}H).

2.5.3 B2 samples

The nuclides listed below were the principal radionuclides present in the B2 samples. The composition of the B2 sample was identical to the B2 offered in the last exercise.

2.5.3.1 Hydrogen-3 (Tritium)
This nuclide is produced by neutron activation of deuterium and neutron induced fission and spallation. It occurs widely in the environment as a result of cosmic ray interactions, releases from nuclear weapon tests and discharges from the nuclear industry. It undergoes beta minus decay (E_{max} = 18.6 keV) to ^{3}He. The chemical form of ^{3}H in the B2 samples was tritiated water. The ^{3}H source was traceable to national standards of radioactivity.

2.5.3.2 Iron-55
This nuclide is produced by neutron activation of ^{54}Fe. It decays via electron capture to ^{55}Mn. Iron-55 may be present in environmental samples originating from the nuclear industry. The ^{55}Fe source was standardised by a medium-pressure proportional counter.

2.5.3.3 Strontium-89

This relatively short-lived nuclide is formed by neutron induced fission of ^{235}U and ^{239}Pu (and/or neutron activation of ^{88}Sr). It undergoes beta minus decay (E_{max} = 1495 keV) to ^{89}Y. Significant activities of ^{89}Sr were released in the environment due to atmospheric nuclear weapon tests in the 1950s and 1960s and the Chernobyl accident, although this has now decayed to negligible environmental concentrations. Fission-produced ^{90}Sr is always accompanied by ^{89}Sr, which activity dominates in fresh mixtures of fission products. Strontium-89 was standardised by liquid scintillation counting (using CIEMAT / NIST efficiency tracing with ^{3}H). The ^{89}Sr source contained a small amount of ^{85}Sr (0.22% of the ^{89}Sr activity at the reference time), which was determined with gamma spectrometry.

2.5.3.4 Strontium-90

This nuclide is produced by neutron induced fission of ^{235}U and ^{239}Pu. It undergoes beta minus decay (E_{max} = 546 keV) to ^{90}Y which subsequently decays in the same way (E_{max} = 2280 keV) to ^{90}Zr. It occurs widely in the environment as a result of weapon tests and discharges from the nuclear industry. The ^{90}Sr source was standardised by liquid scintillation counting (using CIEMAT / NIST efficiency tracing with ^{3}H).

2.5.4 GH and GL samples

The nuclides listed below were the principal radionuclides added to the gamma- emitting sample types (GL and GH). The composition of the GL and GH samples was different from that in the last exercise: ^{65}Zn, ^{85}Sr, ^{125}Sb and ^{133}Ba were omitted, whilst ^{7}Be, ^{95}Zr, ^{95}Nb and ^{154}Eu were added.

2.5.4.1 Beryllium-7

This nuclide, which is formed in the atmosphere by interactions between cosmic radiation and ^{12}C, decays via electron capture to ^{7}Li. The percentage of disintegrations producing a gamma-ray emission at 478 keV is 10.44%. Beryllium-7 was standardised using an ionisation chamber.

2.5.4.2 Cobalt-60

This nuclide is mainly produced by neutron activation of ^{59}Co. It undergoes beta minus decay to excited levels of ^{60}Ni. The percentage of disintegrations producing a gamma-ray emission at 1173 and 1332 keV is 99.85(3)% and 99.9826(6)%, respectively. This nuclide may show coincidence summing effects on high efficiency detectors. Cobalt-60 is present in the environment due to discharges from the nuclear industry and it is used as a calibration nuclide. Cobalt-60 was standardised by absolute counting techniques.

2.5.4.3 Zirconium-95

This fission product undergoes beta minus decay to both ^{95}Nb (98.8%) and ^{95m}Nb (1.2%). Significant activities of ^{95}Zr were released in the environment due to atmospheric nuclear weapon tests in the 1950s and 1960s and the Chernobyl accident, although this has now decayed to negligible environmental concentrations. Zirconium-95 was standardised using gamma-ray spectrometry.

2.5.4.4 Niobium-95

This radionuclide is the daughter of both ^{95}Zr and ^{95m}Nb and is therefore present in any ^{95}Zr source due to ingrowth. The ^{95}Zr / ^{95}Nb system was not in equilibrium at the time of measurement, due to the relatively long half life of the ^{95}Nb. Niobium-95 undergoes beta minus decay to excited levels of ^{95}Mo. A modified form of the Bateman equations taking account of the multiple branching of the parents must be used to determine the activity concentration as a function of time. Niobium-95 was standardised using gamma-ray spectrometry.

2.5.4.5 Caesium-134
This activation product undergoes beta plus decay to excited levels of ^{134}Xe and beta minus decay to excited levels of ^{134}Ba. It is present in nuclear waste and various ecosystems. Caesium-134 is well known as a nuclide which shows large coincidence summing effects on high efficiency detectors. Caesium-134 was standardised using an ionisation chamber.

2.5.4.6 Caesium-137
This fission product undergoes beta minus decay to ^{137m}Ba which subsequently decays by isomeric transition with the emission of a 662 keV gamma-ray line. The half-life of ^{137m}Ba is so short (i.e., 2.6 minutes) that effectively the 662 keV line may be considered a gamma-ray emission of ^{137}Cs for most purposes. It occurs widely in the environment and it is also used as a calibration nuclide. Caesium-137 was standardised using an ionisation chamber.

2.5.4.7 Europium-152
This activation product decays via electron capture (72.1%) to excited levels of ^{152}Sm and by beta minus emissions (27.9%) to excited levels of ^{152}Gd. Europium-152 is often present in nuclear waste and is well known as a nuclide which shows large coincidence summing effects on high efficiency detectors. Europium-152 was standardised using an ionisation chamber.

2.5.4.8 Europium-154
This nuclide is produced in concrete by neutron activation of europium (^{153}Eu). It undergoes mainly beta minus decay (99.982%) to ^{154}Gd excited levels. Europium-154 is well known as a nuclide which shows large coincidence summing effects on high efficiency detectors.

2.5.5 S samples

The nuclides listed below were the principal radionuclides present in the S samples.

Cobalt-60 (see Section 2.5.4.2)

Caesium-137 (see Section 2.5.4.6)

Europium-152 (see Section 2.5.4.7)

Europium-154 (see Section 2.5.4.8)

Americium-241 (see Section 2.5.1.10)

2.6 TREATMENT OF DATA

The laboratory data were reported back to the participants in order for the participants to check for gross errors. The deviation from the assigned (NPL) value for each laboratory value is given by:

$$D = \frac{L - N}{N} = \left(\frac{L}{N} - 1\right) \quad [1]$$

The error bars in the graphs represent the standard uncertainty (k=1) of the deviation:

$$u_{\mathrm{D}} = \frac{L}{N}\sqrt{\left(\frac{u_{\mathrm{L}}}{L}\right)^2 + \left(\frac{u_{\mathrm{N}}}{N}\right)^2} \quad [2]$$

The results were evaluated by three tests:

$$\zeta = \frac{L - N}{\sqrt{u_{\mathrm{L}}^2 + u_{\mathrm{N}}^2}} \quad [3]$$

$$R_L = \frac{u_{\mathrm{L}}}{L} \quad [4]$$

$$z = \frac{L - N}{\sigma_p} = \frac{L - N}{0.05823\,N} \quad [5]$$

where:		unit:
D	– deviation from the assigned value	
L	– laboratory value	(Bq kg^{-1} or Bq g^{-1})
N	– assigned value	(Bq kg^{-1} or Bq g^{-1})
u_{D}	– standard uncertainty of the deviation	
u_{L}	– standard uncertainty of the laboratory value	(Bq kg^{-1} or Bq g^{-1})
u_{N}	– standard uncertainty of the assigned value	(Bq kg^{-1} or Bq g^{-1})
ζ	– zeta score	
R_{L}	– relative uncertainty of the laboratory value	
z	– z-score	
σ_{p}	– standard uncertainty for proficiency assessment	(Bq kg^{-1} or Bq g^{-1})

The zeta and z-scores were used to determine whether the difference between the laboratory value and the assigned value were significantly different from zero. The Interquartile Range (IQR) outlier test (see Appendix G) was used to determine whether the relative uncertainty of the laboratory value R_{L} was significantly larger than the other values in the data set. This test is unable to identify outliers if the data set is smaller than 7.

Results for which the absolute values of the zeta score and the z-score are both ≤ 2.576 (corresponding to a significance levels of $\alpha = 0.01$) and for which the relative uncertainty R_{L} is not significantly larger than the other values in the data set is taken to mean that the laboratory value is ‘in agreement’ (dark blue points). If either (i) the relative uncertainty R_{L} is significantly larger than the other values in the data set, (ii) the result passes the zeta test but not the z-test (i.e., there is a large deviation from the assigned value combined with a large uncertainty), or (iii) the result passes the z-test but not the zeta test (where there is a small deviation from the assigned value and a small uncertainty), the laboratory value is classified as 'questionable' (yellow points). If the absolute values of both the zeta score and the z-score > 2.576, then the laboratory value is classified as 'discrepant' from the assigned value (red points), whatever the value of its relative uncertainty R_L. The factor of 0.05823 used to calculate the z-score is the ratio between 0.15 (i.e. a deviation of 15%) and 2.576. In other words, a deviation D with an absolute value of ≤ 15% will suffice to pass the z-score.

zeta test	R_L test	z test	Classification
pass	pass	pass	in agreement
pass	fail	pass	questionable
fail	pass	pass	questionable
pass	pass/fail	fail	questionable
fail	pass/fail	fail	discrepant

The zeta score and the z-score are related by Equation 6:

$$\zeta = \frac{\sigma_P}{\sqrt{u_L^2 + u_N^2}} z \qquad [6]$$

This can be rewritten as:

$$\frac{z^2}{\zeta^2} - \frac{u_N^2}{\sigma_P^2} = \frac{u_L^2}{\sigma_P^2} \qquad [7]$$

The relative uncertainty of the laboratory R_L and the z-score are related by Equation 8:

$$\frac{u_L}{R_L} = z\sigma_P + N \qquad [8]$$

This can be rewritten as:

$$R_L^2\left(z + \frac{N}{\sigma_P}\right)^2 = \frac{u_L^2}{\sigma_P^2} \qquad [9]$$

So-called 'Kiri' plots were constructed by plotting the squares of the ratio between the uncertainty u_L and the target uncertainty σ_p against the z-score (see Appendix F). The central parabola represents a zeta score of 2.576. The left parabola represents the outlier limit R_{lim} of the relative laboratory uncertainty R_L.

Data points that are inside the ζ = 2.576 parabola (i.e., for which –2.576 ≤ ζ ≤ 2.576), for which –2.576 ≤ z-score ≤ 2.576 and which are outside the R_{lim} parabola (i.e., for which $R_L \leq R_{lim}$) are designated 'in agreement' (dark blue points).

'Questionable' data points (yellow points), which fail either the z-test, the zeta test or the relative uncertainty outlier test (but not both the z-test and zeta test), are either:

(i) inside the ζ = 2.576 parabola with a z-score < –2.576* or > 2.576,

(ii) outside the ζ = 2.576 parabola with –2.576 ≤ z-score ≤ 2.576 or

* Please note that the z-test value ≥ (–N / σ_p) by definition (i.e., in this case z-test value ≥ –17.17)

(iii) inside the ζ = 2.576 parabola with –2.576 ≤ z-score ≤ 2.576 but inside the R_{lim} parabola (i.e., for which $R_{\mathrm{L}} > R_{\mathrm{lim}}$).

All other data points are 'discrepant' (red points).

2.7 HOMOGENEITY TESTING OF S SAMPLES

The between-sample variance was determined by measuring all samples (n = 76) once with high-resolution gamma spectrometry, while the measurement variance was determined by measuring a single sample m times (m = 10). For each sample, decay-corrected count rates per unit mass x_i or x_j for ^{60}Co (1173 keV peak), ^{137}Cs (662 keV peak), ^{152}Eu (121 keV peak), ^{154}Eu (1274 keV peak) and ^{241}Am (60 keV peak) with their corresponding counting uncertainties u_i or u_j were determined. The homogeneity uncertainty was calculated as the difference between the between-sample variance and either (i) the measurement variance or (ii) the squared mean of the counting uncertainties (whichever was greater). In cases where the between-sample variance was smaller than either the measurement variance or the squared mean of the counting uncertainties, the value of relative homogeneity uncertainty was set to zero. The uncertainty of the assigned value u_{N} was obtained by quadrature summation of the relative homogeneity uncertainty, the stability uncertainty (2.5%) and the relative uncertainty on the NPL value for mixed nuclide solution. More information on the homogeneity uncertainty can be found in Appendix C8.

$$u_{bb} = \sqrt{\frac{\sum_i \left(x_i - \bar{x}_i\right)^2}{n-1}}\left(\frac{1}{\bar{x}_i}\right)$$

$$u_{\mathrm{meas}} = \sqrt{\frac{\sum_j \left(x_j - \bar{x}_j\right)^2}{m-1}}\left(\frac{1}{\bar{x}_j}\right)$$

$$u_{\mathrm{int}} = mean\left(\frac{u_i}{x_i}\right)$$

$$u_{\mathrm{hom}}^2 = u_{bb}^2 - u_{meas}^2 \quad \text{or} \quad u_{\mathrm{hom}}^2 = u_{bb}^2 - u_{\mathrm{int}}^2 \quad \text{(whichever gives the lower result)}$$

$$u_{N,\,rel}^2 = u_{\mathrm{cons}}^2 + u_{\mathrm{hom}}^2 + u_{\mathrm{stab}}^2$$

$$u_{N*} = u_{N,rel}\ N$$

where:		unit:
n	– number of samples tested	
x_i	– decay-corrected count rate per unit mass for sample i	(cps g^{-1})
u_{bb}	– relative standard deviation of x_i	
m	– number of measurements on single selected sample	
x_j	– decay-corrected count rate per unit mass for sample j	(cps g^{-1})
u_i	– standard uncertainty of x_i	(cps g^{-1})
u_{meas}	– relative measurement uncertainty	
u_{int}	– mean of the relative uncertainties of x_i	
u_{cons}	– relative uncertainty of the consensus value	
u_{hom}	– relative homogeneity uncertainty	
u_{stab}	– relative stability uncertainty	
$u_{N,\mathrm{rel}}$	– relative uncertainty of the assigned value N	

2.8 COMPARISON OF THE ASSIGNED VALUES WITH THE PARTICIPANTS' VALUES

The means and the uncertainties for the participants' results of the aqueous samples were calculated in accordance with the method described in Appendix H and subsequently compared with the assigned values. The mean N^* was tested against the assigned value N using this equation:

$$t = \frac{N^* - N}{\sqrt{(u_N)^2 + (u_N^*)^2}}$$

The effective degrees of freedom v_{eff} were determined with the simplified Welch-Satterthwaite equation (it is assumed that the degrees of freedom for u_{N} are infinite).

$$v_{eff} = \frac{\left((u_N)^2 + (u_N^*)^2\right)^2}{(u_N^*)^4}(p-1)$$

The effective degrees of freedom v_{eff} were rounded and t_{crit} was identified from the values tabulated in Appendix J. The criteria for passing the t test is:

$-t_{crit} < t < t_{crit}$

If the value of t lies outside this range, this indicates there is a significant difference between the participants' results and the assigned value.

2.9 UNCERTAINTIES

Uncertainties quoted in this report are (combined) standard uncertainties with a coverage factor of k=1, unless otherwise indicated. The numerical result of a measurement is stated in the format xxx(y), where the number in parentheses is the numerical value of the standard uncertainty referred to the corresponding last digits of the quoted result.

2.10 NUCLEAR DATA

This was not supplied to the participants, but currently recommended values for half-life data are given in Appendix I and these are the values used by NPL to provide the reference values in this exercise. Although there are discrepancies between the half-life data used by NPL and those used by the participants, the differences are minor and make little or no difference to the overall results. The choice of gamma-ray emission probabilities assumes similar importance to the half-life values in this exercise, although the choice is an important one, affecting as it does the calculation of the final result. Minor differences probably do not contribute greatly to the overall acceptability of any particular result, although in the interests of assuring the quality of data reported and minimising discrepancies between laboratories, it would be in the interests of all concerned to use a common data set.

2.11 NIOBIUM-95 AND ZIRCONIUM-95

Zirconium-95 decays to both ^{95}Nb (98.88%) and ^{95m}Nb (1.12%). Niobium-95m decays to both ^{95}Nb (97.5%) and stable ^{95}Mo (2.5%) and was in secular equilibrium with its mother ^{95}Zr at the reference time. Niobium-95 is the daughter of both ^{95}Zr and ^{95m}Nb and was therefore present in the ^{95}Zr source due to ingrowth. An integrated form of the Bateman equations taking account of the multiple branching of the parents must be used to determine the activity concentration as a function of time.*

The ^{95}Nb / ^{95}Zr ratio as a function of time is given by the Equation below:

$$\frac{A_3(t)}{A_1(t)} = \frac{(1-p)\lambda_3}{(\lambda_3-\lambda_1)}\left(1-e^{(\lambda_1-\lambda_3)t}\right)+\frac{q\,p\,\lambda_2\,\lambda_3}{(\lambda_2-\lambda_1)}\left[\frac{\left(1-e^{(\lambda_1-\lambda_3)t}\right)}{(\lambda_3-\lambda_1)}-\frac{\left(e^{(\lambda_1-\lambda_2)t}-e^{(\lambda_1-\lambda_3)t}\right)}{(\lambda_3-\lambda_2)}\right]$$

for $t \to \infty$, *and* $\lambda_1 \langle \lambda_3 \langle \lambda_2$ *then*

$$\frac{A_3(\infty)}{A_1(\infty)} = \frac{(1-p)\lambda_3}{(\lambda_3-\lambda_1)}+\frac{q\,p\,\lambda_2\,\lambda_3}{(\lambda_2-\lambda_1)}\left[\frac{1}{(\lambda_3-\lambda_1)}\right] = \frac{\lambda_3}{(\lambda_3-\lambda_1)}\left[1-p+\frac{q\,p\,\lambda_2}{(\lambda_2-\lambda_1)}\right] = 2.2057(6)$$

This equation reduces to a transient equilibrium equation by setting $p = 0$.

$$\frac{A_3(\infty)}{A_1(\infty)} = \frac{\lambda_3}{(\lambda_3-\lambda_1)} = 2.2049(6)$$

The ratio between ^{95}Nb and ^{95}Zr at the reference time 1 October 2010 12:00 UTC was 2.175(25).

In order to take account of decay and ingrowth during acquisition the following equations can be used to calculate the ^{95}Nb activity at the start of the acquisition.

$$A_3\left(t_{ref}\right) = \frac{\lambda_3\,C_3\,(t_2-t_1)}{E_3} - R_1\left[\frac{\lambda_3 E_1}{\lambda_1 E_3}-1\right] - R_2\left[\frac{\lambda_3 E_2}{\lambda_2 E_3}-1\right]$$

with:

$$R_1 = \frac{\lambda_3\,A_1\left(t_{ref}\right)}{(\lambda_3-\lambda_1)}\left[1-p+\frac{q\,p\,\lambda_2}{(\lambda_2-\lambda_1)}\right]$$

$$R_2 = \frac{q\,\lambda_3}{(\lambda_3-\lambda_2)}\left[A_2\left(t_{ref}\right)-\frac{p\,\lambda_2\,A_1\left(t_{ref}\right)}{(\lambda_2-\lambda_1)}\right]$$

$$E_i = e^{-\lambda_i\left(t_1-t_{ref}\right)} - e^{-\lambda_i\left(t_2-t_{ref}\right)}$$

$t_{ref} \geq 0$ and $0 \leq t_1 < t_2$

It is helpful to express this equation as a function of C_1, C_2 and C_3, which are easily obtained as the reported ^{95}Zr, ^{95m}Nb and ^{95}Nb activities (i.e., the experimental background-corrected count rates divided by the decay probabilities and the detection efficiencies):

* More information is given in Harms, A., Johansson, L., MacMahon, D., 2009. Decay correction of ^{95}Nb. Applied Radiation and Isotopes, 67, 641-642.

$$A_3(t_{ref}) = F_{31}(t_1,t_2,t_{ref})\,C_1 + F_{32}(t_1,t_2,t_{ref})\,C_2 + F_{33}(t_1,t_2,t_{ref})\,C_3$$

with:

$$F_{31}(t_1,t_2,t_{ref}) = \left[\frac{\left((1-p)(\lambda_2-\lambda_1)+q\,p\,\lambda_2\right)(\lambda_1 E_3-\lambda_3 E_1)}{(\lambda_3-\lambda_1)(\lambda_2-\lambda_1)\,E_1} + \frac{q\,p\,\lambda_2(\lambda_3 E_2-\lambda_2 E_3)}{(\lambda_3-\lambda_2)(\lambda_2-\lambda_1)\,E_2}\right]\frac{\lambda_3(t_2-t_1)}{E_3}$$

$$F_{32}(t_1,t_2,t_{ref}) = \frac{q\,\lambda_3(t_2-t_1)}{(\lambda_3-\lambda_2)}\left[\frac{\lambda_2}{E_2}-\frac{\lambda_3}{E_3}\right]$$

$$F_{33}(t_1,t_2,t_{ref}) = \frac{\lambda_3\,(t_2-t_1)}{E_3}$$

where:		value
$A_1(t)$	– ^{95}Zr activity at time t	
$A_2(t)$	– ^{95m}Nb activity at time t	
$A_3(t)$	– ^{95}Nb activity at time t	
λ_1	– decay constant ^{95}Zr:	0.0108250(10) d^{-1}
λ_2	– decay constant ^{95m}Nb:	0.1920(16) d^{-1}
λ_3	– decay constant ^{95}Nb:	0.019809(4) d^{-1}
p	– decay probability of ^{95}Zr to ^{95m}Nb:	0.0112(10)
q	– decay probability of ^{95m}Nb to ^{95}Nb:	0.975(1)
t	– time since separation	
t_{ref}	– reference time	
t_1	– start of the acquisition	
t_2	– end of the acquisition	
C_1	– reported ^{95}Zr activity	
C_2	– reported ^{95m}Nb activity	
C_3	– reported ^{95}Nb activity	

3 RESULTS AND DISCUSSION

3.1 AL, AH AND P SAMPLES

Lead-210

Lead-210 can be measured by a variety of measurement techniques: these include gas-flow proportional counting and gamma spectrometry. The main difficulty in measuring the ^{210}Pb activity concentration with gas-flow proportional counting is the need for a radiochemical separation from the other radionuclides present in the sample.

Ten results were reported for the AH samples (see Figures 8A to 8D). Four results are in agreement with the assigned value, while one result is questionable. Five results are discrepant. The reported results show a significant positive bias. Most participants used gamma spectrometry to determine ^{210}Pb, while three participants (Labs 35, 46 and 106) used gas-flow proportional counting. There is no indication that there are significant differences between the results obtained from the various techniques used, although several gamma spectrometry results show a significant positive bias (Labs 8, 24, 55 and 129).

Reported AH results:	10
In agreement with the assigned value:	4
Questionable result:	1
Discrepant from the assigned value:	5

Polonium-210

Polonium-210 can be measured by alpha spectrometry. The main difficulty in measuring the ^{210}Po activity concentration is the need for a radiochemical separation from the other radionuclides present in the sample combined with decay correction (in this exercise ^{210}Po is in equilibrium with its grandmother ^{210}Pb).

Ten results were reported for the AH samples (see Figures 9A to 9D). Three results are in agreement with the assigned value, while four results are questionable. Three results are discrepant. The reported results show a significant positive bias. All participants used alpha spectrometry to determine ^{210}Po after spontaneous deposition of ^{210}Po on Ag disks. Two participants (Labs 1 and 47) used ^{208}Po as the yield tracer, while the other participants used ^{209}Po. There is no indication that there are significant differences between the results obtained from the two yield tracers used.

Reported AH results:	10
In agreement with the assigned value:	3
Questionable result:	4
Discrepant from the assigned value:	3

Radium-226

Radium-226 can be measured by a variety of measurement techniques: these include alpha spectrometry, liquid scintillation counting, gas-flow proportional counting, gamma spectrometry and ^{222}Rn emanation techniques. The main difficulty in measuring the ^{226}Ra activity concentration with alpha spectrometry, gas-flow proportional counting or liquid scintillation counting is the need for a radiochemical separation from the other radionuclides present in the sample.

Seventeen results were reported for the AL samples (see Figures 1A to 1D). Ten results are in agreement with the assigned value, while four results are questionable. Three results are discrepant. The reported results show no significant bias. Three participants (Labs 24, 42 and 86) used gamma spectrometry to determine ^{226}Ra (all three results were ‘questionable’ with a positive bias), six participants (Labs 8, 26, 32, 47, 106 and 129) used alpha spectrometry, three participants (Labs 25, 35 and 46) used gas-flow proportional counting, two participants (Labs 28 and 65) used a ^{222}Rn emanation technique and two participants (Labs 34 and 73) used liquid scintillation counting. A variety of yield tracers was used: ^{133}Ba (Labs 25, 26, 34, 35, 106 and 129), ^{223}Ra (Lab 47), and ^{224}Ra (Lab 32). A variety of separation techniques was used to separate ^{226}Ra from the matrix: precipitation techniques (Labs 25, 26, 34, 35, 46, 73, 106 and 129) and chromatography (Labs 8, 32 and 47). There is some indication that there are significant differences between the results obtained from the various techniques used.

Reported AL results:	17
In agreement with the assigned value:	10
Questionable result:	4
Discrepant from the assigned value:	3

Thorium-232

Thorium-232 can be measured by alpha spectrometry, gamma spectrometry and mass spectrometry. The main difficulty in measuring the ^{232}Th activity concentration with alpha spectrometry is the need for a radiochemical separation from the other radionuclides present in the sample.

Twenty results were reported for the AL samples (see Figures 2A to 2D). Eighteen results are in agreement with the assigned value, while one result is questionable. One result is discrepant. The reported results show no significant bias. Most participants used alpha spectrometry to determine ^{232}Th, while three participants (Labs 32, 34 and 47) used mass spectrometry and one participant (Lab 24) used gamma spectrometry. Ten participants (Labs 8, 13, 25, 28, 32, 35, 40, 46, 51 and 65) who used alpha spectrometry as the detection method used ion-exchange chromatography to separate the ^{232}Th from the matrix. Six participants (Labs 26, 47, 90, 106, 120 and 129) used extraction chromatography. Most participants used ^{229}Th as the yield tracer, while one participant (Lab 47) used ^{227}Th. Most participants who used alpha spectrometry as the detection method used electrodeposition to prepare the ^{232}Th sources. Labs 65 and 129 (who used LaF_3) and Lab 106 (who used NdF_3) all used microprecipitation. There is no evidence that there are differences between the results obtained from the techniques used.

Reported AL results:	20
In agreement with the assigned value:	18
Questionable results:	1
Discrepant from the assigned value:	1

Neptunium-237

Neptunium-237 can be measured by three independent techniques: alpha spectrometry, gamma spectrometry and mass spectrometry. The main difficulty in measuring the ^{237}Np activity concentration with alpha spectrometry and mass spectrometry is the need for a radiochemical separation from the other radionuclides present in the sample (in case of alpha spectrometry this is especially true of the ^{226}Ra 4.60 MeV and 4.78 MeV peaks which interfere with the 4.65 MeV and 4.78 MeV peaks of ^{237}Np).

Ten results were reported for the AH samples (see Figures 10A to 10D). Five results are in agreement with the assigned value, while three results are questionable. Two results are discrepant. The reported results show no significant bias. Three participants used gamma spectrometry to determine ^{237}Np (Labs 32, 55 [both with (55R) and without (55G) a radiochemical separation] and 65), while two participants used mass spectrometry (Labs 8 and 47) and four participants used alpha spectrometry (Labs 1, 47, 106 and 129). There is no indication that there are significant differences between the results obtained from the various techniques used.

Reported AH results:	10
In agreement with the assigned value:	5
Questionable result:	3
Discrepant from the assigned value:	2

Uranium-238

Uranium-238 can be measured by alpha spectrometry, gamma spectrometry and mass spectrometry. The main difficulty in measuring the ^{238}U activity concentration with alpha spectrometry is the need for a radiochemical separation from the other radionuclides present in the sample.

Twenty-four results were reported for the AL samples (see Figures 3A to 3D). Nineteen results are in agreement with the assigned value, while four results are questionable. One result is discrepant. The reported results show no significant bias. Most participants used alpha spectrometry to determine ^{238}U, while four participants (Labs 8, 32, 34 and 47) used mass spectrometry. Nine participants (Labs 4, 17, 26, 47, 65, 90, 106, 120 and 129) who used alpha spectrometry as the detection method used extraction chromatography to separate the ^{238}U from the matrix. Seven participants (Labs 13, 25, 28, 31, 35, 40, 46) used ion-exchange chromatography, three participants (Labs 51, 73 and 91) used liquid extraction techniques and one participant (Lab 32) used a combination of ion-exchange chromatography and extraction chromatography. A large majority of participants used ^{232}U as the yield tracer, while one participant (Lab 47) used ^{236}U. Most participants who used alpha spectrometry as the detection method used electrodeposition to prepare the ^{238}U sources. Labs 65, 106 and 129 used microprecipitation (CeF_3, NdF_3 and LaF_3, respectively). There is no evidence that there are significant differences between the results obtained from the techniques used.

Reported AL results:	24
In agreement with the assigned value:	19
Questionable results:	4
Discrepant from the assigned value:	1

Plutonium-238

The main difficulty in measuring the ^{238}Pu activity concentration with alpha spectrometry is the need for a radiochemical separation from the other radionuclides present in the AH sample (especially the ^{241}Am 5.44 MeV and 5.49 MeV peaks which interfere with the 5.46 MeV and 5.50 MeV peaks of ^{238}Pu). It is possible to determine ^{238}Pu by gamma spectrometry, although the emission probability for the 43 keV peak is only 0.0397(8)%.

Fifteen results were reported for the AH samples (see Figures 11A to 11D). Twelve results are in agreement with the assigned value. Three results are discrepant. The reported results show a significant negative bias. All participants used alpha spectrometry to determine ^{238}Pu. Most participants separated the ^{238}Pu from the matrix by ion-exchange chromatography. Four participants (Labs 31, 47 and 129) used extraction chromatography, while one participant (Lab 73) used liquid-liquid extraction. Two participants (Labs 32 and 47) used ^{236}Pu as the yield tracer, while the other participants used ^{242}Pu. Most participants used electrodeposition to prepare the ^{238}Pu sources. Labs 106 and 129 used microprecipitation (NdF_3 and LaF_3). There is no indication that there is a significant difference between the results obtained from the various techniques used.

Reported AH results:	15
In agreement with the assigned value:	12
Questionable result:	0
Discrepant from the assigned value:	3

Seventeen results were reported for the P samples (see Figures 16A to 16D). Fifteen results are in agreement with the assigned value, while one result is questionable. One result is discrepant. The reported results show no significant bias. All participants used alpha spectrometry to determine ^{238}Pu, except Lab 86 who used both mass spectrometry and alpha spectrometry. Most participants separated the ^{238}Pu from the matrix by ion-exchange chromatography. Two participants (Labs 7 and 47) used extraction chromatography, while one participant (Lab 107) used solid phase extraction. Two participants (Lab 32 and 47) used ^{236}Pu as the yield tracer, while the other participants used ^{242}Pu. Most participants used electrodeposition to prepare the ^{238}Pu sources. Lab 106 used microprecipitation (NdF_3). There is no indication that there is a significant difference between the results obtained from the various techniques used (although the mass spectrometry result showed a significant negative bias).

Reported P results:	17
In agreement with the assigned value:	15
Questionable result:	1
Discrepant from the assigned value:	1

Plutonium-239

The main difficulty in measuring the ^{239}Pu activity concentration is the need for a radiochemical separation from the other radionuclides present in the AL and AH samples.

Twenty-three results were reported for the AL samples (see Figures 4A to 4D). Nineteen results are in agreement with the assigned value. Four results are discrepant. The reported results show no significant bias. All participants used alpha spectrometry to determine ^{239}Pu. Most participants used ion-exchange chromatography to separate the ^{239}Pu from the matrix. Six participants (Labs 26, 31, 47, 90, 120 and 129) used extraction chromatography and one participant (Lab 73) used liquid-liquid extraction chromatography. Three participants (Labs 32, 47 and 65) used ^{236}Pu as the yield tracer, while the other participants used ^{242}Pu. Most participants used electrodeposition to prepare the ^{239}Pu sources. Labs 65, 106 and 129 used microprecipitation (LaF_3, NdF_3 and LaF_3, respectively). There is no indication that there are significant differences between the results obtained from the various techniques used.

Reported AL results:	23
In agreement with the assigned value:	19
Questionable result:	0
Discrepant from the assigned value:	4

Fifteen results were reported for the AH samples (see Figures 12A to 12D). Eleven results are in agreement with the assigned value, while one result is questionable. Three results are discrepant. The reported results show a significant negative bias. All participants used alpha spectrometry to determine ^{239}Pu. Most participants separated the ^{239}Pu from the matrix by ion-exchange chromatography. Four participants (Labs 31, 47 and 129) used extraction chromatography, while one participant (Lab 73) used liquid-liquid extraction. Two participants (Labs 32 and 47) used ^{236}Pu as the yield tracer, while the other participants used ^{242}Pu. Most participants used electrodeposition to prepare the ^{239}Pu sources. Labs 106 and 129 used microprecipitation (NdF_3 and LaF_3). There is no indication that there is a significant difference between the results obtained from the various techniques used.

Reported AH results:	15
In agreement with the assigned value:	11
Questionable result:	1
Discrepant from the assigned value:	3

Seventeen results were reported for the P samples (see Figures 17A to 17D). Fourteen results are in agreement with the assigned value, while one result is questionable. Two results are discrepant. The reported results show no significant bias. All participants used alpha spectrometry to determine ^{239}Pu, except Lab 86 who used both mass spectrometry and alpha spectrometry. Most participants separated the ^{239}Pu from the matrix by ion-exchange chromatography. Two participants (Labs 7 and 47) used extraction chromatography, while one participant (Lab 107) used solid phase extraction. Two participants (Lab 32 and 47) used ^{236}Pu as the yield tracer, while the other participants used ^{242}Pu. Most participants used electrodeposition to prepare the ^{239}Pu sources. Lab 106 used microprecipitation (NdF_3). There is no indication that there is a significant difference between the results obtained from the various techniques used (although the mass spectrometry result showed a significant negative bias).

Reported P results:	17
In agreement with the assigned value:	14
Questionable result:	1
Discrepant from the assigned value:	2

Plutonium-241
The main difficulty in measuring the ^{241}Pu activity concentration is the fact it is a weak beta emitter (E_{max} = 20.8 keV).

Fourteen results were reported for the P samples (see Figures 18A to 18D). Eight results are in agreement with the assigned value. Six results are discrepant. The reported results show no significant bias. The large majority of the participants used liquid scintillation counting to determine ^{241}Pu (with ^{242}Pu as the yield tracer; Labs 32 and 47 used ^{236}Pu as the yield tracer). One participant (Lab 86) used mass spectrometry. Six participants (Labs 1, 7, 35, 38, 47 and 107), who used liquid scintillation counting as the detection method, first determined ^{238}Pu and ^{239}Pu by alpha spectrometry followed by leaching the Pu from the metal disk and measurement by liquid scintillation counting. Five participants (Labs 8, 32, 46, 94 and 120), who used liquid scintillation counting as the detection method, determined ^{241}Pu independently from the ^{238}Pu and ^{239}Pu alpha spectrometry source. No detailed information was received from Labs 31 and 55. There is no indication that there are significant differences between the results obtained from the various techniques used. Lab 86 obtained discrepant (and similar low) results for both ^{238}Pu and ^{239}Pu done by mass spectrometry and this may have affected the ^{241}Pu result.

Reported P results:	14
In agreement with the assigned value:	8
Questionable result:	0
Discrepant from the assigned value:	6

Americium-241
Americium-241 can be measured by three independent techniques: alpha spectrometry, gamma spectrometry and mass spectrometry. The main difficulty in measuring the ^{241}Am activity concentration with alpha spectrometry is the need for a radiochemical separation from the other radionuclides present in the sample (especially the ^{238}Pu 5.46 MeV and 5.50 MeV peaks which interfere with the 5.44 MeV and 5.49 MeV peaks of ^{241}Am).

Twenty-six results were reported for the AL samples (see Figures 5A to 5D). Twenty-four results are in agreement with the assigned value. Two results are discrepant. The reported results show no significant bias. The large majority of the participants used alpha spectrometry to determine ^{241}Am (with ^{243}Am as the yield tracer). Four participants (Labs 8, 24, 32 and 42) used gamma spectrometry. Five participants (Labs 26, 47, 90, 120 and 129) who used alpha spectrometry as the detection method separated the ^{241}Am from the matrix by extraction chromatography. Eight participants (Labs 8, 25, 28, 34, 35, 46, 51 and 91) used ion-exchange chromatography, seven participants (Labs 4, 29, 32, 40, 62, 65 and 106) used a combination of ion-exchange chromatography and extraction chromatography and one participant (Lab 73) used liquid-liquid extraction. Most participants who used alpha spectrometry as the detection method used electrodeposition to prepare the ^{241}Am sources. Labs 65, 106 and 129 used microprecipitation (LaF_3, NdF_3 and LaF_3, respectively). There is no indication that there are significant differences between the results obtained from the various techniques used.

Reported AL results:	26
In agreement with the assigned value:	24
Questionable result:	0
Discrepant from the assigned value:	2

Twenty-one results were reported for the AH samples (see Figures 13A to 13D). Fifteen results are in agreement with the assigned value, while four results are questionable. Two results are discrepant. The reported results show no significant bias. The majority of the participants used alpha spectrometry to determine ^{241}Am (with ^{243}Am as the yield tracer). Seven participants (Labs 8, 24, 32, 47, 55, 65 and 129) used gamma spectrometry. Three participants (Labs 7, 47 and 129) who used alpha spectrometry as the detection method separated ^{241}Am with extraction chromatography. Six participants (Labs 1, 8, 28, 35, 41 and 46) used ion-exchange chromatography, three participants (Labs 32, 38 and 106) used a combination of ion-exchange chromatography and extraction chromatography and two participants (Lab 31 and 73) used liquid-liquid extraction. Most participants who used alpha spectrometry as the detection method used electrodeposition to prepare the ^{241}Am sources. Labs 106 and 129 used microprecipitation (NdF_3 and LaF_3). There is no indication that there are significant differences between the results obtained from the various techniques used.

Reported AH results:	21
In agreement with the assigned value:	15
Questionable result:	4
Discrepant from the assigned value:	2

Curium-244

The main difficulty in measuring the ^{244}Cm activity concentration is the need for a radiochemical separation from the other radionuclides present in the sample and the absence of a suitable curium yield tracer.

Fifteen results were reported for the AL samples (see Figures 6A to 6D). Twelve results are in agreement with the assigned value, while one result is questionable. Two results are discrepant. The reported results show no significant bias. All participants used alpha spectrometry to determine ^{244}Cm with most sources prepared by electrodeposition (except Labs 65 and 129 who both used LaF_3 microprecipitation). All participants used ^{243}Am as the yield tracer. Participants used ion-exchange chromatography and extraction chromatography to separate the ^{244}Cm from the matrix (see ^{241}Am AL above). There is no indication that there are significant differences between the results obtained from the various techniques used. In most cases, the normalised ^{244}Cm / ^{241}Am ratios obtained by the labs (see Figure 121A) are somewhat lower than unity (with two results significantly lower than unity), which may indicate a chemical separation of ^{244}Cm from its yield tracer ^{243}Am during the separation and/or source preparation procedure.

Reported AL results:	15
In agreement with the assigned value:	12
Questionable result:	1
Discrepant from the assigned value:	2

Thirteen results were reported for the AH samples (see Figures 14A to 14D). Ten results are in agreement with the assigned value, while one result is questionable. Two results are discrepant. The reported results show no significant bias. All participants used alpha spectrometry to determine ^{244}Cm. All participants prepared the sources by electrodeposition. All participants used ^{243}Am as the yield tracer. Participants used ion-exchange chromatography, liquid extraction and extraction chromatography to separate the ^{244}Cm from the matrix (see ^{241}Am AH above). There is no indication that there are significant differences between the results obtained from the various techniques used. In most cases, the normalised ^{244}Cm / ^{241}Am ratios obtained by the labs (see Figure 121B) are not significantly different from unity.

Reported AH results:	13
In agreement with the assigned value:	10
Questionable result:	1
Discrepant from the assigned value:	2

Gross alpha

The main difficulty in measuring the gross alpha activity concentration is the possibility that some volatile radionuclides (e.g., ^{210}Po, ^{214}Po, ^{218}Po and ^{222}Rn) may be lost during the sample preparation.

Eight results were reported for the AL samples (see Figures 7A to 7D). One result is in agreement with the assigned value, while five results are questionable. Two results are discrepant. The only result that was ‘in agreement’ was obtained using a ZnS scintillation detector (Lab 8). The other results which were all either ‘questionable’ or ‘discrepant’, were all obtained using a gas-flow proportional counter (Labs 5, 42, 99 and 129), liquid scintillation counting (Lab 47) or summation (Lab 25).

Reported AL results:	8
In agreement with the assigned value:	1
Questionable result:	5
Discrepant from the assigned value:	2

Eleven were reported for the AH samples (see Figures 15A to 15D). Four results are in agreement with the assigned value, while two results are questionable. Five results are discrepant. The reported results show a significant negative bias. The four results that were ‘in agreement’ were obtained using either gas-flow proportional counter (Labs 1 and 123), or liquid scintillation counting (Labs 41 and 47). The other results, which were all either ‘questionable’ or ‘discrepant’, were obtained using a gas-flow proportional counter (Labs 99 and 129), a ZnS scintillation detector (Lab 8 and 55), an unknown technique (Lab 31) or liquid scintillation counting (Lab 7).

Reported AH results:	11
In agreement with the assigned value:	4
Questionable result:	2
Discrepant from the assigned value:	5

3.2 B1 SAMPLES

Hydrogen-3

The main difficulty in measuring the tritiated water activity concentration is the need for a radiochemical separation from ^{14}C, ^{36}Cl and ^{99}Tc.

Twenty-nine results were reported for this nuclide (see Figures 19A to 19D). Twenty-six results are in agreement with the assigned value, while two results are questionable. One result is discrepant. The reported results show no significant bias. The majority of the participants (except Labs 5, 7, 16, 17, 29, 32, 35, 38 and 108 who used combustion and Lab 94 who used tritium column) used distillation to separate tritium from the other nuclides. All participants used liquid scintillation counting as the detection method.

Reported results:	29
In agreement with the assigned value:	26
Questionable results:	2
Discrepant from the assigned value:	1

Carbon-14
The main difficulty in measuring the ^{14}C activity concentration is the need for a radiochemical separation from ^{3}H, ^{36}Cl and ^{99}Tc.

Seventeen results were reported for this nuclide (see Figures 20A to 20D). Thirteen results are in agreement with the assigned value, while one result is questionable. Three results are discrepant. The reported results show no significant bias. All participants used liquid scintillation counting as the detection method. Most of the participants used $[^{14}C]O_2$ gas generation (either by sample combustion or the addition of acid to the sample) as the separation technique. The other technique used was $BaCO_3$ precipitation (Labs 91 and 106).

Reported results:	17
In agreement with the assigned value:	13
Questionable results:	1
Discrepant from the assigned value:	3

Chlorine-36
The main difficulty in measuring the ^{36}C activity concentration is the need for a radiochemical separation from ^{3}H, ^{14}C and ^{99}Tc.

Six results were reported for this nuclide (see Figures 21A to 21D). Four results are in agreement with the assigned value, while two results are questionable. The reported results show no significant bias. All participants used liquid scintillation counting as the detection method except Lab 8 who used gas-flow proportional counting. Most of the participants used a form of AgCl precipitation as the separation technique. Other techniques used included chlorine gas generation (Lab 32).

Reported results:	6
In agreement with the assigned value:	4
Questionable results:	2
Discrepant from the assigned value:	0

Technetium-99
The main difficulty in measuring the ^{99}Tc activity concentration is the need for a radiochemical separation from ^{3}H, ^{14}C and ^{36}Cl.

Seventeen results were reported for this nuclide (see Figures 22A to 22D). Thirteen results are in agreement with the assigned value, while four results are questionable. The reported results show no significant bias. There is no indication that either the detection method [mass spectrometry (Labs 8, 32 and 47), liquid scintillation counting (Labs 35, 59, 62, 65, 107 and 120), gas-flow proportional counting (Labs 13, 25, 28 and 76) or low level beta GM (Labs 34 and 83)], yield tracer [^{99m}Tc (Labs 28, 34, 35, 59 and 62) or stable Re (Labs 13, 25, 32, 65, 76)] or the radiochemical separation technique (a wide variety of precipitation techniques, solvent extractions, ion-exchange chromatography and extraction (TEVA) chromatography) led to any significant differences between the results.

Reported results:	17
In agreement with the assigned value:	13
Questionable result:	4
Discrepant from the assigned value:	0

3.3 B2 SAMPLES

Hydrogen-3
The main difficulty in measuring the ^{3}H activity concentration is the need for a radiochemical separation from the other radionuclides present in the sample.

Twenty-eight results were reported for this nuclide (see Figures 23A to 23D). Twenty-two results are in agreement with the assigned value, while one result is questionable. Five results are discrepant. The reported results show a significant negative bias. The majority of the participants (except Labs 5, 16, 32, 35 and 38 who used combustion, Lab 129 who used an evaporation technique and Lab 31 who provided no information) used distillation to separate tritium from the other nuclides. There is no indication that the separation technique led to any significant differences between the results. Lab 35 obtained discrepant (and similar) tritium results for both the B1 and B2 samples done by distillation (while both its combustion results were 'in agreement').

Reported results:	28
In agreement with the assigned value:	22
Questionable result:	1
Discrepant from the assigned value:	5

Iron-55
The main difficulties in measuring the ^{55}Fe activity concentration is the need for a radiochemical separation from the other radionuclides present in the sample and the fact that ^{55}Fe emits only low-energy X rays (0.6 – 6.5 keV) and Auger electrons (0.5 – 6.5 keV).

Eleven results were reported for this nuclide (see Figures 24A to 24D). Five results are in agreement with the assigned value, while two results are questionable. Four results are discrepant. The reported results show a significant negative bias. There is no indication that the detection method [liquid scintillation counting (Labs 8, 16, 31, 32, 38, 65 and 129), gas-flow proportional counting (Lab 25) or X-ray spectrometry or gamma spectrometry (Labs 7 and 21)] led to a significant difference between the results.

Reported results:	11
In agreement with the assigned value:	5
Questionable result:	2
Discrepant from the assigned value:	4

Strontium-89
The main difficulty in measuring the ^{89}Sr activity concentration is the need for a radiochemical separation from the other radionuclides present in the sample combined with presence of ^{90}Sr which may interfere with the measurement of ^{89}Sr. Several approaches can be adopted: decay and/or ingrowth counting, chemical separation of ^{90}Y (the daughter of ^{90}Sr) followed by Cerenkov and LSC counting and/or spectral deconvolution.

Thirteen results were reported for this nuclide (see Figures 25A to 25D). Seven results are in agreement with the assigned value, while four results are questionable. Two results are discrepant. The reported results show no significant bias. There is no indication that the detection method [liquid scintillation counting or Cerenkov counting (Labs 7, 8, 26, 32, 38, 65, 74, 90, 91 and 129) or gas-flow proportional counting (Labs 35 and 106)], the nature of the yield tracer [unknown (Labs 8 and 55), ^{85}Sr (Labs 7, 38 and 90) or stable Sr (Labs 26, 32, 35, 65, 74, 91, 106 and 129)], nor the radiochemical separation technique [unspecified (Labs 55 and 91), extraction chromatography (Labs 7, 8, 26, 32, 35, 38, 65, 74, 90 and 129) and precipitation/extraction (Lab 106)] led to any significant differences between the results.

Reported results:	13
In agreement with the assigned value:	7
Questionable results:	4
Discrepant from the assigned value:	2

Strontium-90

The main difficulty in measuring the ^{90}Sr activity concentration is the need for a radiochemical separation from the other radionuclides present in the sample, combined with presence of ^{89}Sr which may interfere with the measurement of ^{90}Sr. Again, several approaches can be adopted: decay and/or ingrowth counting, separation of ^{90}Y followed by Cerenkov and LSC counting and/or spectral deconvolution.

Nineteen results were reported for this nuclide (see Figures 26A to 26D). Thirteen results are in agreement with the assigned value, while three results are questionable. Three results are discrepant. The reported results show a significant negative bias. Most participants used LSC or Cerenkov counting to detect ^{90}Sr or its daughter ^{90}Y, while five participants (Labs 8, 25, 35, 106 and 114) used gas flow proportional counting. Four participants (Labs 7, 38, 41 and 90) used ^{85}Sr as the yield tracer for ^{90}Sr; nine participants (Labs 26, 32, 35, 65, 74, 91, 106, 114 and 129) used stable Sr; two participants (Labs 25 and 76) used stable Y and no information was provided by two participants (Labs 55 and 73). The most popular method for separating ^{90}Sr from the matrix was extraction chromatography, with the exception of Labs 55 and 91 (no information provided), Lab 73, 76 and 106 (extraction), Labs 25 and 114 (precipitation techniques). There is no indication that either the detection method, the nature of the yield tracer or the radiochemical separation technique led to any significant differences between the results. The participants who also reported ^{89}Sr values did not obtain more accurate (or less accurate) results than the participants who had not (Labs 25, 41, 73, 76 and 114).

Reported results:	19
In agreement with the assigned value:	13
Questionable result:	3
Discrepant from the assigned value:	3

Gross beta

The main difficulty in measuring the gross beta activity concentration is the possibility that some radionuclides may be either lost during the sample preparation (e.g., ^{3}H) or measured with a low efficiency due to self-absorption or quenching (e.g., ^{3}H and ^{55}Fe). Two different assigned values were used (one for ISO method 9697:2008 gas-flow proportional counting and one for liquid scintillation counting (Labs 7 and 129); see Appendix C4).

Ten results were reported for this nuclide (see Figures 27A to 27D). Six results are in agreement with the assigned value, while two results are questionable. Two results are discrepant. There is some indication that the detection method led to any significant differences between the results with the liquid scintillation counting results being less accurate.

Reported results:	10
In agreement with the assigned value:	6
Questionable result:	2
Discrepant from the assigned value:	2

3.4 GL AND GH SAMPLES

The following nuclides were present in the samples and should have been reported. In cases where they had not been reported by a participant, they were classified as a 'missing result'.

Beryllium-7
There are no specific measurement problems for this nuclide other than the relatively low emission probability (10.44%) for the only gamma-ray emission at 477.6 keV.

Thirty-eight results were reported for the GL samples (see Figures 28A to 28D). Eighteen results are in agreement with the assigned value, while sixteen results are questionable. Four results are discrepant. The reported results show no significant bias.

Reported GL results:	38
In agreement with the assigned value:	18
Questionable results:	16
Discrepant from the assigned value:	4
Missing results:	7

Thirty-two results were reported for the GH samples (see Figures 36A to 36D). Twenty-eight results are in agreement with the assigned value, while one result is questionable. Three results are discrepant. The reported results show no significant bias.

Reported GH results:	32
In agreement with the assigned value:	28
Questionable results:	1
Discrepant from the assigned value:	3
Missing results:	3

Cobalt-60
There are no specific measurement problems for this nuclide.

Forty-five results were reported for the GL samples (see Figures 29A to 29D). Thirty-eight results are in agreement with the assigned value, while five results are questionable. Two results are discrepant. The reported results show no significant bias.

Reported GL results:	45
In agreement with the assigned value:	38
Questionable results:	5
Discrepant from the assigned value:	2
Missing results:	0

Thirty-five results were reported for the GH samples (see Figures 37A to 37D). Twenty-eight results are in agreement with the assigned value, while seven results are questionable. The reported results show a significant positive bias.

Reported GH results:	35
In agreement with the assigned value:	28
Questionable results:	7
Discrepant from the assigned value:	0
Missing results:	0

Zirconium-95
In general, there are no specific measurement problems for this radionuclide, as this radionuclides emits two gamma-rays which are not in coincidence. However, in this exercise

there was a major interference for both gamma-ray emissions (at 724.2 and 756.7 keV) caused by gamma-ray emissions of ^{154}Eu (at 723.3 and 756.8 keV, respectively).

Thirty-eight results were reported for the GL samples (see Figures 30A to 30D). Eighteen results are in agreement with the assigned value, while eleven results are questionable. Nine results are discrepant. The reported results show a significant positive bias.

Reported GL results:	38
In agreement with the assigned value:	18
Questionable results:	11
Discrepant from the assigned value:	9
Missing results:	7

Thirty-one results were reported for the GH samples (see Figures 38A to 38D). Twenty-four results are in agreement with the assigned value, while three results are questionable. Four results are discrepant. The reported results show a significant positive bias.

Reported GH results:	31
In agreement with the assigned value:	24
Questionable results:	3
Discrepant from the assigned value:	4
Missing results:	4

Niobium-95

The main difficulty in measuring ^{95}Nb was the need for a modified form of the Bateman equations taking account of the multiple branching of the parents that must be used to determine the activity concentration at the reference time.

Forty results were reported for the GL samples (see Figures 31A to 31D). Twenty-two results are in agreement with the assigned value, while eight results are questionable. Ten results are discrepant. The reported results show no significant bias.

Reported GL results:	40
In agreement with the assigned value:	22
Questionable results:	8
Discrepant from the assigned value:	10
Missing results:	5

Thirty-two results were reported for the GH samples (see Figures 39A to 39D). Twenty-one results are in agreement with the assigned value, while five results are questionable. Six results are discrepant. The reported results show a significant positive bias.

Reported GH results:	32
In agreement with the assigned value:	21
Questionable results:	5
Discrepant from the assigned value:	6
Missing results:	3

Caesium-134

The challenge in the measurement of this nuclide is the need for coincidence summing corrections.

Forty-four results were reported for the GL samples (see Figures 32A to 32D). Thirty-five results are in agreement with the assigned value, while eight results are questionable. One result is discrepant. The reported results show a significant negative bias.

Reported GL results:	44
In agreement with the assigned value:	35
Questionable results:	8
Discrepant from the assigned value:	1
Missing results:	1

Thirty-four results were reported for the GH samples (see Figures 40A to 40D). Twenty-five results are in agreement with the assigned value, while six results are questionable. Three results are discrepant. The reported results show a significant negative bias.

Reported GH results:	34
In agreement with the assigned value:	25
Questionable results:	6
Discrepant from the assigned value:	3
Missing results:	1

Caesium-137

There are no specific measurement problems for this nuclide.

Forty-five results were reported for the GL samples (see Figures 33A to 33D). Thirty-four results are in agreement with the assigned value, while eight results are questionable. Three results are discrepant. The reported results show no significant bias.

Reported GL results:	45
In agreement with the assigned value:	34
Questionable results:	8
Discrepant from the assigned value:	3
Missing results:	0

Thirty-five results were reported for the GH samples (see Figures 41A to 41D). Thirty-two results are in agreement with the assigned value, while three results are questionable. The reported results show a significant positive bias.

Reported GH results:	35
In agreement with the assigned value:	32
Questionable results:	3
Discrepant from the assigned value:	0
Missing results:	0

Europium-152

The challenge in the measurement of this nuclide is the need for coincidence summing corrections.

Forty-two results were reported for the GL samples (see Figures 34A to 34D). Thirty-three results are in agreement with the assigned value, while six results are questionable. Three results are discrepant. The reported results show a significant negative bias.

Reported GL results:	42
In agreement with the assigned value:	33
Questionable results:	6
Discrepant from the assigned value:	3
Missing results:	3

Thirty-three results were reported for the GH samples (see Figures 42A to 42D). Twenty-six results are in agreement with the assigned value, while five results are questionable. Two results are discrepant. The reported results show no significant bias.

Reported GH results:	33
In agreement with the assigned value:	26
Questionable results:	5
Discrepant from the assigned value:	2
Missing results:	2

Europium-154

The challenge in the measurement of this nuclide is the need for coincidence summing corrections.

Thirty-seven results were reported for the GL samples (see Figures 35A to 35D). Twenty-eight results are in agreement with the assigned value, while six results are questionable. Three results are discrepant. The reported results show no significant bias.

Reported GL results:	37
In agreement with the assigned value:	28
Questionable results:	6
Discrepant from the assigned value:	3
Missing results:	8

Thirty-one results were reported for the GH samples (see Figures 43A to 43D). Twenty-four results are in agreement with the assigned value, while four results are questionable. Three results are discrepant. The reported results show no significant bias.

Reported GH results:	31
In agreement with the assigned value:	24
Questionable results:	4
Discrepant from the assigned value:	3
Missing results:	4

3.5 S SAMPLES

Cobalt-60

There are no specific measurement problems for this nuclide.

Twenty-five results were reported for this nuclide (see Figures 44A to 44D). Twenty-one results are in agreement with the assigned value, while two results are questionable. Two results are discrepant. The reported results show no significant bias. All participants used gamma spectrometry as the detection method.

Reported results:	25
In agreement with the assigned value:	21
Questionable results:	2
Discrepant from the assigned value:	2

Caesium-137

There are no specific measurement problems for this nuclide.

Twenty-six results were reported for this nuclide (see Figures 45A to 45D). Twenty-two results are in agreement with the assigned value, while two results are questionable. Two results are discrepant. The reported results show no significant bias. All participants used gamma spectrometry as the detection method.

Reported results:	26
In agreement with the assigned value:	22
Questionable results:	2
Discrepant from the assigned value:	2

Europium-152
The challenge in the measurement of this nuclide is the need for coincidence summing corrections.

Twenty-five results were reported for this nuclide (see Figures 46A to 46D). Seventeen results are in agreement with the assigned value, while five results are questionable. Three results are discrepant. The reported results show no significant bias. All participants used gamma spectrometry as the detection method.

Reported results:	25
In agreement with the assigned value:	17
Questionable results:	5
Discrepant from the assigned value:	3

Europium-154
The challenge in the measurement of this nuclide is the need for coincidence summing corrections.

Twenty-four results were reported for this nuclide (see Figures 47A to 47D). Seventeen results are in agreement with the assigned value, while one result is questionable. Six results are discrepant. The reported results show no significant bias. All participants used gamma spectrometry as the detection method.

Reported results:	24
In agreement with the assigned value:	17
Questionable results:	1
Discrepant from the assigned value:	6

Americium-241
The challenge in the measurement of this nuclide is the relative low energy of the gamma-ray emission at 59.5 keV.

Twenty-six results were reported for this nuclide (see Figures 48A to 48D). Seventeen results are in agreement with the assigned value, while five results are questionable. Four results are discrepant. The reported results show no significant bias. All participants used gamma spectrometry as the detection method with two participants (Labs 32 and 35) submitting an additional result obtained with alpha spectrometry after a radiochemical separation of ^{241}Am from the other radionuclides present in the sample.

Reported results:	26
In agreement with the assigned value:	17
Questionable results:	5
Discrepant from the assigned value:	4

3.6 RESULT SUMMARY

The combined results for all samples are listed below in Tables 3.1 to 3.8.

Table 3.1 – Results AL

Nuclide	In agreement	Questionable	Discrepant
^{226}Ra	10 (59%)	4 (24%)	3 (18%)
^{232}Th	18 (90%)	1 (5%)	1 (5%)
^{238}U	19 (79%)	4 (17%)	1 (4%)
^{239}Pu	19 (83%)	0	4 (17%)
^{241}Am	24 (92%)	0	2 (8%)
^{244}Cm	12 (80%)	1 (7%)	2 (13%)
gross alpha	1 (13%)	5 (63%)	2 (25%)
Total	103	15	15
Total (%)	77	11	11

Table 3.2 – Results AH

Nuclide	In agreement	Questionable	Discrepant
^{210}Pb	4 (40%)	1 (10%)	5 (50%)
^{210}Po	3 (30%)	4 (40%)	3 (30%)
^{237}Np	5 (50%)	3 (30%)	2 (20%)
^{238}Pu	12 (80%)	0	3 (20%)
^{239}Pu	11 (73%)	1 (7%)	3 (20%)
^{241}Am	15 (71%)	4 (19%)	2 (10%)
^{244}Cm	10 (77%)	1 (8%)	2 (15%)
gross alpha	4 (36%)	2 (18%)	5 (45%)
Total	64	16	25
Total (%)	61	15	24

Table 3.3 – Results P

Nuclide	In agreement	Questionable	Discrepant
^{238}Pu	15 (88%)	1 (6%)	1 (6%)
^{239}Pu	14 (82%)	1 (6%)	2 (12%)
^{241}Pu	8 (57%)	0	6 (43%)
Total	37	2	9
Total (%)	77	4	19

Table 3.4 – Results B1

Nuclide	In agreement	Questionable	Discrepant
^{3}H	26 (90%)	2 (7%)	1 (3%)
^{14}C	13 (76%)	1 (6%)	3 (18%)
^{36}Cl	4 (67%)	2 (33%)	0
^{99}Tc	13 (76%)	4 (24%)	0
Total	56	9	4
Total (%)	81	13	6

Table 3.5 – Results B2

Nuclide	In agreement	Questionable	Discrepant
^{3}H	22 (79%)	1 (4%)	5 (18%)
^{55}Fe	5 (45%)	2 (18%)	4 (36%)
^{89}Sr	7 (54%)	4 (31%)	2 (15%)
^{90}Sr	13 (68%)	3 (16%)	3 (16%)
gross beta	6 (60%)	2 (20%)	2 (20%)
Total	53	12	16
Total (%)	65	15	20

Table 3.6 – Results GL

Nuclide	In agreement	Questionable	Discrepant	Missing
^{7}Be	18 (40%)	16 (36%)	4 (9%)	7 (16%)
^{60}Co	38 (84%)	5 (11%)	2 (4%)	0
^{95}Zr	18 (40%)	11 (24%)	9 (20%)	7 (16%)
^{95}Nb	22 (49%)	8 (18%)	10 (22%)	5 (11%)
^{134}Cs	35 (78%)	8 (18%)	1 (2%)	1 (2%)
^{137}Cs	34 (76%)	8 (18%)	3 (7%)	0
^{152}Eu	33 (73%)	6 (13%)	3 (7%)	3 (7%)
^{154}Eu	28 (62%)	6 (13%)	3 (7%)	8 (18%)
Total	226	68	35	31
Total (%)	63	19	10	9

Table 3.7 – Results GH

Nuclide	In agreement	Questionable	Discrepant	Missing
^{7}Be	28 (80%)	1 (3%)	3 (9%)	3 (9%)
^{60}Co	28 (80%)	7 (20%)	0	0
^{95}Zr	24 (69%)	3 (9%)	4 (11%)	4 (11%)
^{95}Nb	21 (60%)	5 (14%)	6 (17%)	3 (9%)
^{134}Cs	25 (71%)	6 (17%)	3 (9%)	1 (3%)
^{137}Cs	32 (91%)	3 (9%)	0	0
^{152}Eu	26 (74%)	5 (14%)	2 (6%)	2 (6%)
^{154}Eu	24 (69%)	4 (11%)	3 (9%)	4 (11%)
Total	208	34	21	17
Total (%)	74	12	8	6

Table 3.8 – Results S

Nuclide	In agreement	Questionable	Discrepant
^{60}Co	21 (84%)	2 (8%)	2 (8%)
^{137}Cs	22 (85%)	2 (8%)	2 (8%)
^{152}Eu	17 (68%)	5 (20%)	3 (12%)
^{154}Eu	17 (71%)	1 (4%)	6 (25%)
^{241}Am	17 (65%)	5 (19%)	4 (15%)
Total	94	15	17
Total (%)	75	12	13

3.7 FALSE POSITIVE IDENTIFICATIONS

The following results were evaluated as 'false positives' as the radionuclides listed below were not present in the samples within the specified specific activity ranges.

Table 3.9 – False positive identifications

Nuclide	Number of participants	Potential cause
^{22}Na (GL)	7	Mistaken for ^{154}Eu
^{210}Pb (GL)	6	Background?
^{58}Co (GL)	1	Unknown
^{125}I (GL)	1	Unknown
^{129}I (GL)	1	X-ray from ^{152}Eu?
^{207}Bi (GL)	1	Mistaken for ^{134}Cs?
^{210}Pb (GH)	6	Background?
^{22}Na (GH)	4	Mistaken for ^{154}Eu
^{58}Co (GH)	1	Unknown
^{109}Cd (GH)	1	Unknown

3.8 ANALYSIS OF RESULTS BY PARTICIPANT

The combined results for each participant are presented in Table 3.10. The individual deviation results are presented in Figures 50 to 119.

Table 3.10 – Individual results

Participant	Results in agreement	Questionable results	Discrepant results	Missing results
1	8 (73%)	1 (9%)	2 (18%)	0
4	4 (100%)	0	0	0
5	20 (74%)	2 (7%)	5 (19%)	0
7	16 (55%)	8 (28%)	5 (17%)	0
8	39 (78%)	8 (16%)	3 (6%)	0
9	8 (100%)	0	0	0
13	9 (100%)	0	0	0
15	9 (56%)	3 (19%)	2 (13%)	2 (13%)
16	10 (48%)	8 (38%)	3 (14%)	0
17	11 (46%)	5 (21%)	5 (21%)	3 (13%)
19	7 (78%)	2 (22%)	0	0
21	20 (83%)	1 (4%)	1 (4%)	2 (8%)
23	6 (75%)	2 (25%)	0	0
24	13 (72%)	2 (11%)	2 (11%)	1 (6%)
25	24 (80%)	5 (17%)	1 (3%)	0
26	10 (83%)	1 (8%)	1 (8%)	0
27	6 (38%)	9 (56%)	1 (6%)	0
28	27 (93%)	2 (7%)	0	0
29	10 (56%)	8 (44%)	0	0
31	5 (16%)	4 (13%)	10 (32%)	12 (39%)
32	40 (91%)	4 (9%)	0	0
34	18 (95%)	1 (5%)	0	0
35	32 (73%)	8 (18%)	4 (9%)	0
38	21 (88%)	2 (8%)	1 (4%)	0
40	10 (56%)	8 (44%)	0	0
41	11 (69%)	2 (13%)	3 (19%)	0
42	9 (82%)	2 (18%)	0	0
45	6 (75%)	1 (13%)	0	1 (13%)
46	14 (93%)	0	1 (7%)	0
47	30 (79%)	1 (3%)	7 (18%)	0

continues

continued				
Participant	Results in agreement	Questionable results	Discrepant results	Missing results
48	13 (100%)	0	0	0
51	12 (100%)	0	0	0
52	8 (100%)	0	0	0
53	8 (100%)	0	0	0
55	23 (72%)	3 (9%)	6 (19%)	0
59	9 (100%)	0	0	0
62	6 (55%)	2 (18%)	2 (18%)	1 (9%)
65	19 (83%)	2 (9%)	2 (9%)	0
72	3 (33%)	2 (22%)	4 (44%)	0
73	16 (89%)	1 (6%)	0	1 (6%)
74	3 (100%)	0	0	0
76	5 (50%)	3 (30%)	2 (20%)	0
82	12 (75%)	4 (25%)	0	0
83	8 (42%)	1 (5%)	0	10 (53%)
86	16 (70%)	2 (9%)	5 (22%)	0
89	16 (100%)	0	0	0
90	5 (63%)	1 (13%)	2 (25%)	0
91	14 (82%)	0	2 (12%)	1 (6%)
94	12 (63%)	5 (26%)	2 (11%)	0
95	9 (60%)	2 (13%)	4 (27%)	0
98	1 (20%)	3 (60%)	1 (20%)	0
99	13 (54%)	5 (21%)	6 (25%)	0
104	6 (46%)	3 (23%)	2 (15%)	2 (15%)
106	29 (94%)	2 (6%)	0	0
107	11 (73%)	2 (13%)	2 (13%)	0
108	14 (100%)	0	0	0
111	5 (63%)	1 (13%)	1 (13%)	1 (13%)
114	10 (71%)	2 (14%)	2 (14 %)	0
116	6 (75%)	0	1 (13%)	1 (13%)
117	7 (44%)	1 (6%)	6 (38%)	2 (13%)
118	5 (50%)	0	0	5 (50%)
120	10 (100%)	0	0	0
123	3 (75%)	0	1 (25%)	0
continues				

continued				
Participant	Results in agreement	Questionable results	Discrepant results	Missing results
126	15 (71%)	1 (5%)	5 (24%)	0
127	8 (100%)	0	0	0
128	1 (100%)	0	0	0
129	9 (21%)	14 (33%)	19 (45%)	0
130	14 (67%)	3 (14%)	3 (14%)	1 (5%)
131	4 (25%)	5 (31%)	5 (31%)	2 (13%)
132	0	1 (100%)	0	0
Total	841 (70%)	171 (14%)	142 (12%)	48 (4%)

3.9 RESULTS UK / NON-UK AND 2007 / 2008 / 2009 / 2010 PARTICIPANTS

The following table compares the results of UK participants with the non-UK participants for the aqueous samples in the 2007, 2008, 2009 and 2010 Exercises (thus excluding the C sample (2008) and S samples (2009 and 2010) results).

Table 3.11 – Results UK/non-UK and 2007/2008/2009/2010 participants

Participant sector	Results in agreement (%)	Number of results
UK participants in 2007	74	677 (56%)
UK participants in 2008	66	673 (56%)
UK participants in 2009	72	620 (56%)
UK participants in 2010	69	656 (61%)
non-UK participants in 2007	69	540 (44%)
non-UK participants in 2008	66	529 (44%)
non-UK participants in 2009	69	489 (44%)
non-UK participants in 2010	70	420 (39%)
2009 participants in 2010	71	893 (83%)
non-2009 participants in 2010	60	183 (17%)
Total 2007	72	1217
Total 2008	66	1202
Total 2009	71	1109
Total 2010	69	1076

The following conclusions can be drawn from this table:

(i) The overall performance in 2010 was slightly worse than the overall performance in 2009.

(ii) The performance of the UK participants was similar as the overall performance in 2010.

(iii) The performance of the 2010 participants who also participated in the 2009 Exercise was better than the performance of the new participants.

3.10 WEIGHTED MEAN OF THE LARGEST CONSISTENT SUBSET OF PARTICIPANTS' VALUES

The weighted mean of the largest consistent subset (LCS) for the participants' results were calculated and compared with the assigned values. The weighted mean of the LCS for the participants' results for ^{238}Pu (AH), ^{239}Pu (AH), gross alpha (AH), ^{3}H (B1), ^{55}Fe, ^{90}Sr, gross beta P, ^{134}Cs (GL and GH) and ^{152}Eu (GL) were significantly lower than assigned value, while the weighted mean of the LCS for the participants' results for ^{210}Pb, ^{210}Po, ^{60}Co (GH), ^{95}Zr (GL and GH), ^{95}Nb (GH) and ^{137}Cs (GH) were significantly higher than assigned value.

Table 3.12 – Weighted mean of the largest consistent subset values participants

Nuclide	Assigned value *N*	WM LCS	Size of the LCS (%)	Zeta test	Critical value
	Bq kg^{-1}	Bq kg^{-1}			
^{226}Ra (AL)	10.25(18)	10.23(18)	82	–0.07	2.67
^{232}Th	5.47(8)	5.32(7)	95	–1.33	2.63
^{238}U	7.76(20)	7.44(7)	96	–1.51	2.58
$^{239/240}$Pu	12.37(19)	11.87(11)	91	–2.26	2.59
^{241}Am	5.00(6)	5.06(5)	92	0.65	2.61
^{244}Cm	15.74(19)	15.27(21)	87	–1.64	2.70
gross alpha	72(7)	–	25	–	–
	Bq g^{-1}	Bq g^{-1}			
^{210}Pb (AH)	2.54(3)	2.77(6)	60	3.59 D	3.50
^{210}Po	2.54(3)	2.650(20)	60	3.24 D	2.69
^{237}Np	17.45(18)	17.7(4)	80	0.66	3.25
^{238}Pu	18.08(6)	17.04(19)	80	–5.25 D	3.01
^{239}Pu	17.29(8)	16.67(17)	80	–3.34 D	2.95
^{241}Am	4.382(10)	4.37(4)	90	–0.26	2.85
^{244}Cm	18.29(6)	18.14(25)	85	–0.59	3.11
gross alpha	80.57(21)	74.1(4)	55	–15.79 D	3.25
^{238}Pu (P)	5.054(23)	5.04(6)	88	–0.19	2.88
$^{239/240}$Pu	5.79(6)	5.74(6)	88	–0.62	2.67
^{241}Pu	14.96(16)	14.21(23)	71	–2.66	2.83
^{3}H (B1)	1.345(10)	1.325(12)	97	–1.31	2.65
^{14}C	0.1398(9)	0.1403(21)	88	0.22	2.86
^{36}Cl	0.4544(18)	0.420(12)	83	–2.91	4.60
^{99}Tc	0.1218(11)	0.1155(22)	88	–2.60	2.82
^{3}H (B2)	0.897(7)	0.863(4)	85	–4.72 D	2.59
^{55}Fe	1.235(22)	1.12(3)	70	–3.07 D	2.98
^{89}Sr	0.822(3)	0.785(18)	92	–2.08	3.11

continues

continued					
Nuclide	Assigned value *N*	WM LCS	Size of the LCS (%)	Zeta test	Critical value
	Bq g^{-1}	Bq g^{-1}			
^{90}Sr	1.488(4)	1.384(9)	79	–11.22 D	2.88
gross beta P	3.799(6)	3.590(11)	100	–17.25 D	3.17
gross beta L	5.931(23)	6.48(6)	67	8.62	63.66
	Bq kg^{-1}	Bq kg^{-1}			
^{7}Be (GL)	11.02(13)	11.32(18)	89	1.37	2.64
^{60}Co	11.252(25)	11.26(7)	96	0.19	2.67
^{95}Zr	2.551(20)	2.76(5)	84	4.09 D	2.70
^{95}Nb	5.55(5)	5.70(7)	78	1.88	2.65
^{134}Cs	13.59(10)	13.02(9)	93	–4.33 D	2.60
^{137}Cs	10.58(21)	10.69(7)	91	0.51	2.58
^{152}Eu	16.80(11)	16.18(10)	95	–4.00 D	2.60
^{154}Eu	3.437(25)	3.41(5)	94	–0.49	2.66
	Bq g^{-1}	Bq g^{-1}			
^{7}Be (GH)	4.24(8)	4.28(4)	94	0.52	2.58
^{60}Co	3.427(8)	3.499(16)	89	3.97 D	2.69
^{95}Zr	1.875(15)	1.944(17)	87	3.07 D	2.64
^{95}Nb	4.08(4)	4.21(4)	78	2.79 D	2.63
^{134}Cs	5.81(5)	5.629(24)	85	–3.48 D	2.58
^{137}Cs	10.43(7)	10.75(5)	97	3.68 D	2.59
^{152}Eu	11.78(13)	11.52(5)	91	–1.91	2.58
^{154}Eu	1.94(4)	1.866(15)	87	–1.88	2.58
^{60}Co (S)	7.82(20)	7.65(6)	84	–0.82	2.58
^{137}Cs	10.5(3)	10.22(6)	85	–0.98	2.58
^{152}Eu	16.0(5)	15.22(11)	72	–1.67	2.58
^{154}Eu	1.96(6)	1.825(18)	79	–2.11	2.58
^{241}Am	2.57(12)	2.521(24)	85	–0.37	2.58

3.11 RELATIVE UNCERTAINTY OUTLIERS

The outlier limit R_{lim} for the aqueous samples are listed in Table 3.13 and plotted in Figure 120. The IQR outlier test (see Appendix G) was used to determine whether a relative uncertainty was significantly different from the other results in the data set, resulting in the exclusion of 15 relative uncertainty results (1% of the total results). For 9 results this meant that, although they passed both the zeta test and z-test, the failure to pass the R_{lim} test resulted in a ‘questionable’ classification (these results are close to the assigned value, but have an unacceptably large u_L). The other 6 results were already classified as ‘questionable’ or ‘discrepant’, because they failed the z-test as well. R_{lim}, which is used to define the “upper” limit in the Kiri plots, ranged from 14.1% to 40.7%.

Table 3.13 – Median relative uncertainties and outlier limits aqueous samples

Nuclide	Number of results	Number of outliers	Outlier limit R_{lim} (%)
^{226}Ra (AL)	17	0	33.9
^{232}Th	20	0	26.9
^{238}U	24	0	25.6
^{239}Pu	23	0	25.5
^{241}Am	26	0	26.5
^{244}Cm	15	0	23.6
gross alpha	8	0	22.8
^{210}Pb (AH)	10	0	21.7
^{210}Po	10	0	21.7
^{237}Np	10	0	34.2
^{238}Pu	15	0	17.5
^{239}Pu	15	0	19.1
^{241}Am	21	1	18.7
^{244}Cm	13	1	15.3
gross alpha	11	0	34.4
^{238}Pu (P)	17	0	14.1
^{239}Pu	17	0	16.6
^{241}Pu	14	0	17.4
^{3}H (B1)	29	0	27.5
^{14}C	17	0	40.5
^{36}Cl	6	–	–
^{99}Tc	17	0	18.4
^{3}H (B2)	28	0	27.1
^{55}Fe	11	0	27.9
^{89}Sr	13	0	34.0
^{90}Sr	19	0	29.5
continues			

continued			
gross beta	10	0	25.7
^{7}Be (GL)	38	1	39.0
^{60}Co	45	2	20.9
^{95}Zr	38	1	29.8
^{95}Nb	40	1	26.3
^{134}Cs	44	0	25.9
^{137}Cs	45	2	21.2
^{152}Eu	42	0	24.8
^{154}Eu	37	0	34.2
^{7}Be (GH)	32	1	26.0
^{60}Co	35	1	22.2
^{95}Zr	31	1	31.0
^{95}Nb	32	1	23.2
^{134}Cs	34	0	20.3
^{137}Cs	35	0	23.9
^{152}Eu	33	0	20.7
^{154}Eu	31	0	19.9
^{60}Co (S)	25	0	21.1
^{137}Cs	26	0	20.8
^{152}Eu	25	0	21.2
^{154}Eu	24	0	25.3
^{241}Am	26	2	23.0

4 CONCLUSION

The 2010 proficiency test exercise was successfully completed, with all but 3 of the laboratories returning data. In total, 260 samples were shipped to 73 participants and 1183 results were submitted. All 70 data sets were submitted electronically. In total, 70% of the results was ‘in agreement’, 14% of the results was ‘questionable’, 12% of the results was ‘discrepant’ and 4% of the results was ‘missing’ [100% is represented by 1202 results]. 29 ‘false positives’ were received. The overall level of performance was slightly worse than observed in the previous Exercise (2009). The performance of the new participants was lower than the established participants. 27 participants scored 80% or higher ‘in agreement’ results, 19 participants scored 90% or higher ‘in agreement’ results and 14 participants scored 100% ‘in agreement’ results.

For the AL, AH and P samples 77%, 61% and 77% of the results were ‘in agreement’, respectively. For the P samples the most problematic nuclide was ^{241}Pu, while for the AL and AH samples the most problematic nuclides were ^{226}Ra and ^{210}Po, respectively. There was a significant negative bias between the assigned result and the participants’ results for ^{238}Pu (AH), ^{239}Pu (AH) and gross alpha (AH). There was a significant positive bias between the assigned result and the participants’ results for ^{210}Pb (AH) and ^{210}Po (AH).

For the B1 samples 81% of the results were ‘in agreement’. For the B1 samples the most problematic nuclide was ^{36}Cl. For the B2 samples 65% of the results were ‘in agreement’. The most problematic nuclides were ^{55}Fe and ^{89}Sr. There was a significant negative bias between the assigned result and the participants’ results for ^{3}H (B2), ^{55}Fe (B2), ^{90}Sr (B2) and gross beta (B2).

Most participants were able to identify all the nuclides in the GL and GH samples. The number of ‘false positives’ results was 29. More than one false positive result was returned for ^{22}Na (GL), ^{210}Pb (GL), ^{22}Na (GH) and ^{210}Pb (GH) (reported by 7, 6, 4 and 6 participants, respectively). For the GL and GH samples 63% and 74% of the results were ‘in agreement’. For the GL samples the most problematic nuclides were ^{7}Be, ^{95}Zr and ^{95}Nb, while for the GH samples the most problematic nuclide was ^{95}Nb. There was a significant negative bias between the assigned result and the participants’ results for ^{134}Cs (GL and GH) and ^{152}Eu (GL). There was a significant positive bias between the assigned result and the participants’ results for ^{60}Co (GH), ^{95}Zr (GL and GH), ^{95}Nb (GH) and ^{137}Cs (GH).

For the solid S samples 75% of the results were ‘in agreement’. For the S samples the most problematic nuclide was ^{241}Am.

Coincidence summing has been discussed in previous exercises, and is a problem for some of the nuclides included in this exercise (i.e., ^{60}Co, ^{134}Cs and ^{152}Eu). Coincidence summing leads to signal loss and hence underestimation of the activity levels of these nuclides. It is clear from the results that some participants do not make corrections for coincidence summing.

5 FIGURES

Figures 1 to 48

A Deviations D for results 'in agreement' are represented by the dark blue points. Questionable and discrepant results are represented by the yellow and red points, respectively. The error bars represent the standard uncertainties u_D (with a coverage factor of k=1). The light blue lines represent z-scores of –2.576 and 2.576.

B The zeta score values are represented by the light blue bars.

C The relative uncertainties of the laboratory values R_L that are not outliers are represented by the light blue bars. Relative uncertainties R_L that are outliers are represented by the yellow bars. The median is represented by the dark blue bar(s). The black line represents the outlier limit R_{lim}.

D Kiri plots were constructed by plotting the squared ratio between the laboratory uncertainty u_L and the standard uncertainty for proficiency assessment σ_p against the z-scores. Data points that are in agreement are represented by the dark blue points. Questionable data points are represented by the yellow points. Discrepant data points are represented by the red points.

Figure 49 Homogeneity tests for ^{60}Co (A), ^{137}Cs (B), ^{152}Eu (C), ^{154}Eu (D) and ^{241}Am (E). The green points represent samples sent to the participants in this Exercise. The dark blue and red points represent samples kept at NPL.

Figures 50 to 119 Deviations D for results 'in agreement' are represented by the dark blue points. Questionable and discrepant results are represented by the yellow and red points, respectively. The error bars represent the standard uncertainties u_D (with a coverage factor of k=1).

Figure 120 The outlier limits for the relative uncertainties R_{lim} are represented by the light blue bars.

Figure 121 Normalised ^{244}Cm / ^{241}Am ratios AL (A) and AH (B). The values significantly different from unity are represented by the red points.

Figure 1A – Deviation Ra-226 AL

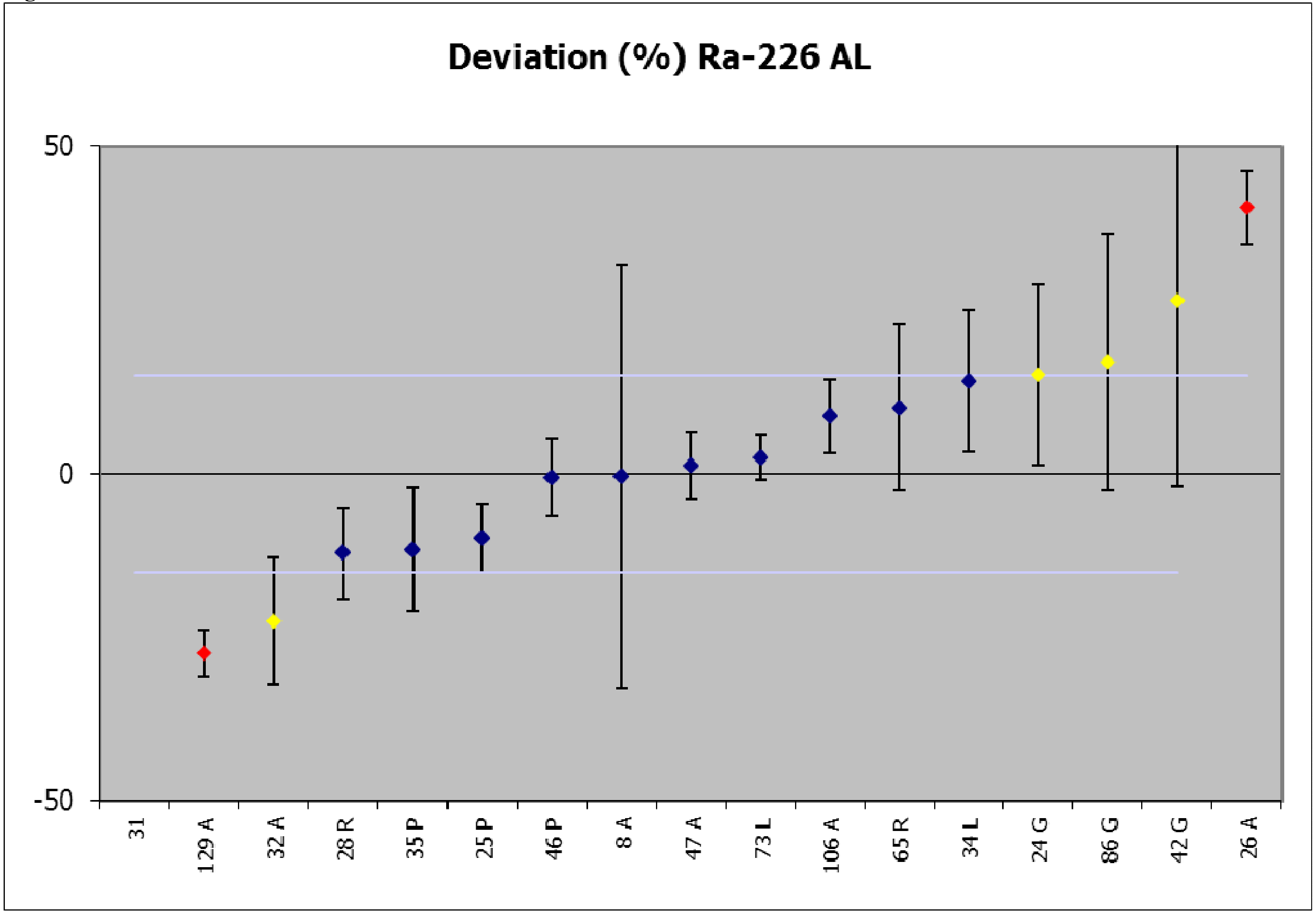


Figure 1B – Zeta score Ra-226 AL

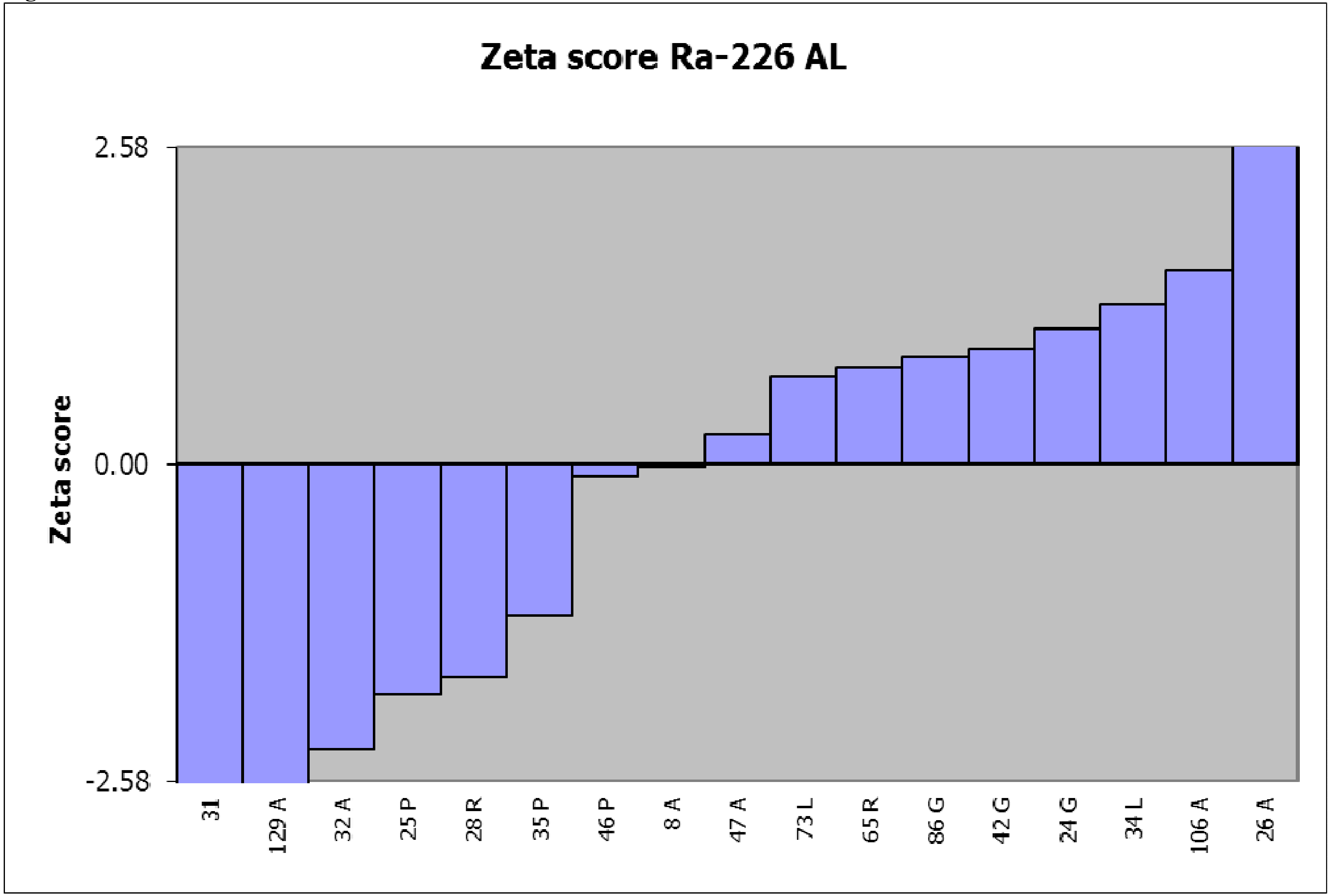


Figure 1C – Relative uncertainty Ra-226 AL

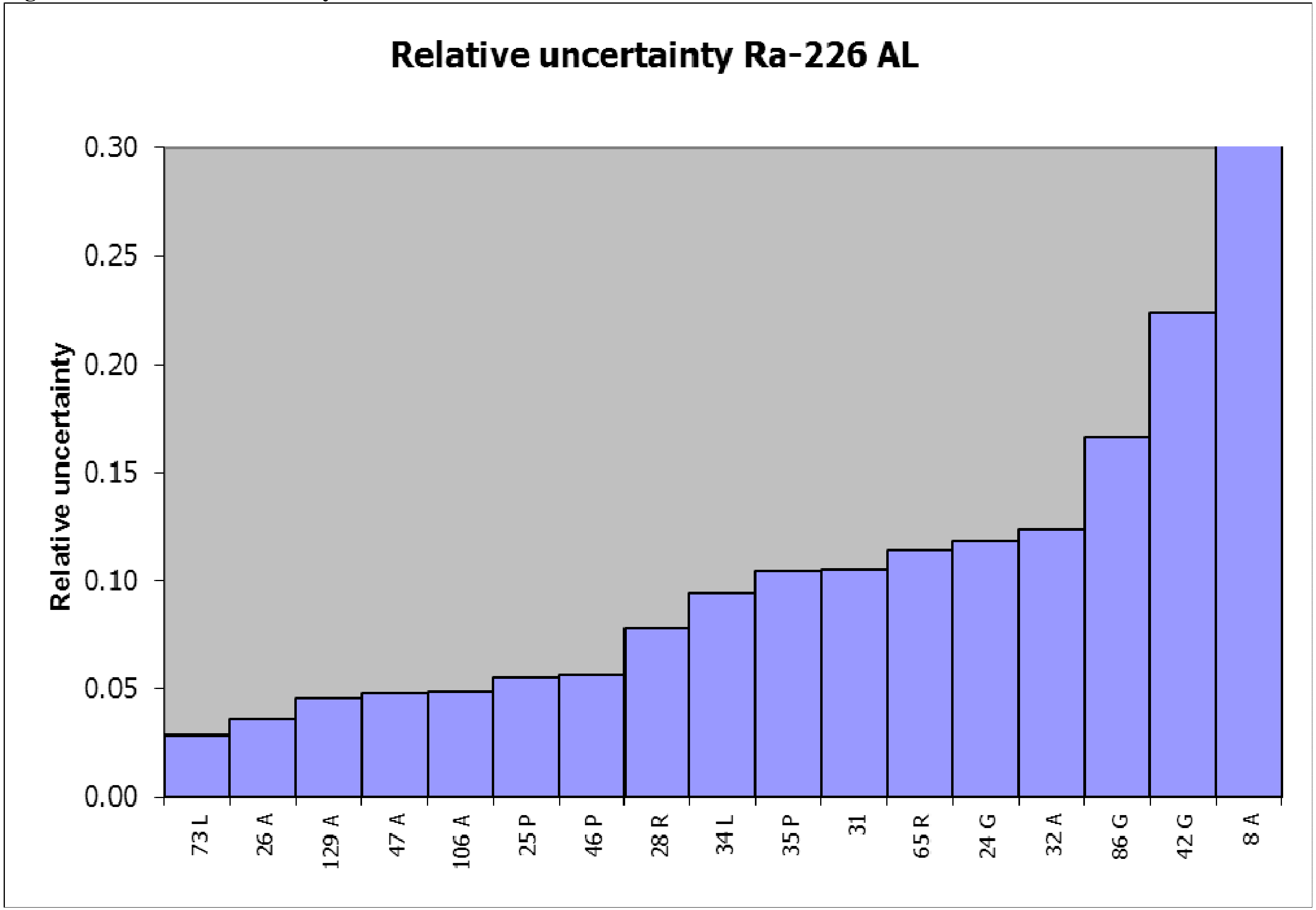


Figure 1D – Kiri plot Ra-226 AL

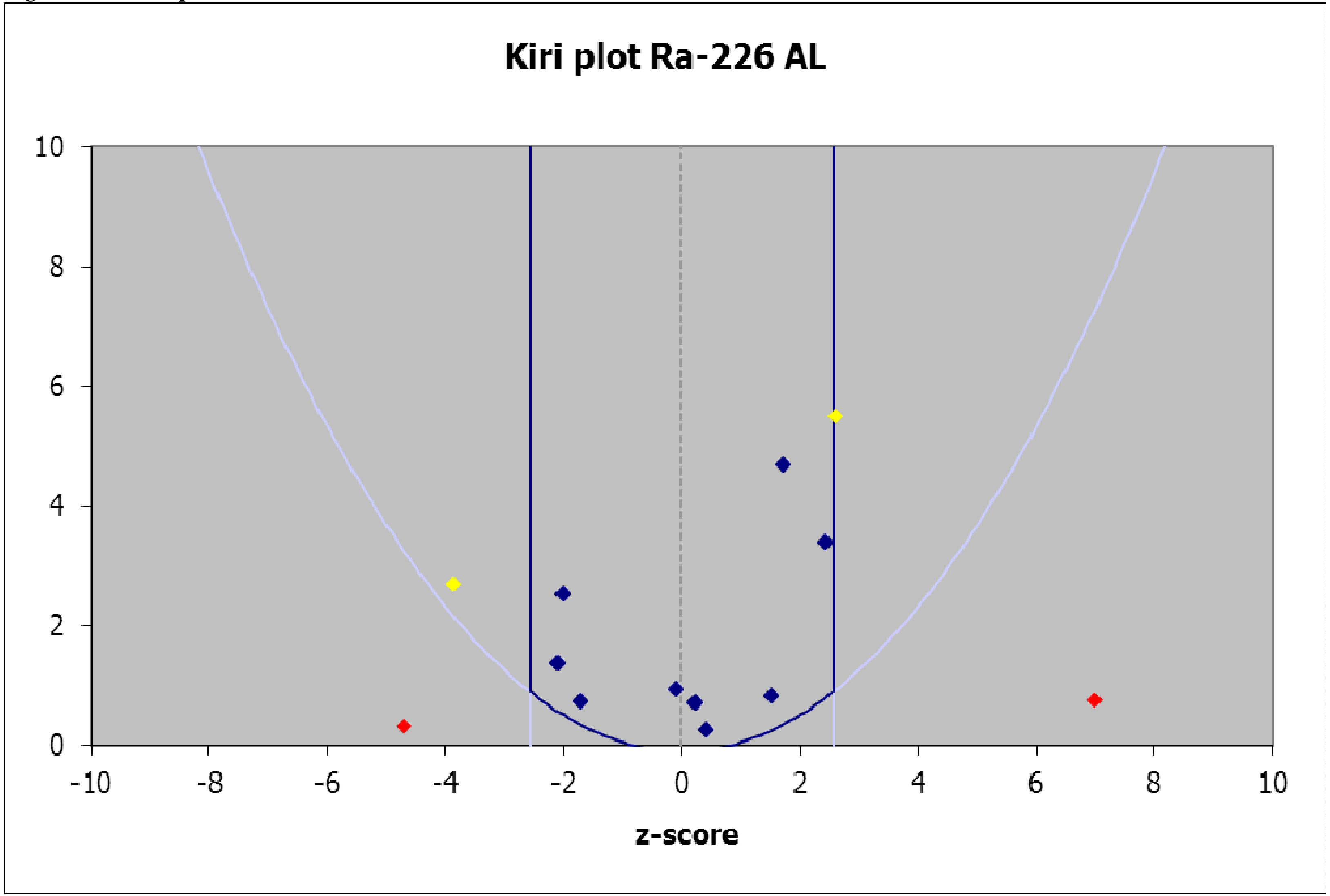


Figure 2A – Deviation Th-232 AL

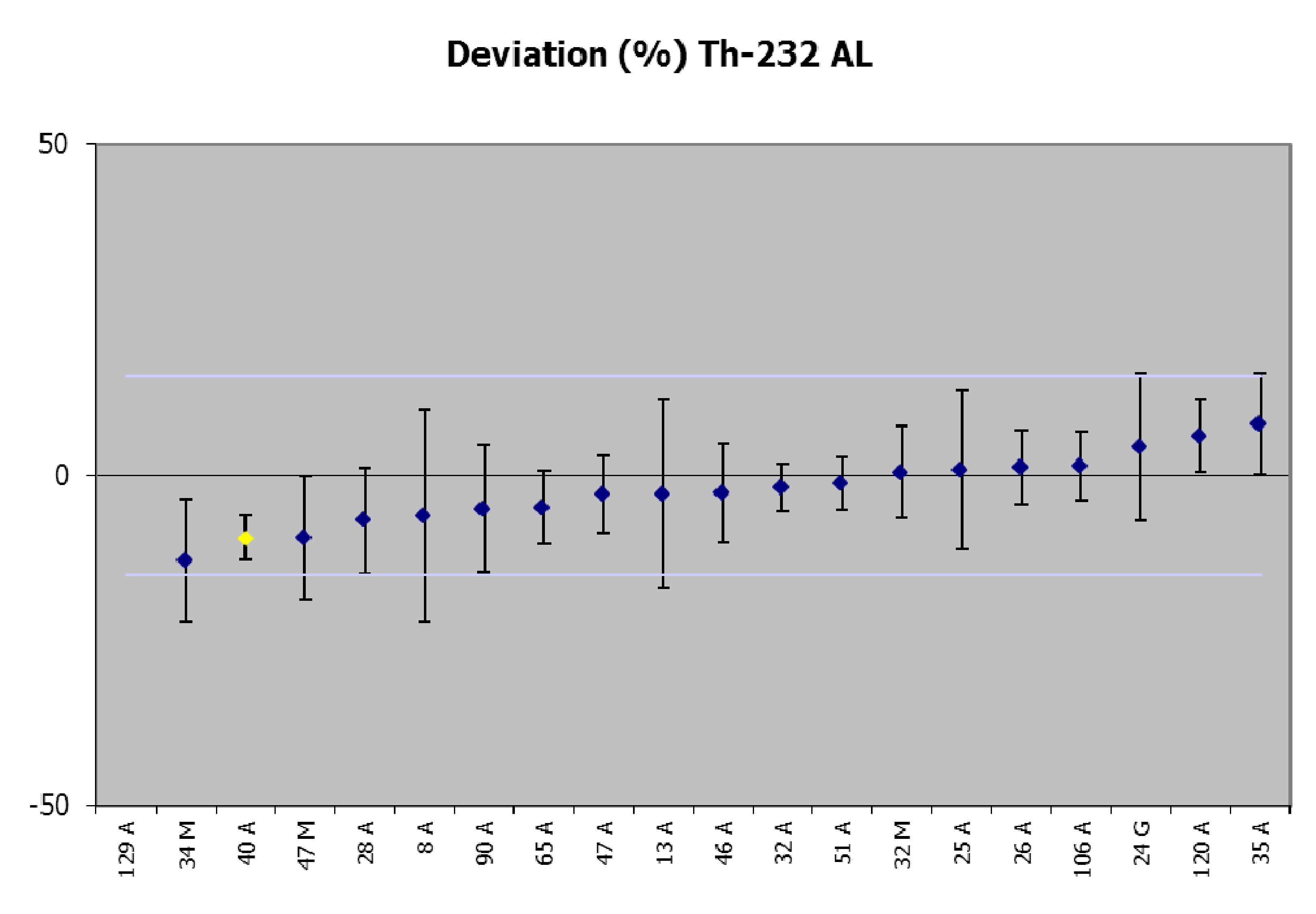


Figure 2B – Zeta score Th-232 AL

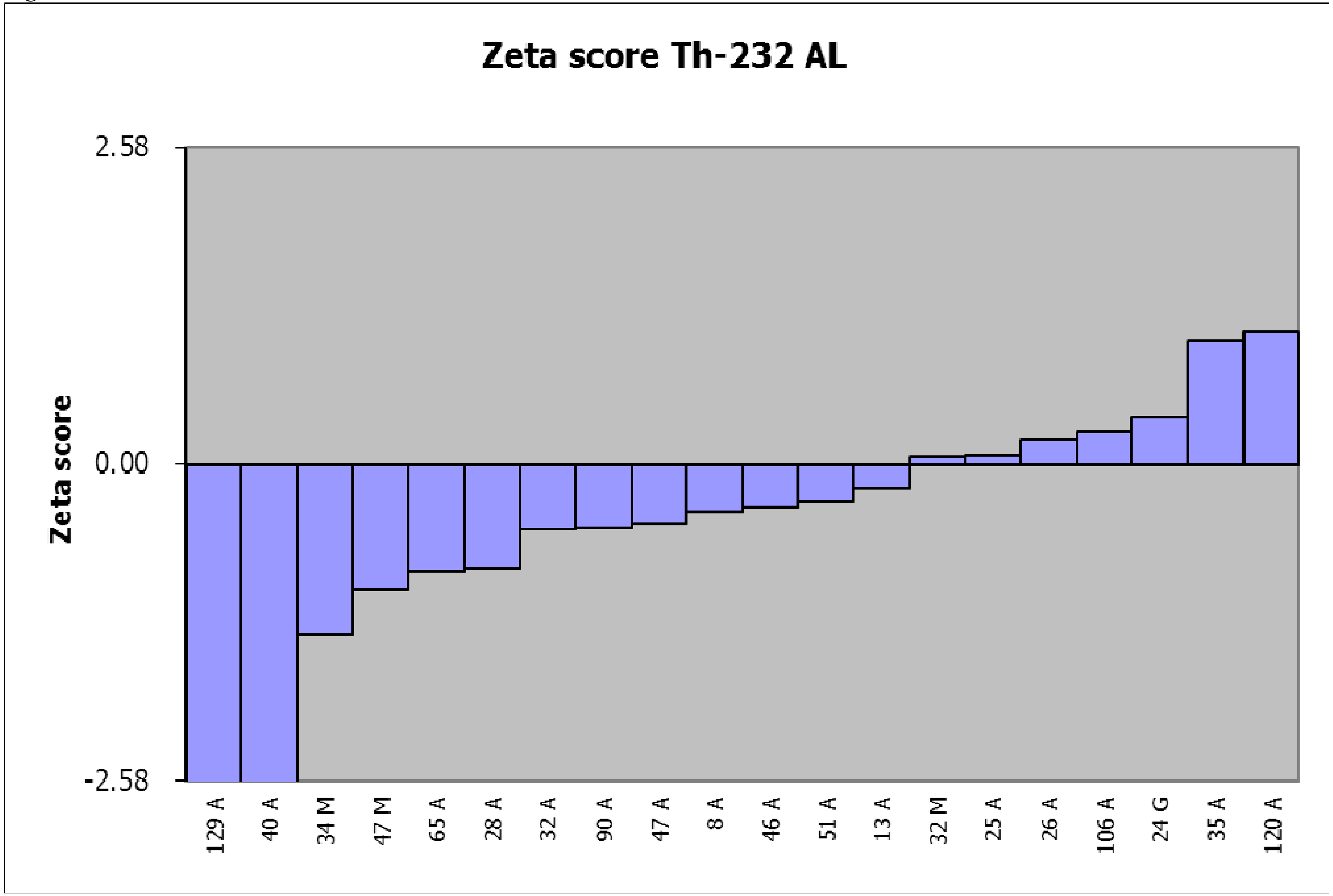


Figure 2C – Relative uncertainty Th-232 AL

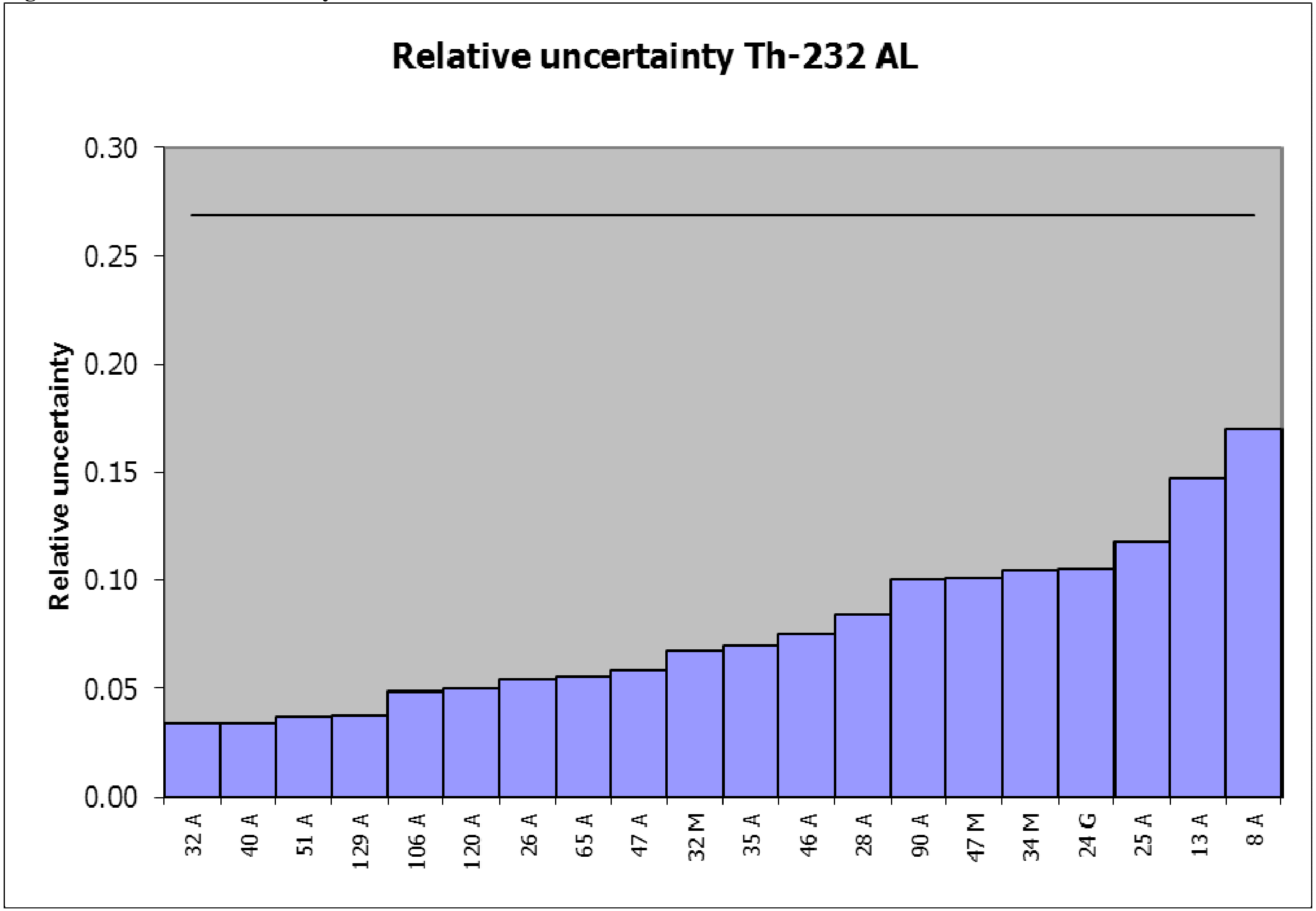


Figure 2D – Kiri plot Th-232 AL

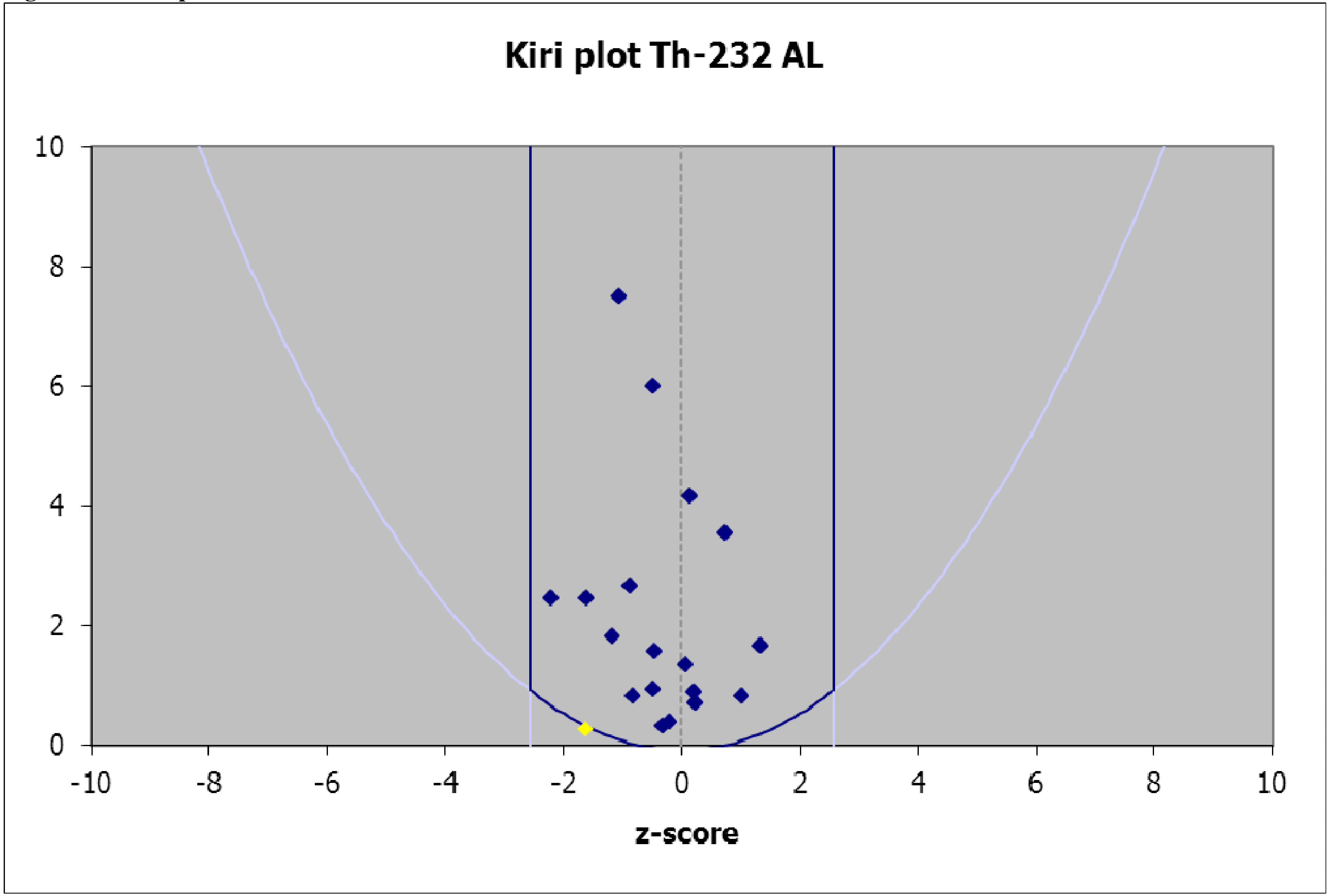


Figure 3A – Deviation U-238 AL

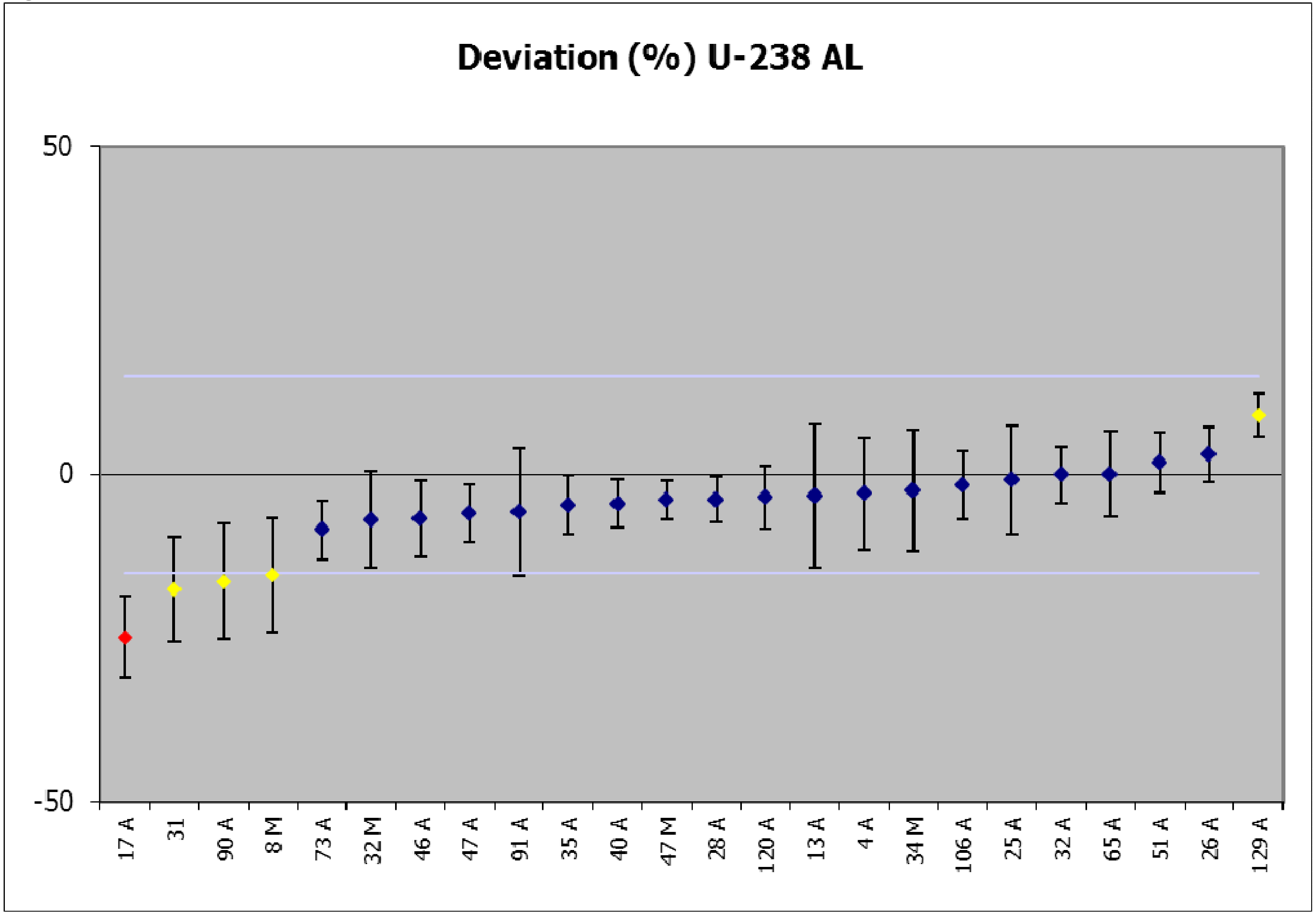


Figure 3B – Zeta score U-238 AL

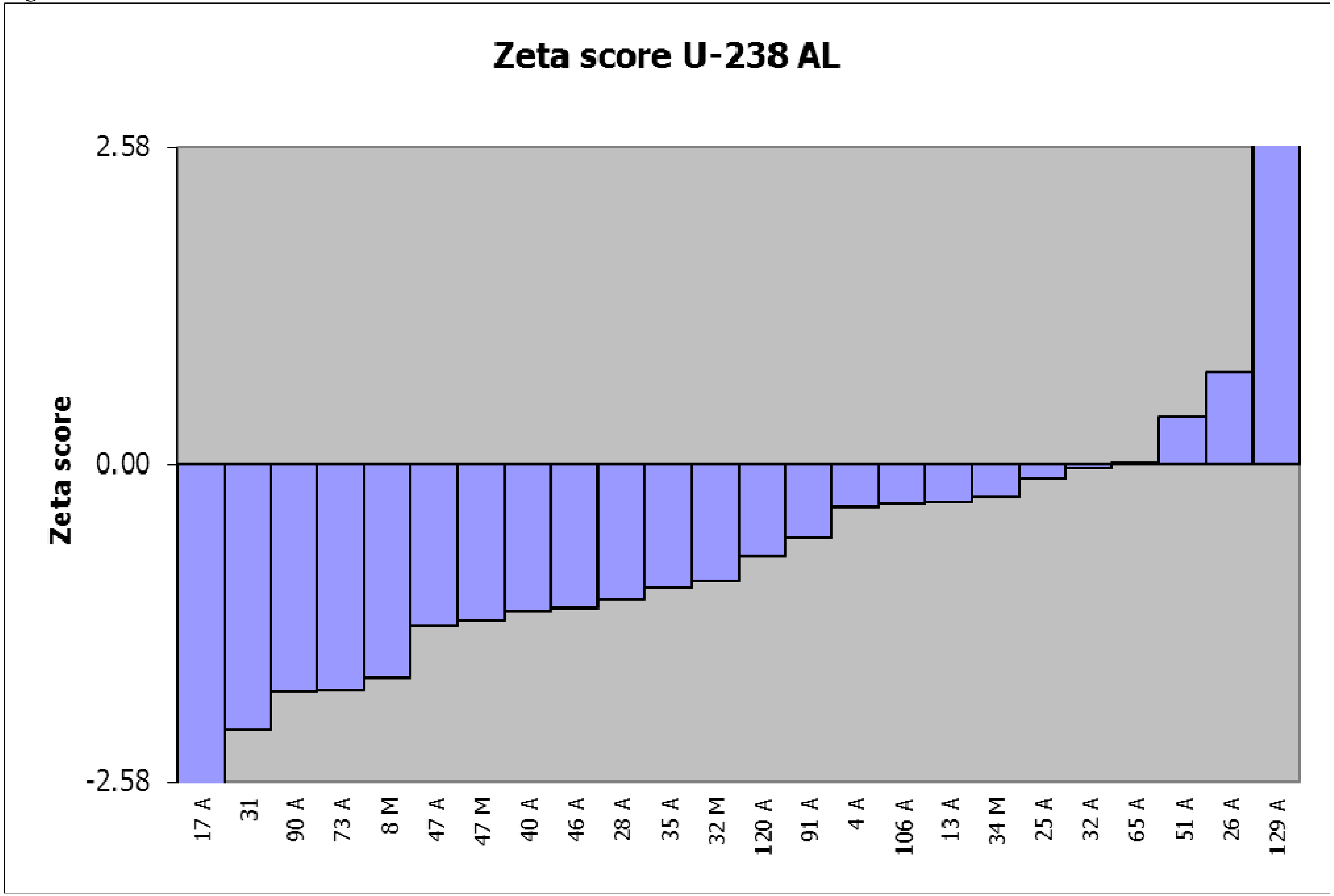


Figure 3C – Relative uncertainty U-238 AL

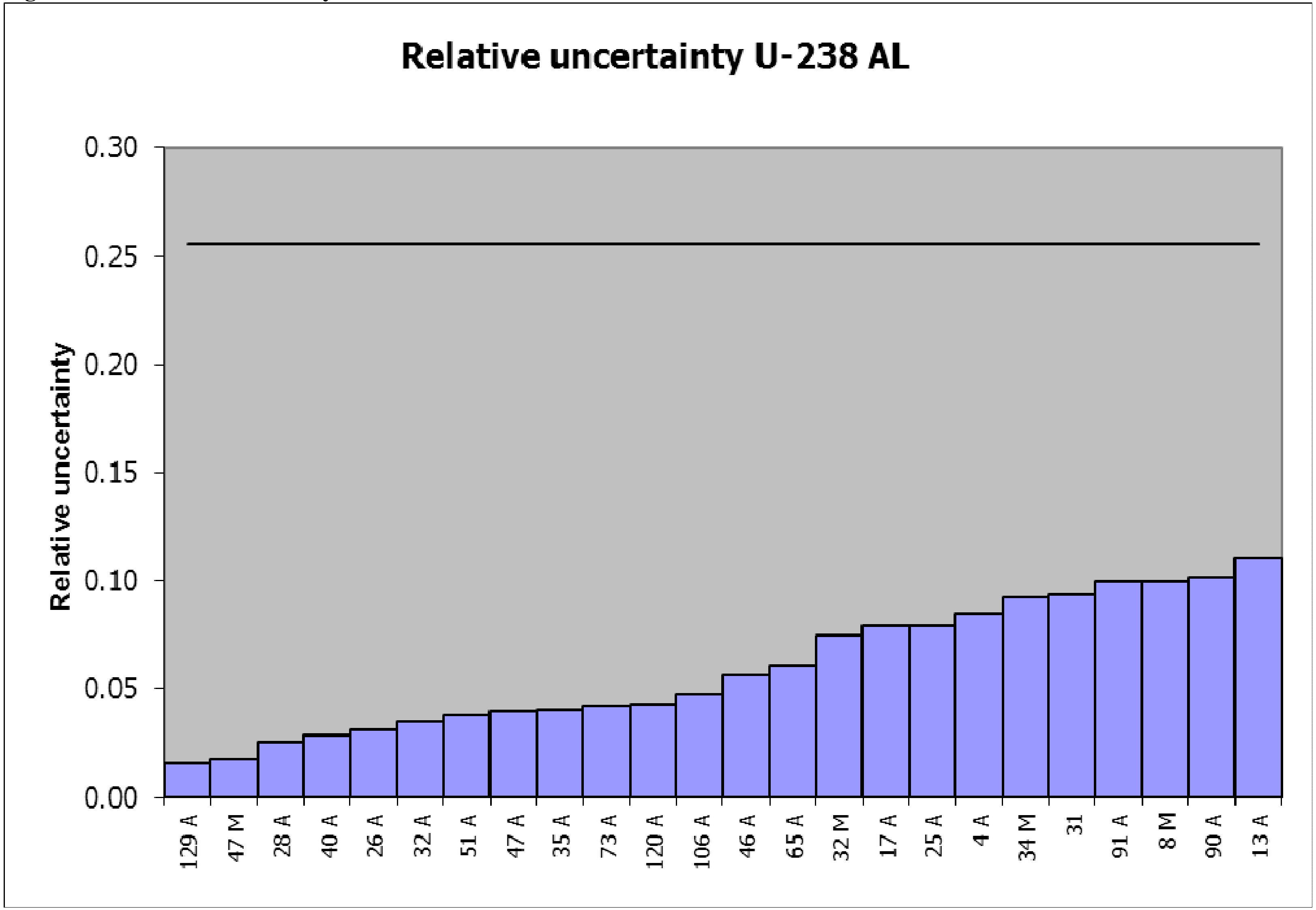


Figure 3D – Kiri plot U-238 AL

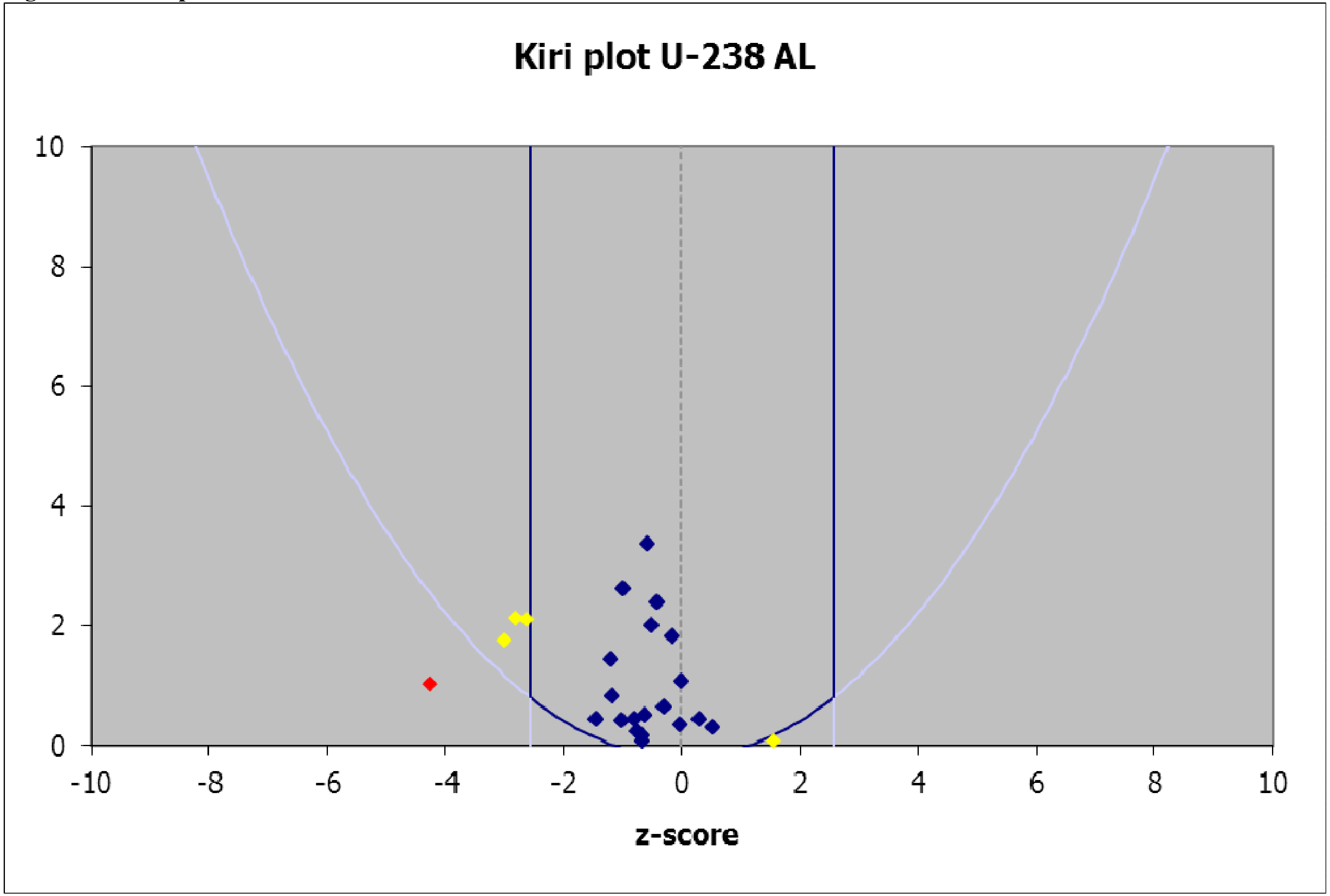


Figure 4A – Deviation Pu-239 AL

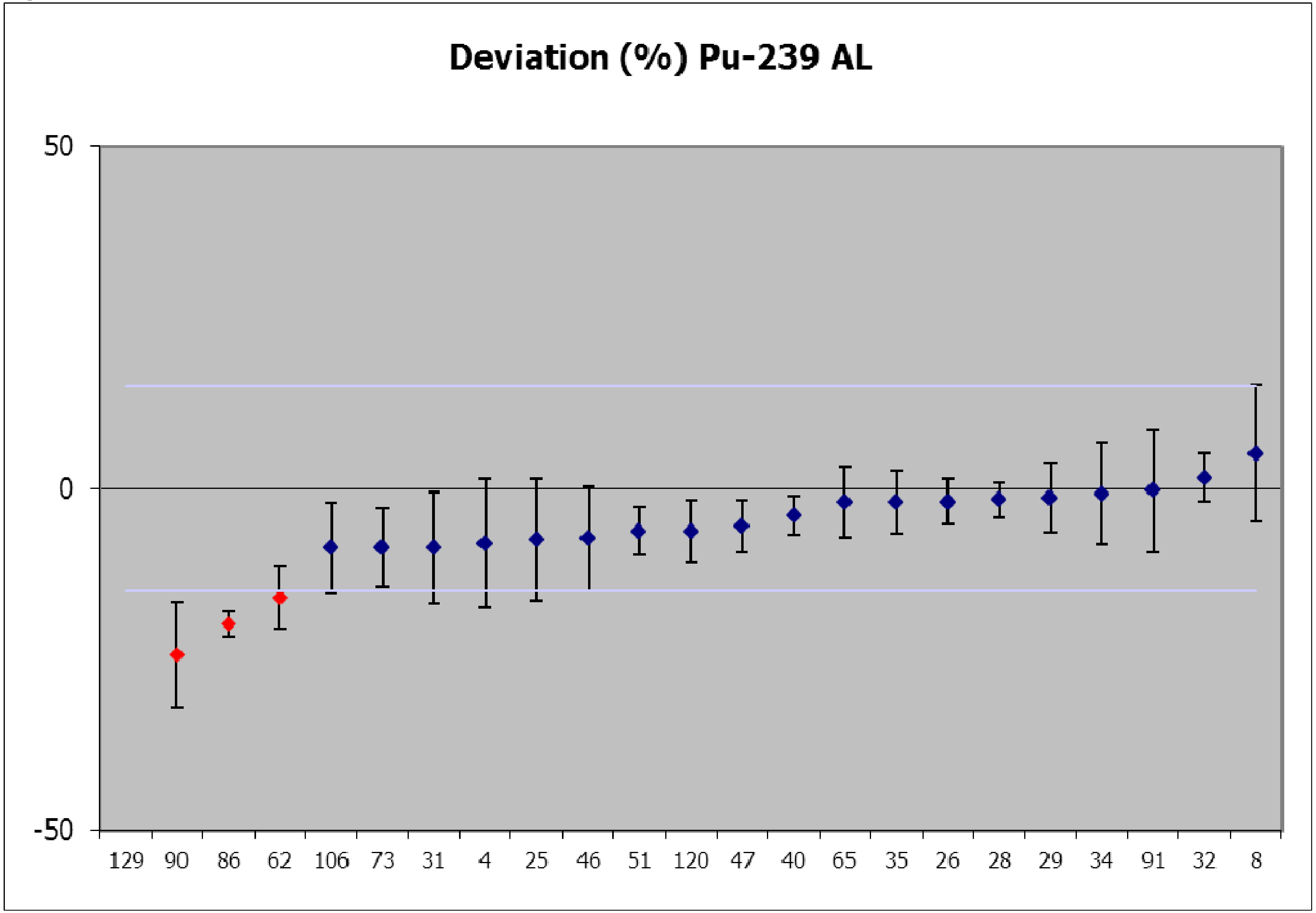


Figure 4B – Zeta score Pu-239 AL

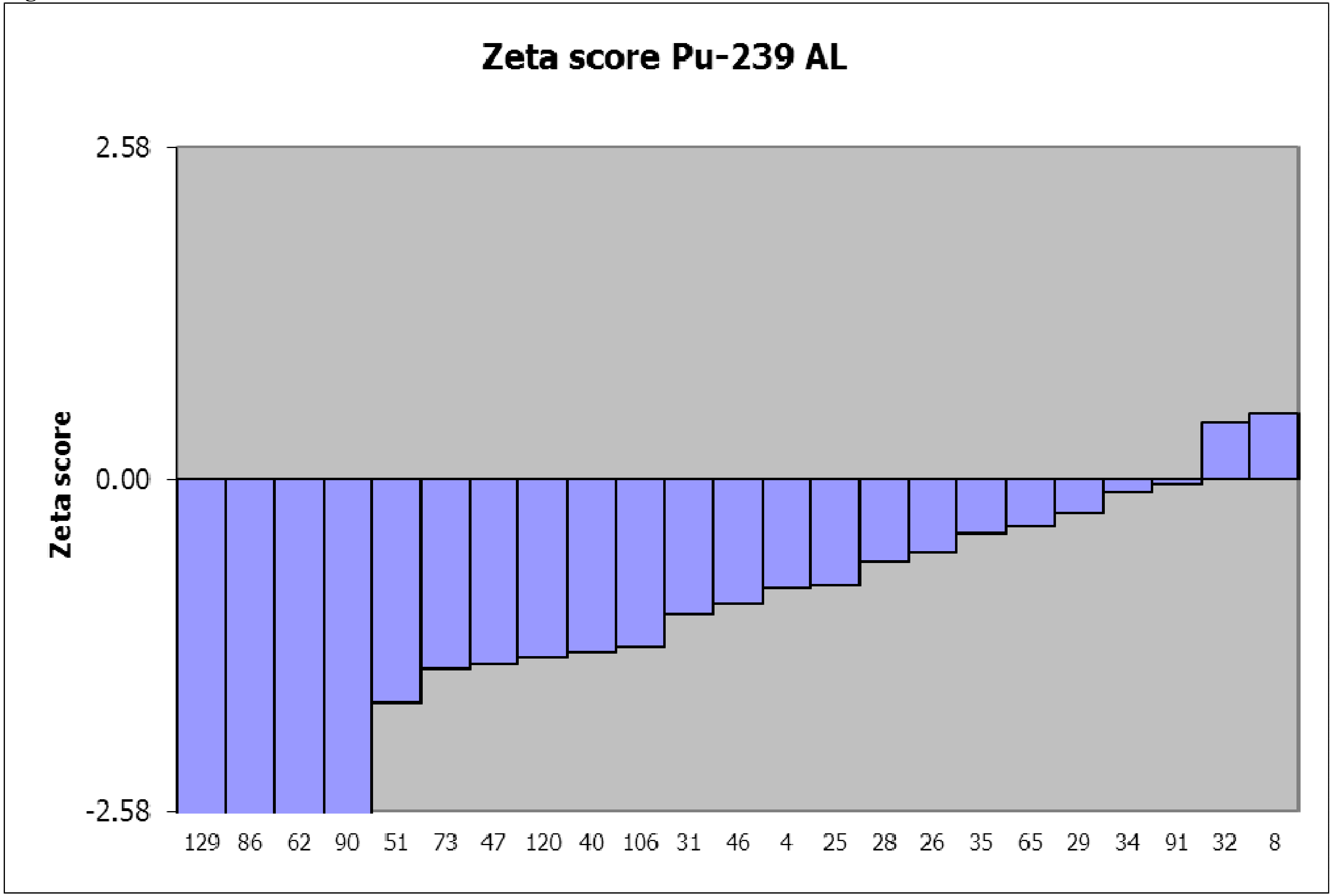


Figure 4C – Relative uncertainty Pu-239 AL

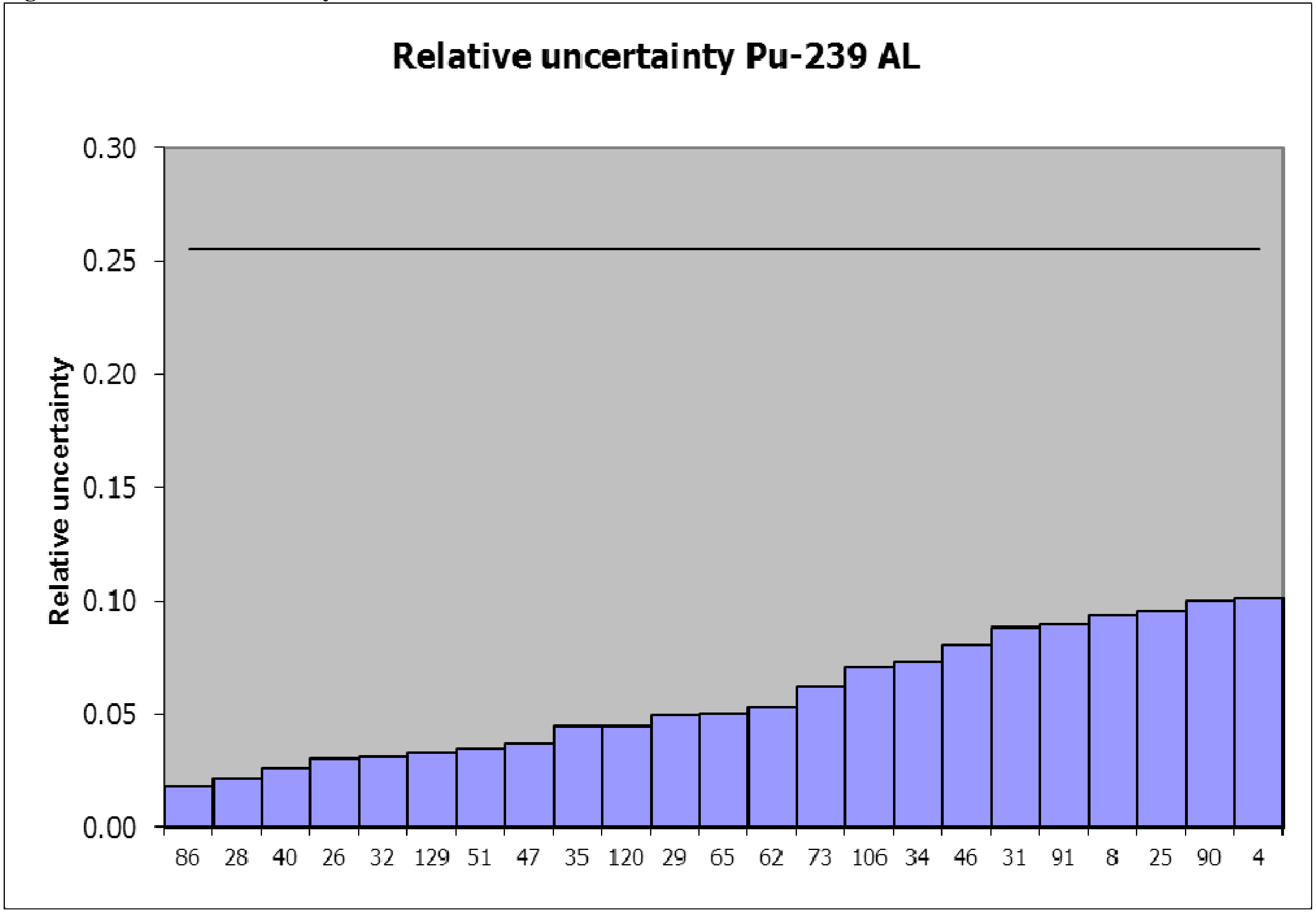


Figure 4D – Kiri plot Pu-239 AL

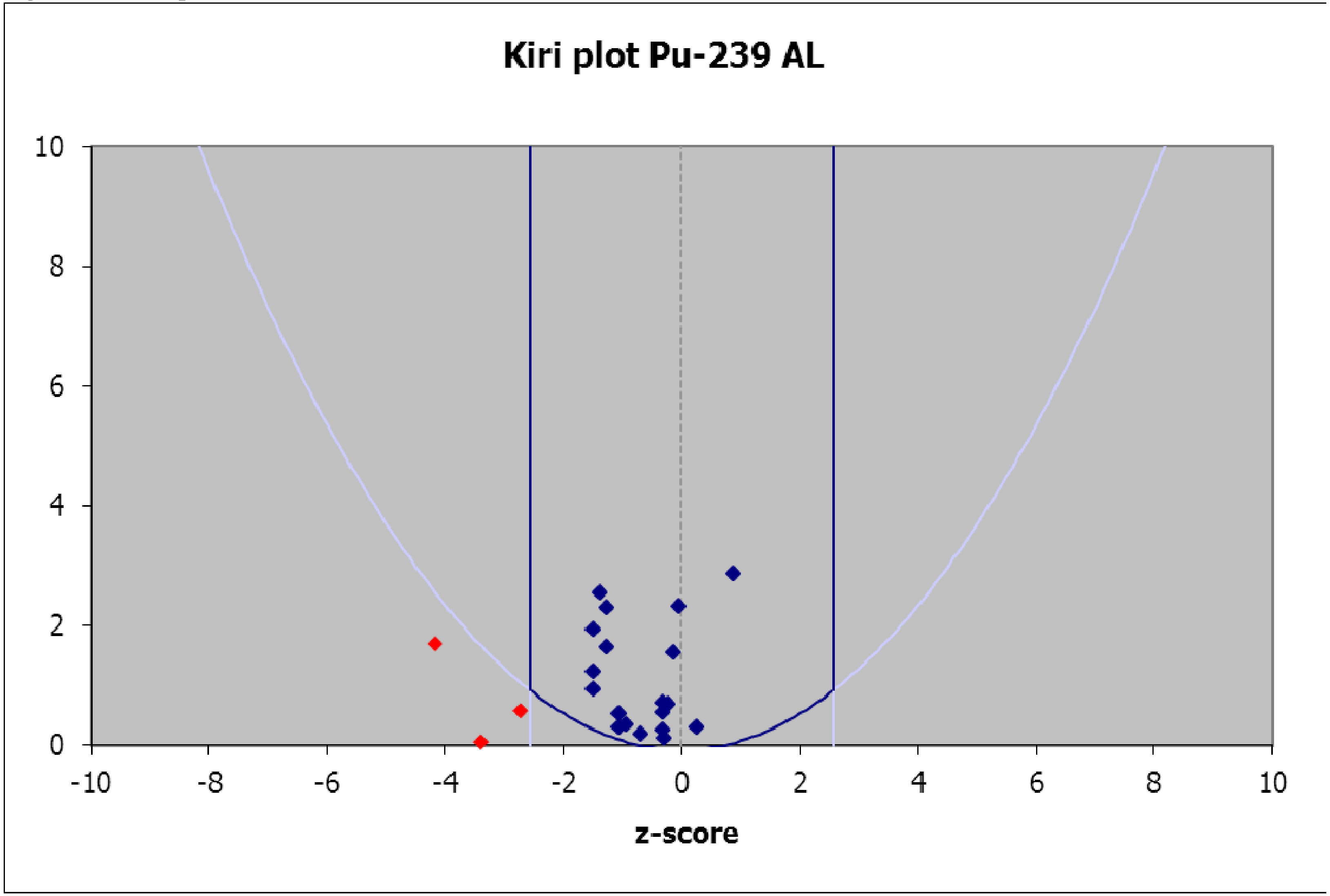


Figure 5A – Deviation Am-241 AL

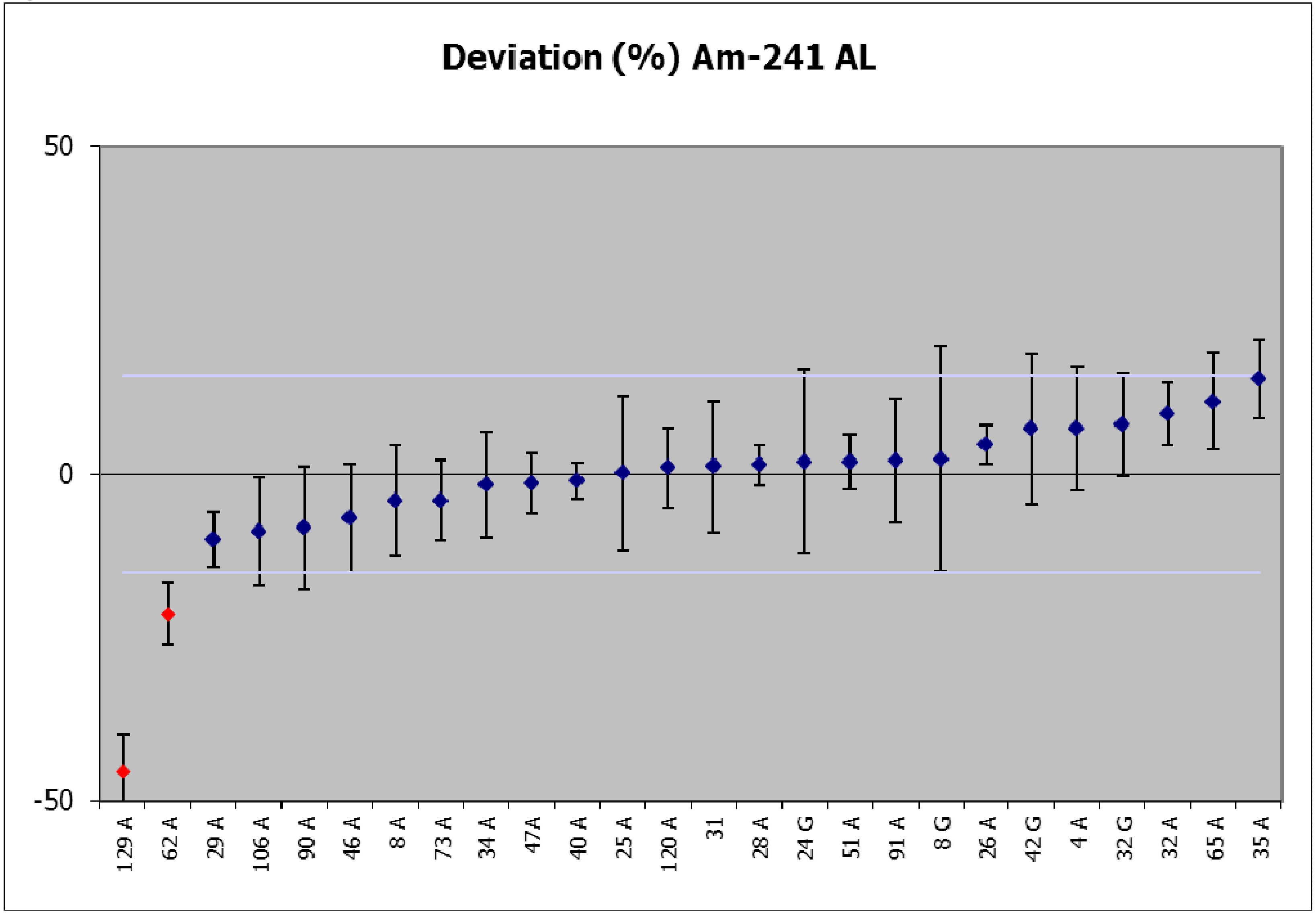


Figure 5B – Zeta score Am-241 AL

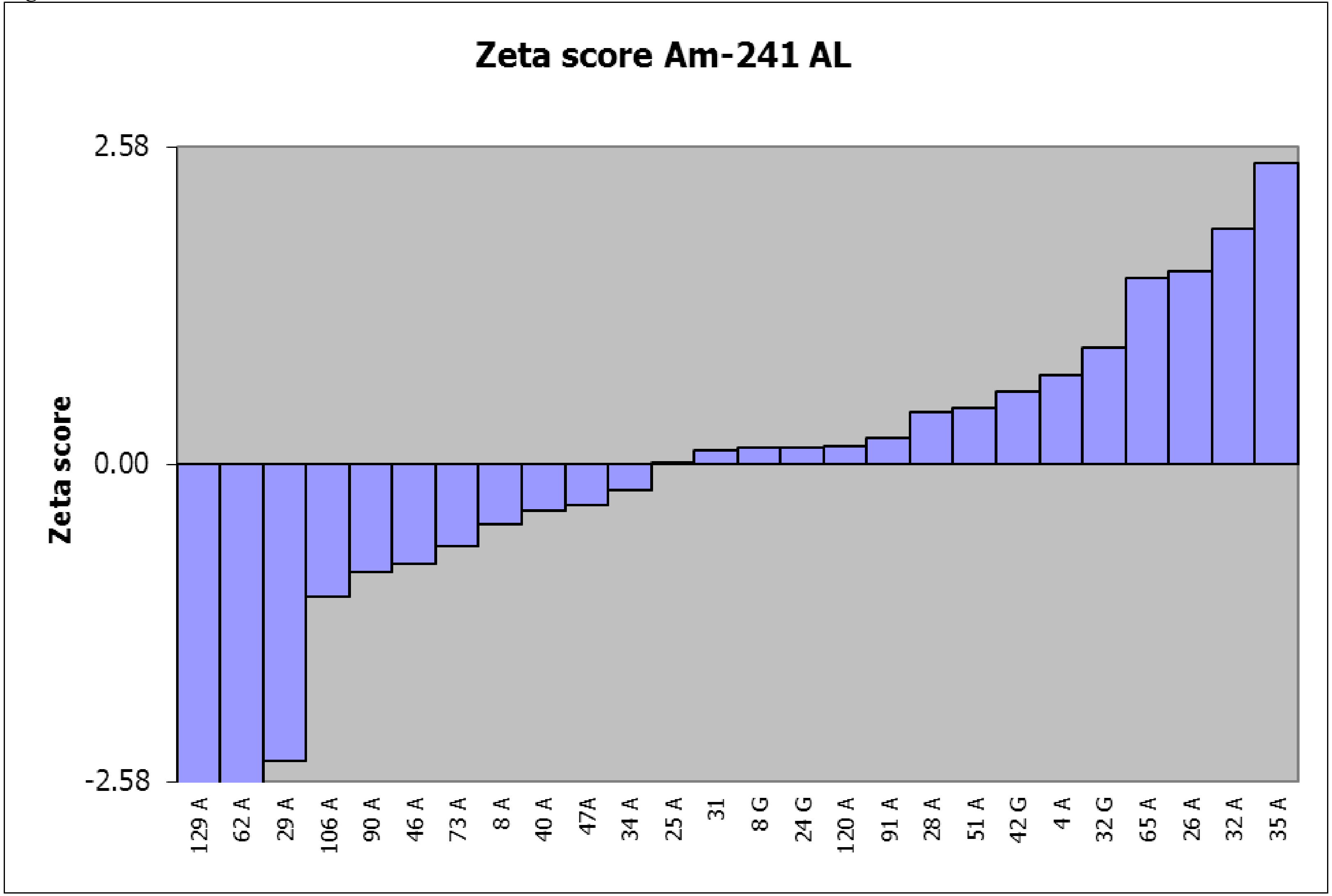


Figure 5C – Relative uncertainty Am-241 AL

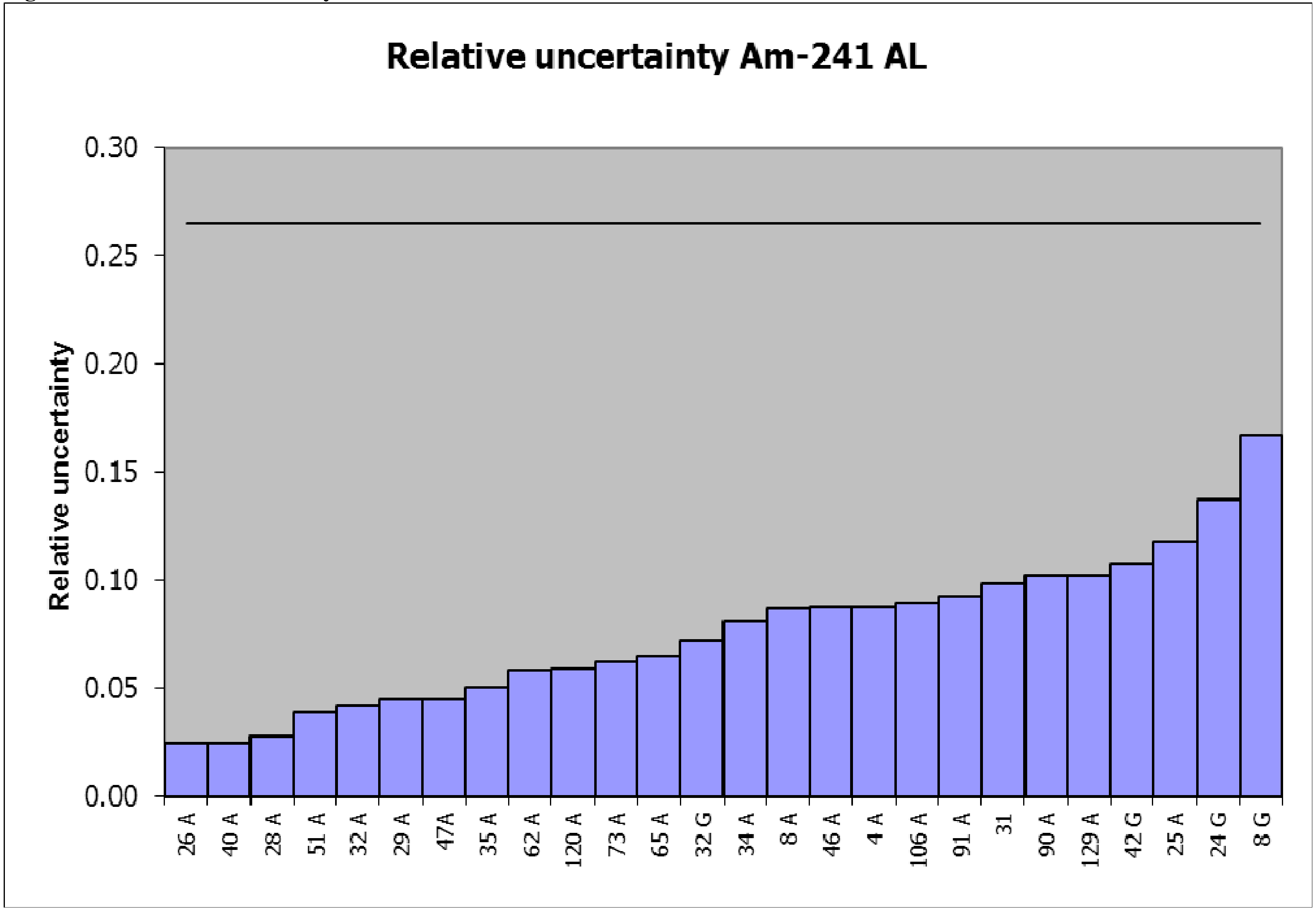


Figure 5D – Kiri plot Am-241 AL

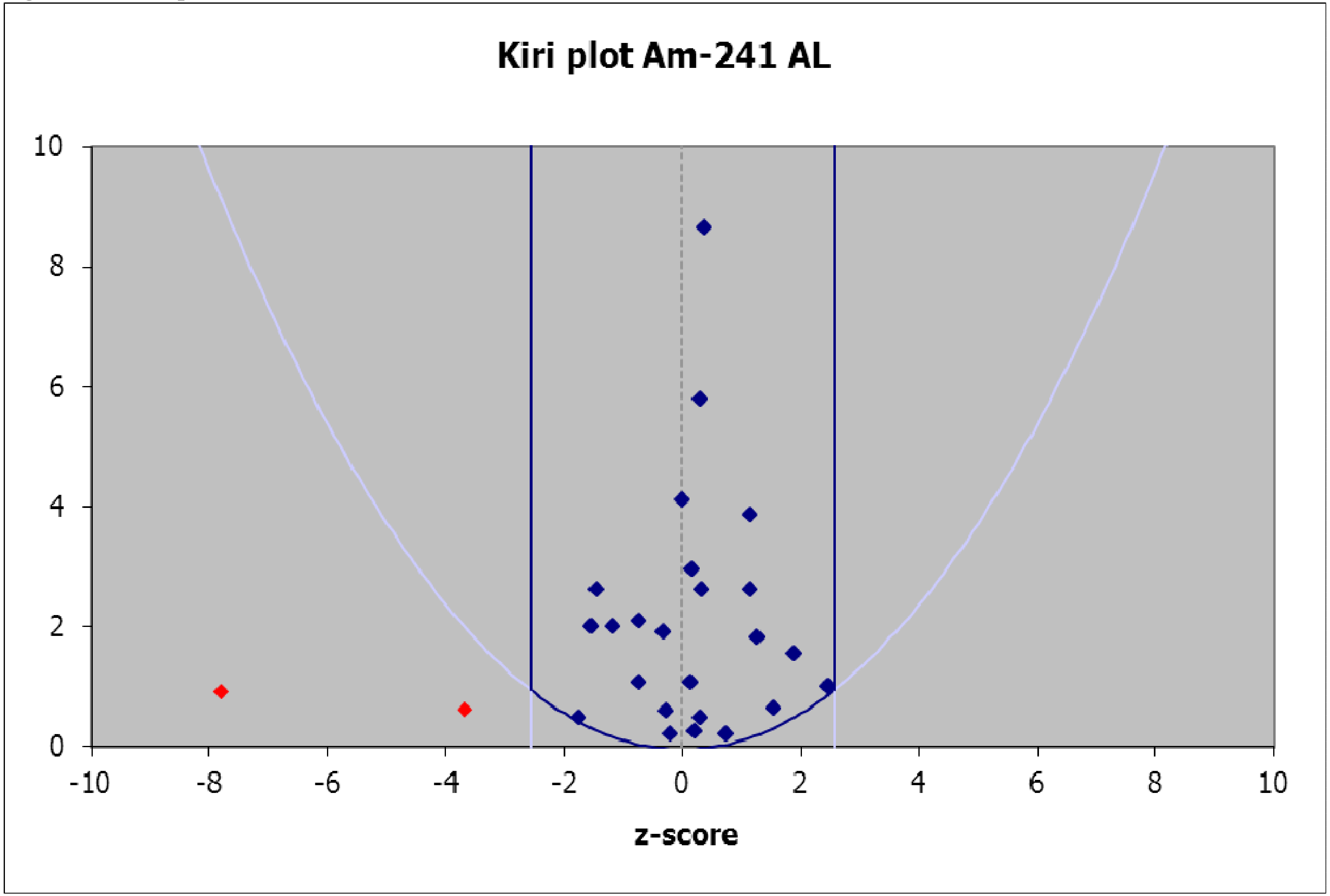


Figure 6A – Deviation Cm-244 AL

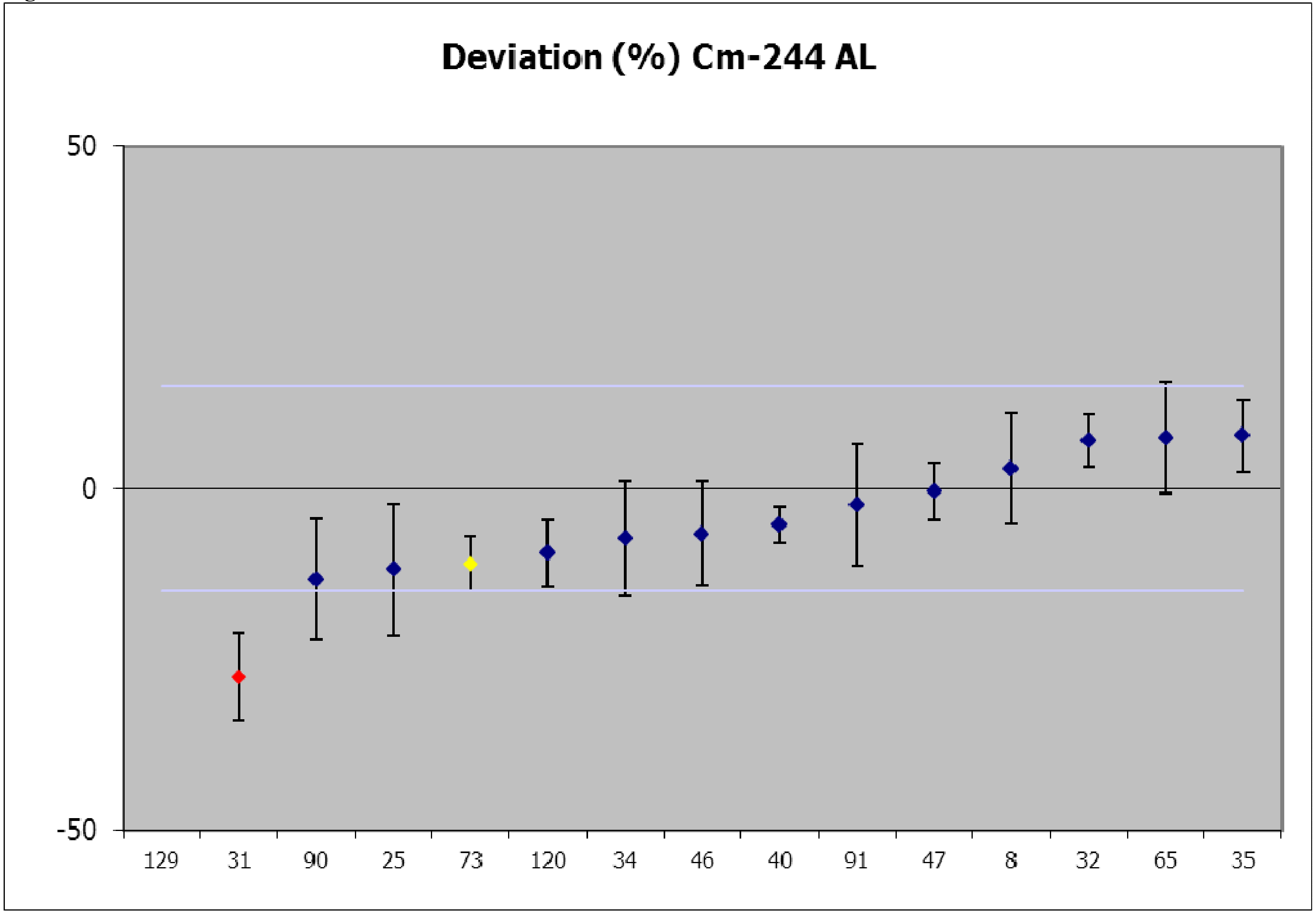


Figure 6B – Zeta score Cm-244 AL

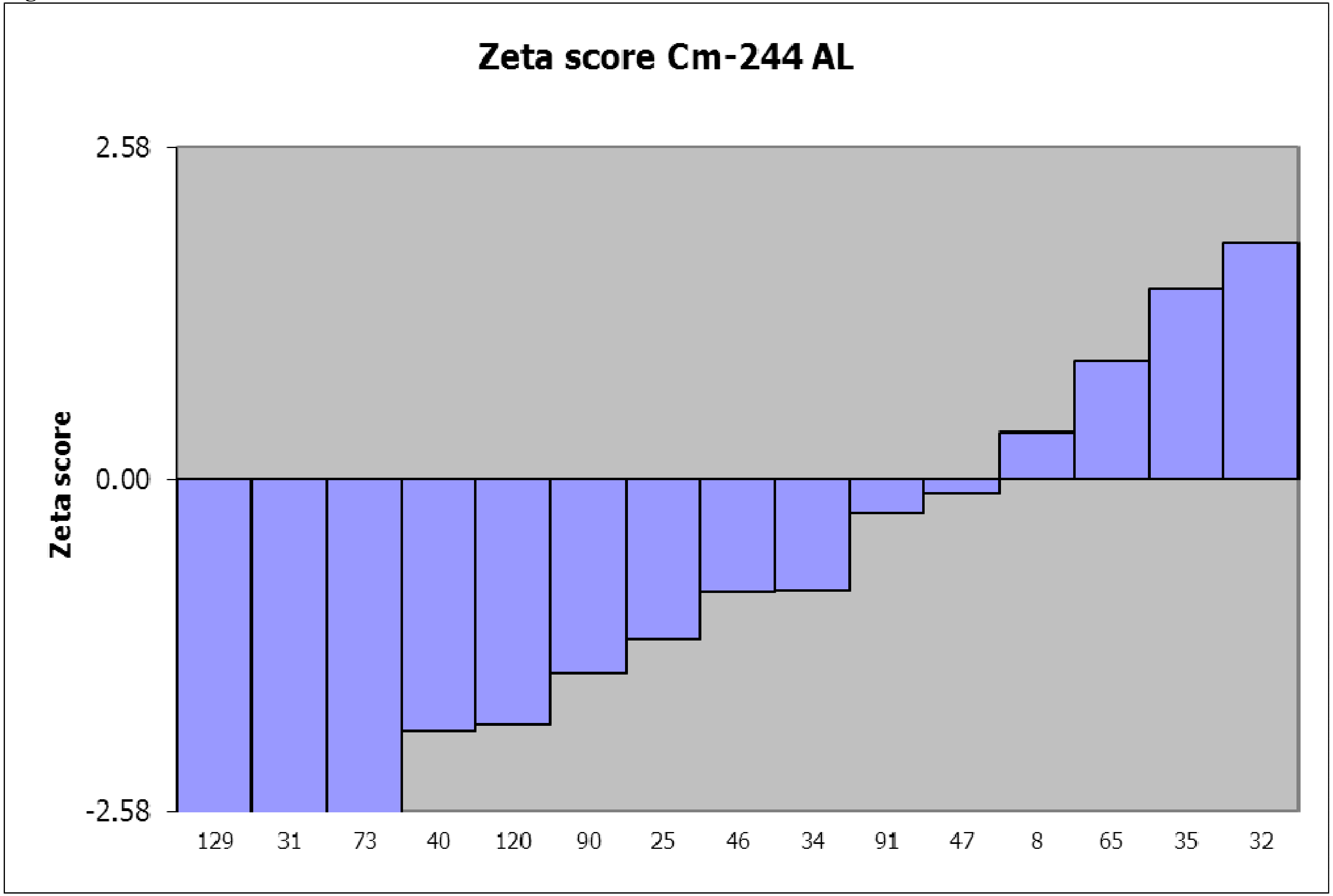


Figure 6C – Relative uncertainty Cm-244 AL

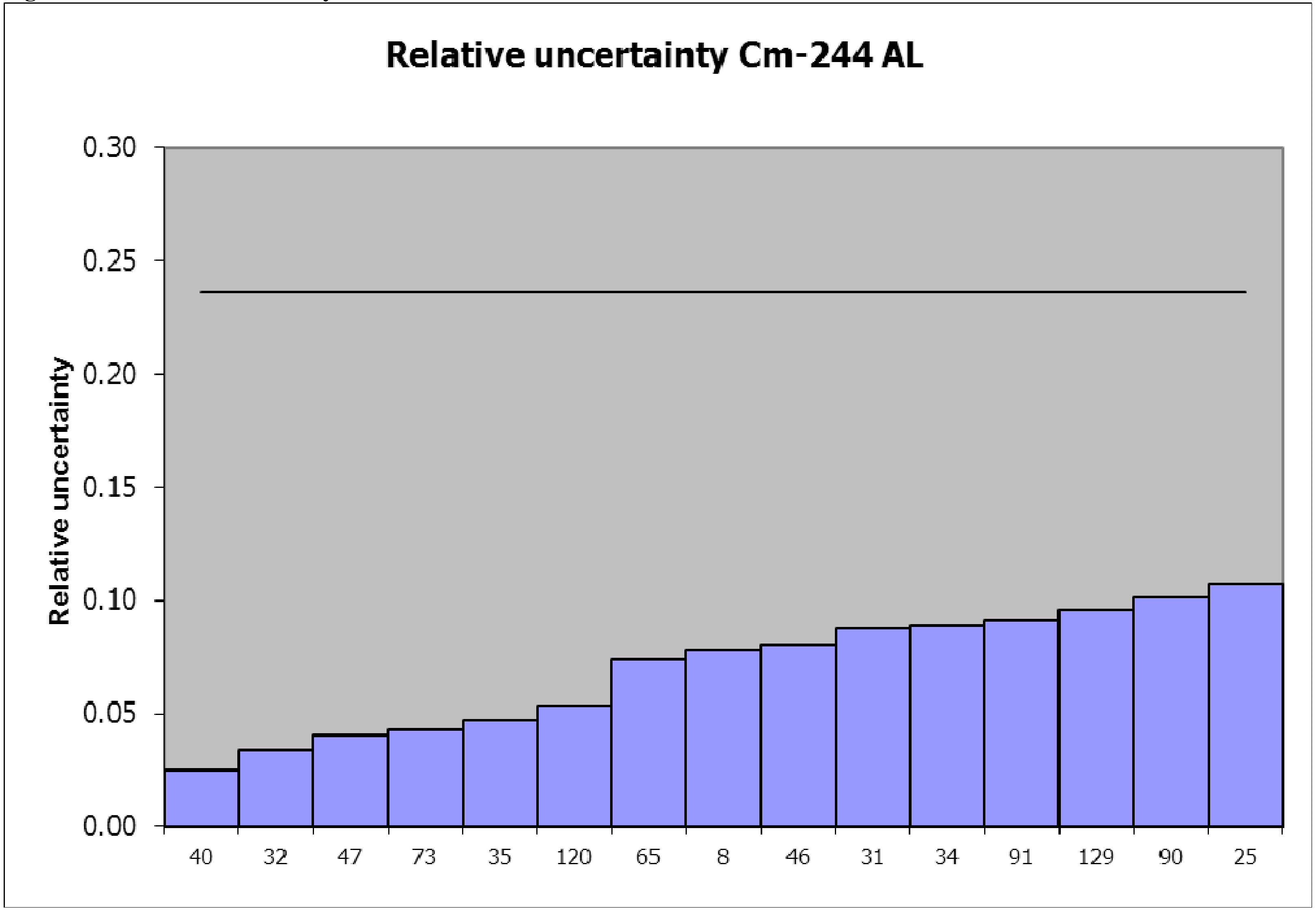


Figure 6D – Kiri plot Cm-244 AL

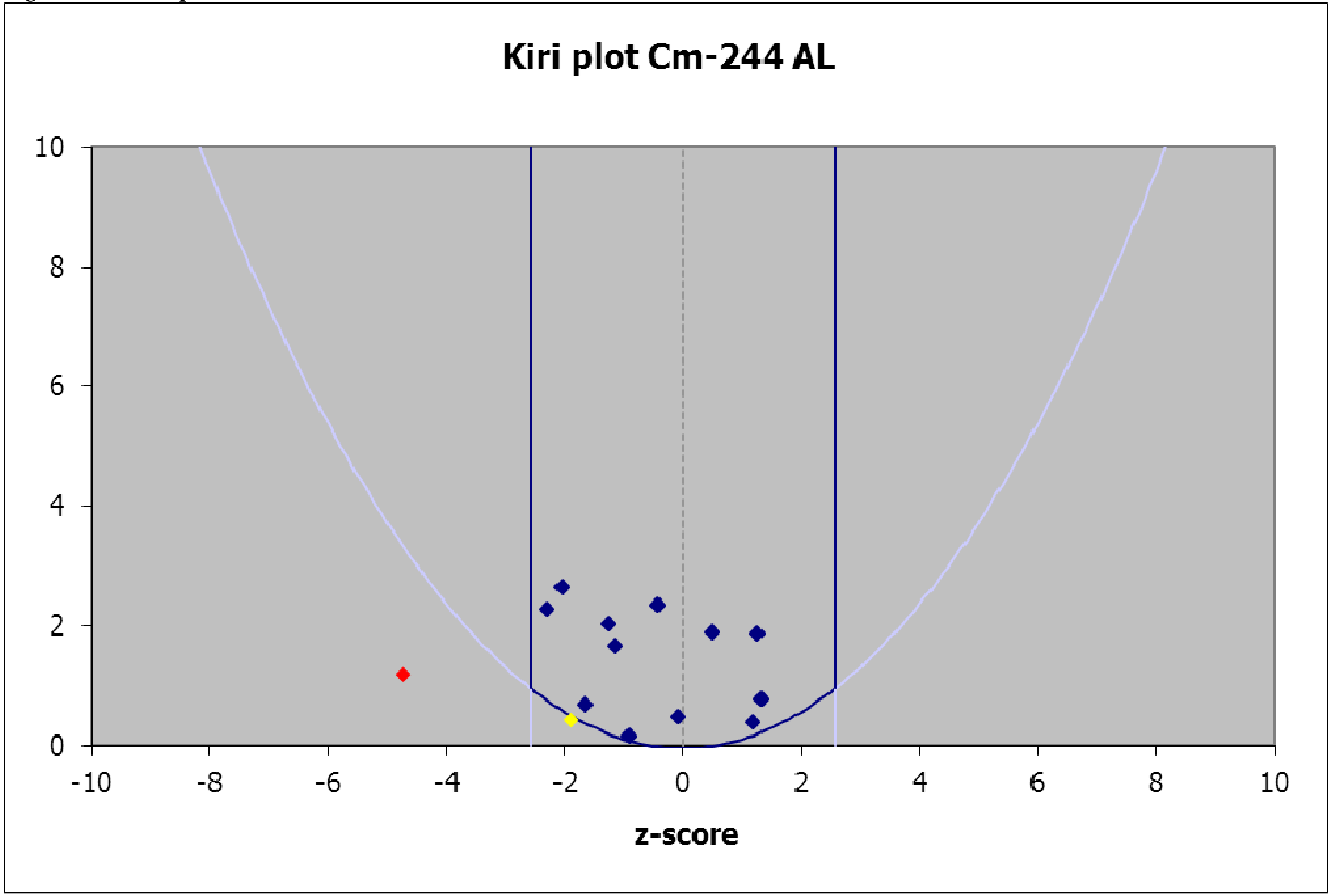


Figure 7A – Deviation gross alpha AL

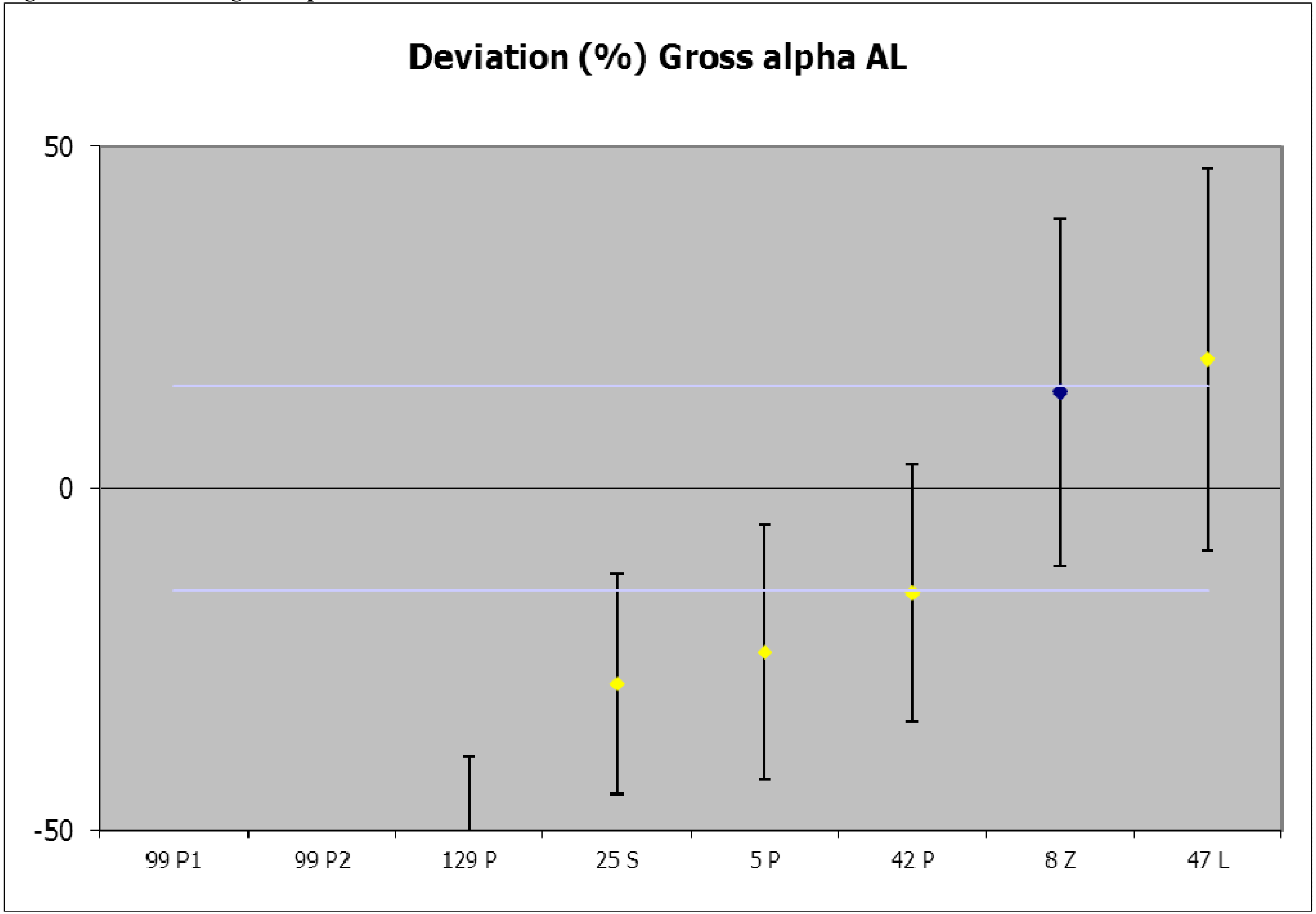


Figure 7B – Zeta score gross alpha AL

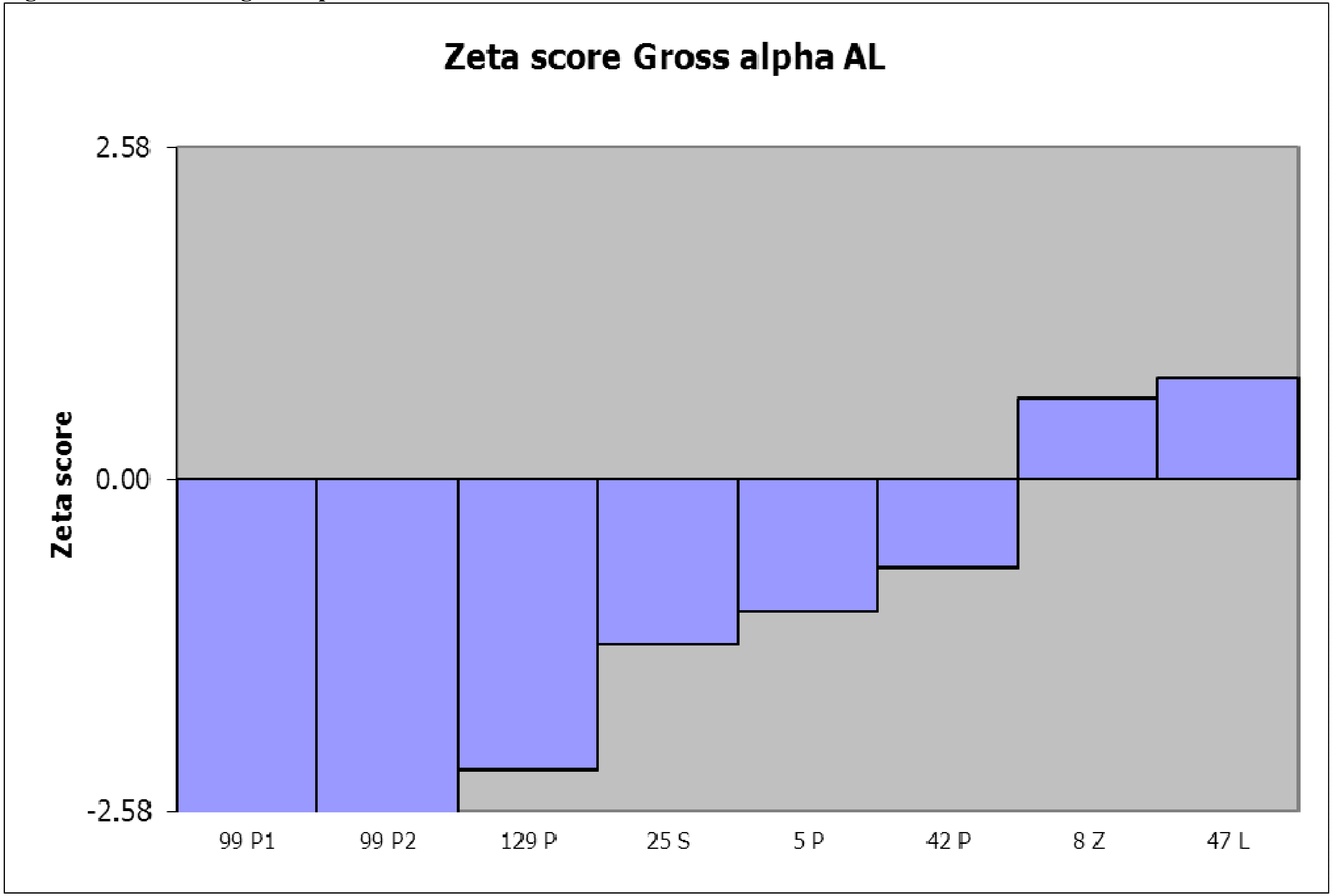


Figure 7C – Relative uncertainty gross alpha AL

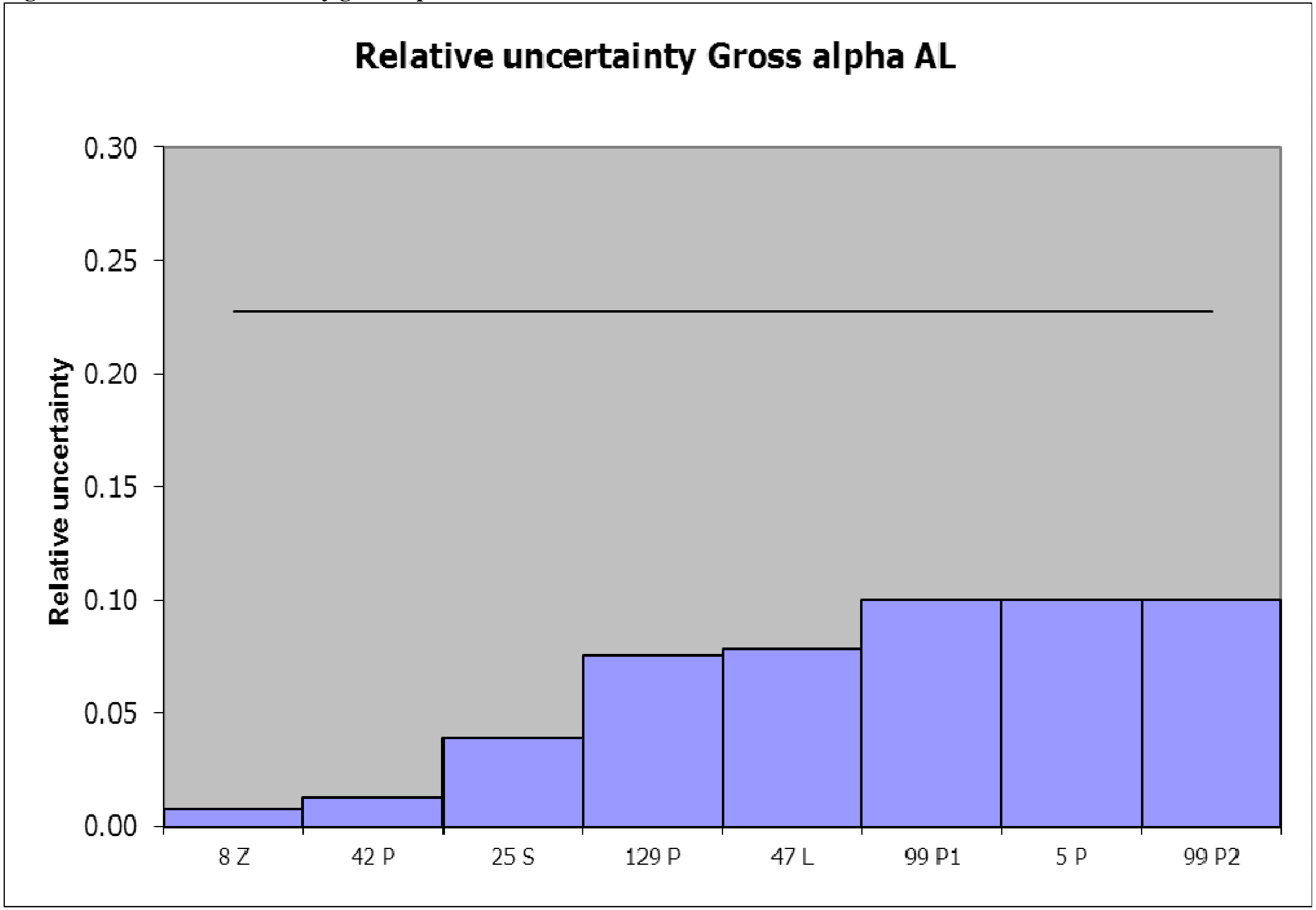


Figure 7D – Kiri plot gross alpha AL

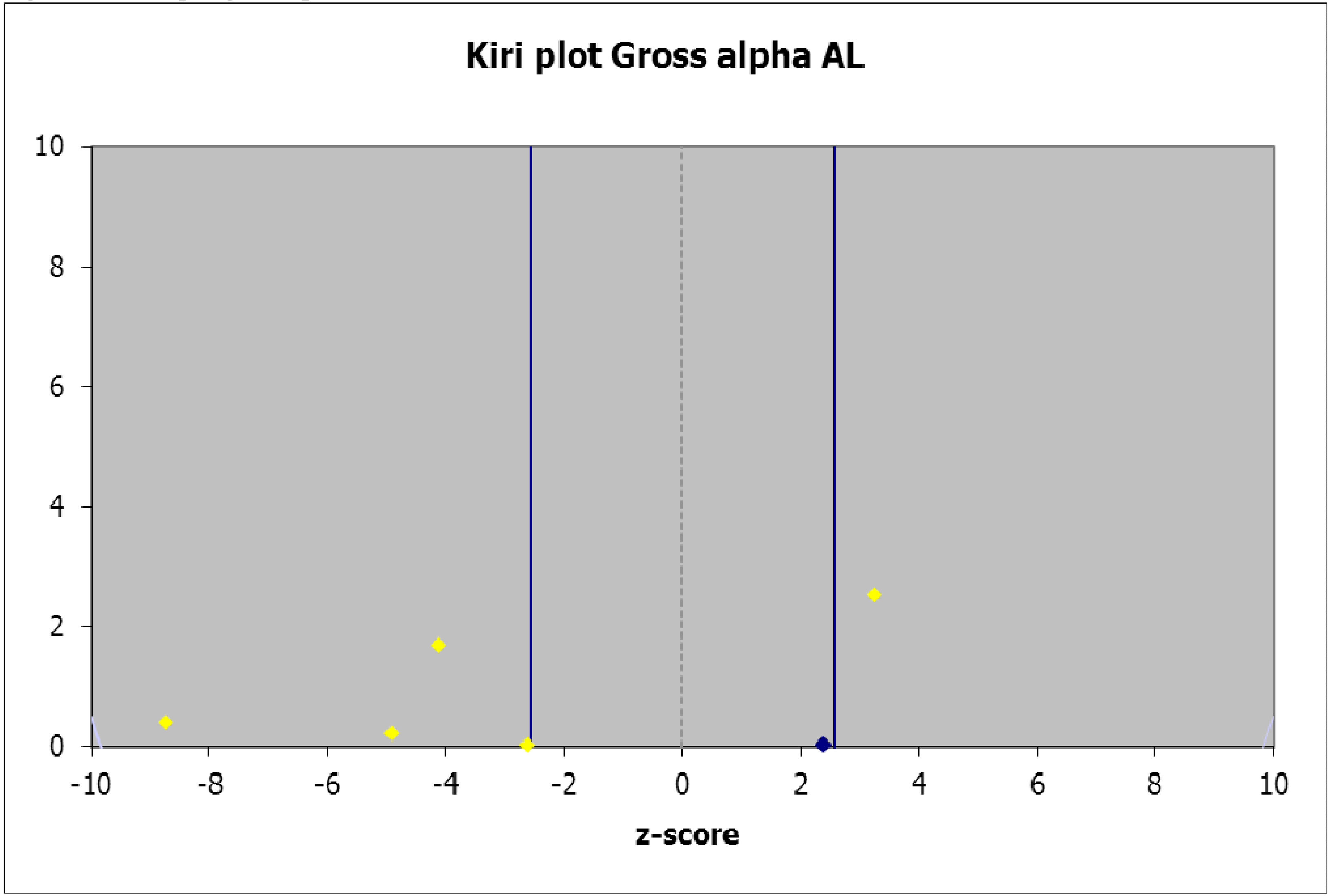


Figure 8A – Deviation Pb-210 AH

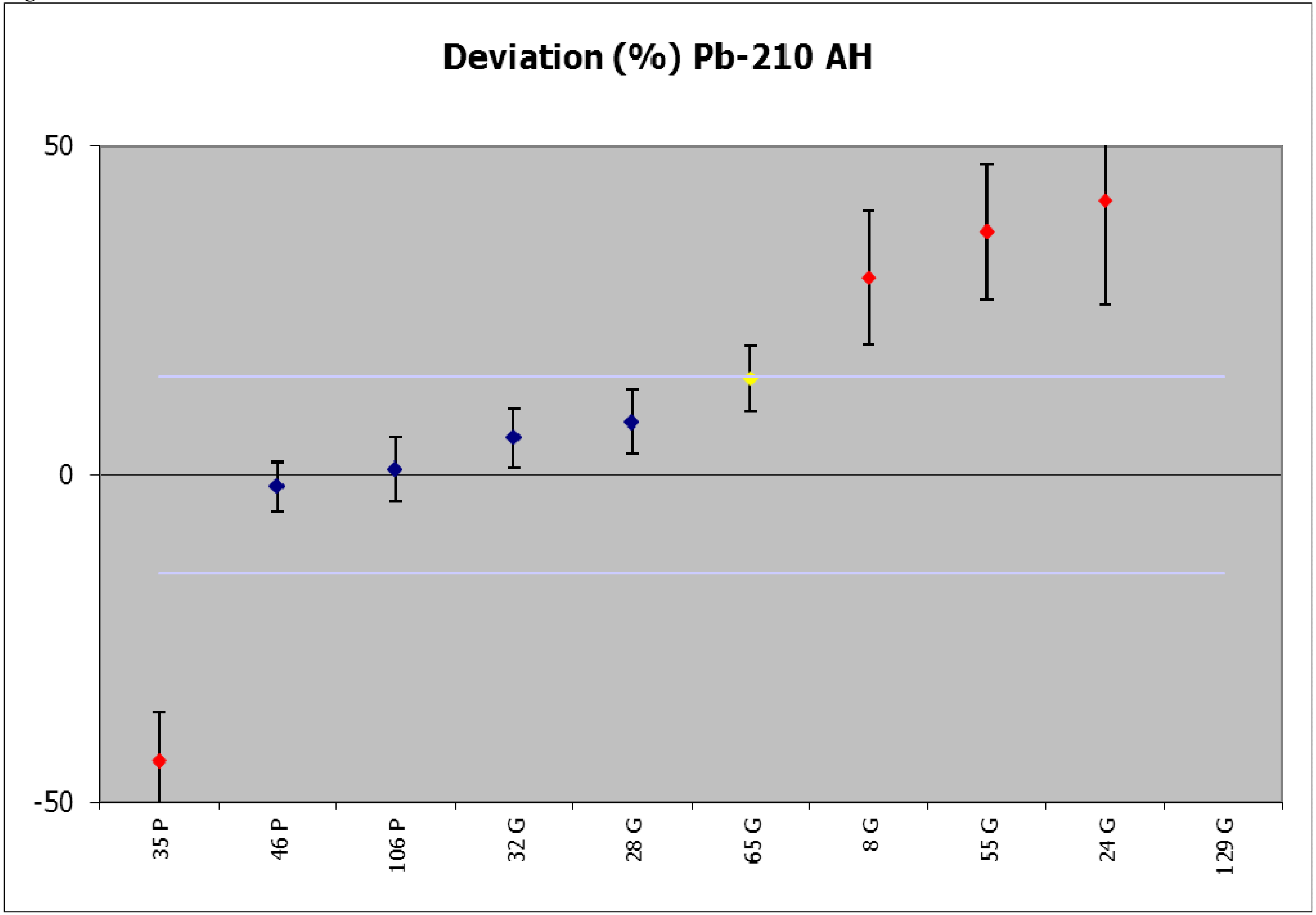


Figure 8B – Zeta score Pb-210 AH

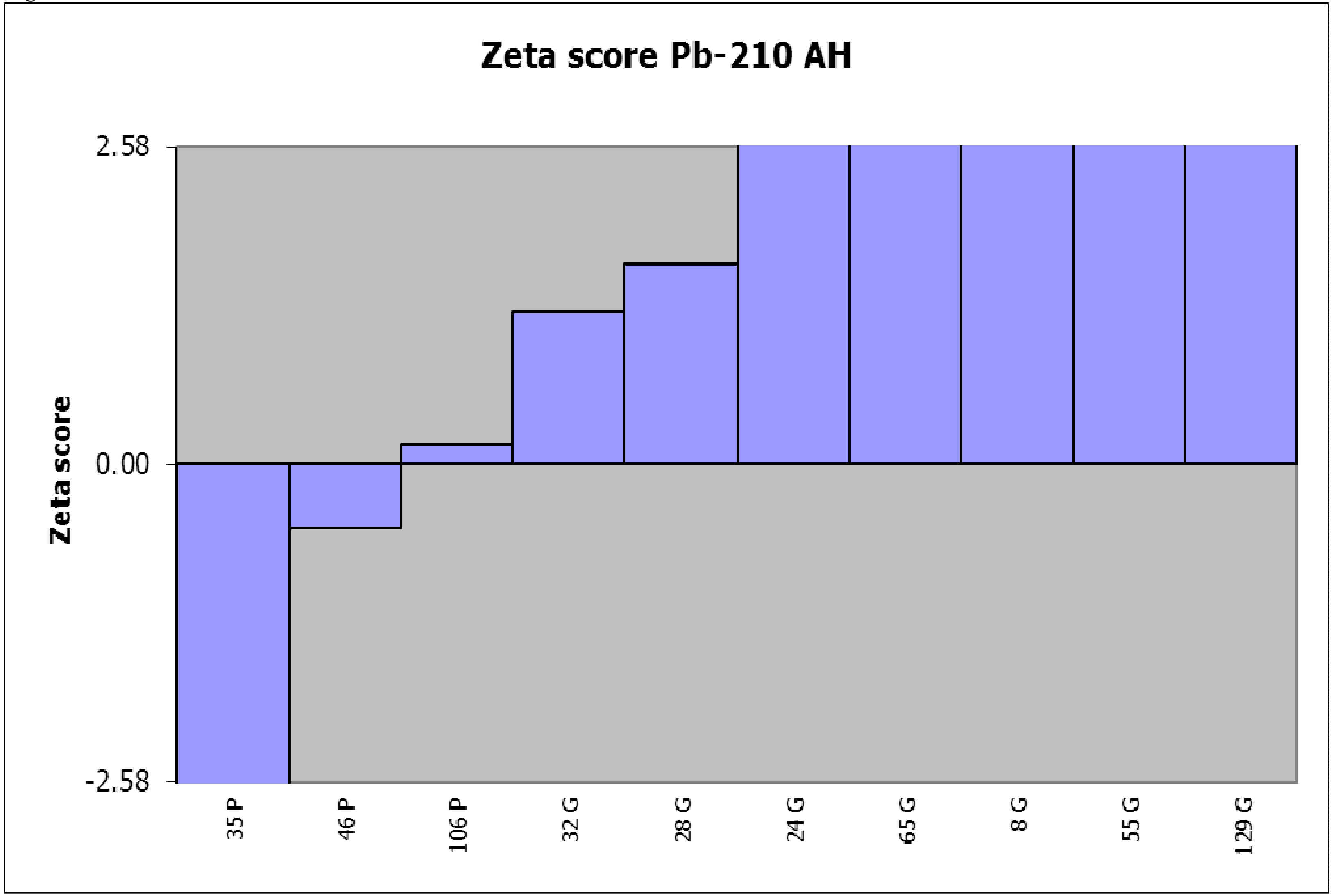


Figure 8C – Relative uncertainty Pb-210 AH

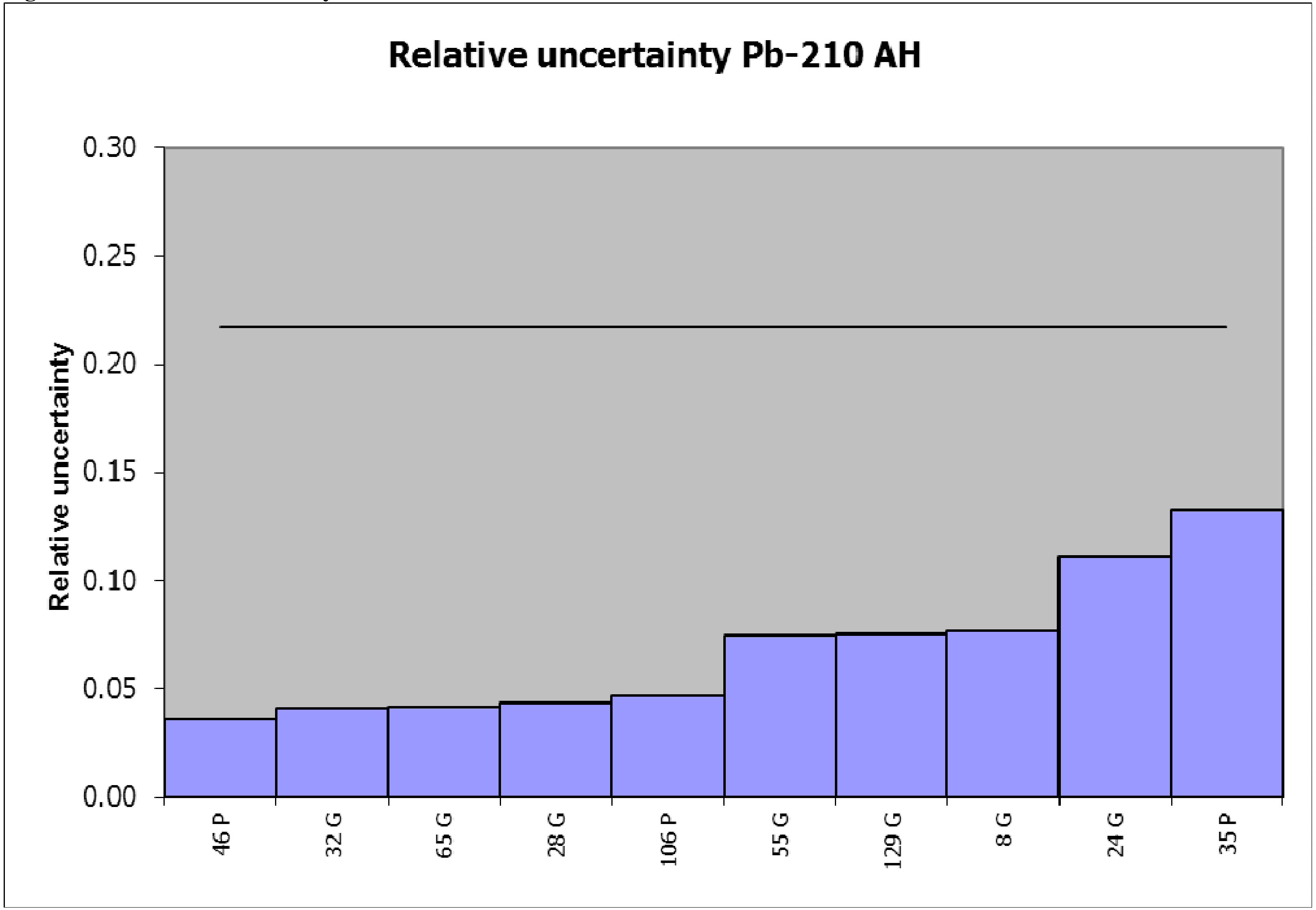


Figure 8D – Kiri plot Pb-210 AH

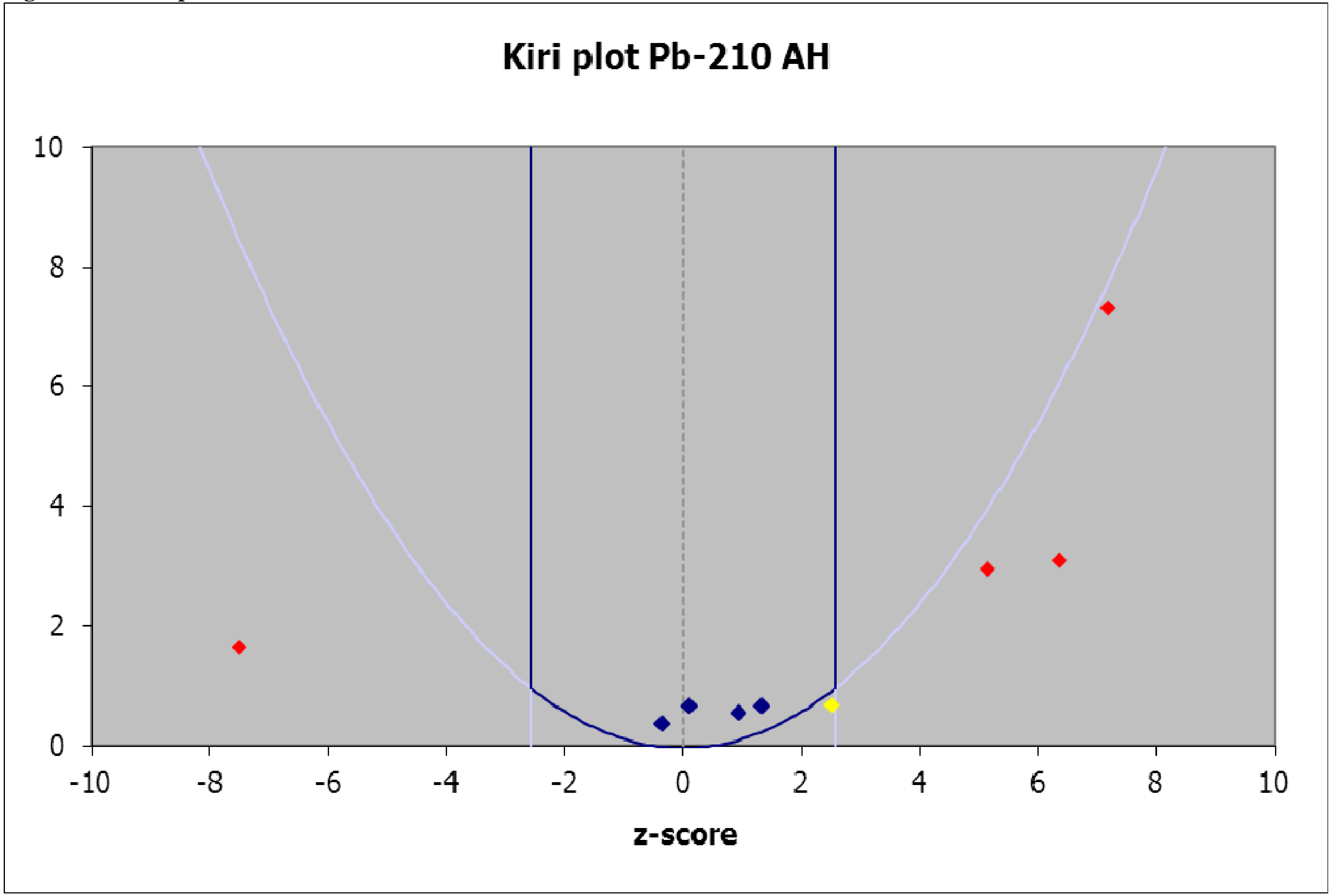


Figure 9A – Deviation Po-210 AH

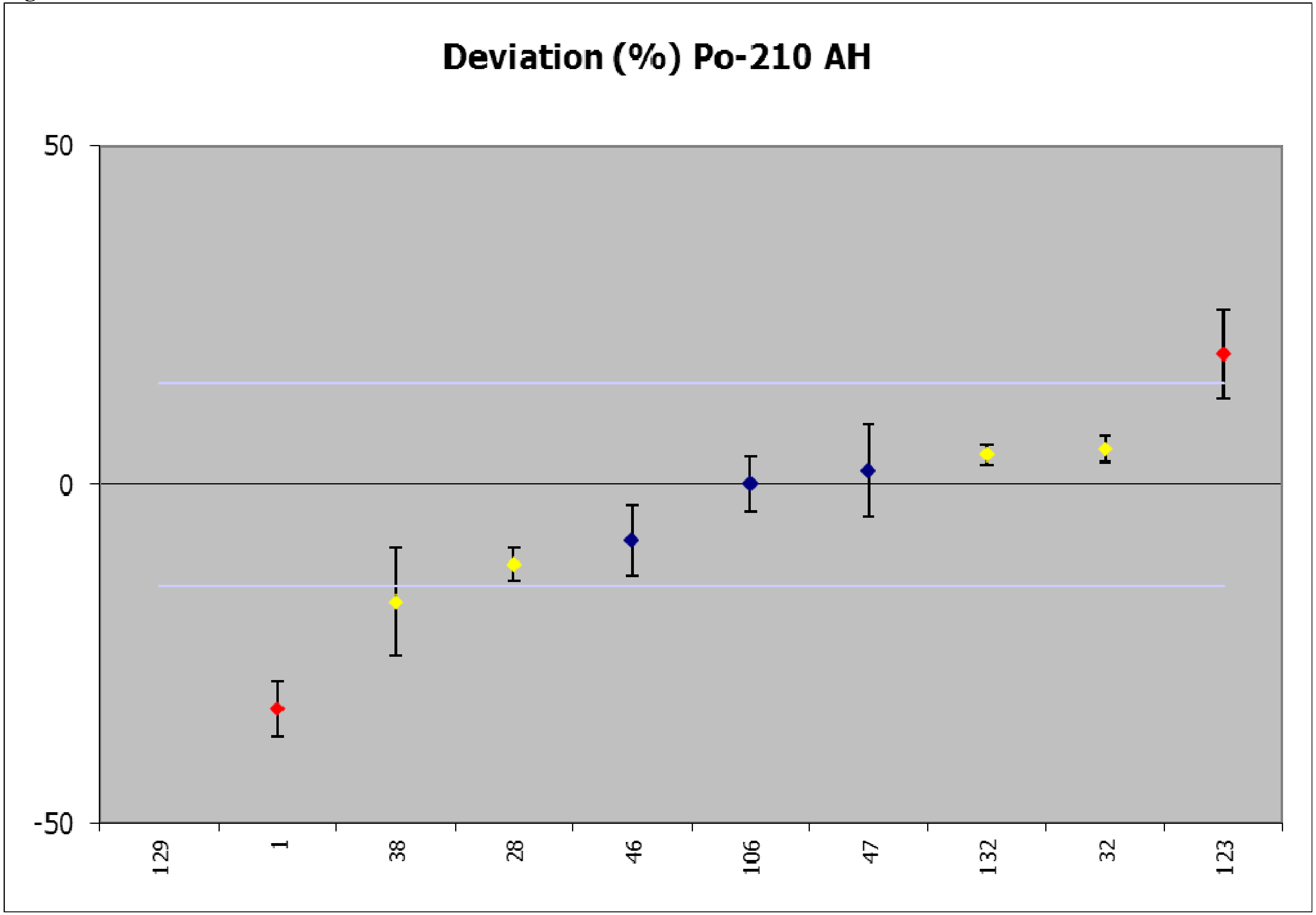


Figure 9B – Zeta score Po-210 AH

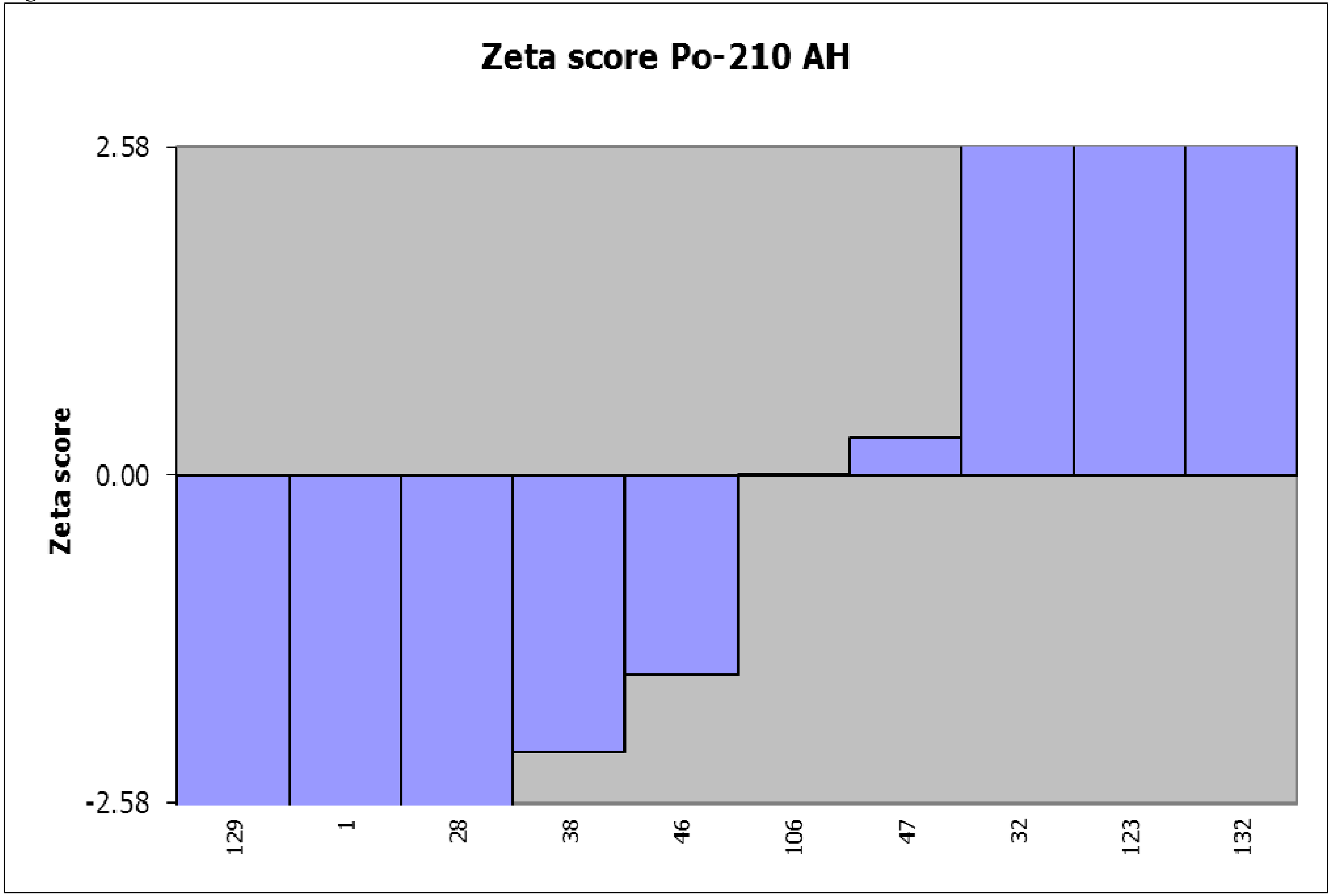


Figure 9C – Relative uncertainty Po-210 AH

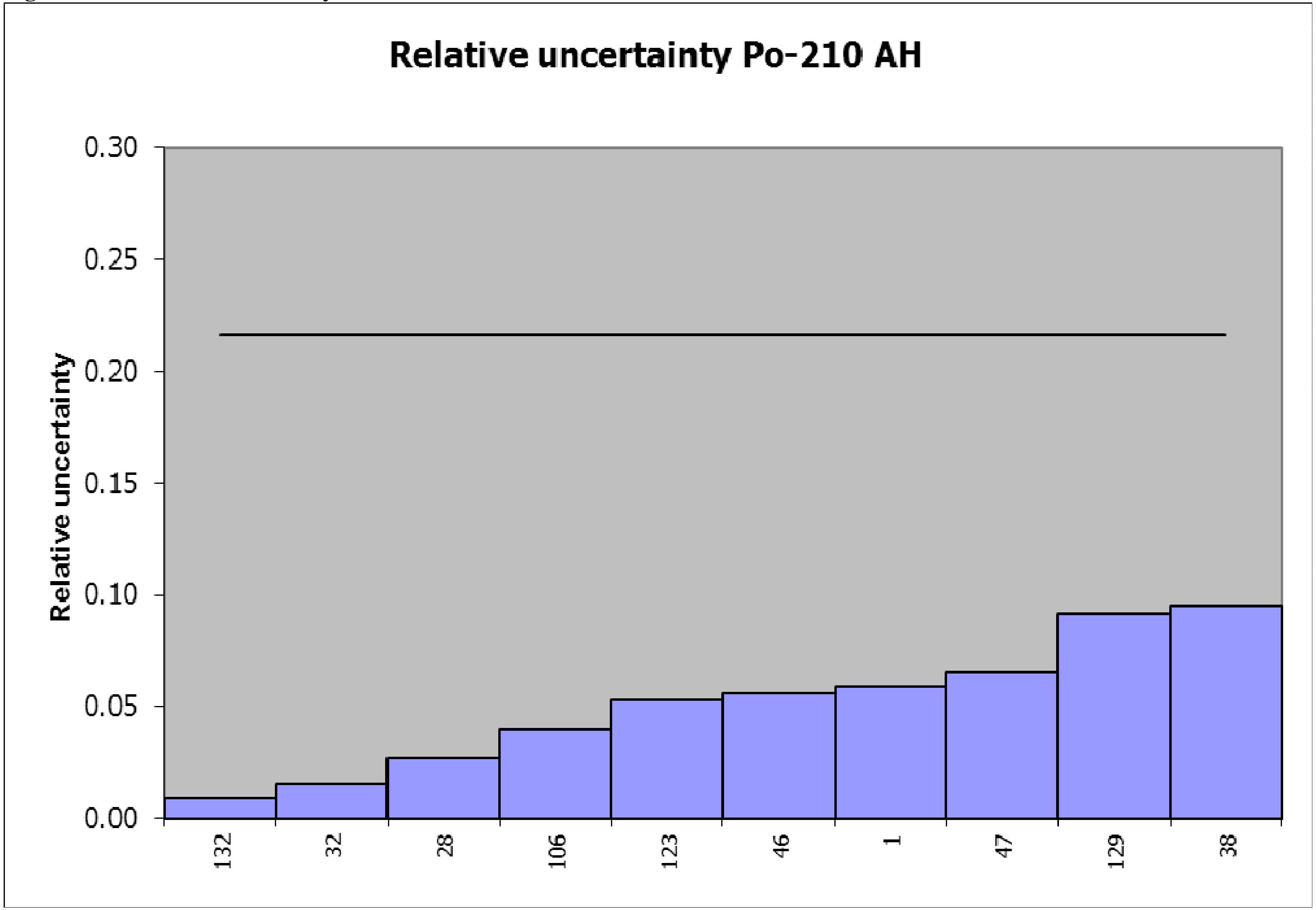


Figure 9D – Kiri plot Po-210 AH

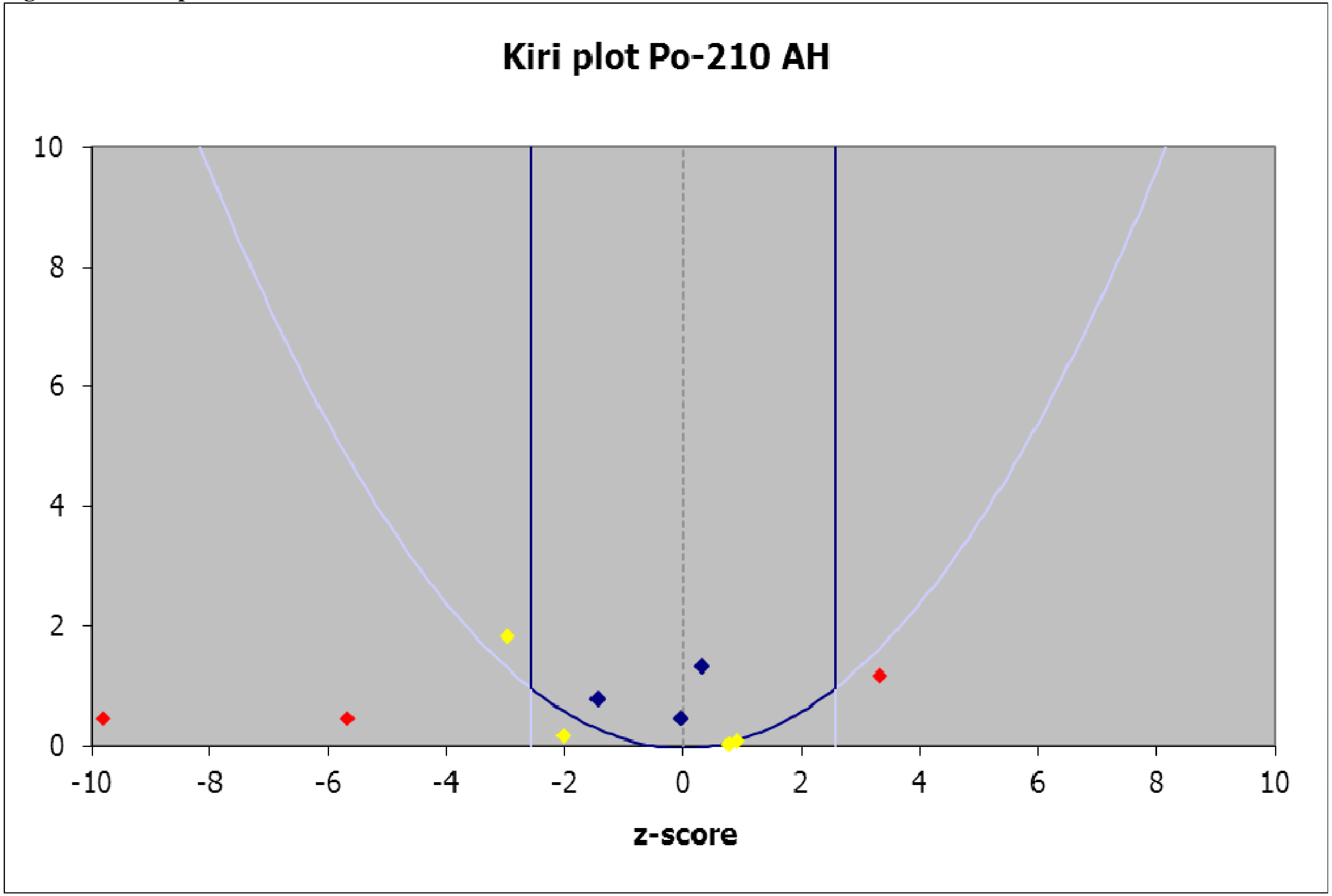


Figure 10A – Deviation Np-237 AH

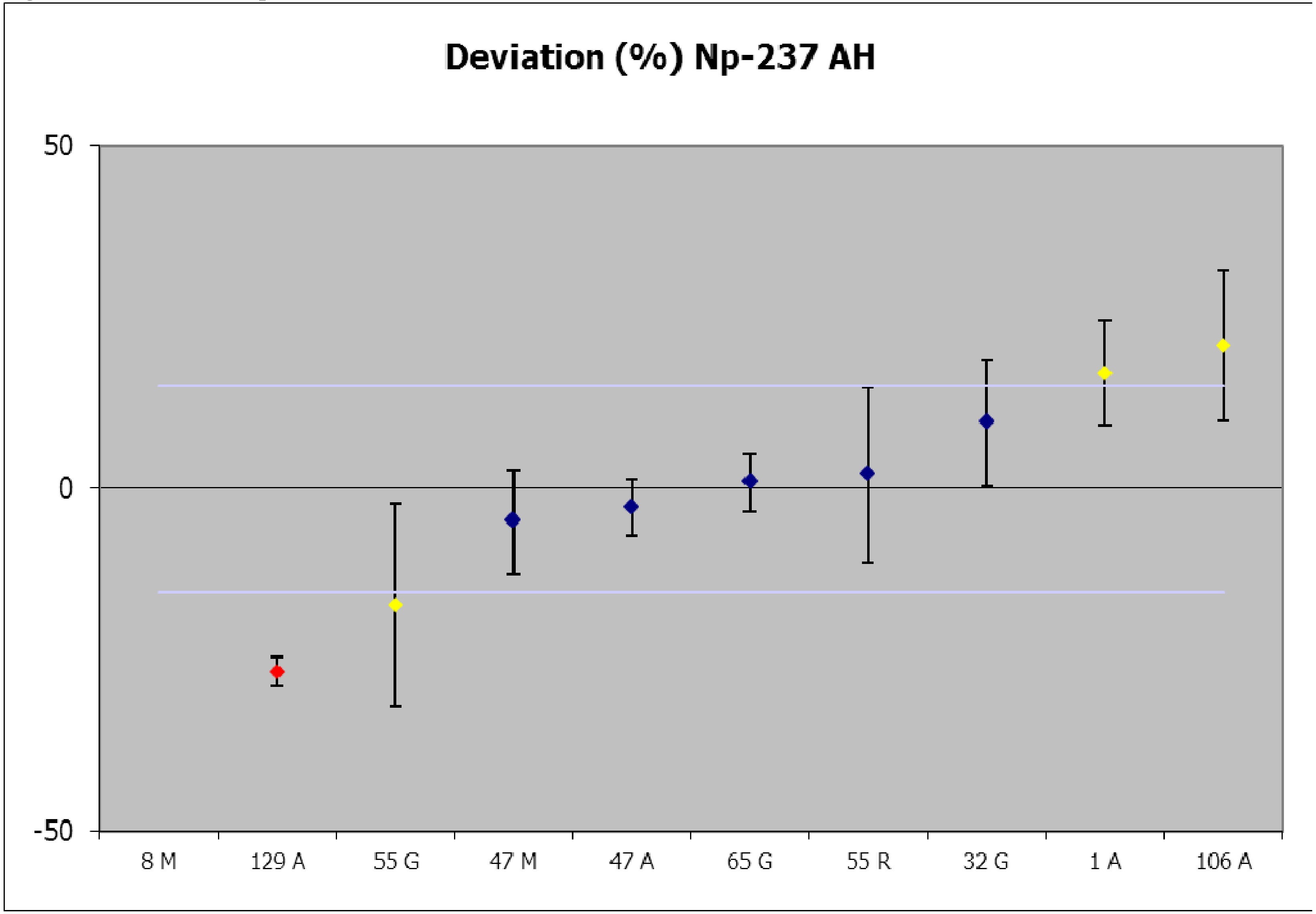


Figure 10B – Zeta score Np-237 AH

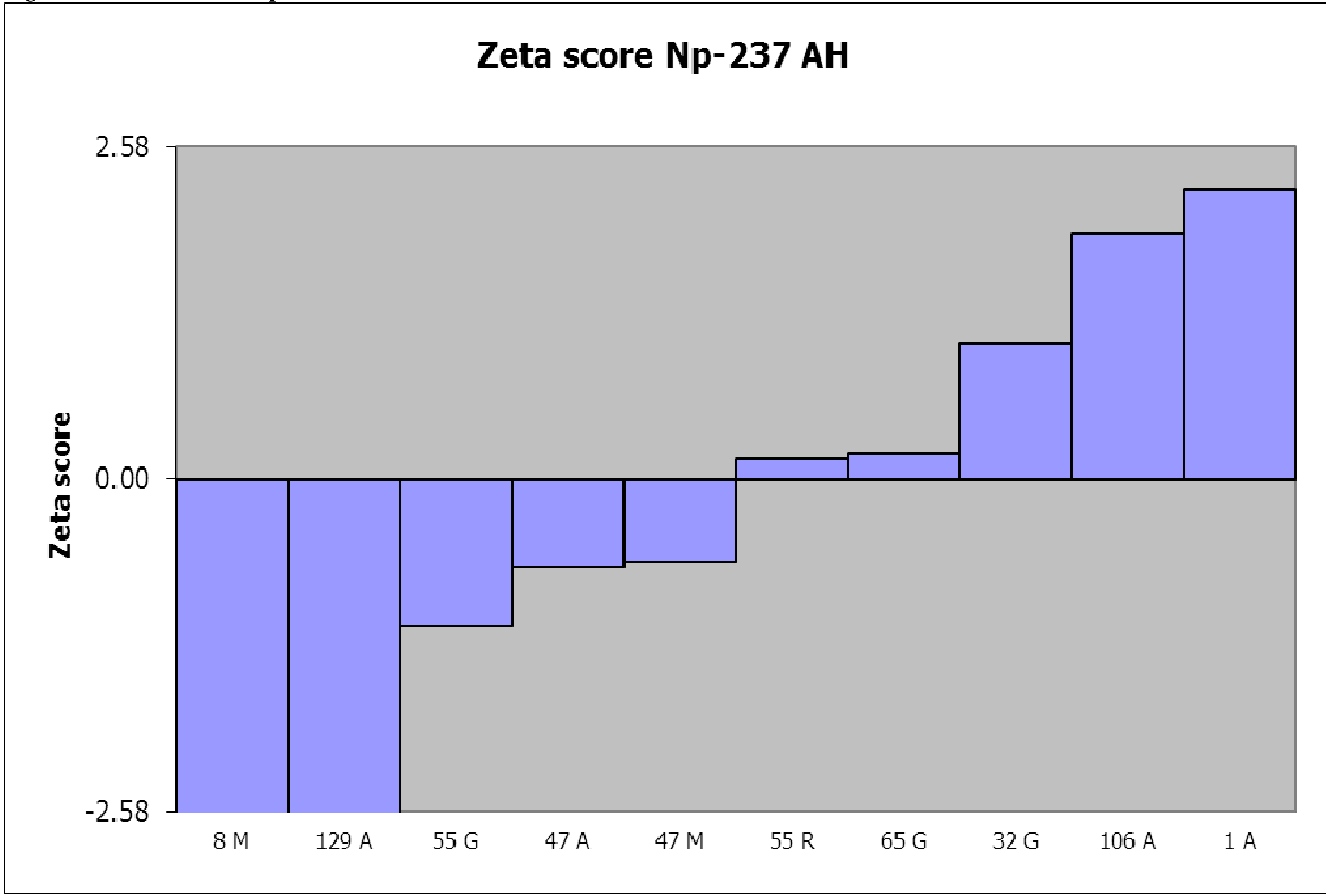


Figure 10C – Relative uncertainty Np-237 AH

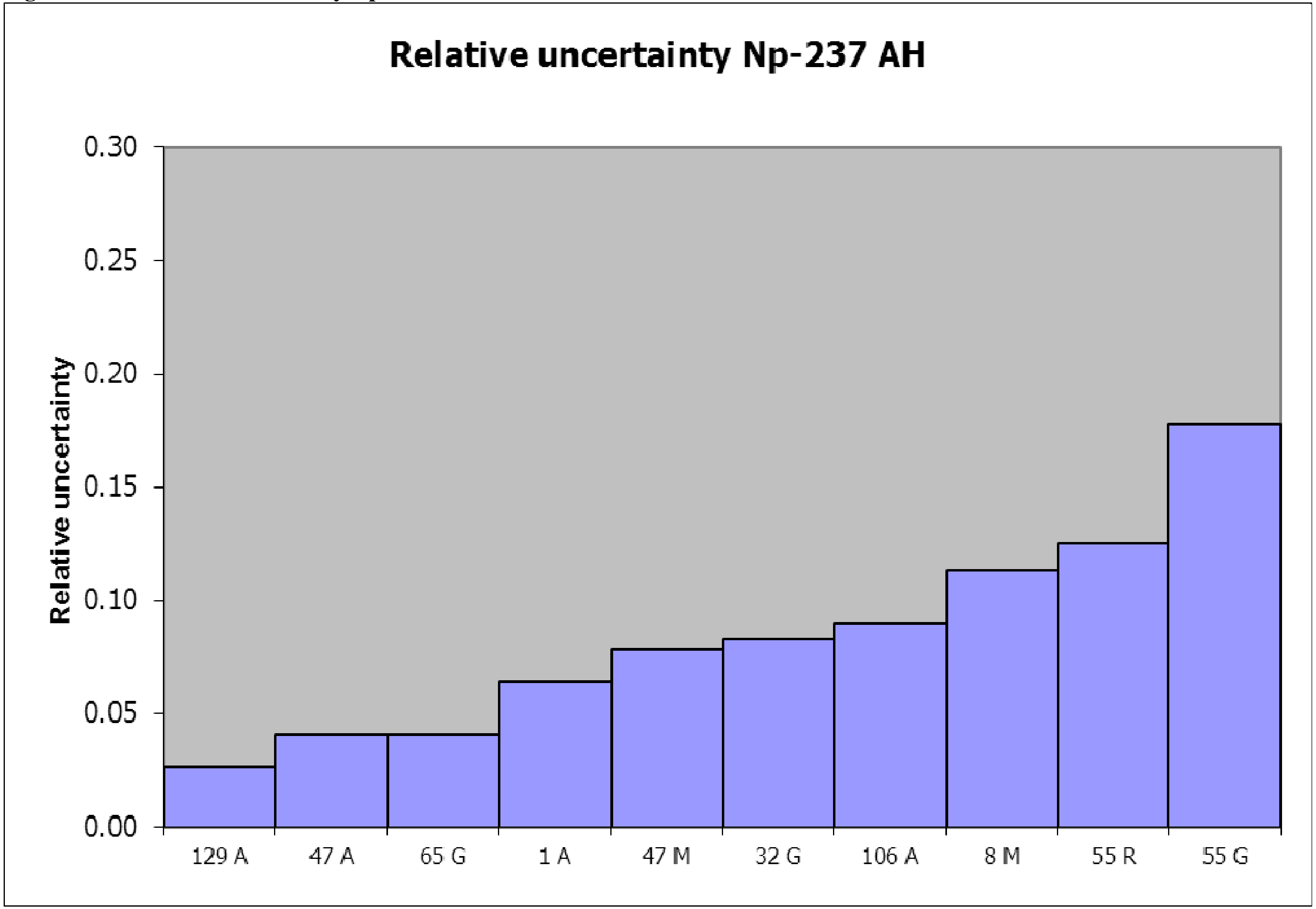


Figure 10D – Kiri plot Np-237 AH

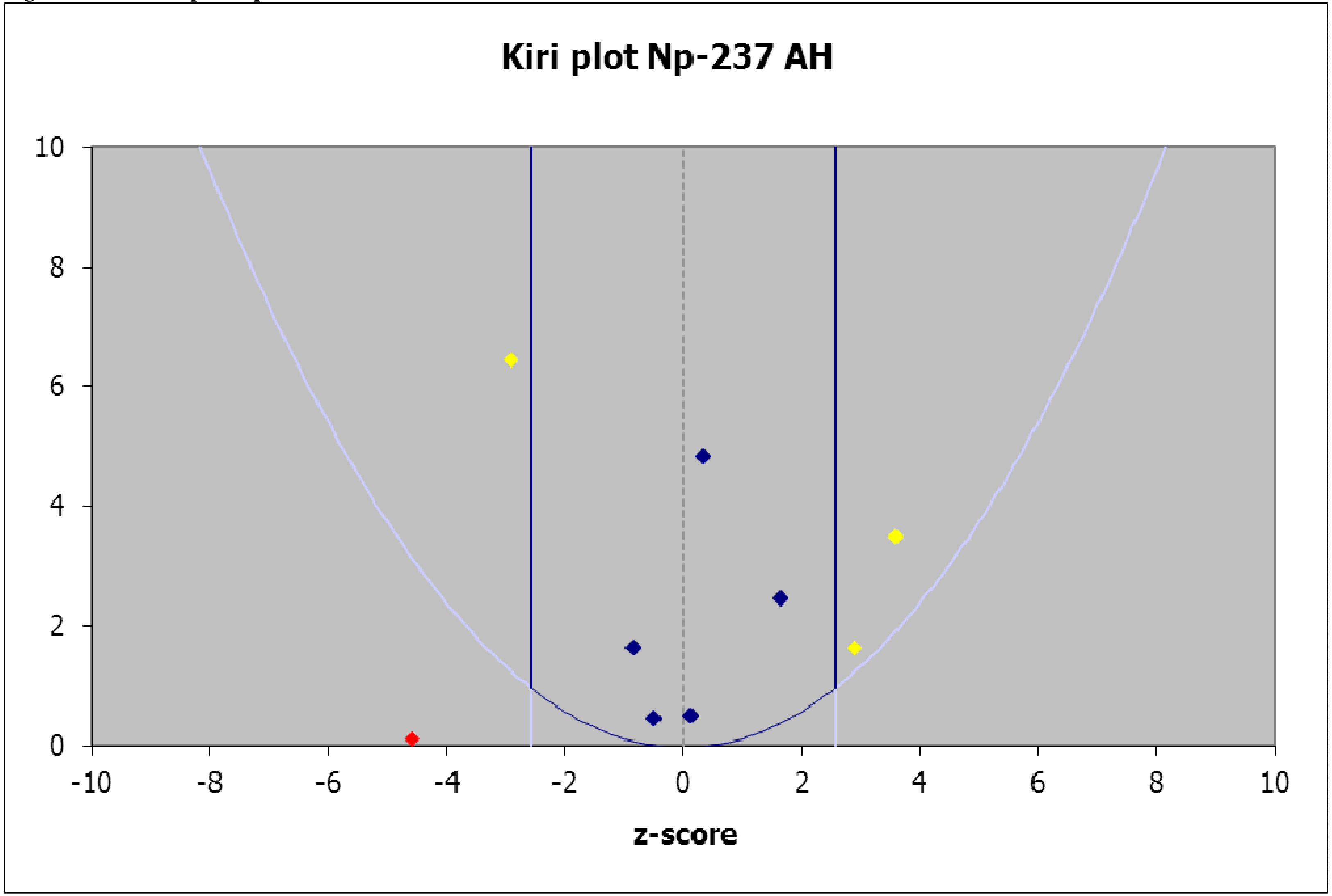


Figure 11A – Deviation Pu-238 AH

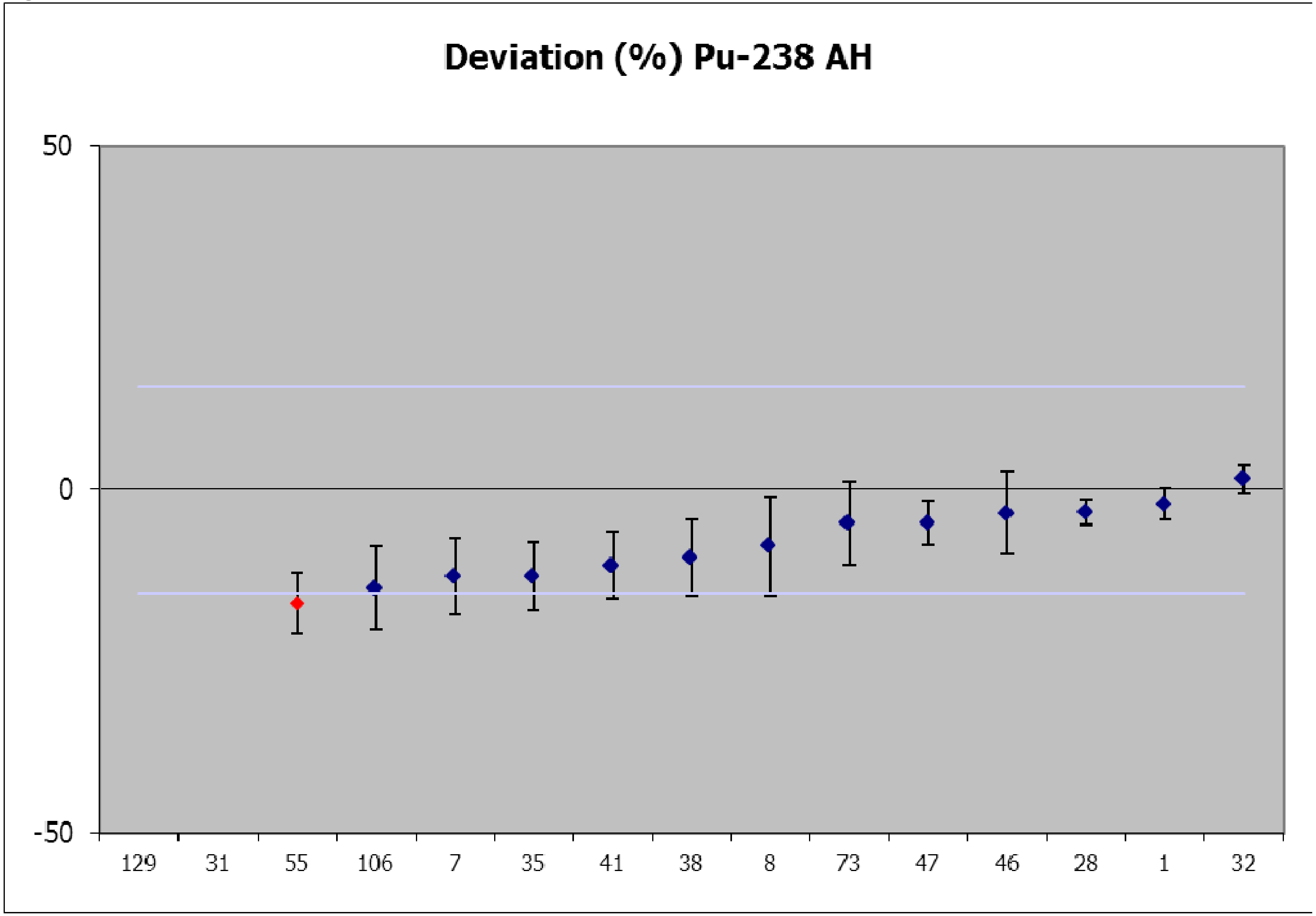


Figure 11B – Zeta score Pu-238 AH

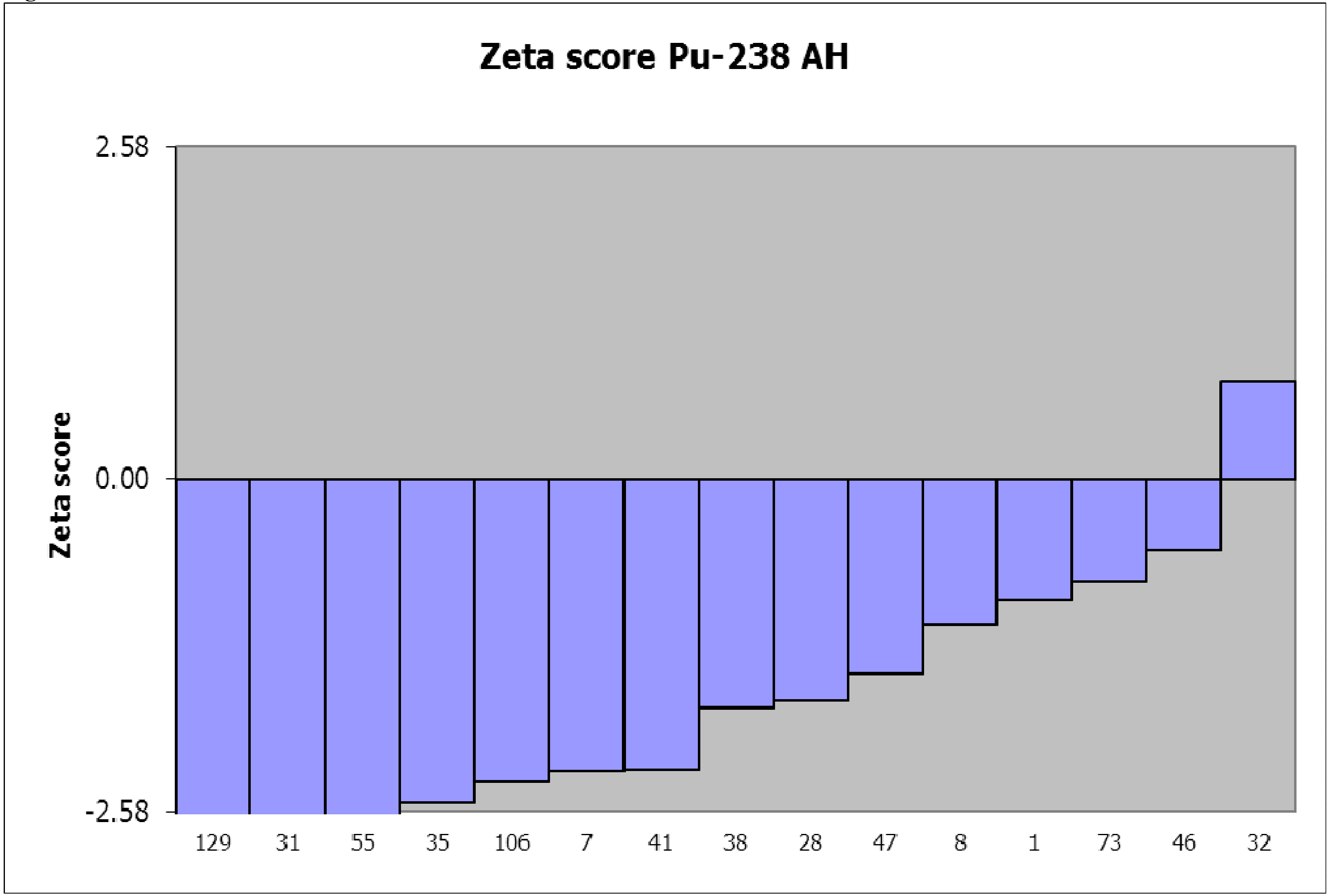


Figure 11C – Relative uncertainty Pu-238 AH

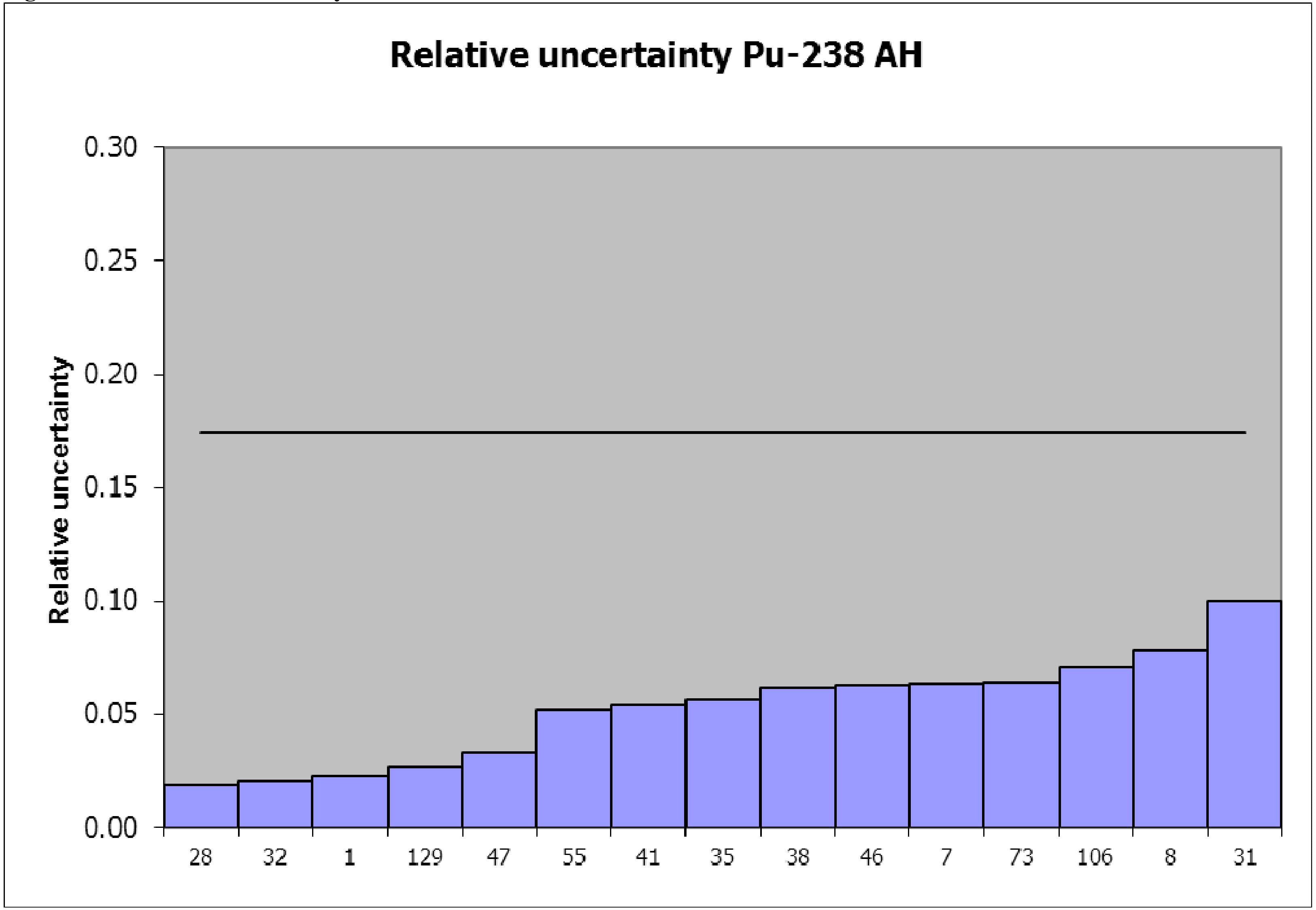


Figure 11D – Kiri plot Pu-238 AH

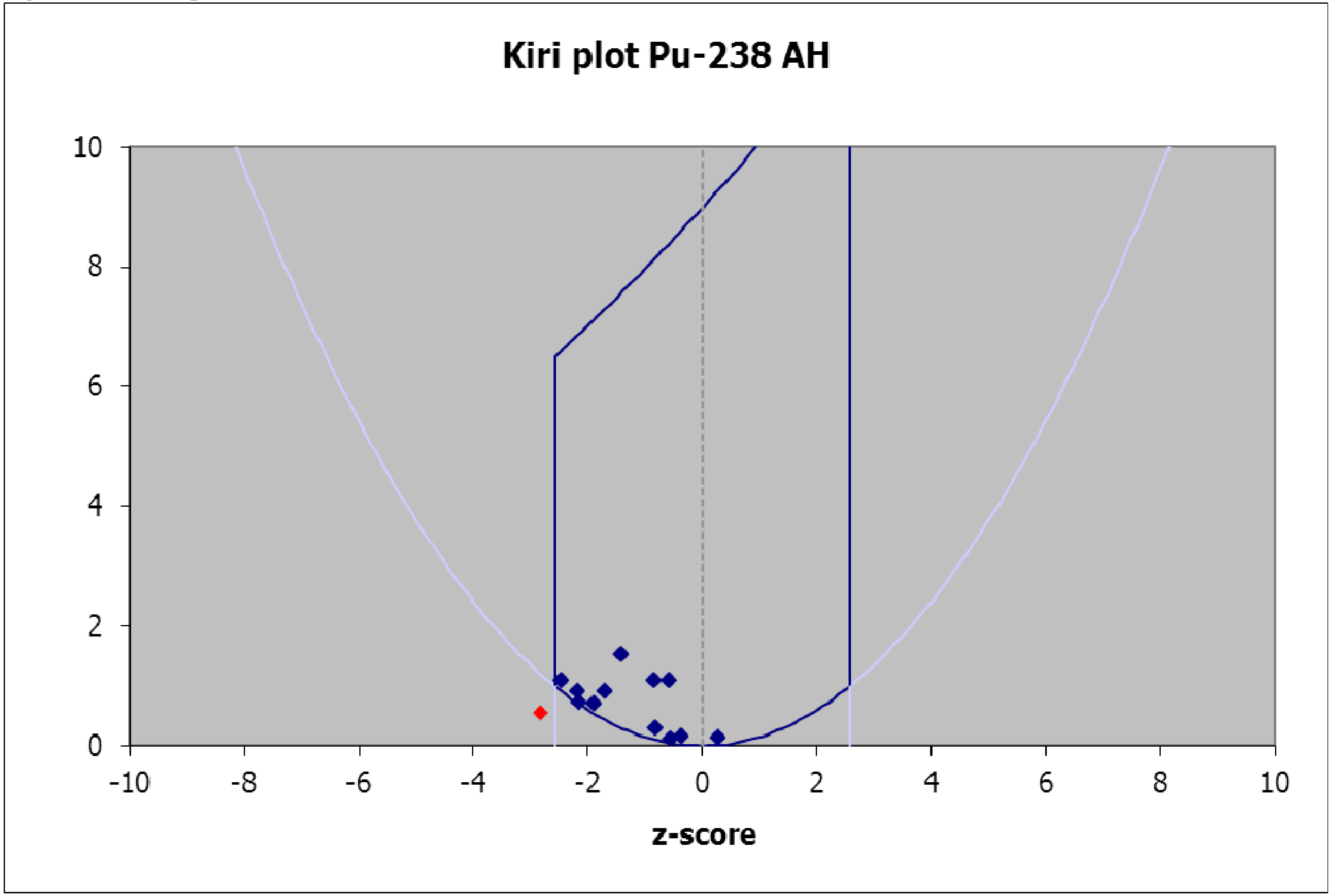


Figure 12A – Deviation Pu-239 AH

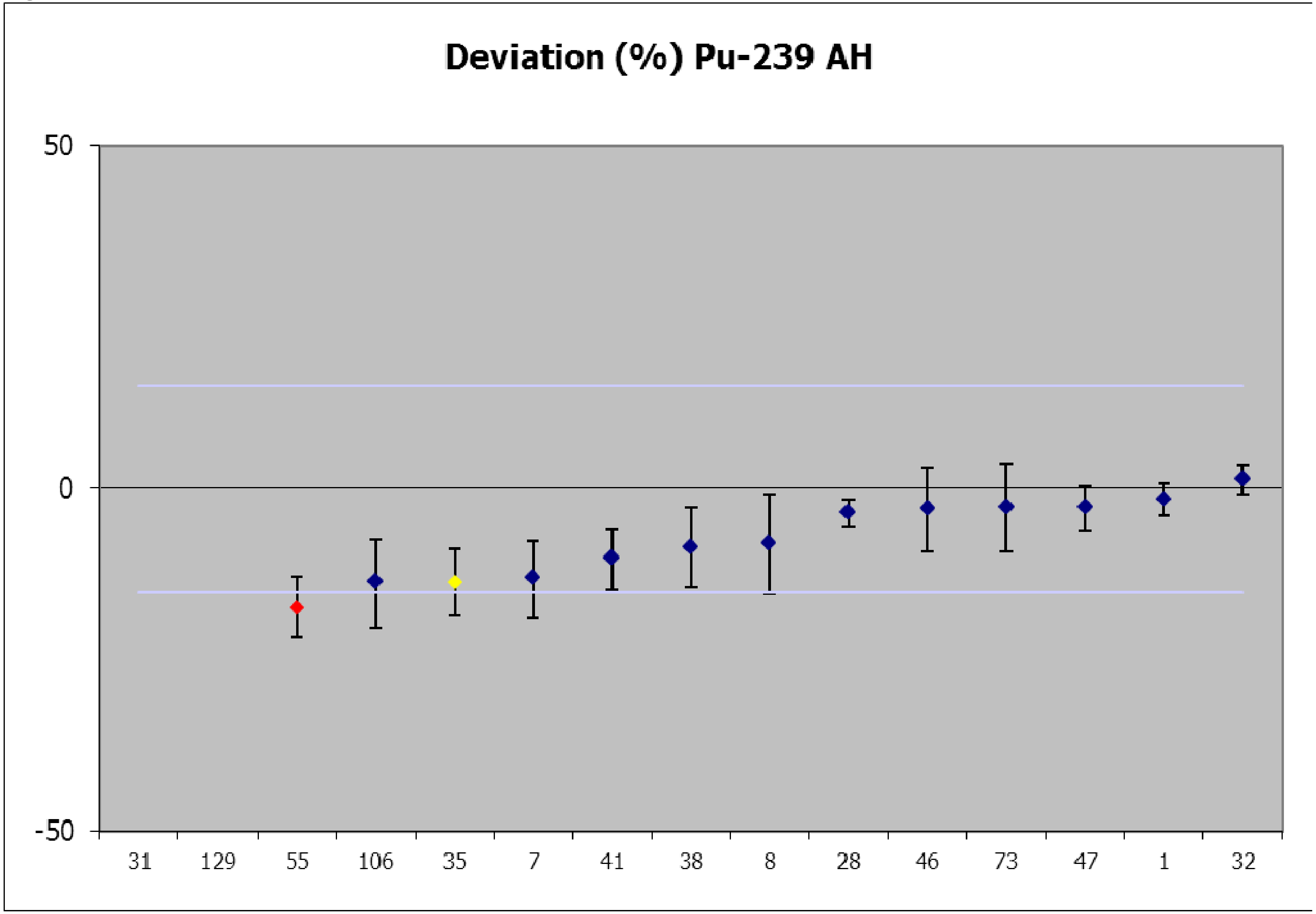


Figure 12B – Zeta score Pu-239 AH

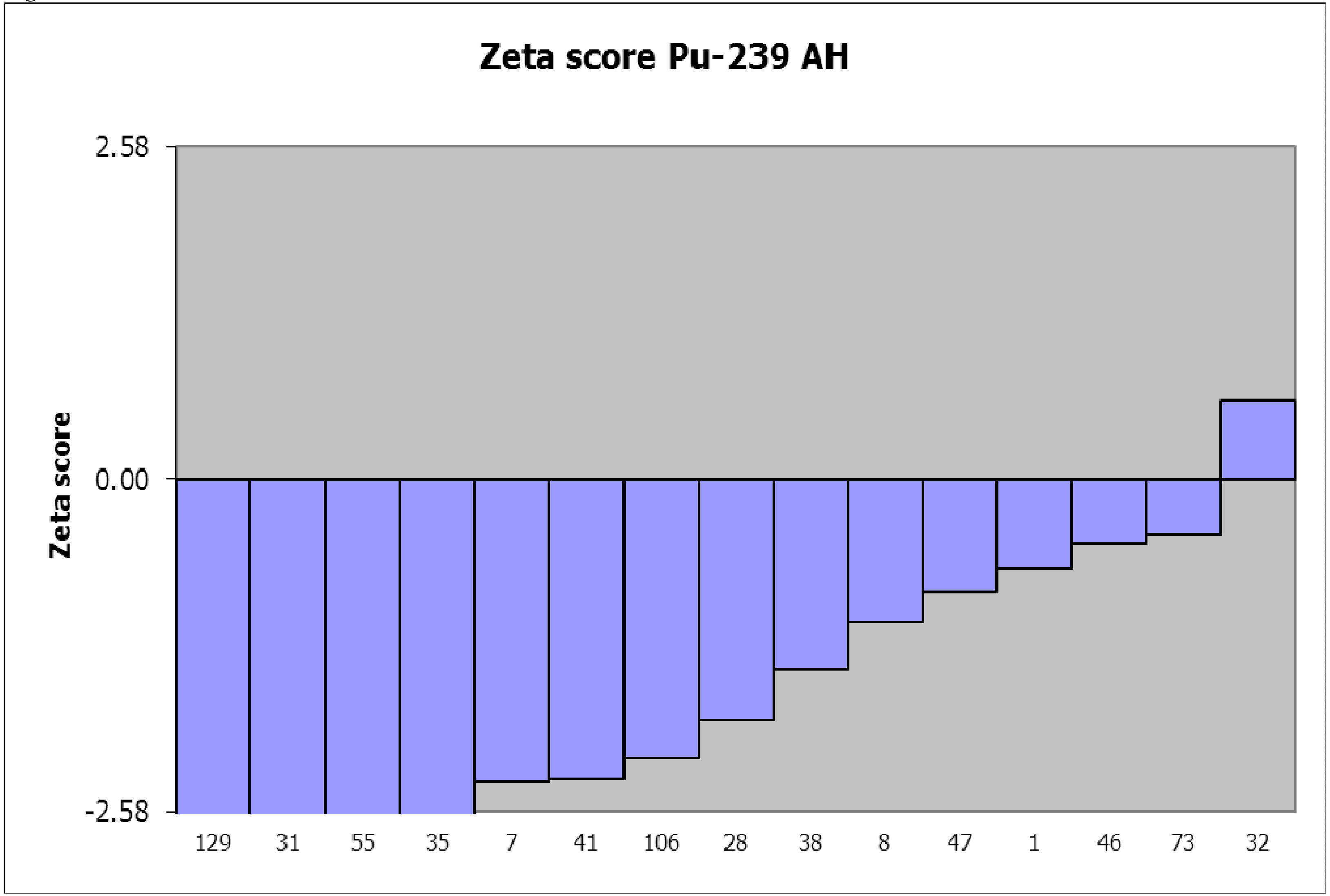


Figure 12C – Relative uncertainty Pu-239 AH

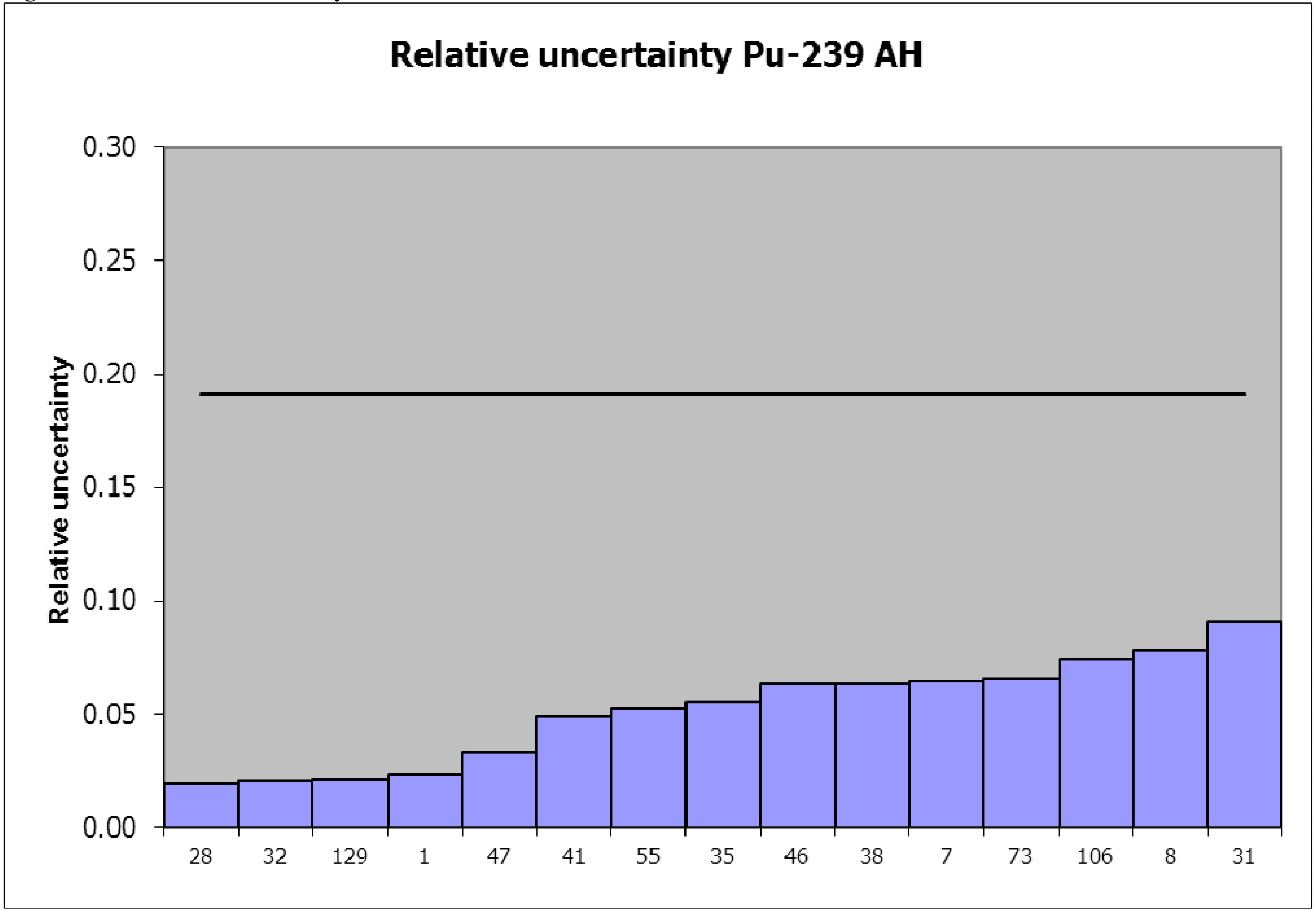


Figure 12D – Kiri plot Pu-239 AH

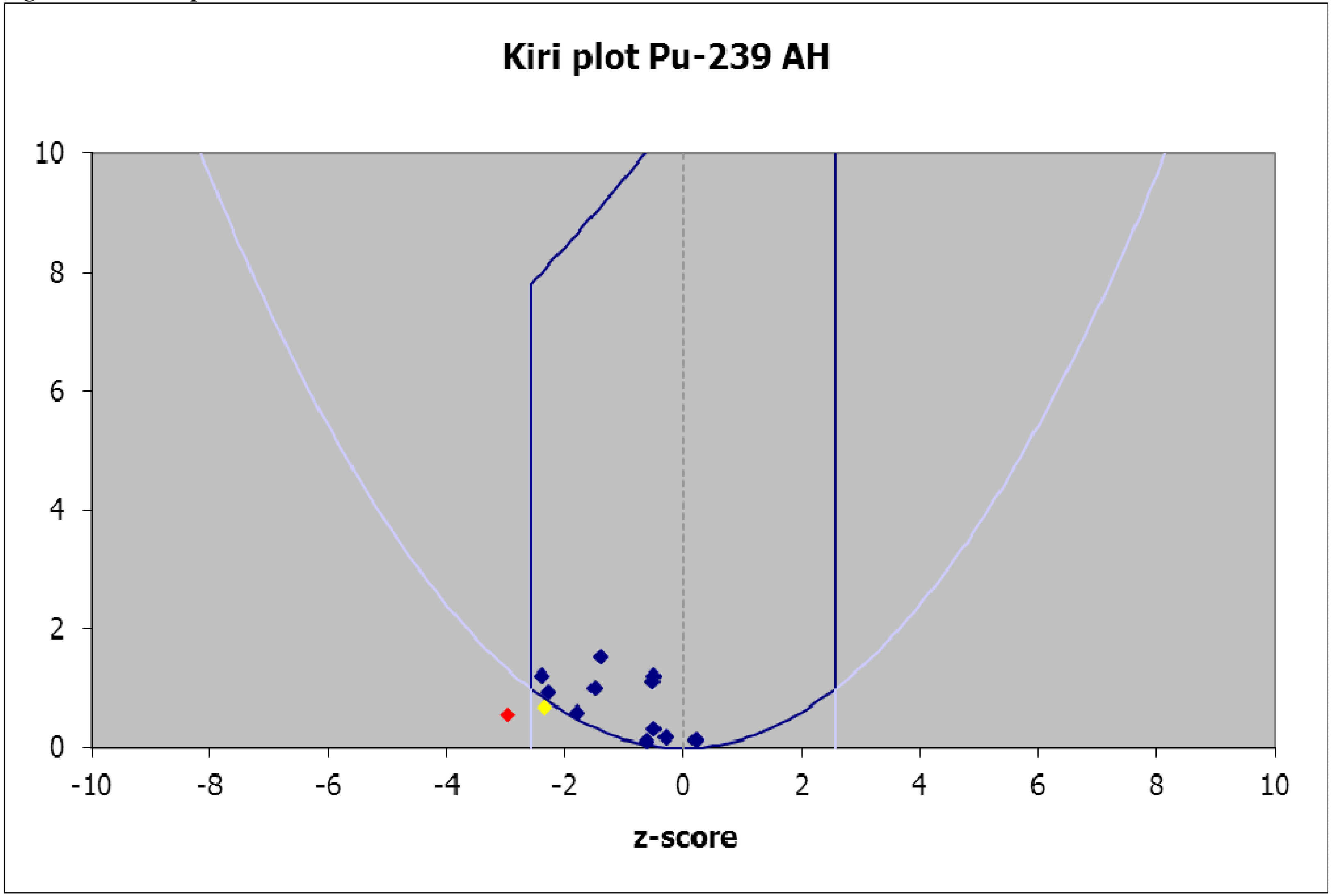


Figure 13A – Deviation Am-241 AH

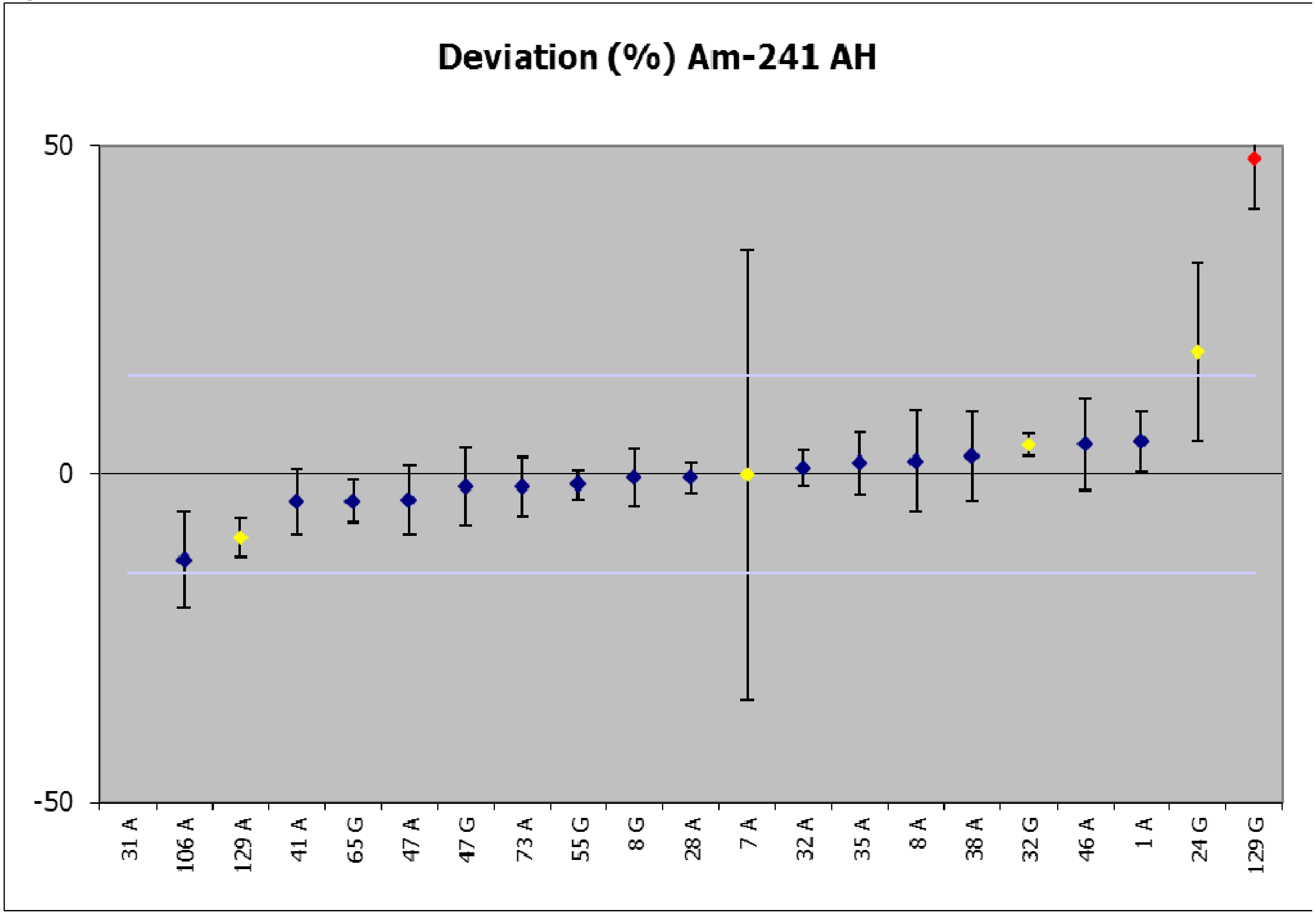


Figure 13B – Zeta score Am-241 AH

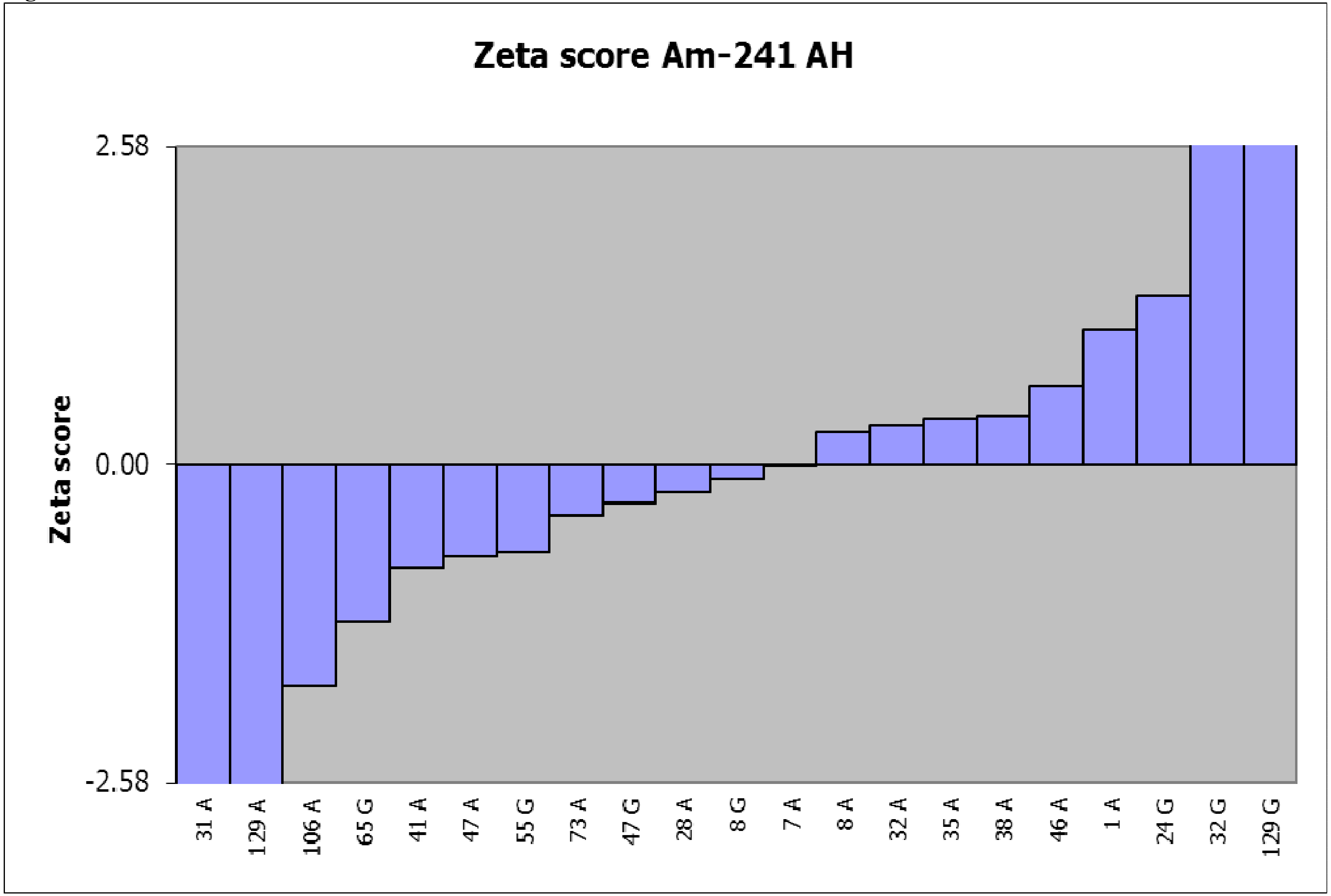


Figure 13C – Relative uncertainty Am-241 AH

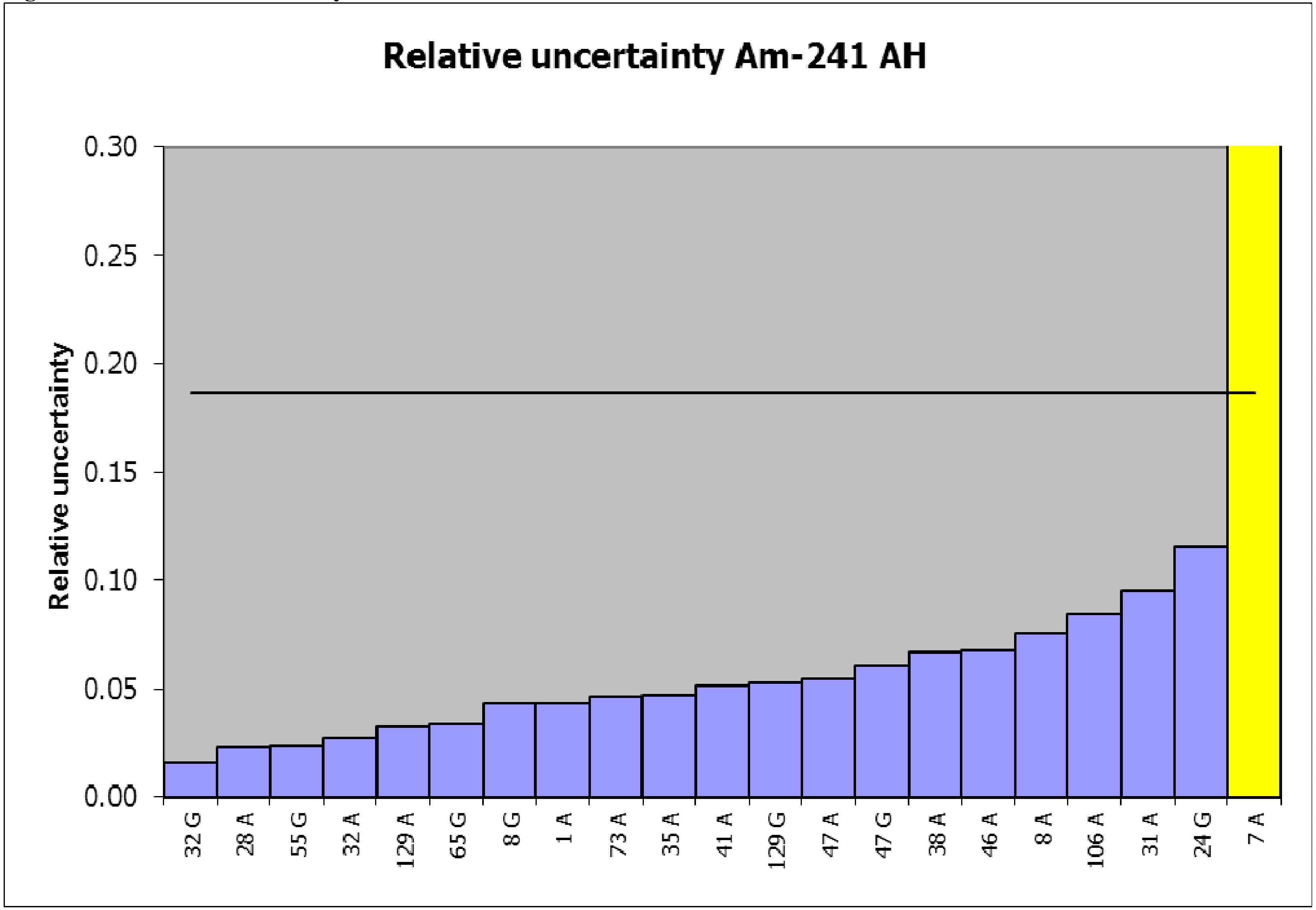


Figure 13D – Kiri plot Am-241 AH

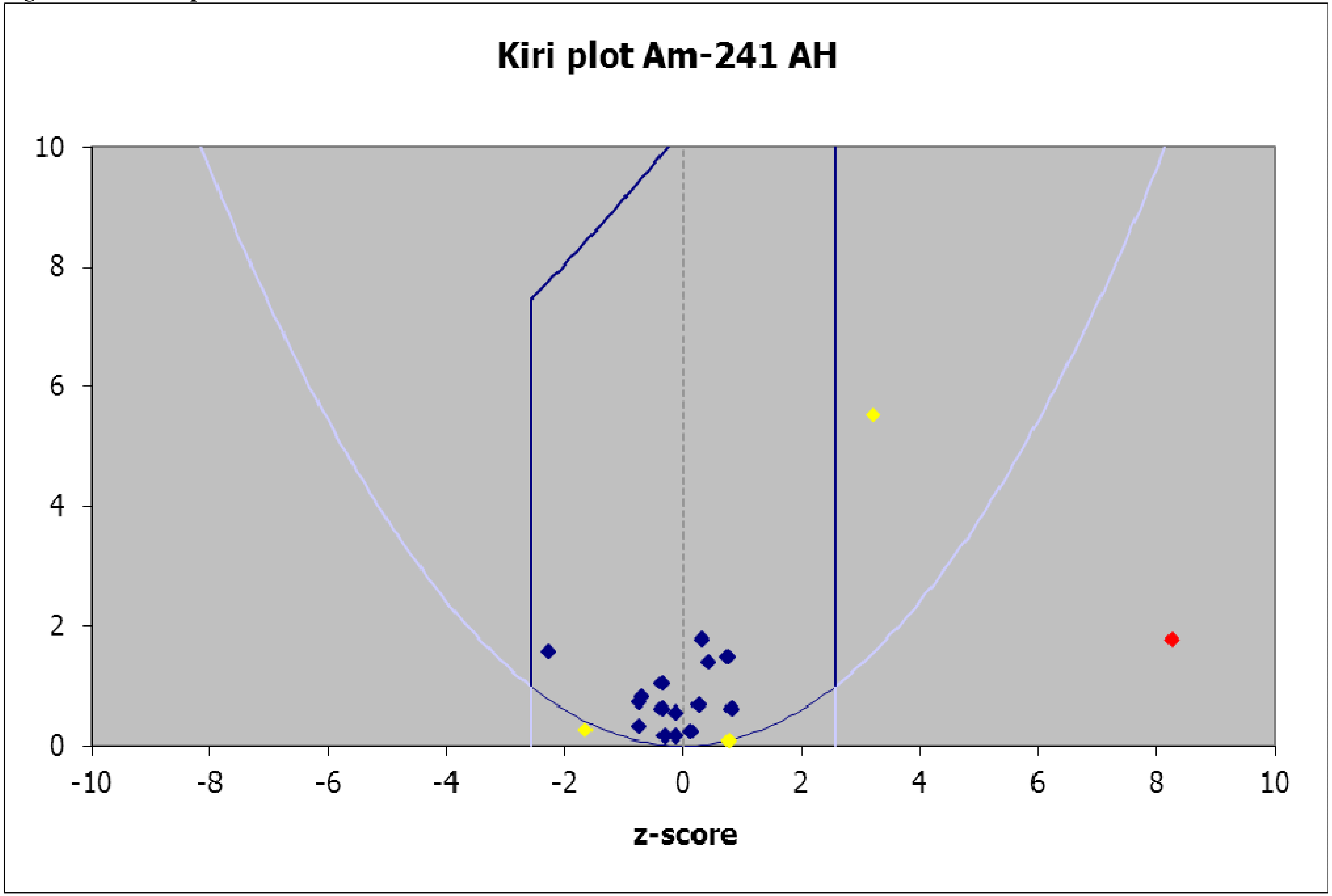


Figure 14A – Deviation Cm-244 AH

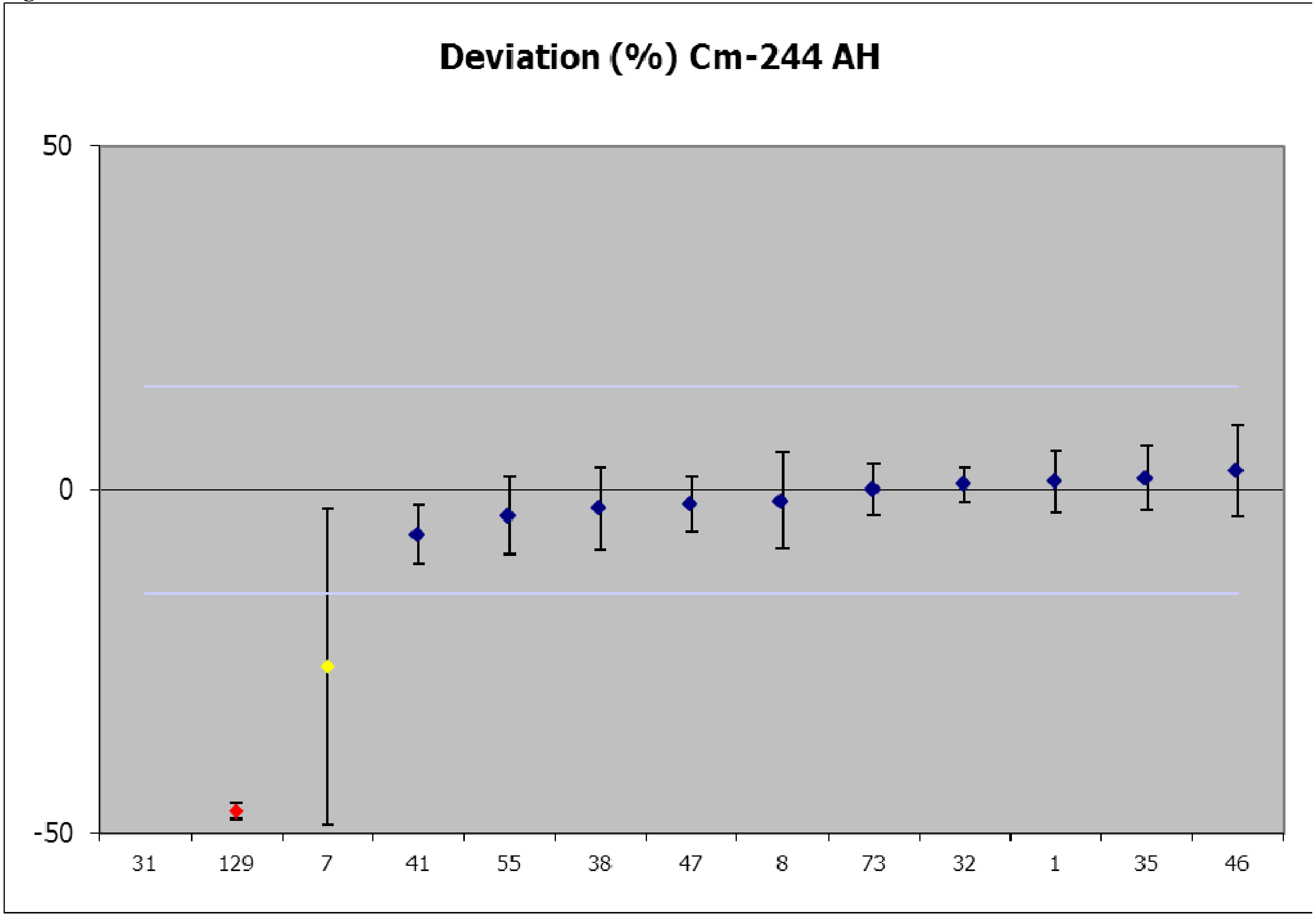


Figure 14B – Zeta score Cm-244 AH

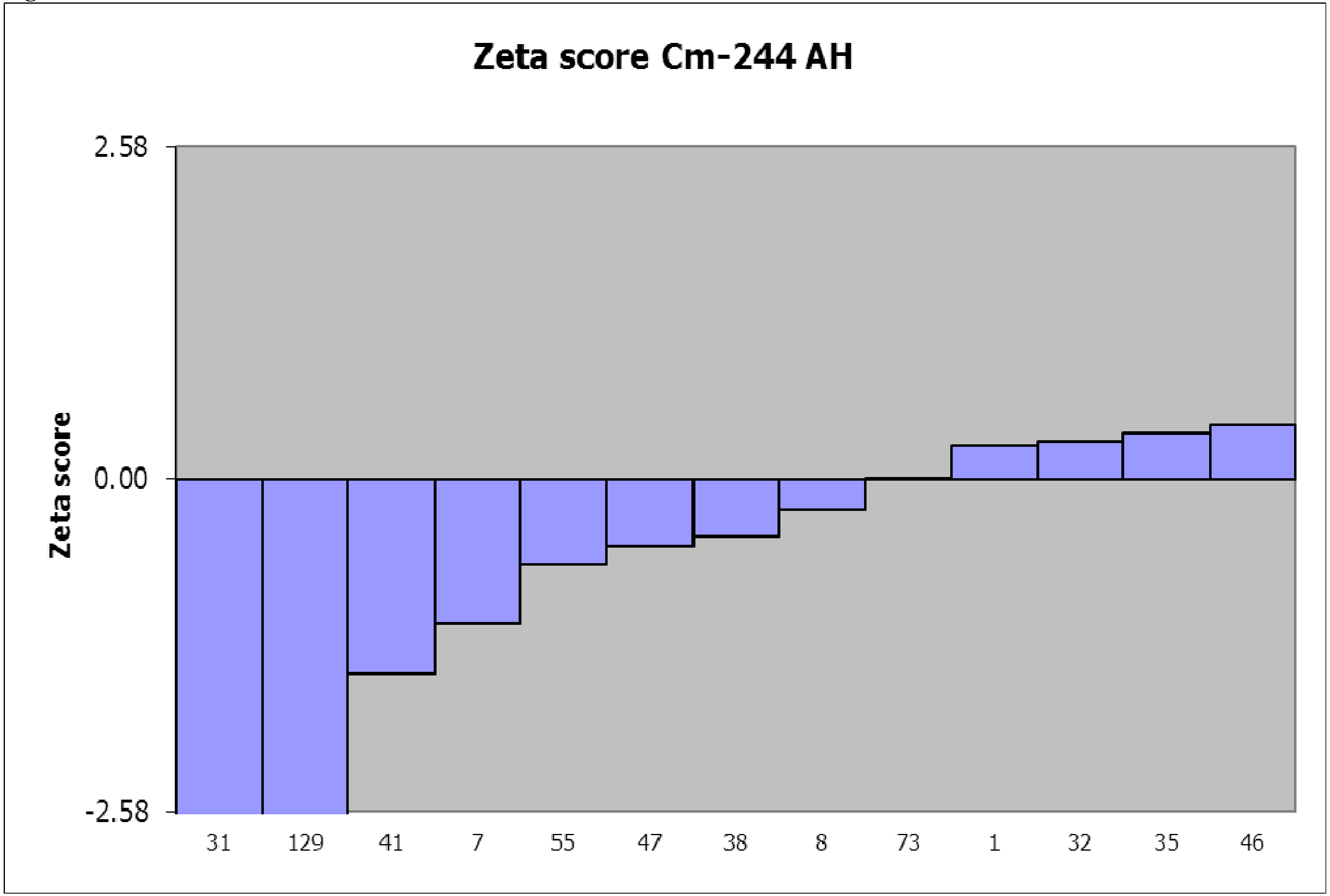


Figure 14C – Relative uncertainty Cm-244 AH

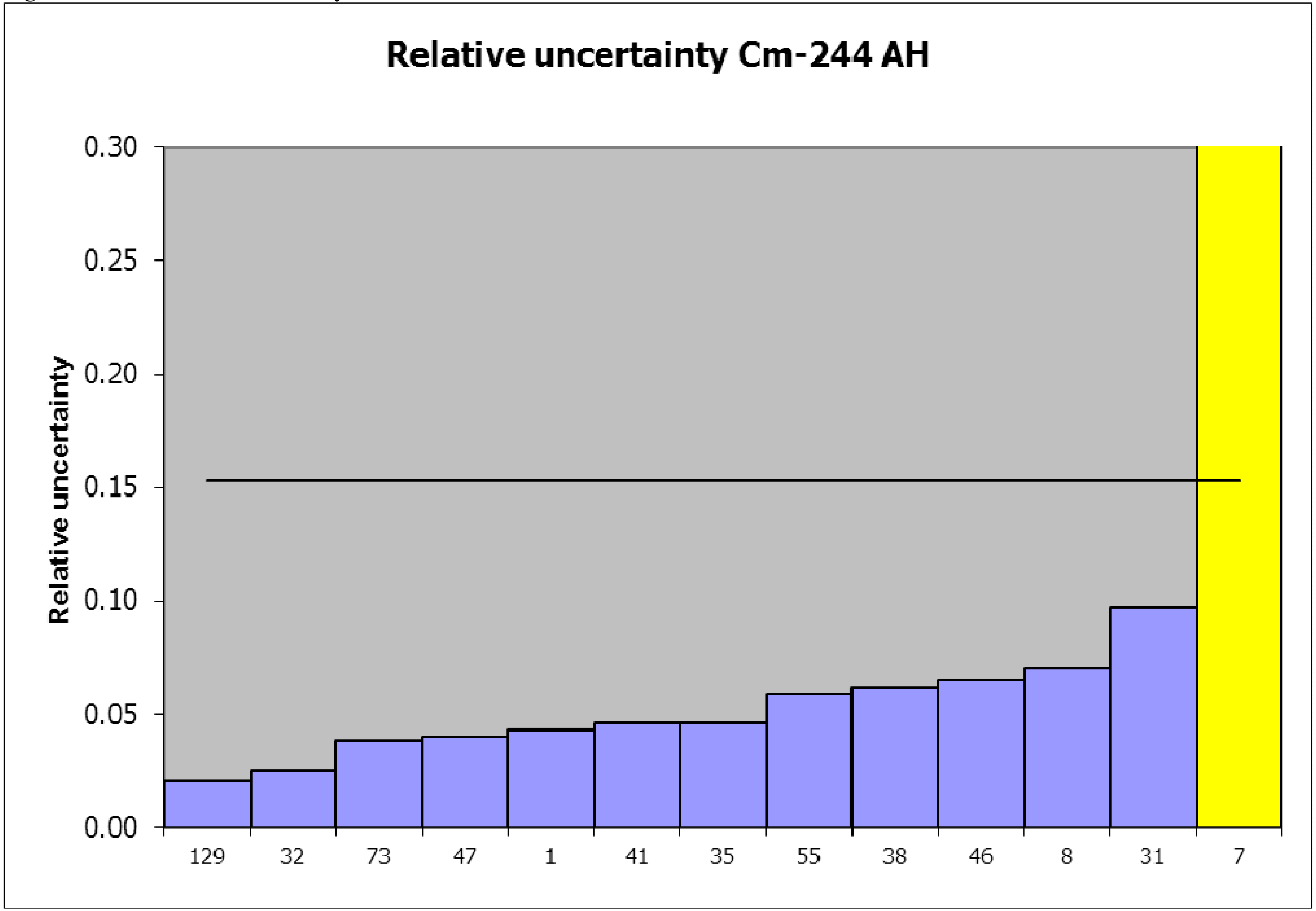


Figure 14D – Kiri plot Cm-244 AH

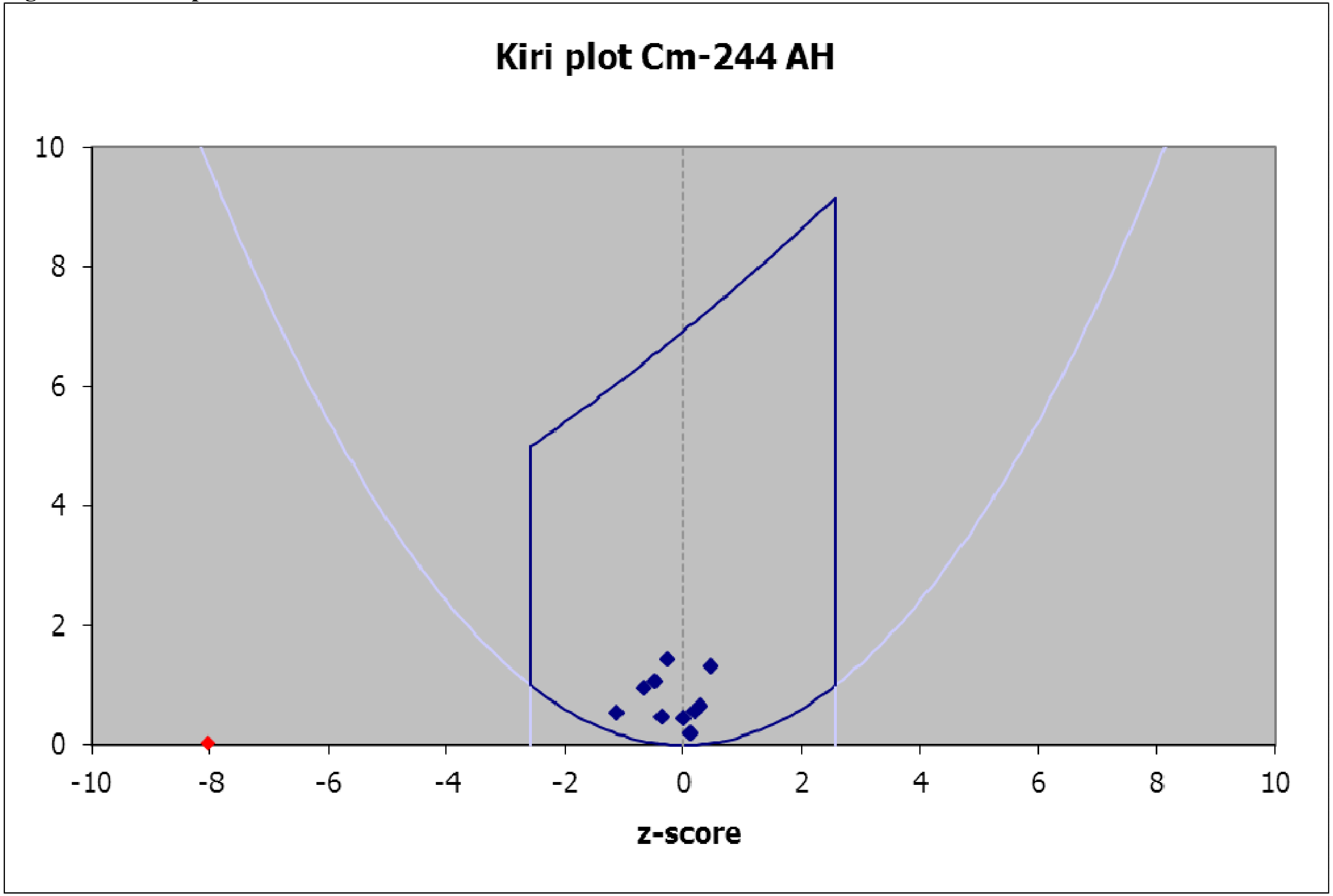


Figure 15A – Deviation gross alpha AH

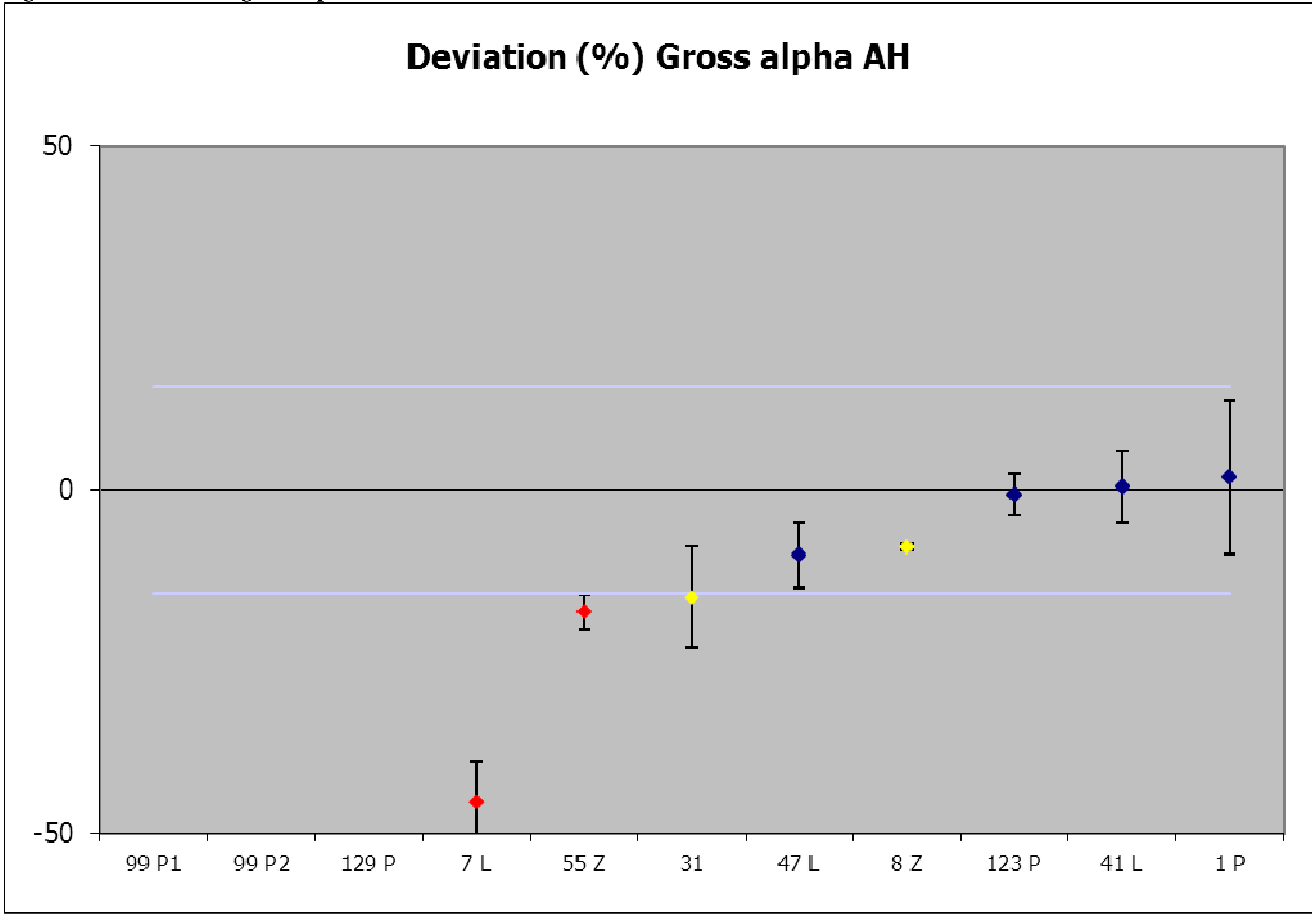


Figure 15B – Zeta score gross alpha AH

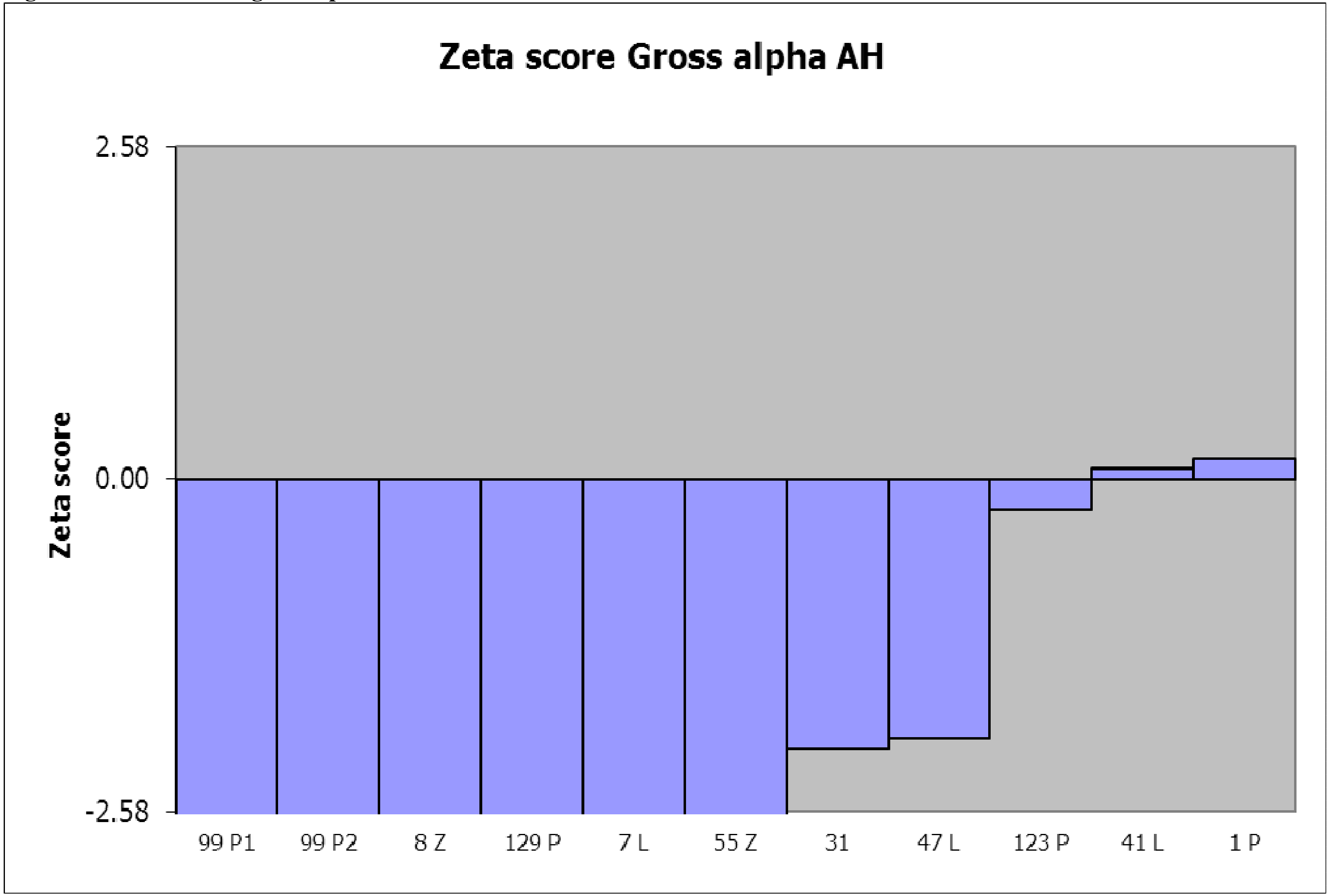


Figure 15C – Relative uncertainty gross alpha AH

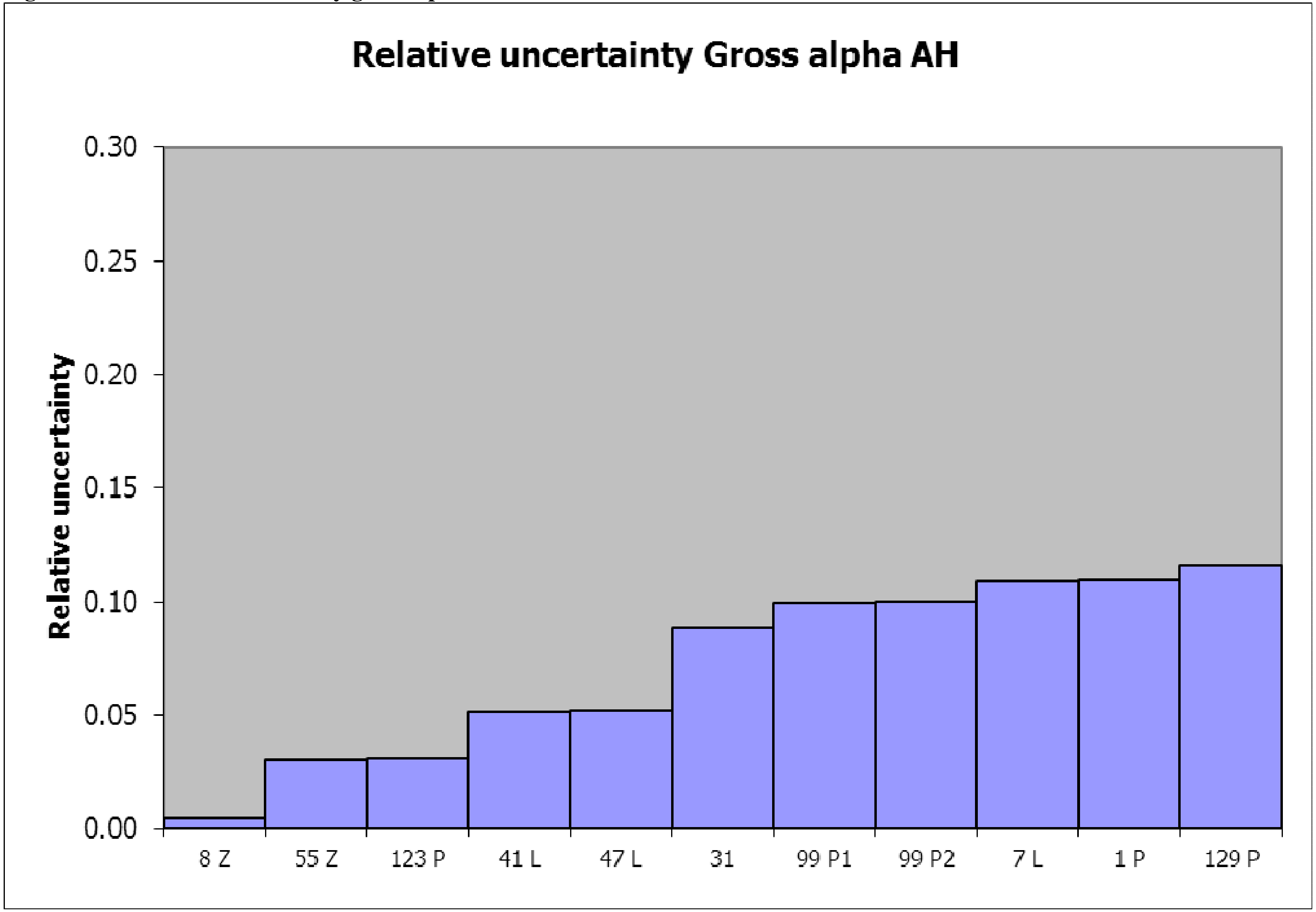


Figure 15D – Kiri plot gross alpha AH

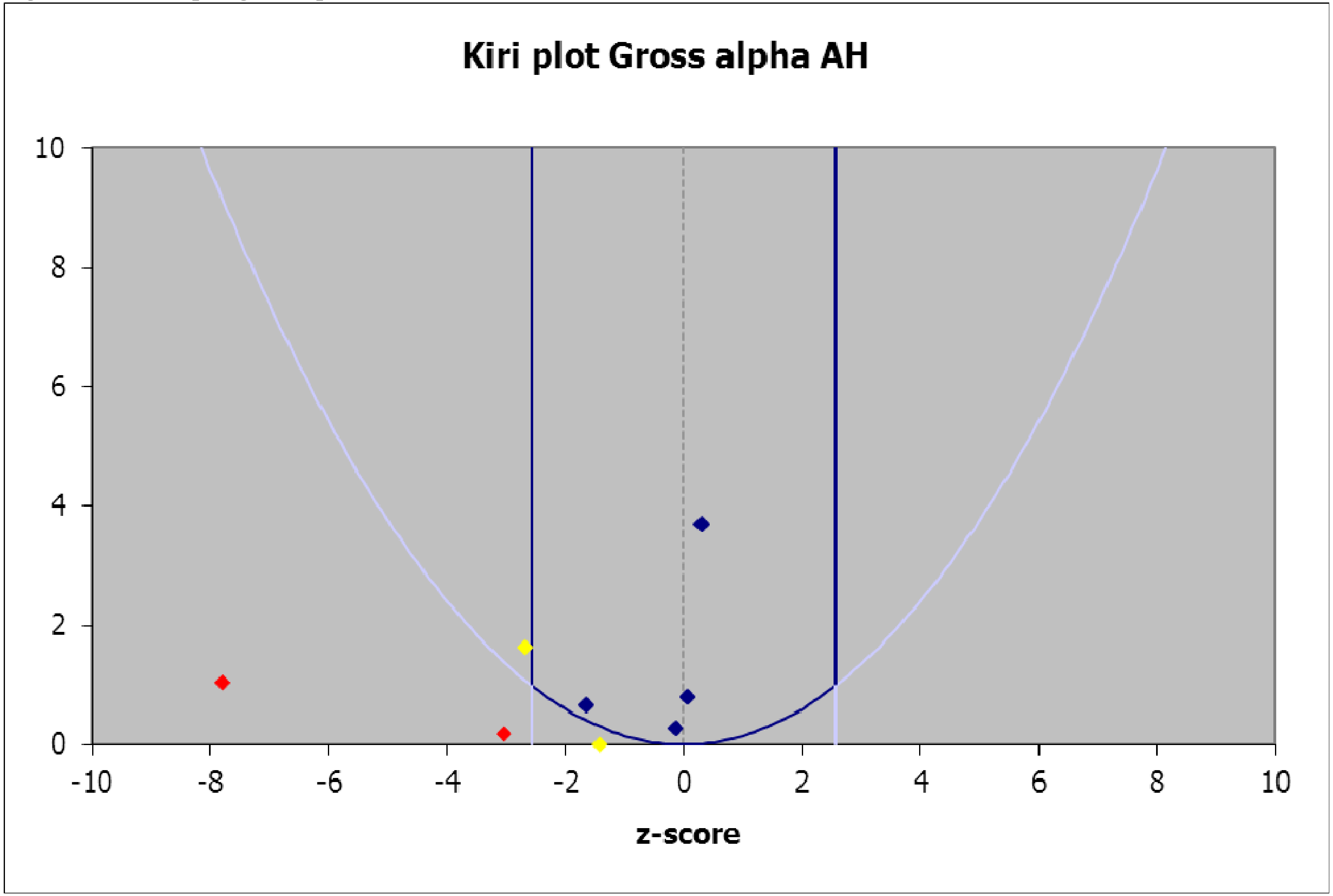


Figure 16A – Deviation Pu-238 P

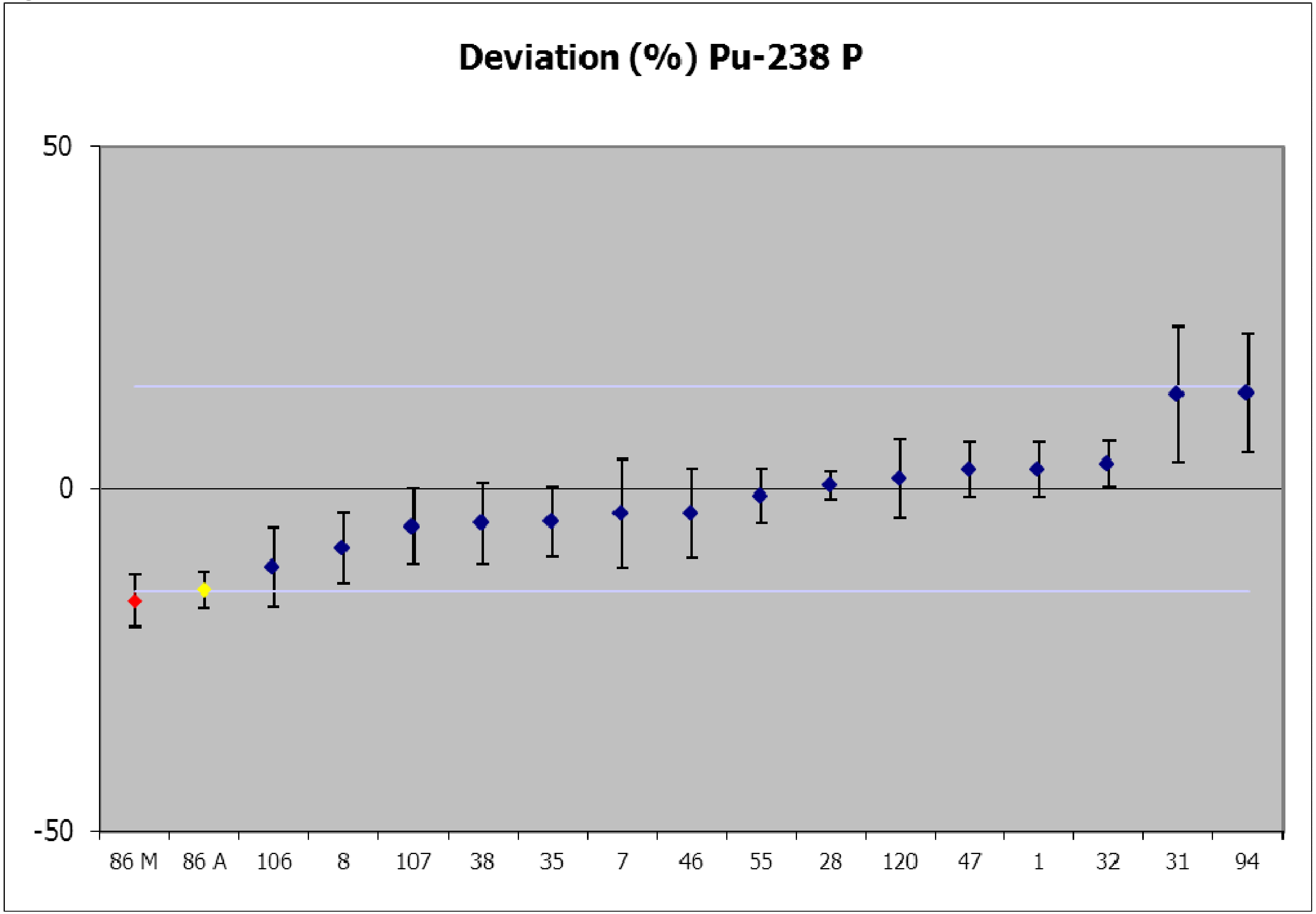


Figure 16B – Zeta score Pu-238 P

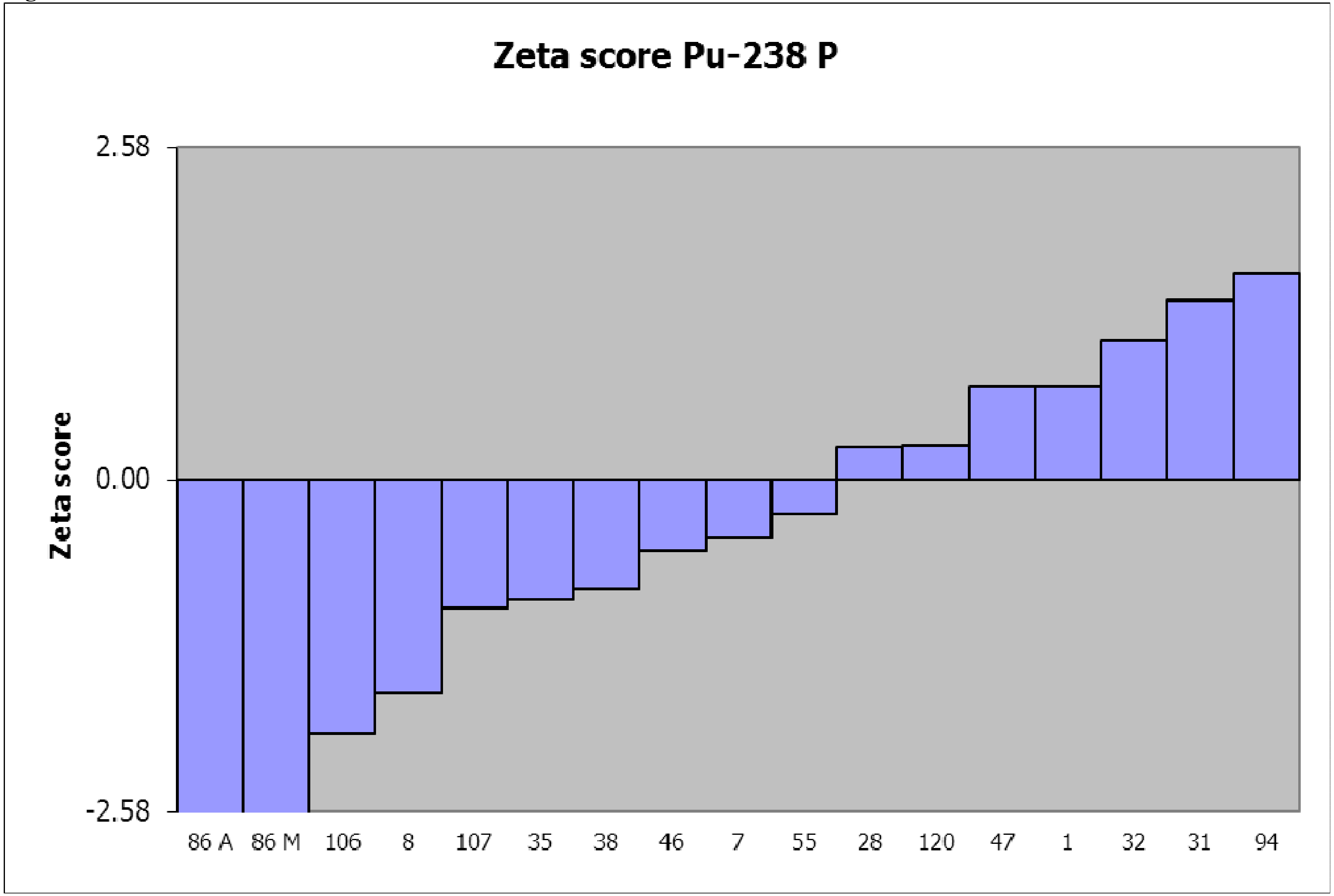


Figure 16C – Relative uncertainty Pu-238 P

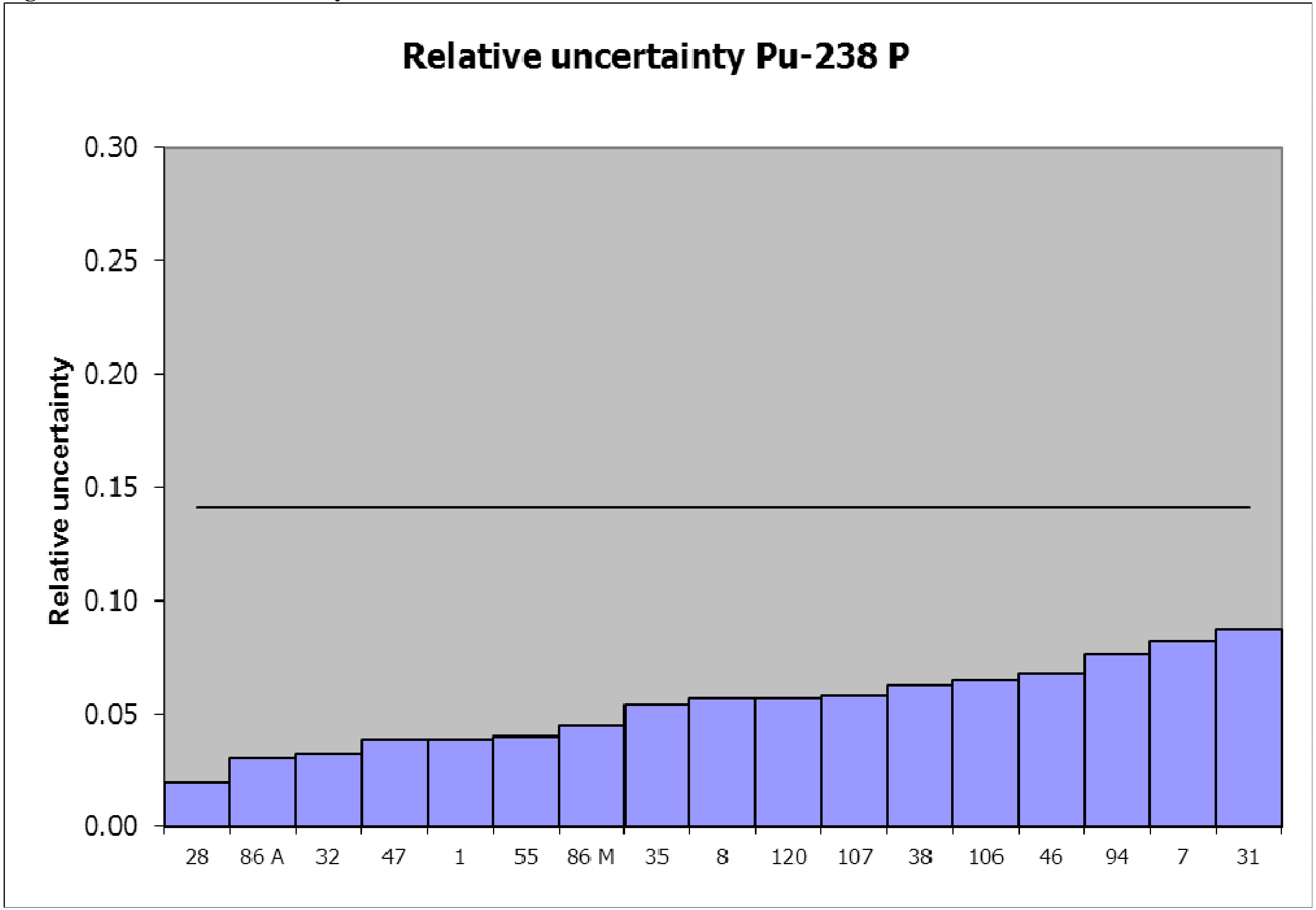


Figure 16D – Kiri plot Pu-238 P

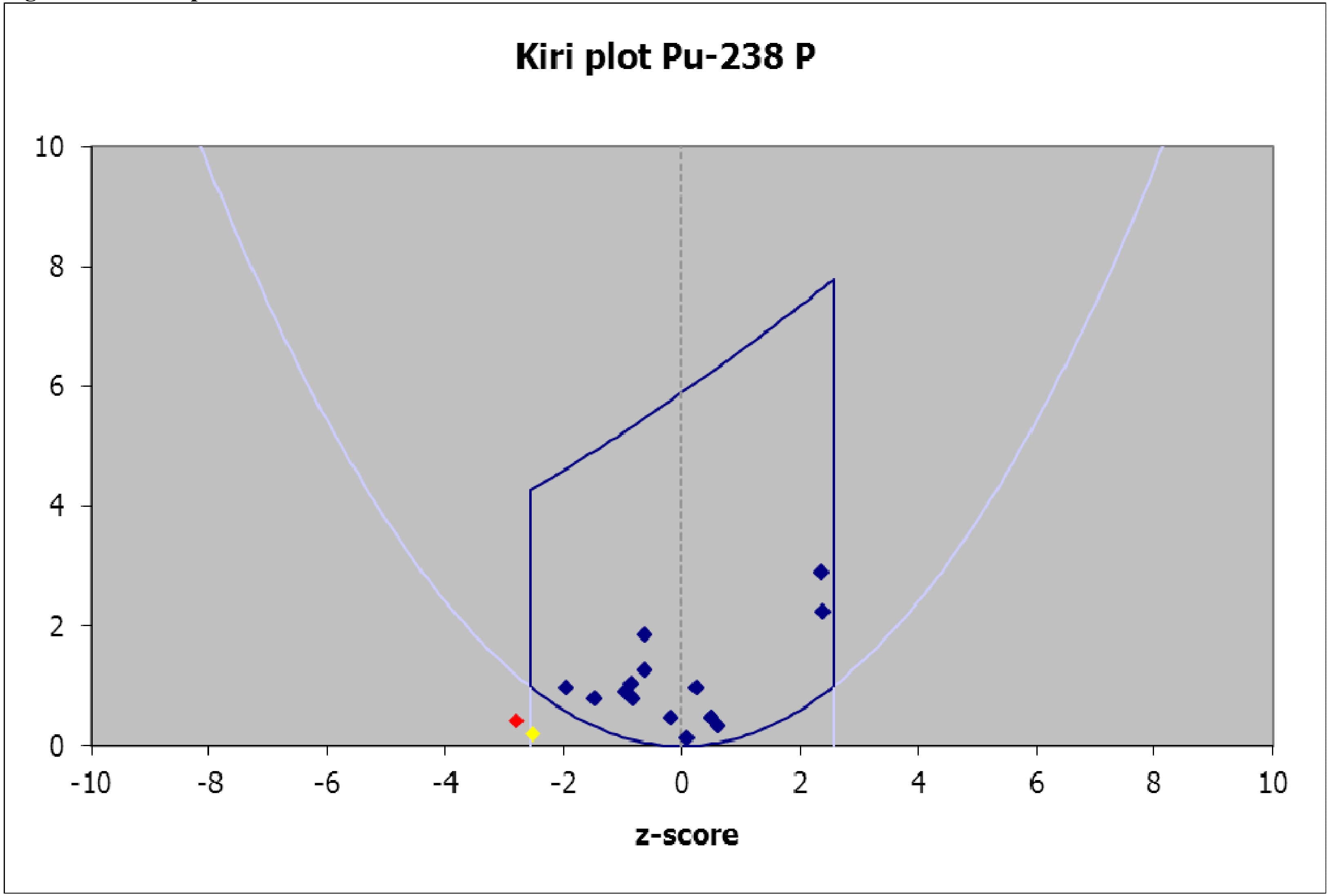


Figure 17A – Deviation Pu-239 P

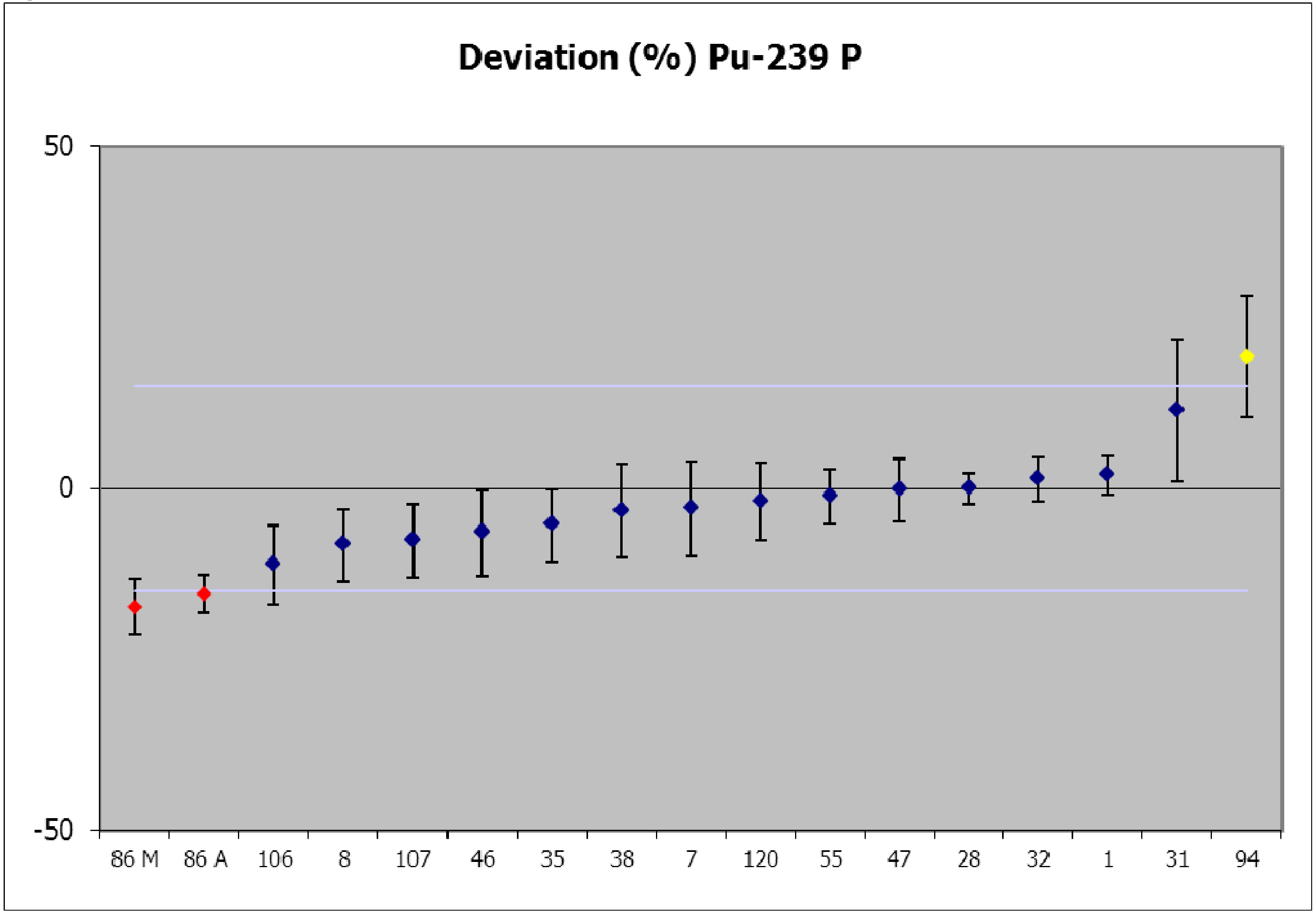


Figure 17B – Zeta score Pu-239 P

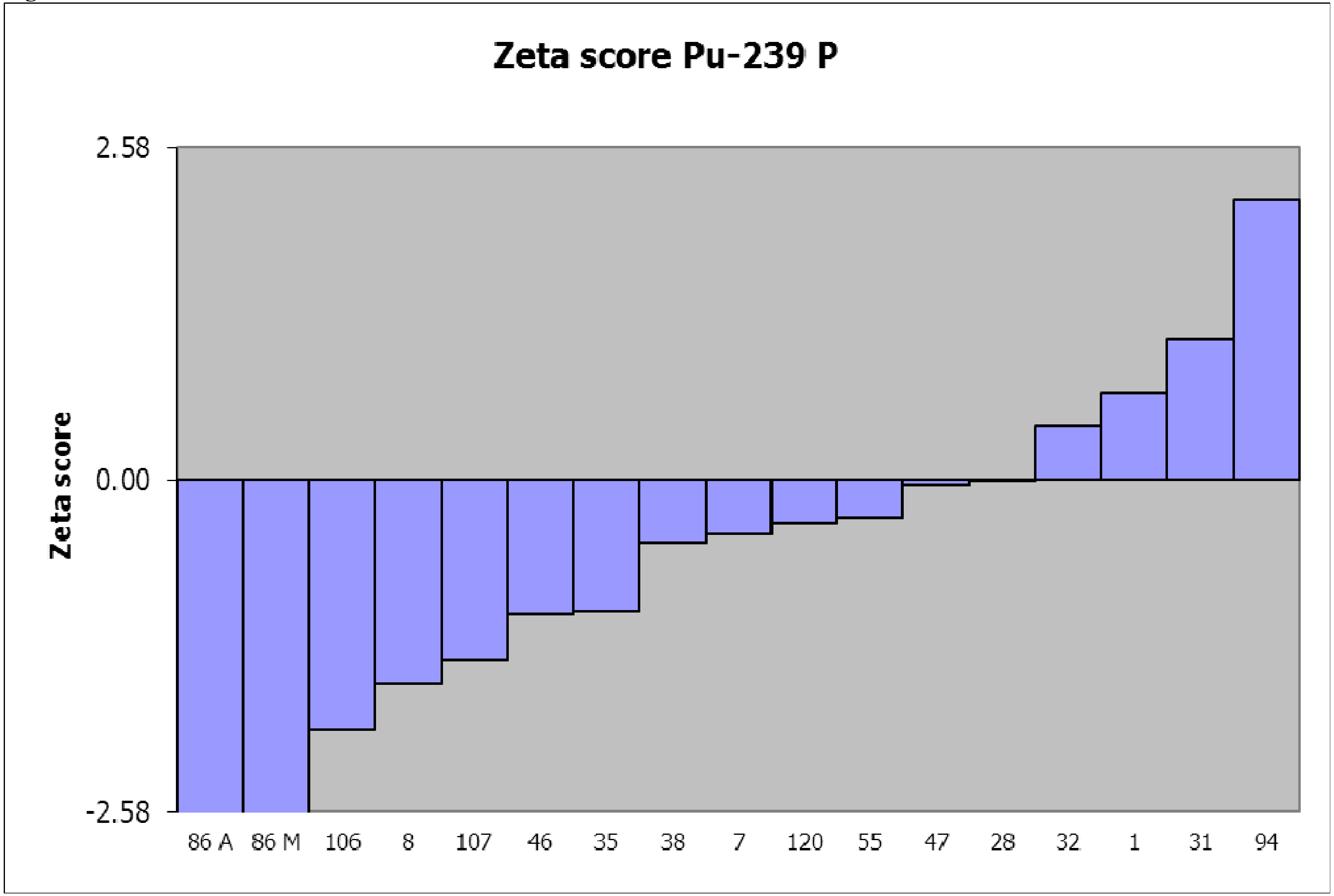


Figure 17C – Relative uncertainty Pu-239 P

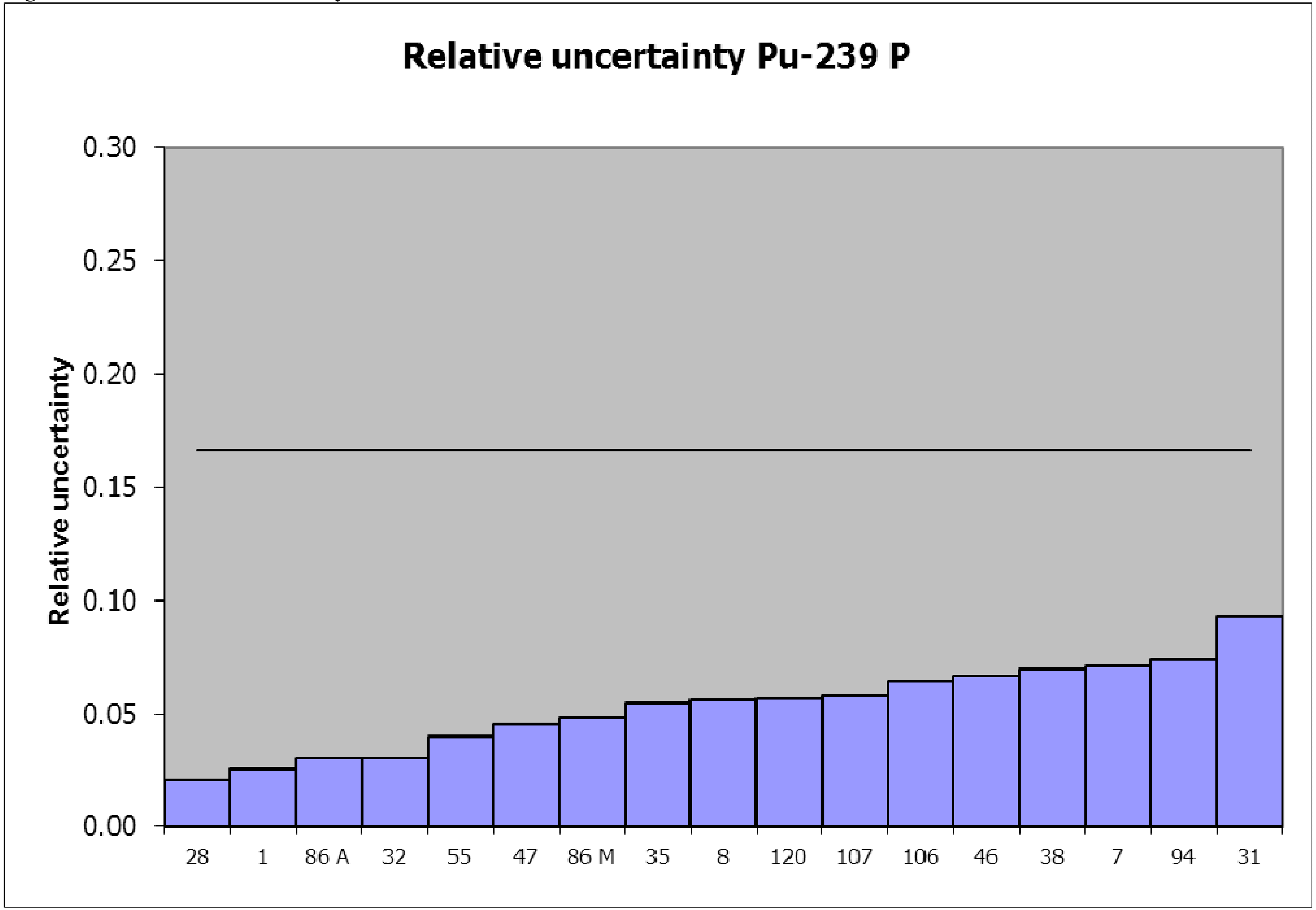


Figure 17D – Kiri plot Pu-239 P

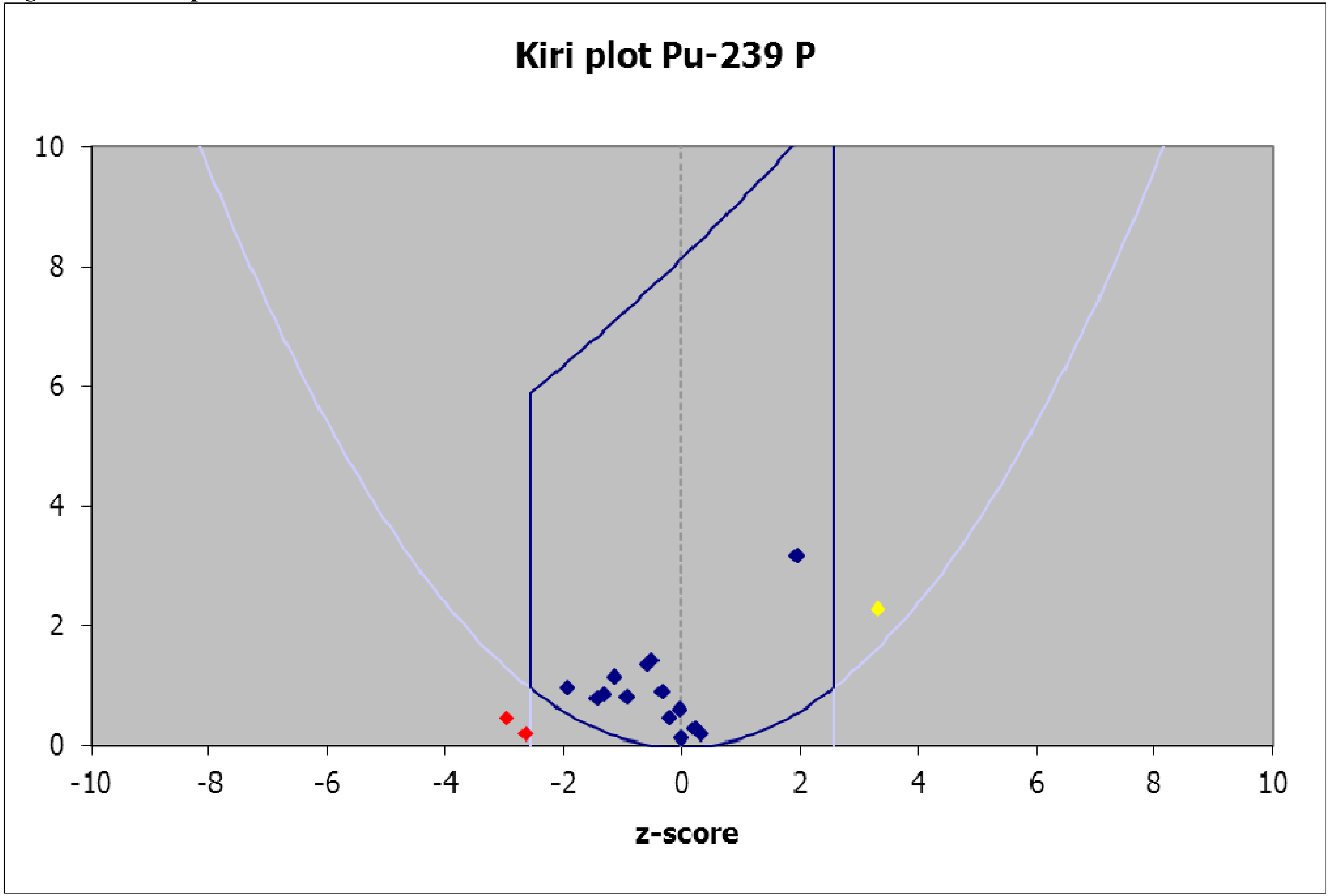


Figure 18A – Deviation Pu-241 P

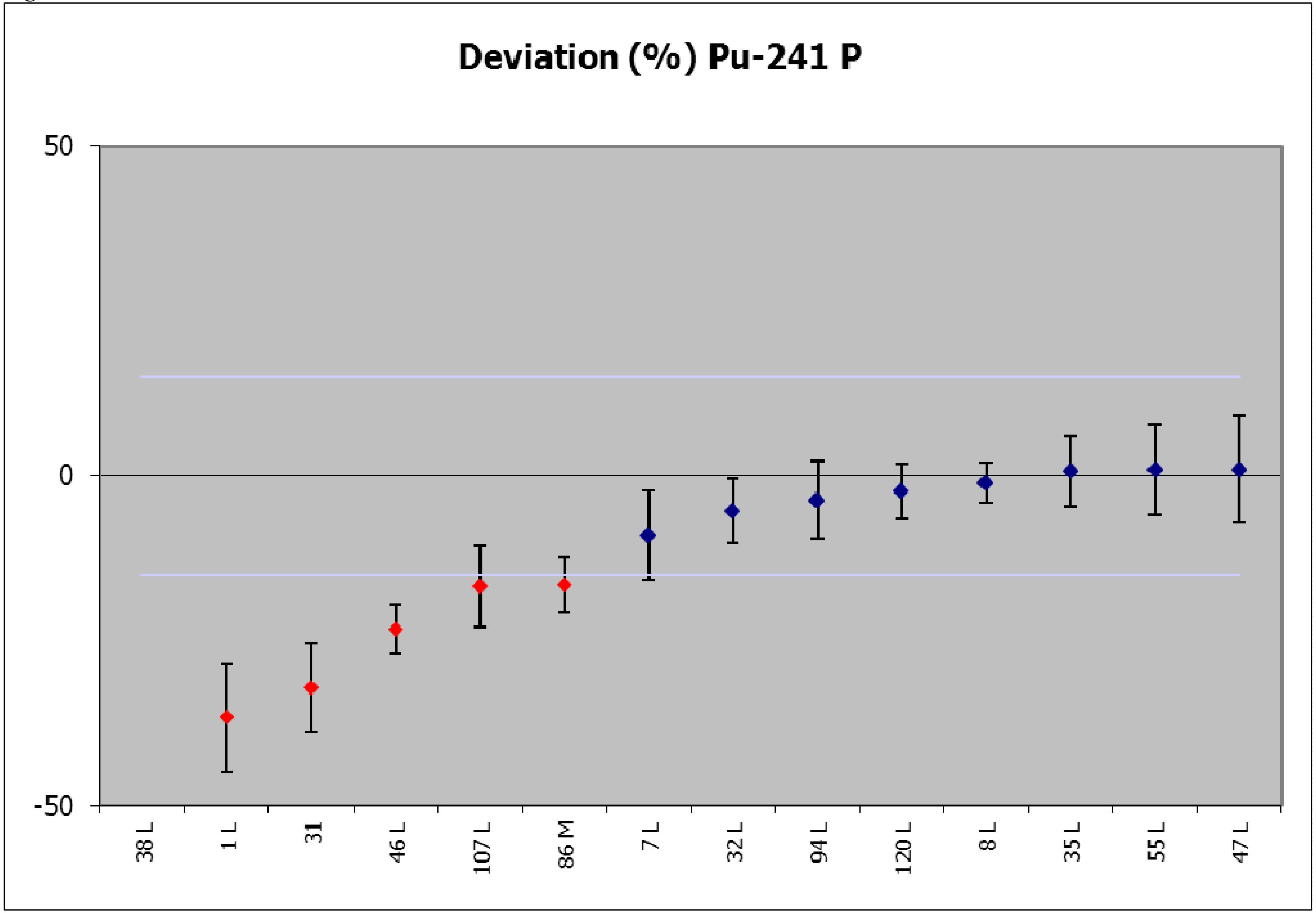


Figure 18B – Zeta score Pu-241 P

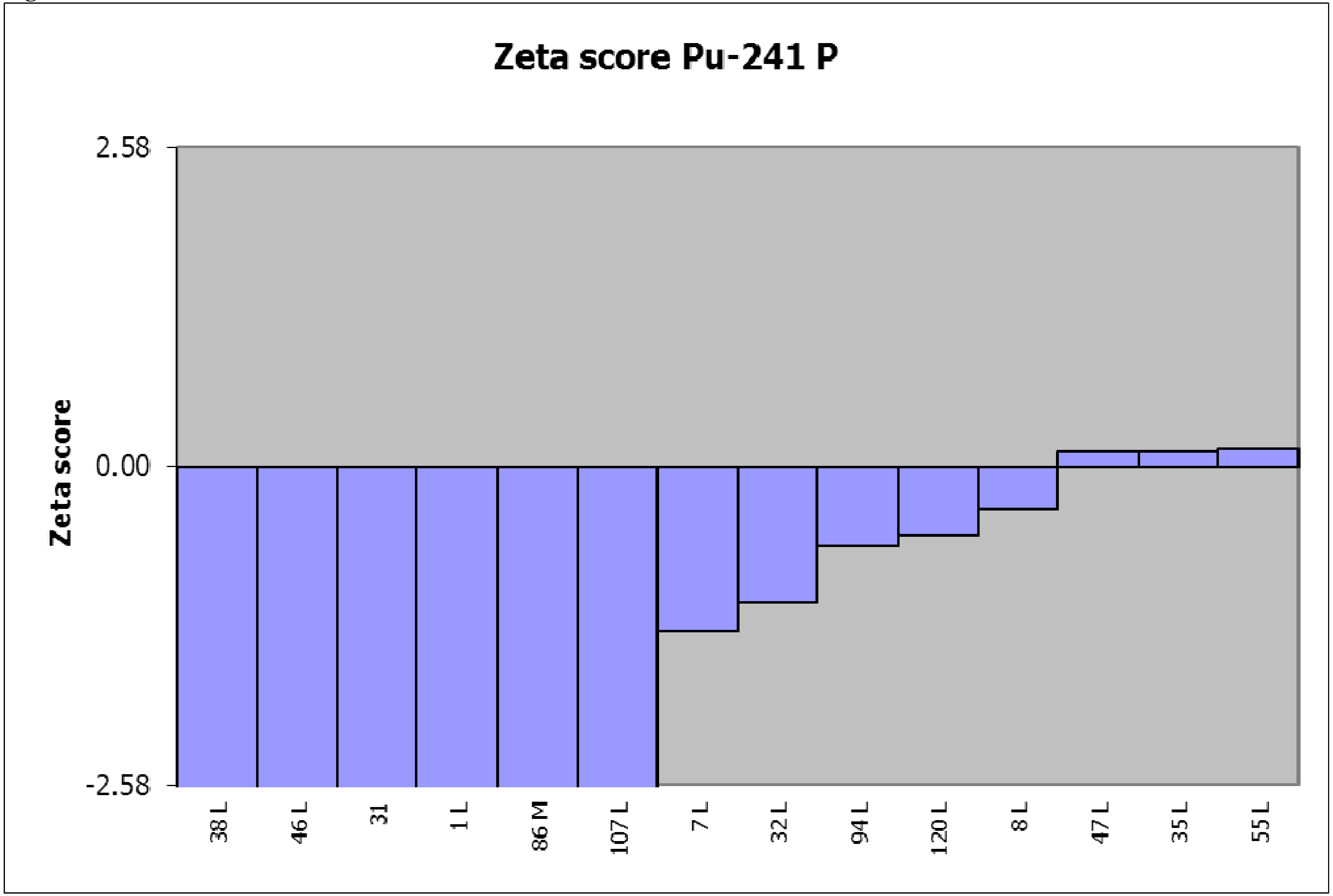


Figure 18C – Relative uncertainty Pu-241 P

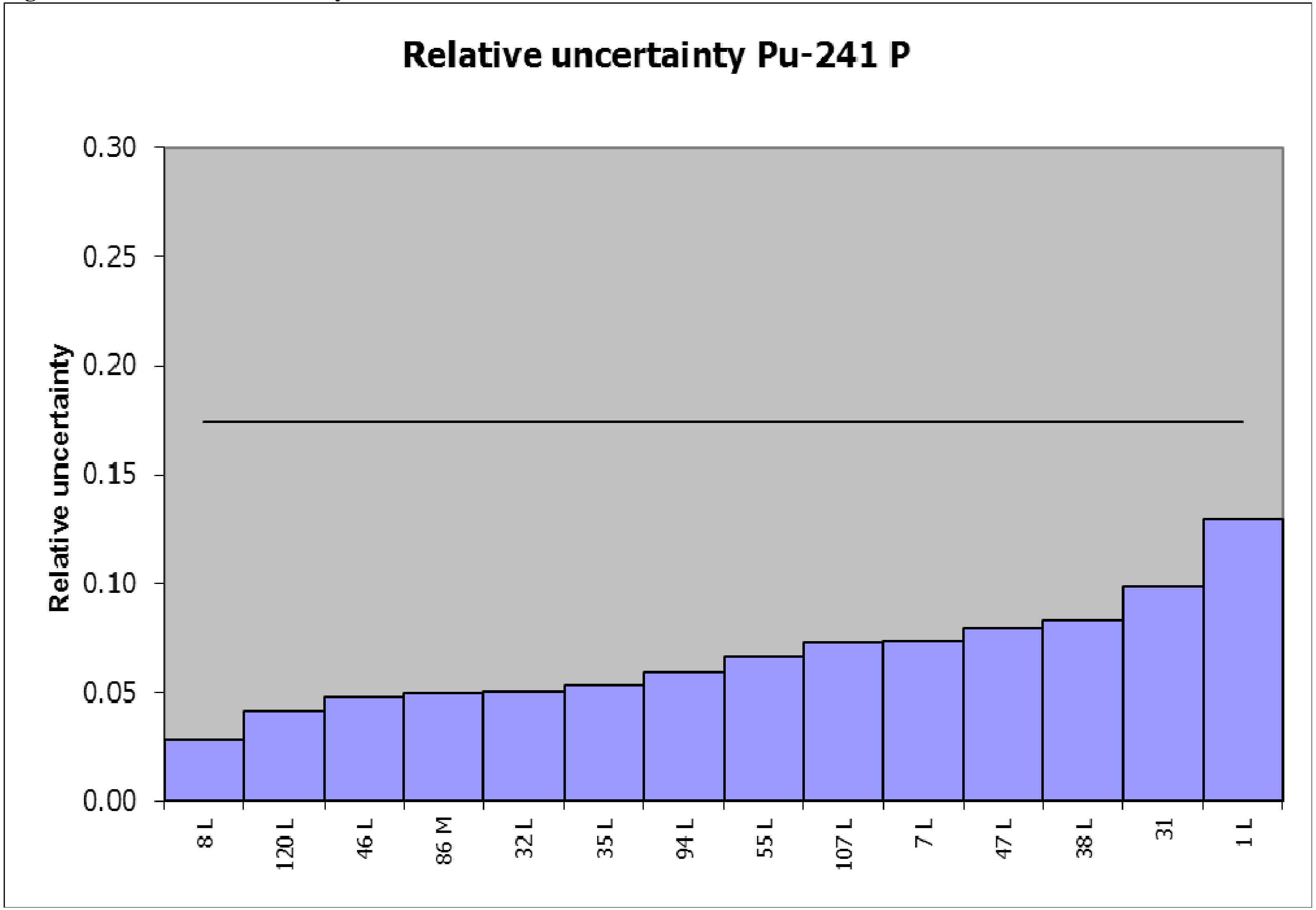


Figure 18D – Kiri plot Pu-241 P

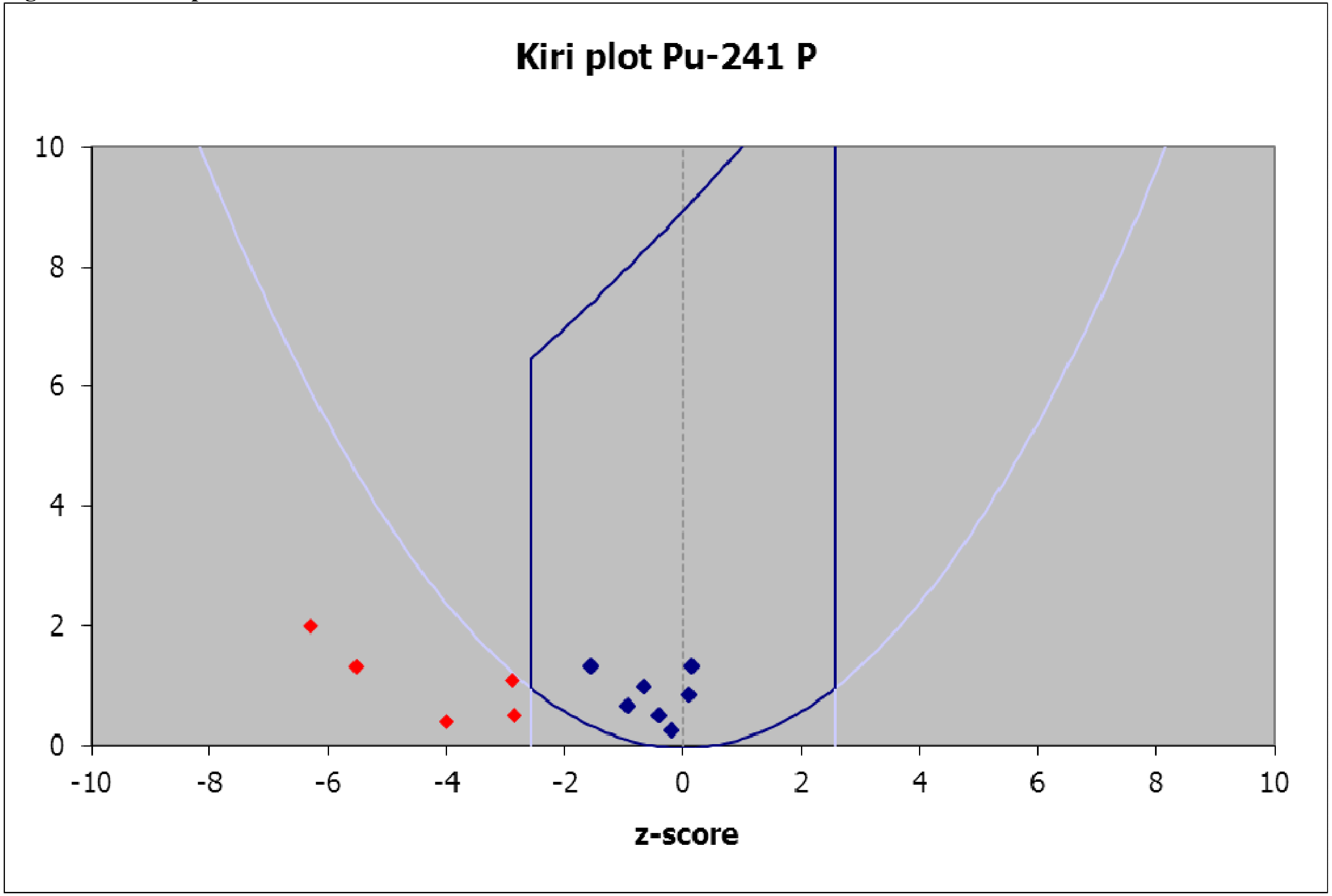


Figure 19A – Deviation H-3 B1

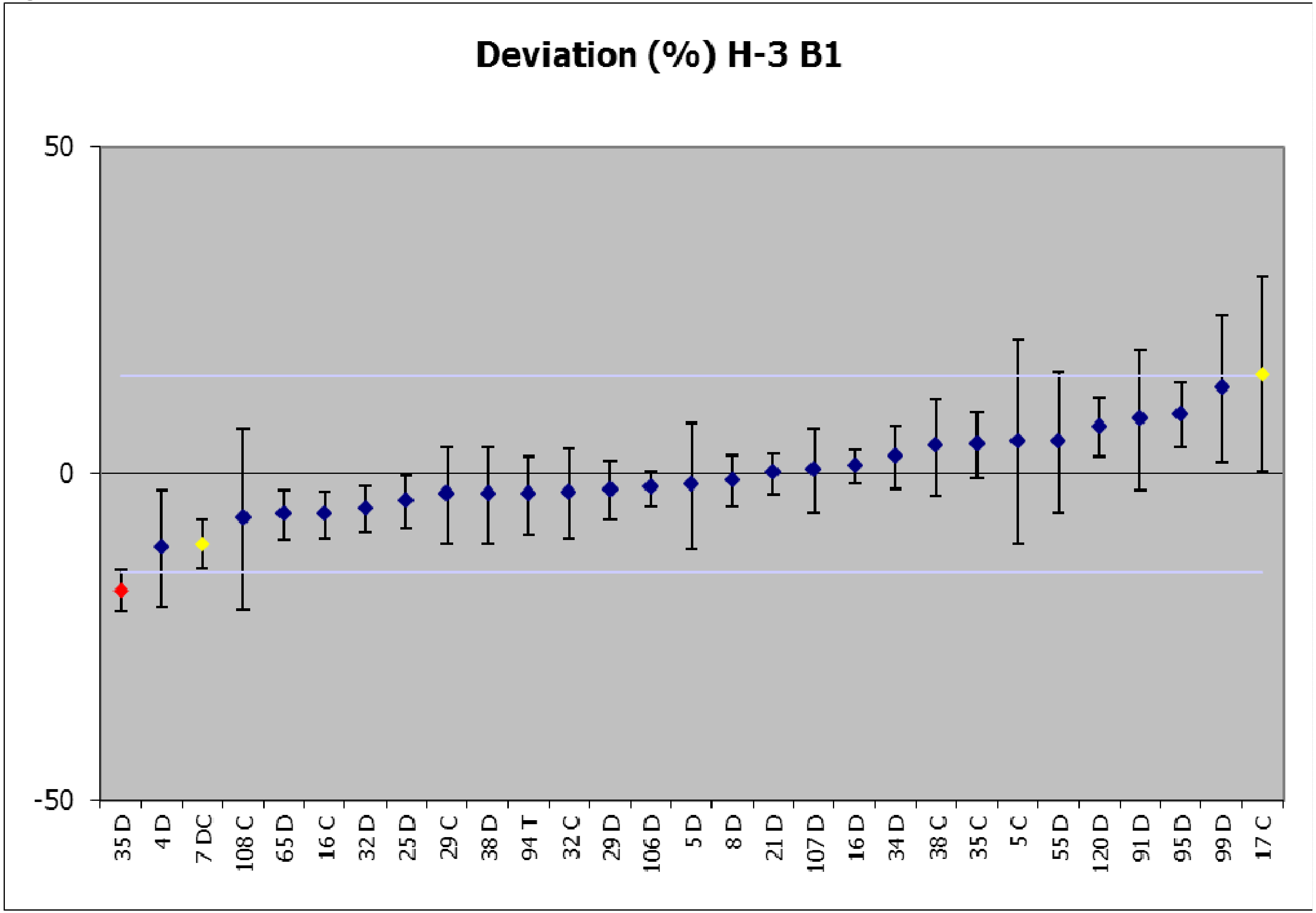


Figure 19B – Zeta score H-3 B1

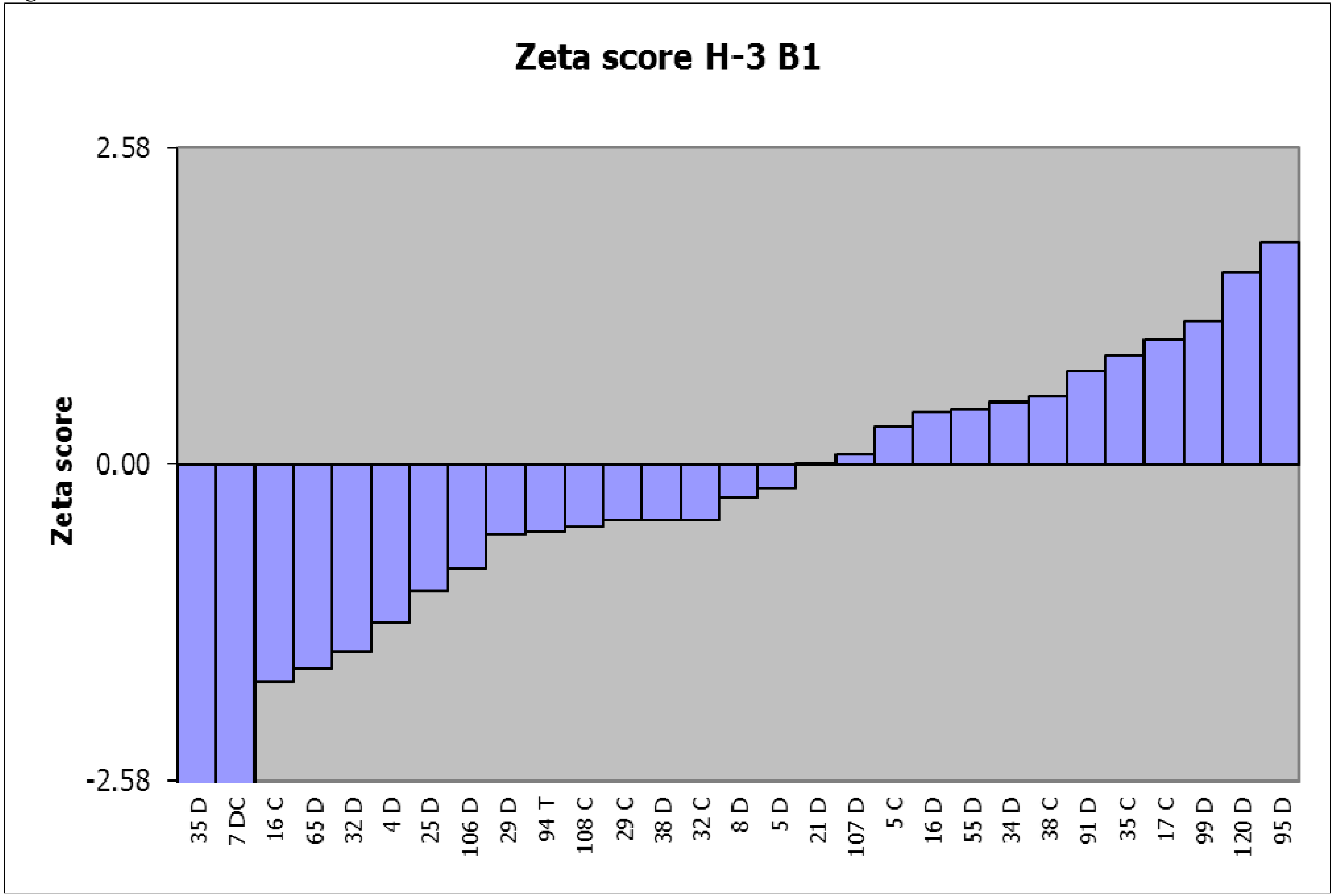


Figure 19C – Relative uncertainty H-3 B1

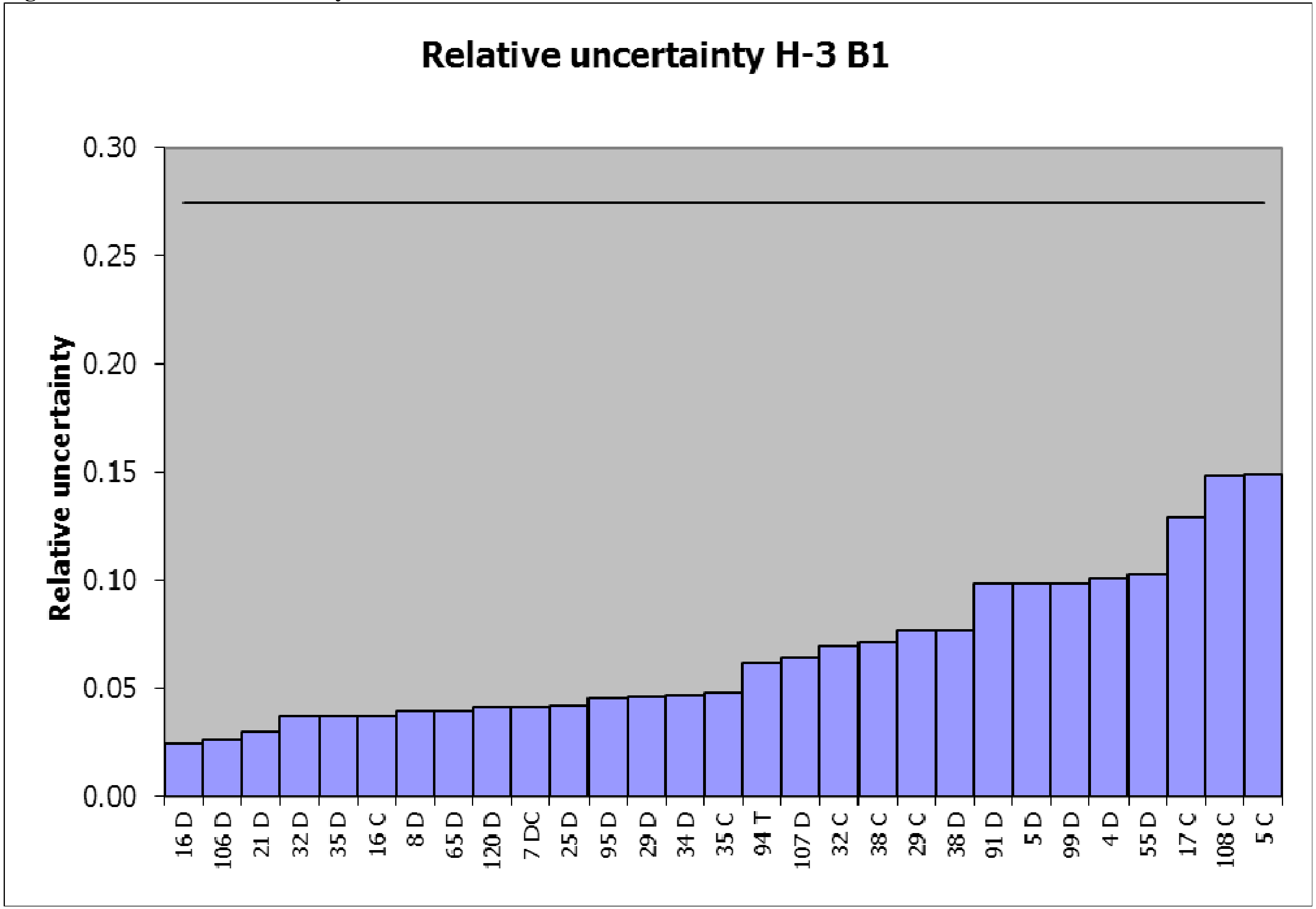


Figure 19D – Kiri plot H-3 B1

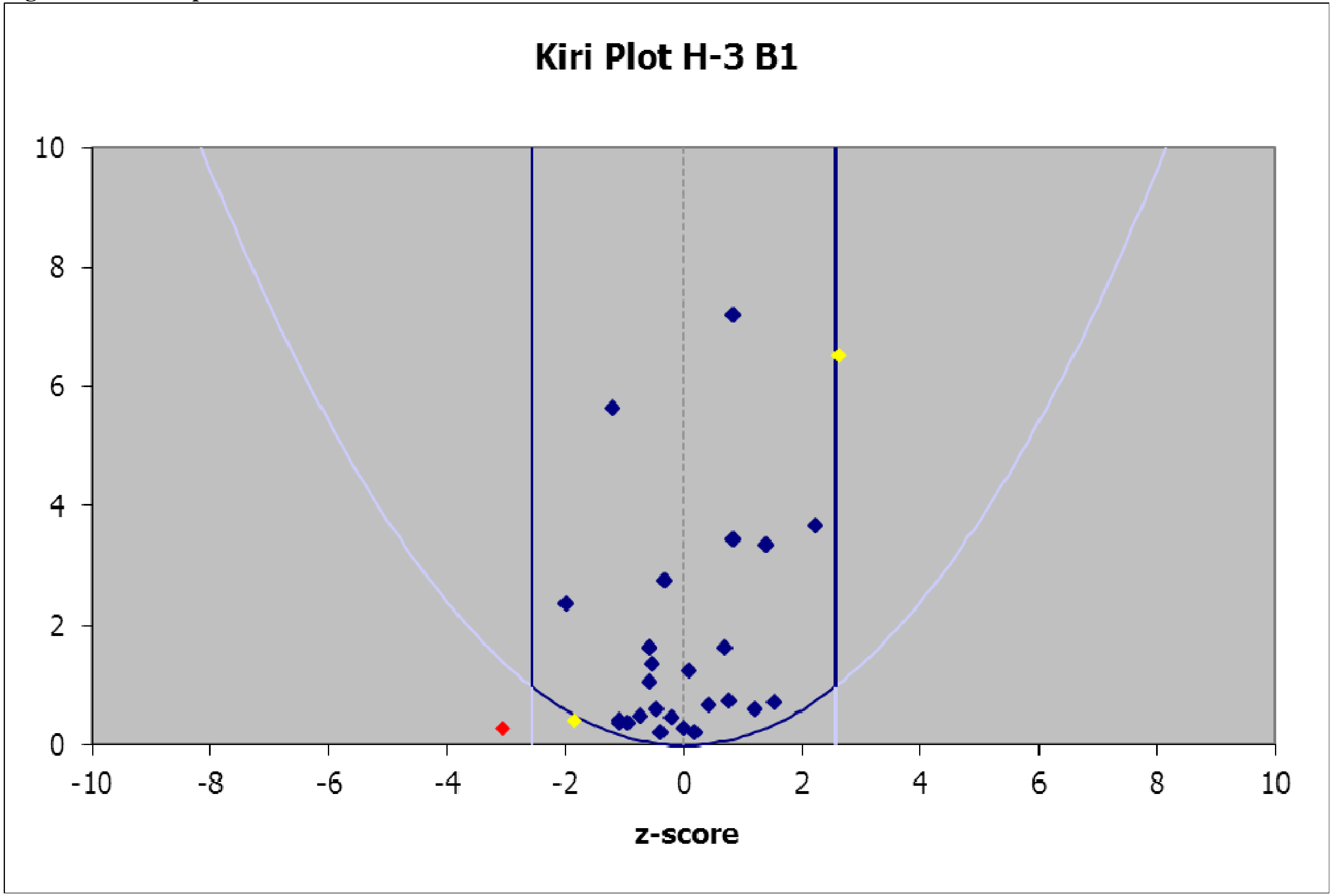


Figure 20A – Deviation C-14 B1

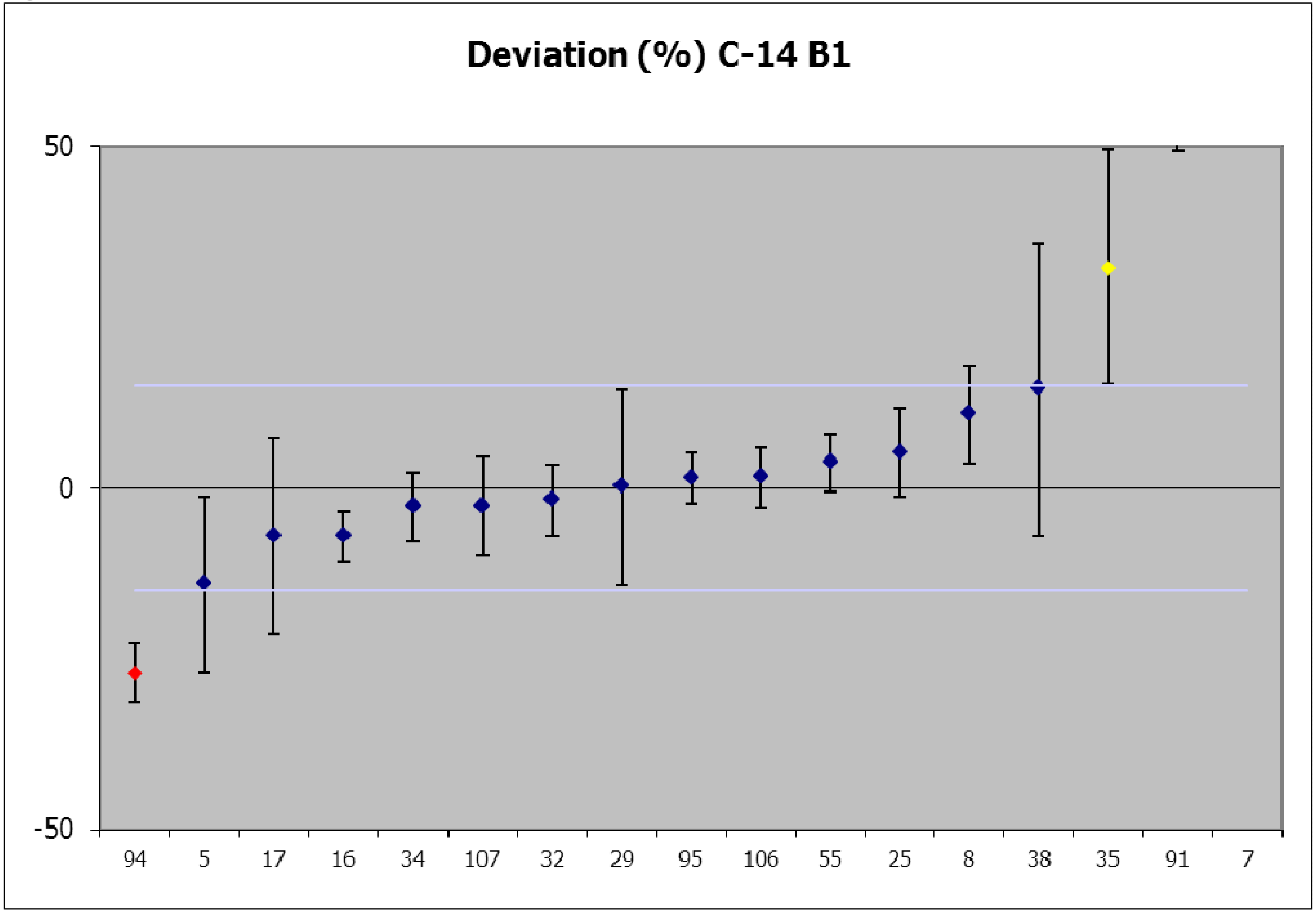


Figure 20B – Zeta score C-14 B1

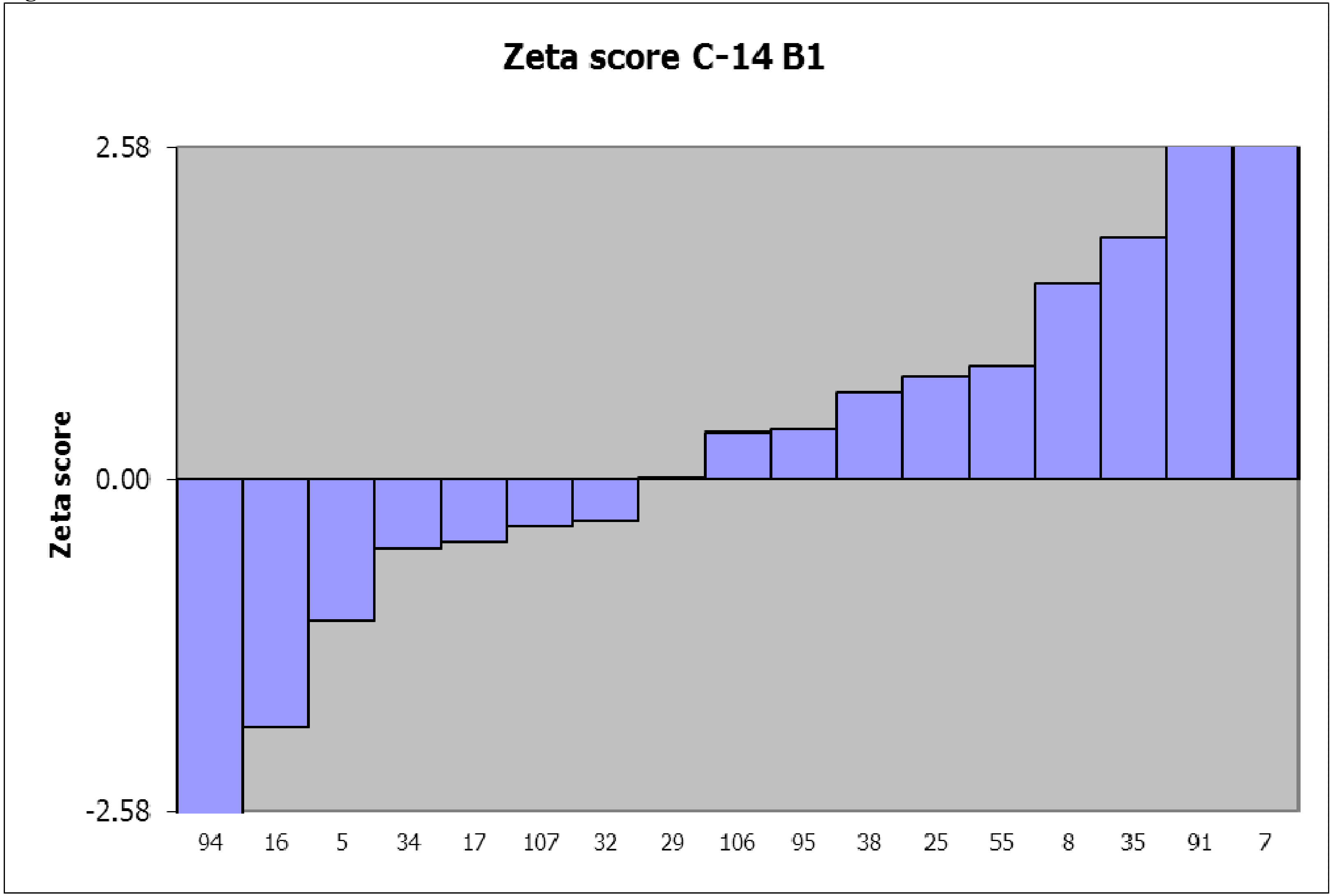


Figure 20C – Relative uncertainty C-14 B1

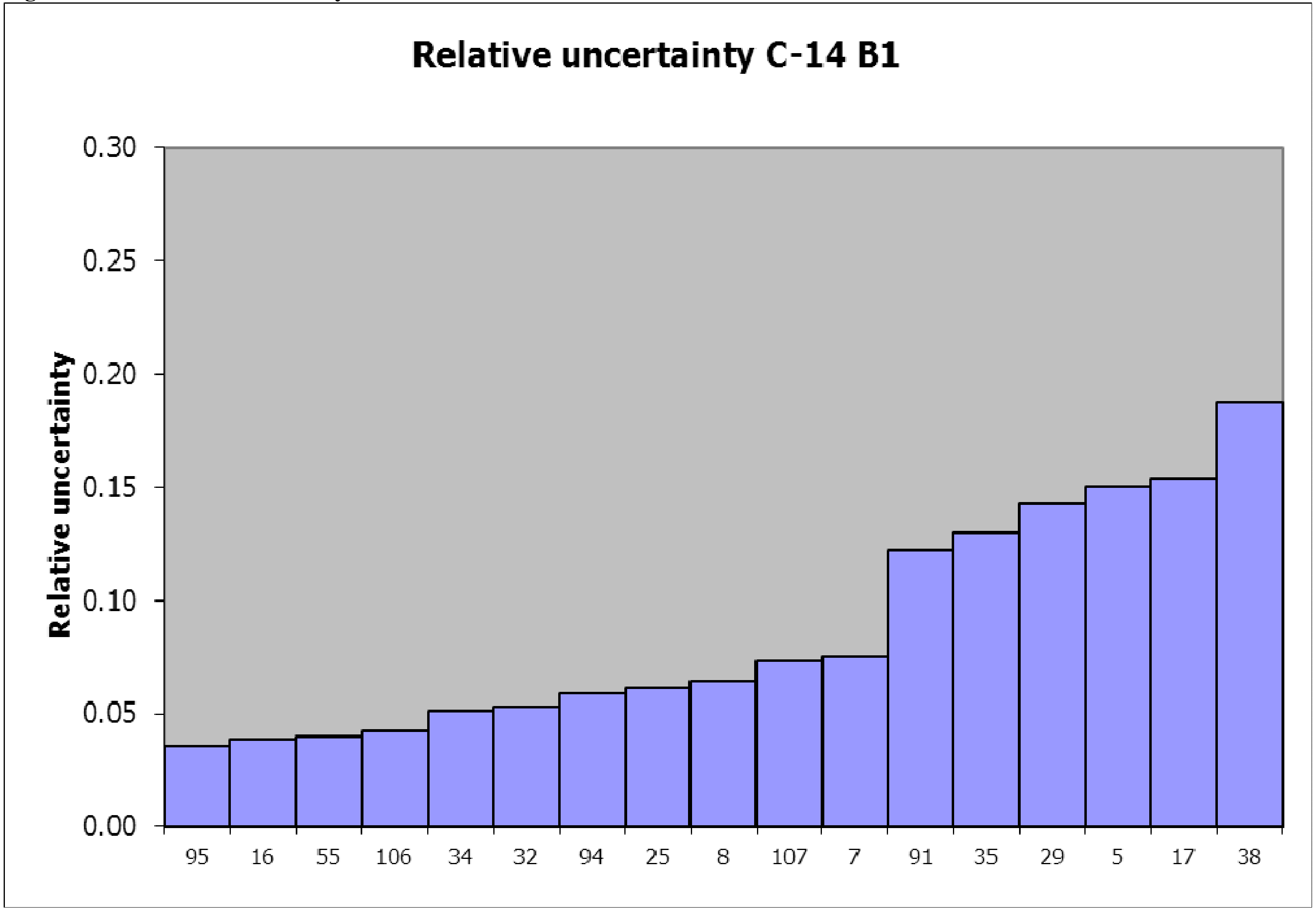


Figure 20D – Kiri plot C-14 B1

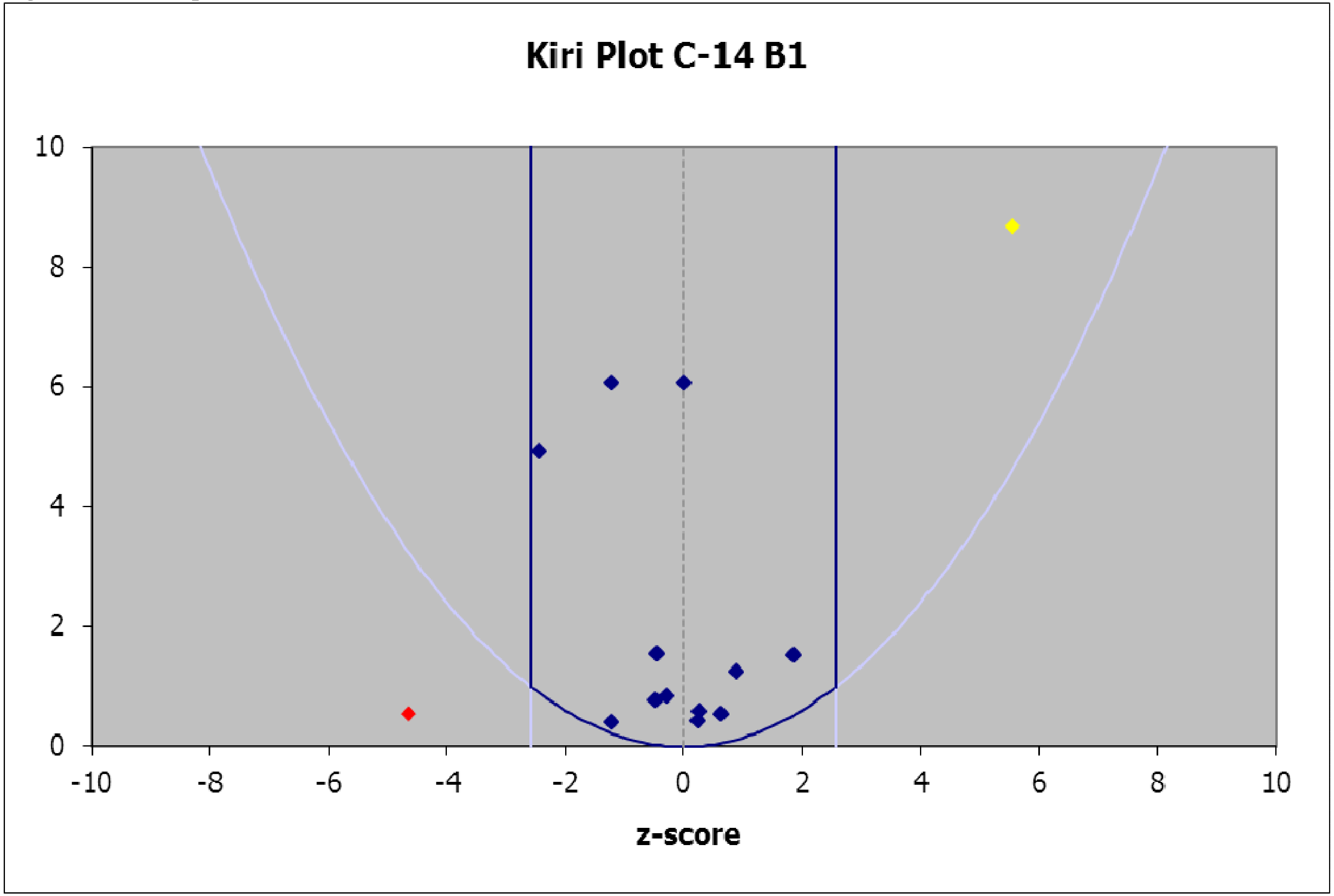


Figure 21A – Deviation Cl-36 B1

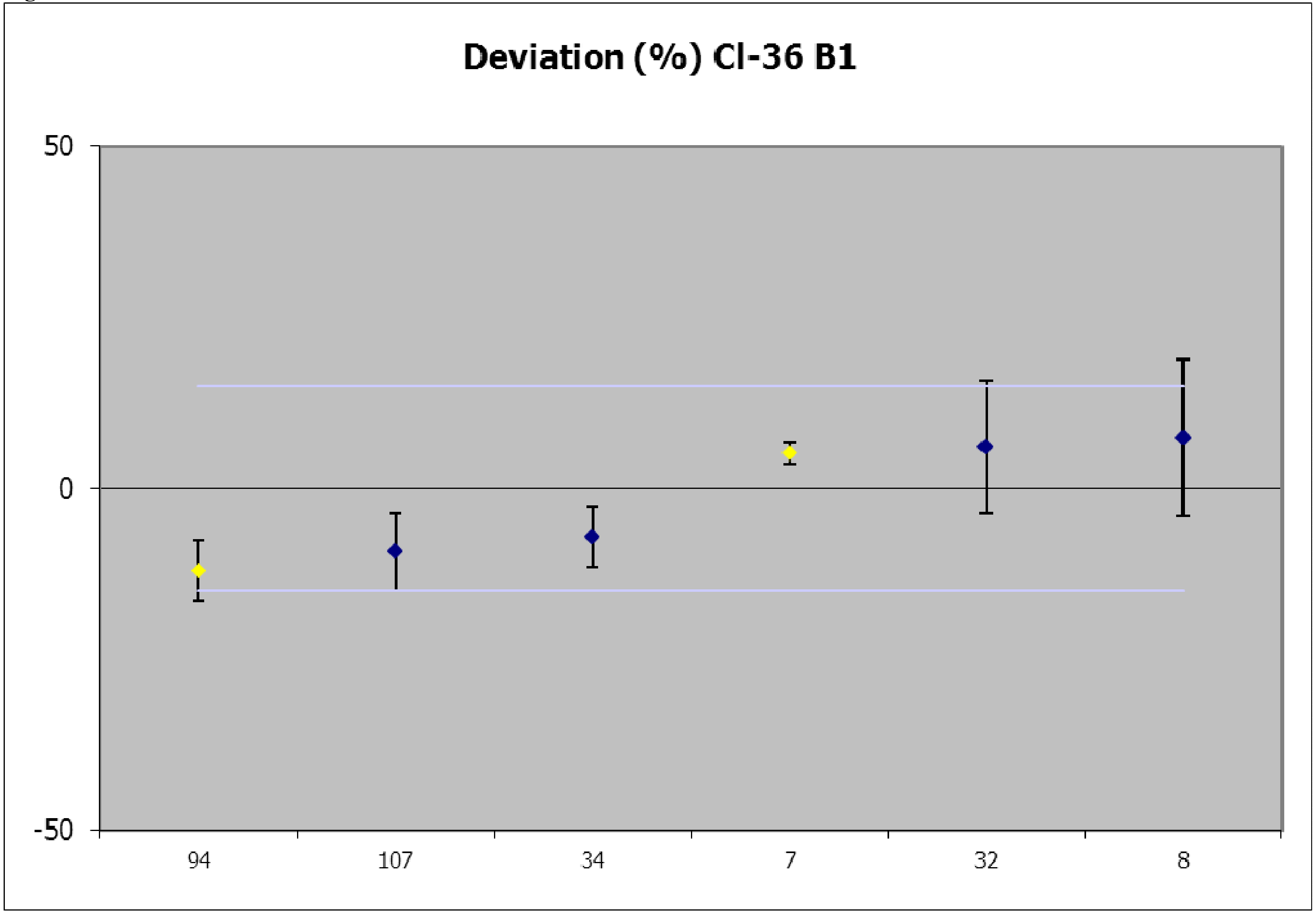


Figure 21B – Zeta score Cl-36 B1

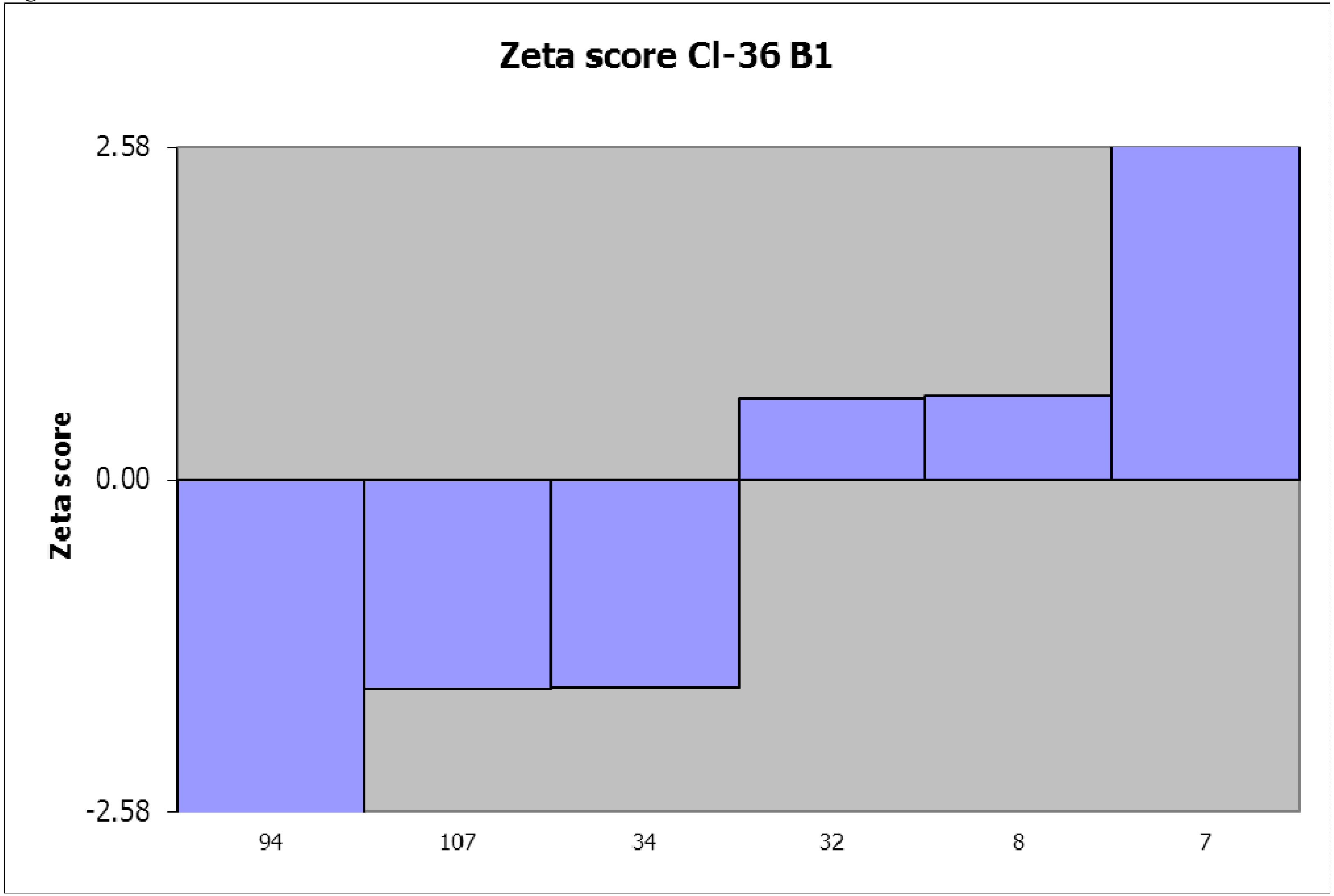


Figure 21C – Relative uncertainty Cl-36 B1

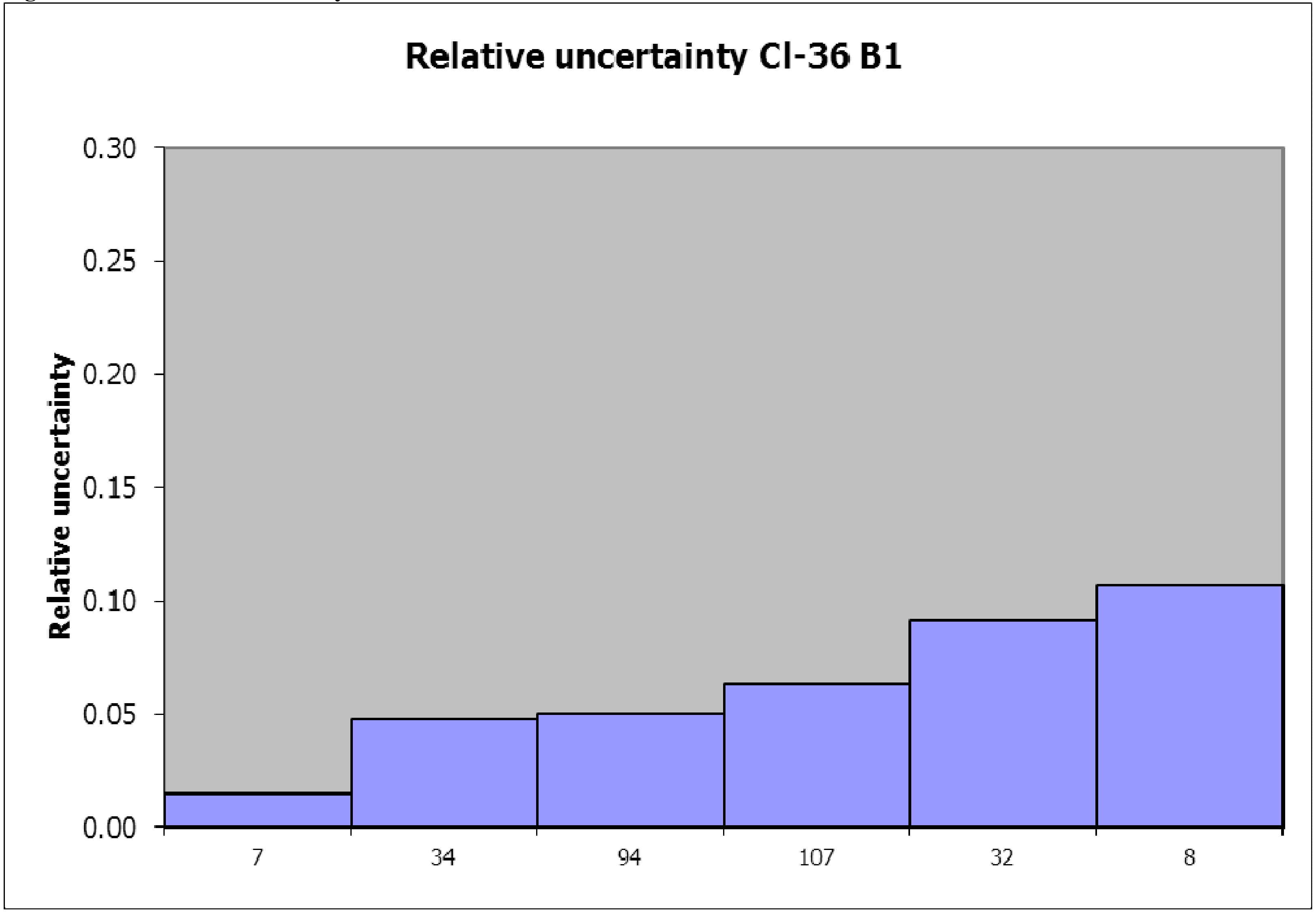


Figure 21D – Kiri plot Cl-36 B1

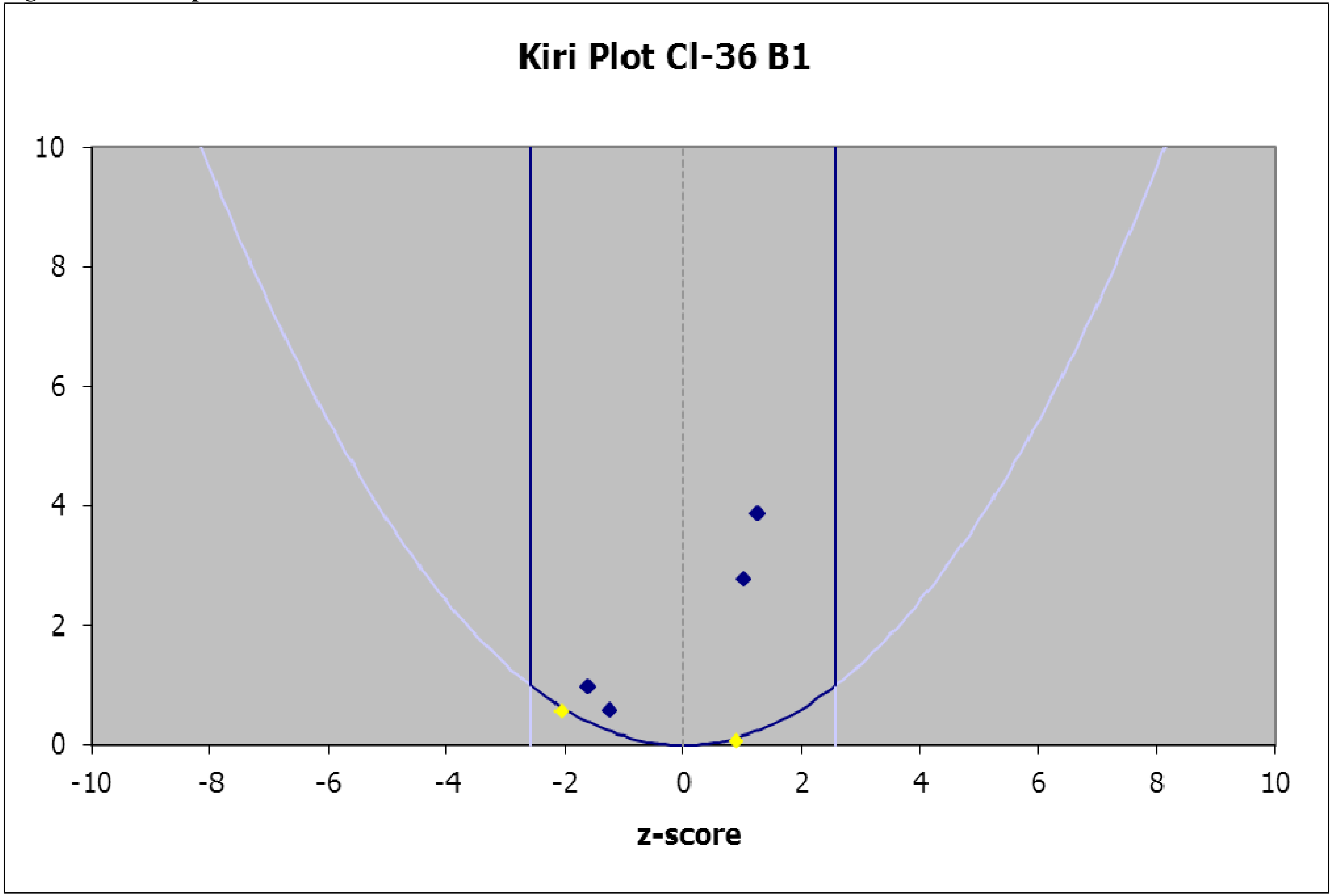


Figure 22A – Deviation Tc-99 B1

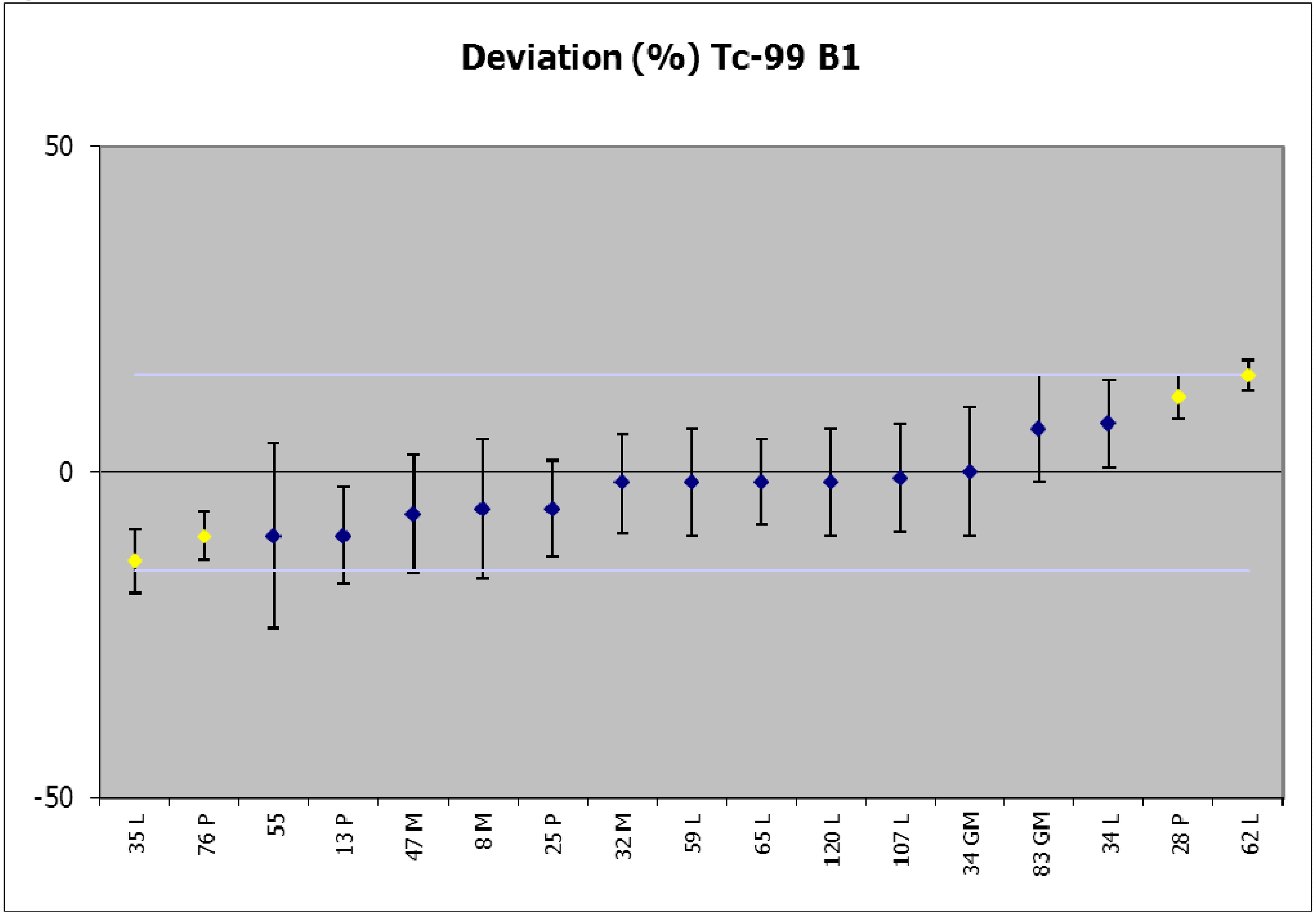


Figure 22B – Zeta score Tc-99 B1

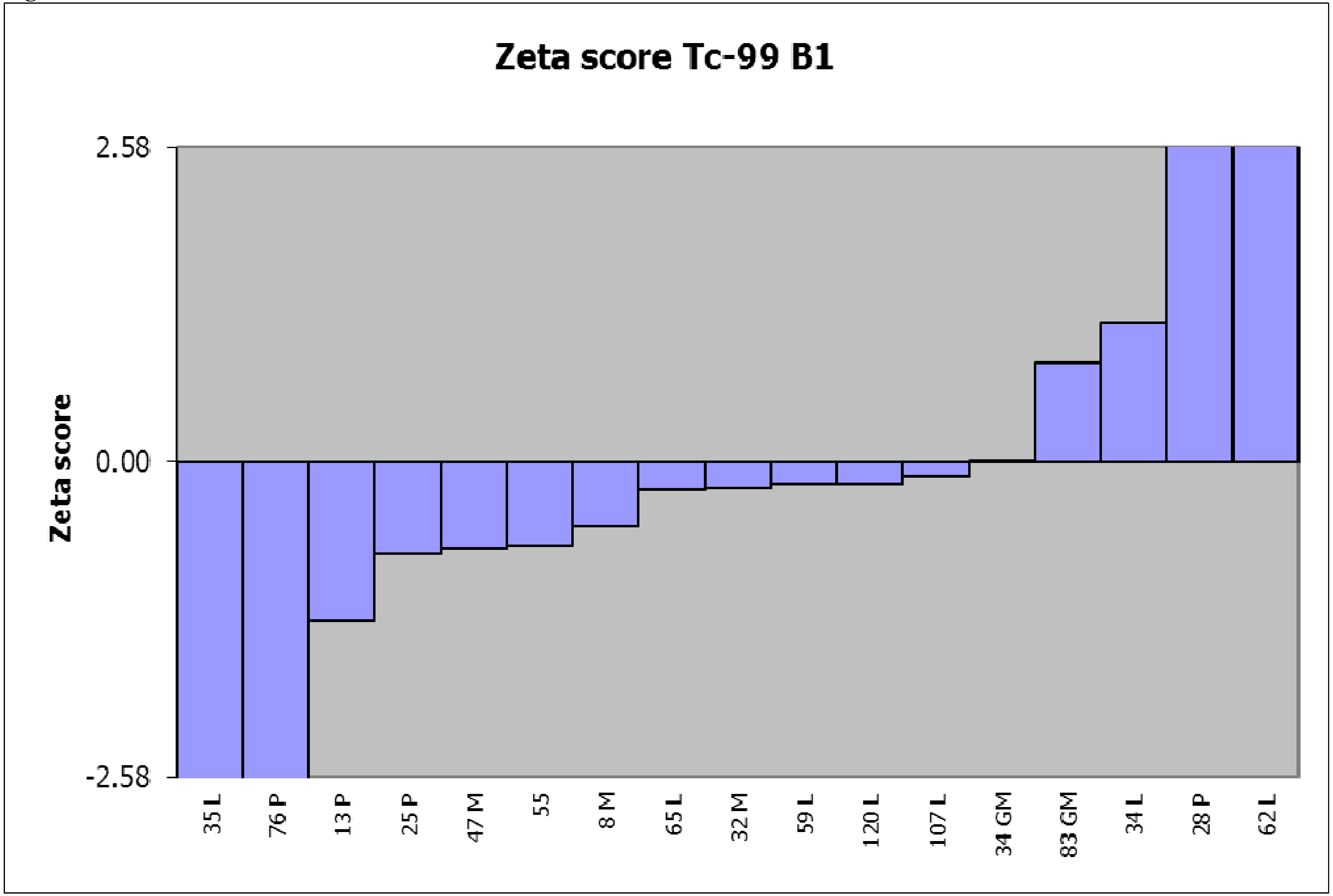


Figure 22C – Relative uncertainty Tc-99 B1

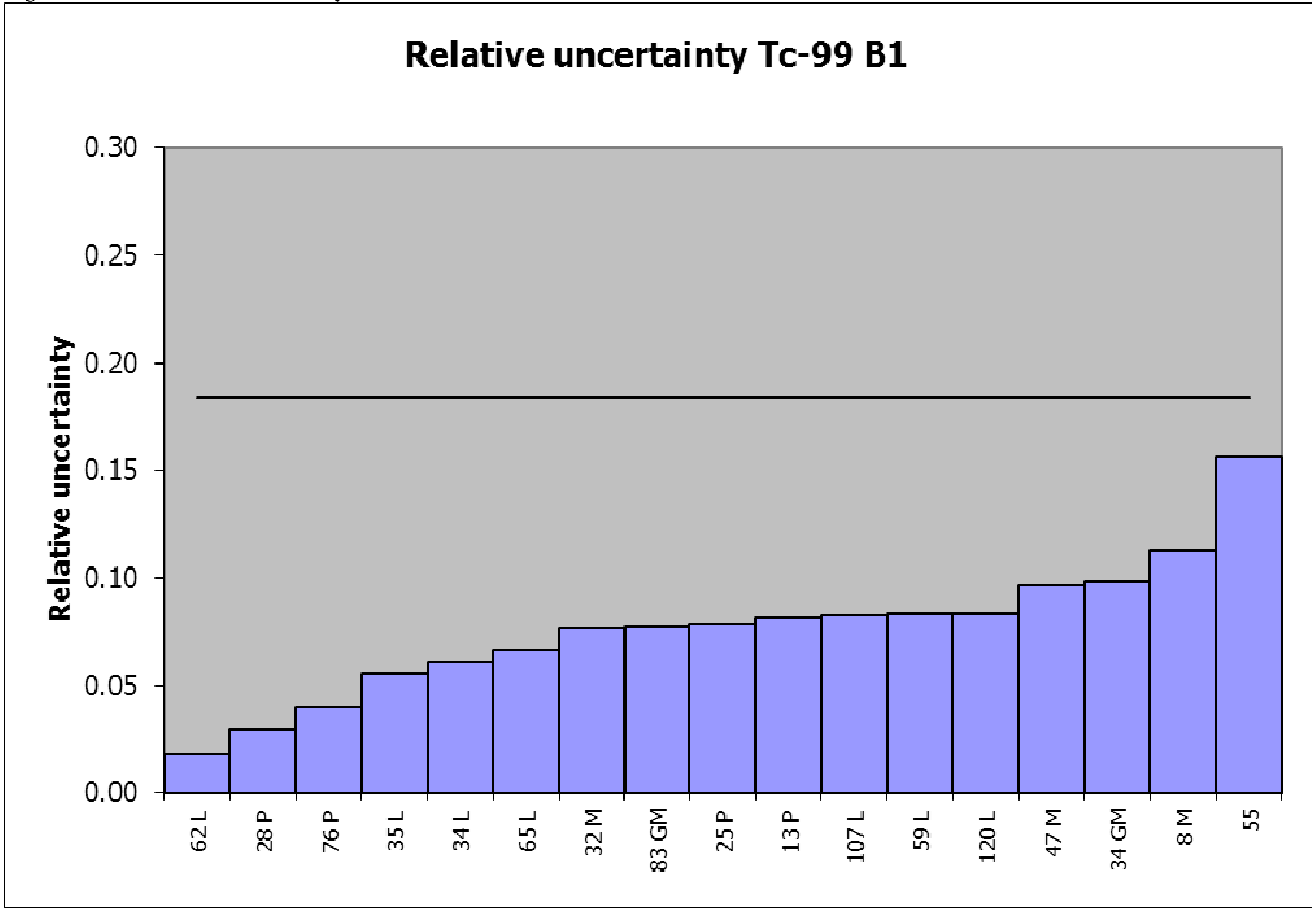


Figure 22D – Kiri plot Tc-99 B1

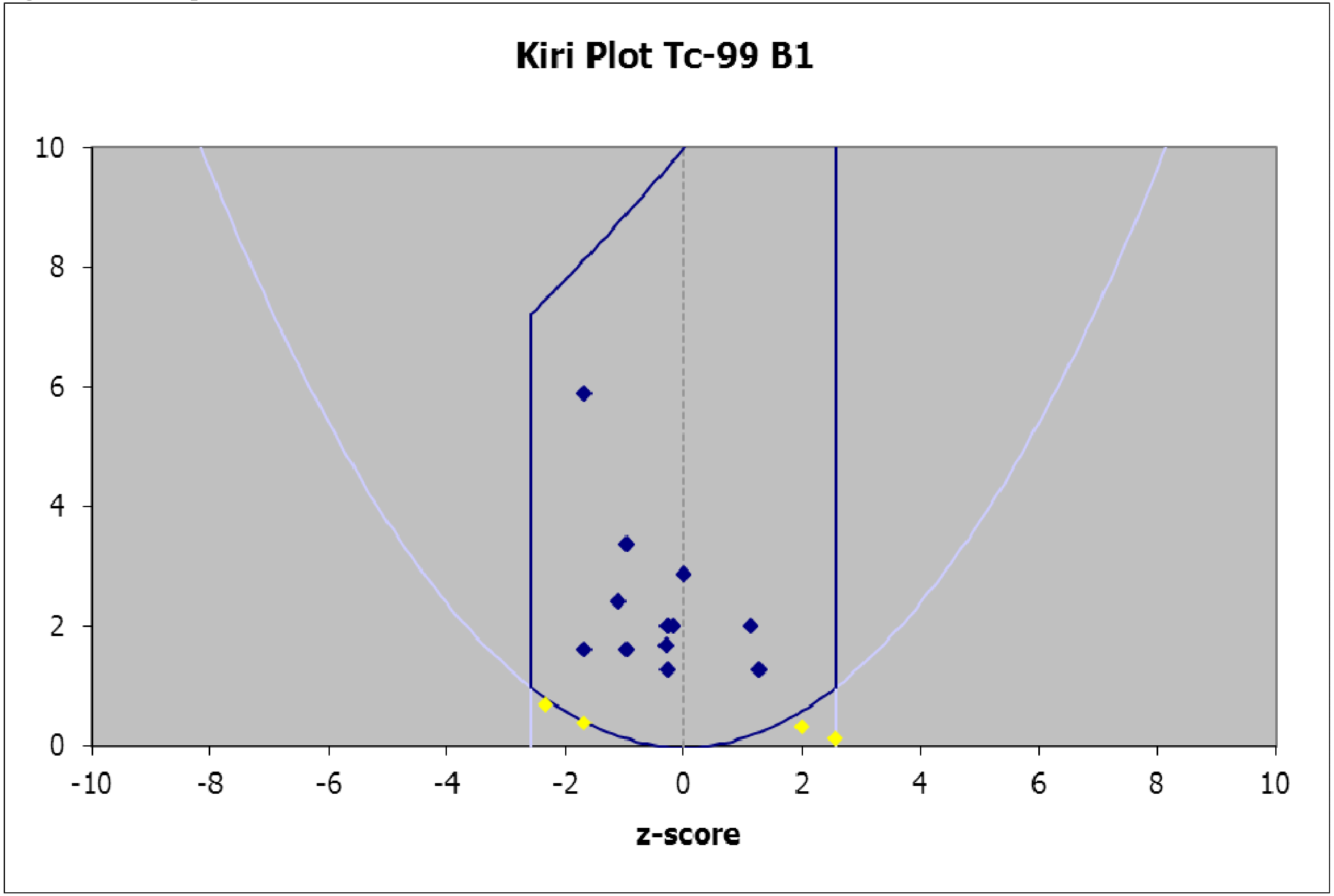


Figure 23A – Deviation H-3 B2

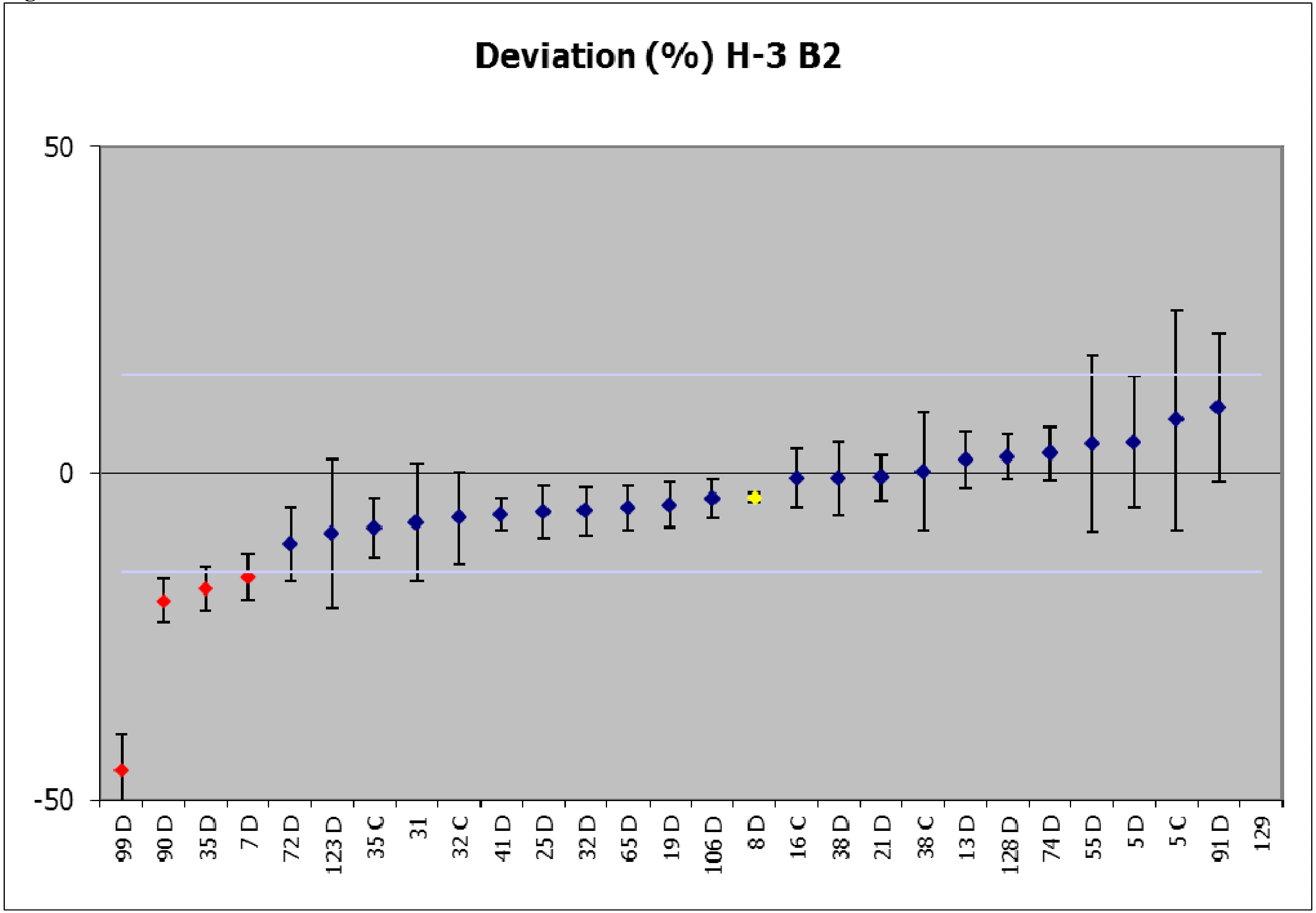


Figure 23B – Zeta score H-3 B2

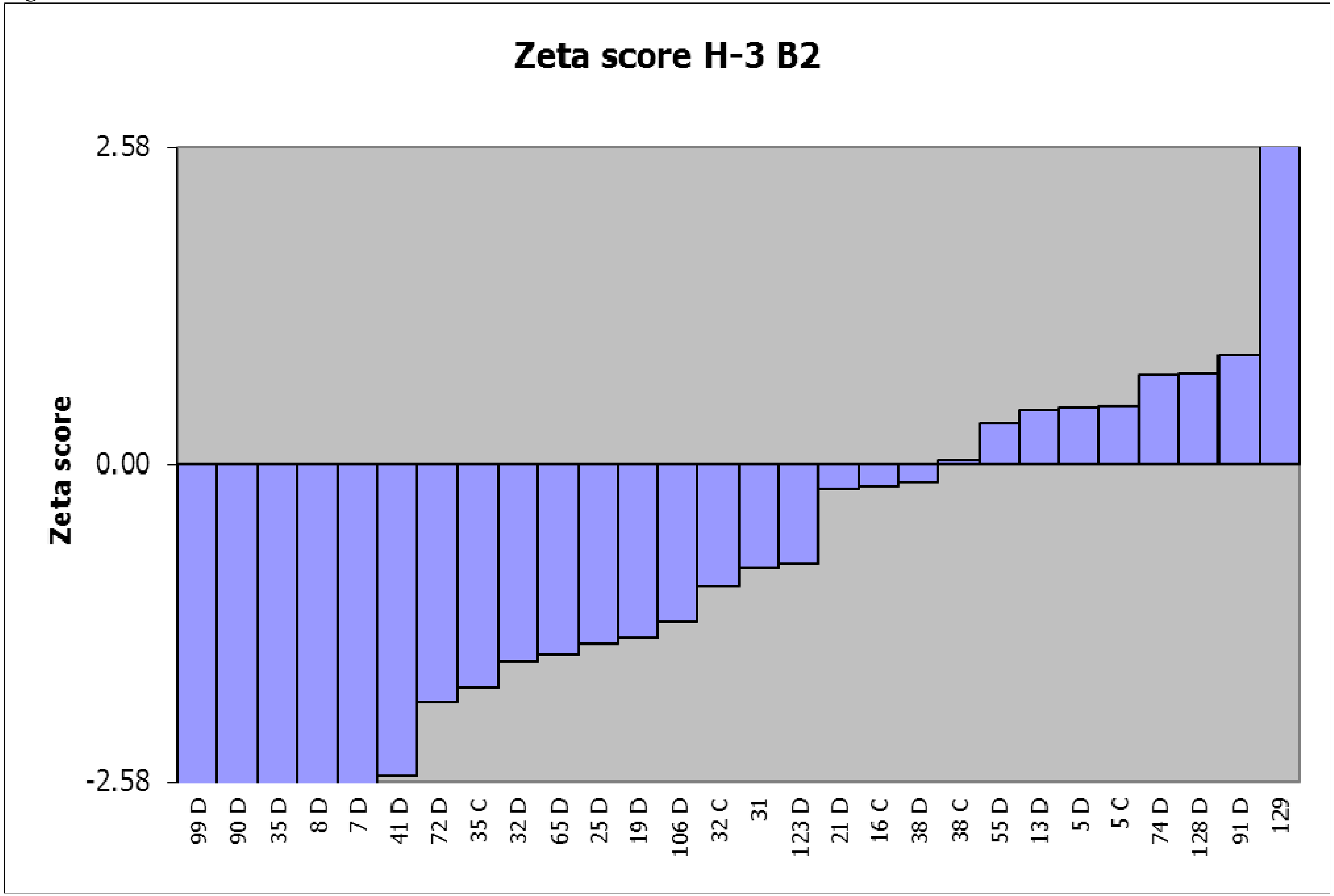


Figure 23C – Relative uncertainty H-3 B2

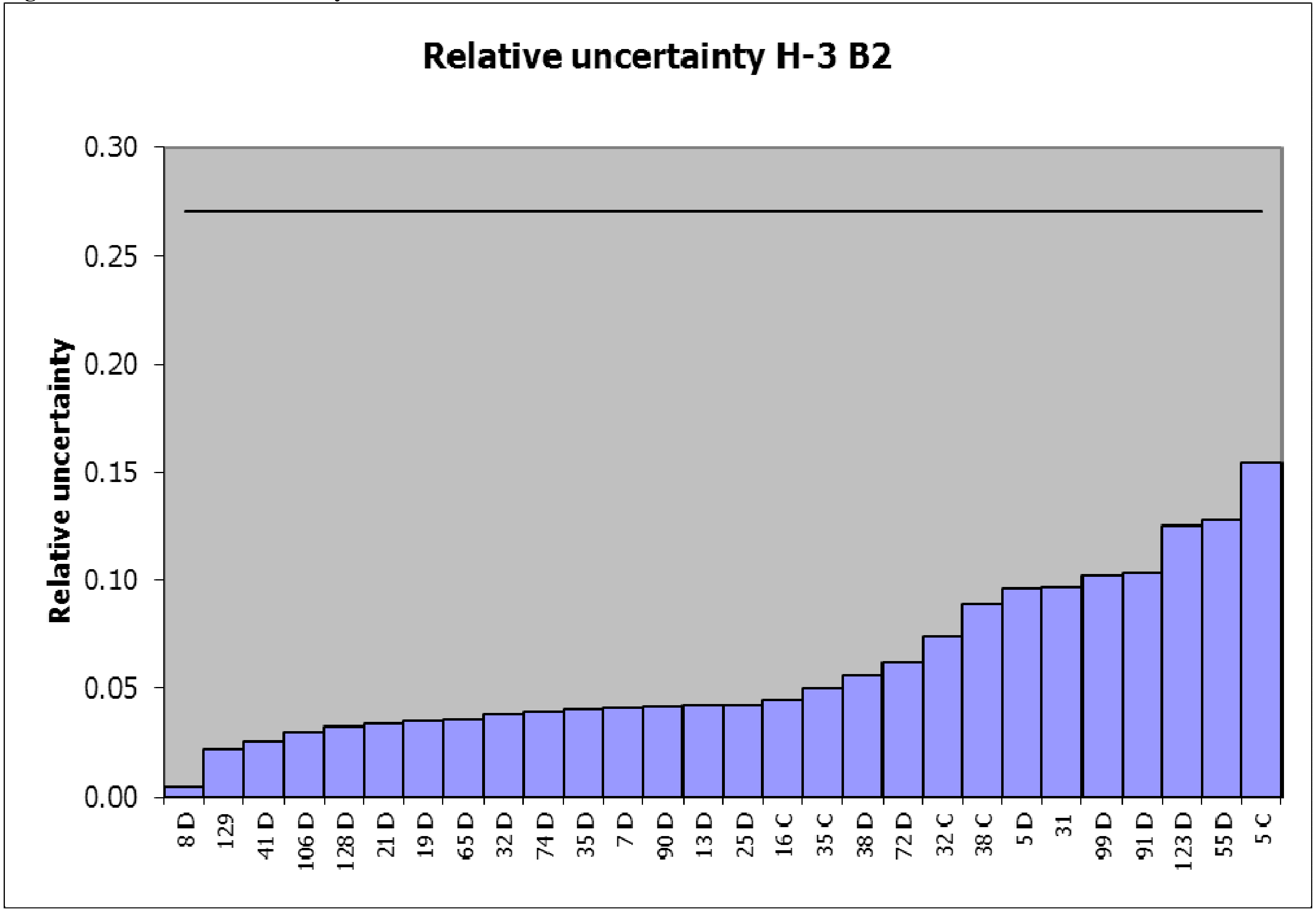


Figure 23D – Kiri plot H-3 B2

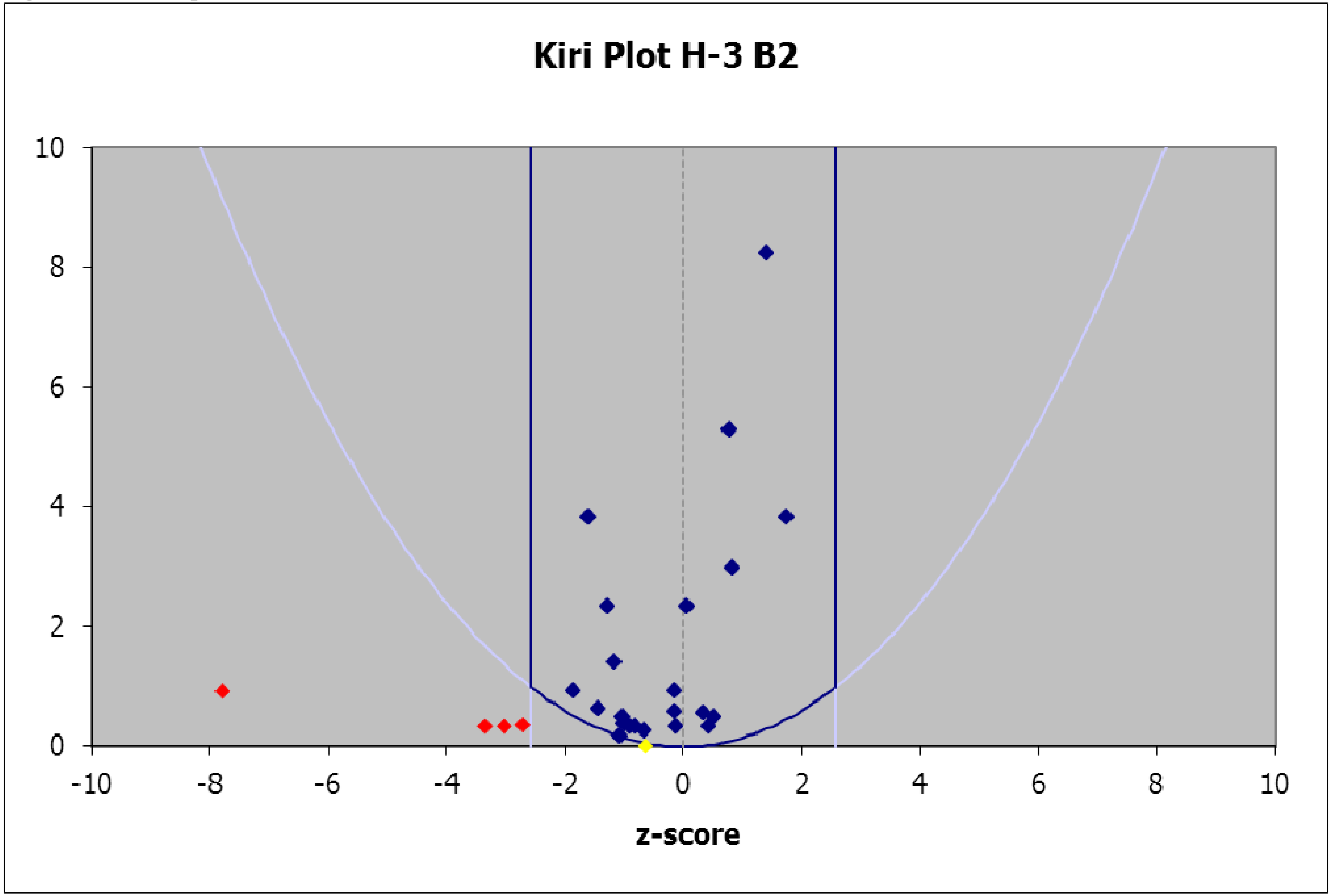


Figure 24A – Deviation Fe-55 B2

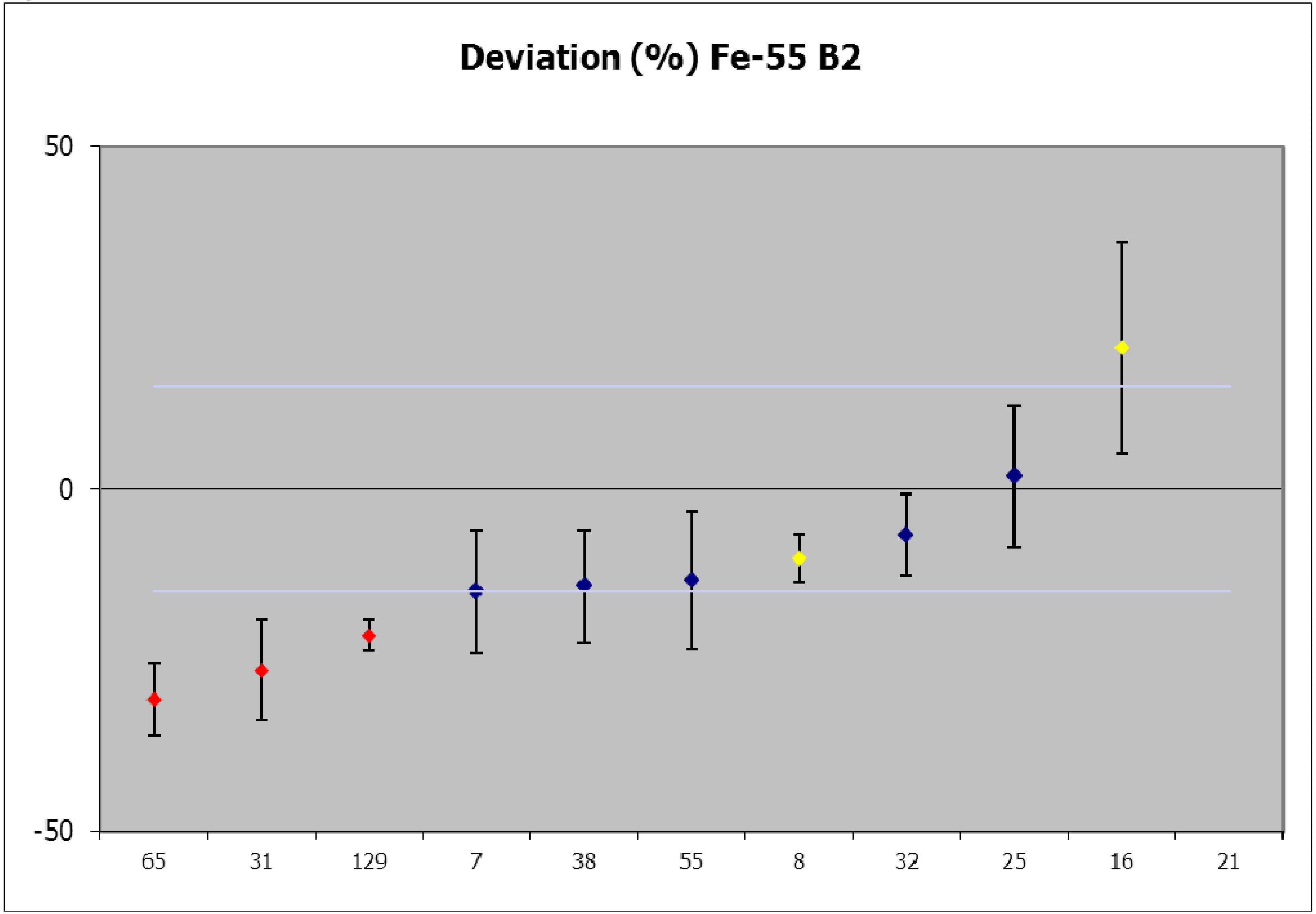


Figure 24B – Zeta score Fe-55 B2

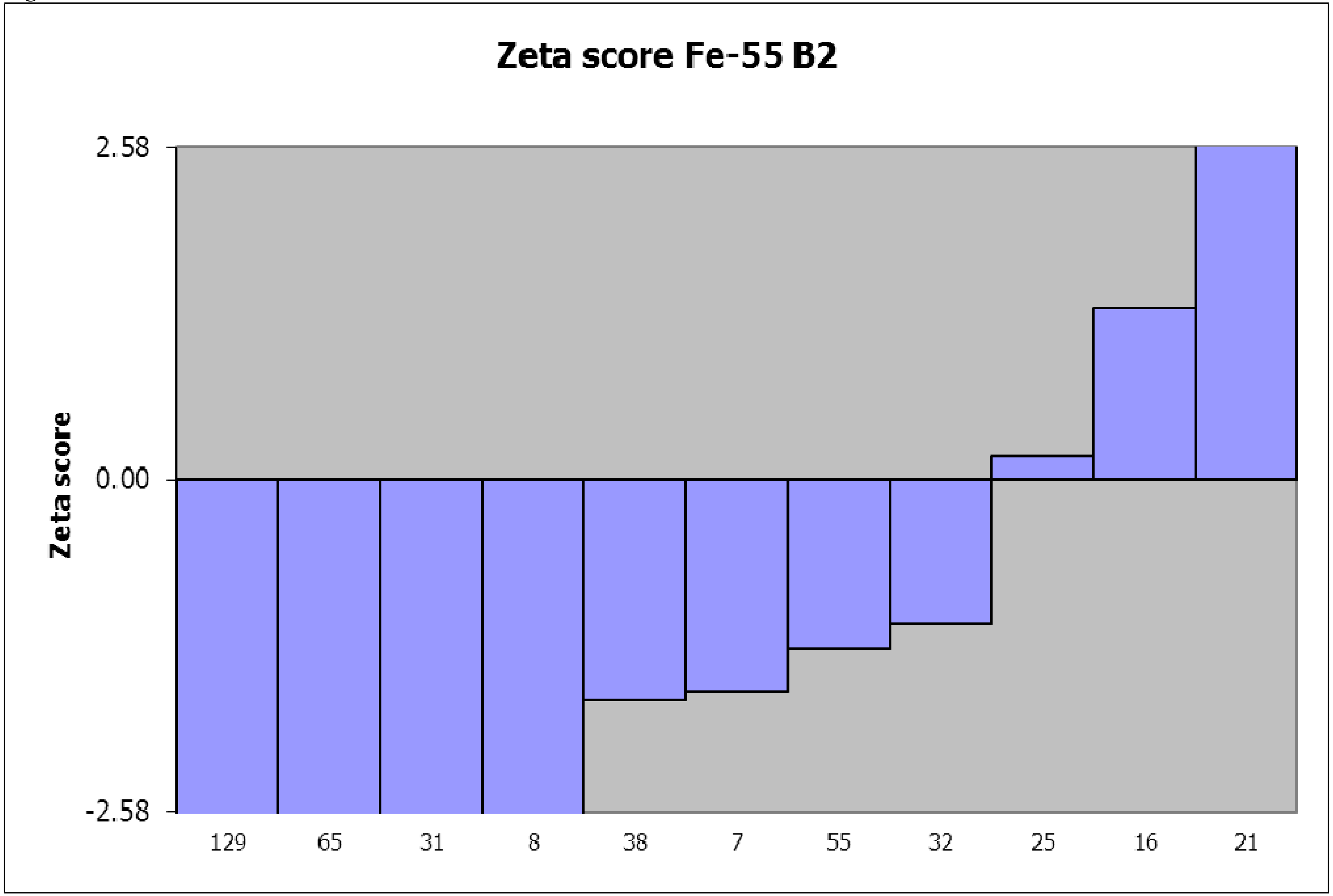


Figure 24C – Relative uncertainty Fe-55 B2

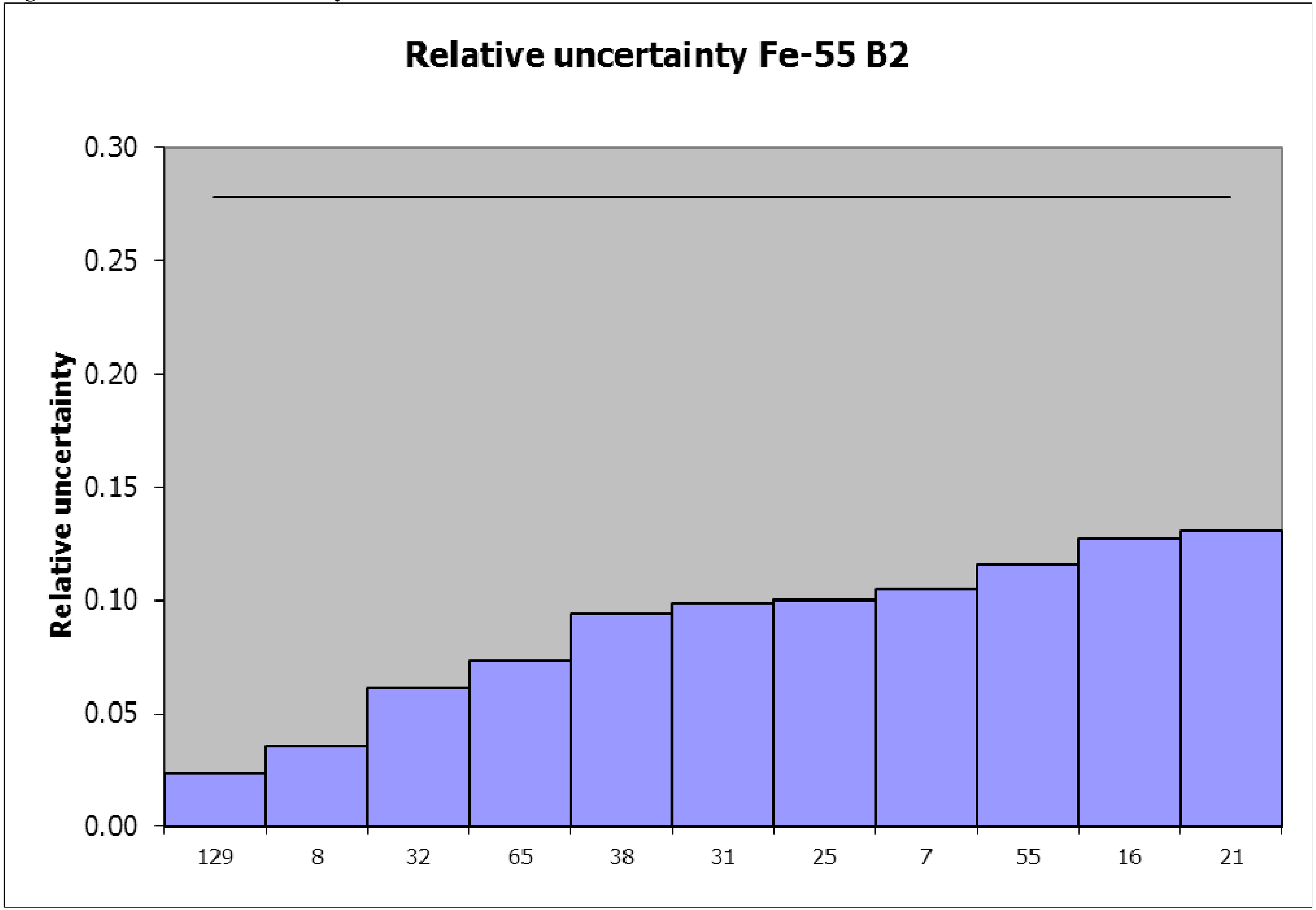


Figure 24D – Kiri plot Fe-55 B2

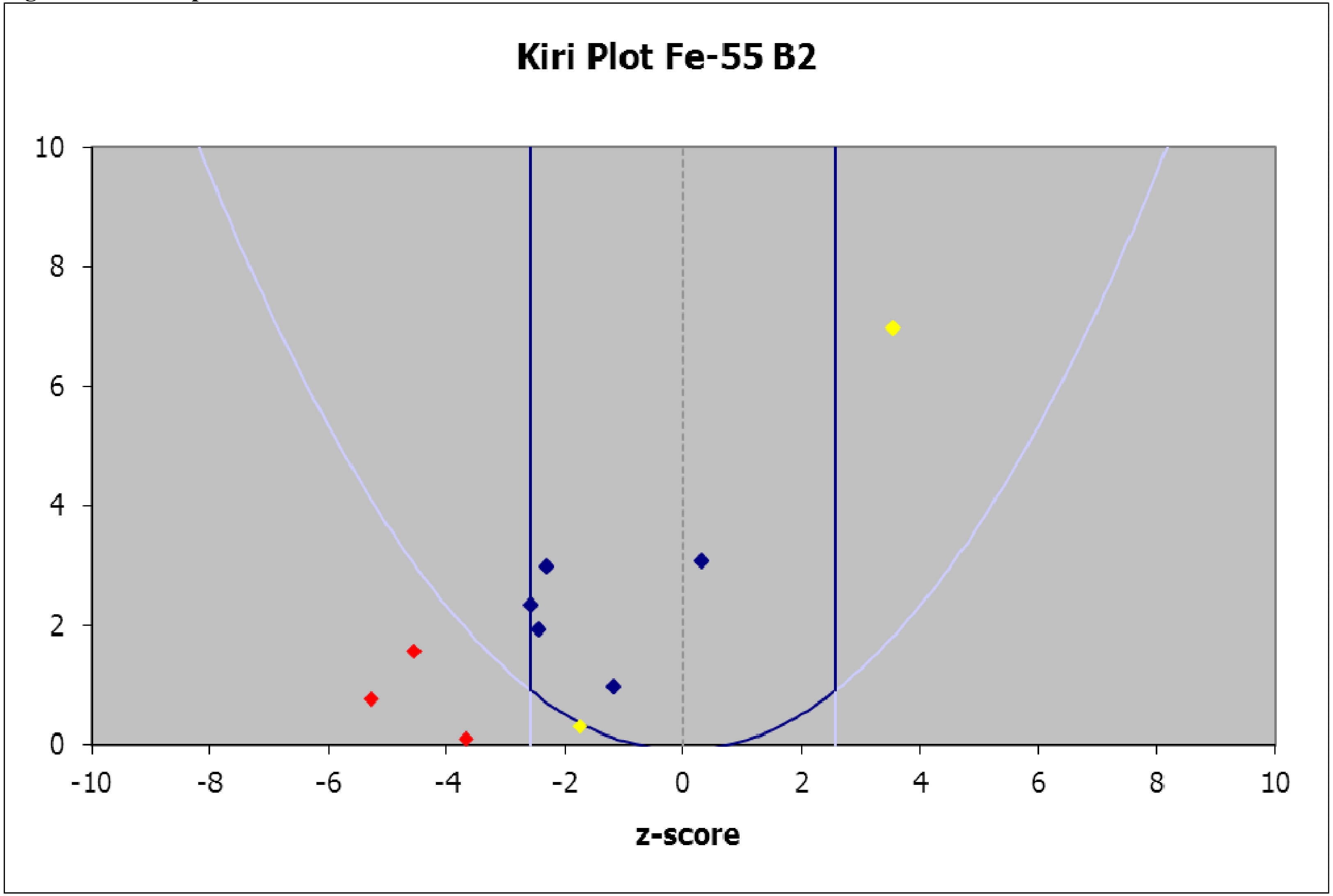


Figure 25A – Deviation Sr-89 B2

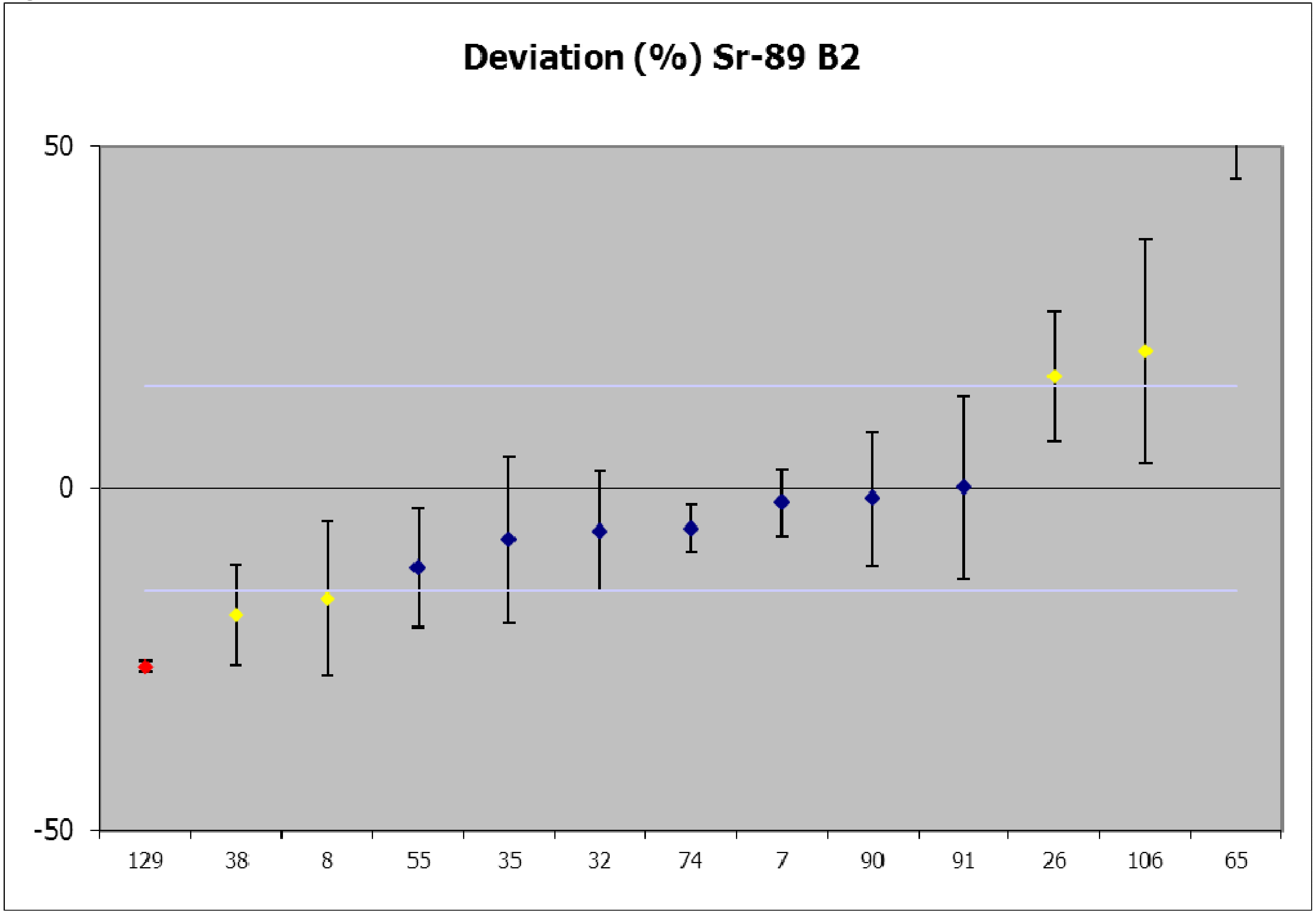


Figure 25B – Zeta score Sr-89 B2

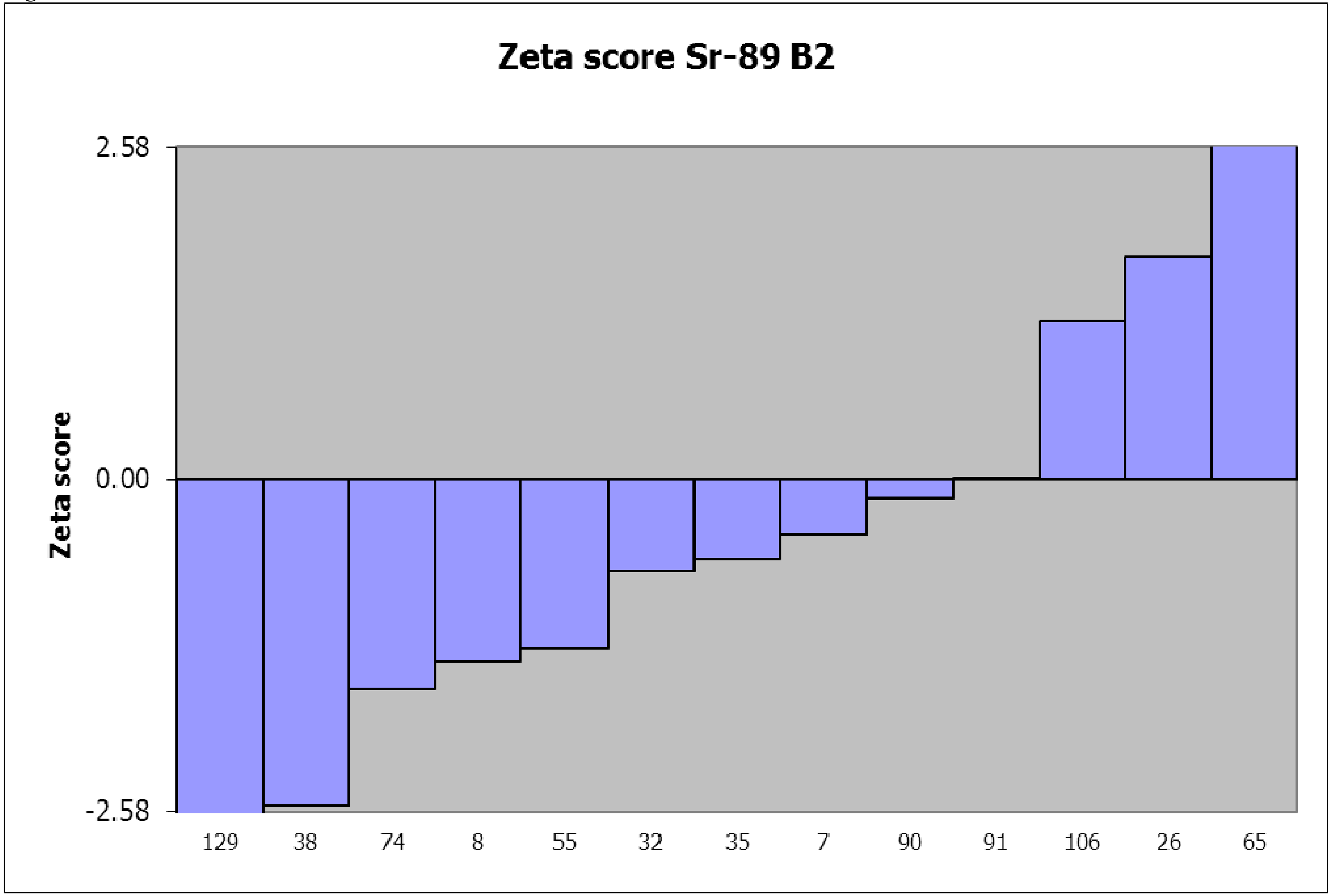


Figure 25C – Relative uncertainty Sr-89 B2

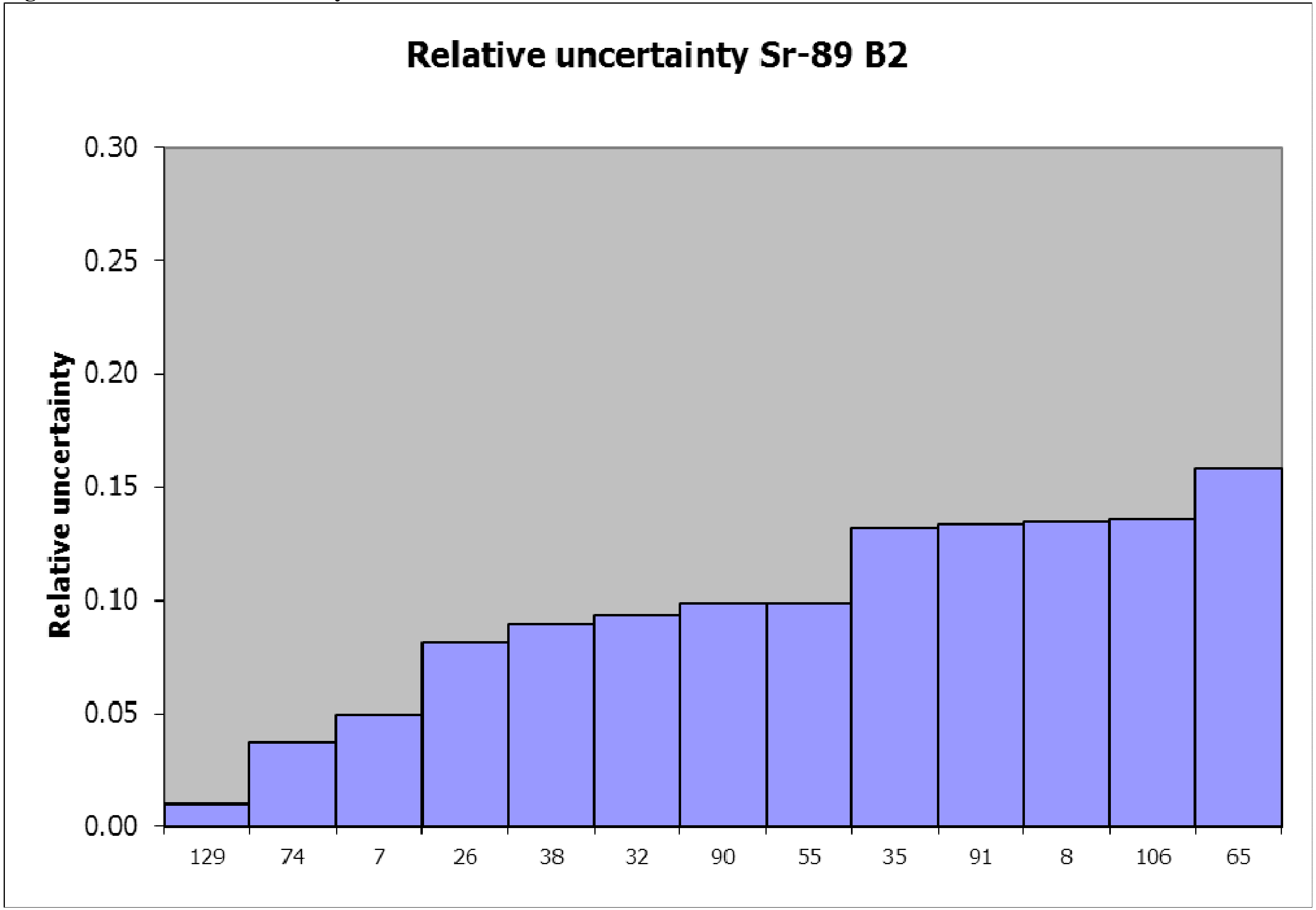


Figure 25D – Kiri plot Sr-89 B2

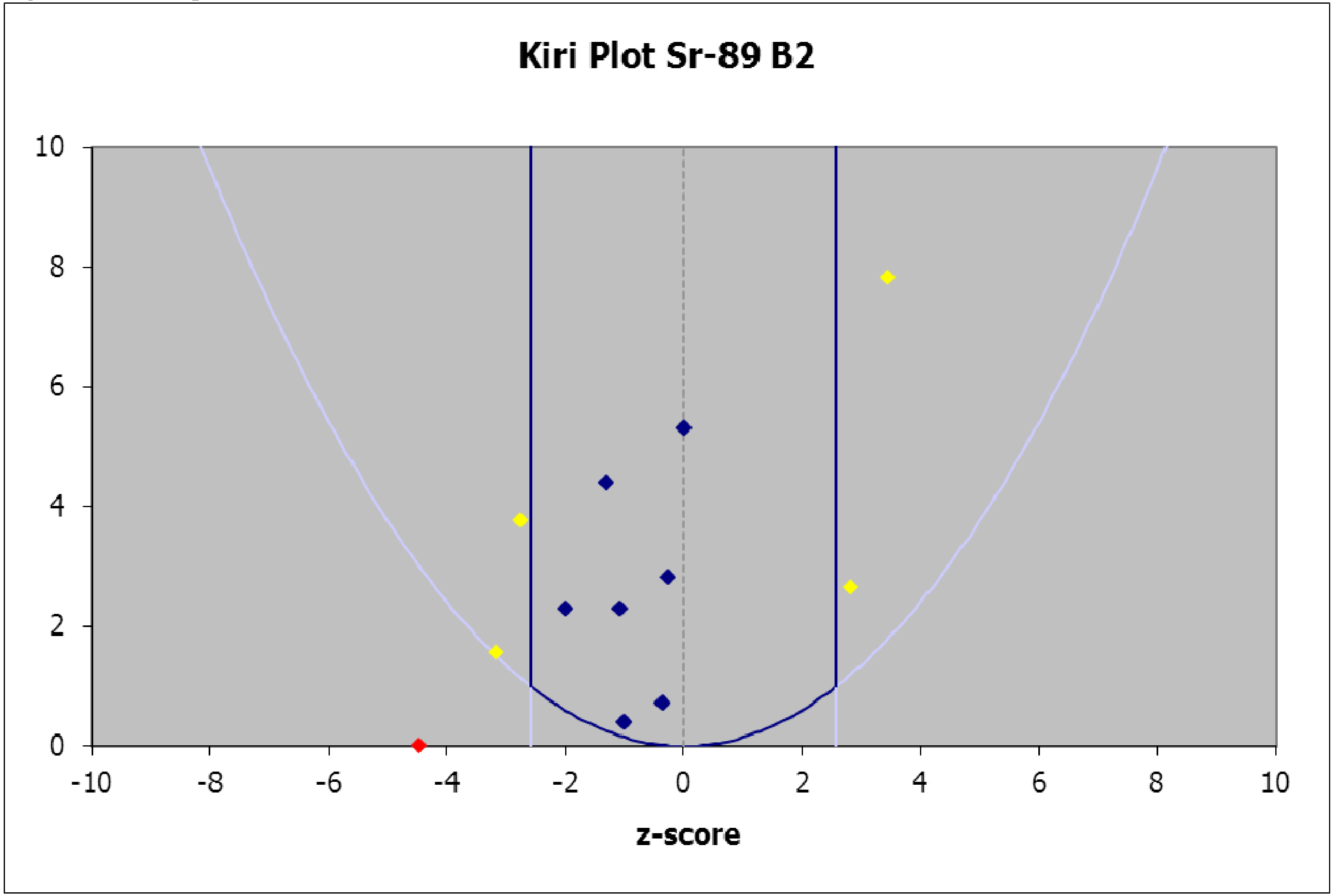


Figure 26A – Deviation Sr-90 B2

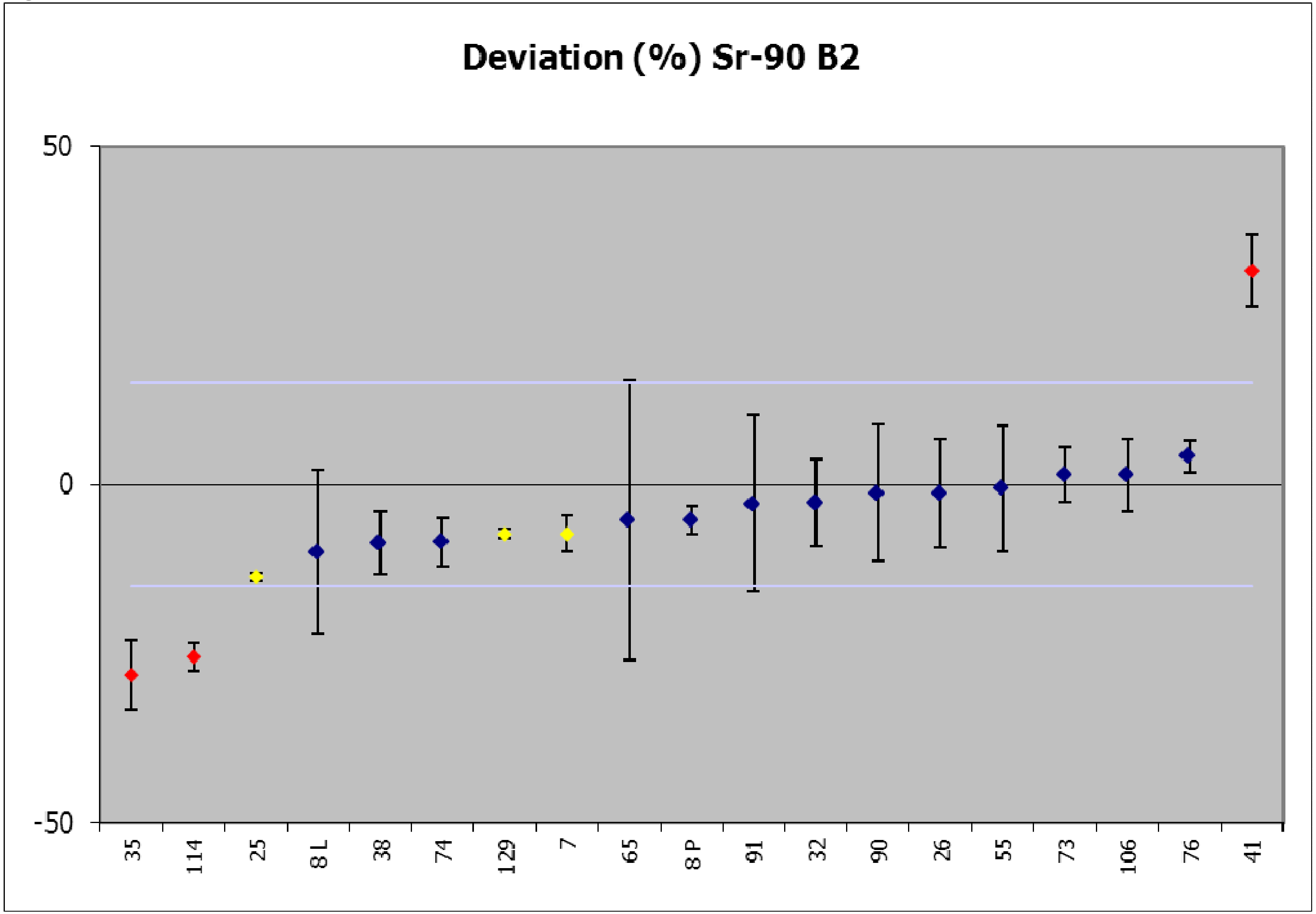


Figure 26B – Zeta score Sr-90 B2

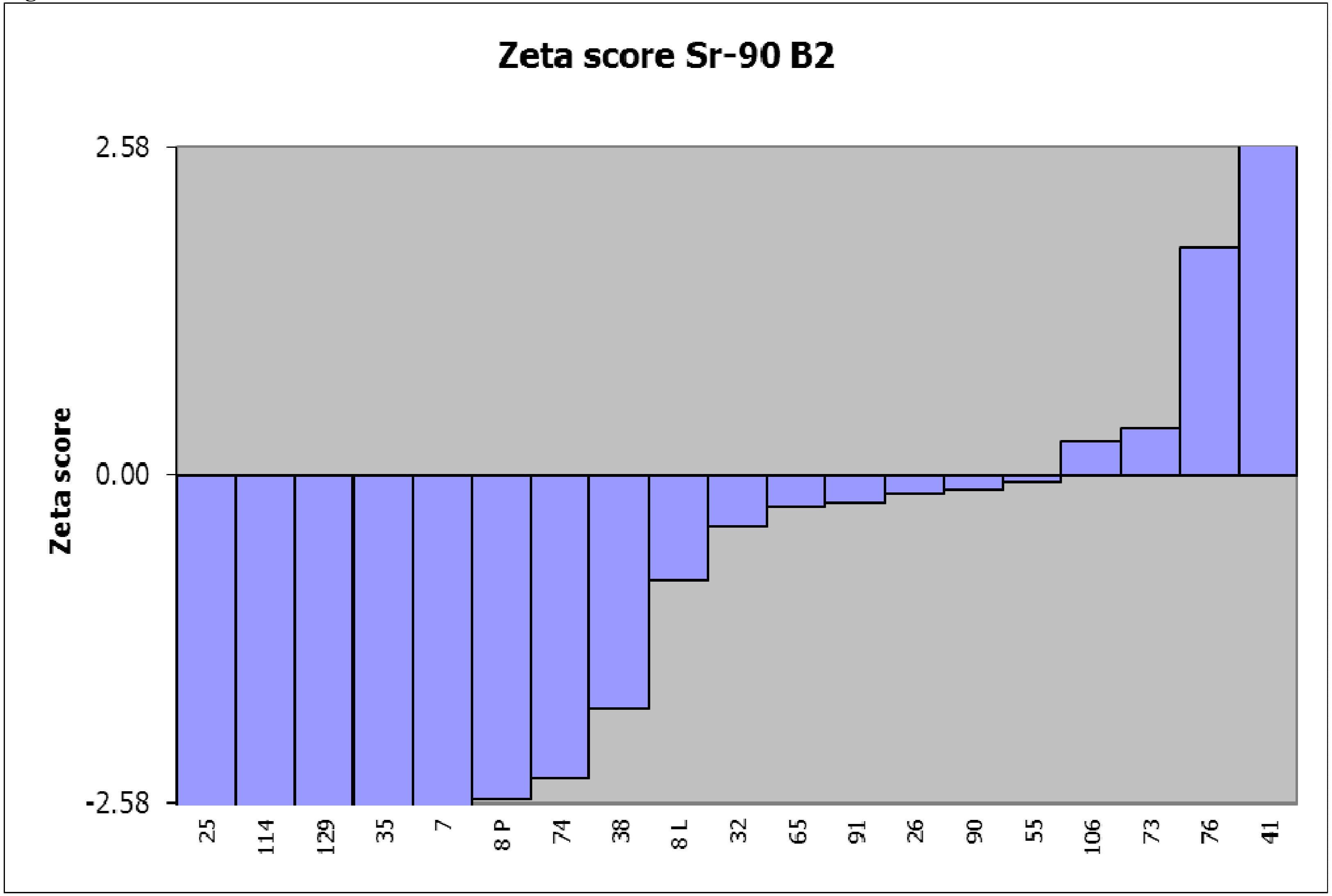


Figure 26C – Relative uncertainty Sr-90 B2

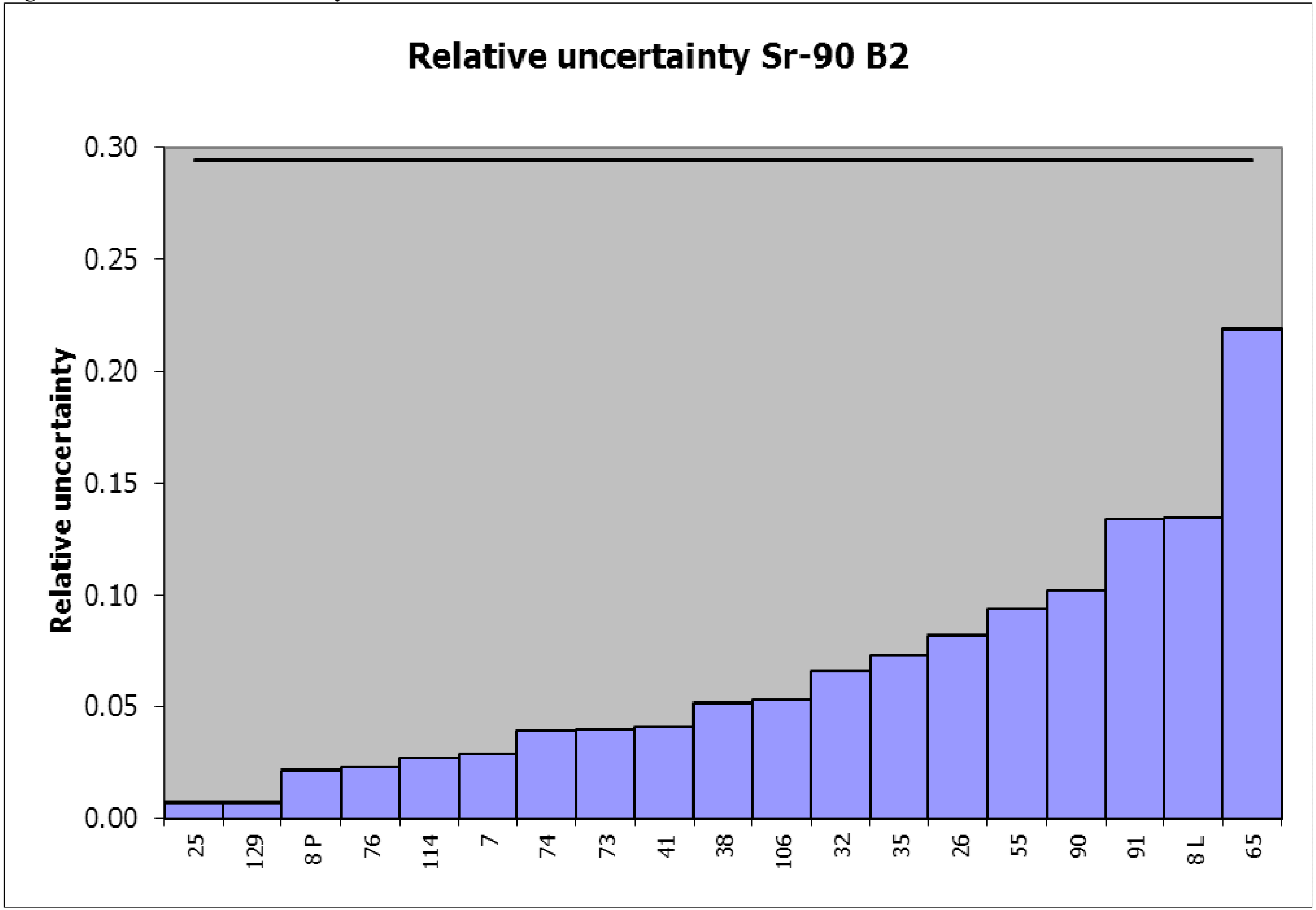


Figure 26D – Kiri plot Sr-90 B2

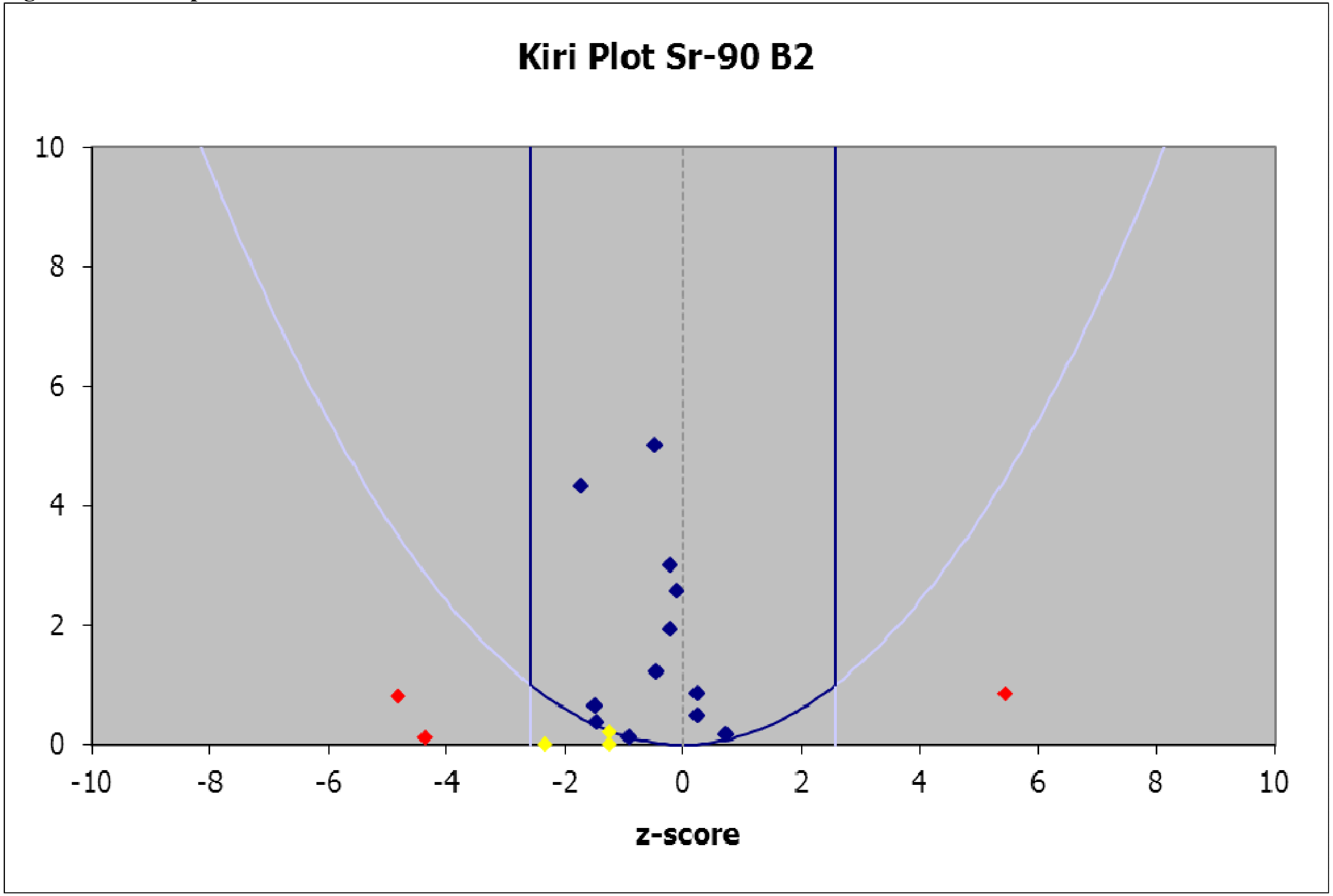


Figure 27A – Deviation gross beta B2

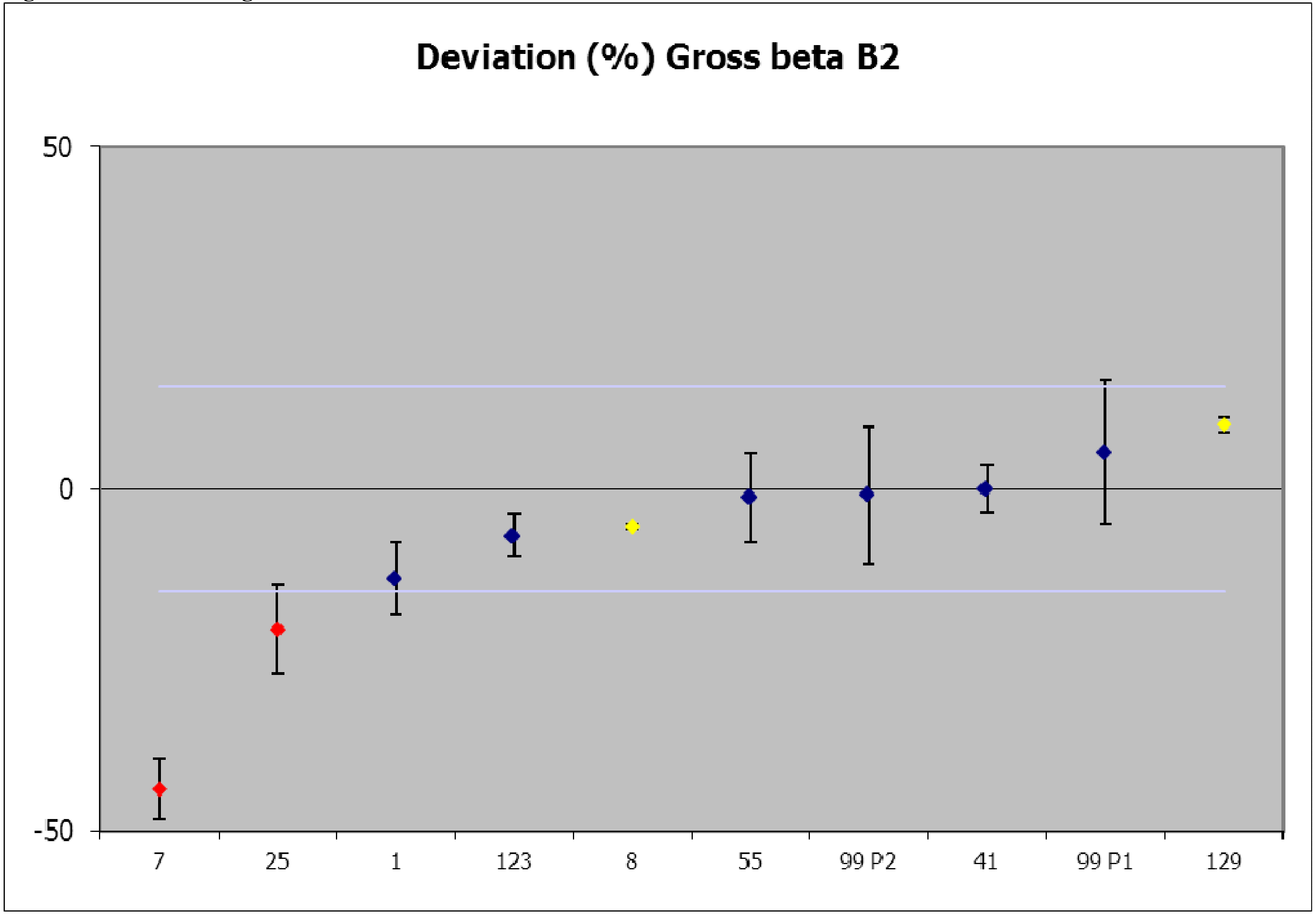


Figure 27B – Zeta score gross beta B2

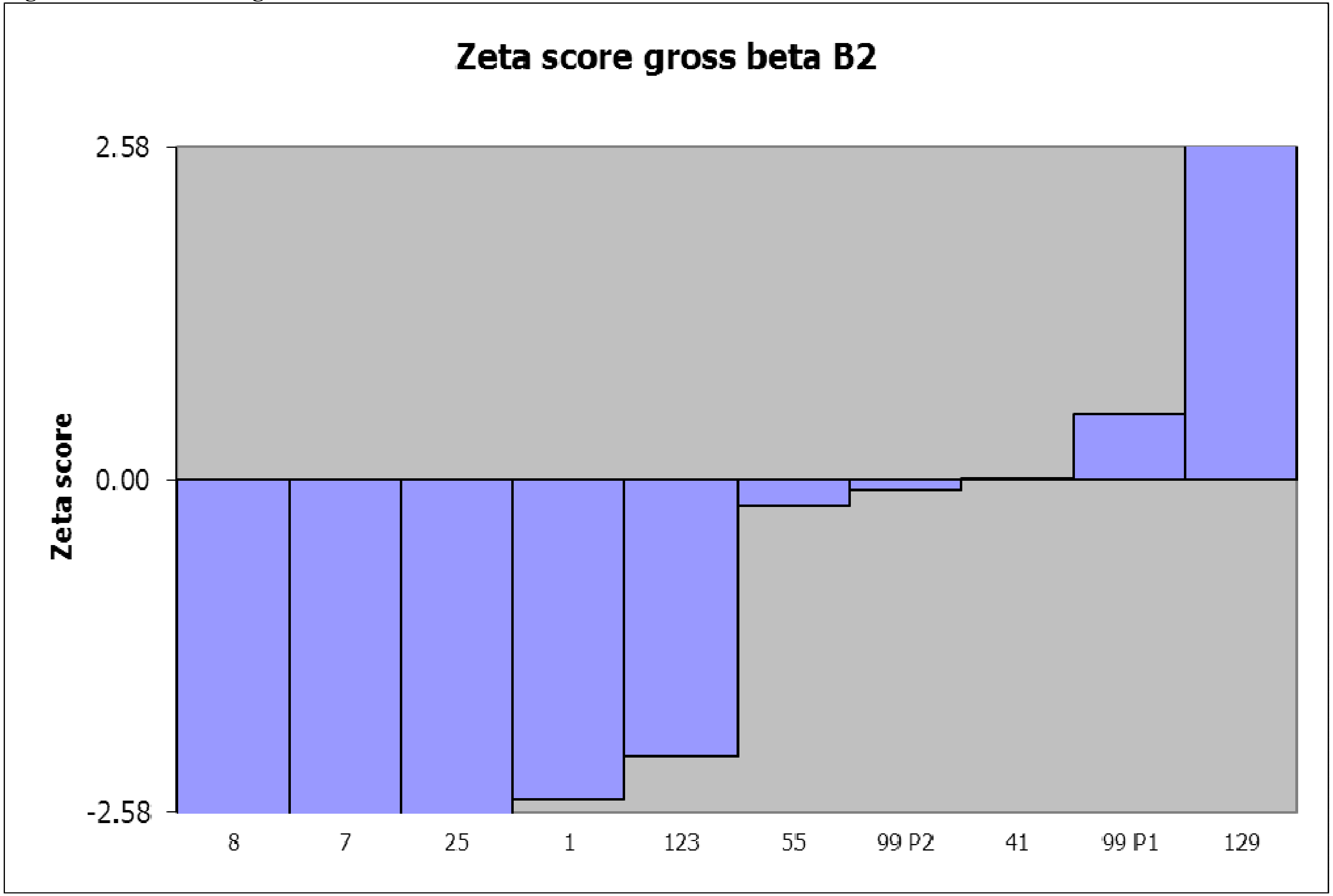


Figure 27C – Relative uncertainty gross beta B2

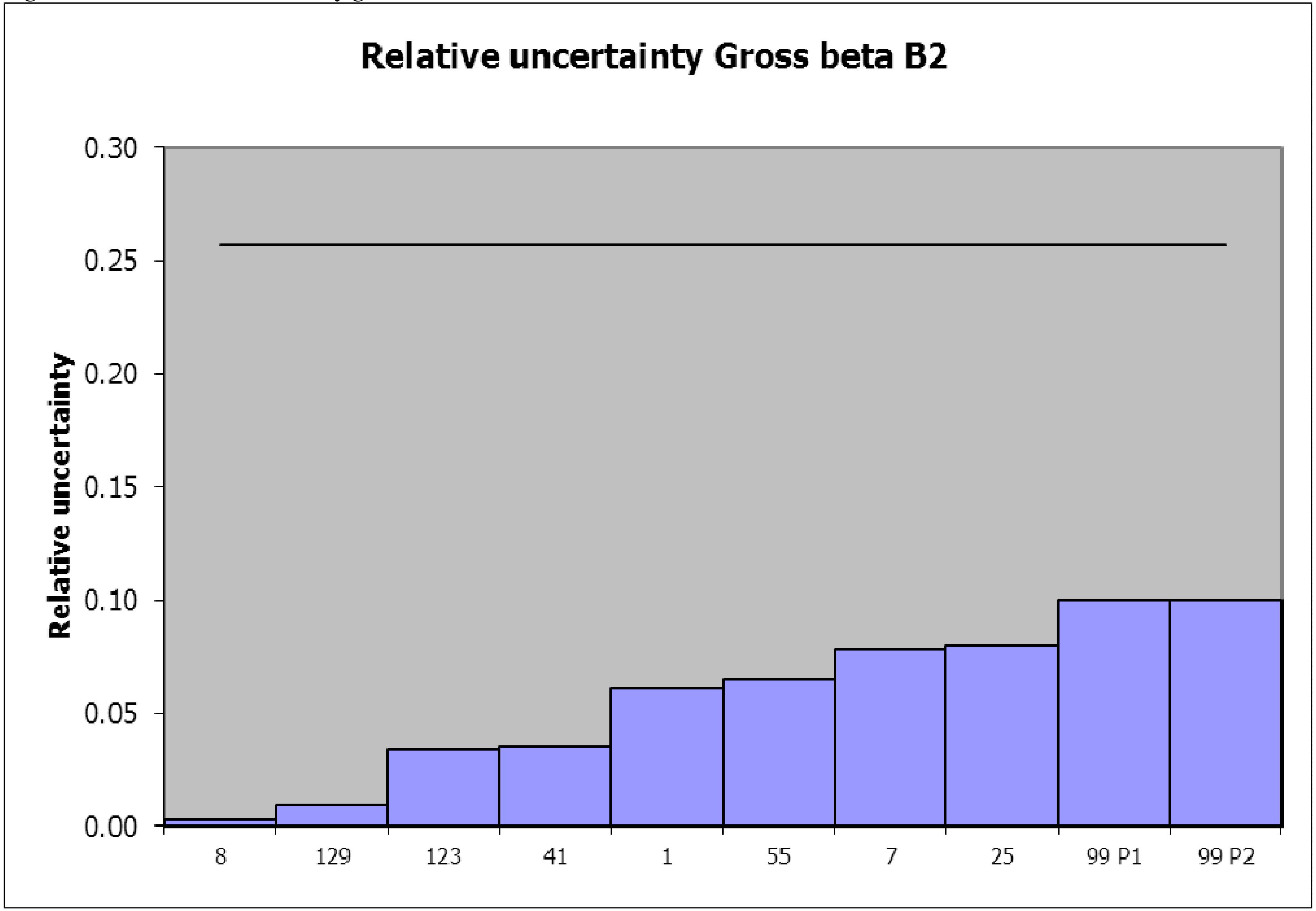


Figure 27D – Kiri plot gross beta B2

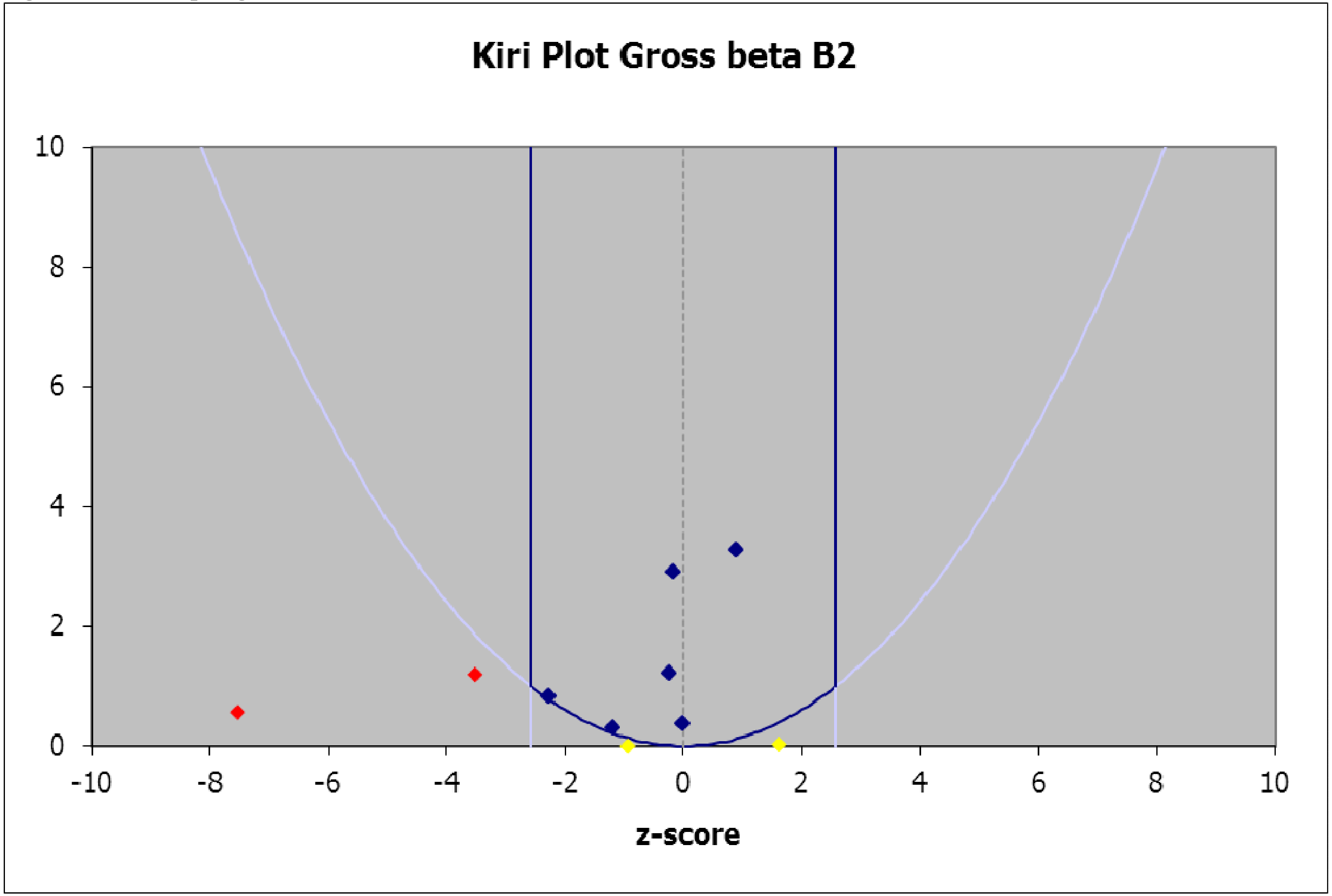


Figure 28A – Deviation Be-7 GL

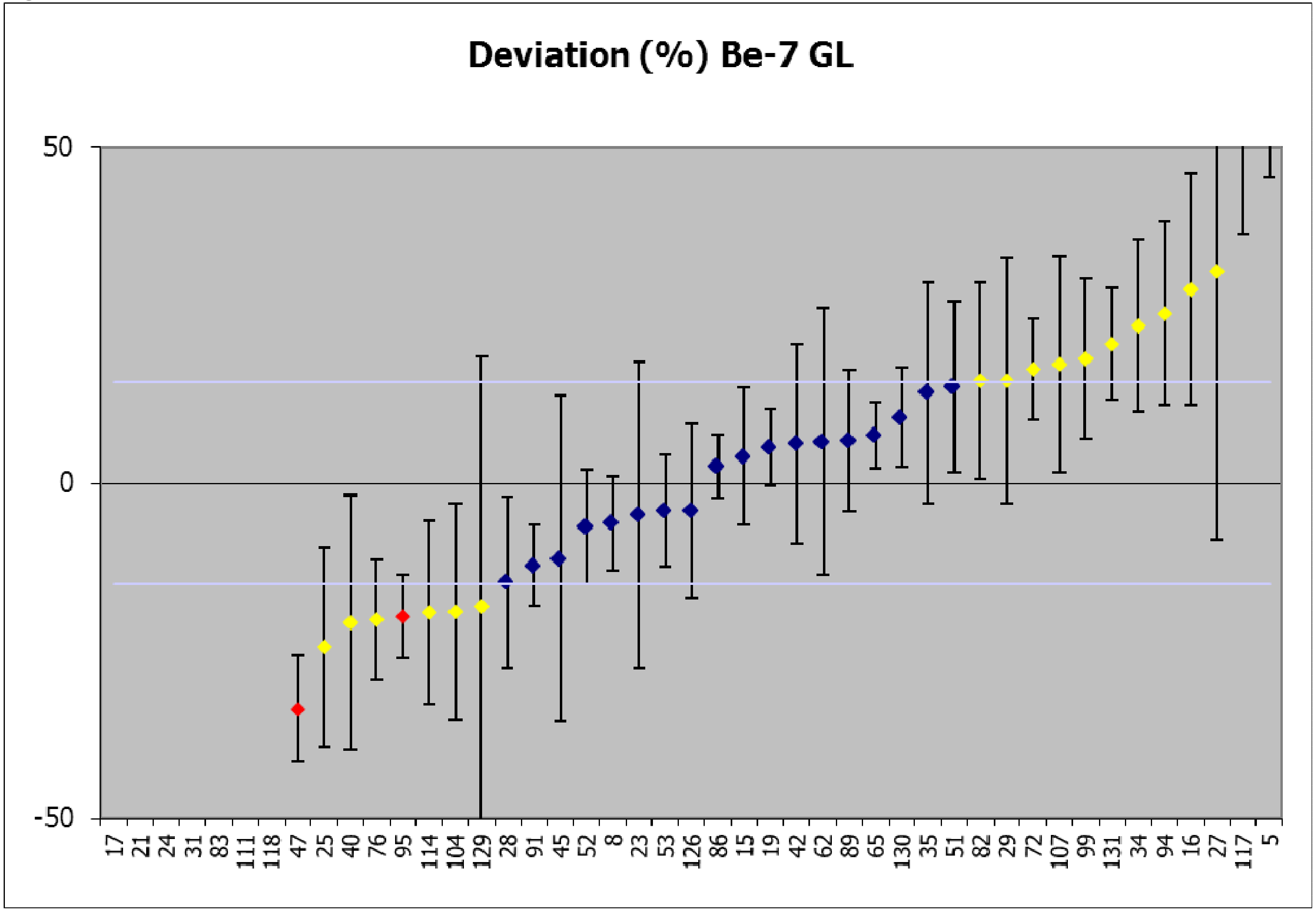


Figure 28B – Zeta score Be-7 GL

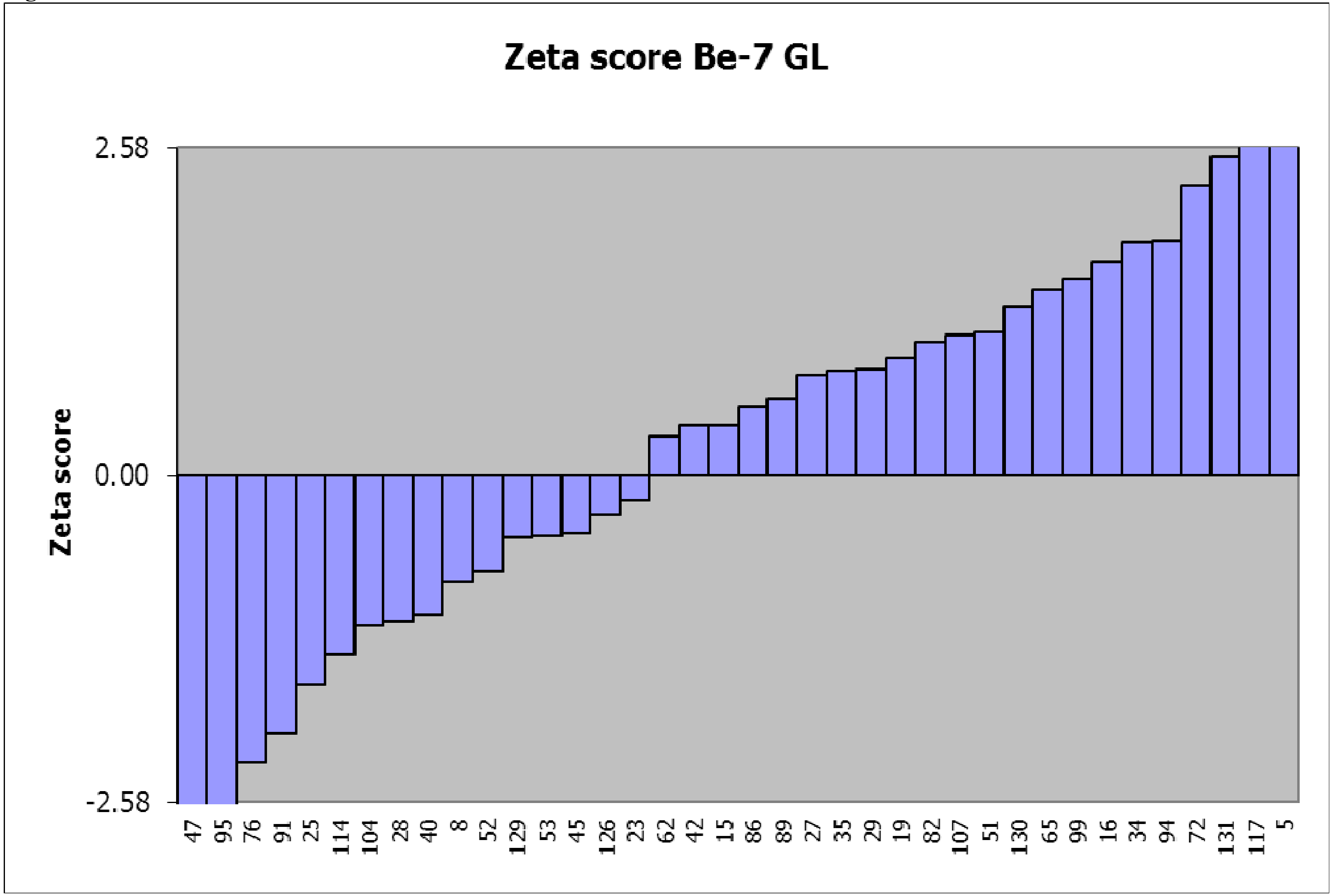


Figure 28C – Relative uncertainty Be-7 GL

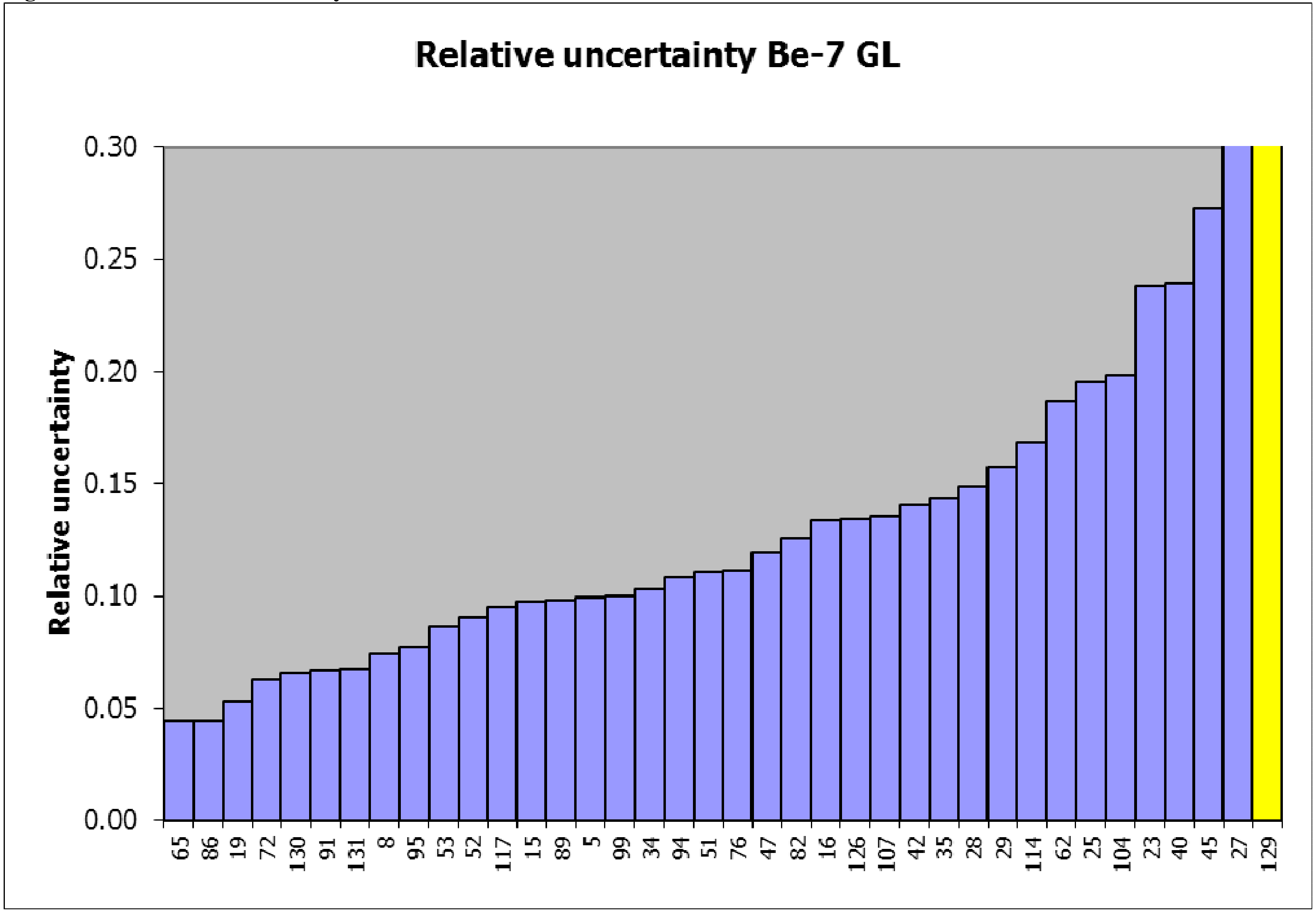


Figure 28D – Kiri plot Be-7 GL

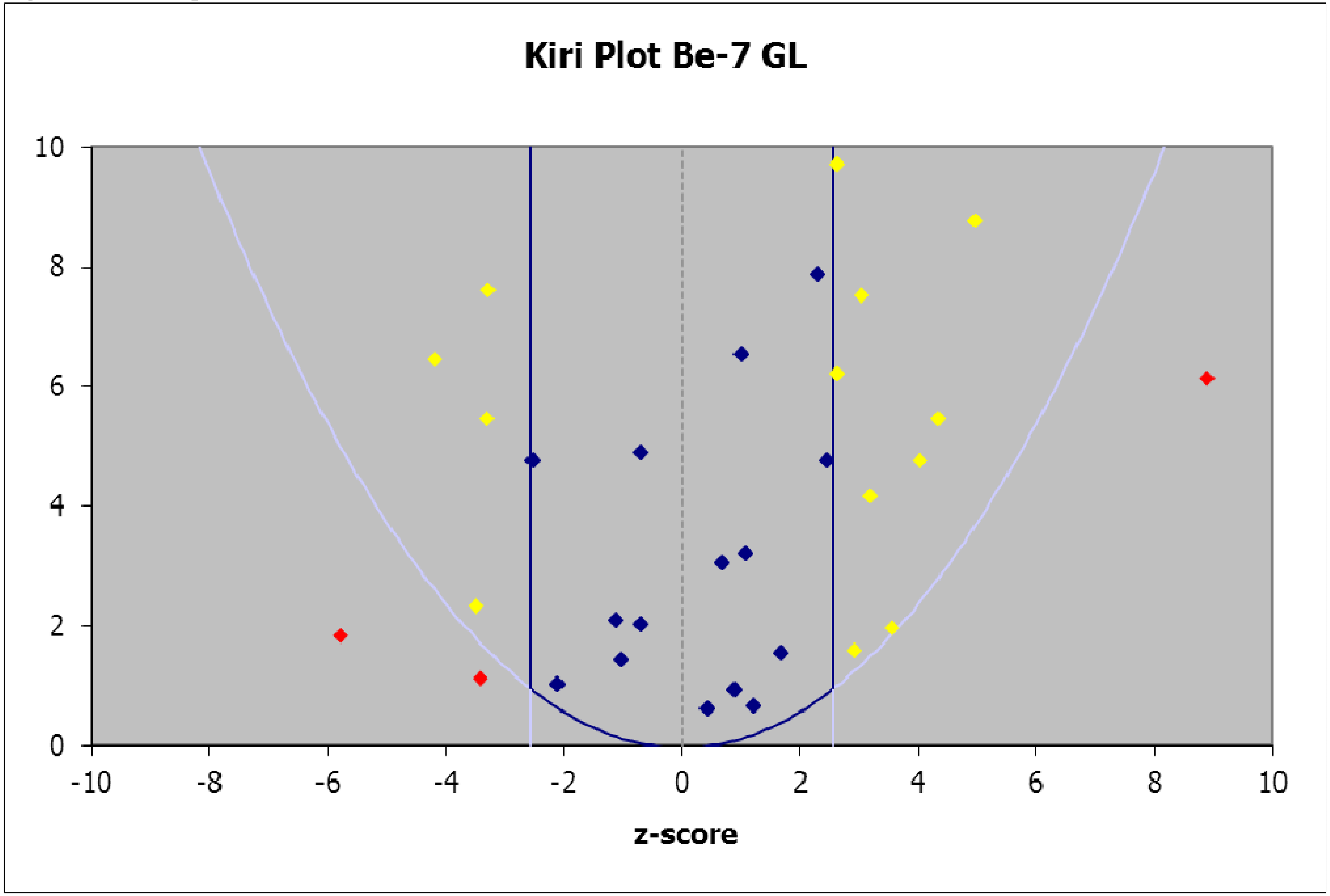


Figure 29A – Deviation Co-60 GL

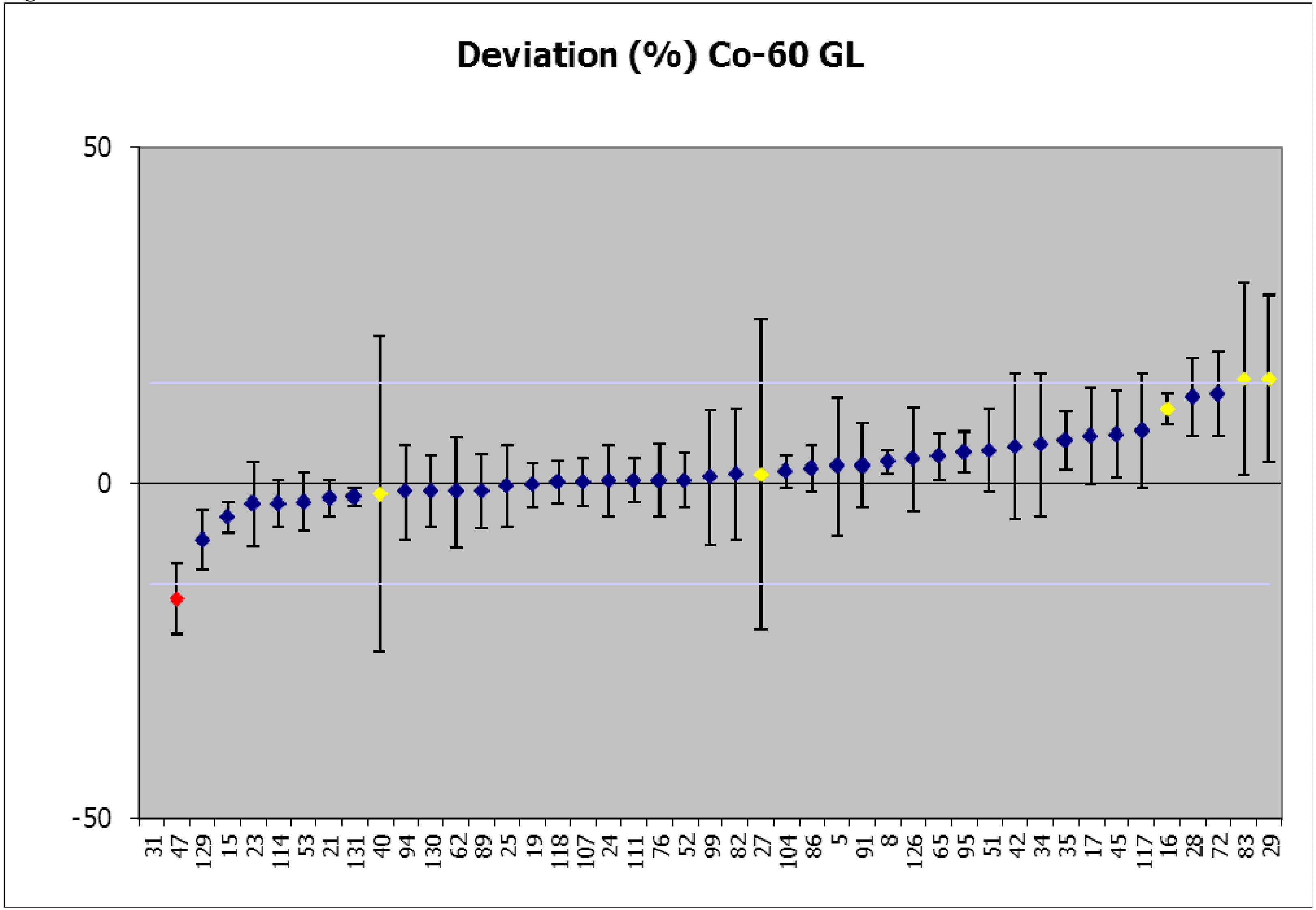


Figure 29B – Zeta score Co-60 GL

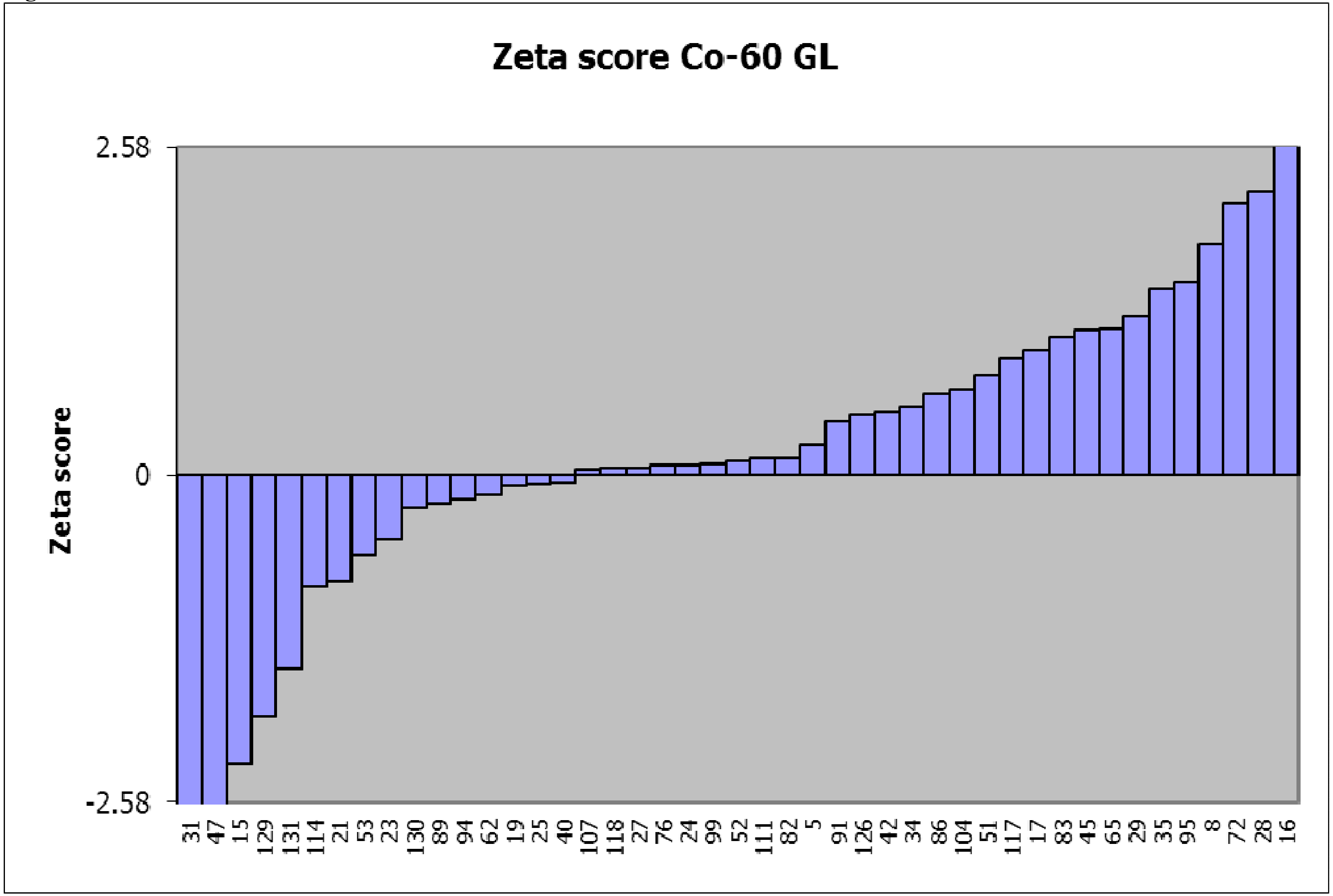


Figure 29C – Relative uncertainty Co-60 GL

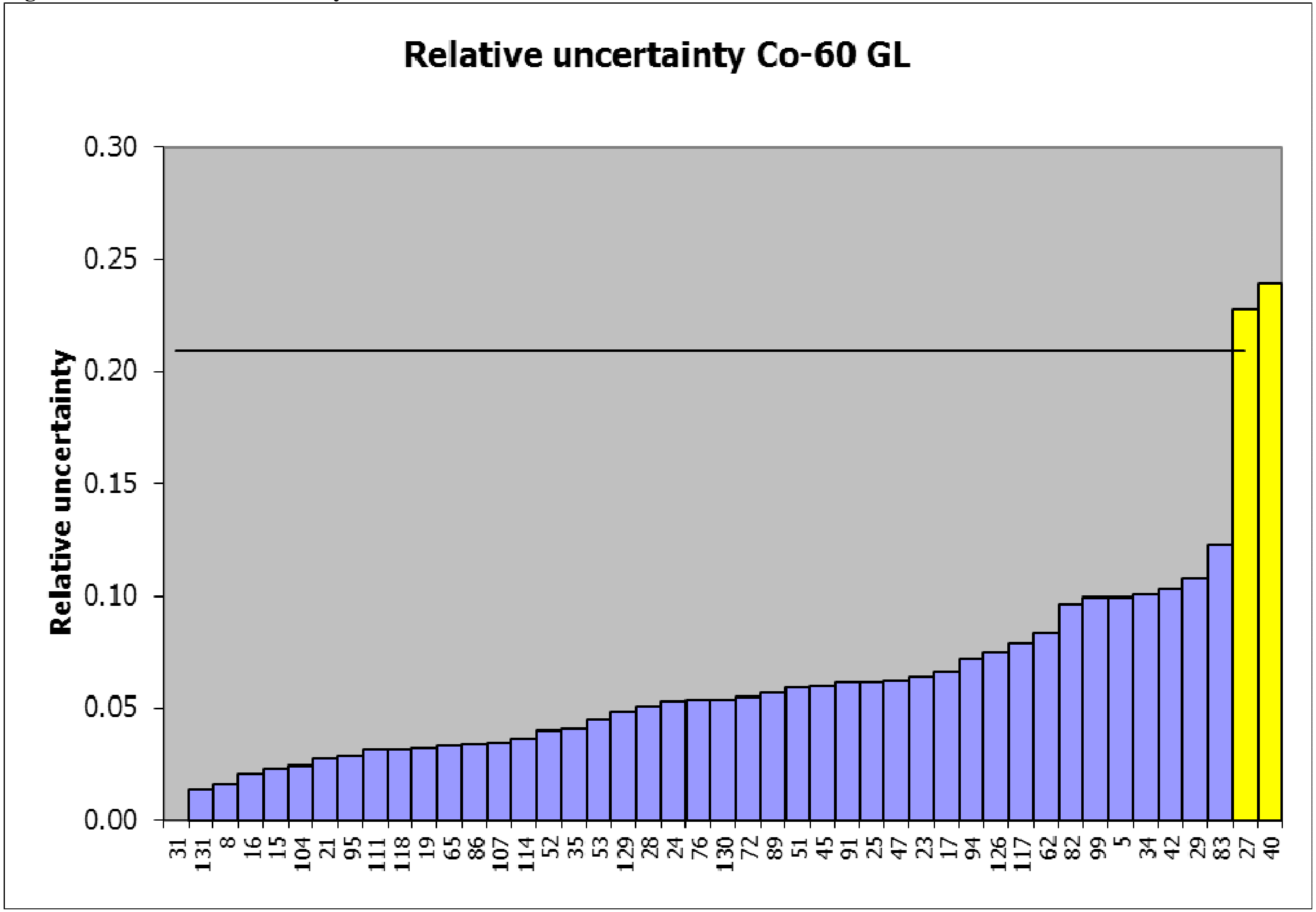


Figure 29D – Kiri plot Co-60 GL

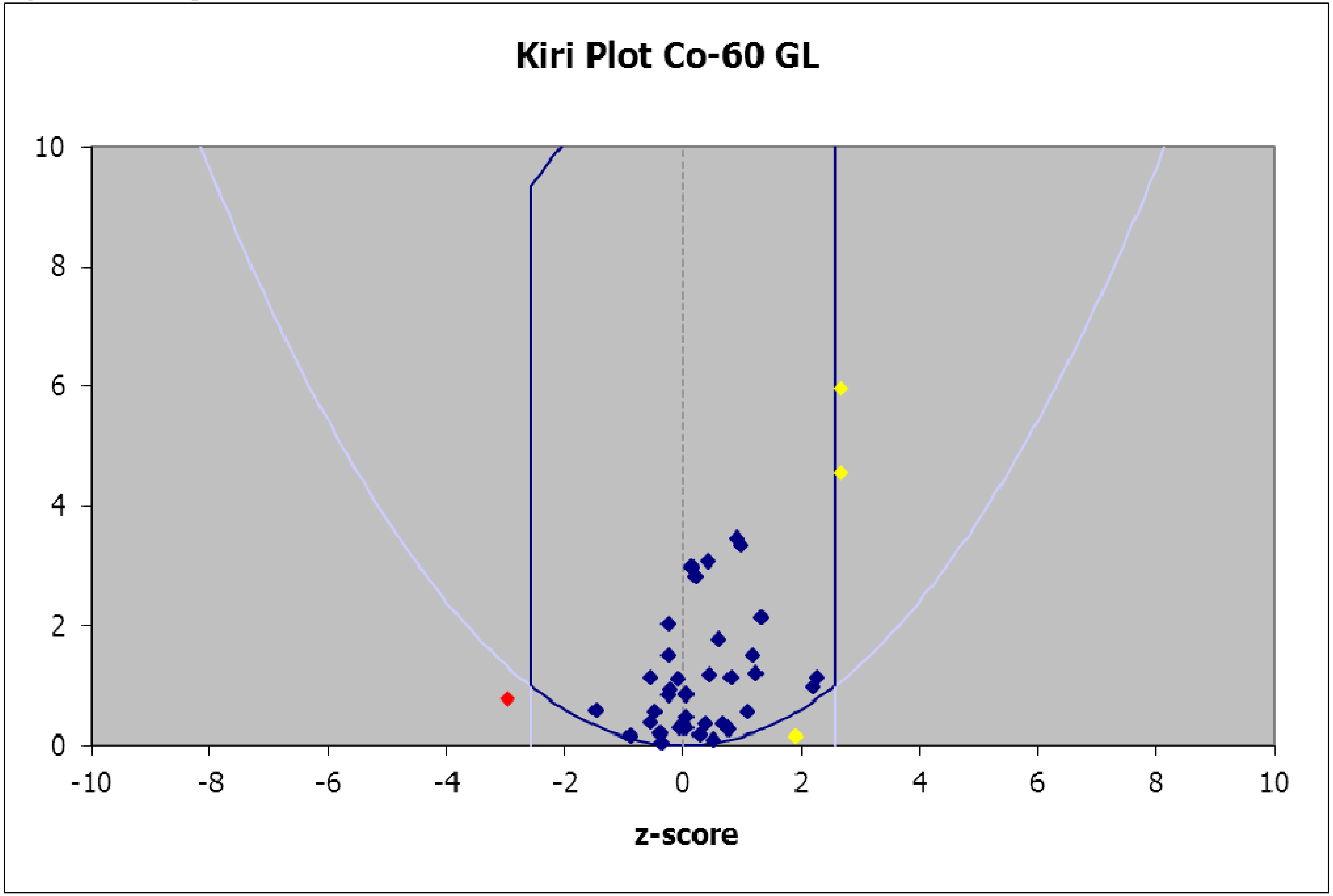


Figure 30A – Deviation Zr-95 GL

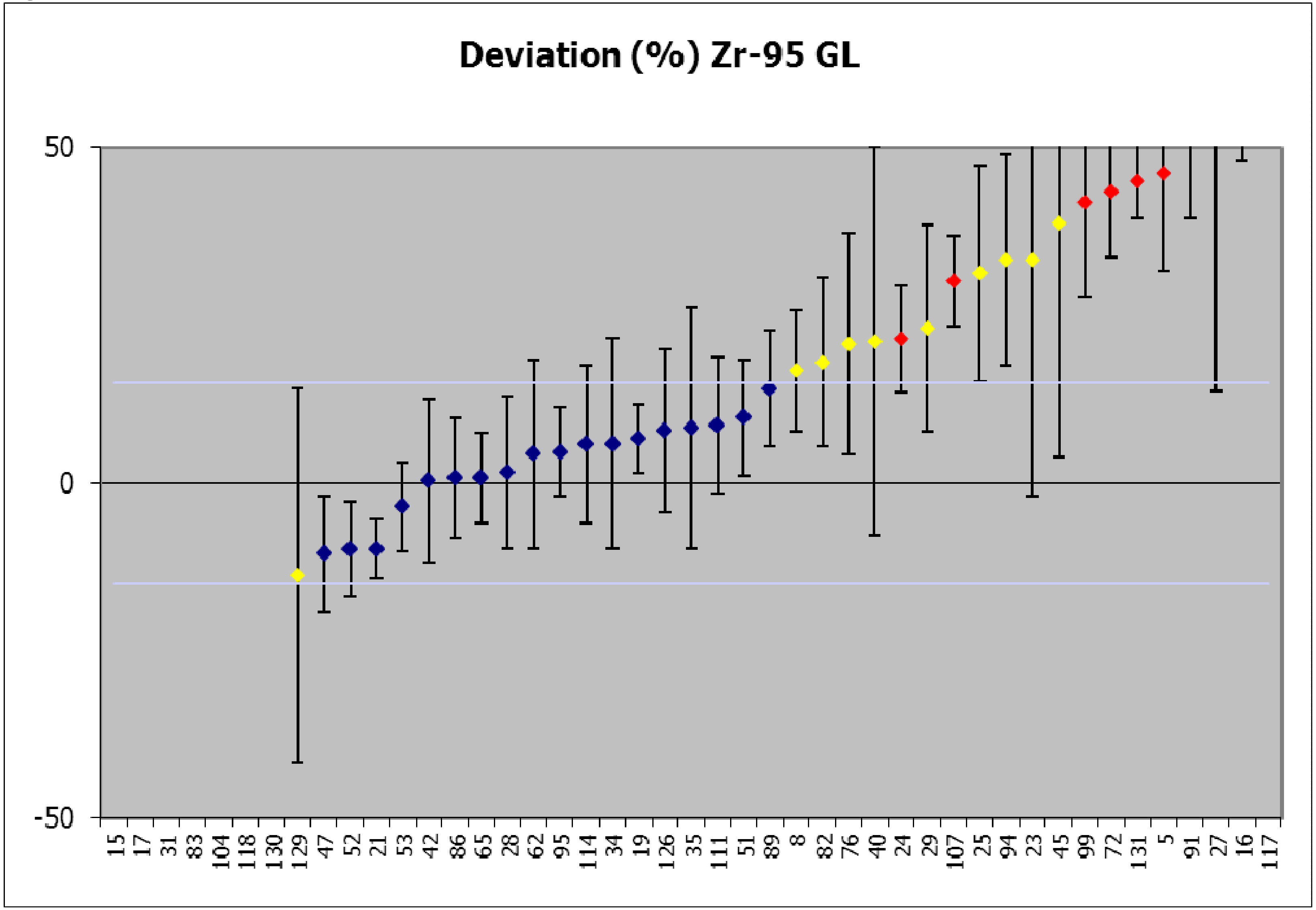


Figure 30B – Zeta score Zr-95 GL

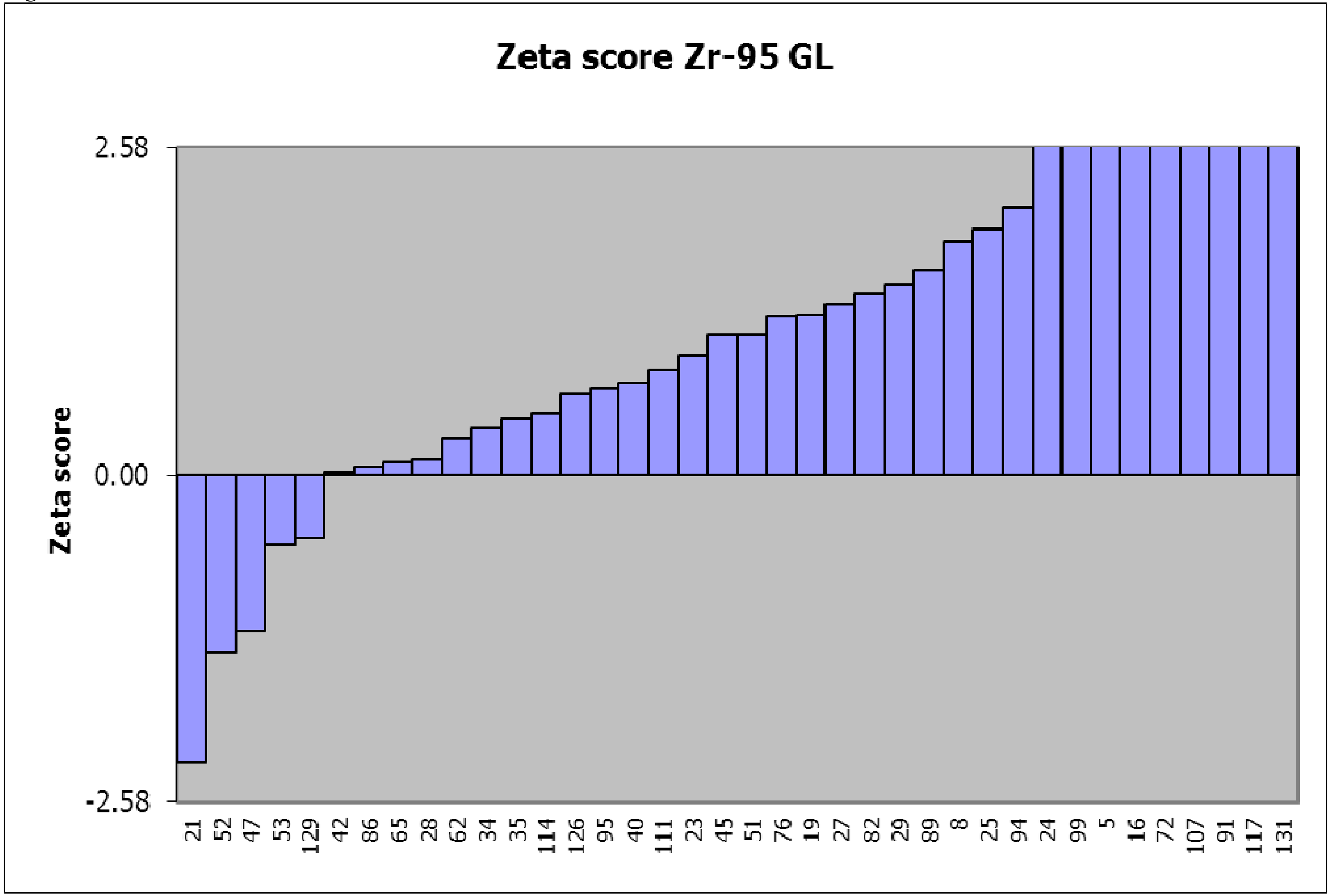


Figure 30C – Relative uncertainty Zr-95 GL

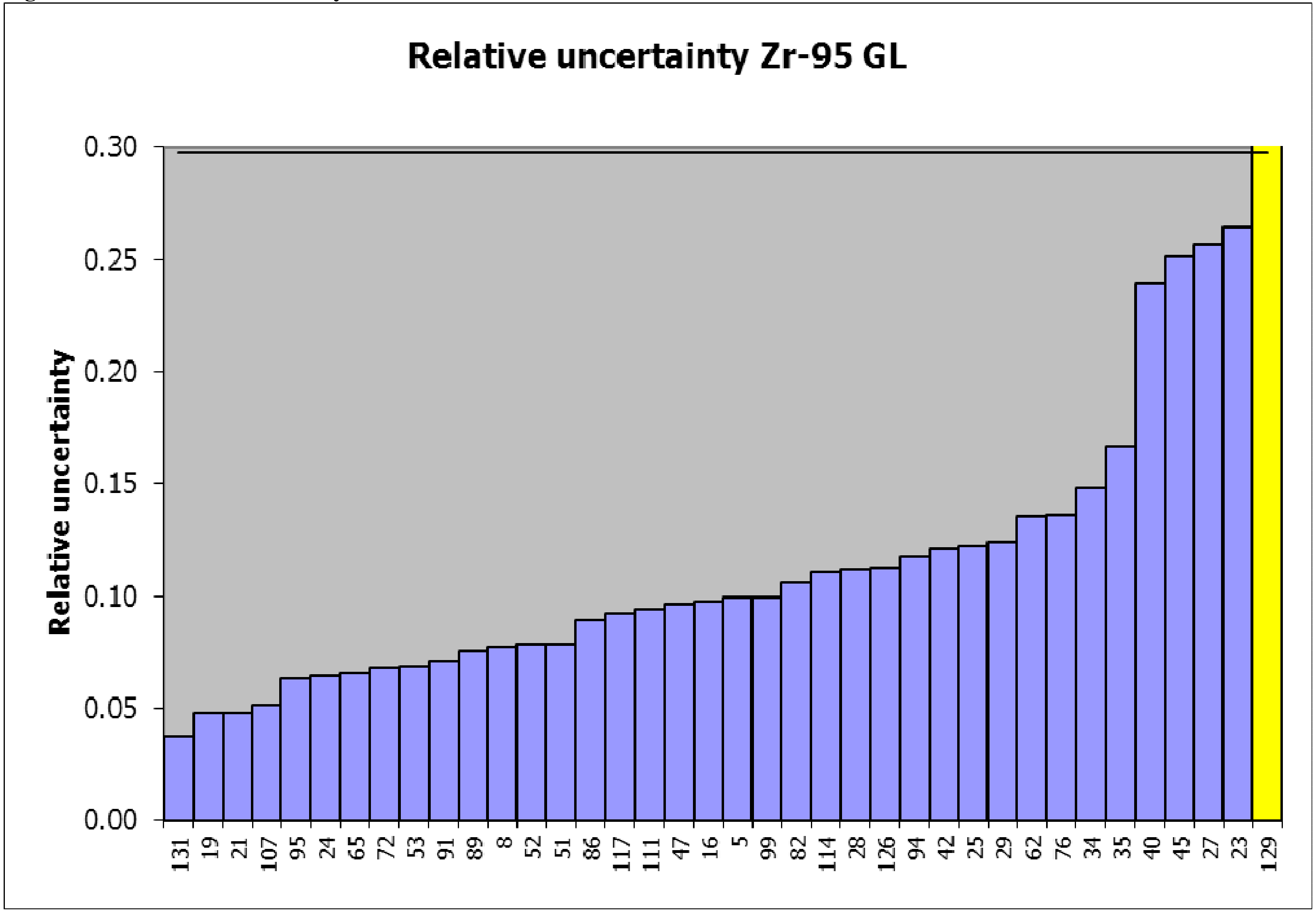


Figure 30D – Kiri plot Zr-95 GL

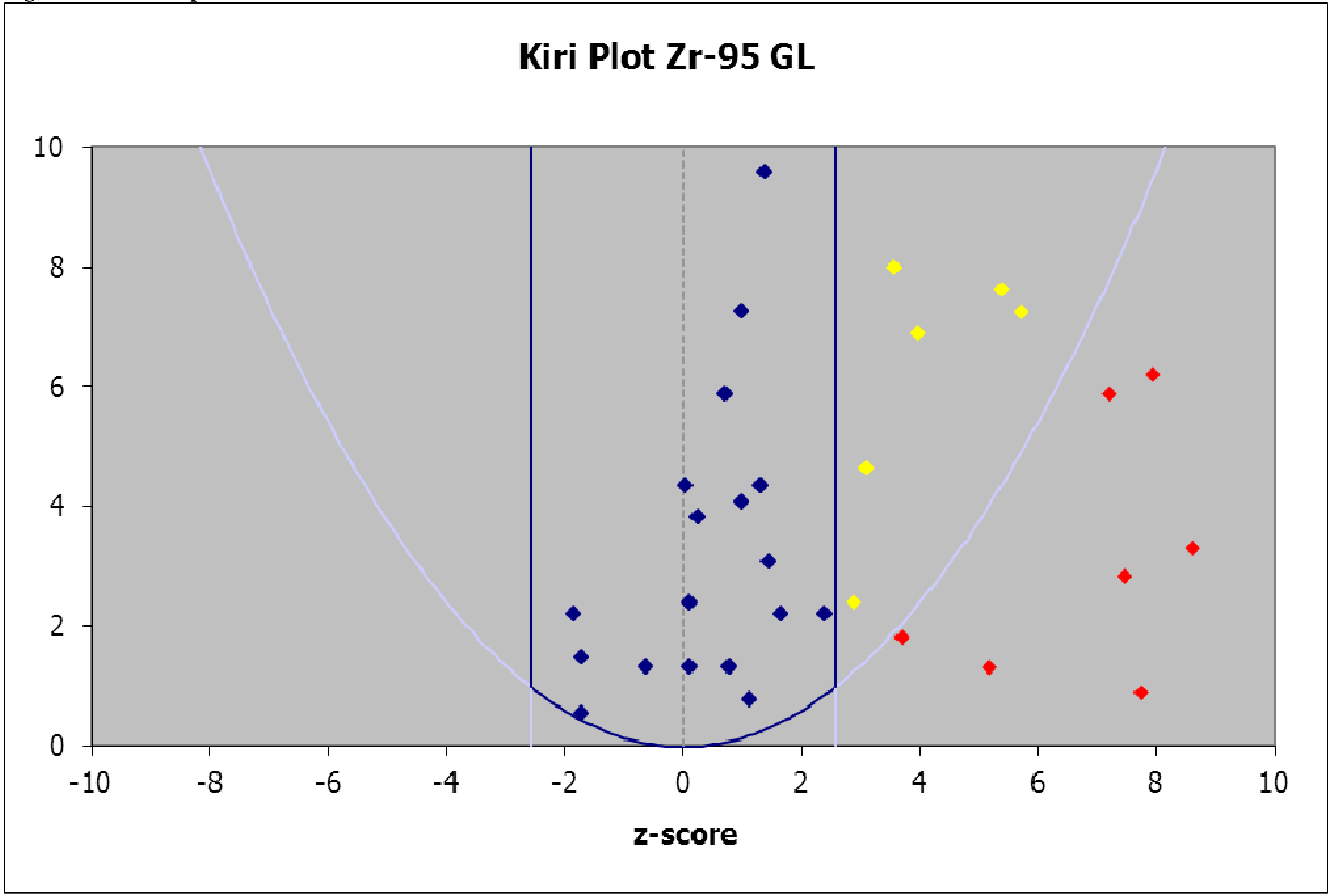


Figure 31A – Deviation Nb-95 GL

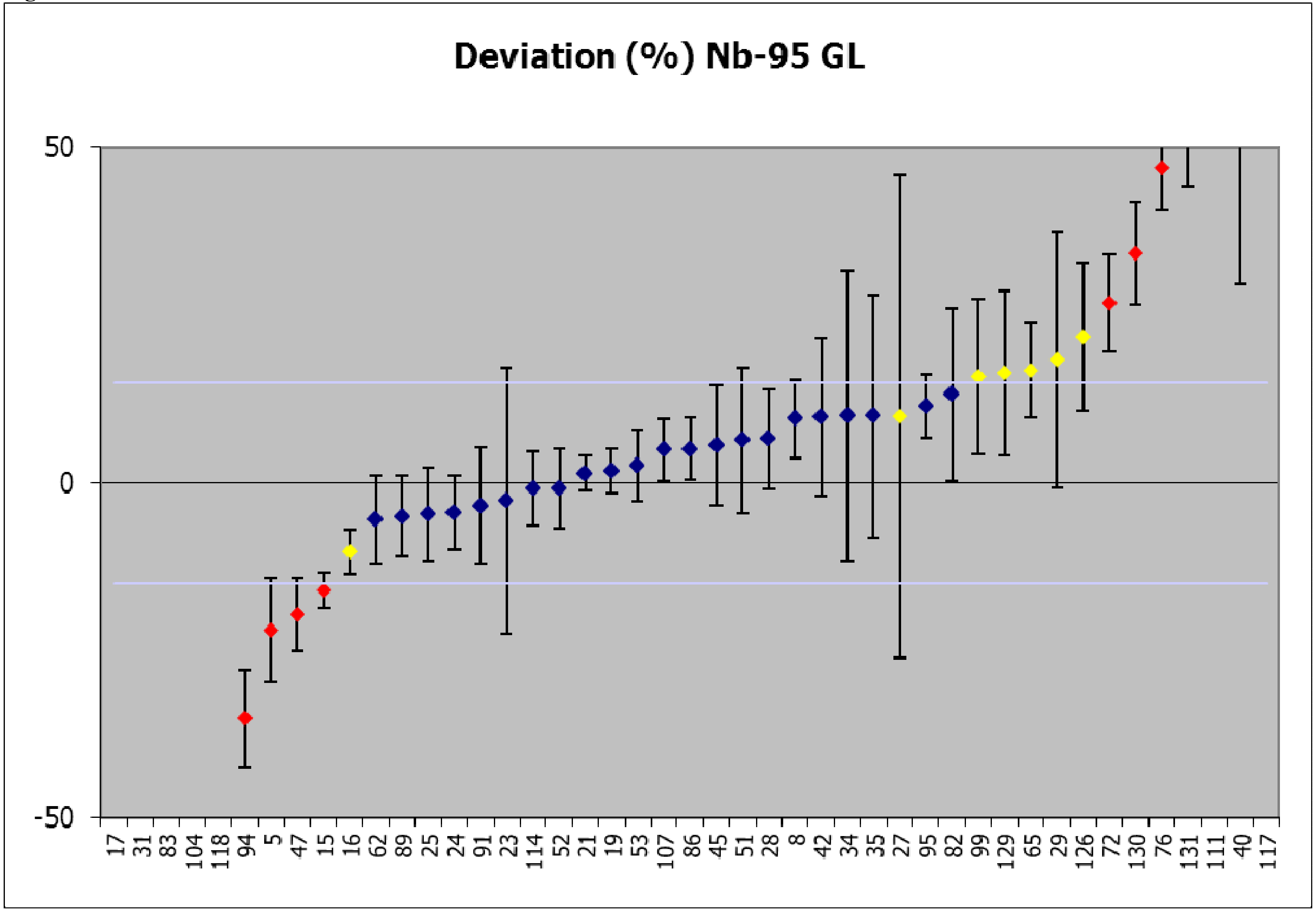


Figure 31B – Zeta score Nb-95 GL

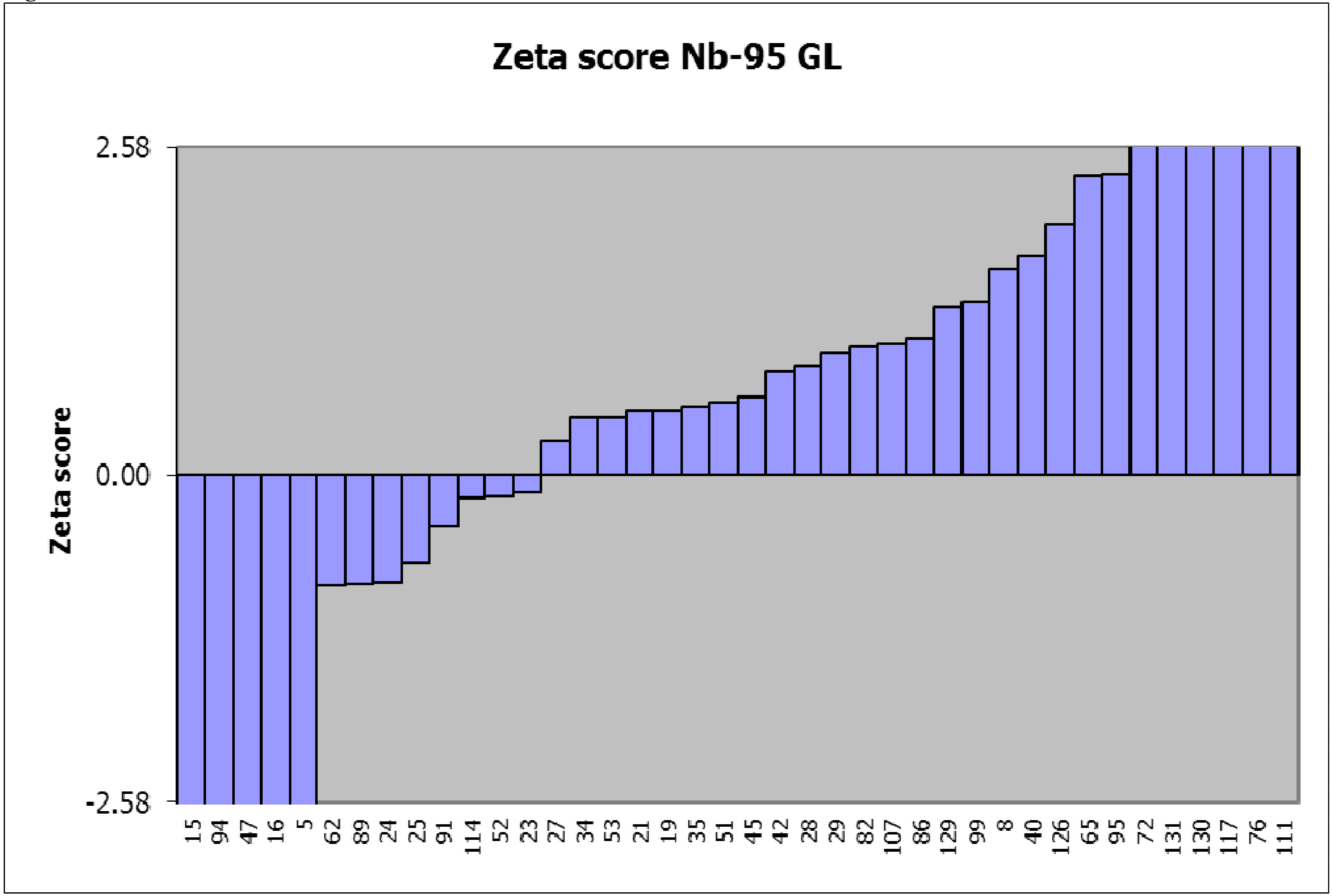


Figure 31C – Relative uncertainty Nb-95 GL

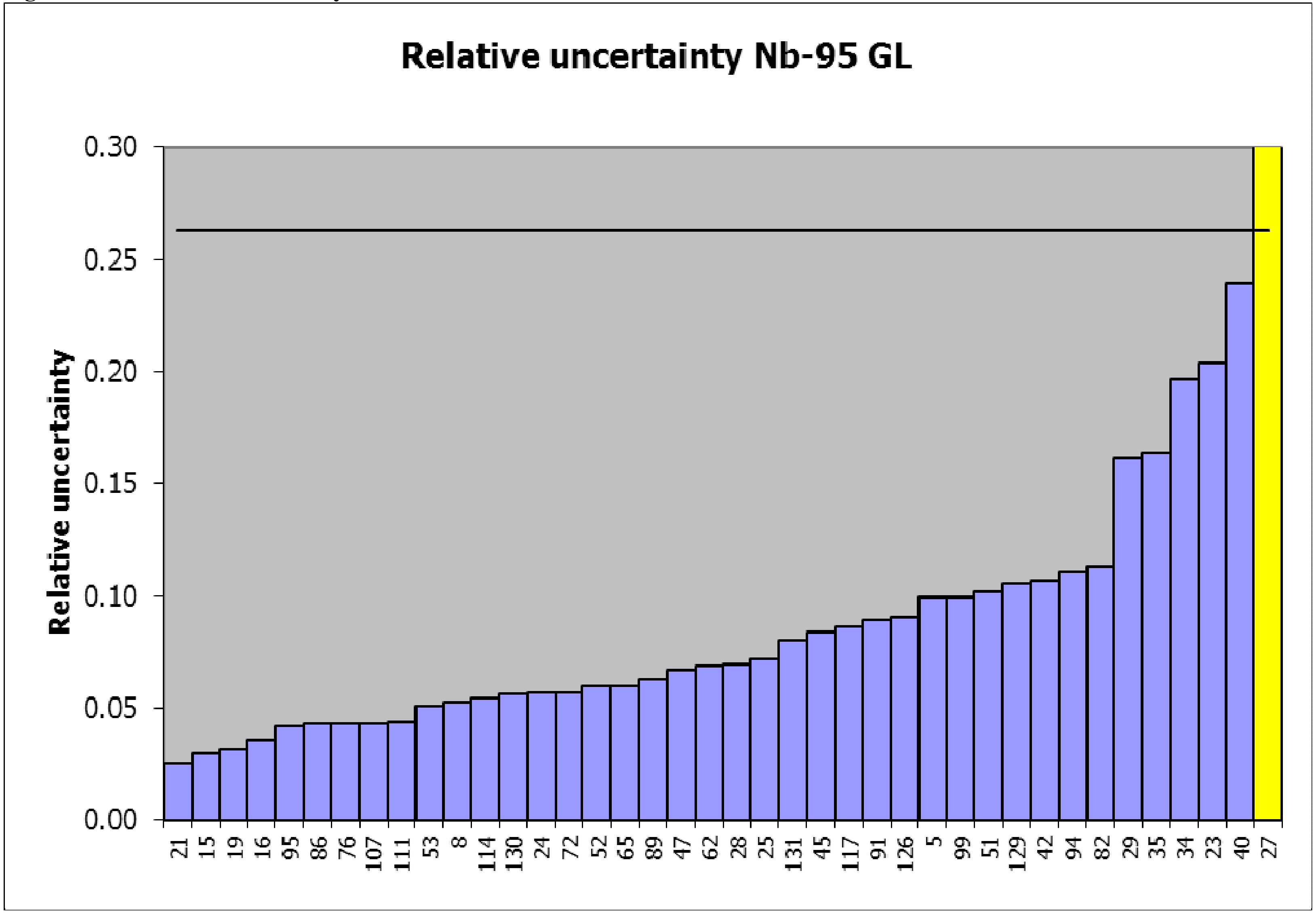


Figure 31D – Kiri plot Nb-95 GL

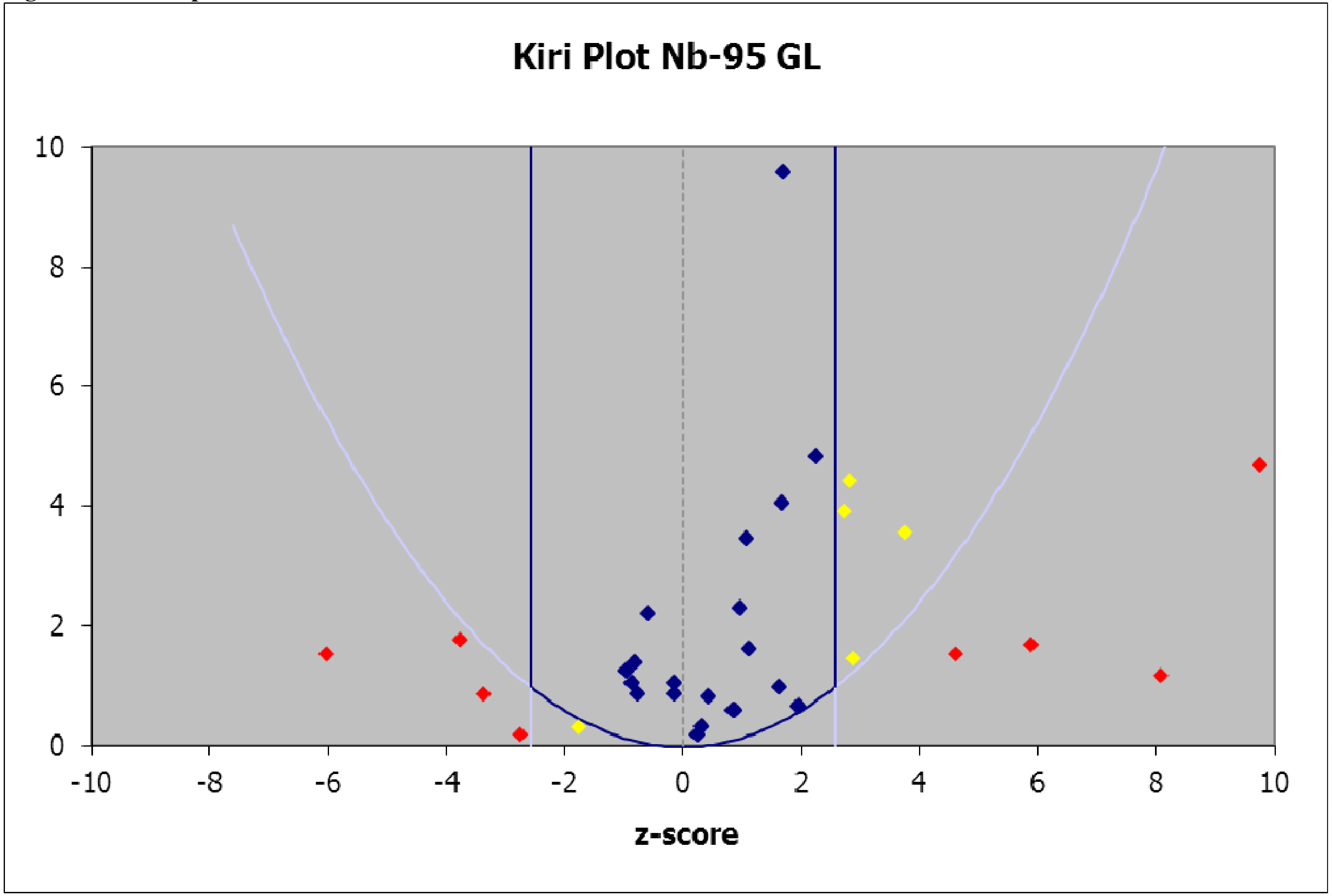


Figure 32A – Deviation Cs-134 GL

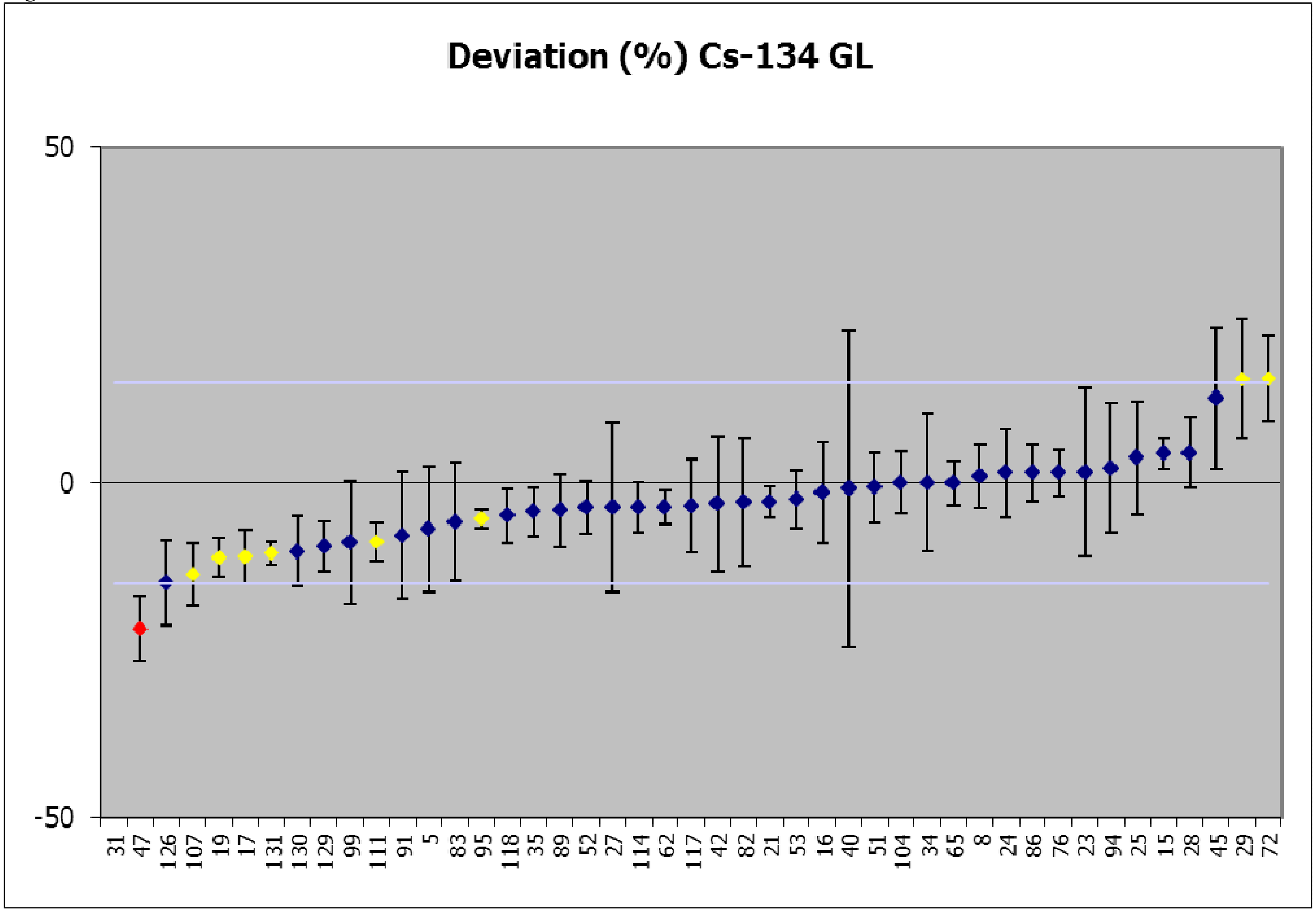


Figure 32B – Zeta score Cs-134 GL

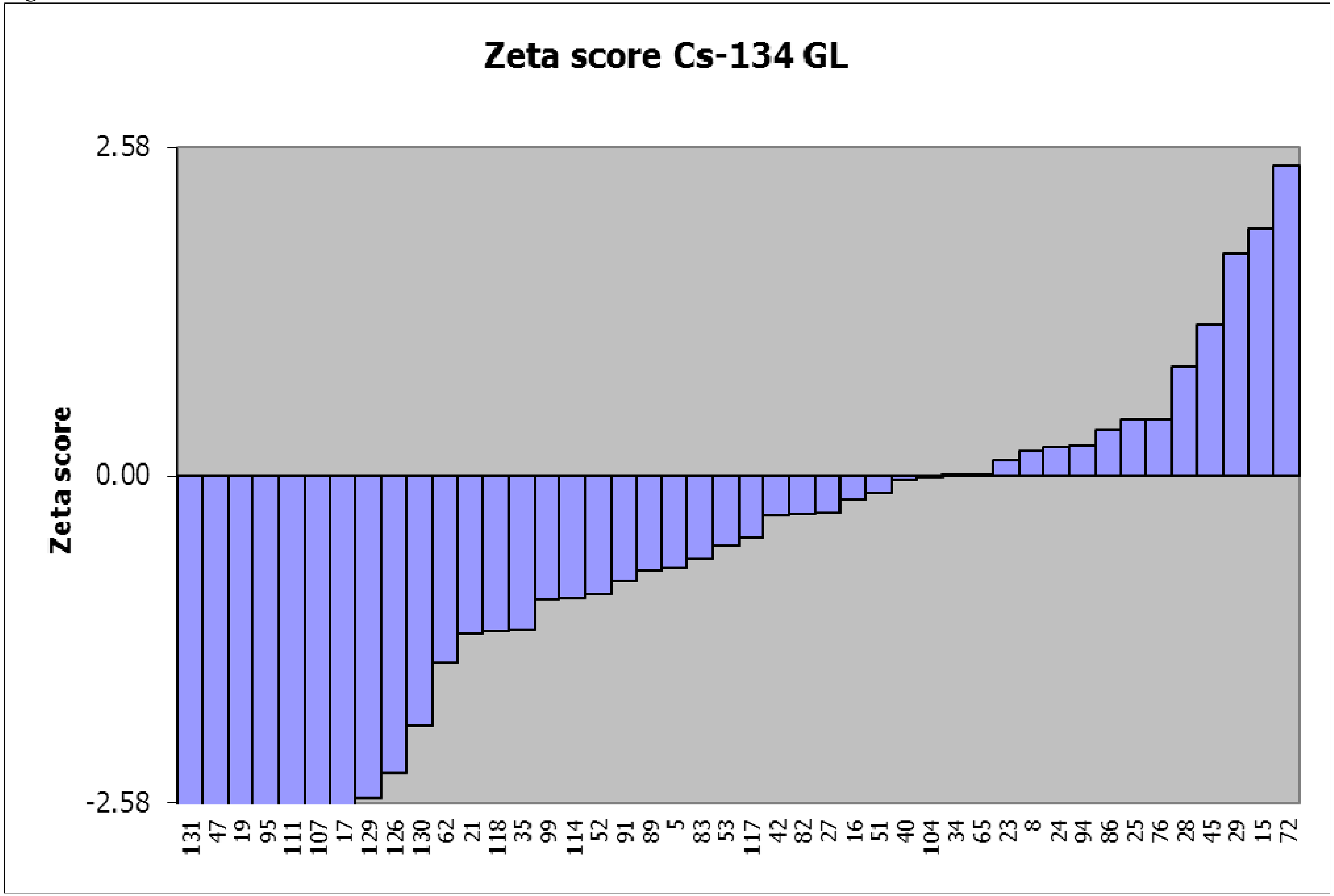


Figure 32C – Relative uncertainty Cs-134 GL

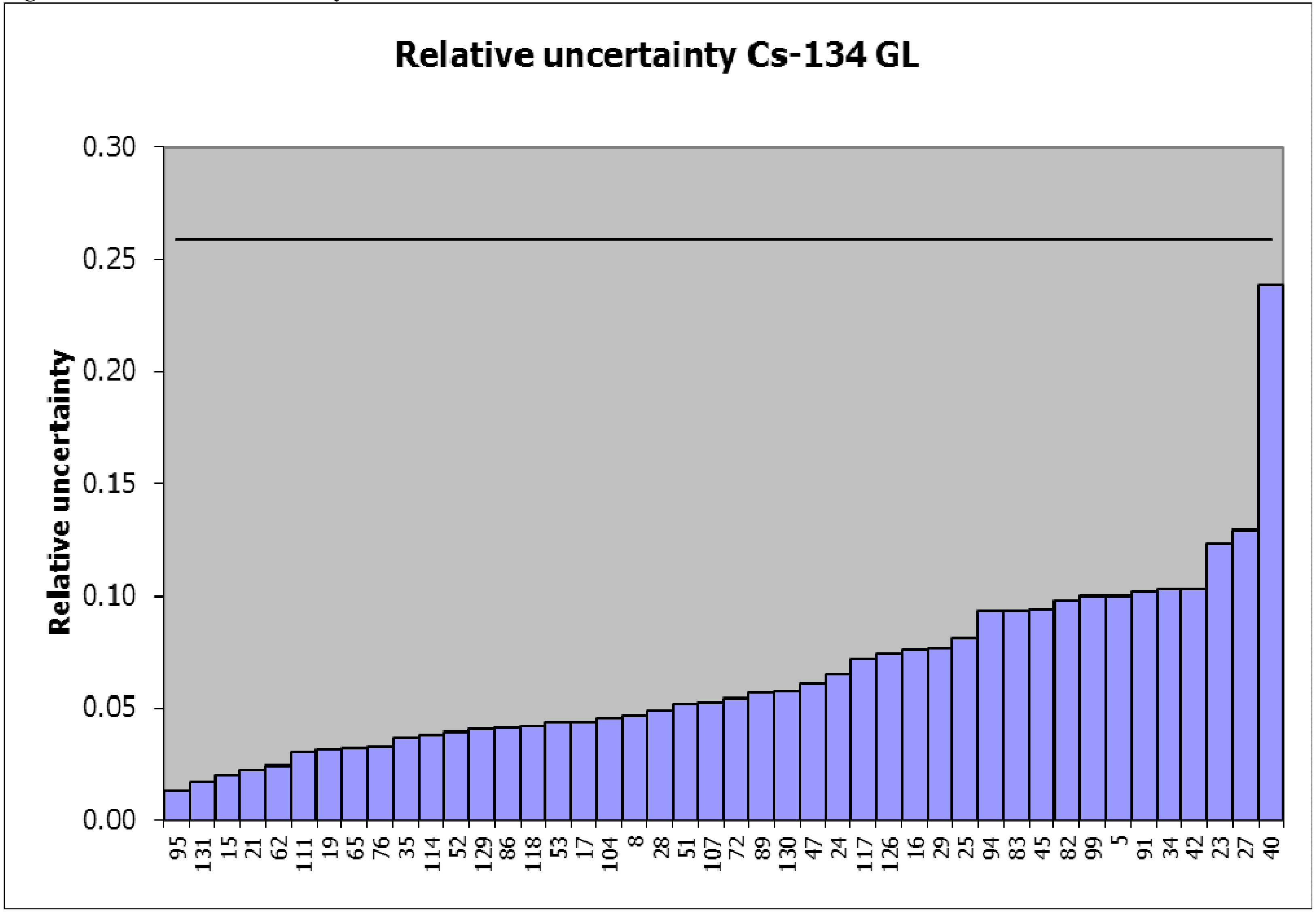


Figure 32D – Kiri plot Cs-134 GL

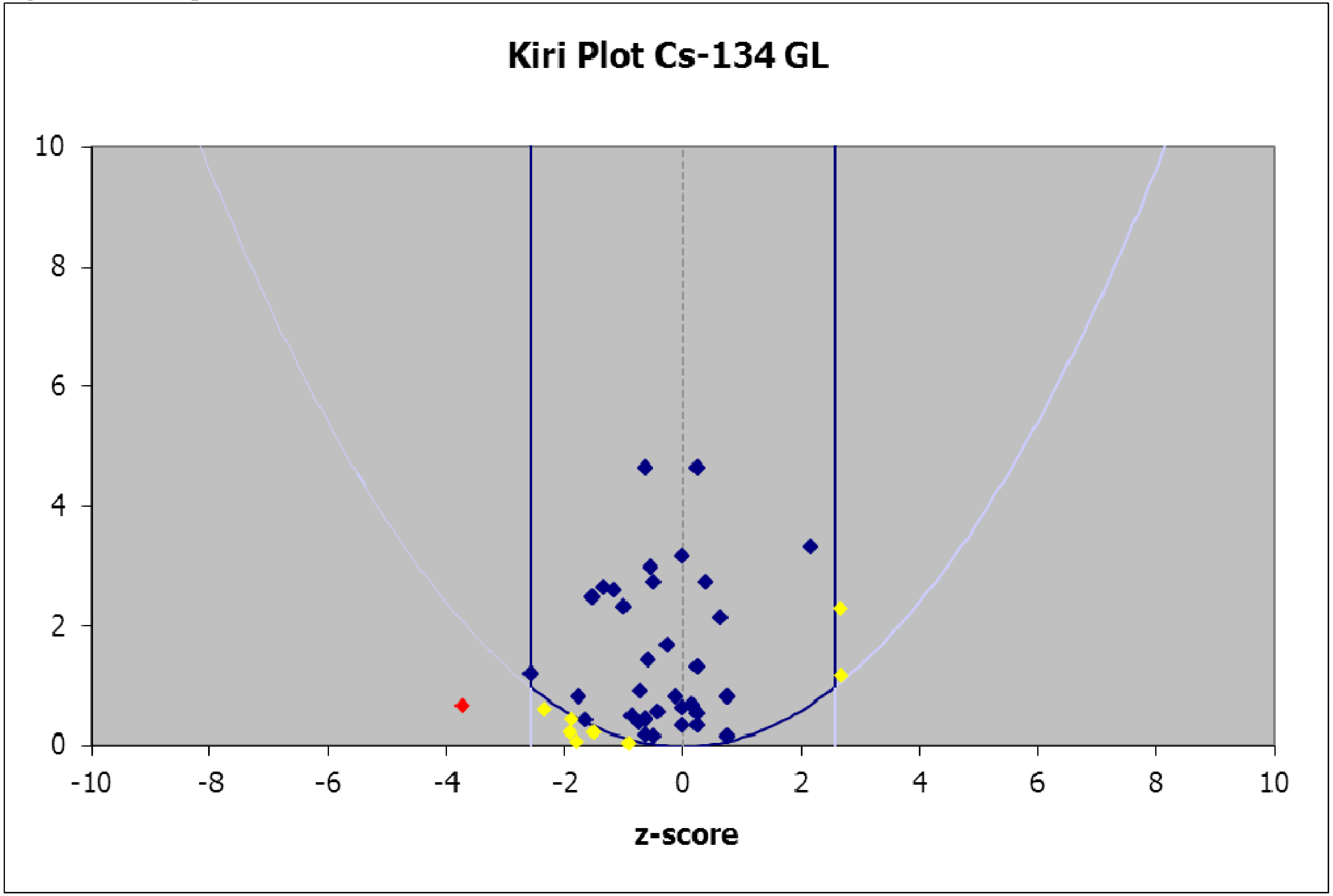


Figure 33A – Deviation Cs-137 GL

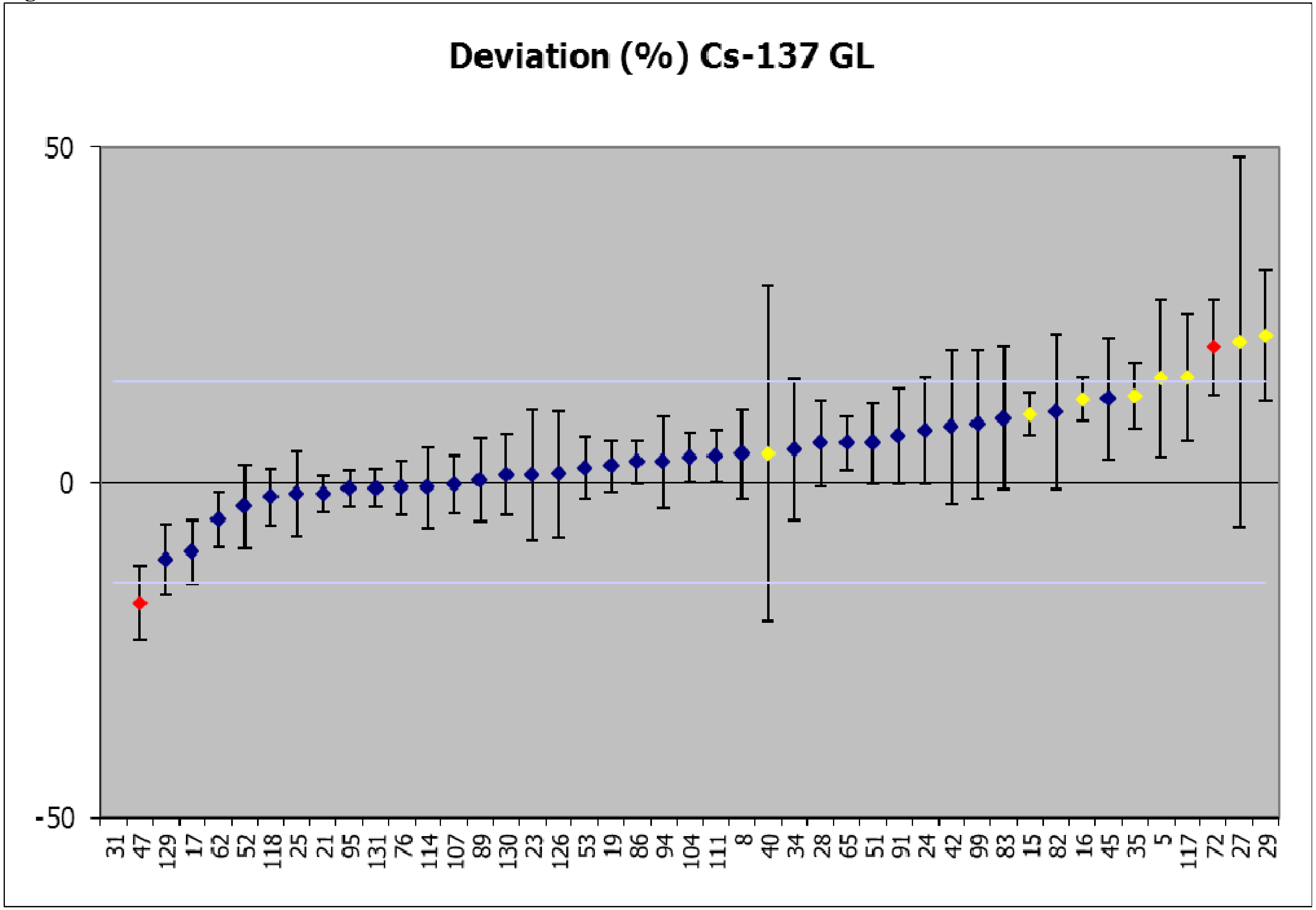


Figure 33B – Zeta score Cs-137 GL

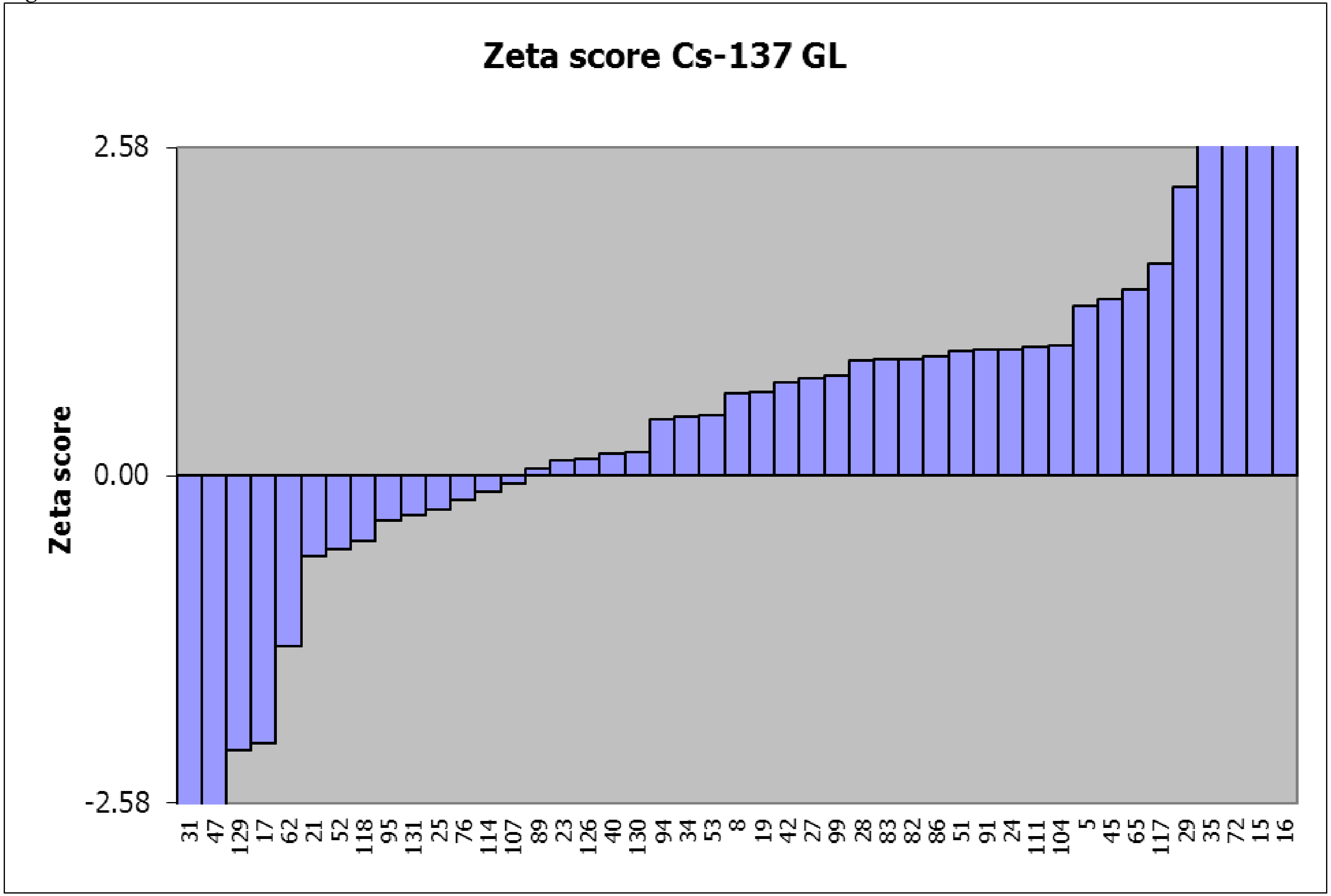


Figure 33C – Relative uncertainty Cs-137 GL

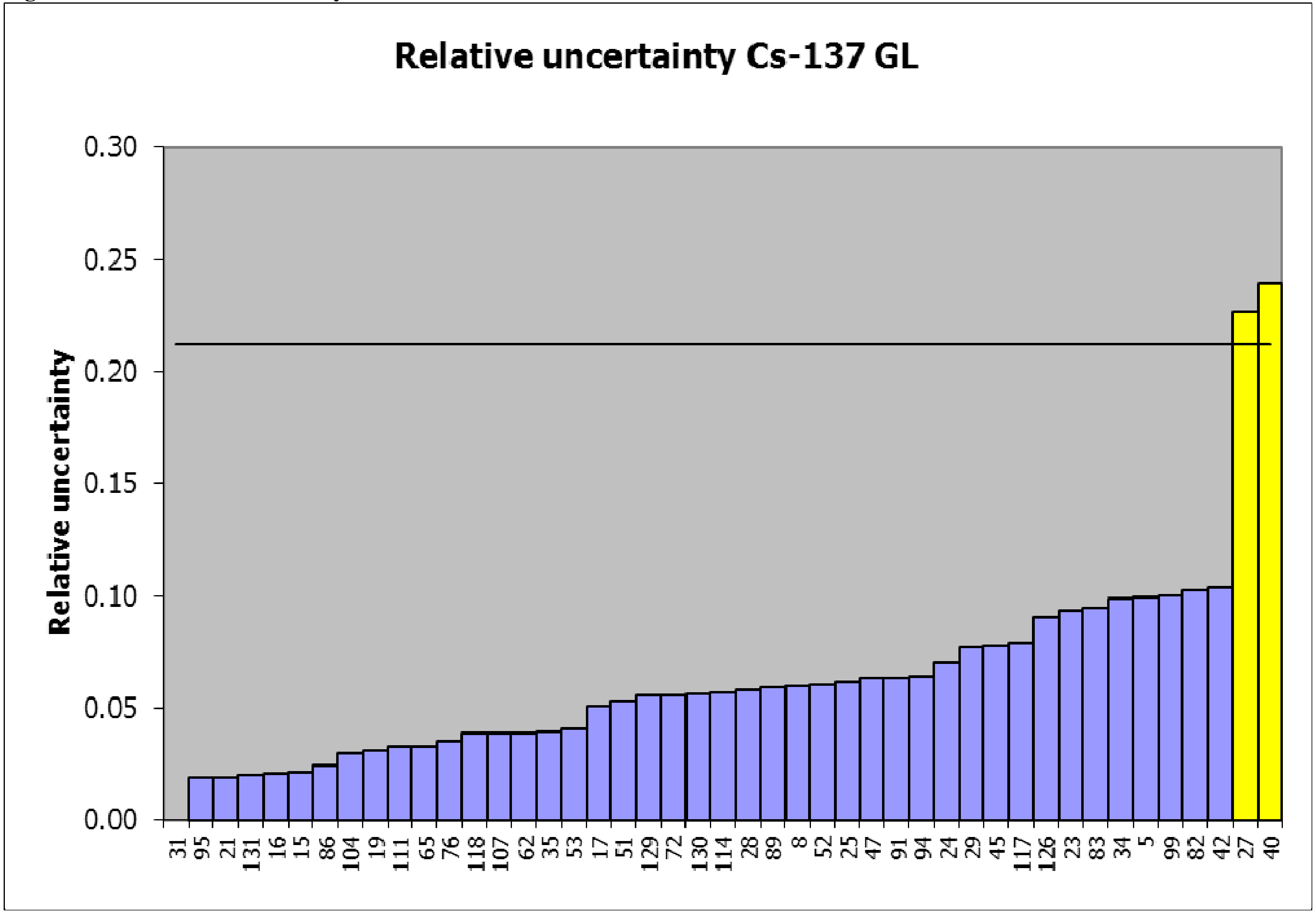


Figure 33D – Kiri plot Cs-137 GL

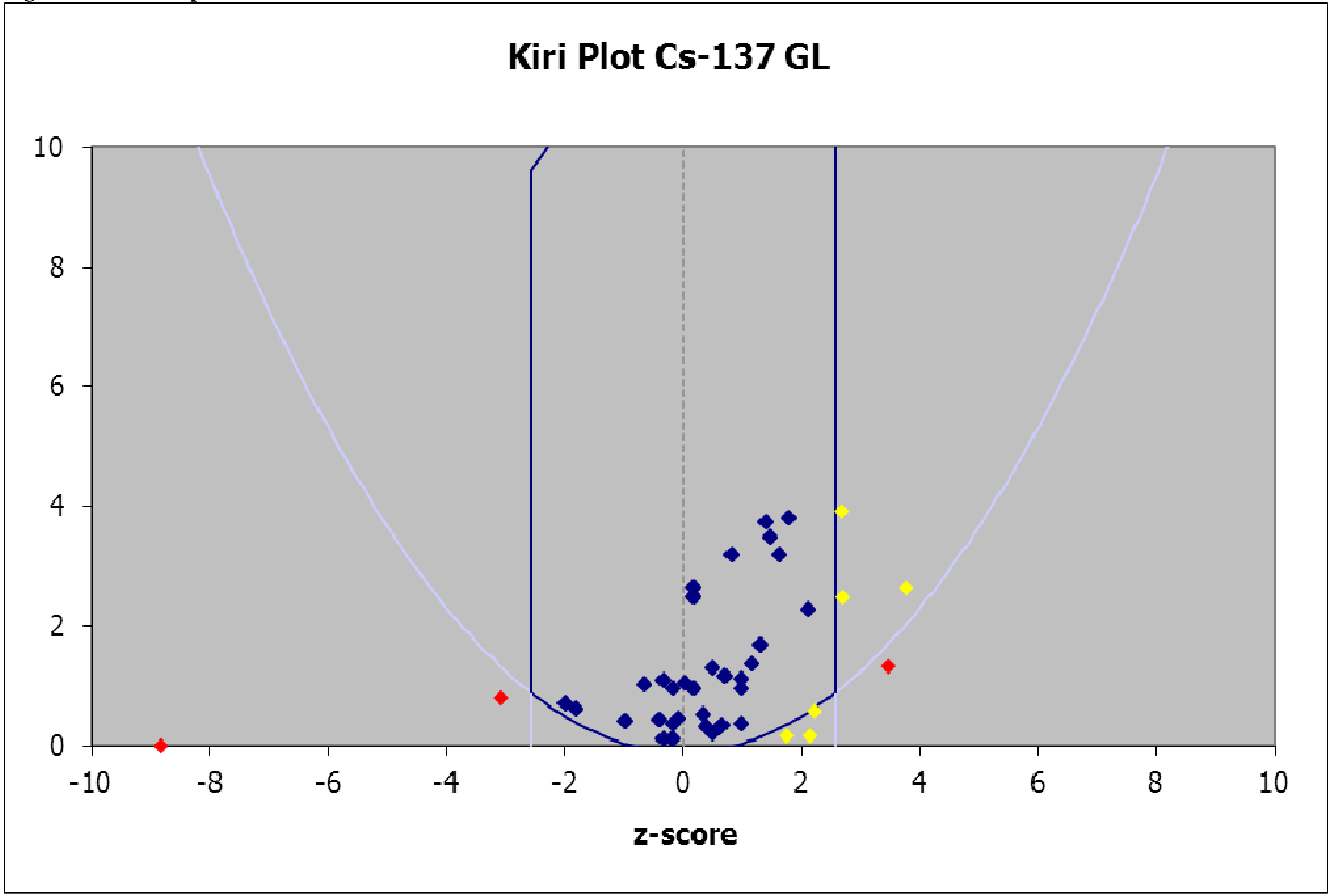


Figure 34A – Deviation Eu-152 GL

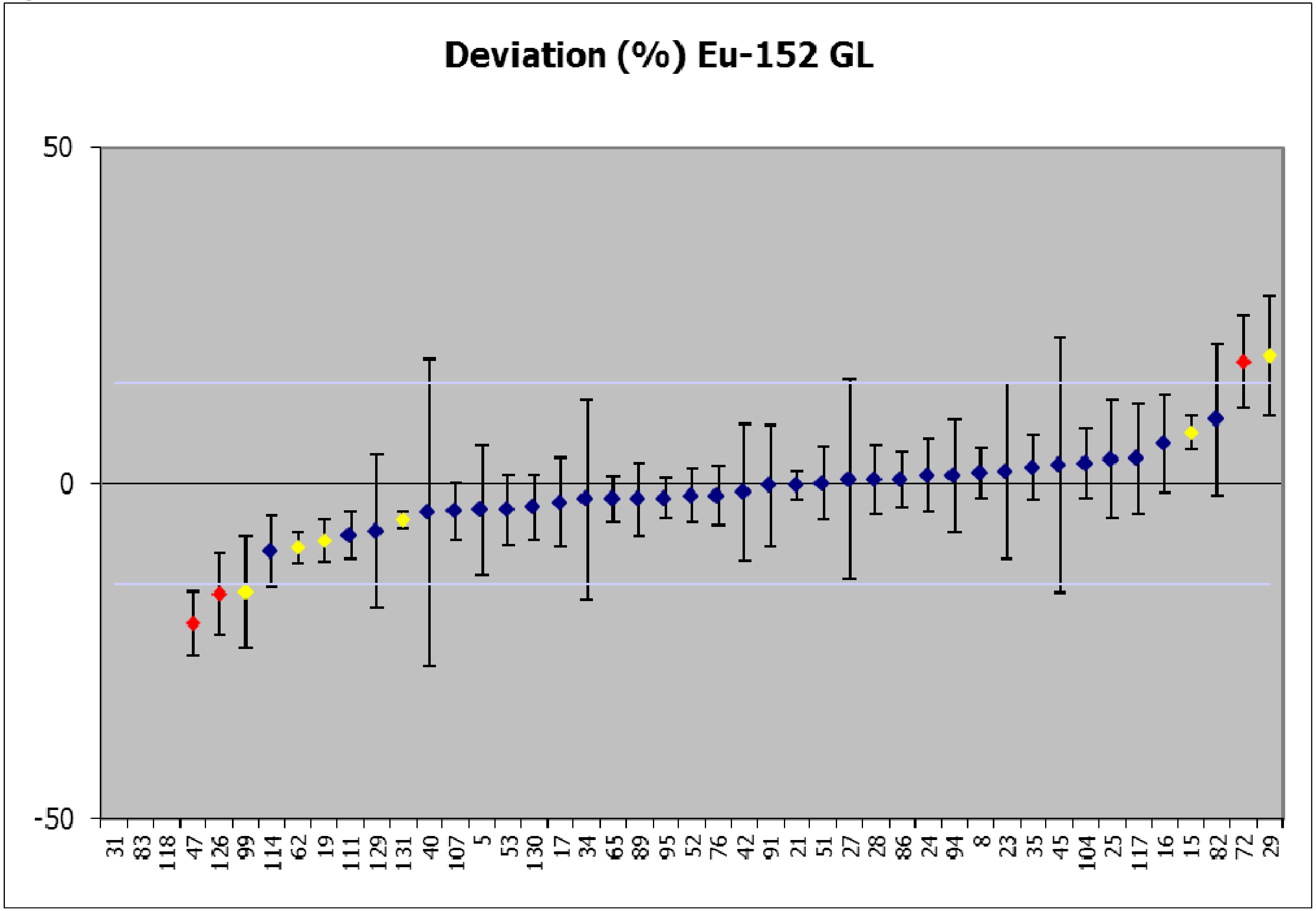


Figure 34B – Zeta score Eu-152 GL

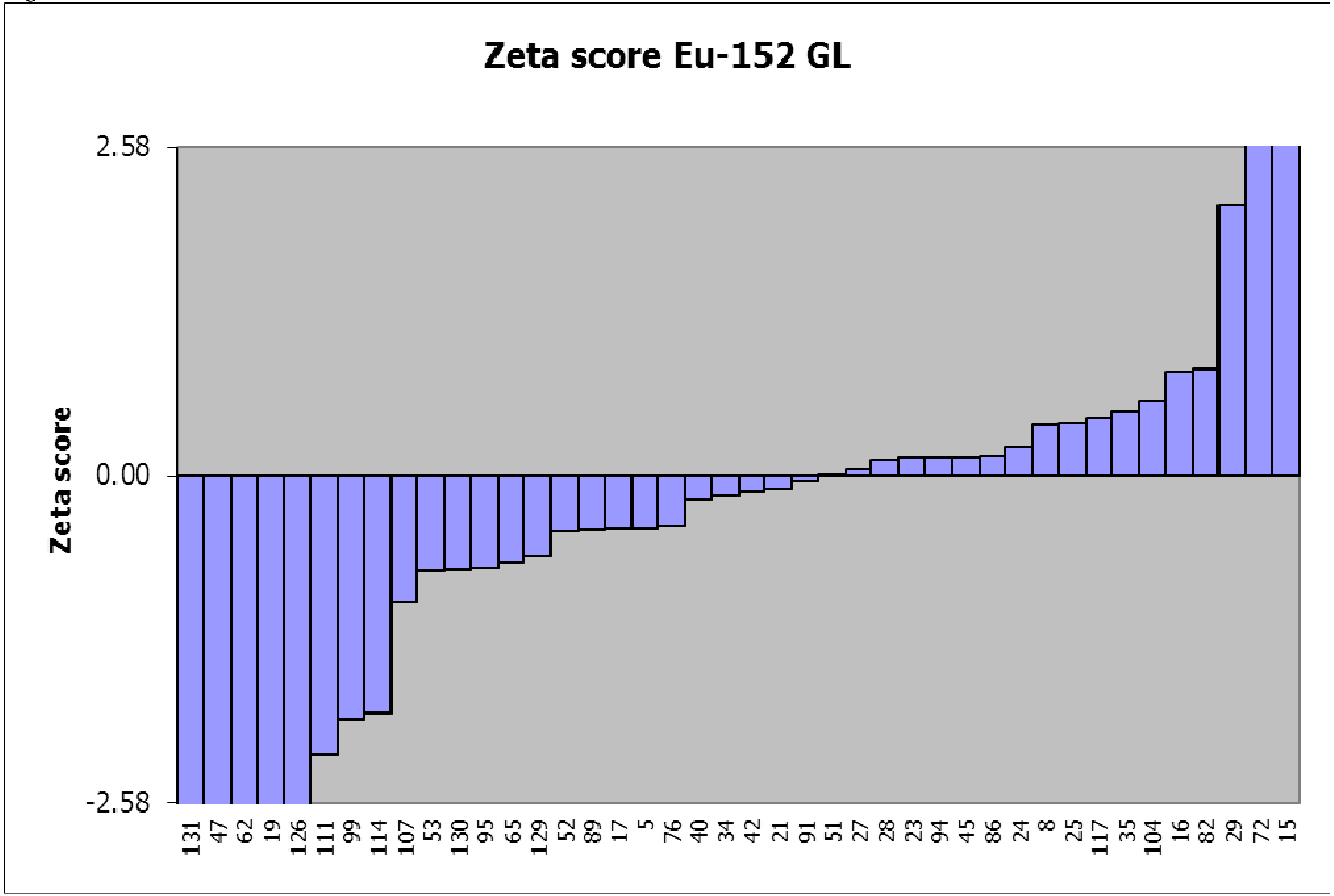


Figure 34C – Relative uncertainty Eu-152 GL

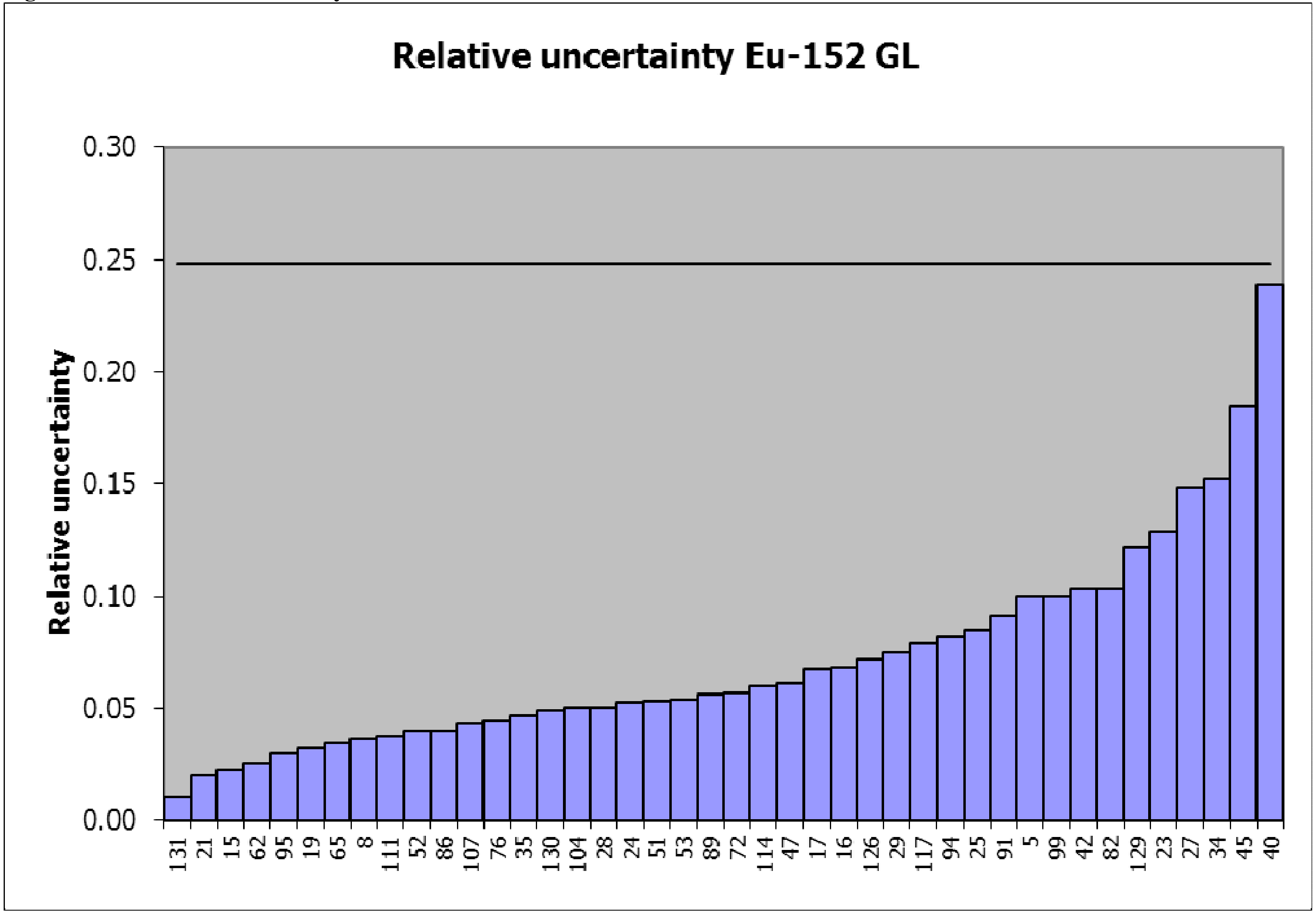


Figure 34D – Kiri plot Eu-152 GL

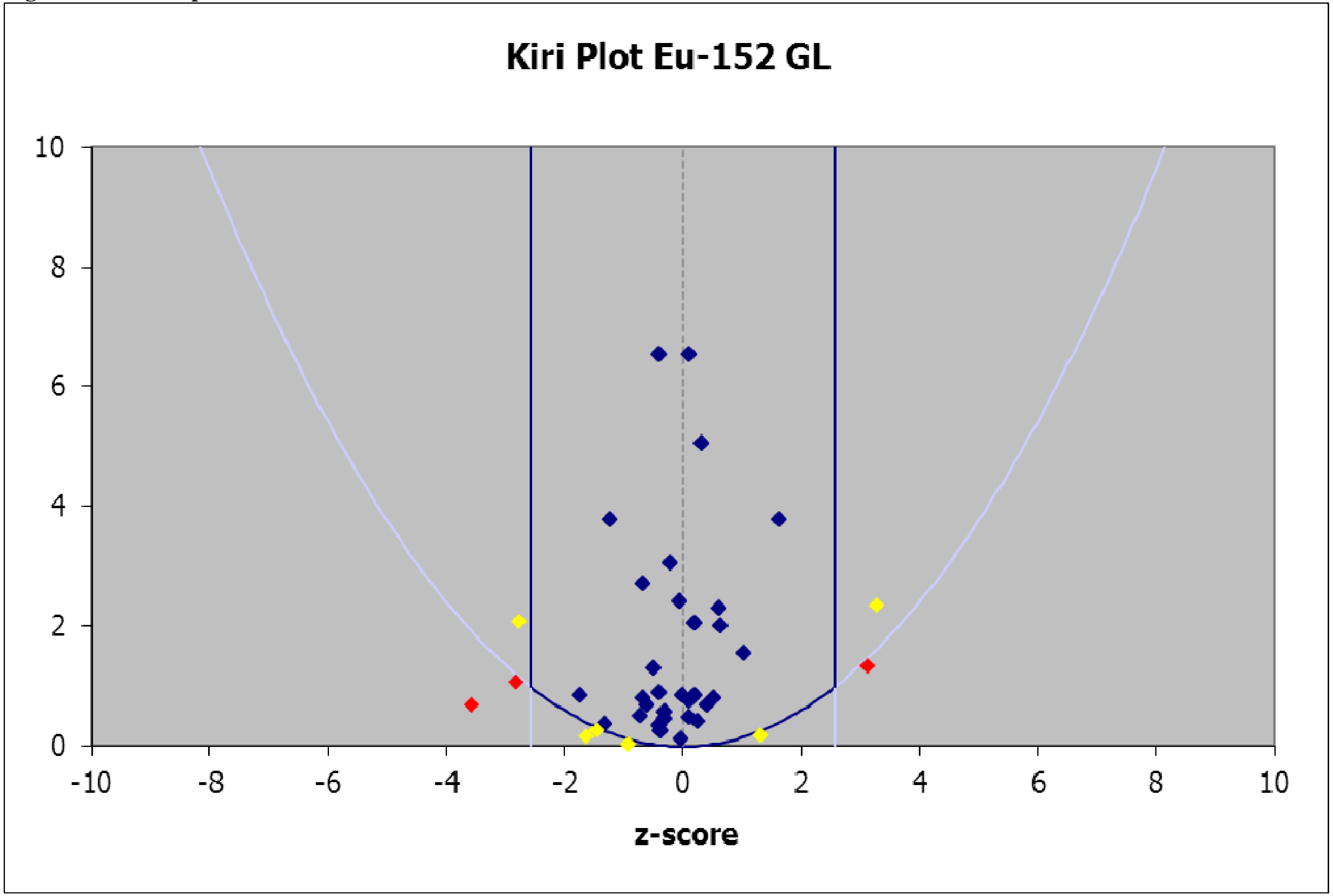


Figure 35A – Deviation Eu-154 GL

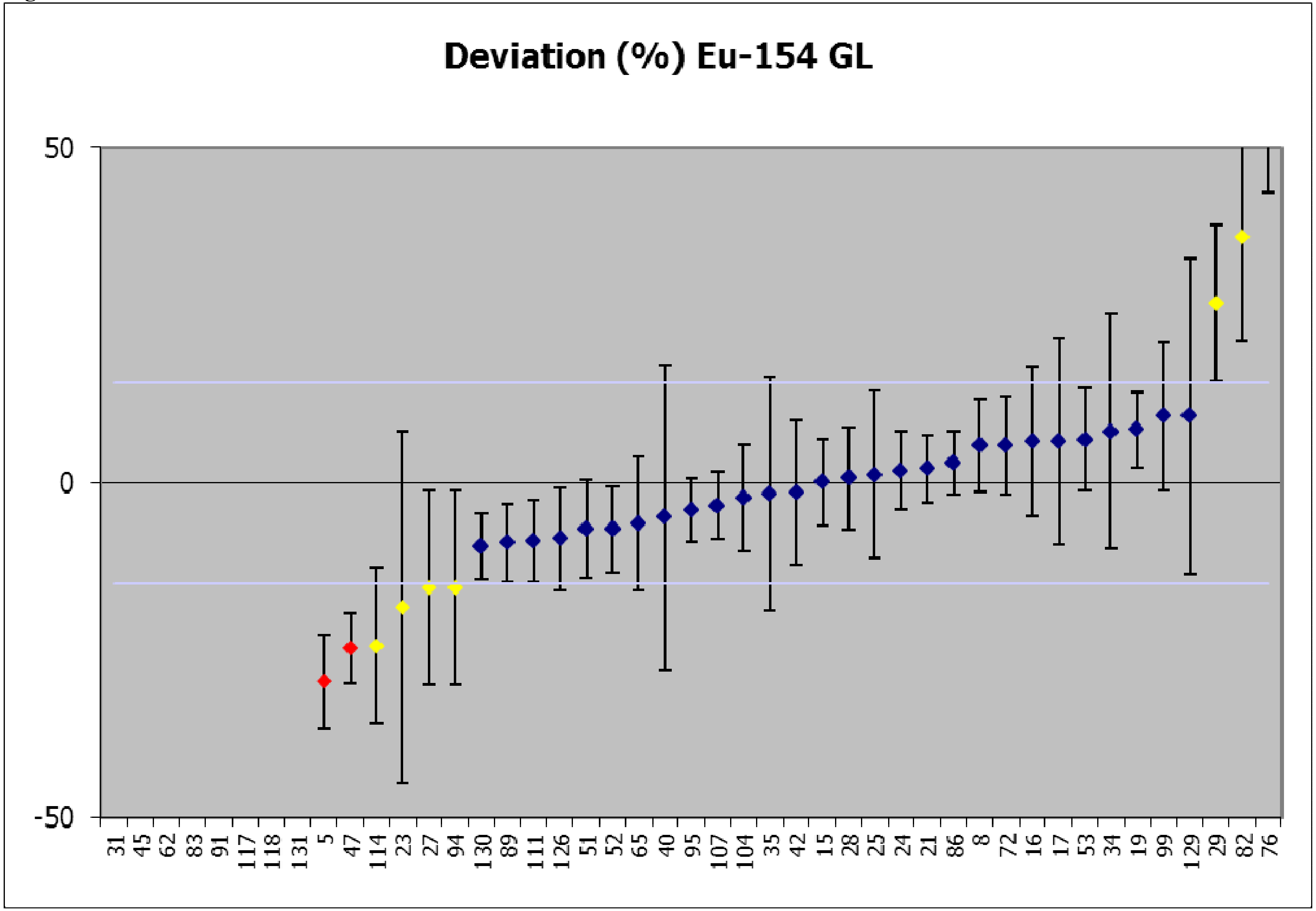


Figure 35B – Zeta score Eu-154 GL

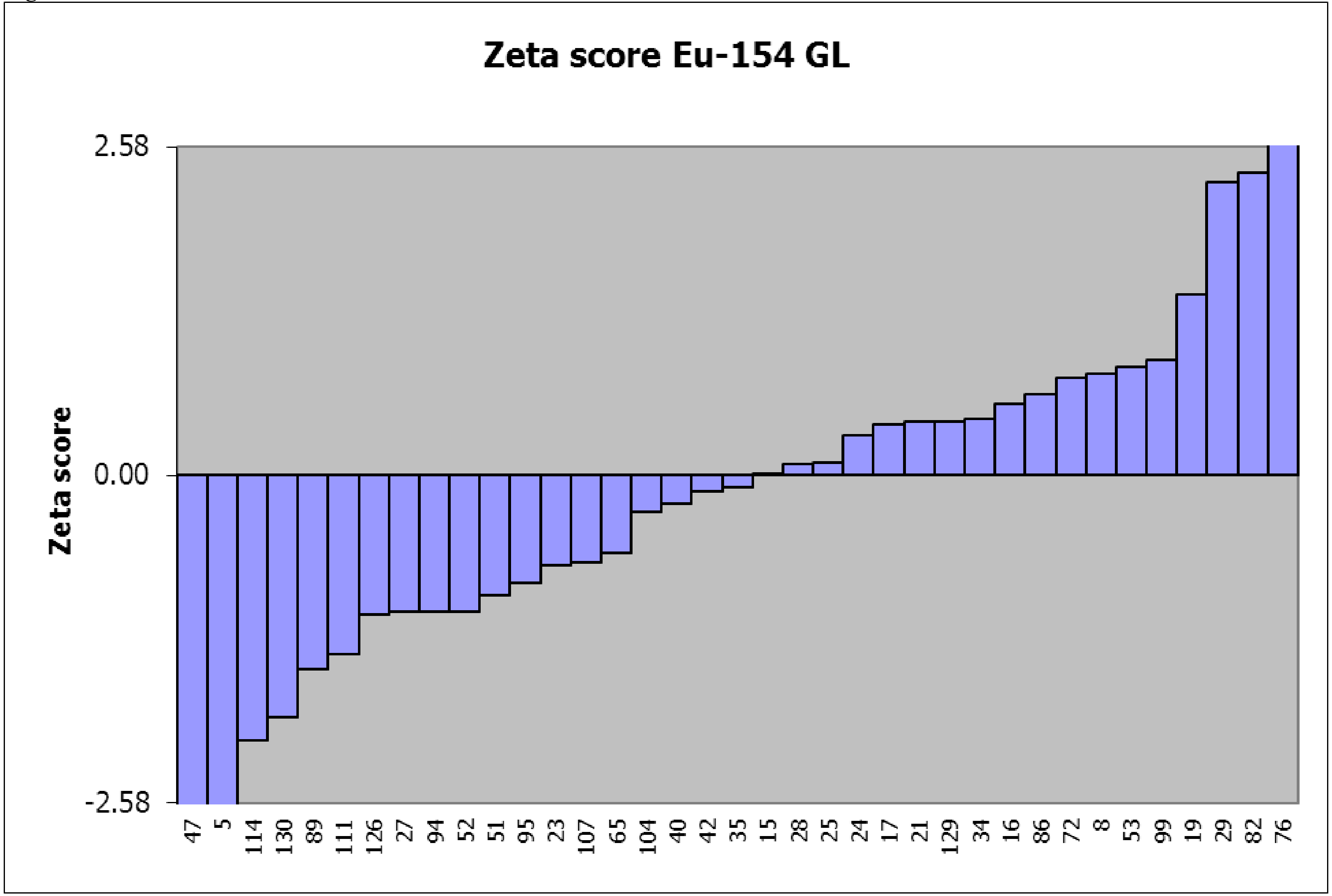


Figure 35C – Relative uncertainty Eu-154 GL

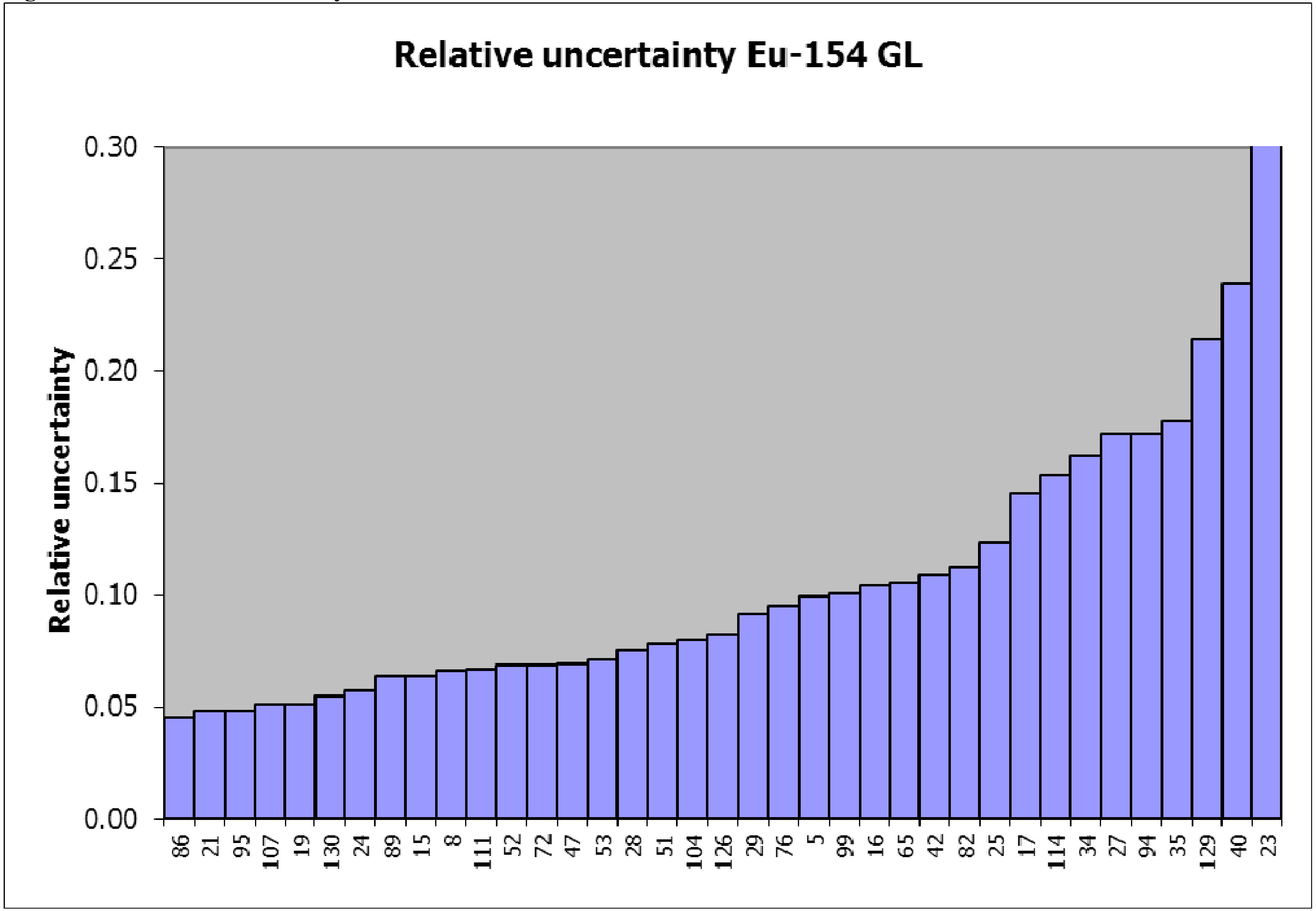


Figure 35D – Kiri plot Eu-154 GL

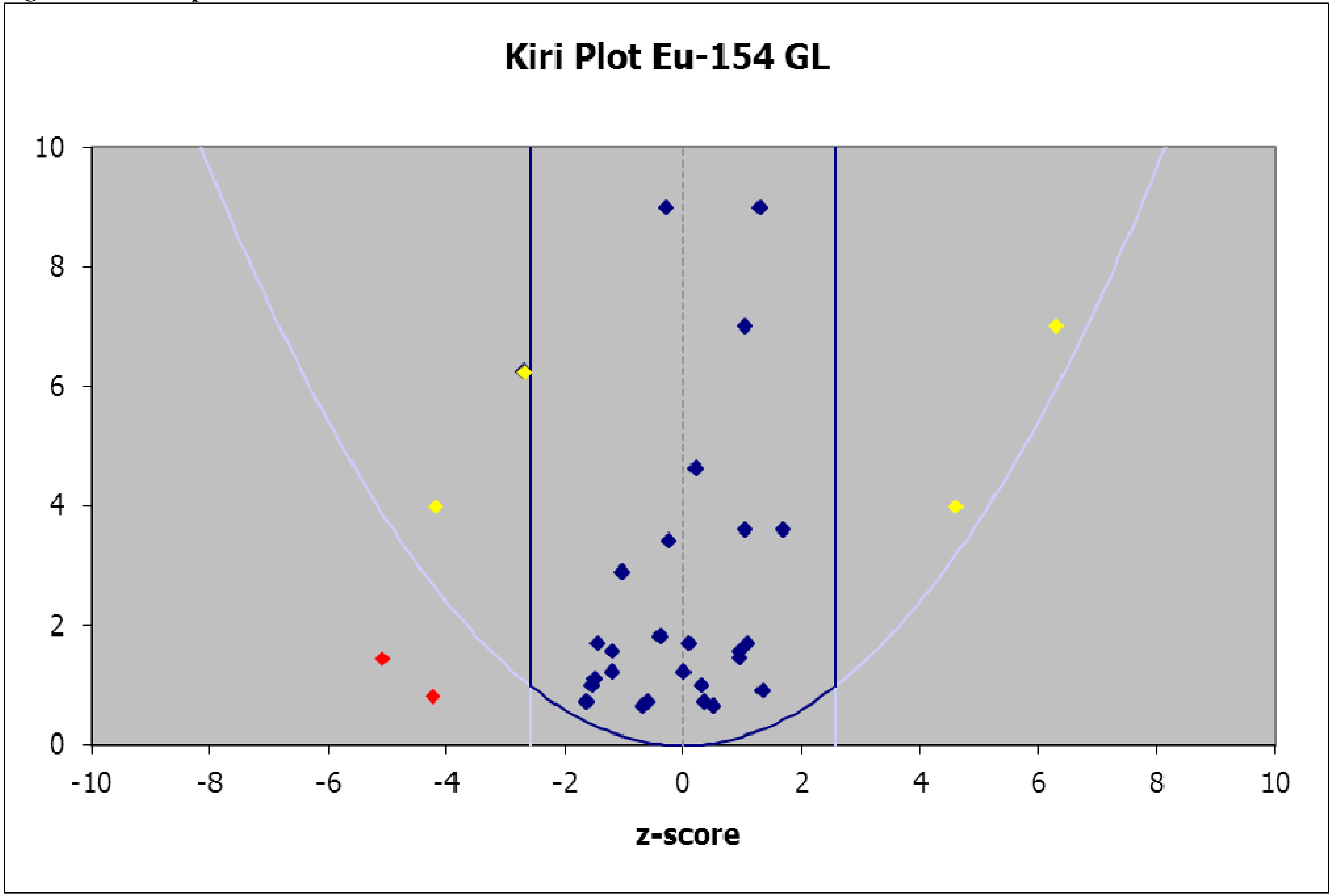


Figure 36A – Deviation Be-7 GH

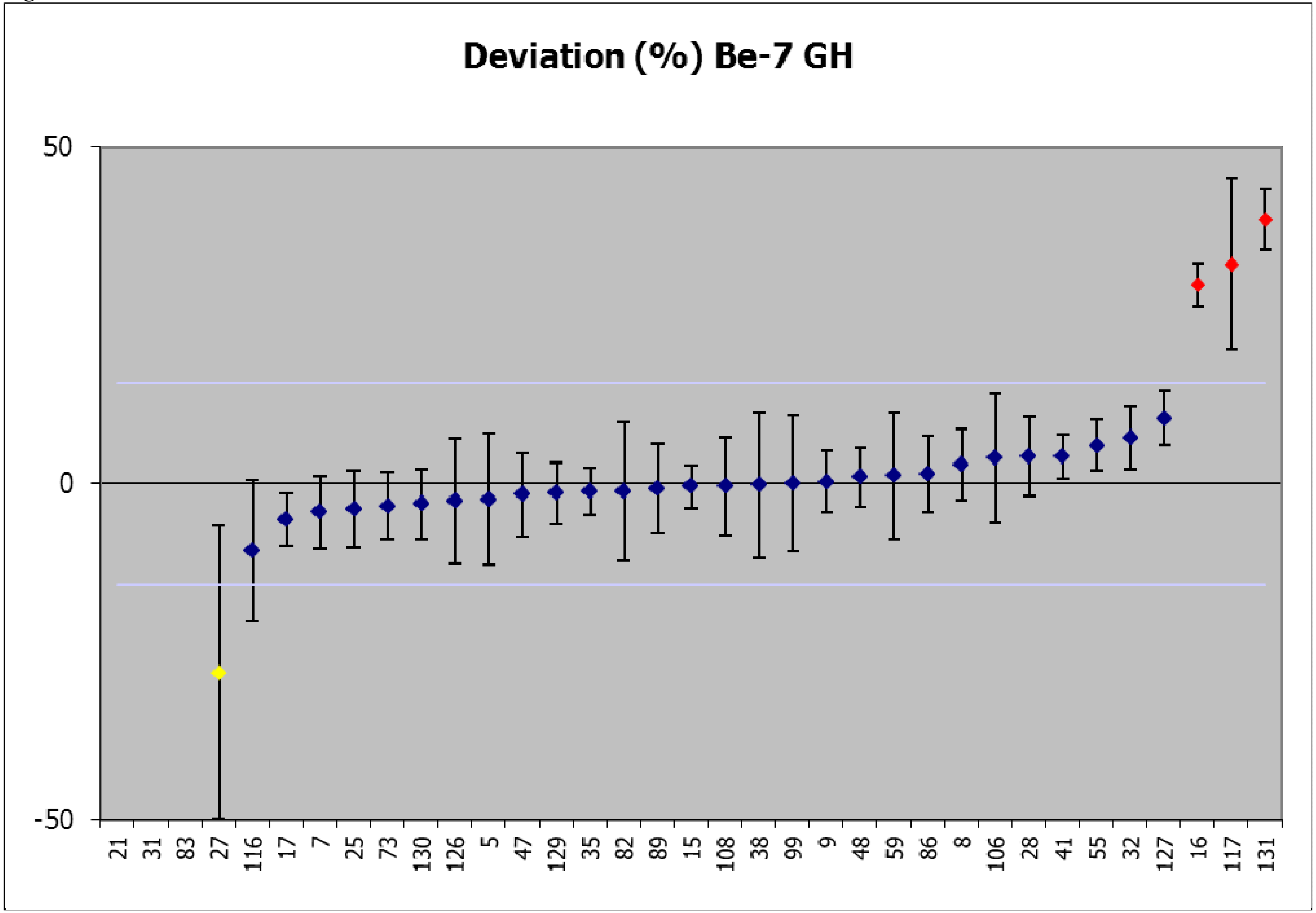


Figure 36B – Zeta score Be-7 GH

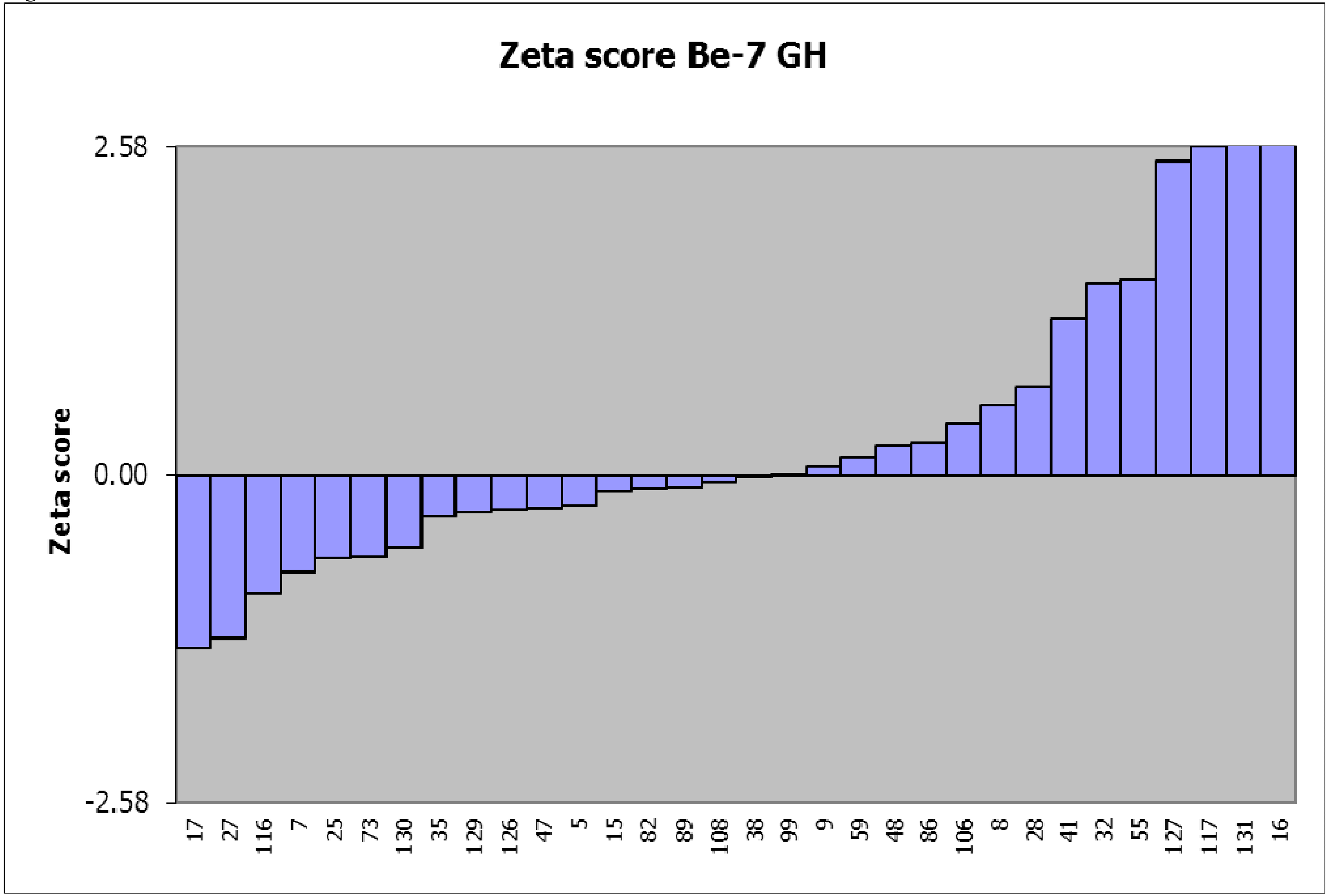


Figure 36C – Relative uncertainty Be-7 GH

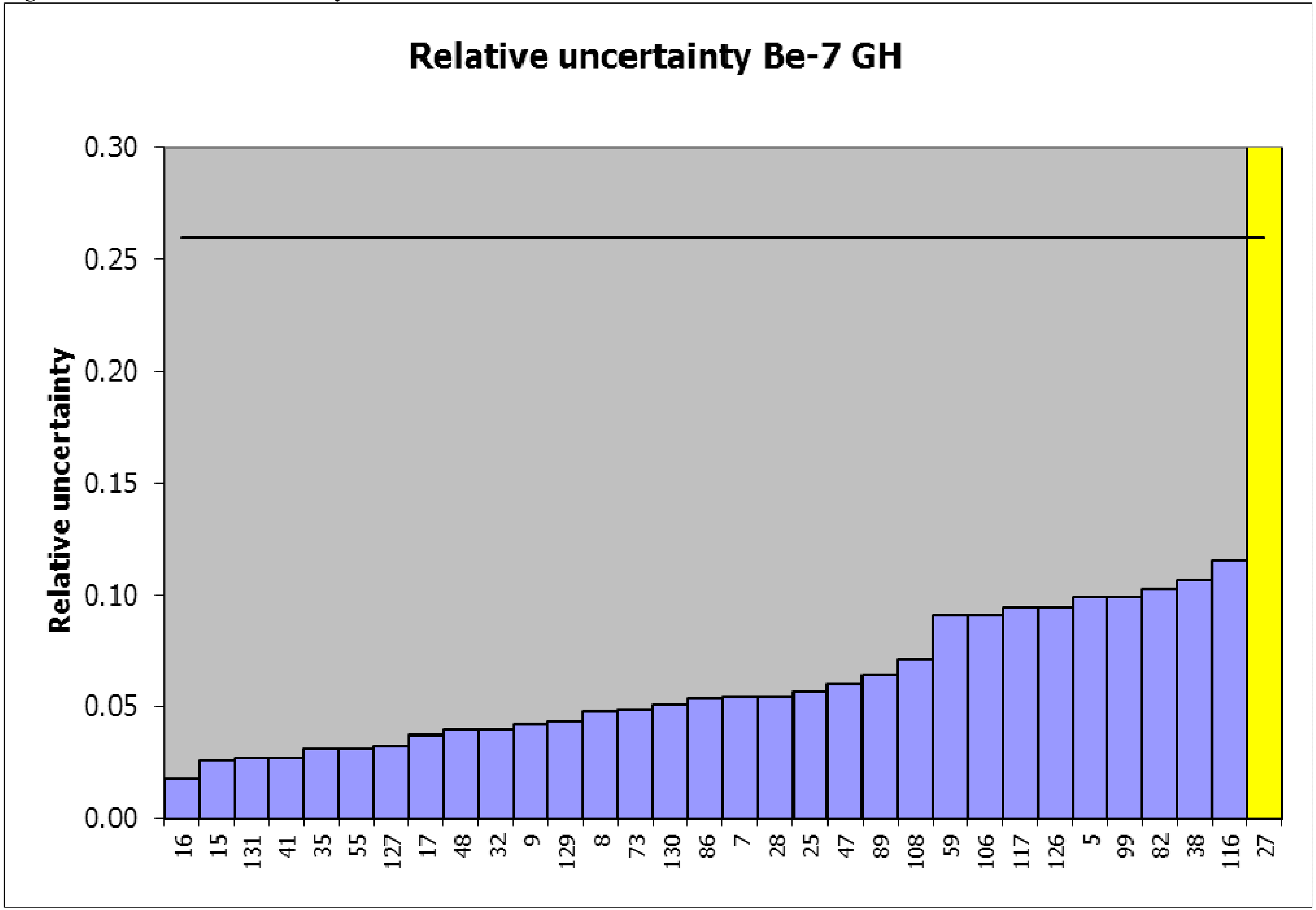


Figure 36D – Kiri plot Be-7 GH

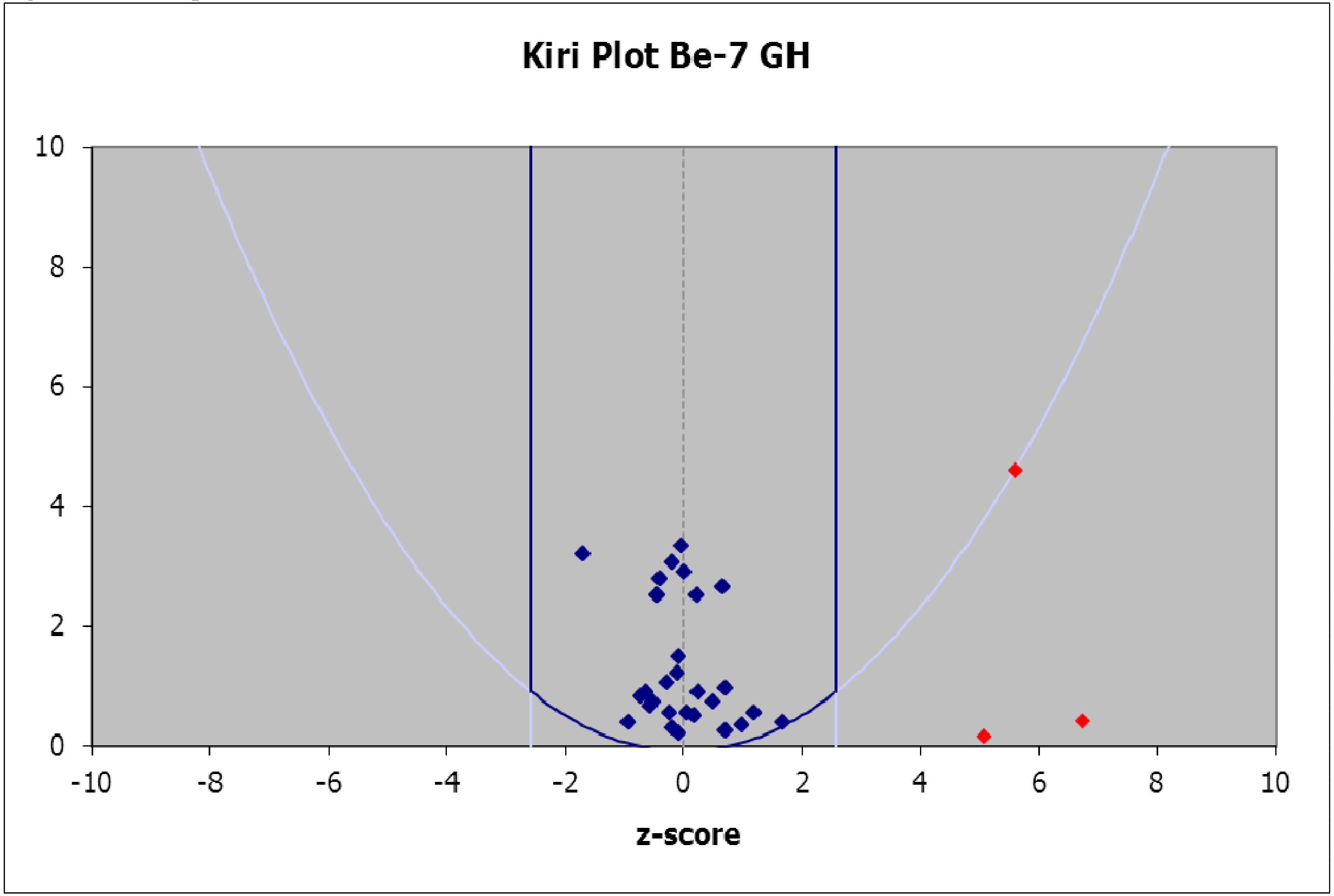


Figure 37A – Deviation Co-60 GH

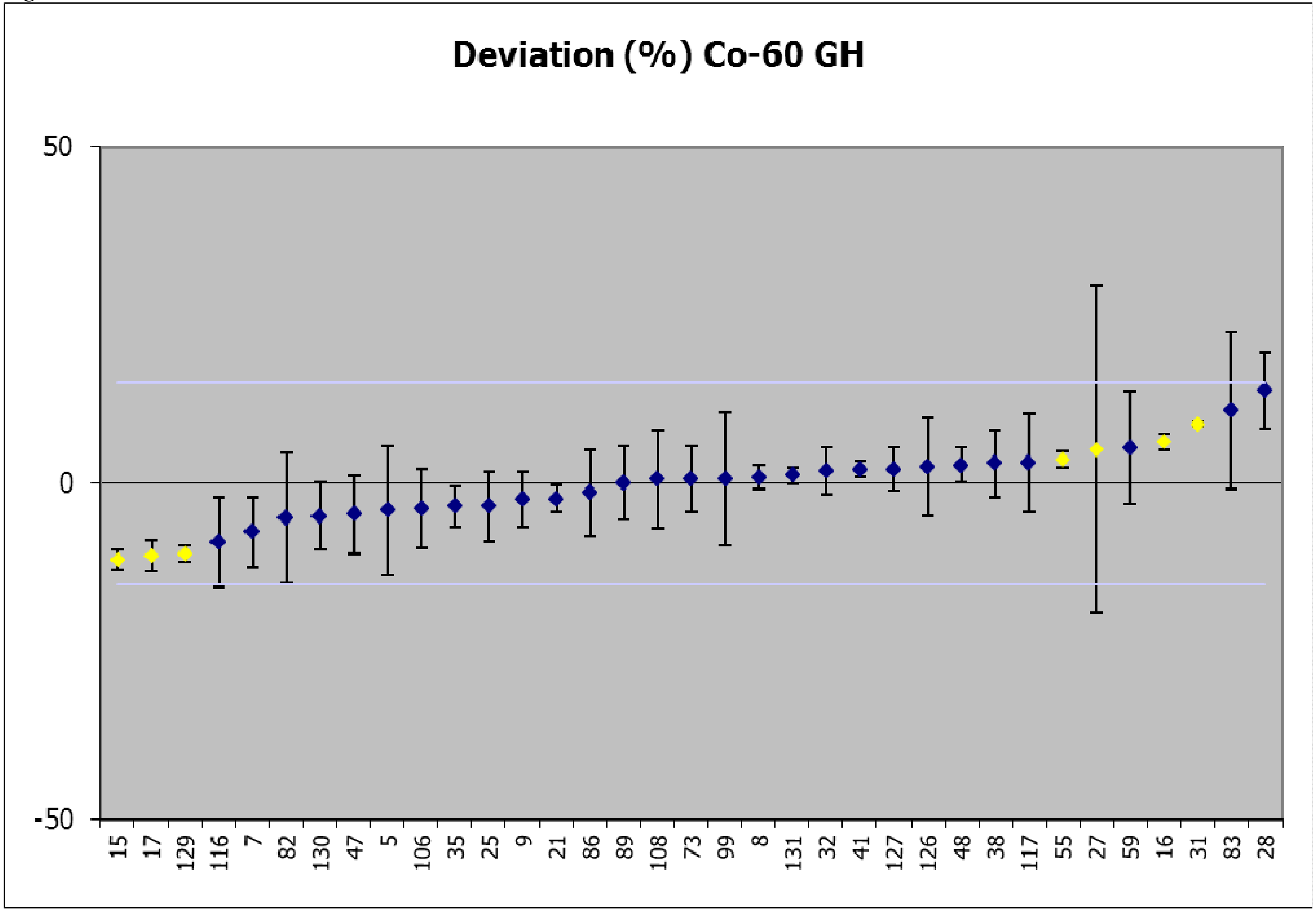


Figure 37B – Zeta score Co-60 GH

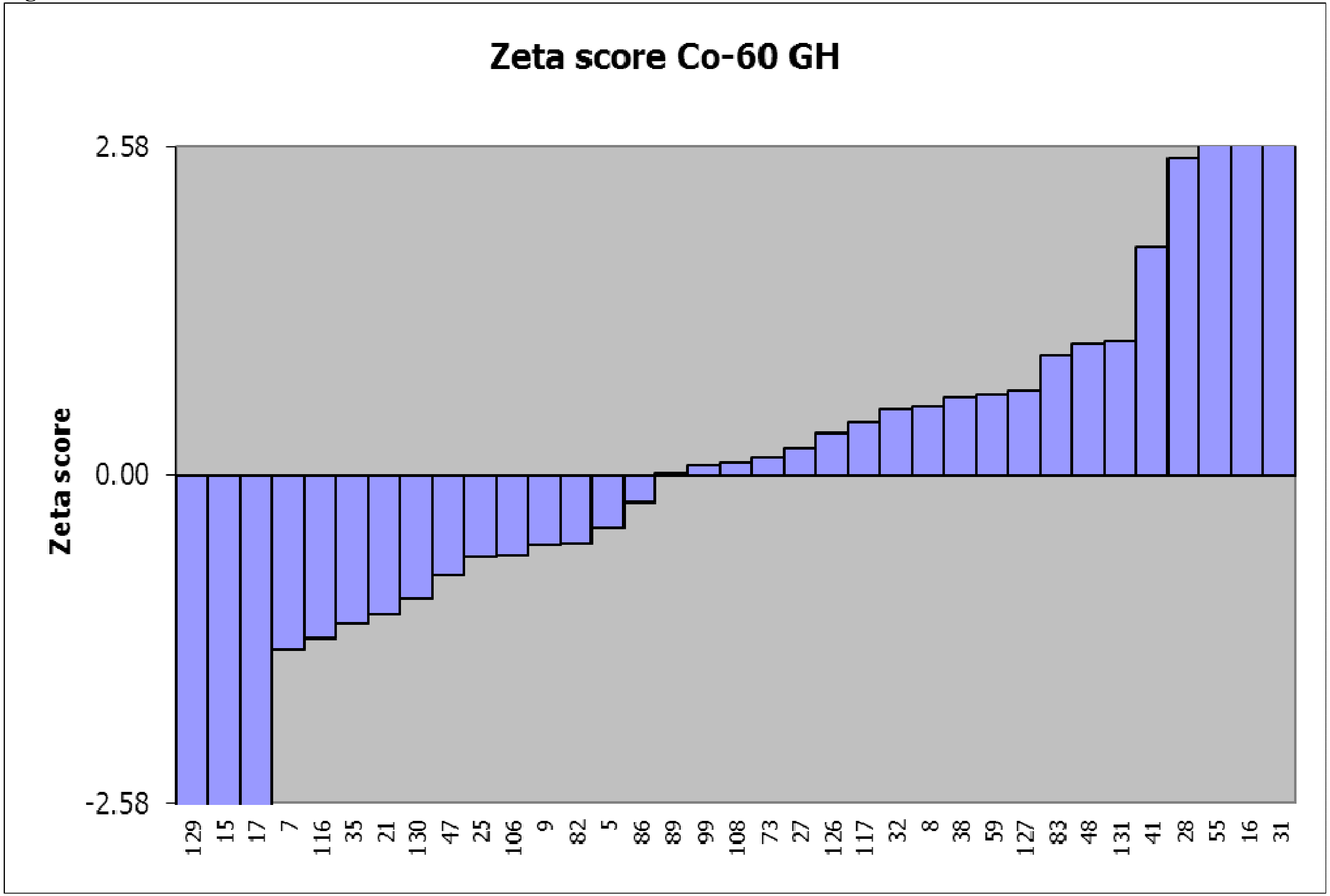


Figure 37C – Relative uncertainty Co-60 GH

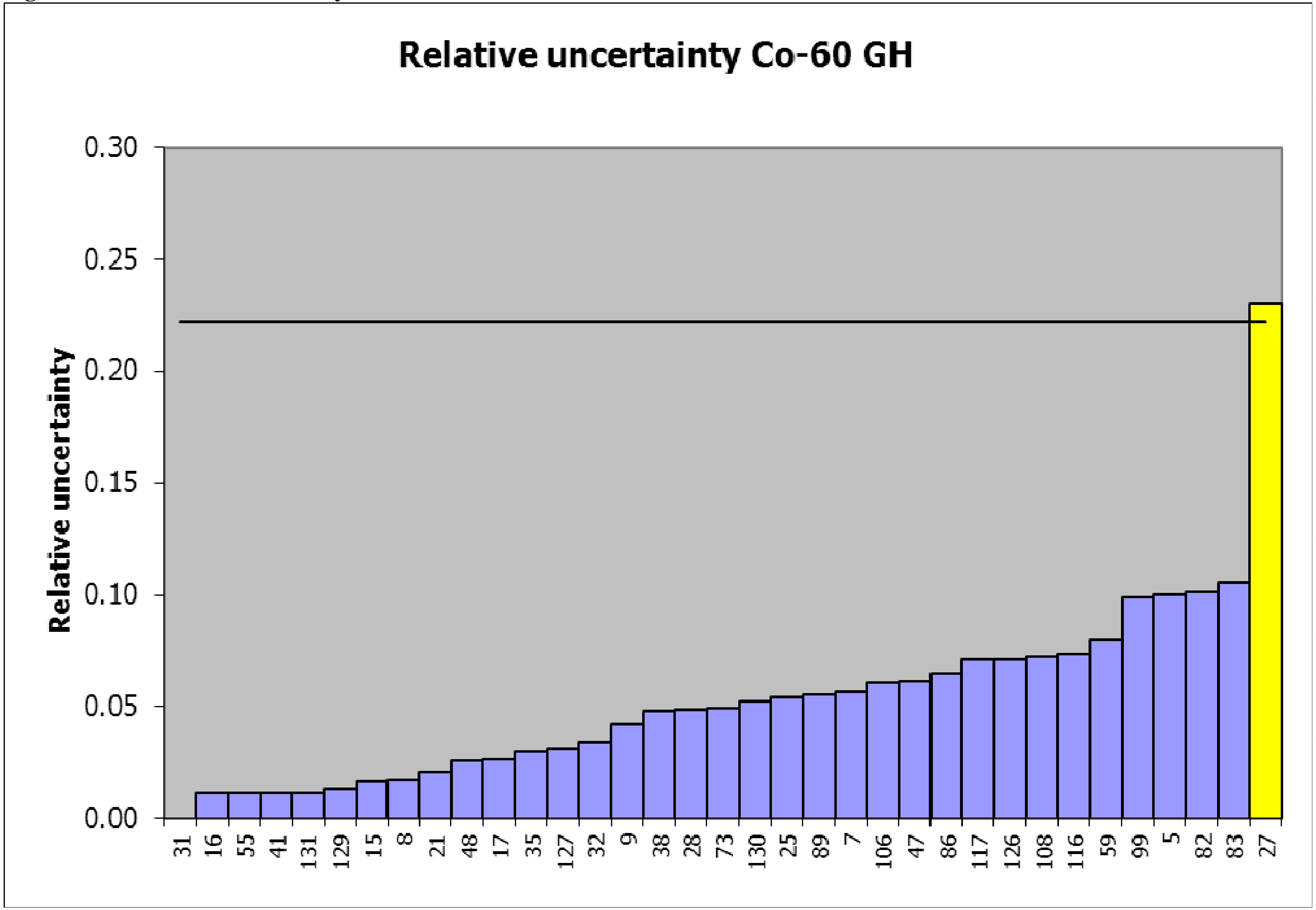


Figure 37D – Kiri plot Co-60 GH

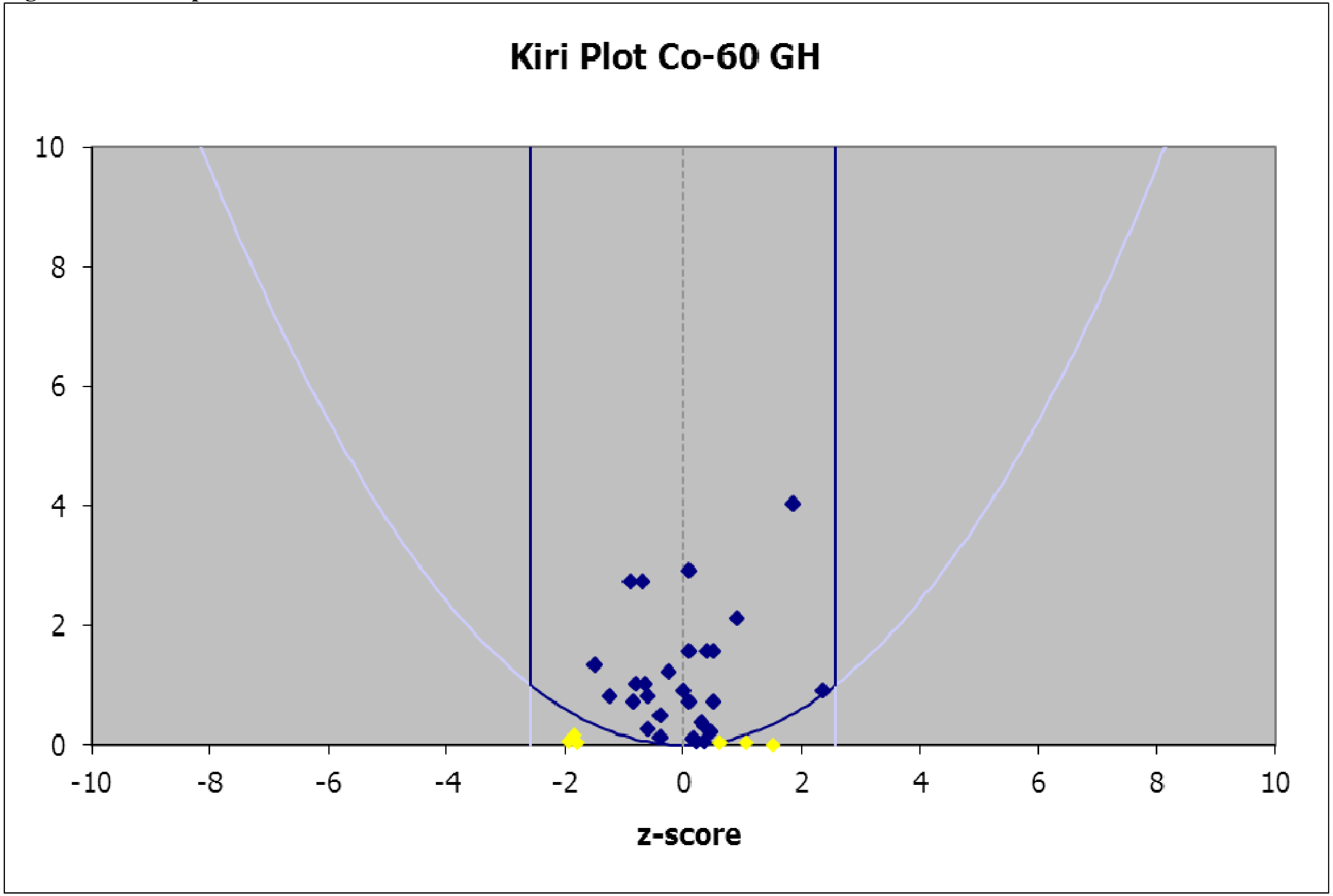


Figure 38A – Deviation Zr-95 GH

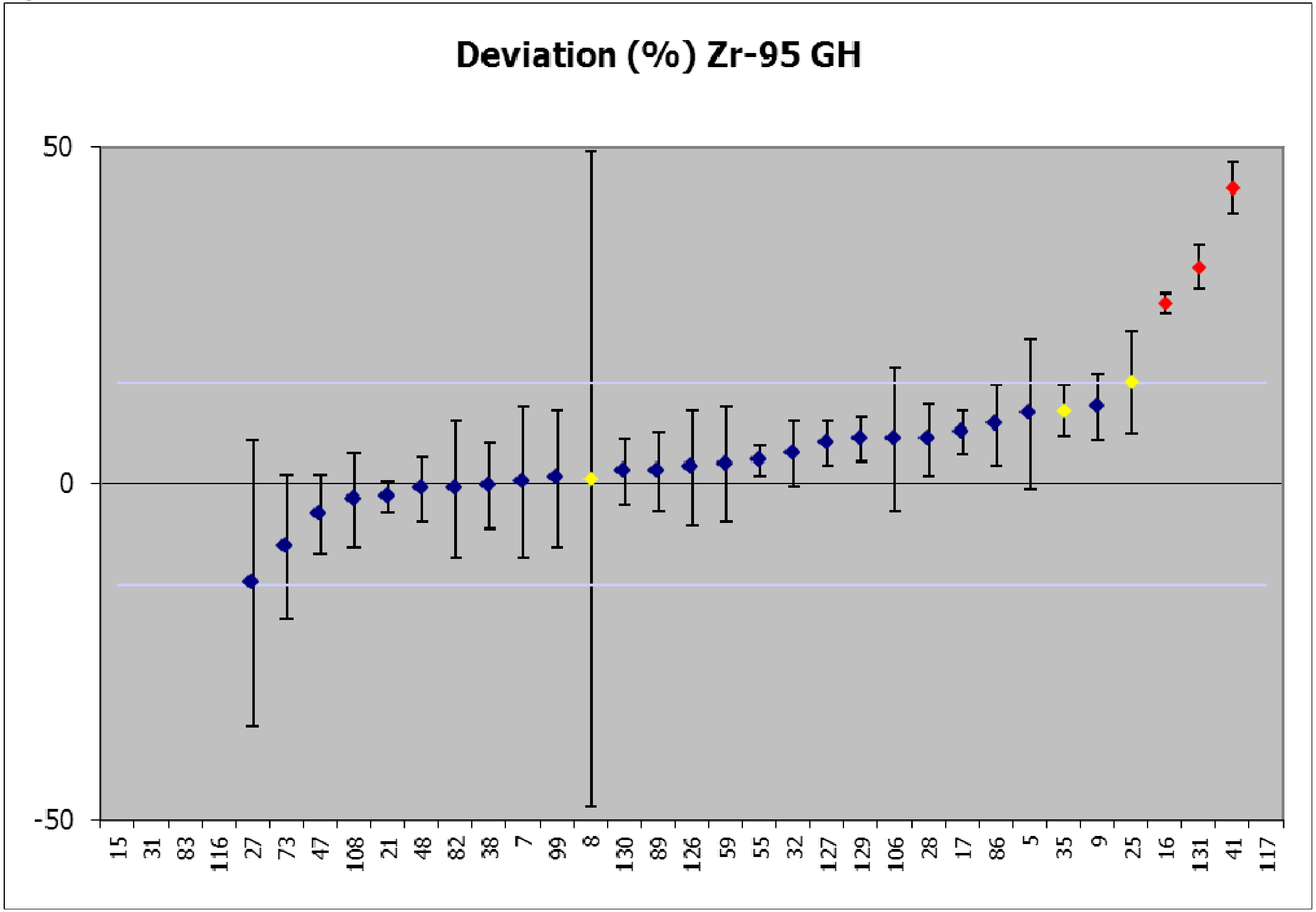


Figure 38B – Zeta score Zr-95 GH

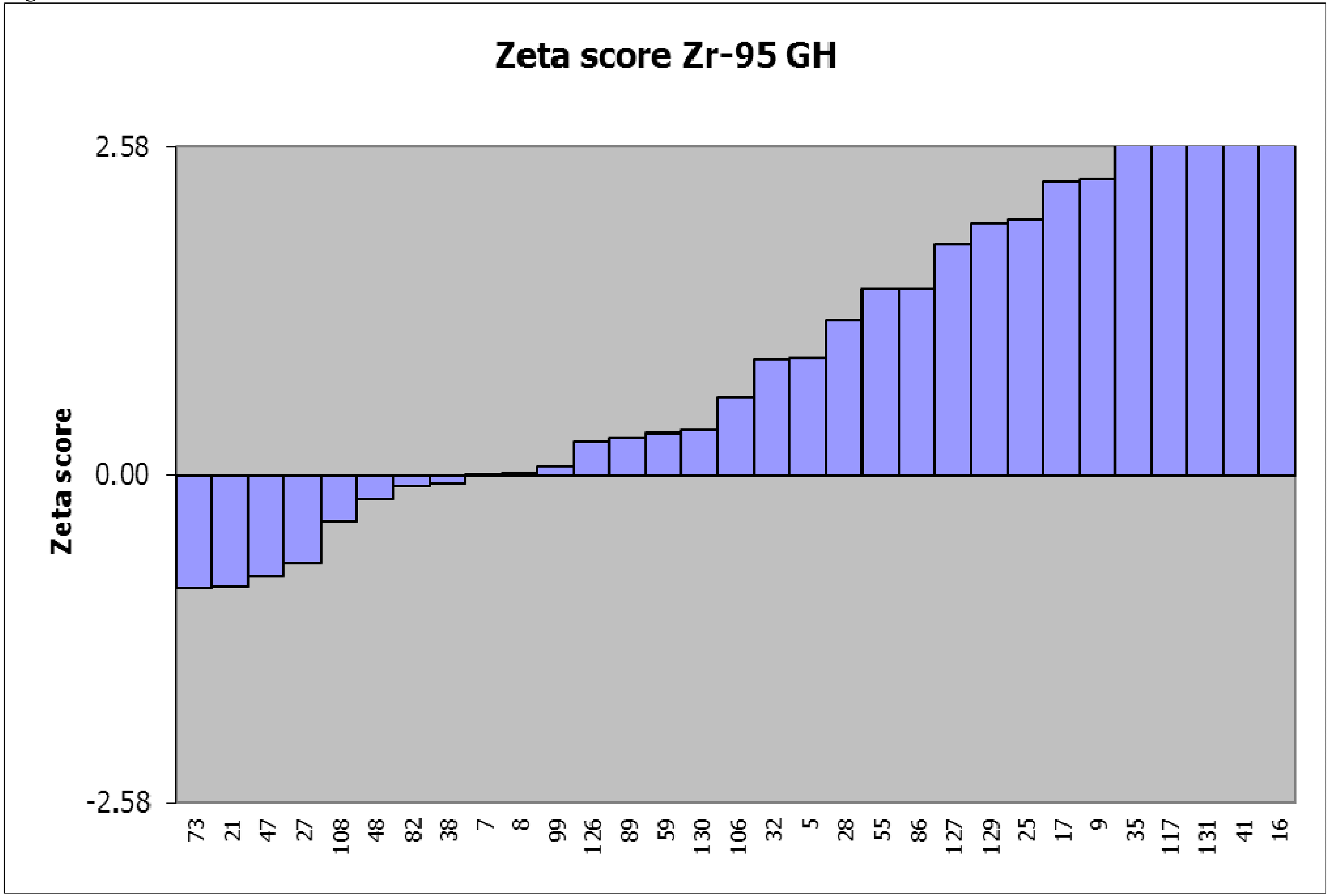


Figure 38C – Relative uncertainty Zr-95 GH

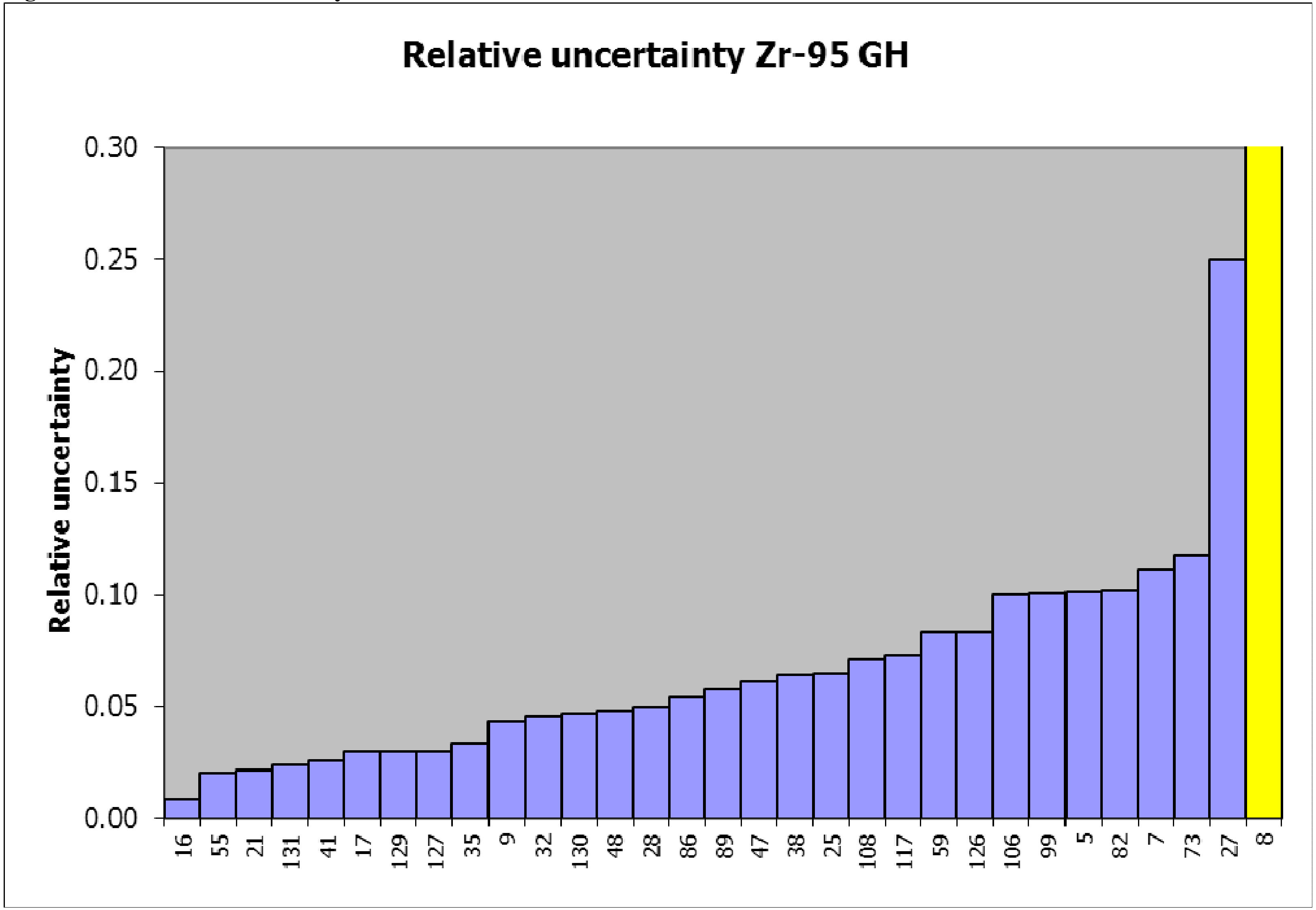


Figure 38D – Kiri plot Zr-95 GH

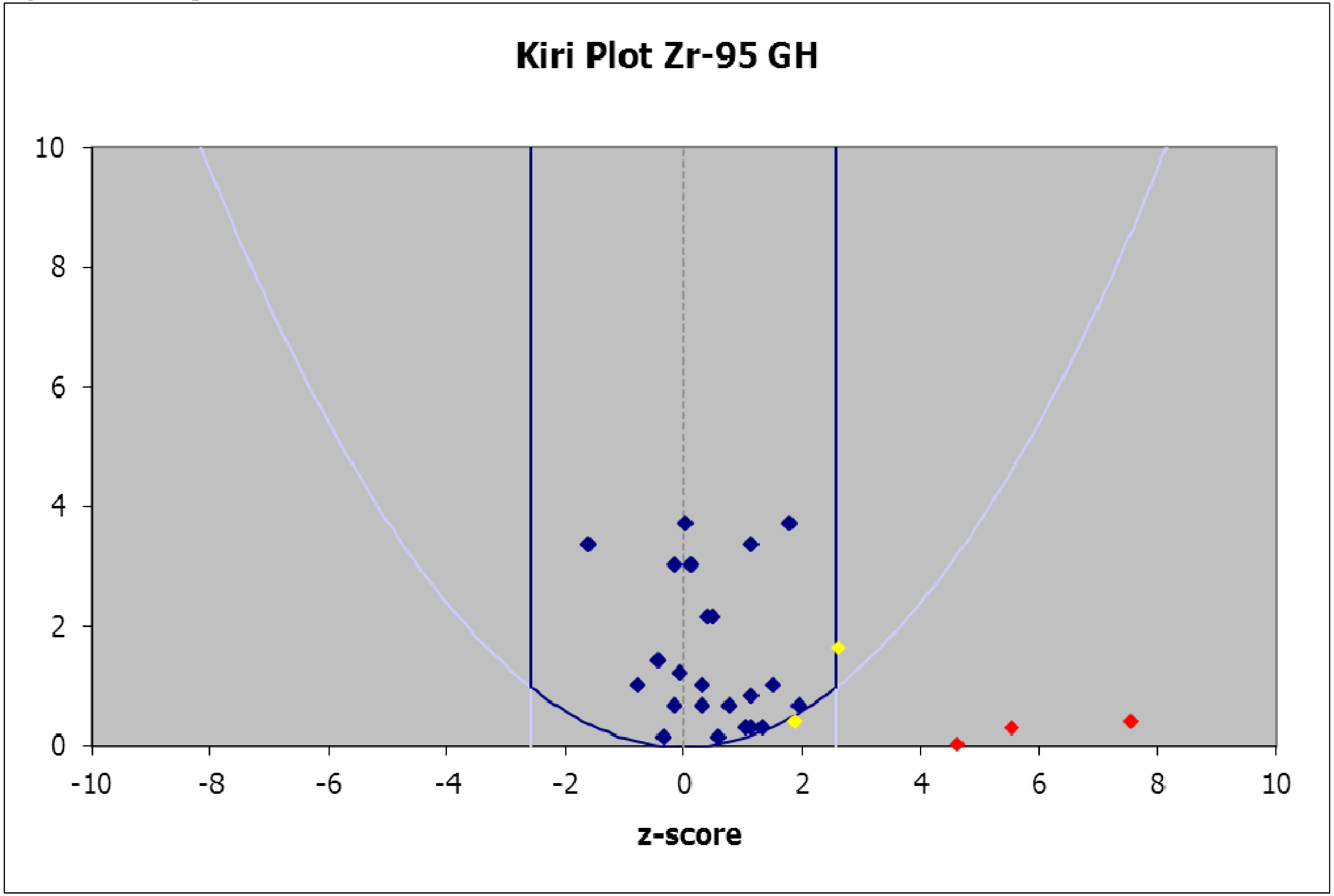


Figure 39A – Deviation Nb-95 GH

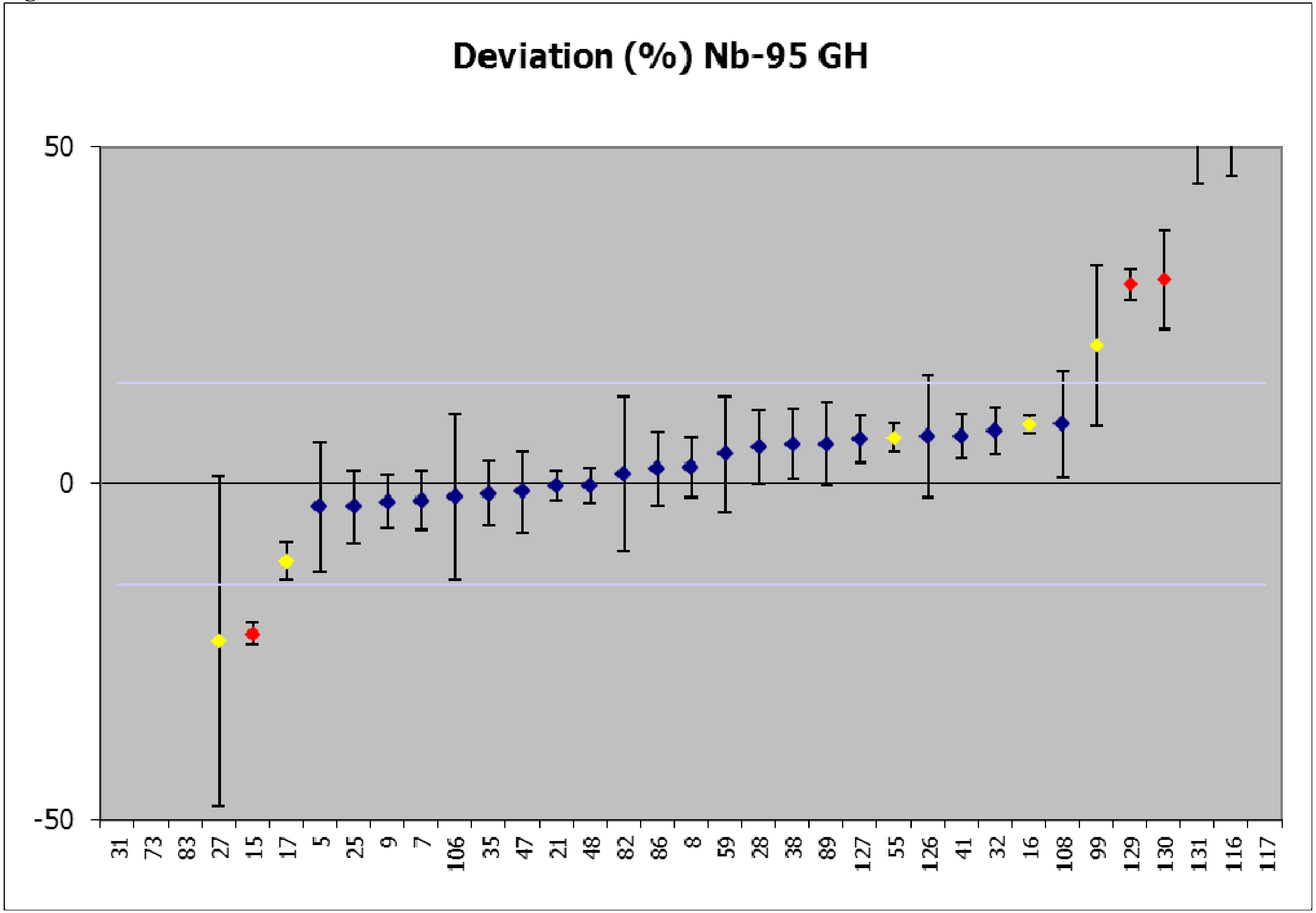


Figure 39B – Zeta score Nb-95 GH

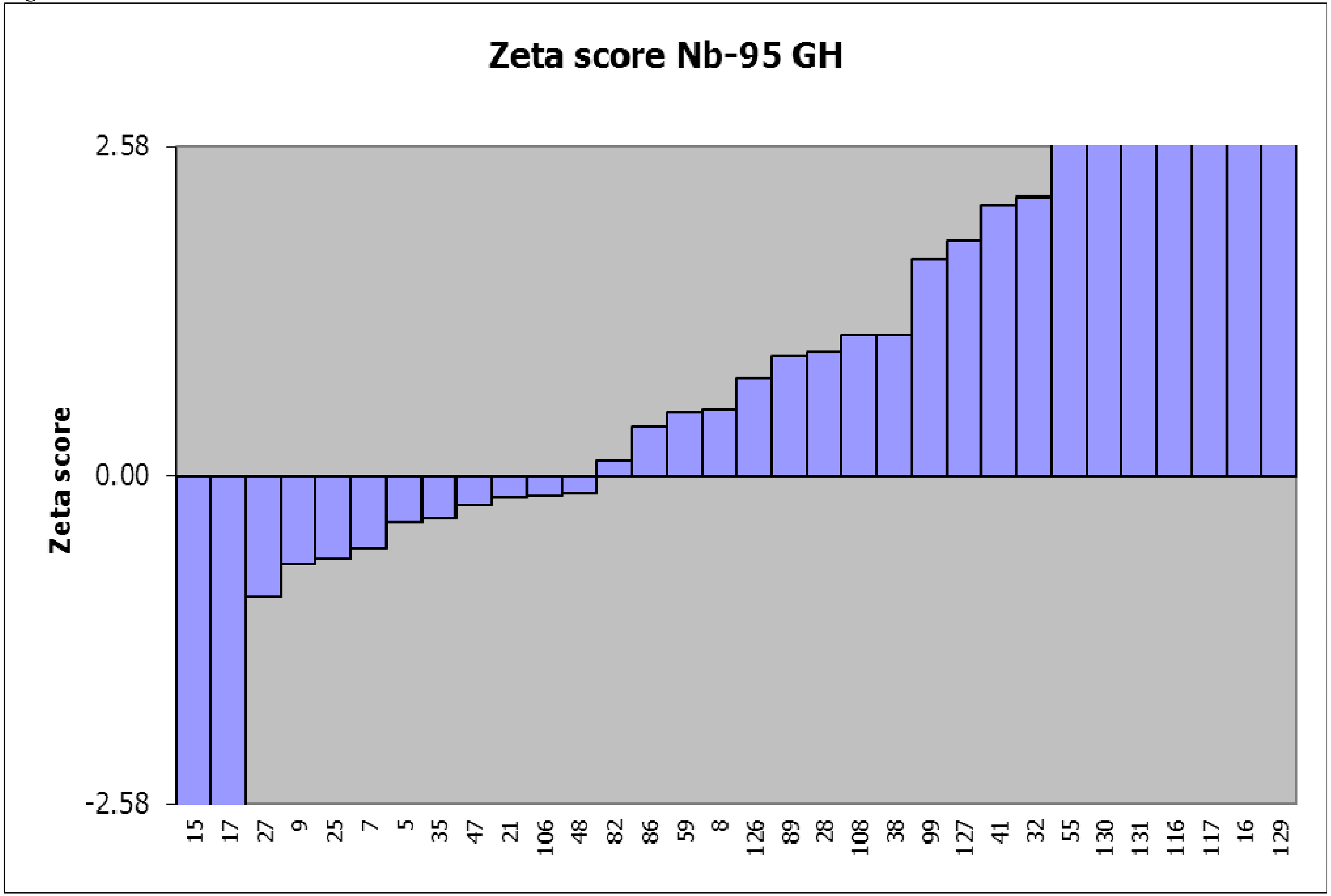


Figure 39C – Relative uncertainty Nb-95 GH

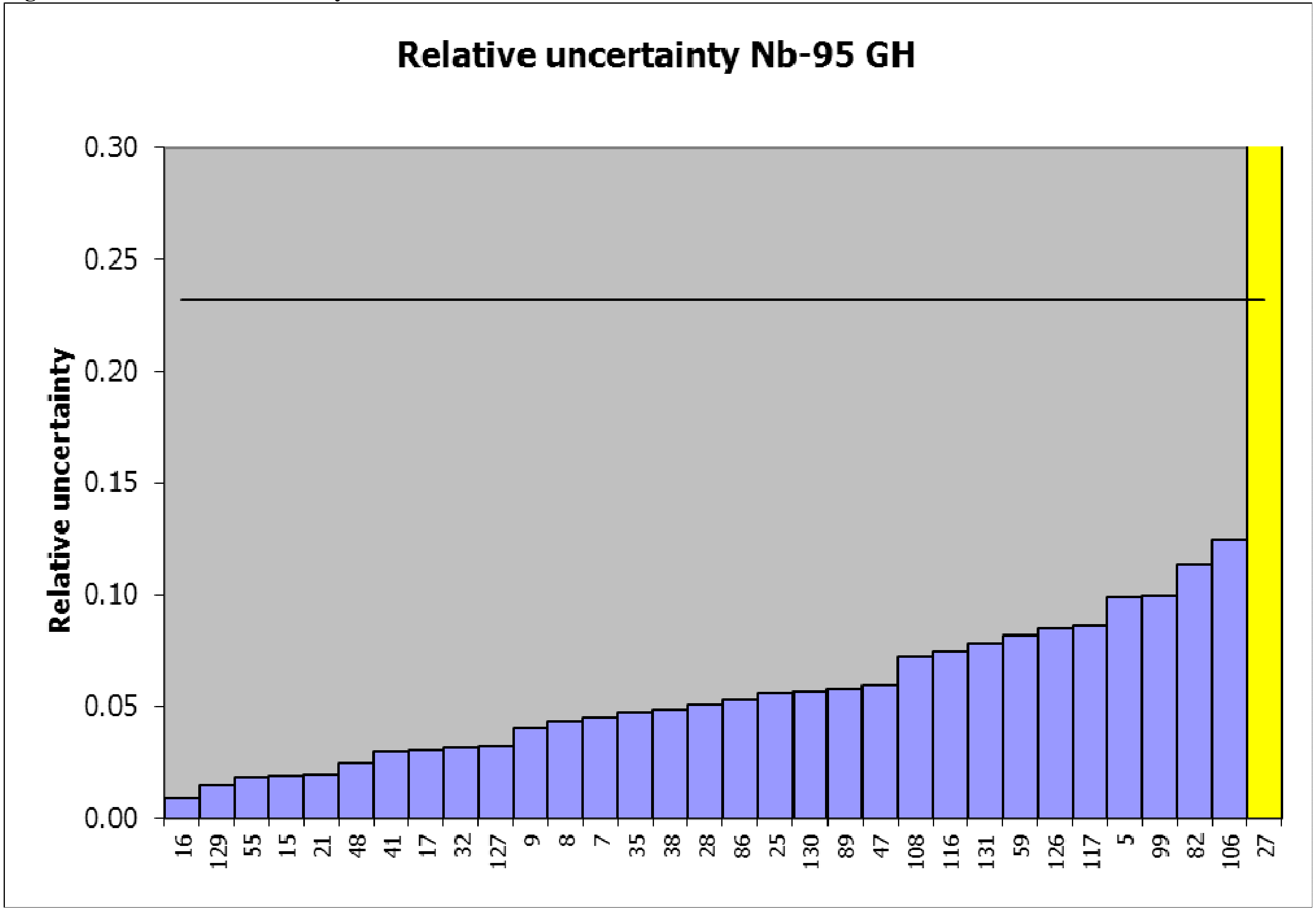


Figure 39D – Kiri plot Nb-95 GH

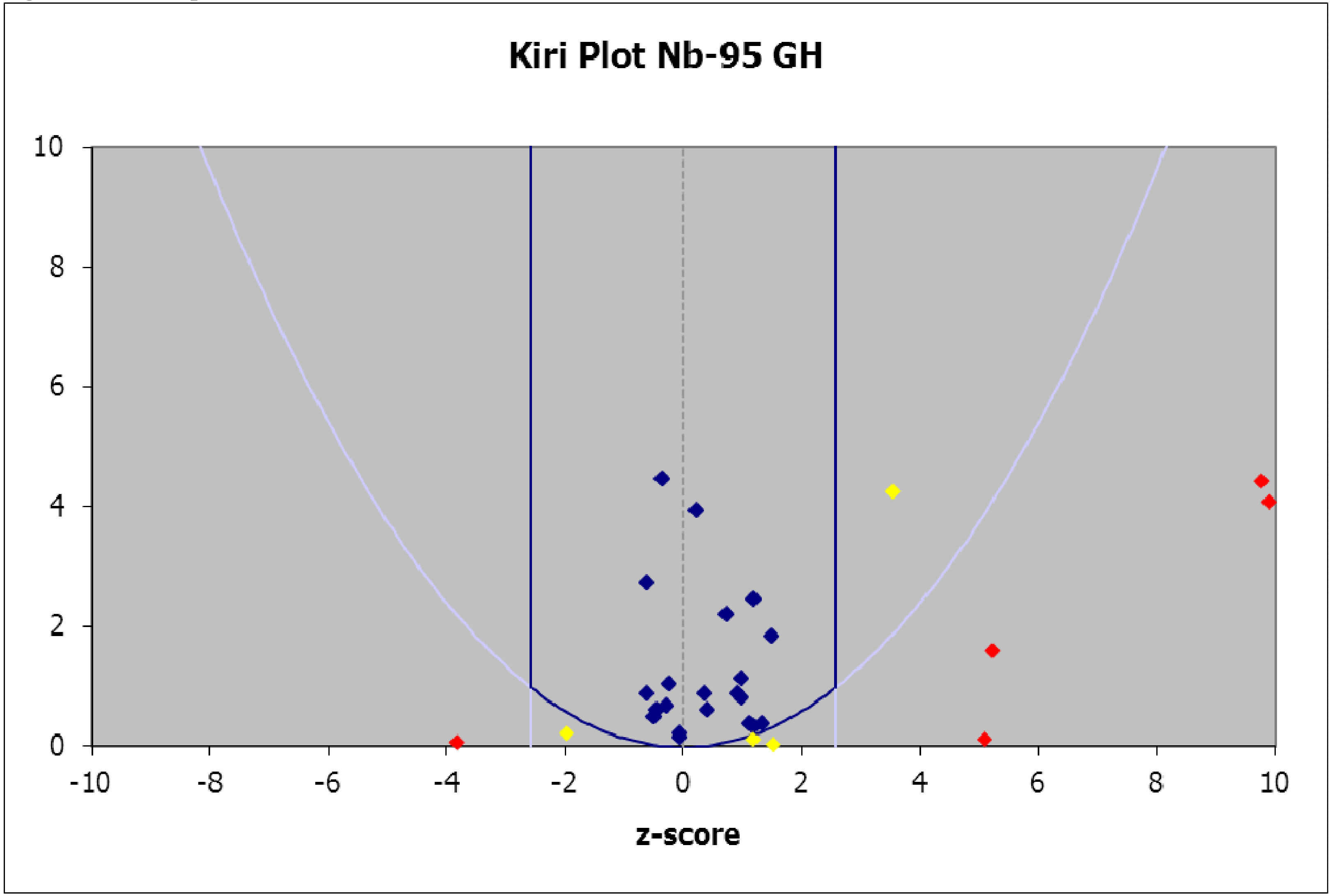


Figure 40A – Deviation Cs-134 GH

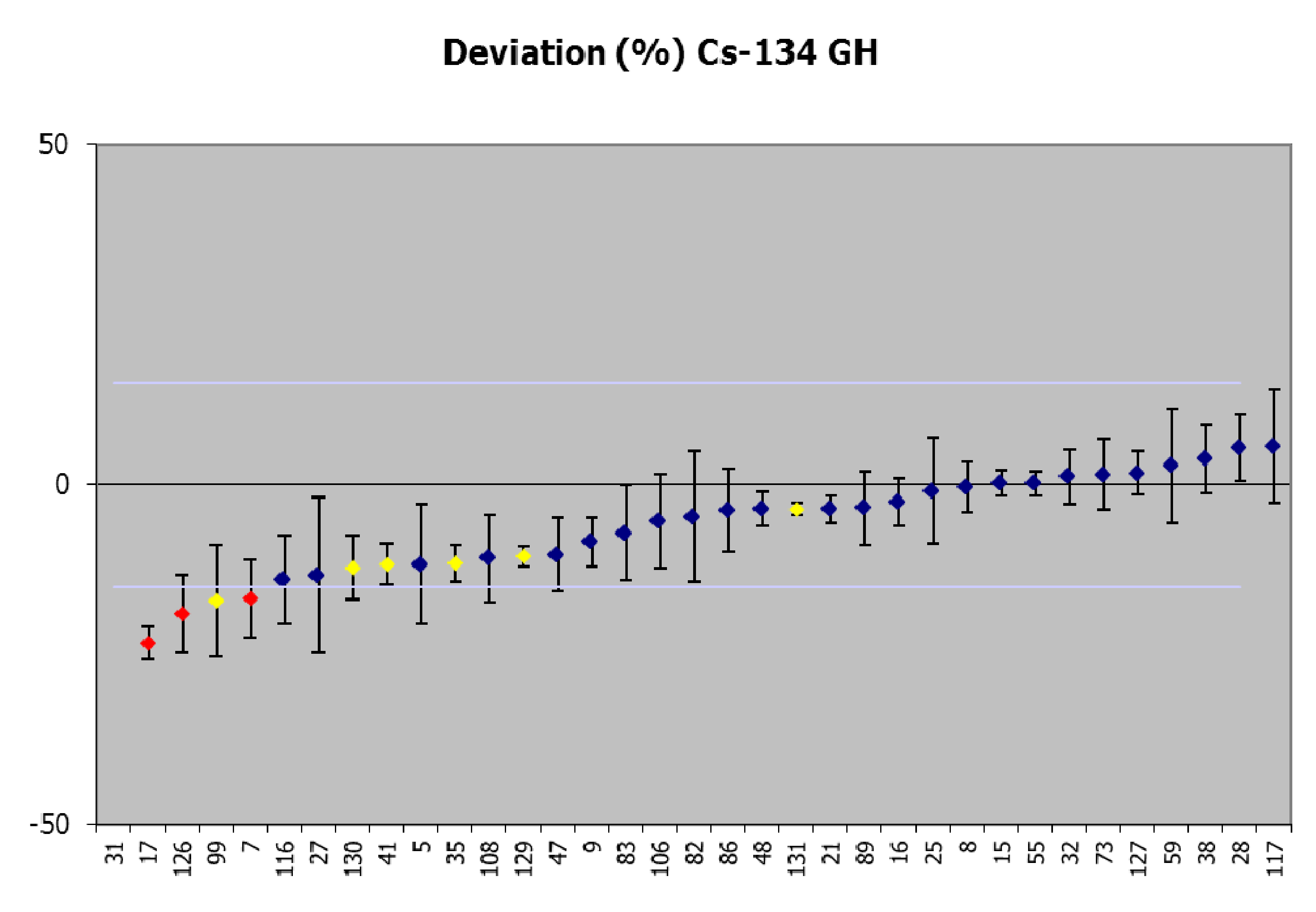


Figure 40B – Zeta score Cs-134 GH

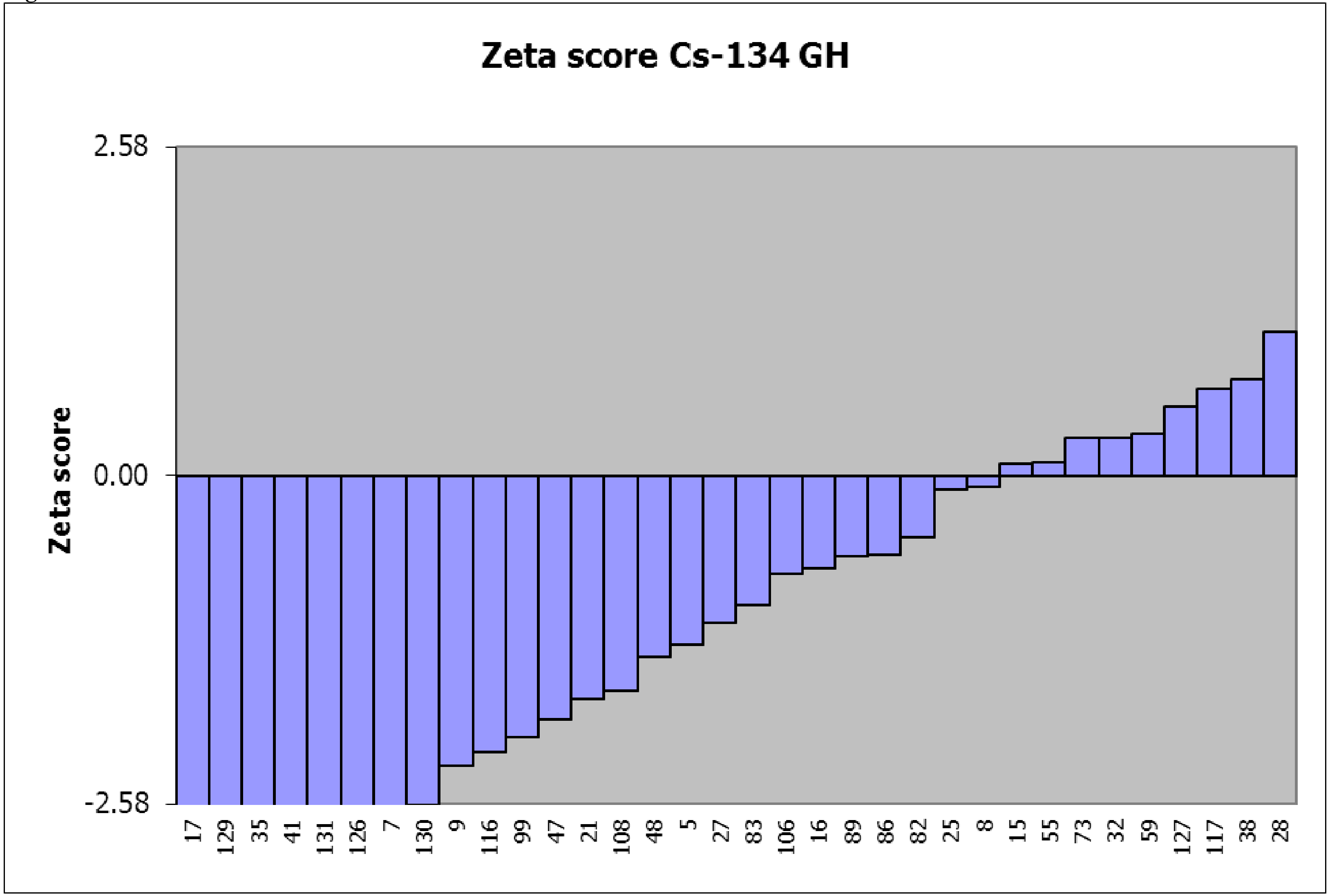


Figure 40C – Relative uncertainty Cs-134 GH

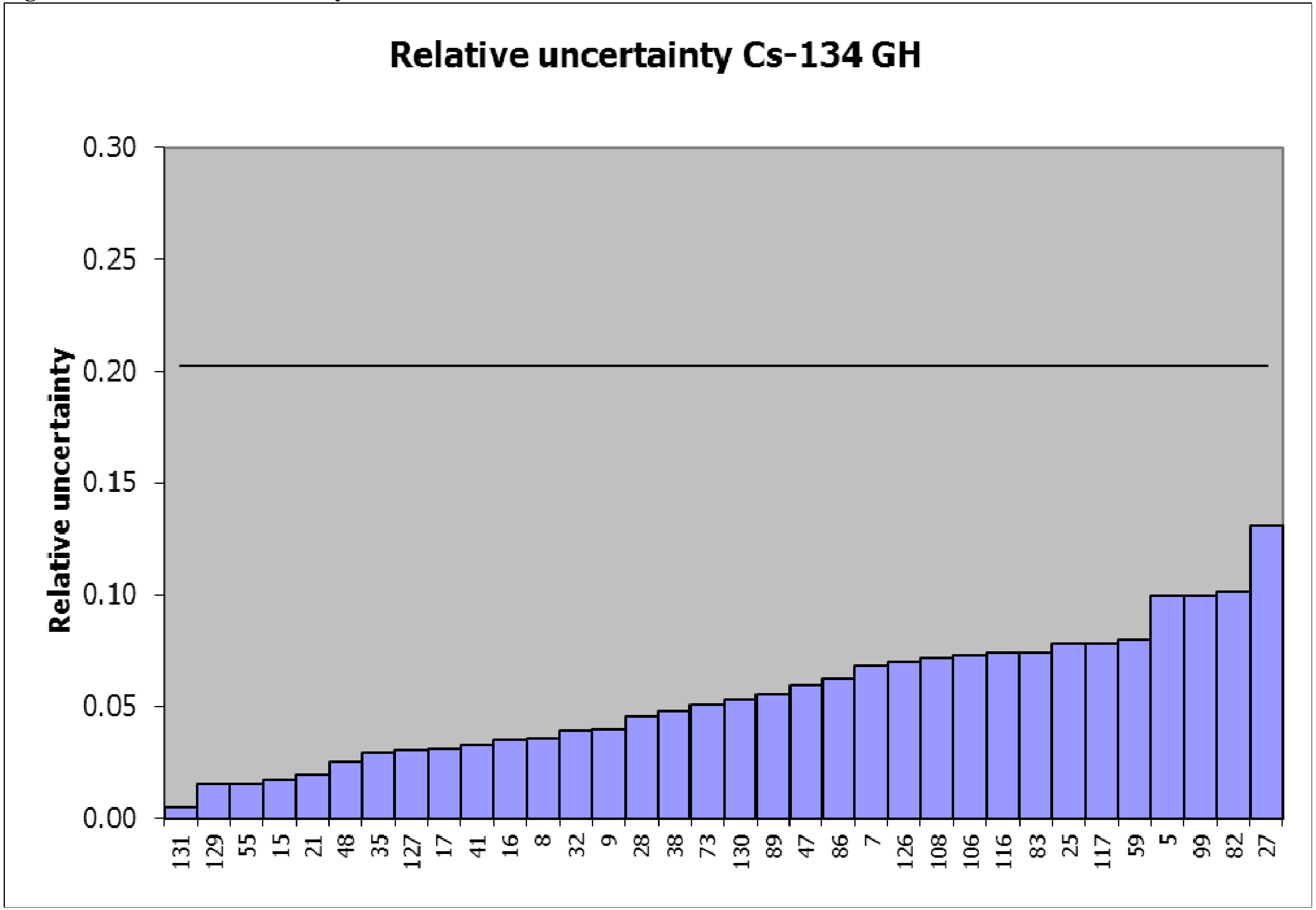


Figure 40D – Kiri plot Cs-134 GH

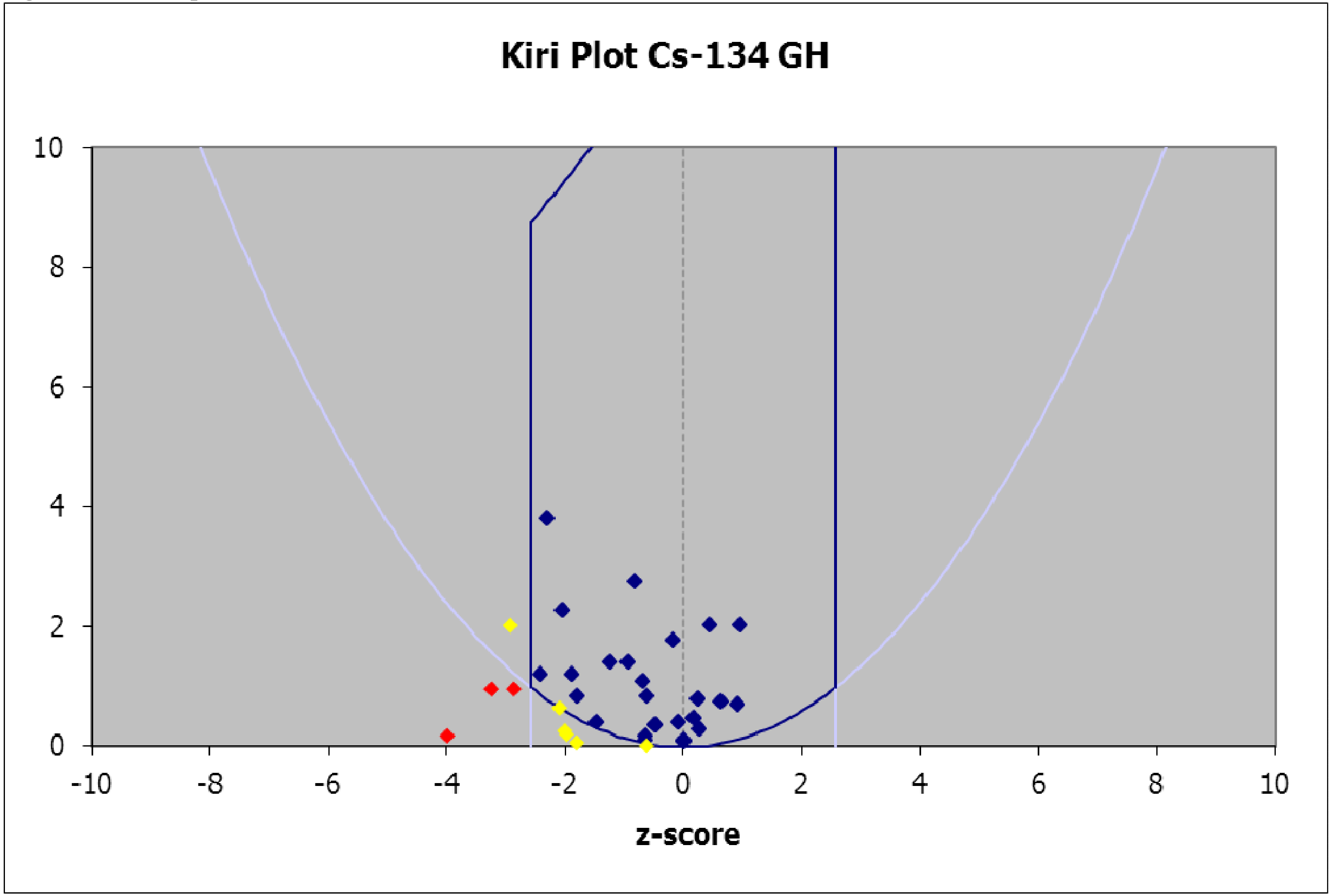


Figure 41A – Deviation Cs-137 GH

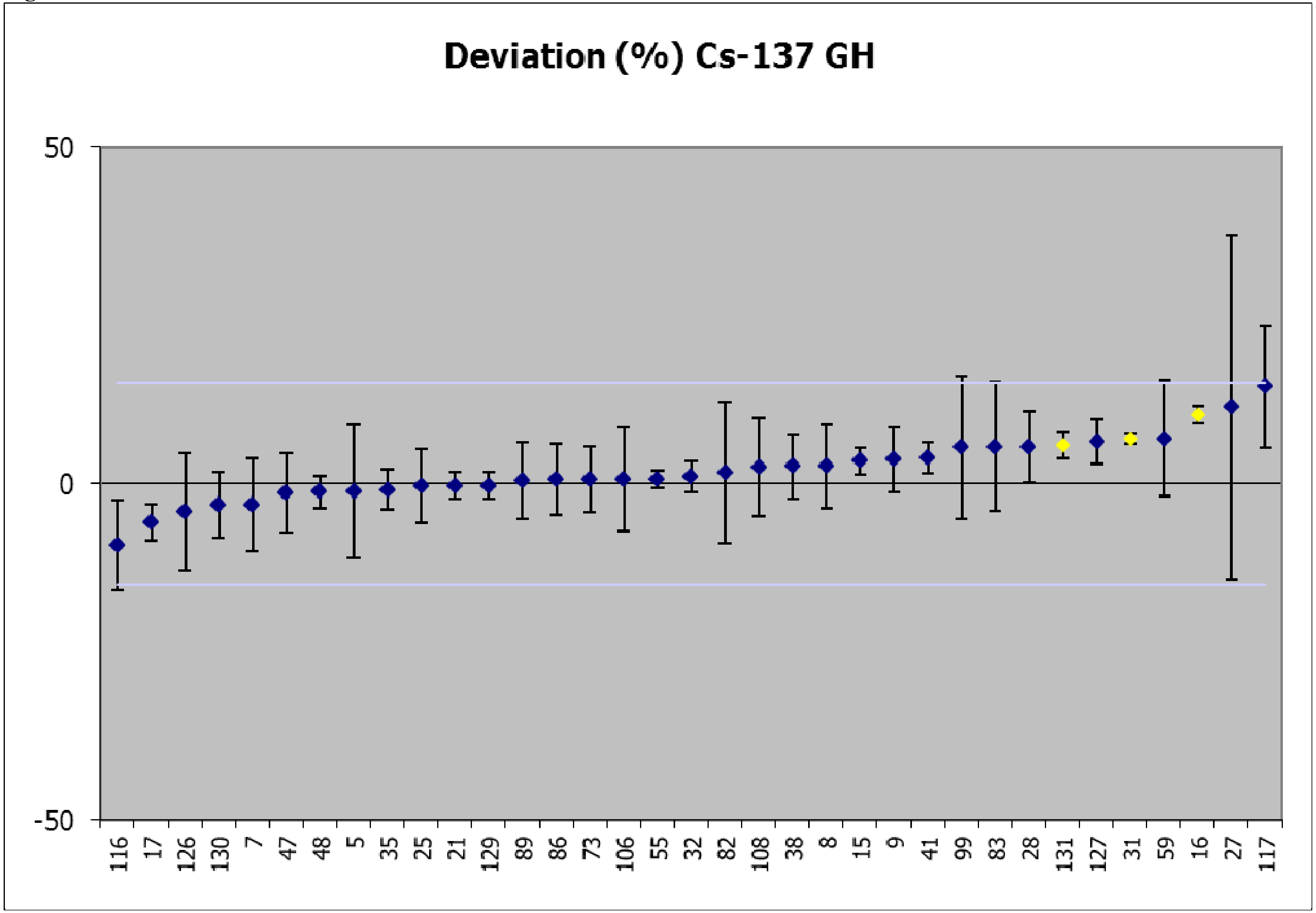


Figure 41B – Zeta score Cs-137 GH

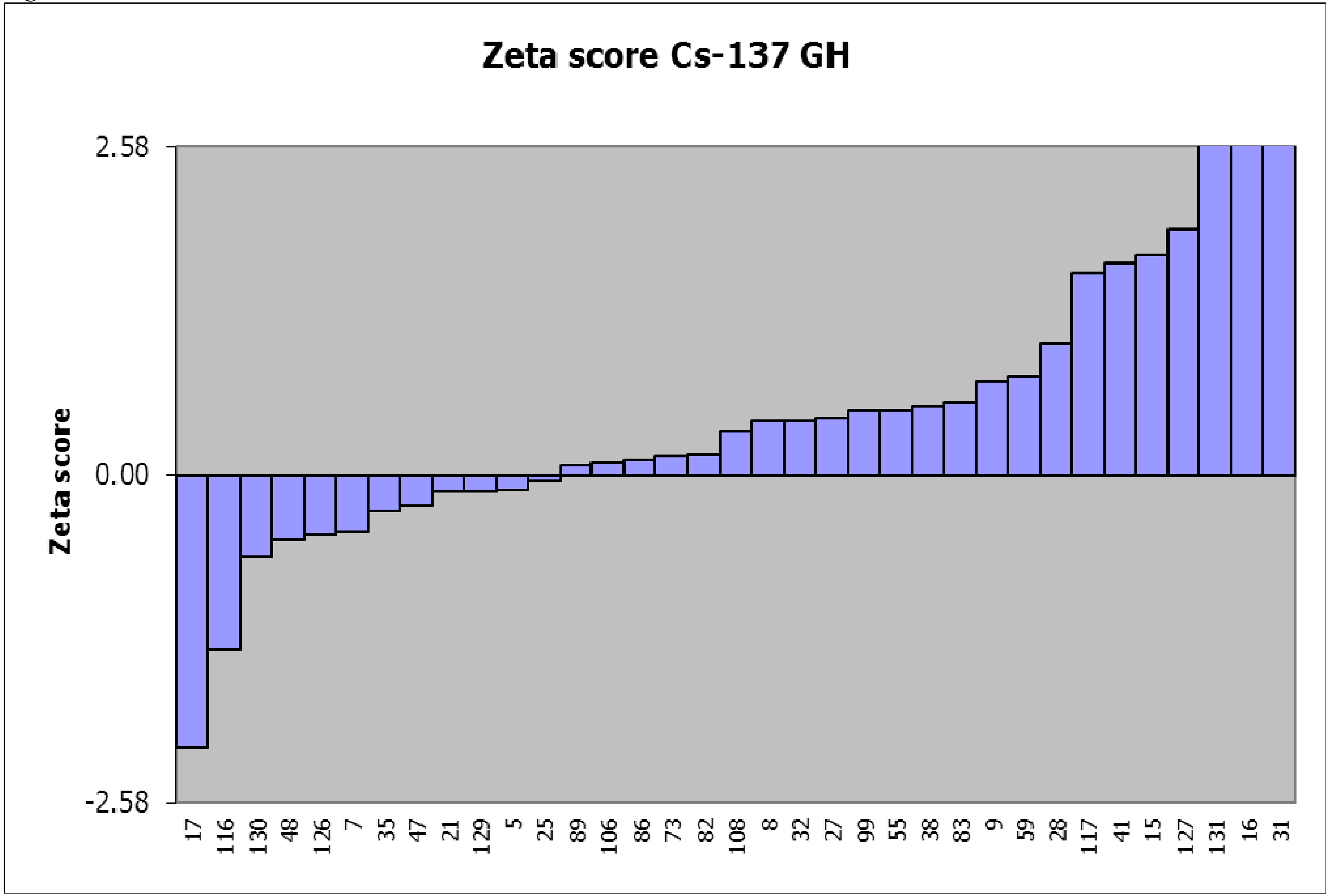


Figure 41C – Relative uncertainty Cs-137 GH

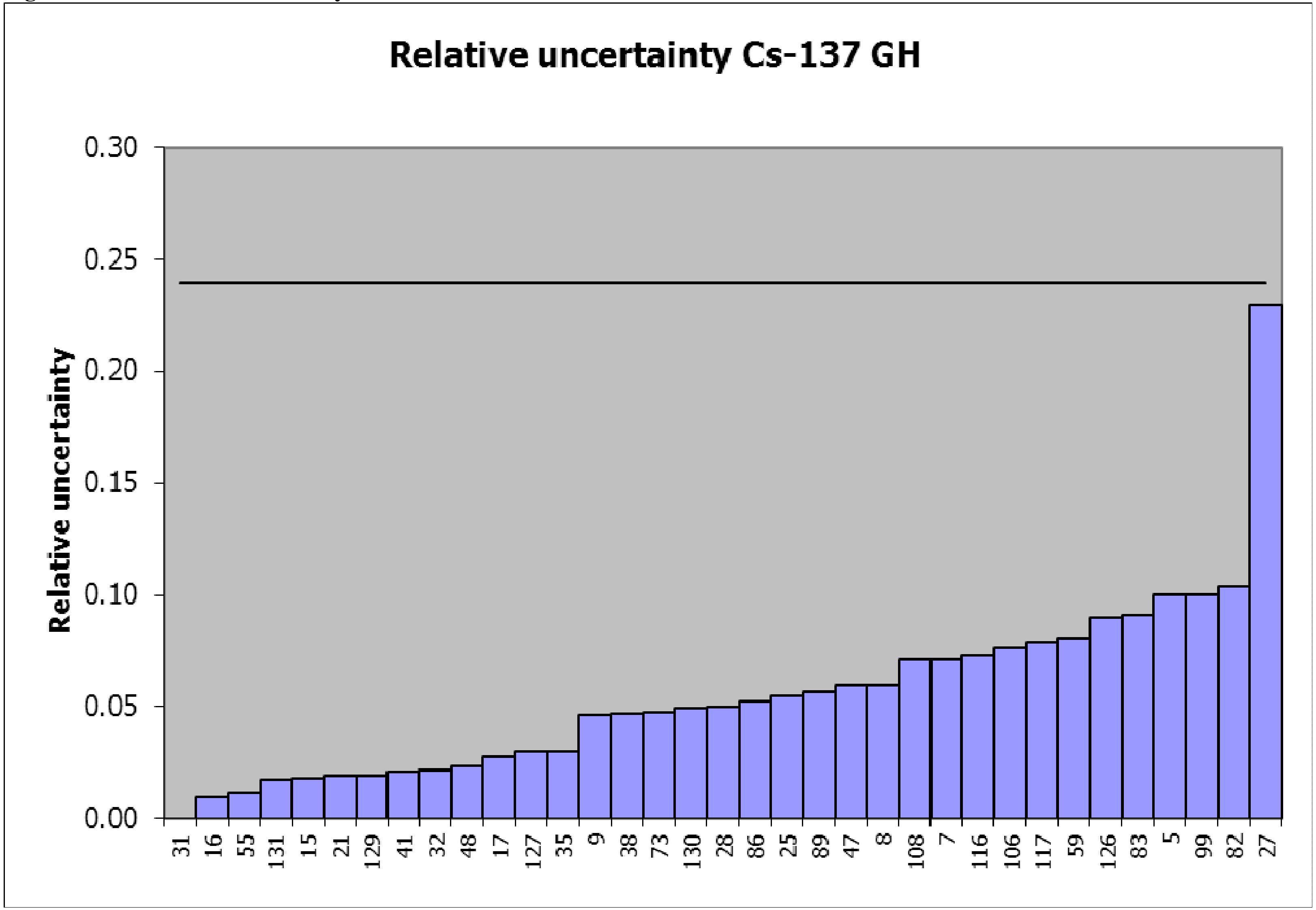


Figure 41D – Kiri plot Cs-137 GH

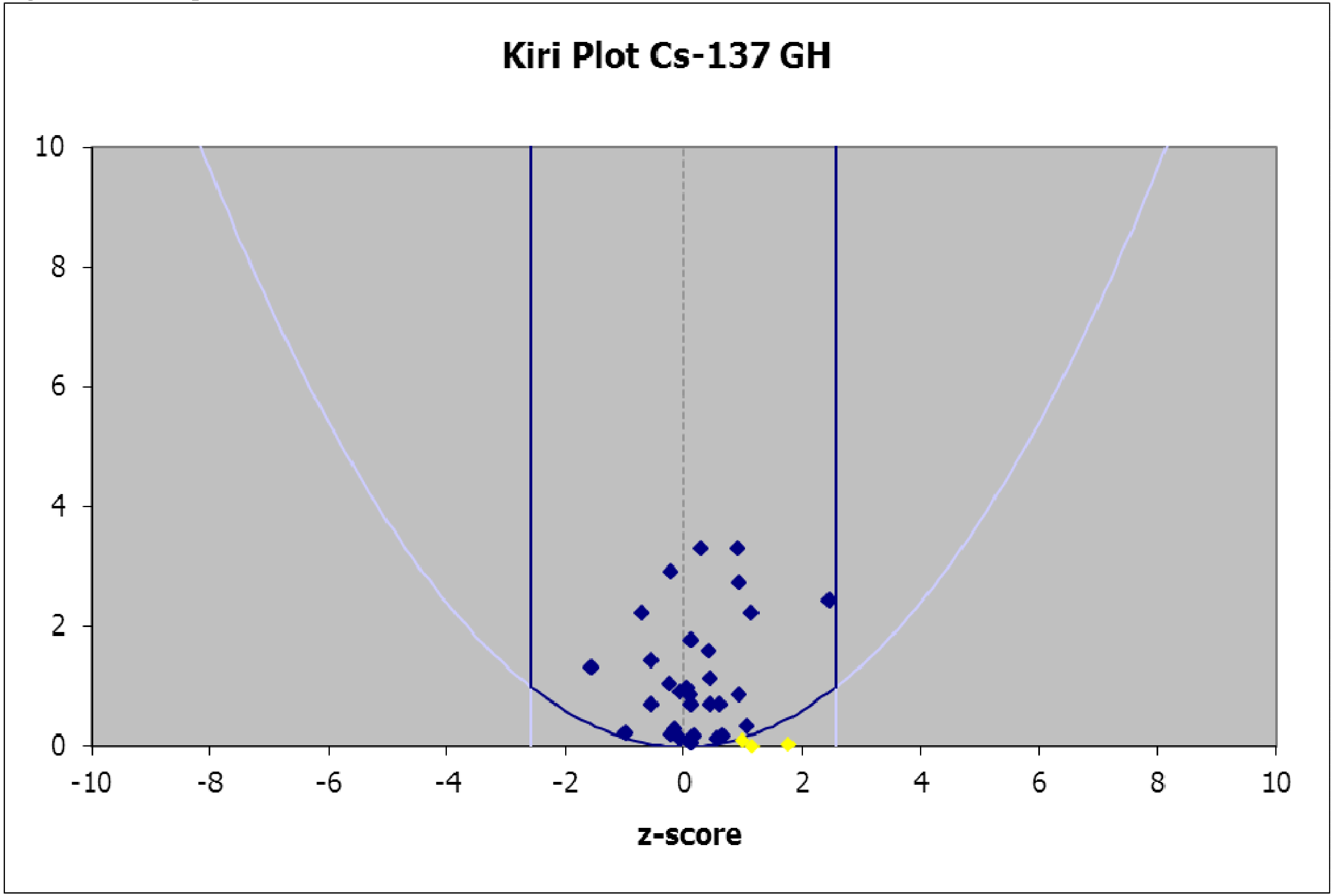


Figure 42A – Deviation Eu-152 GH

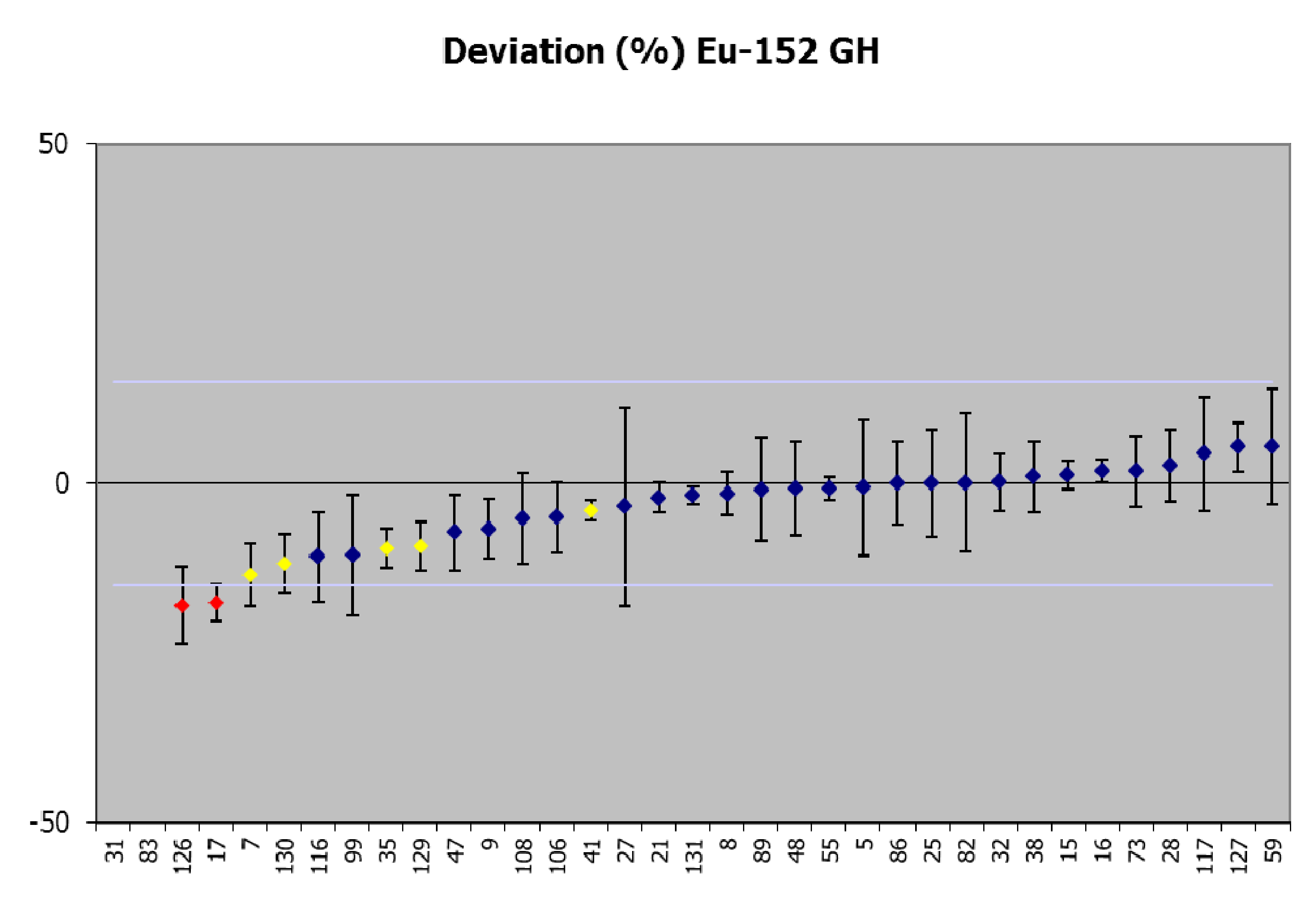


Figure 42B – Zeta score Eu-152 GH

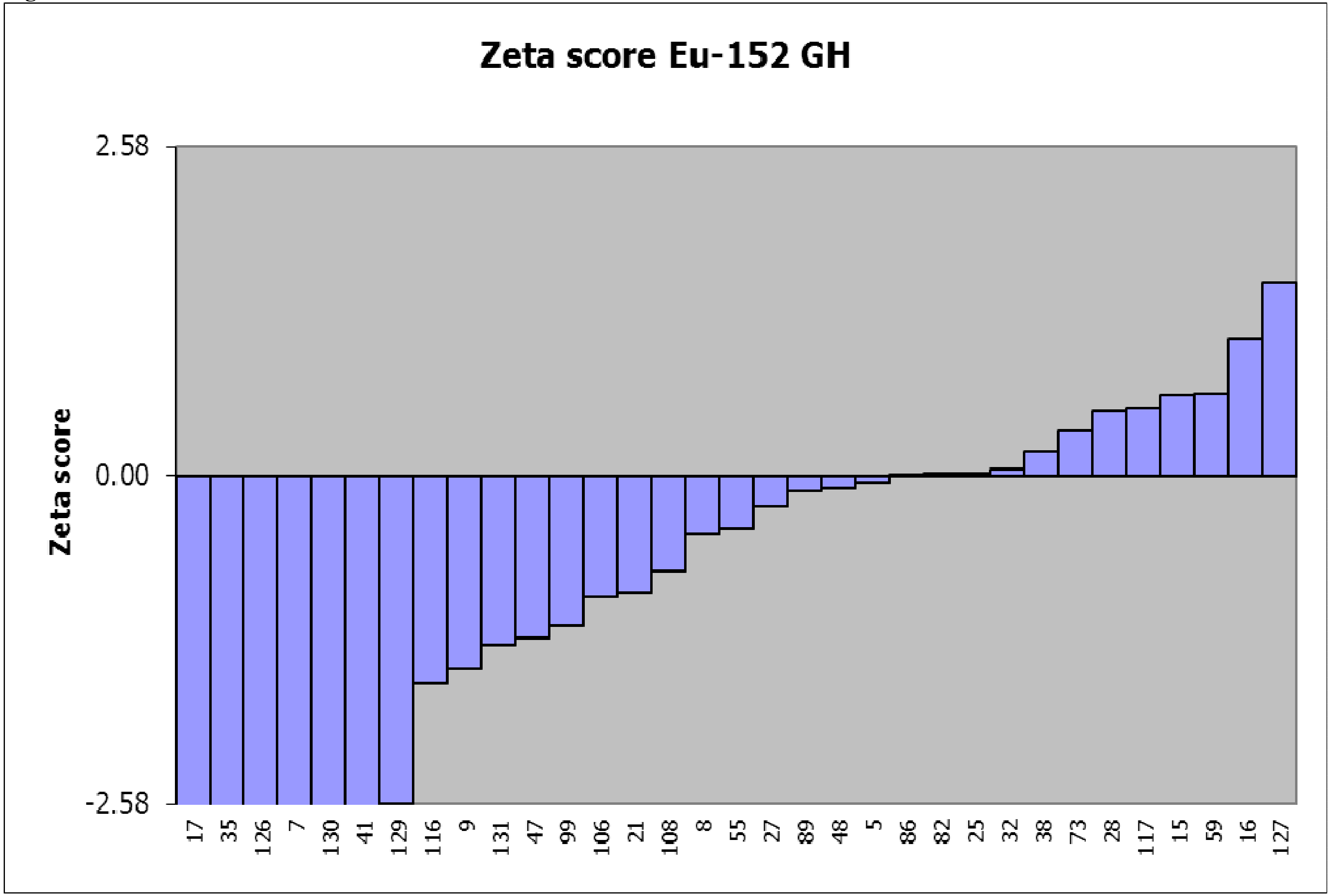


Figure 42C – Relative uncertainty Eu-152 GH

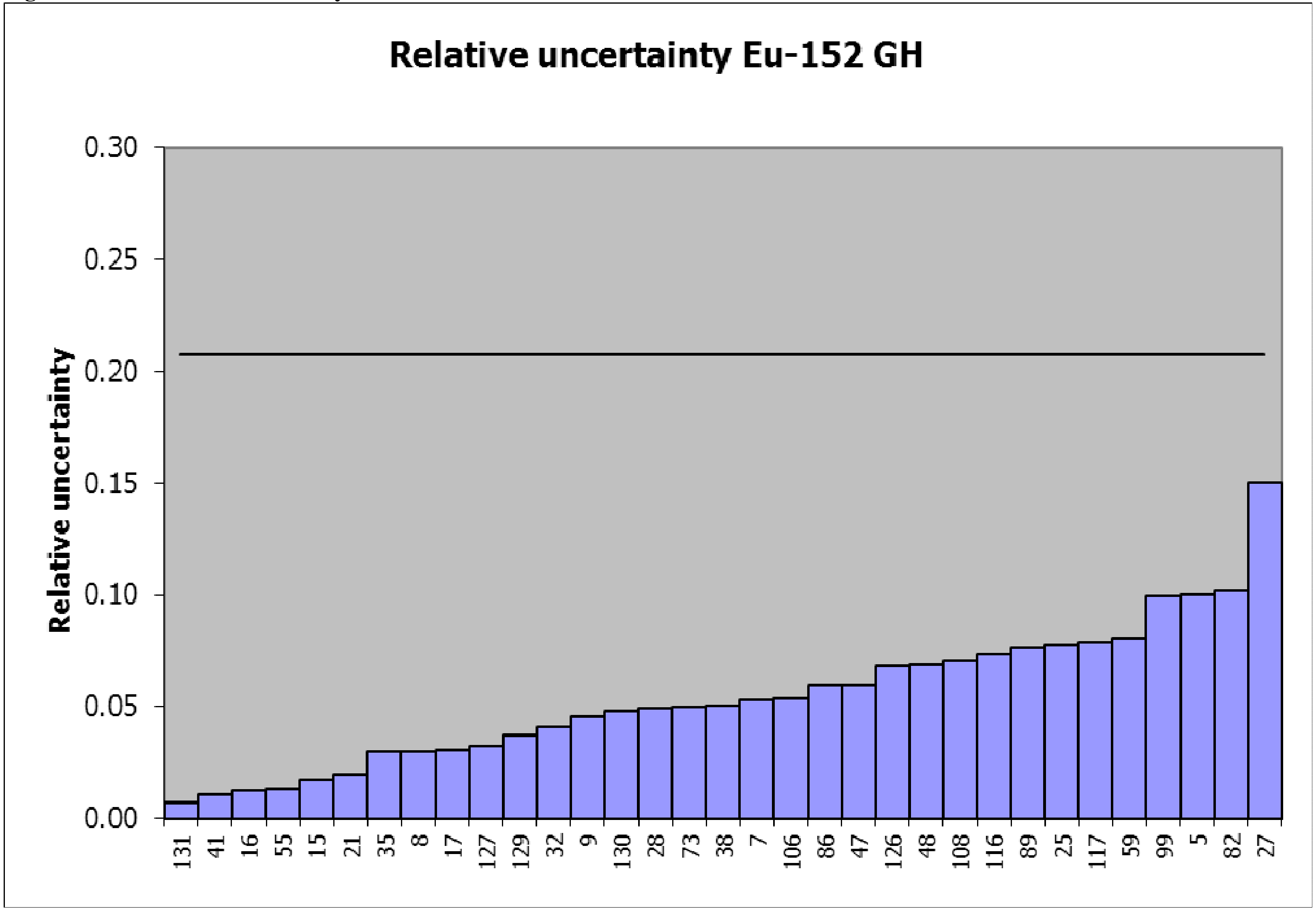


Figure 42D – Kiri plot Eu-152 GH

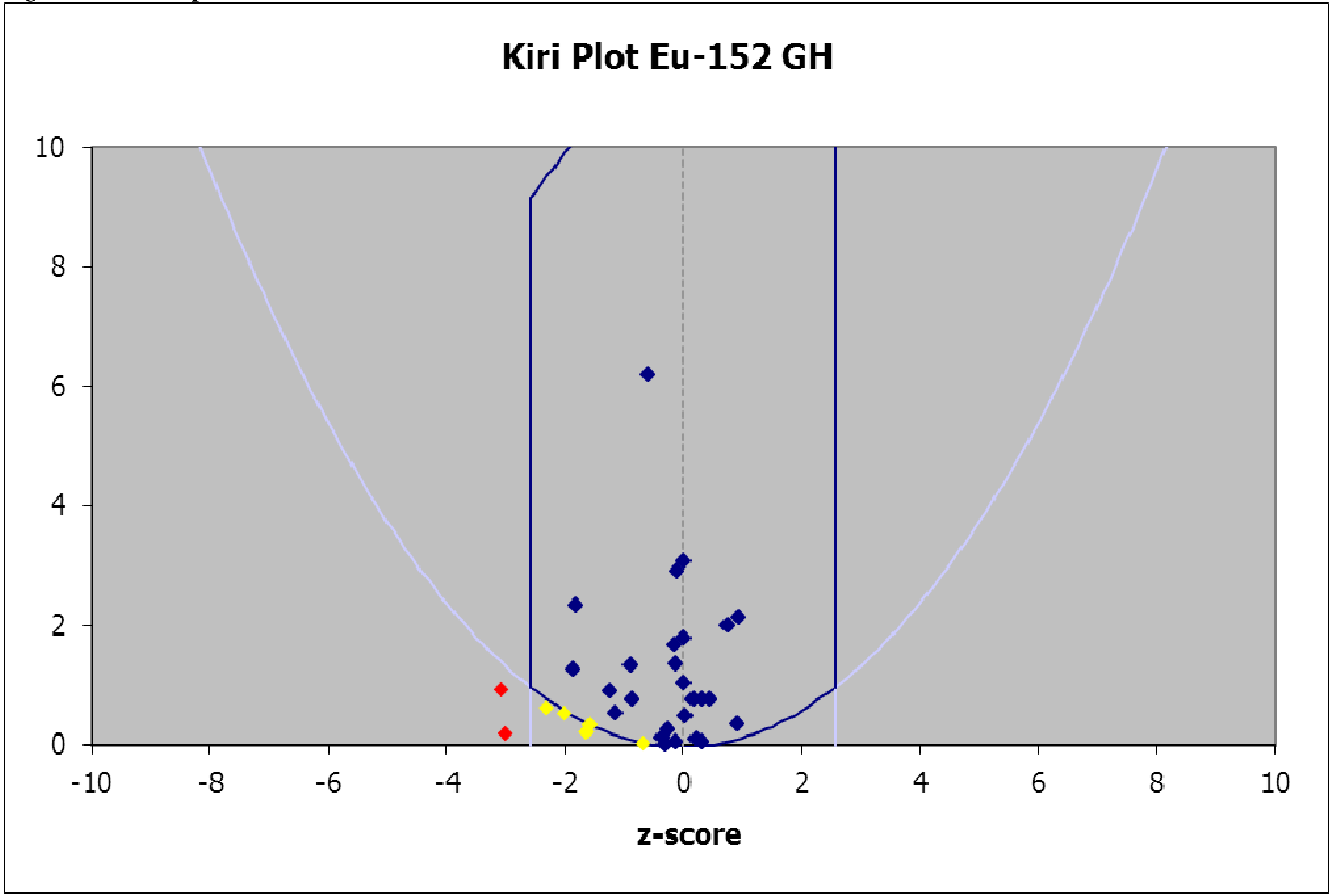


Figure 43A – Deviation Eu-154 GH

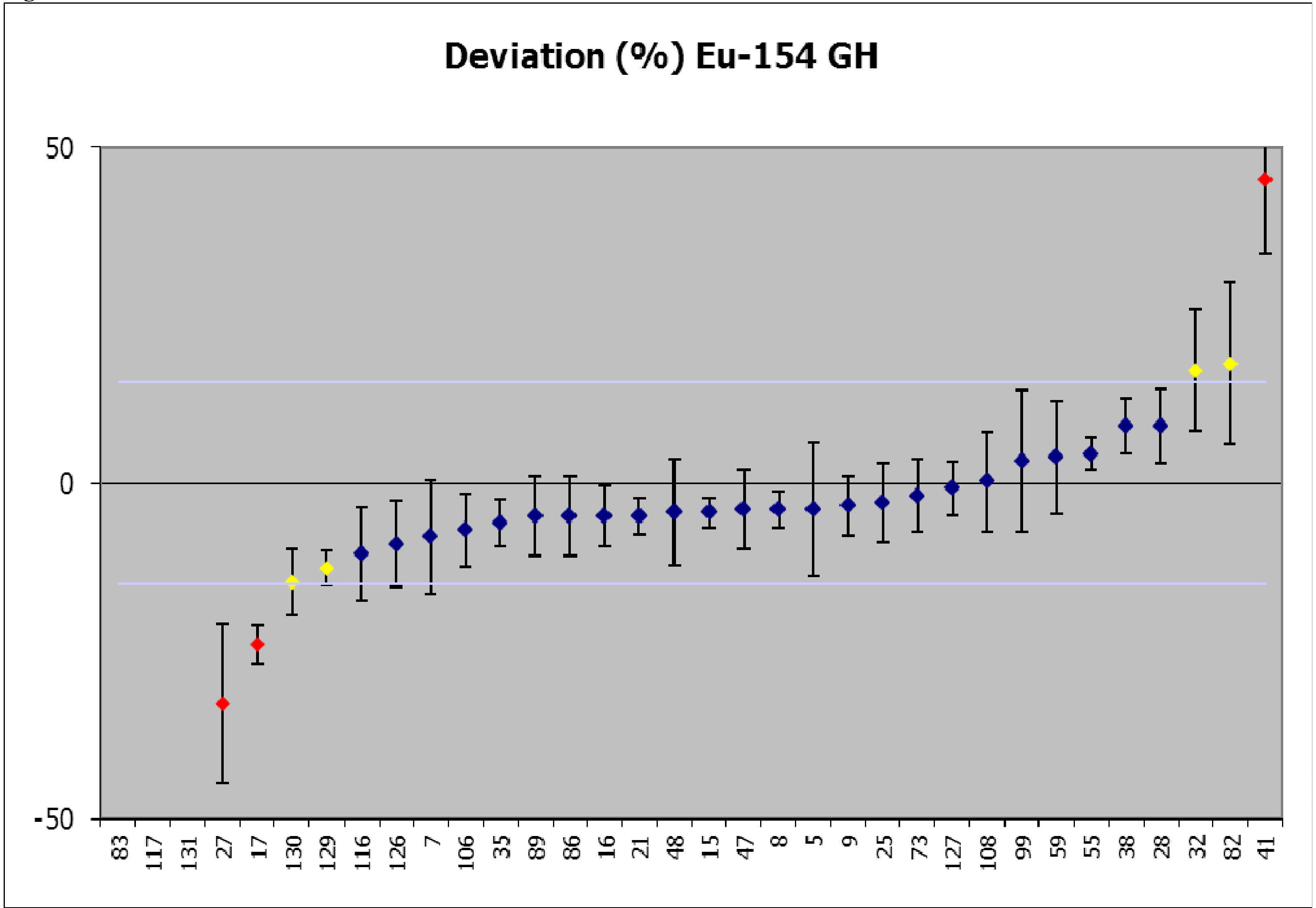


Figure 43B – Zeta score Eu-154 GH

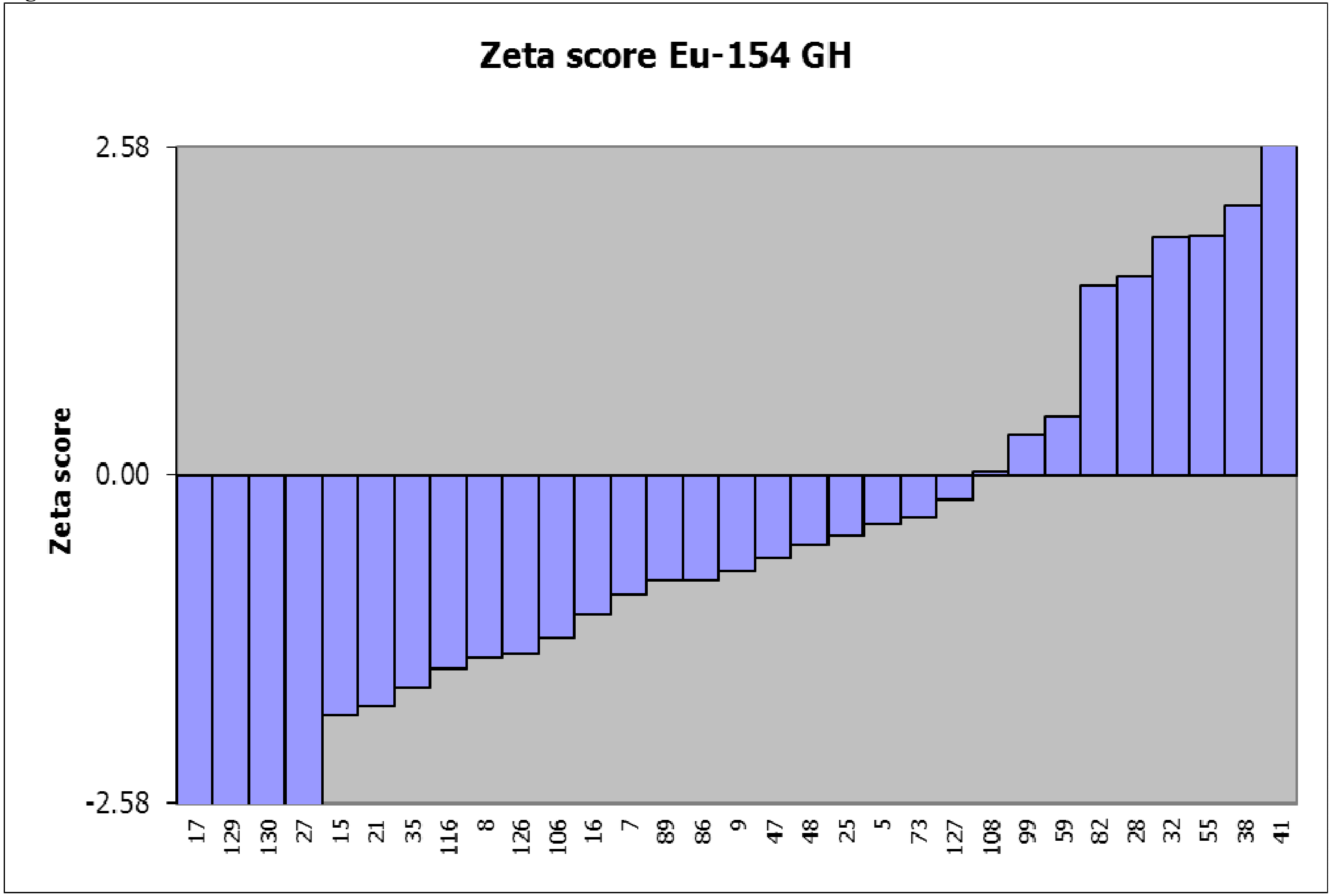


Figure 43C – Relative uncertainty Eu-154 GH

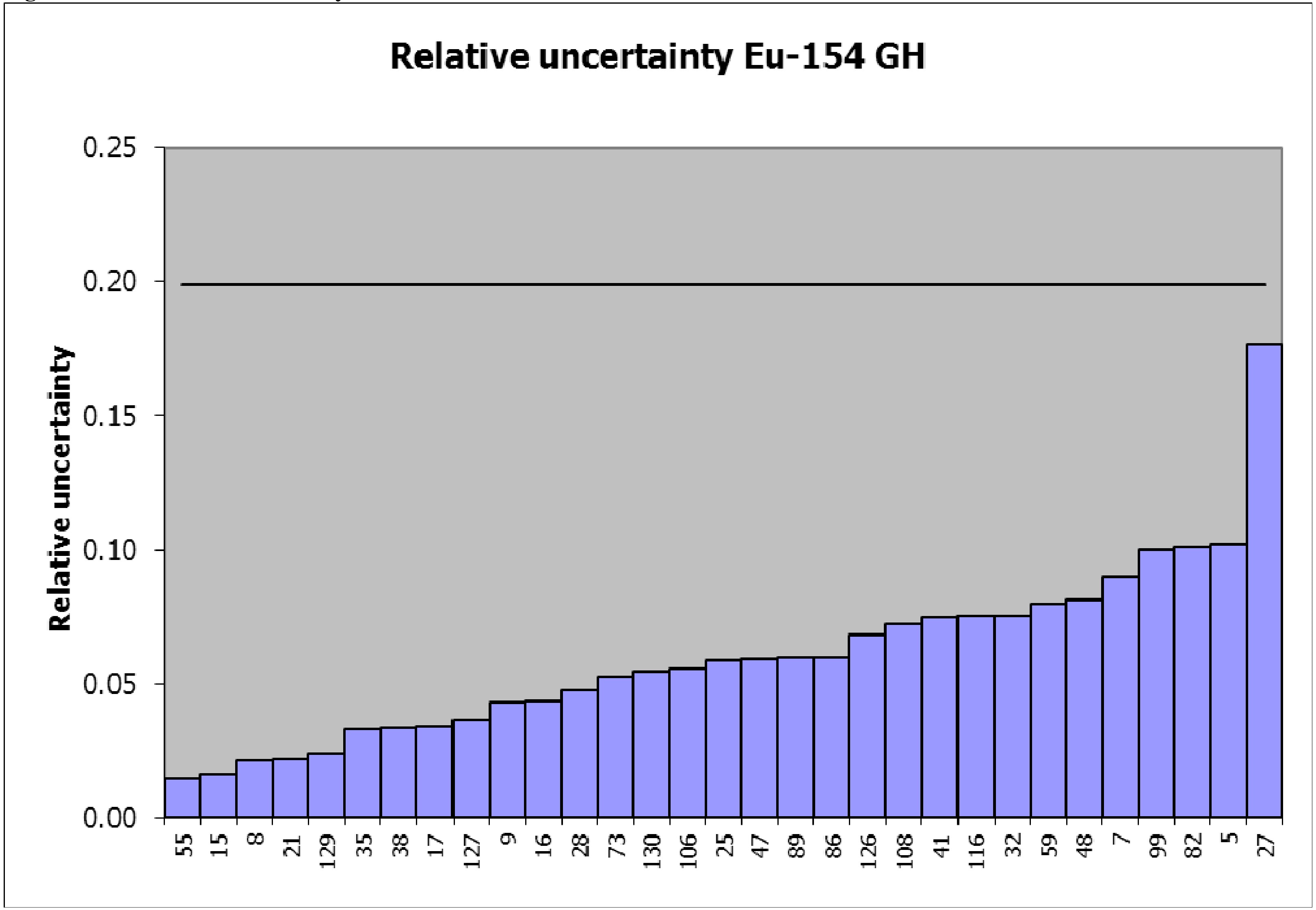


Figure 43D – Kiri plot Eu-154 GH

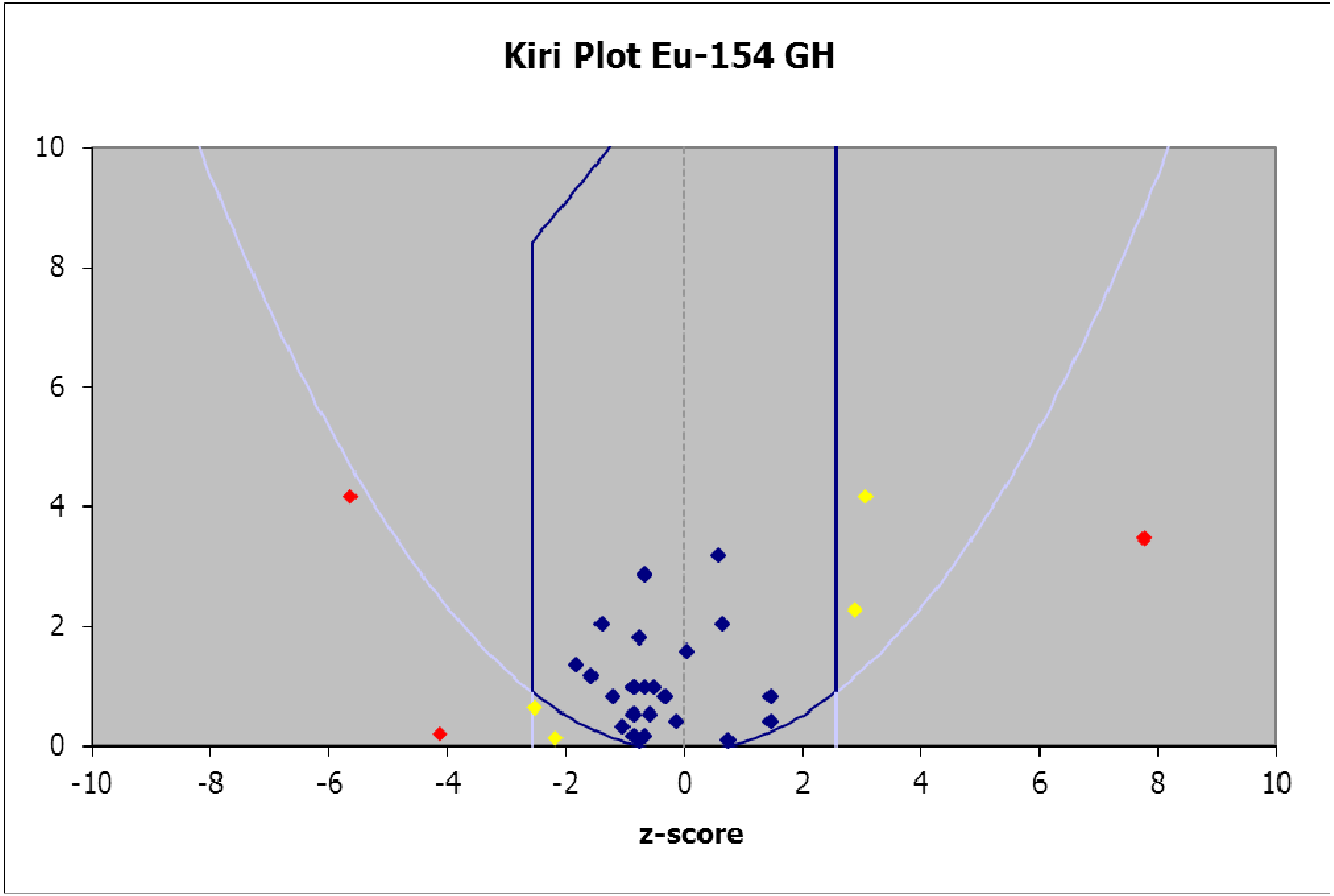


Figure 44A – Deviation Co-60 S

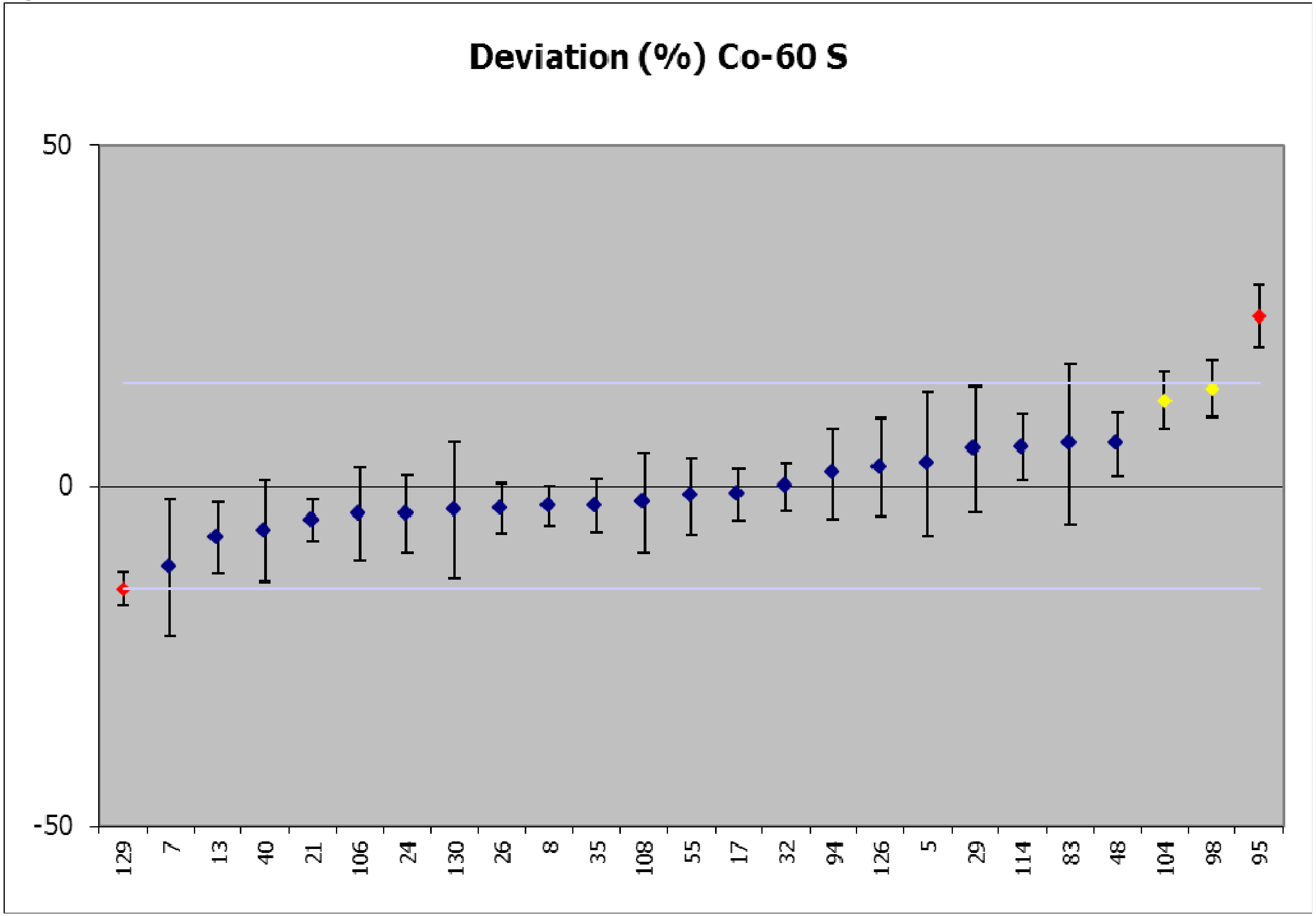


Figure 44B – Zeta score Co-60 S

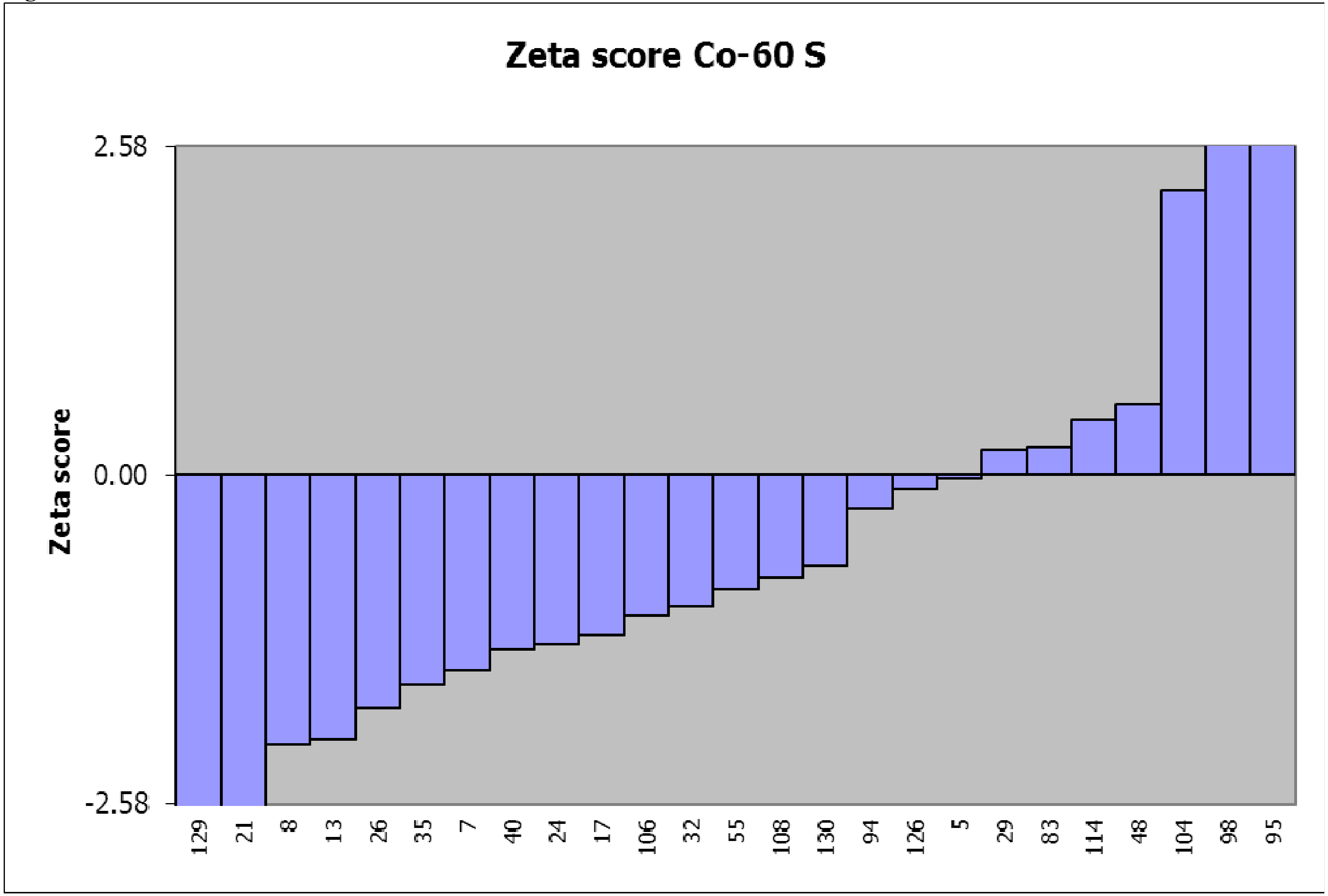


Figure 44C – Relative uncertainty Co-60 S

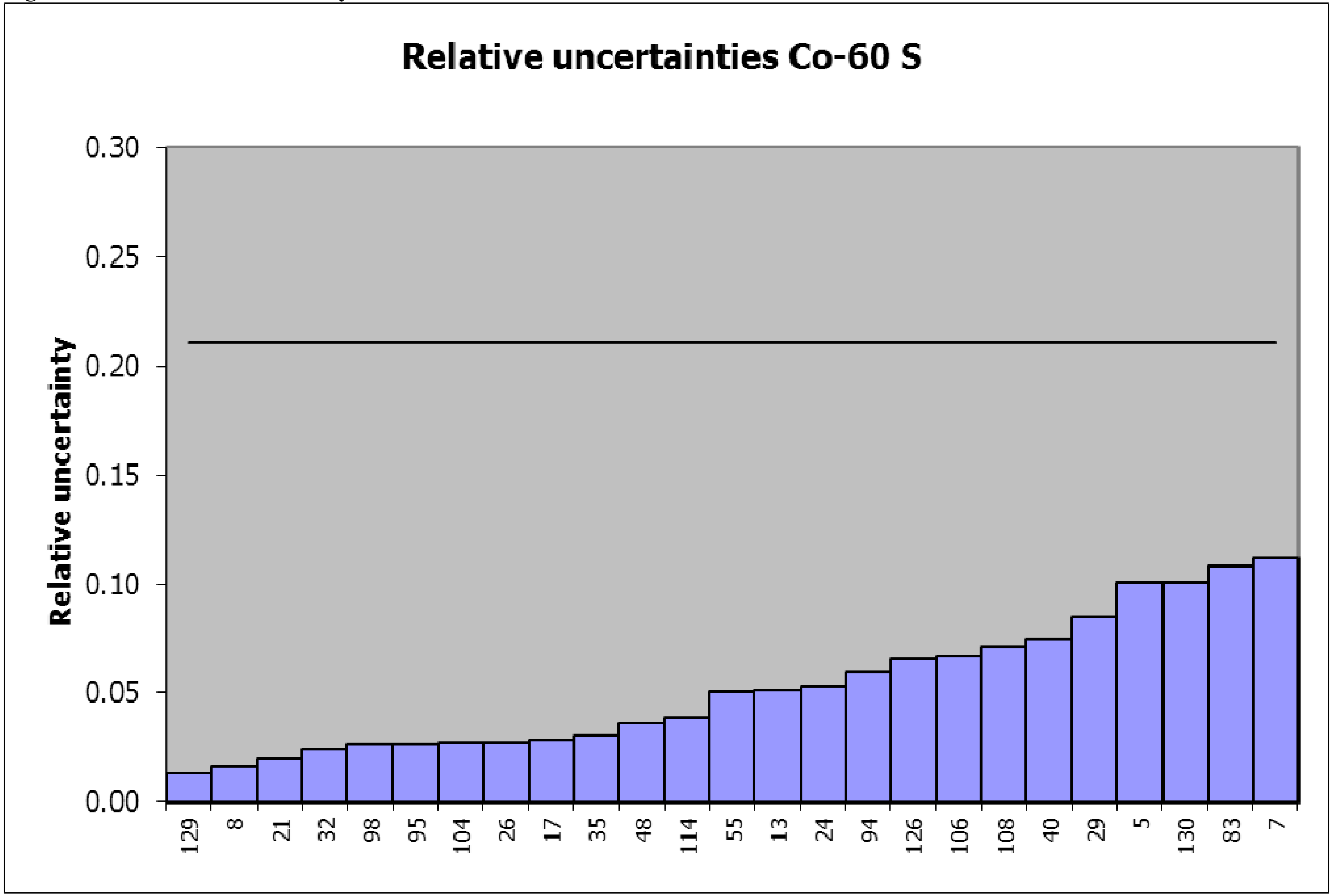


Figure 44D – Kiri plot Co-60 S

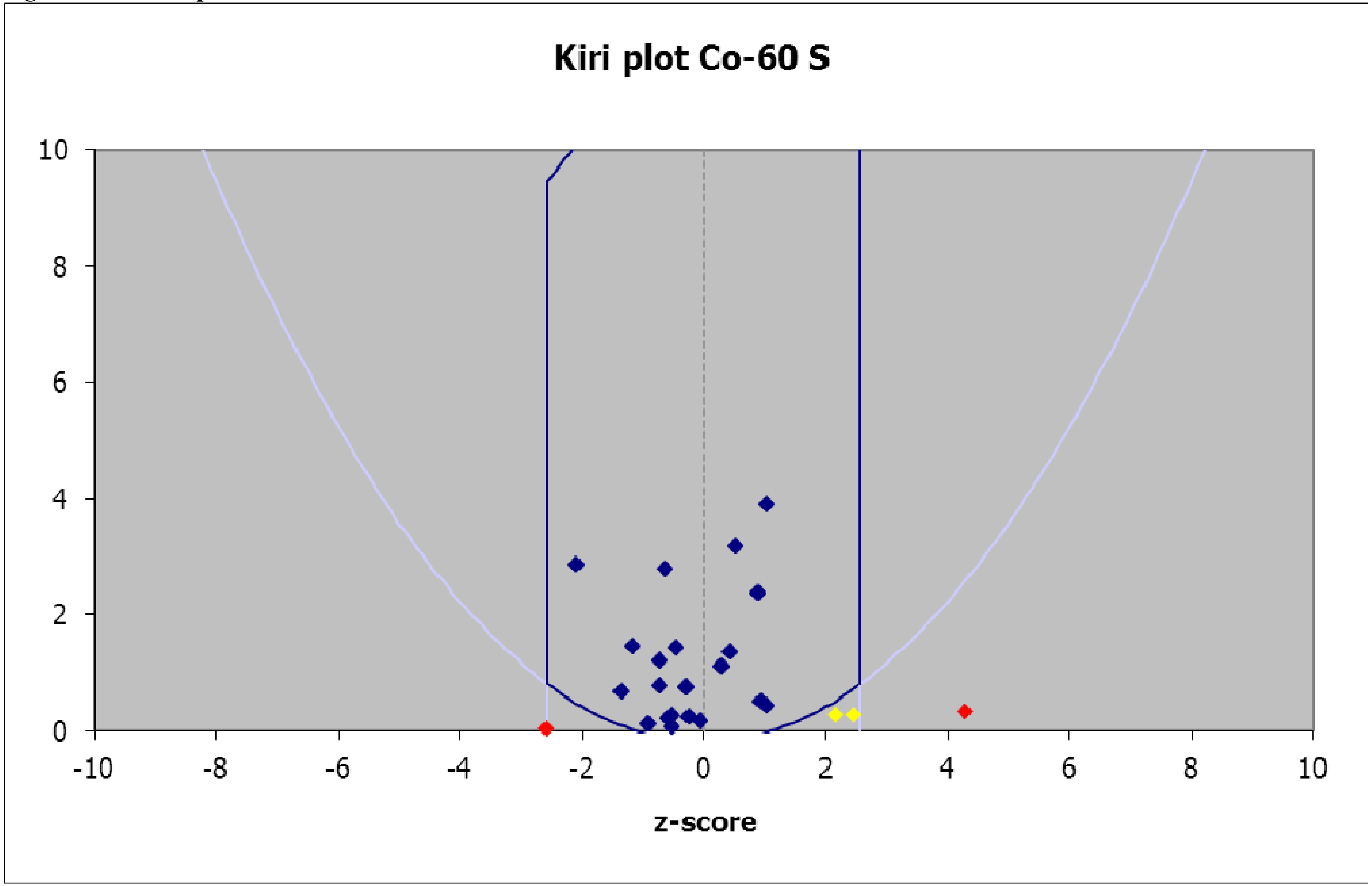


Figure 45A – Deviation Cs-137 S

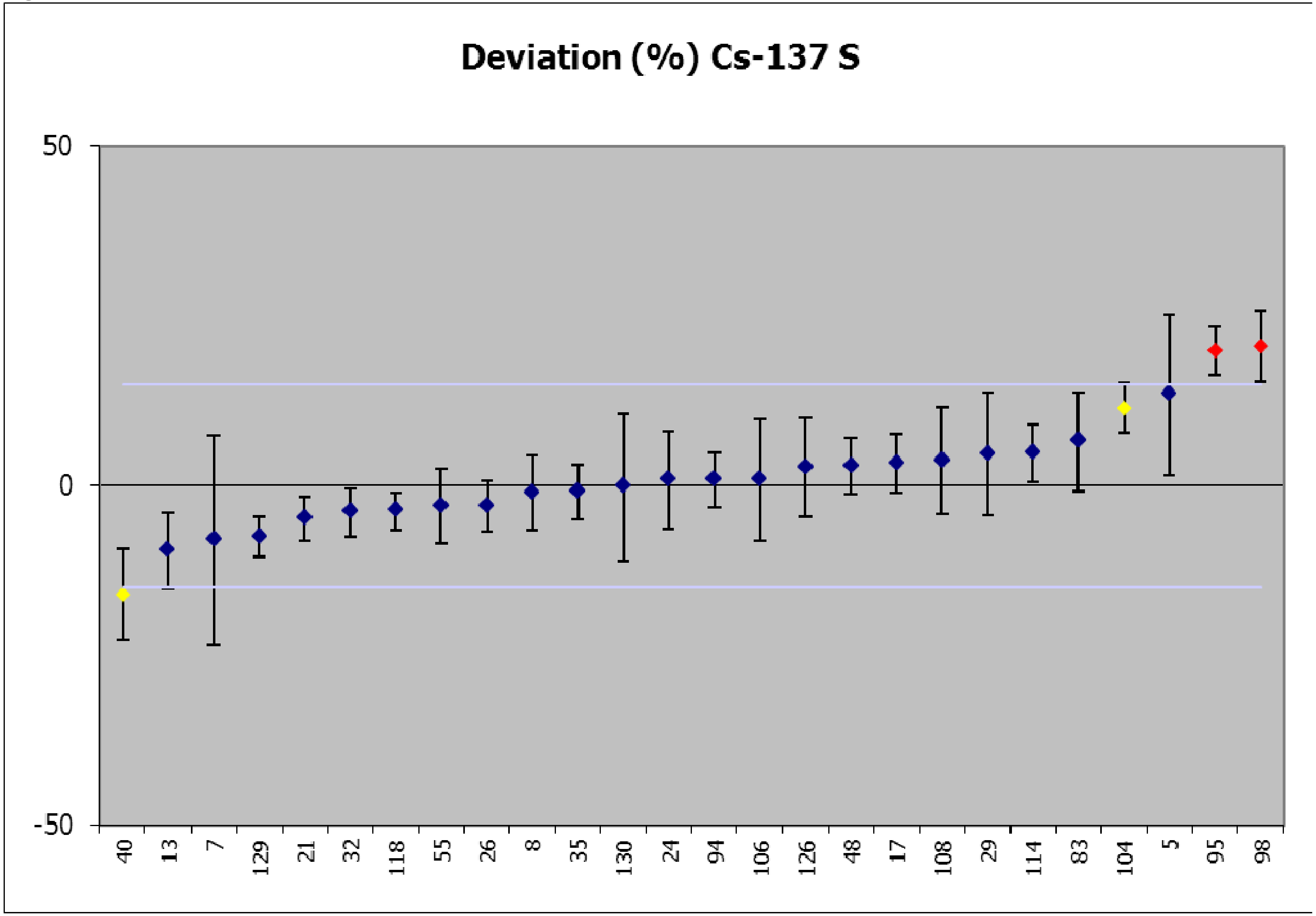


Figure 45B – Zeta score Cs-137 S

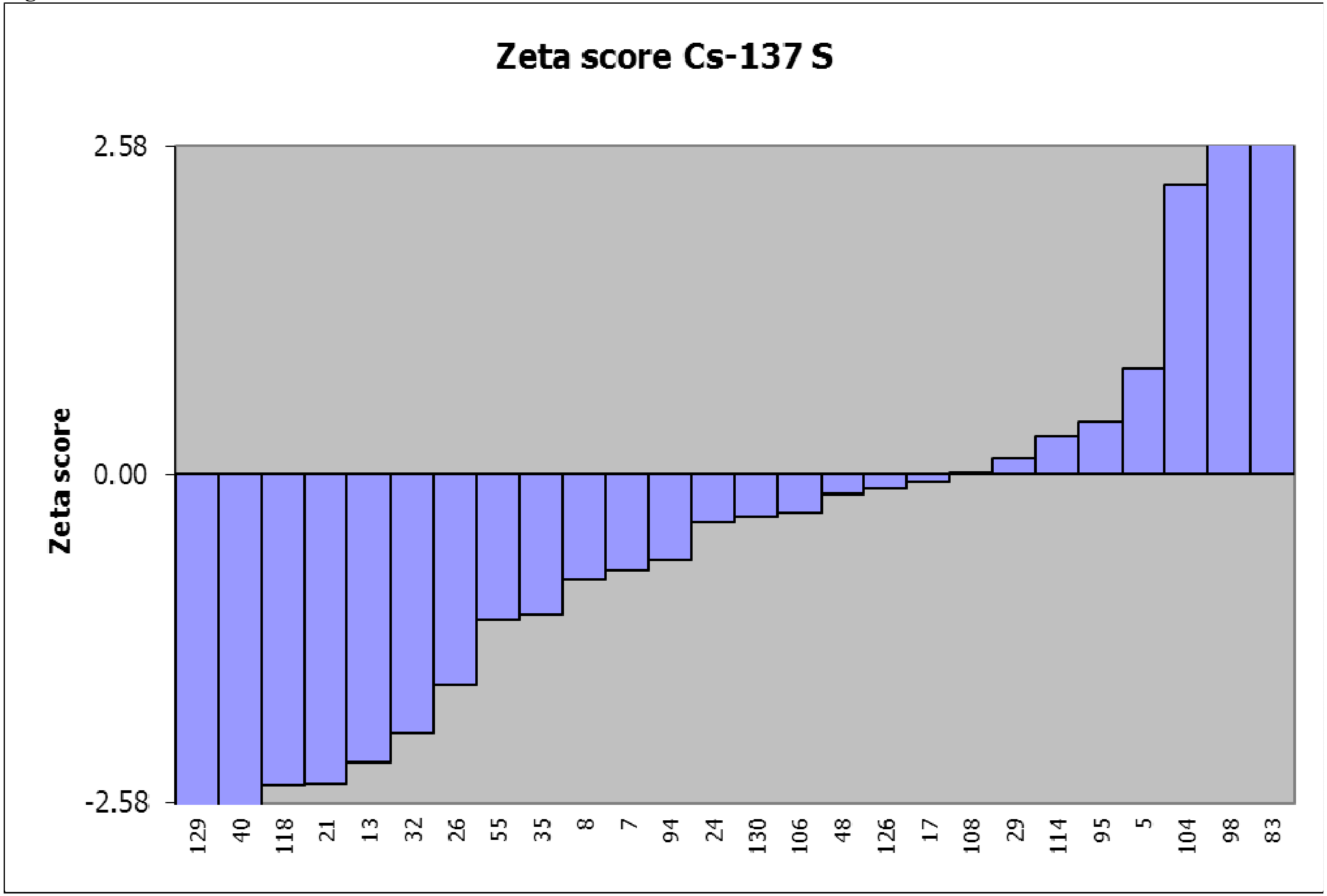


Figure 45C – Relative uncertainty Cs-137 S

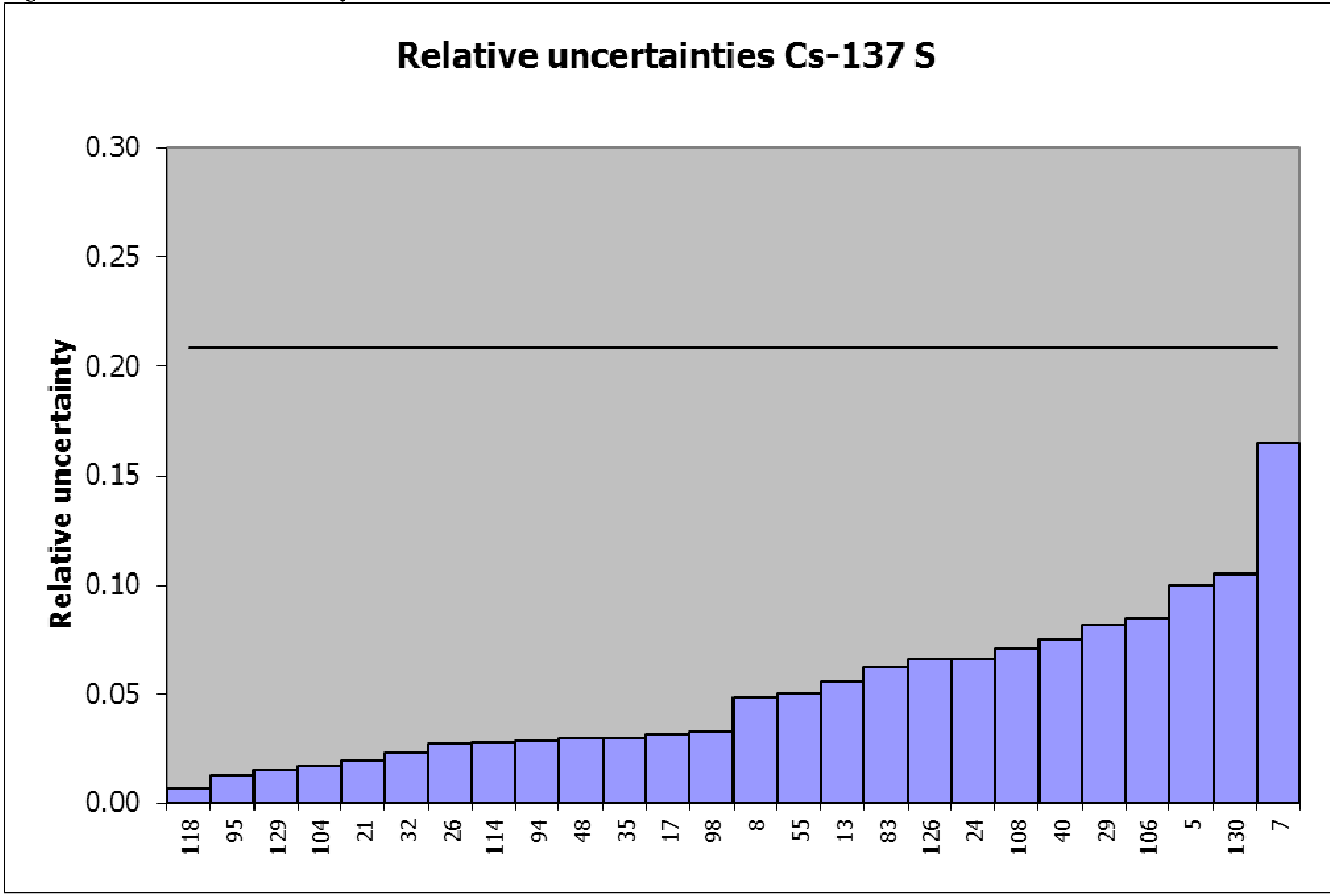


Figure 45D – Kiri plot Cs-137 S

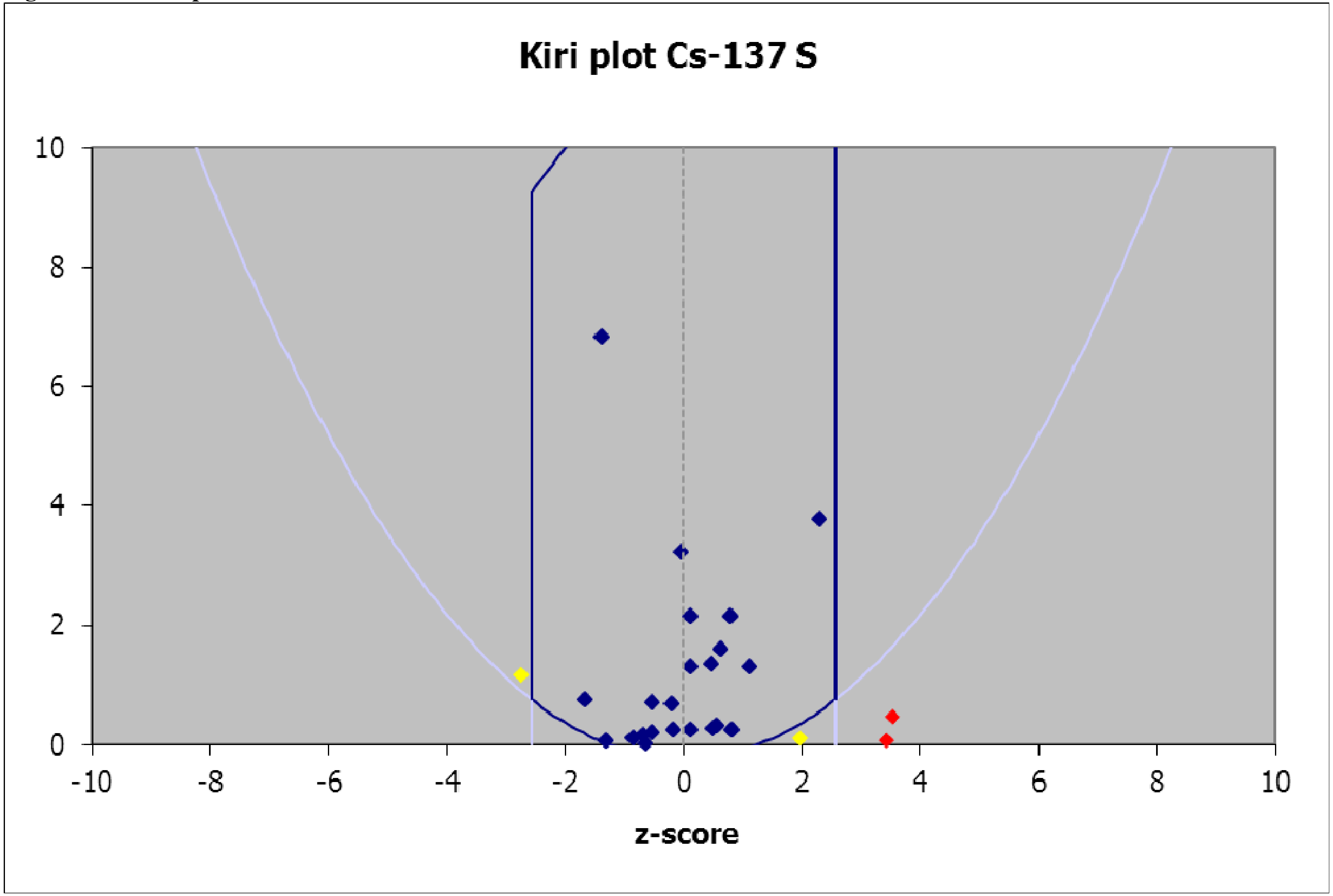


Figure 46A – Deviation Eu-152 S

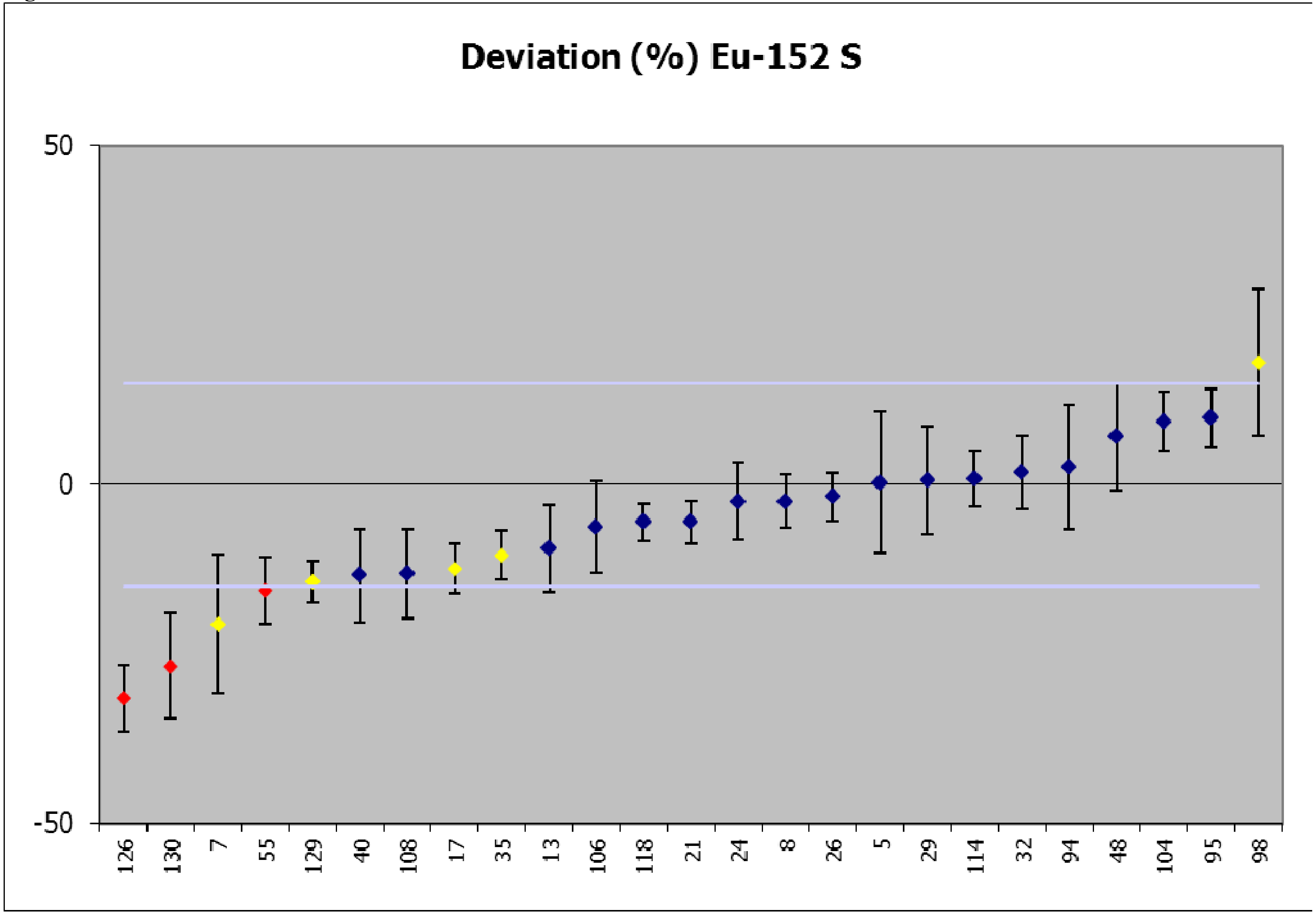


Figure 46B – Zeta score Eu-152 S

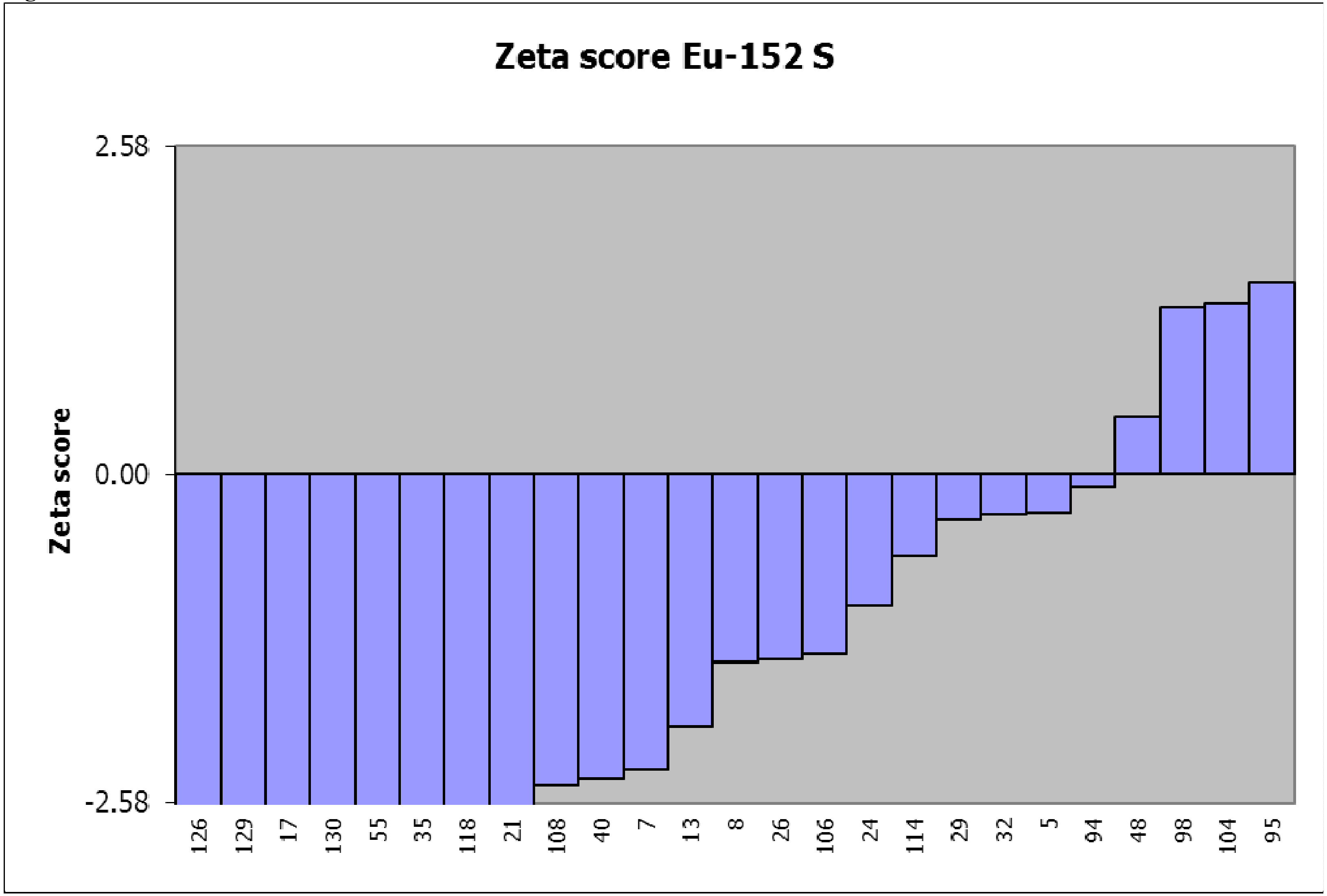


Figure 46C – Relative uncertainty Eu-152 S

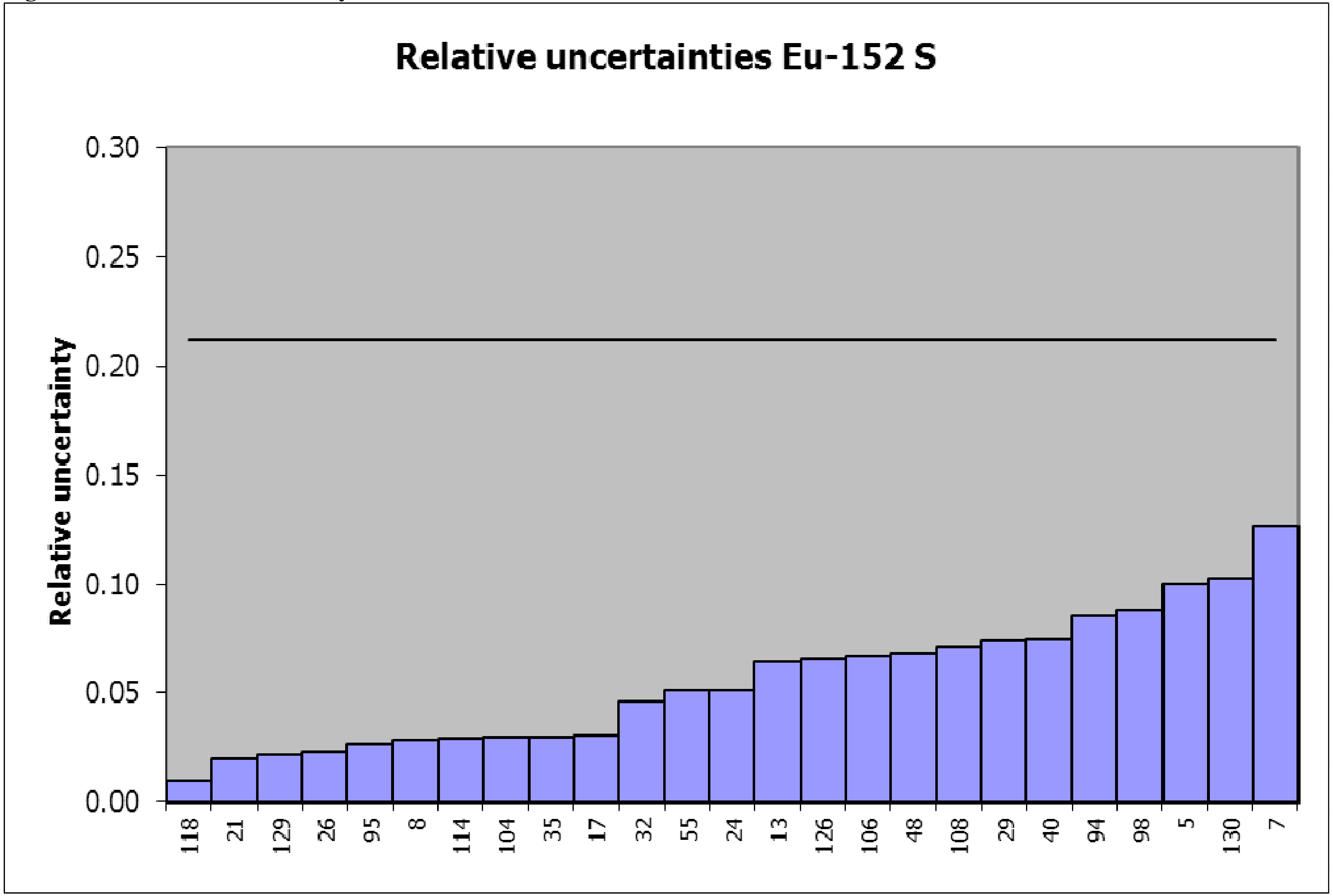


Figure 46D – Kiri plot Eu-152 S

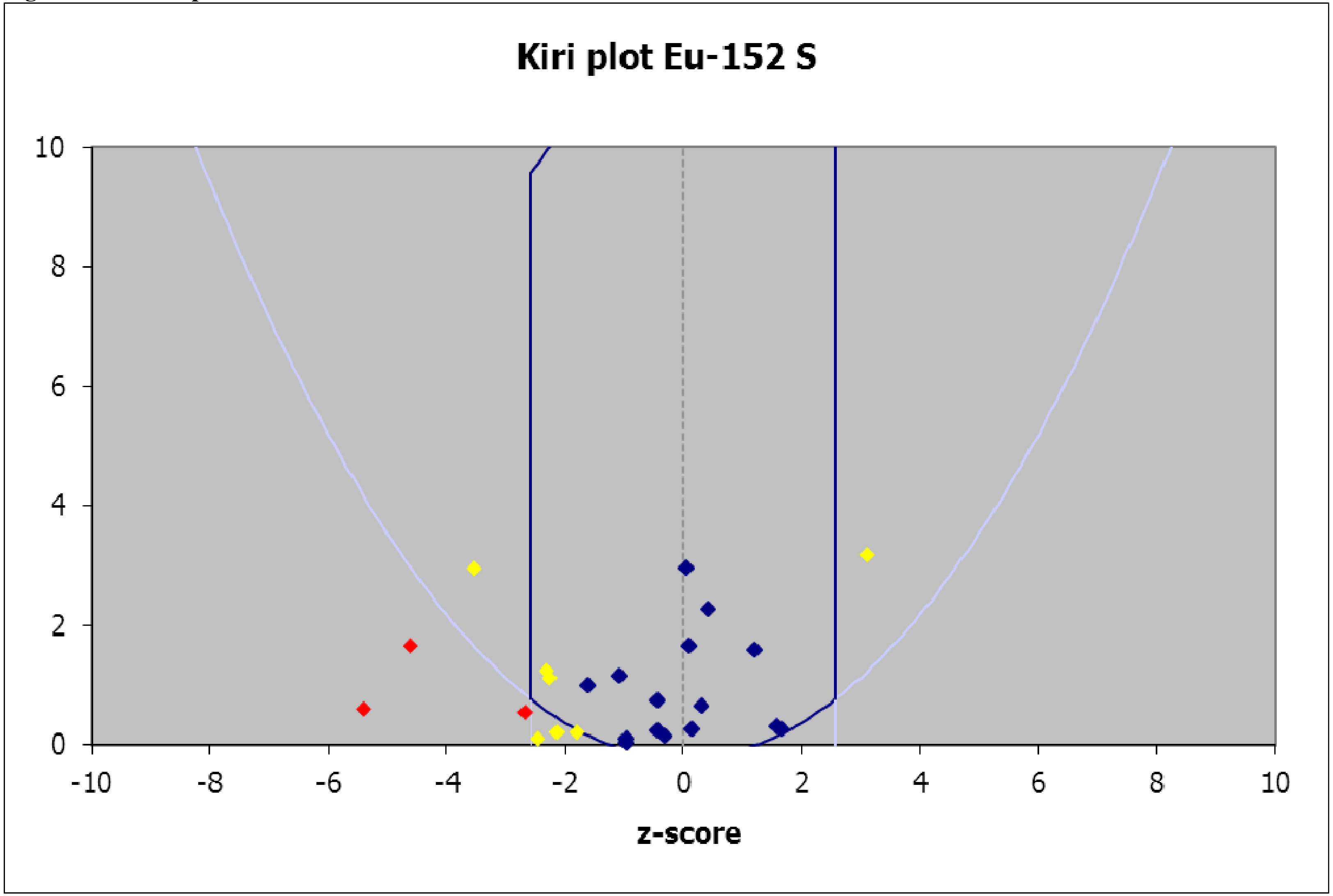


Figure 47A – Deviation Eu-154 S

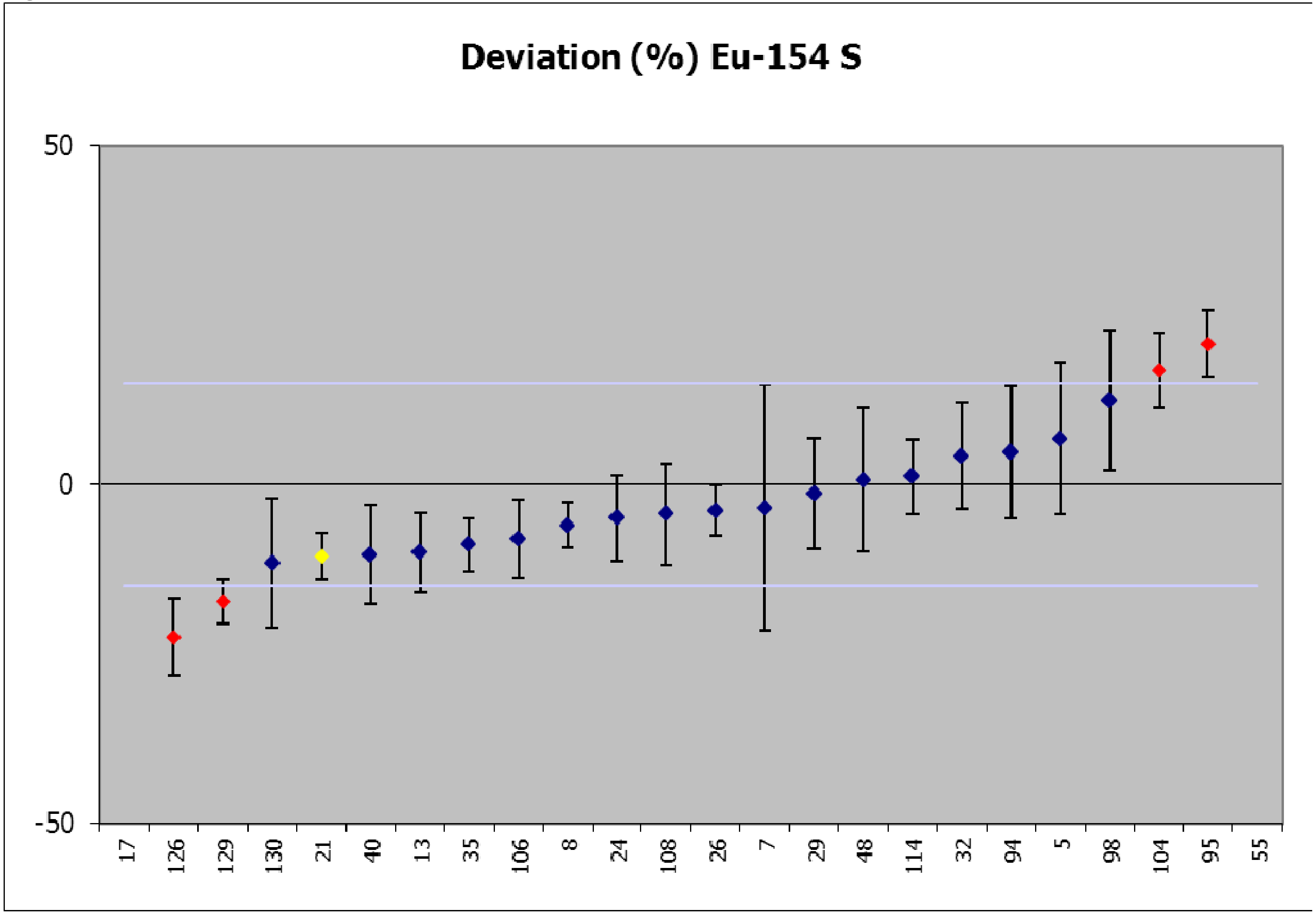


Figure 47B – zeta score Eu-154 S

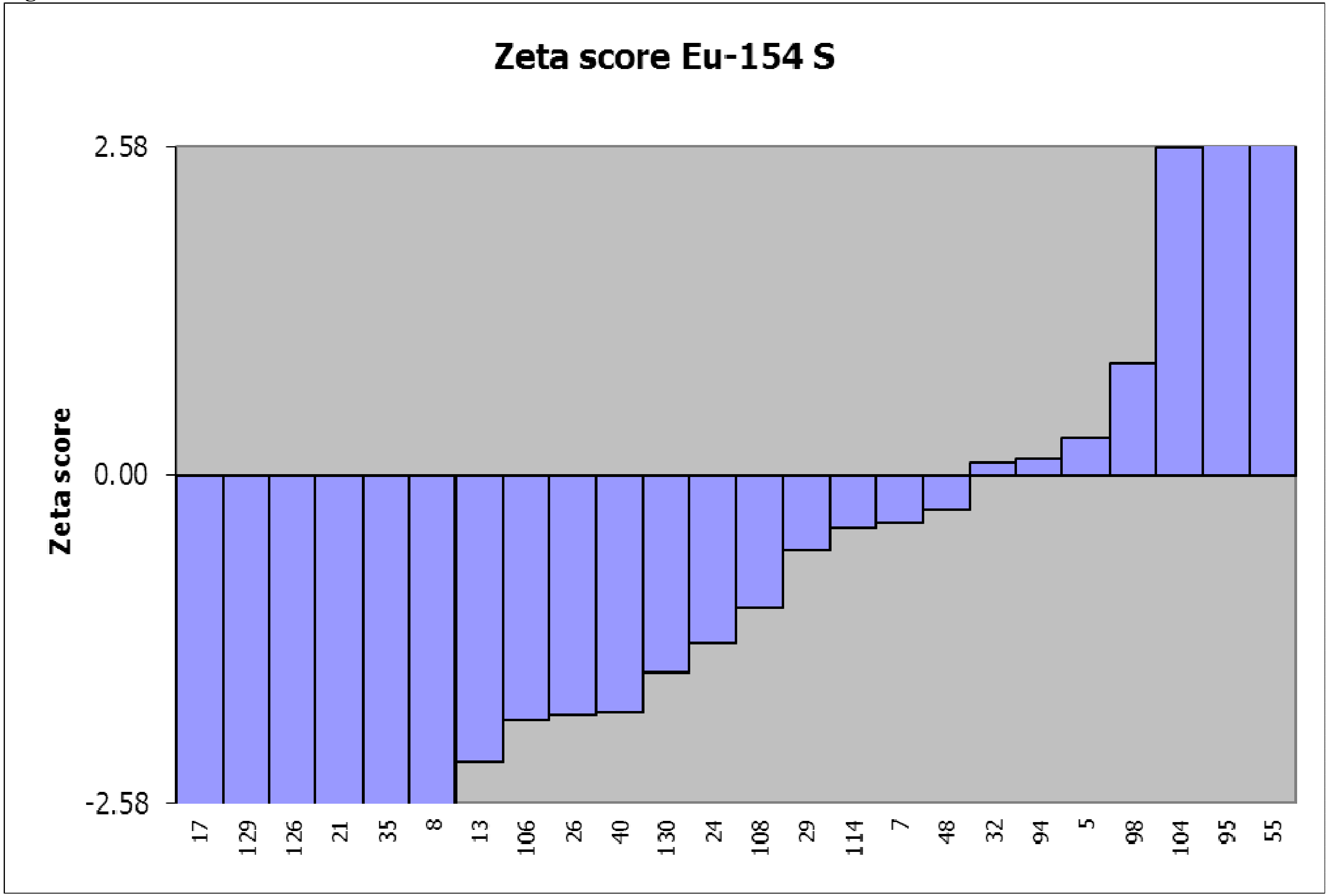


Figure 47C – Relative uncertainty Eu-154 S

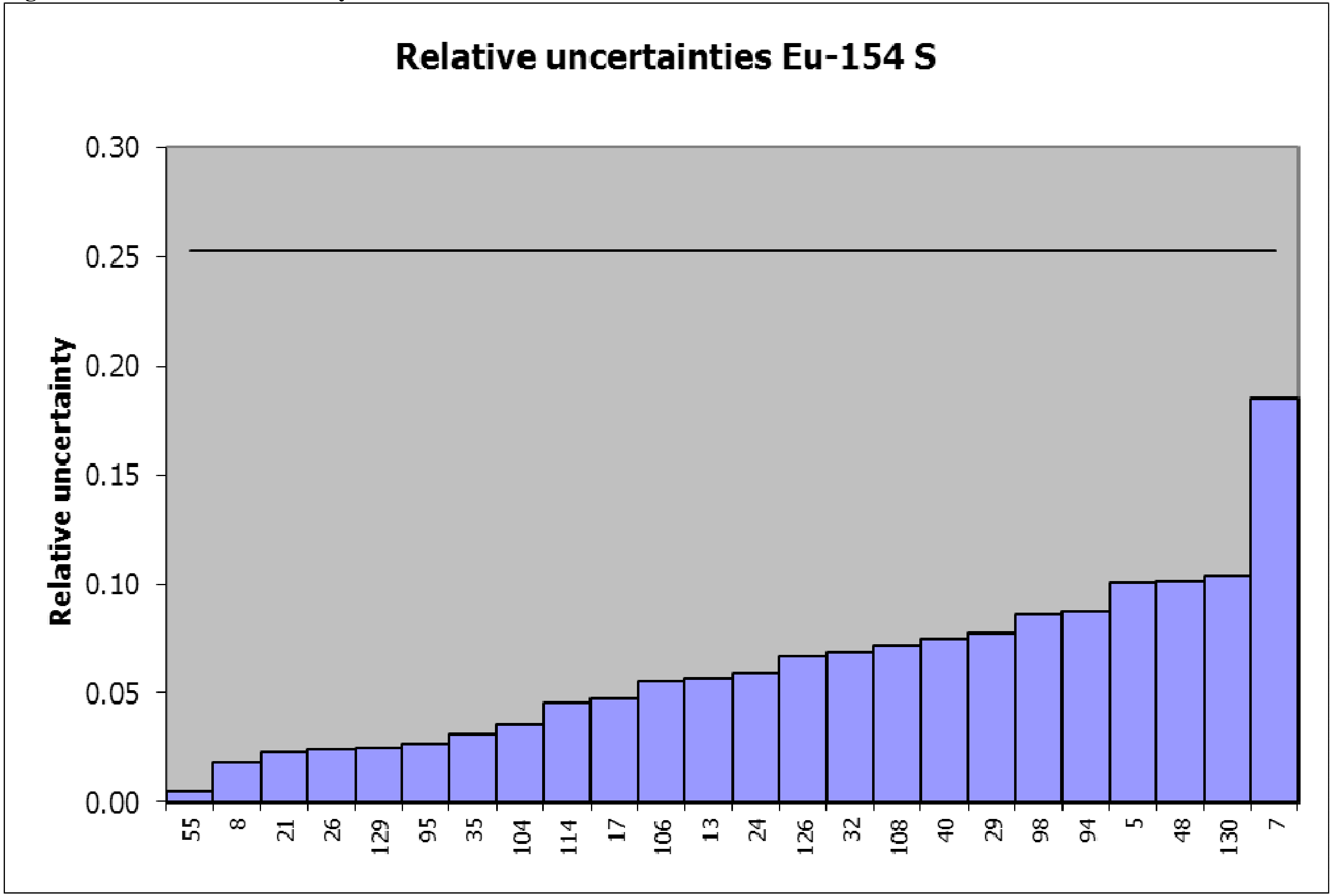


Figure 47D – Kiri plot Eu-154 S

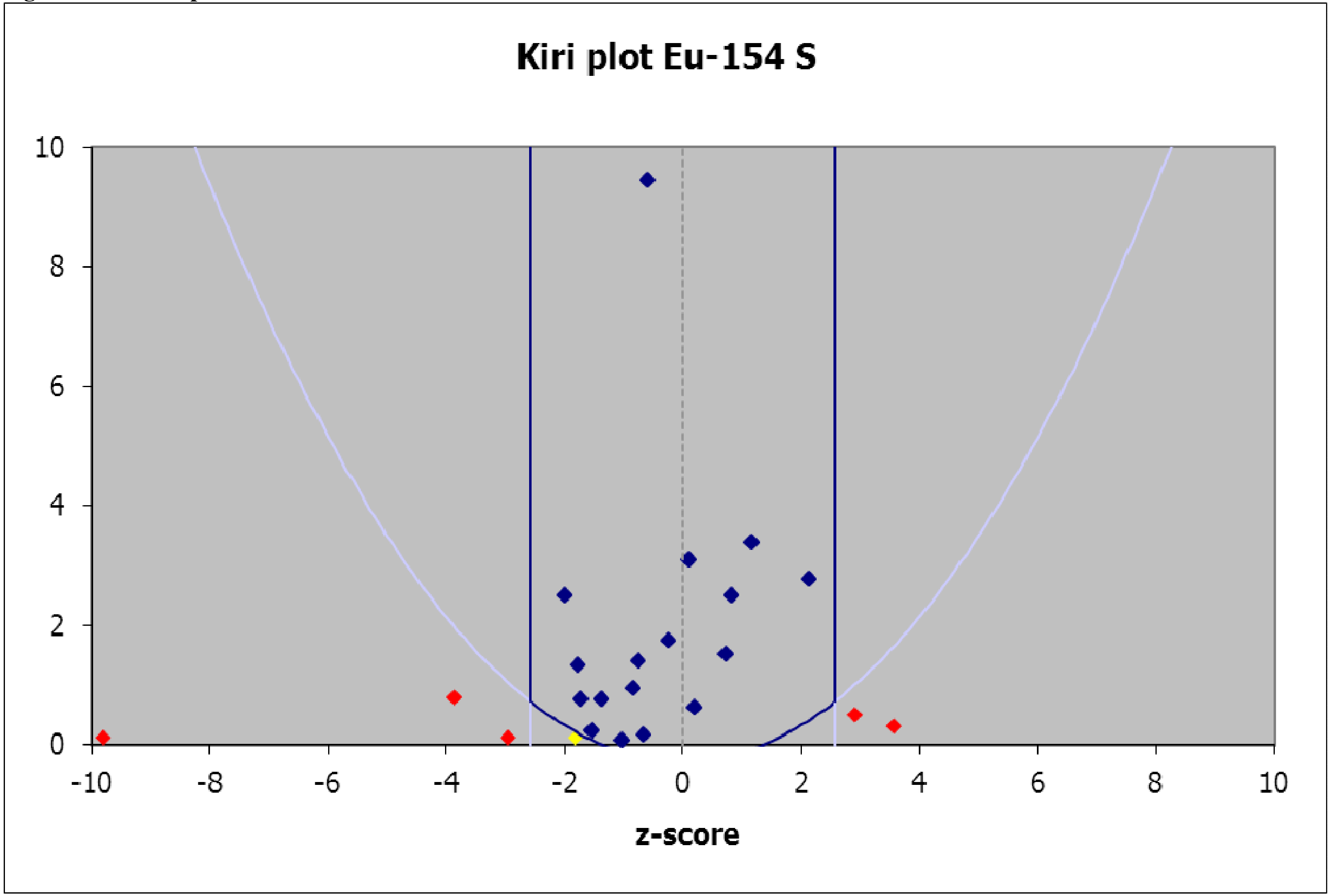


Figure 48A – Deviation Am-241 S

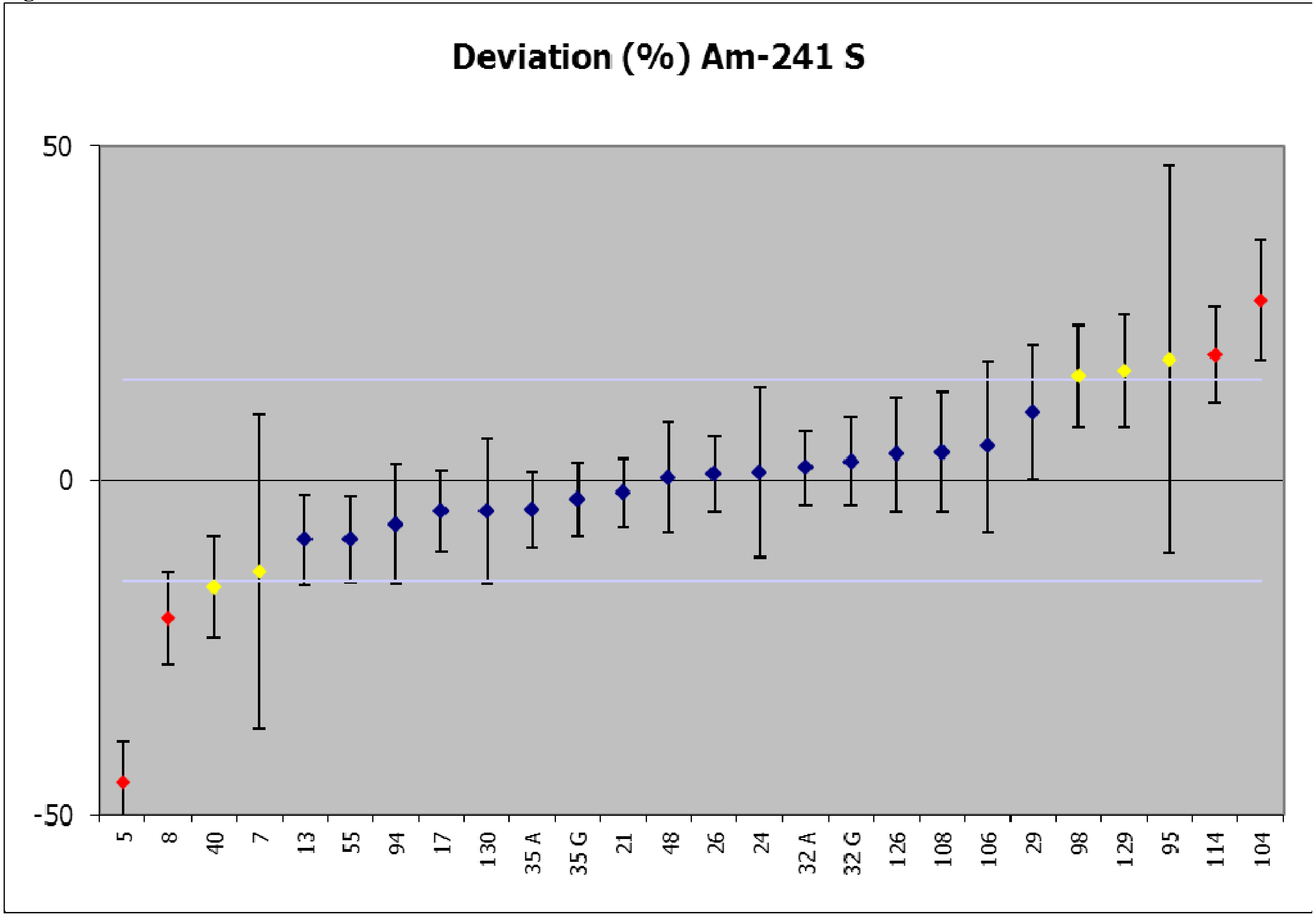


Figure 48B – Zeta score Am-241 S

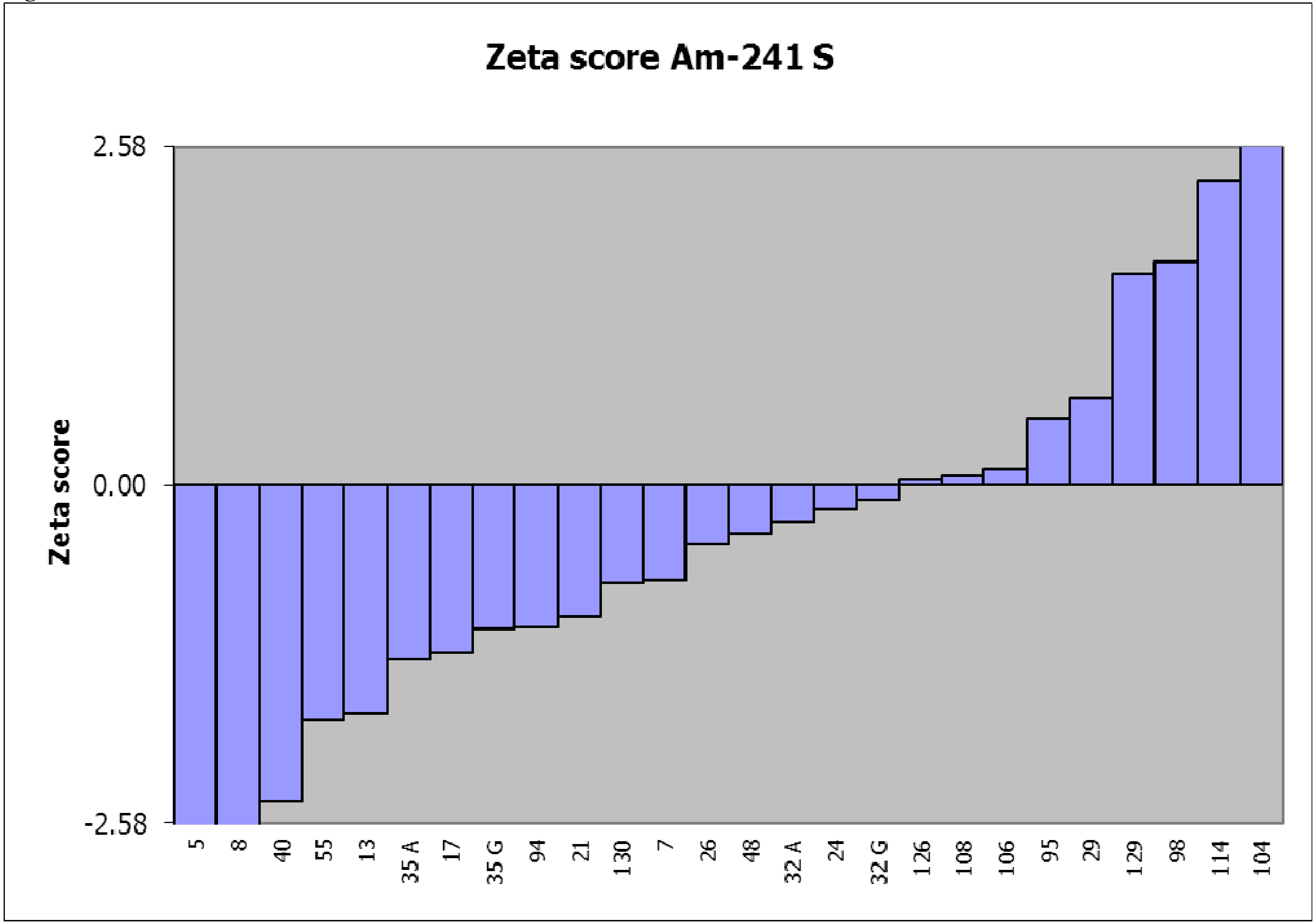


Figure 48C – Relative uncertainty Am-241 S

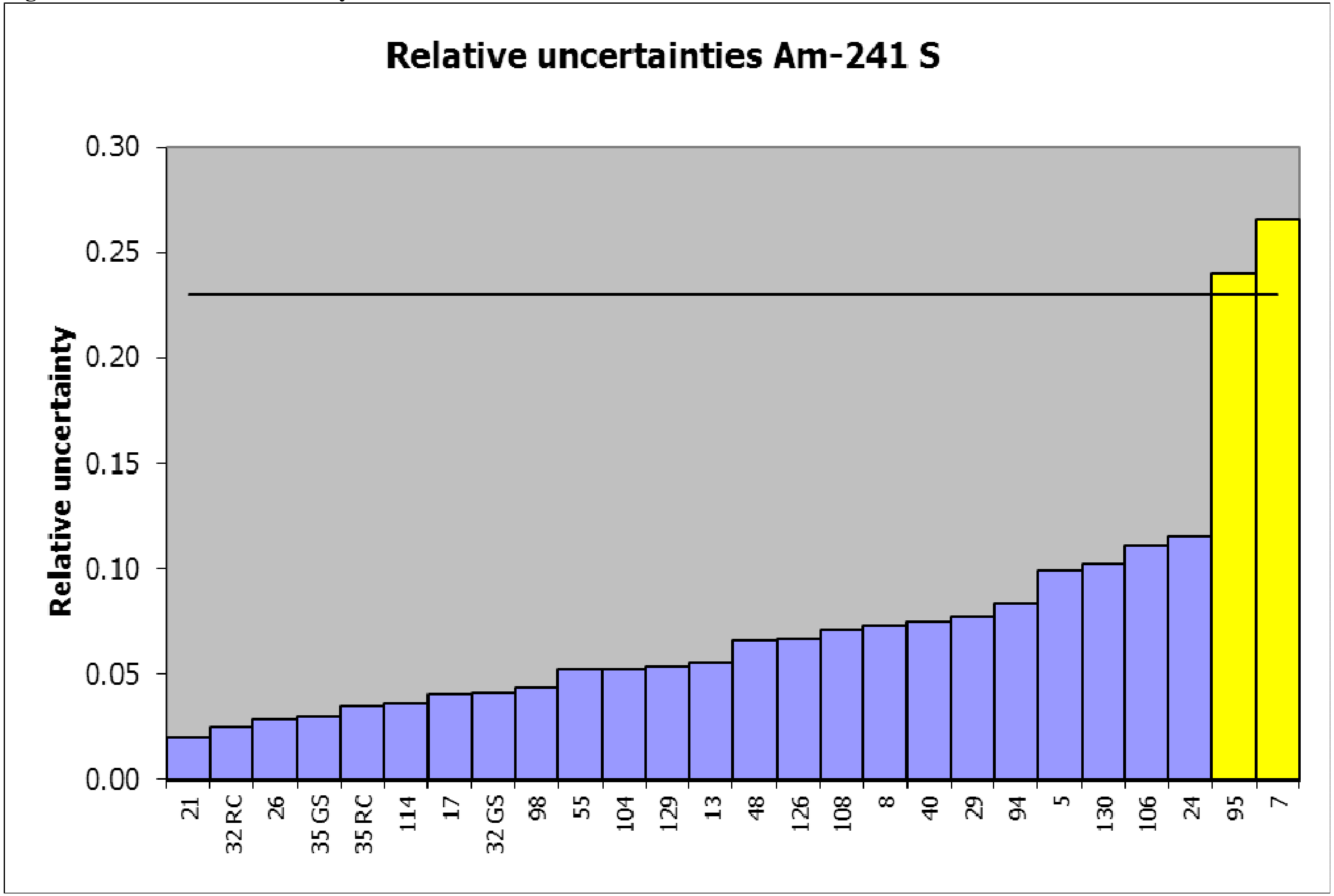


Figure 48D – Kiri plot Am-241 S

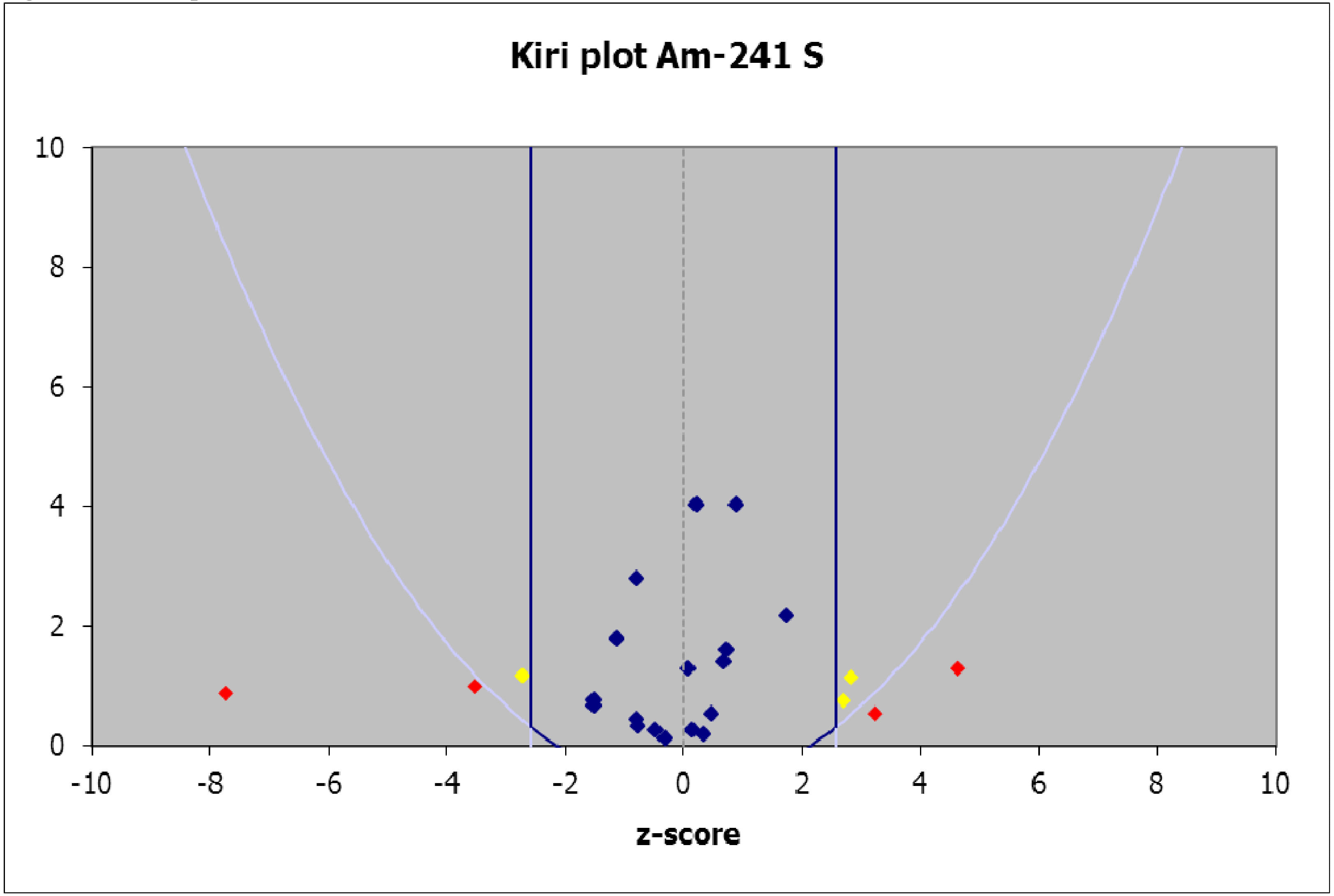


Figure 49A – Homogeneity test ^{60}Co S

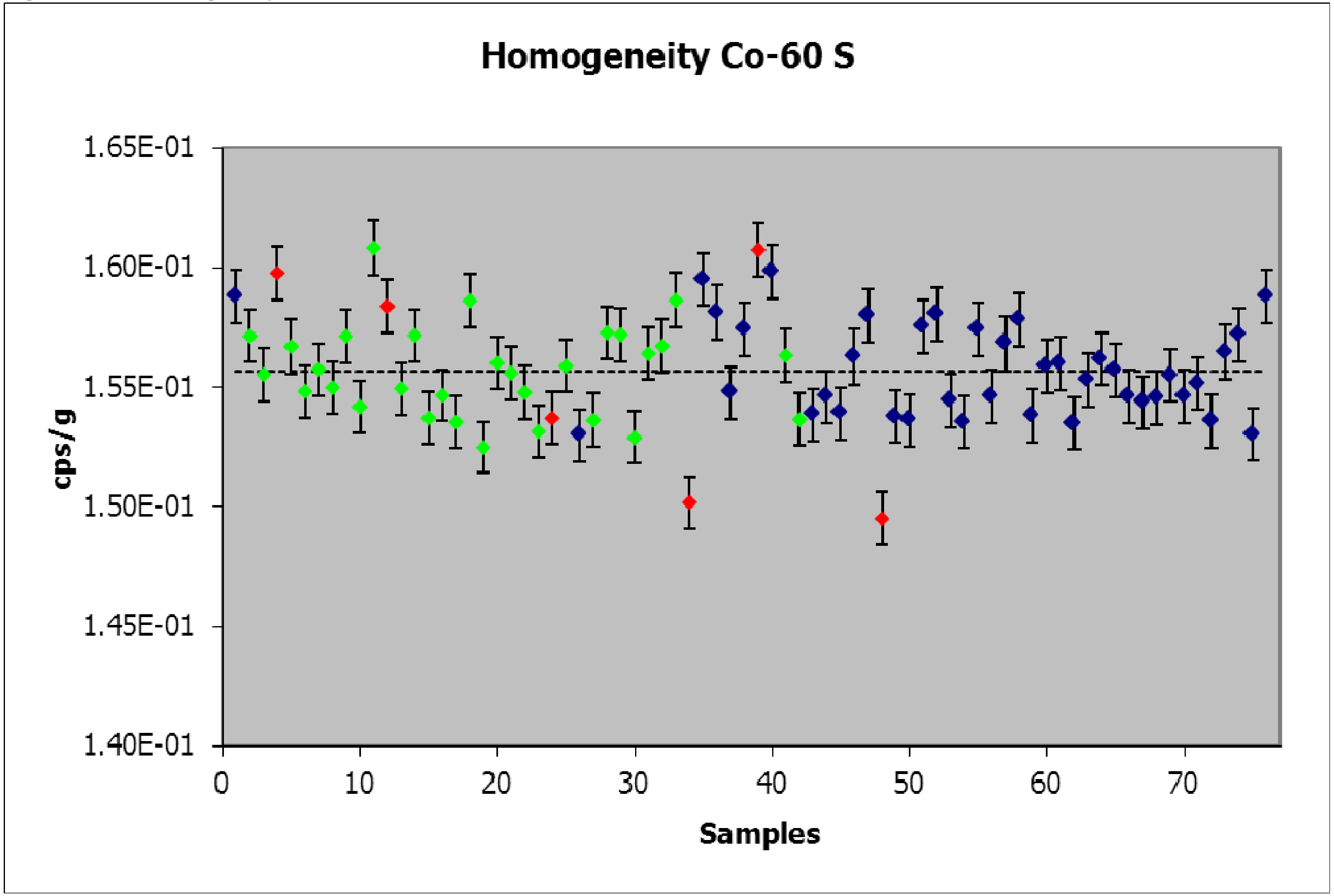


Figure 49B – Homogeneity test ^{137}Cs S

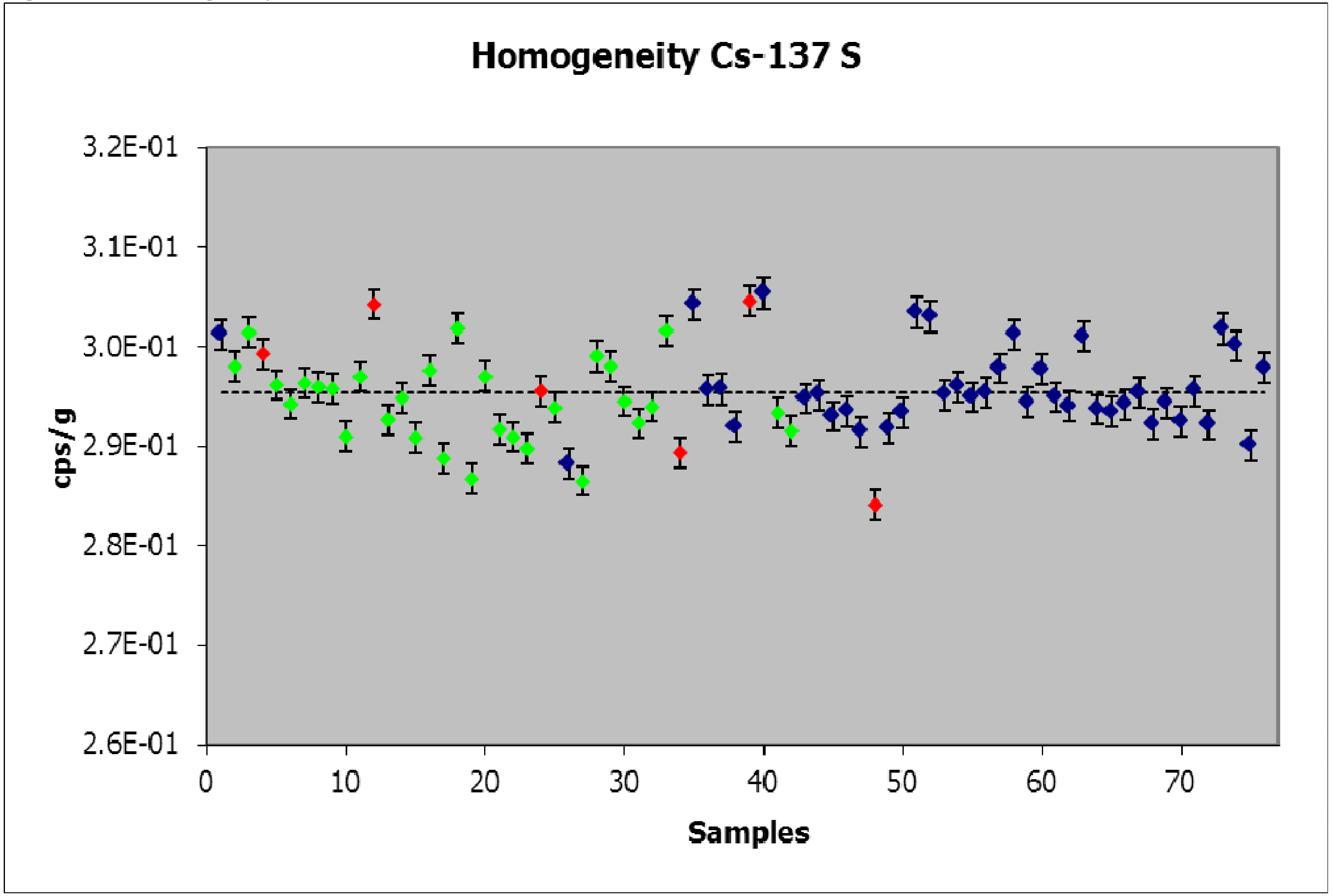


Figure 49C – Homogeneity test ^{152}Eu S

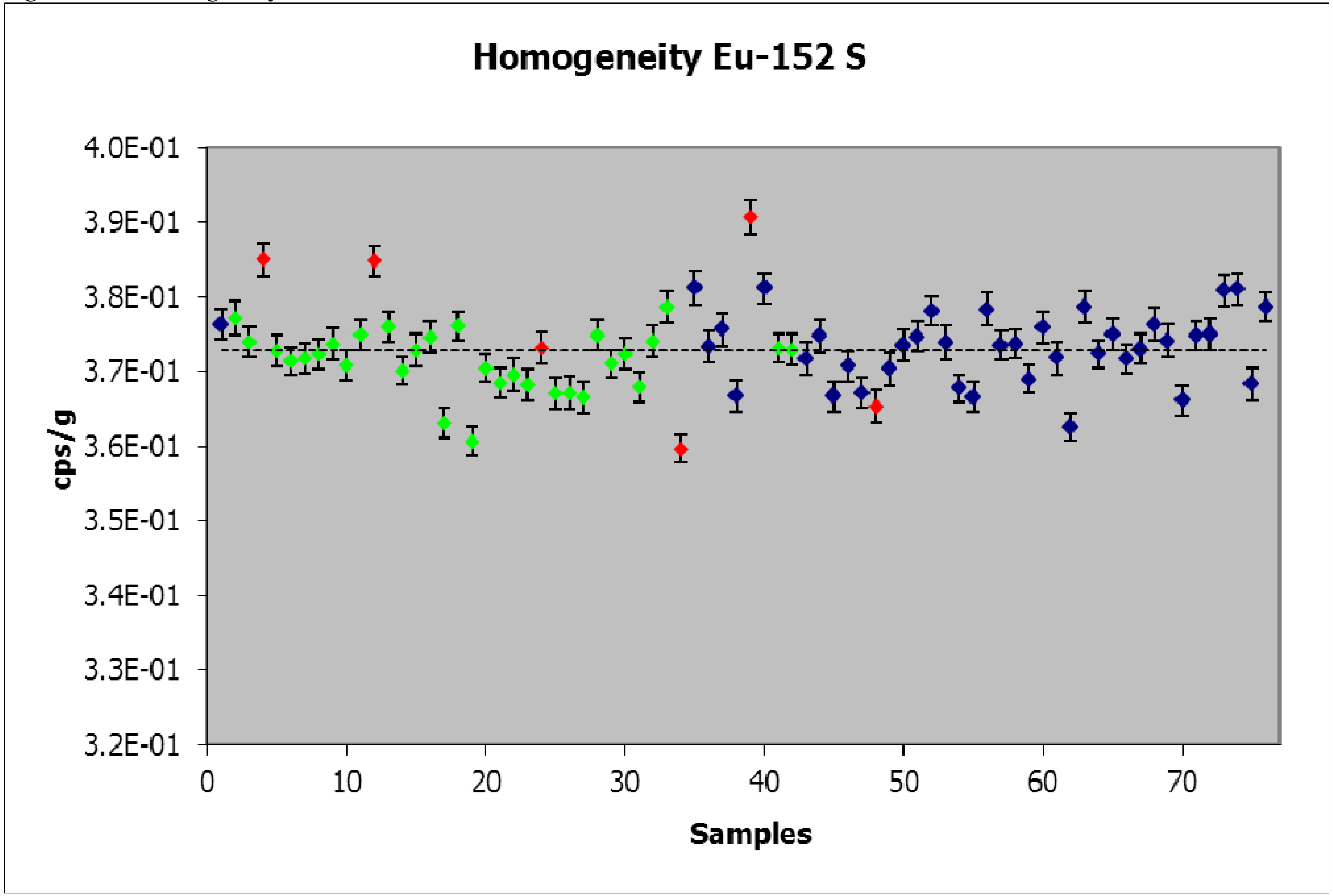


Figure 49D – Homogeneity test ^{154}Eu S

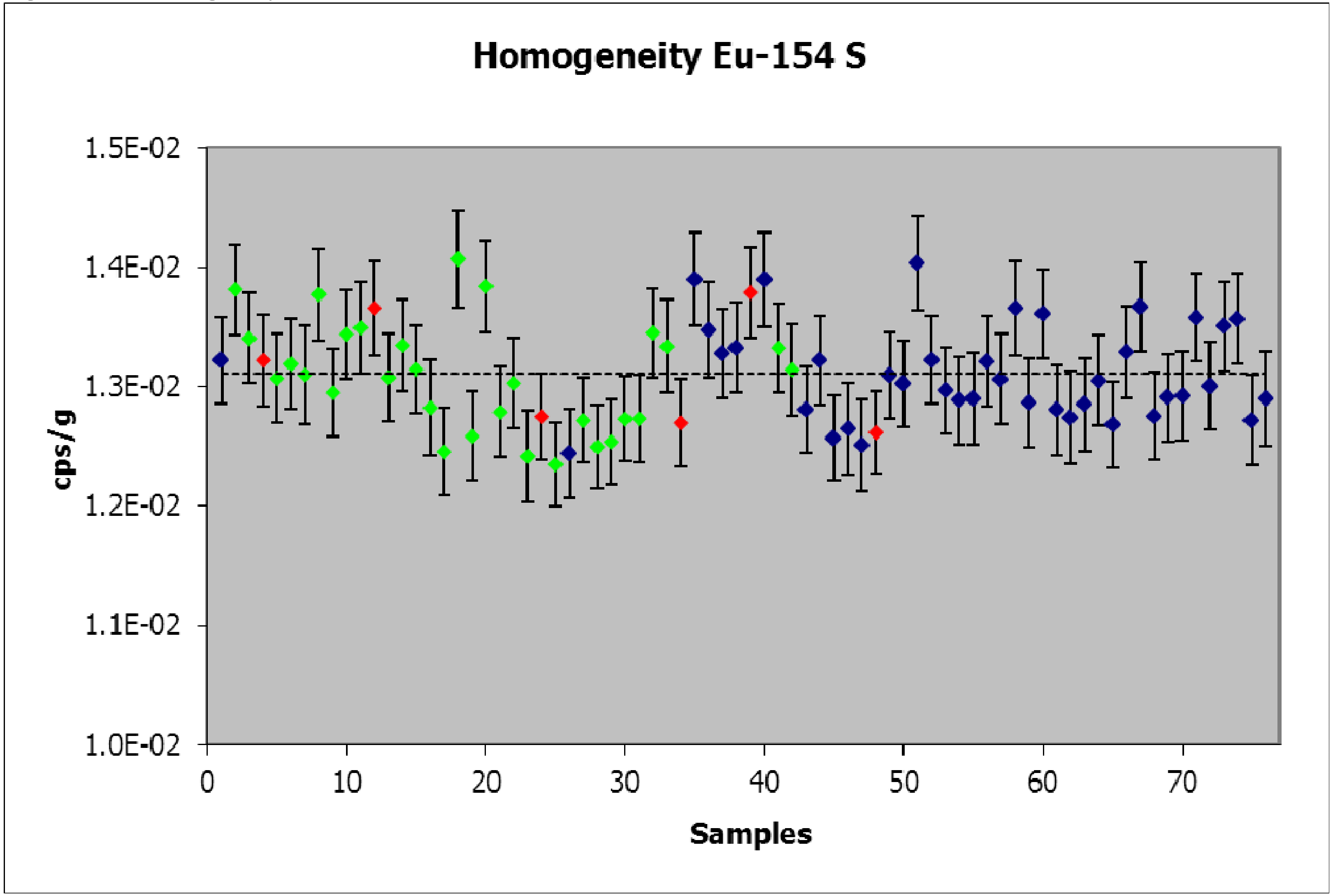


Figure 49E – Homogeneity test ^{241}Am S

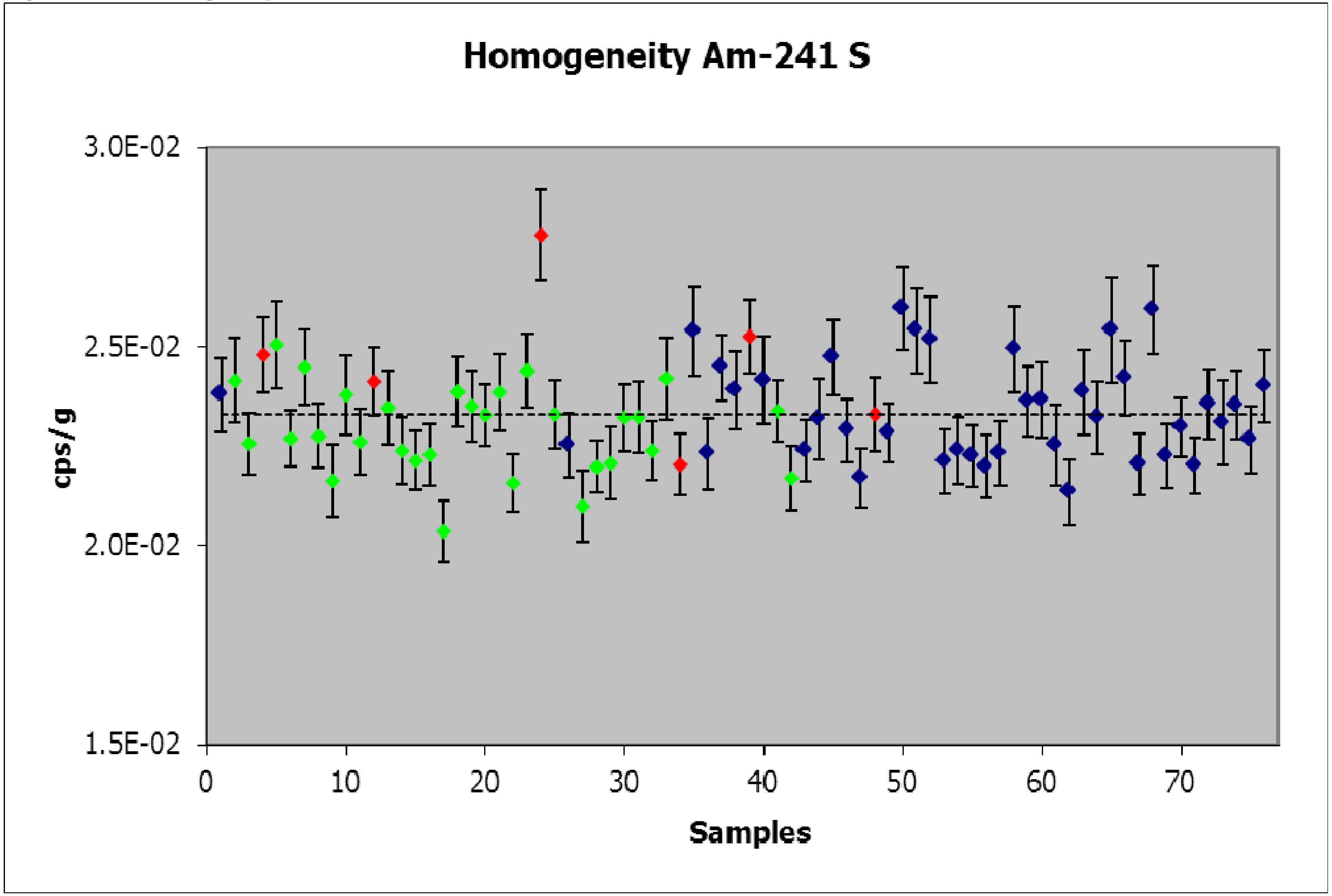


Figure 50 – Laboratory 1

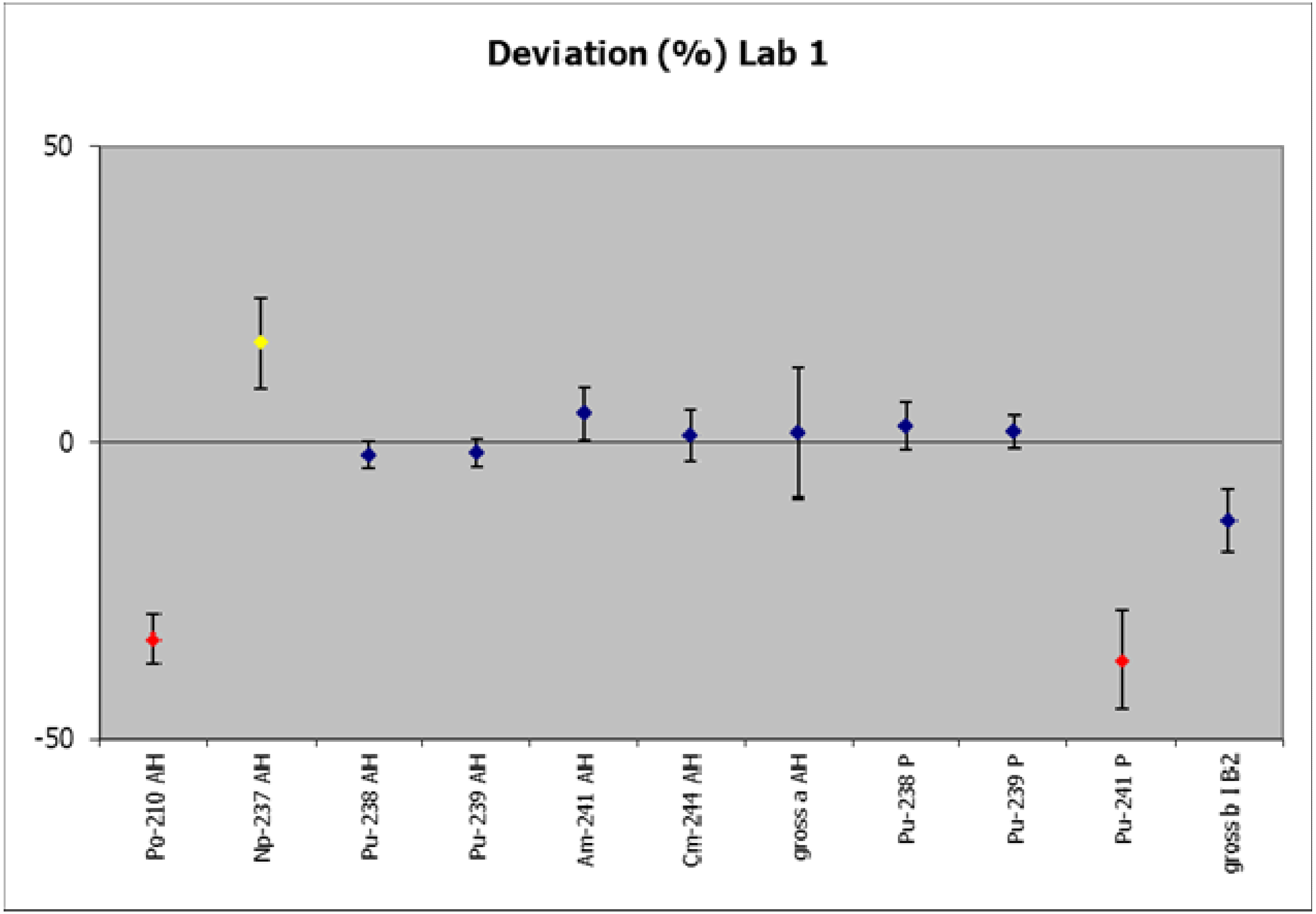


Figure 51 – Laboratory 4

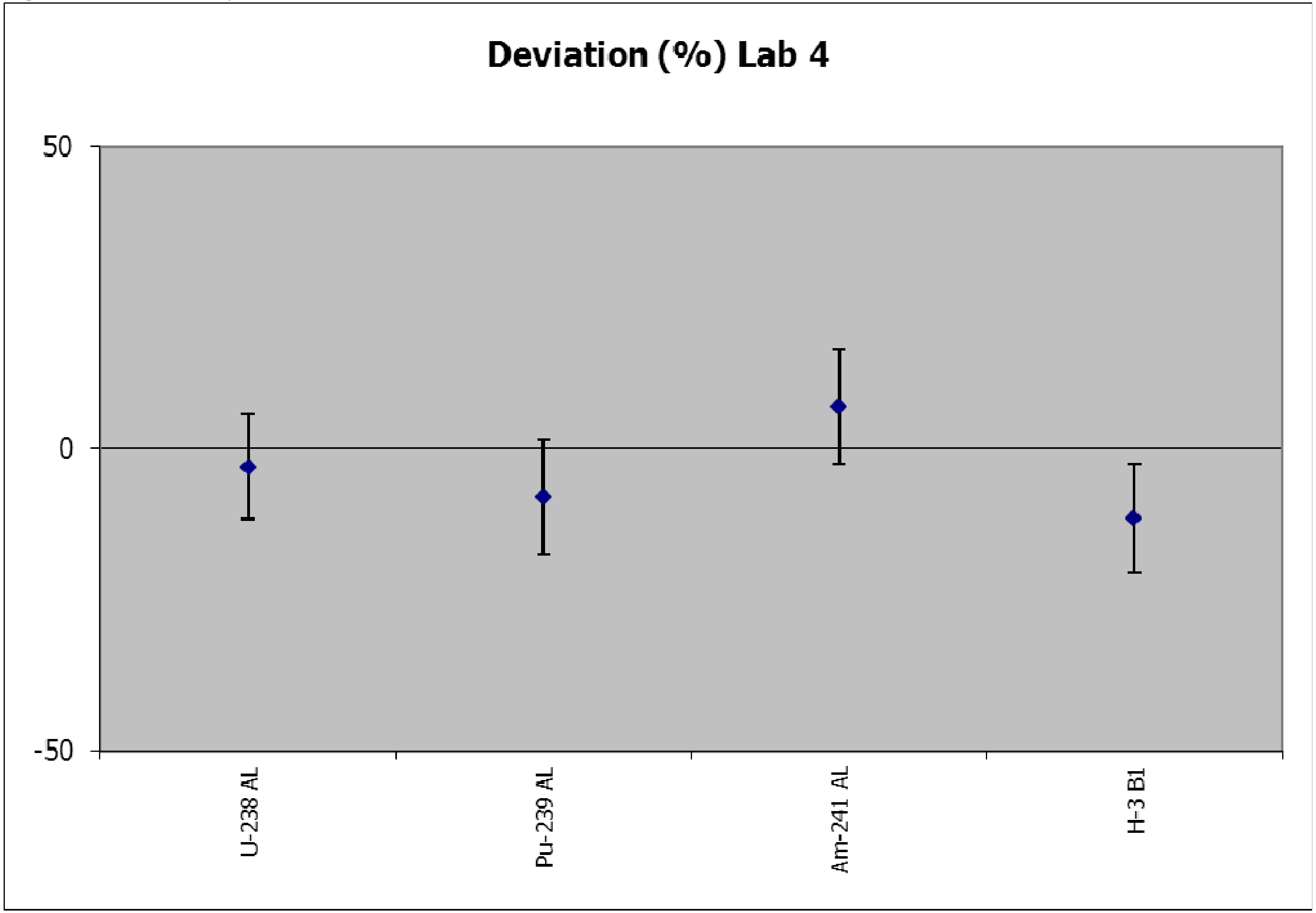


Figure 52 – Laboratory 5

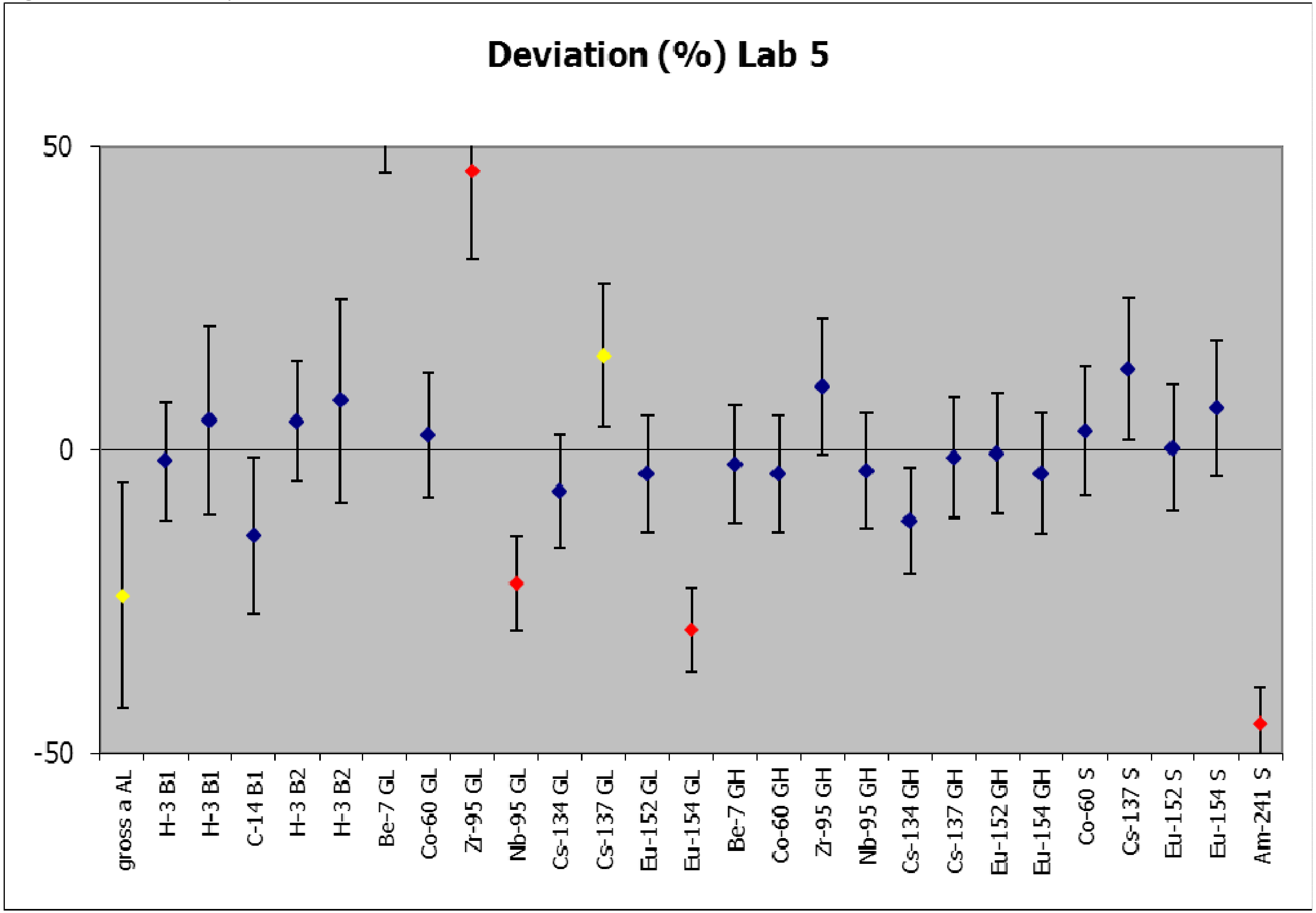


Figure 53 – Laboratory 7

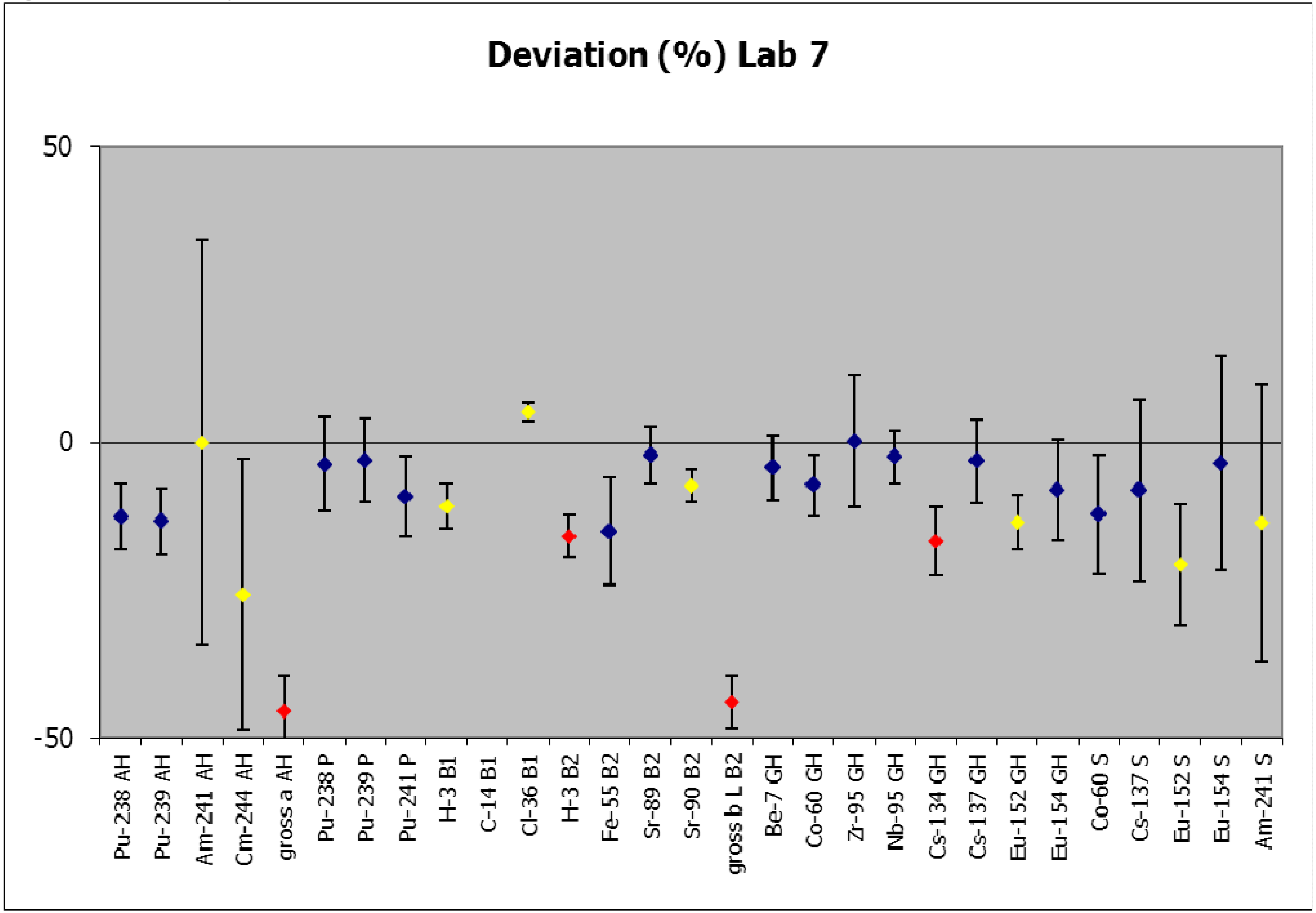


Figure 54 – Laboratory 8

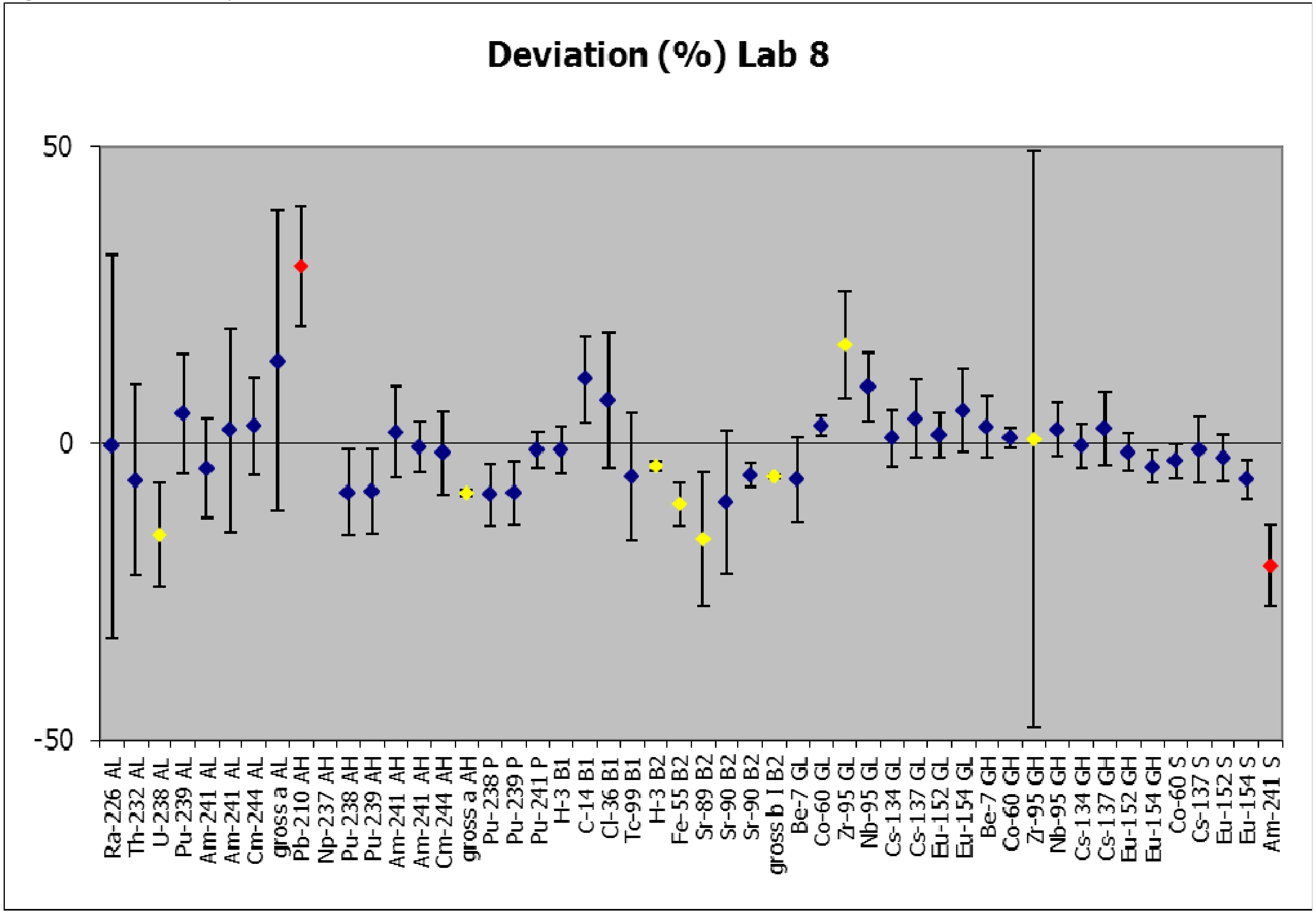


Figure 55 – Laboratory 9

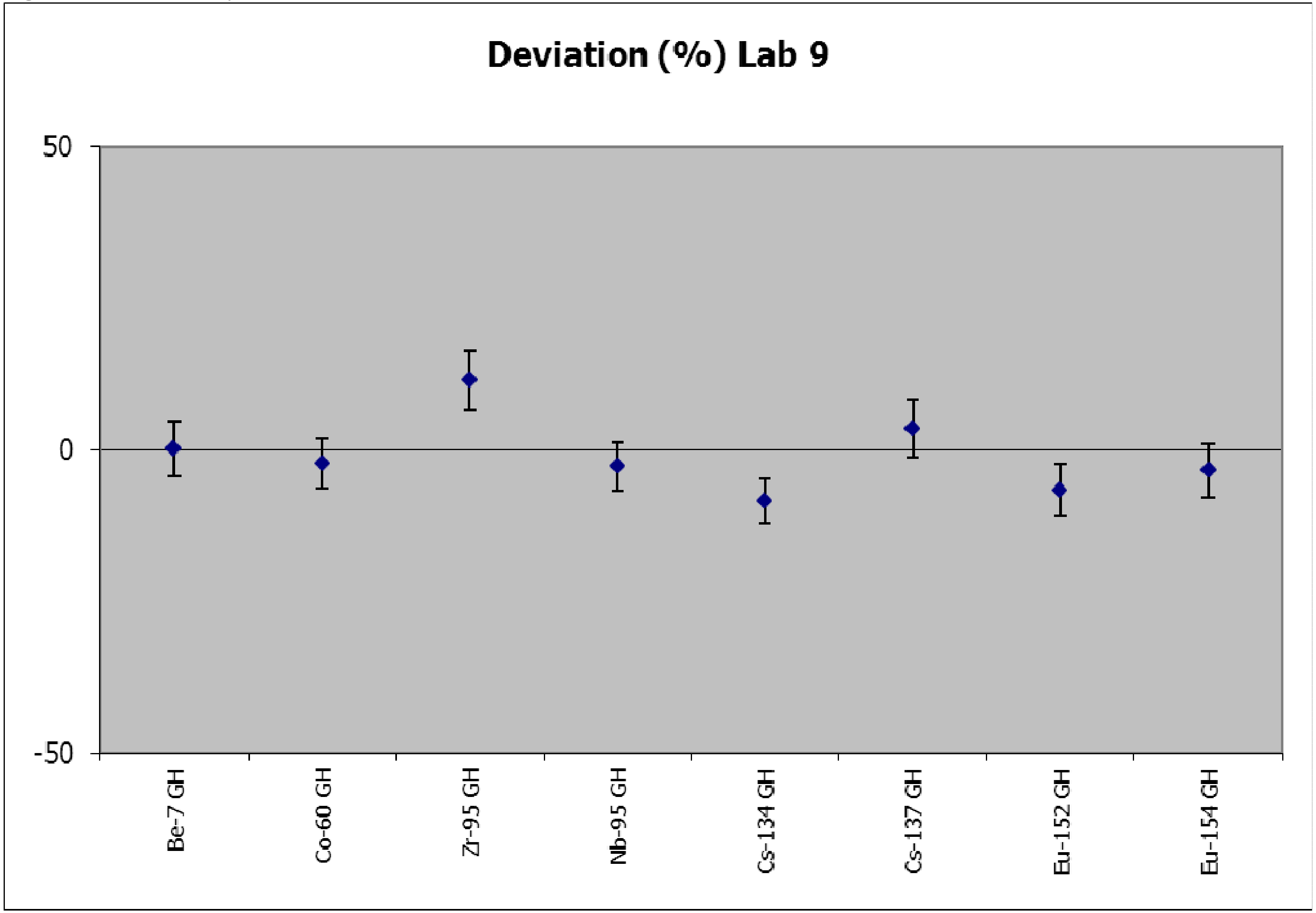


Figure 56 – Laboratory 13

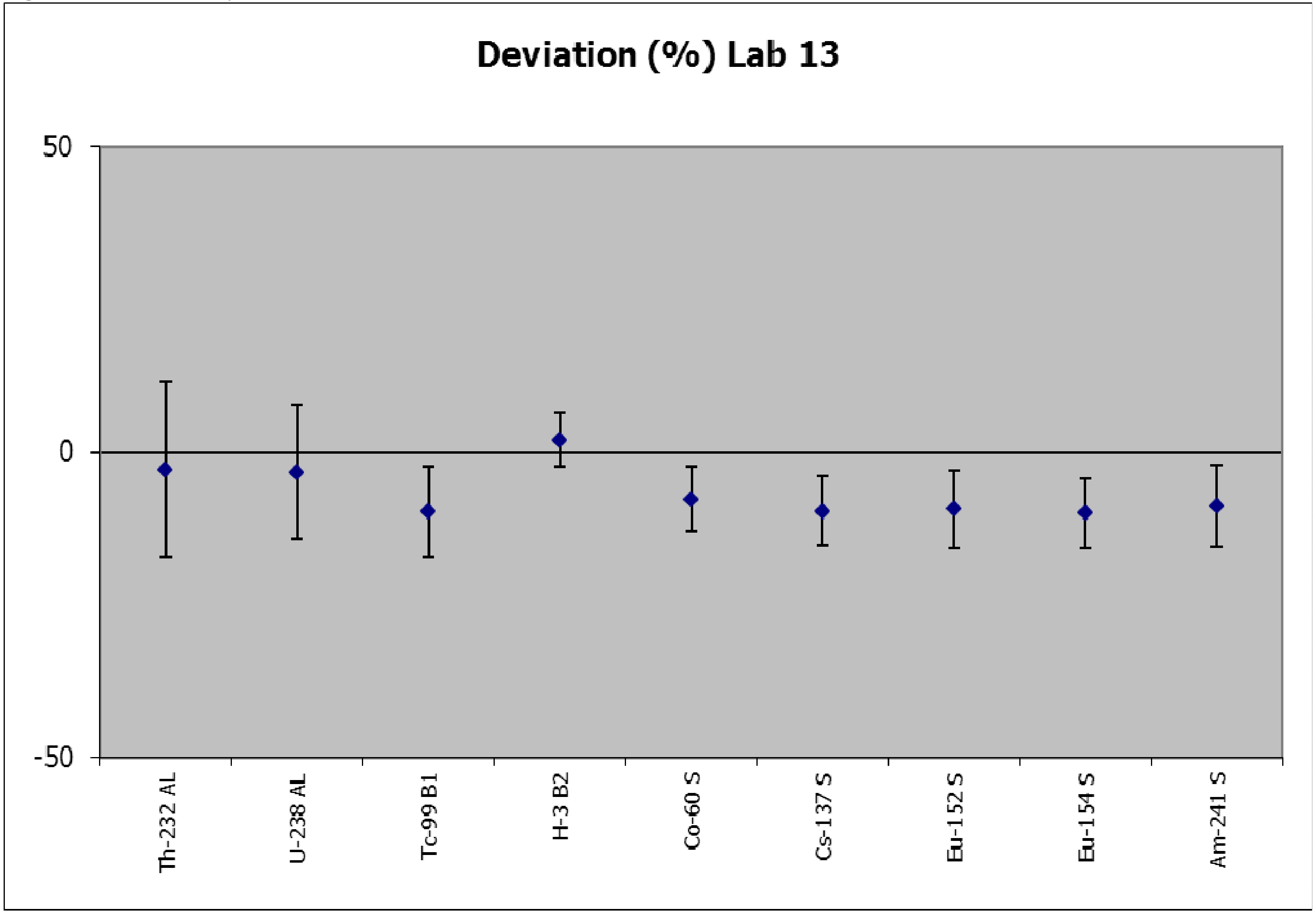


Figure 57 – Laboratory 15

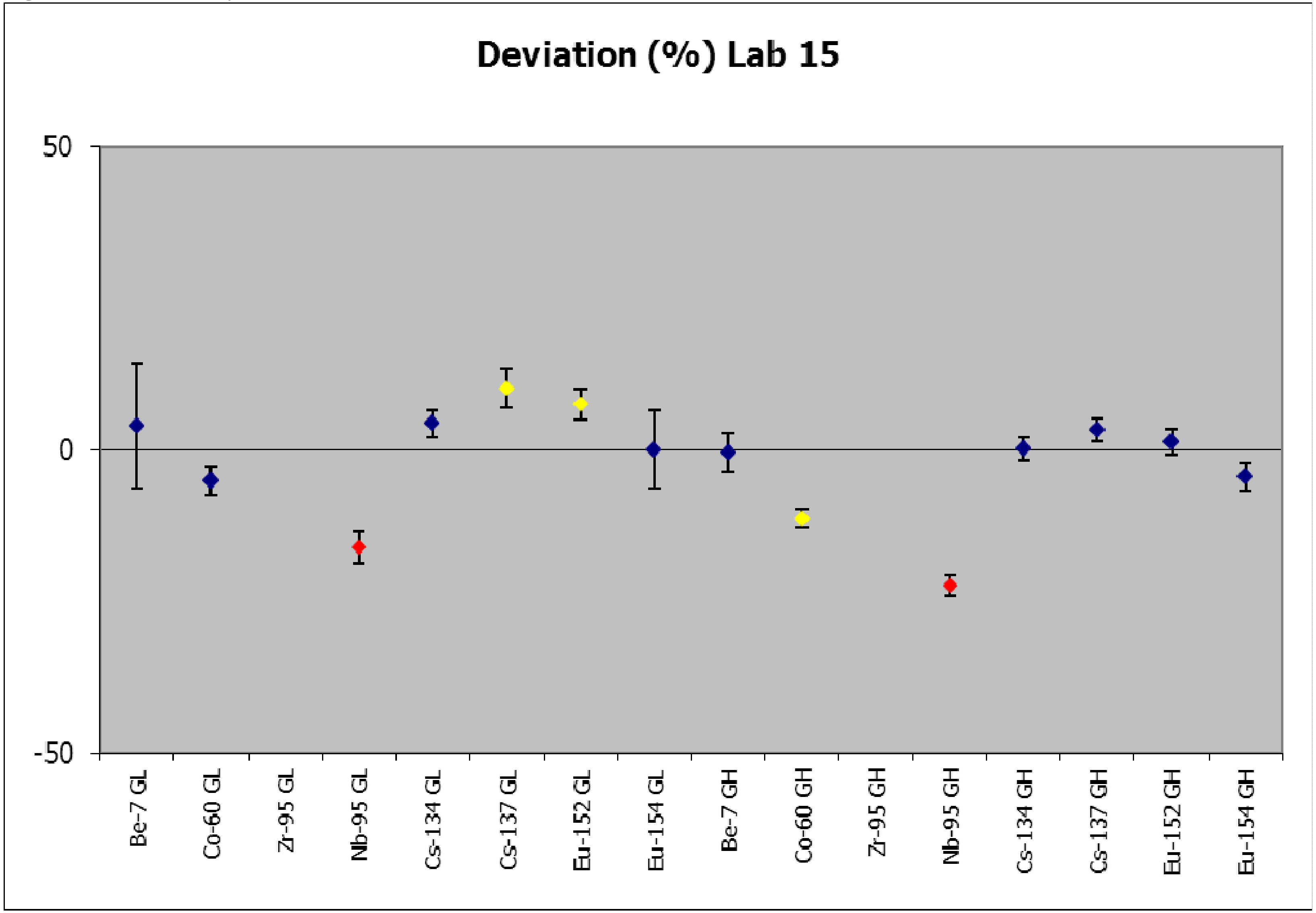


Figure 58 – Laboratory 16

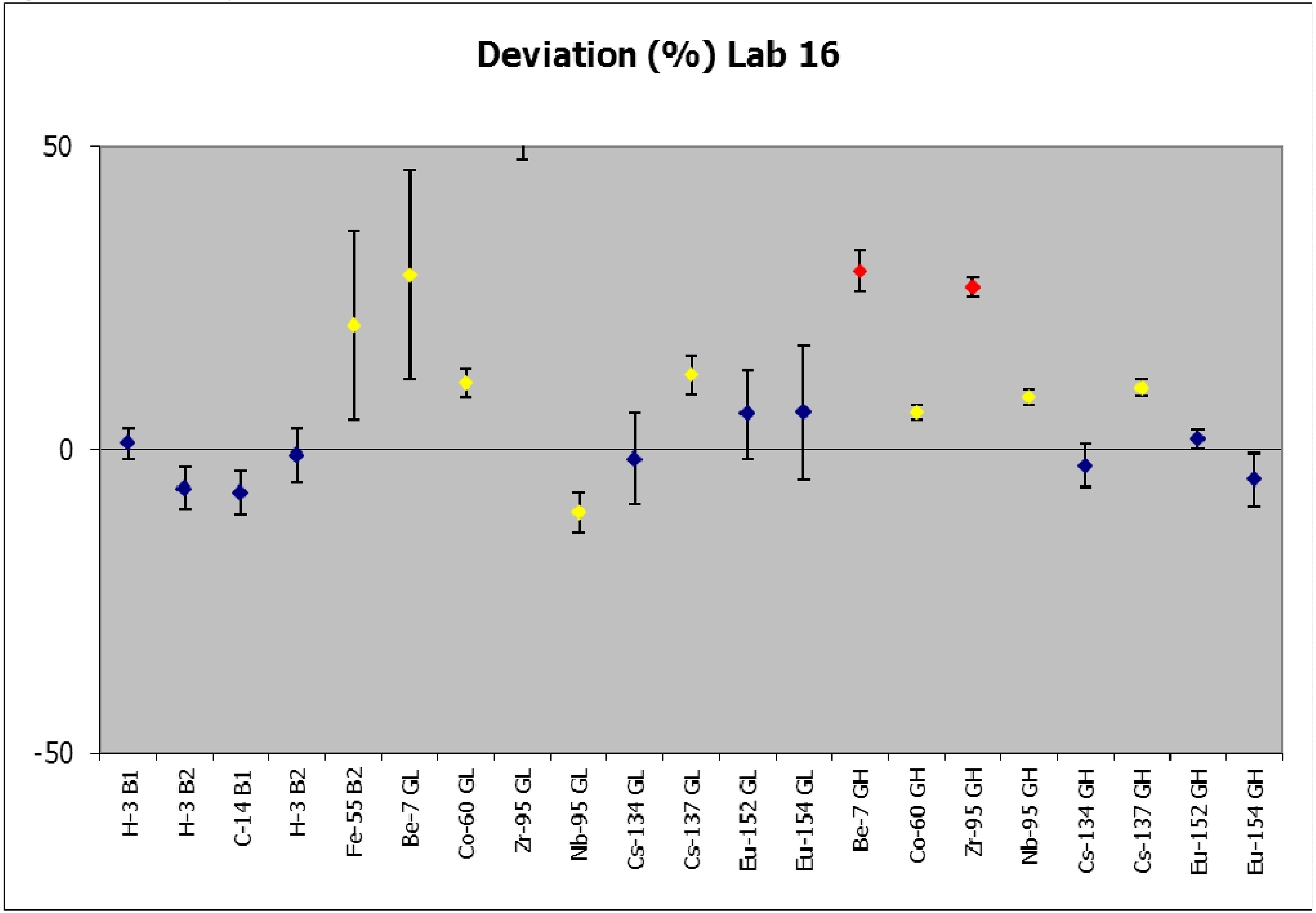


Figure 59 – Laboratory 17

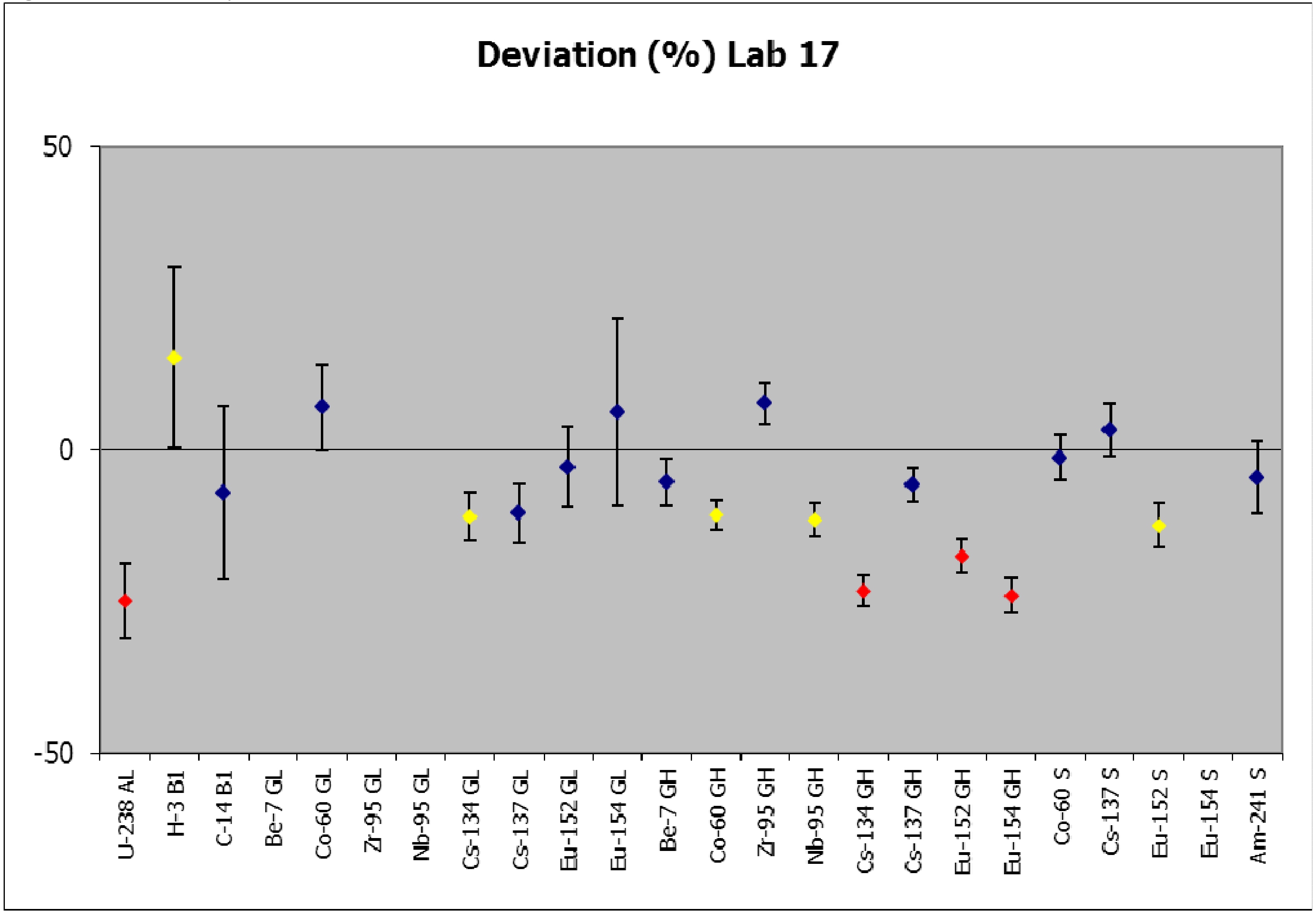


Figure 60 – Laboratory 19

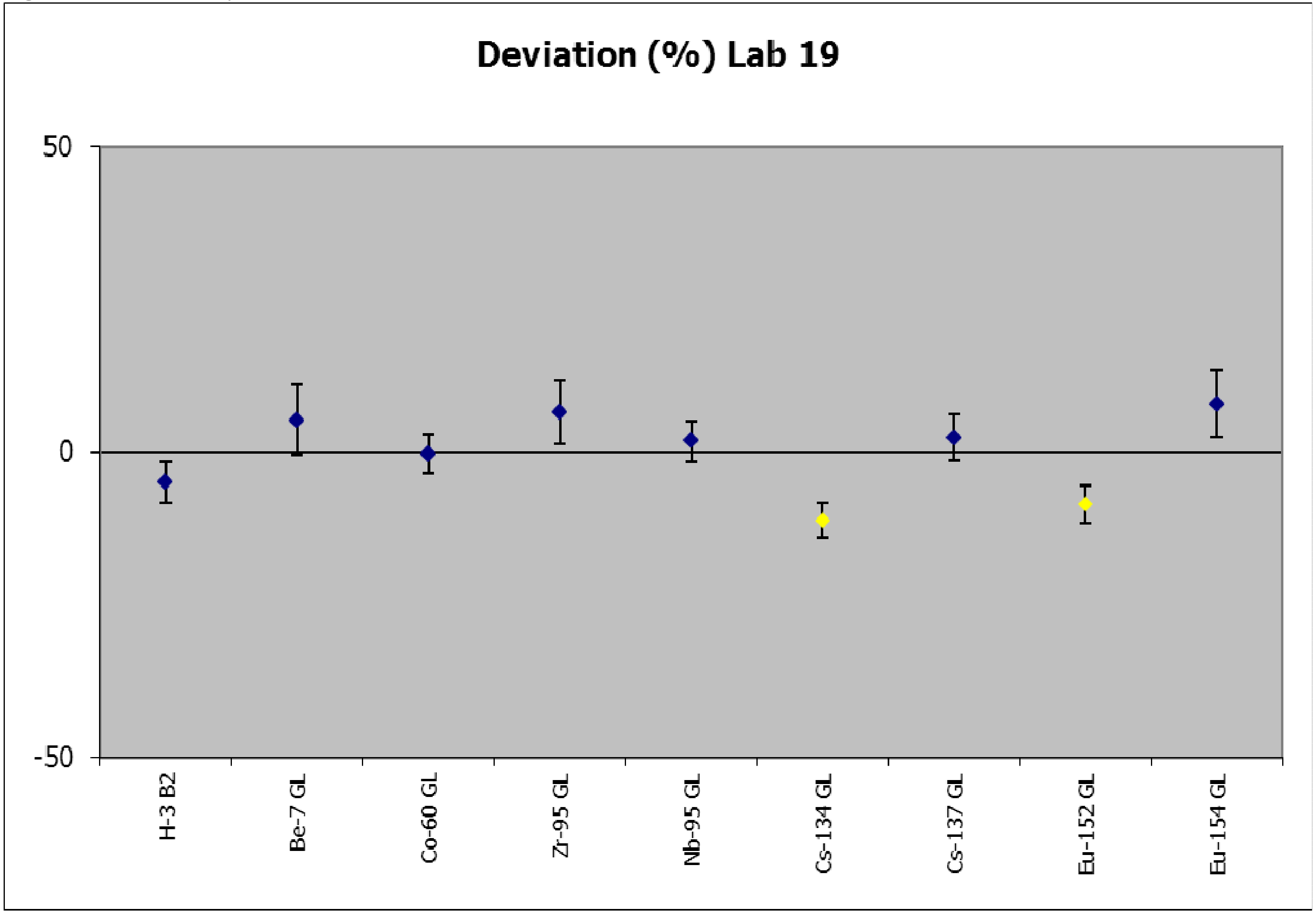


Figure 61 – Laboratory 21

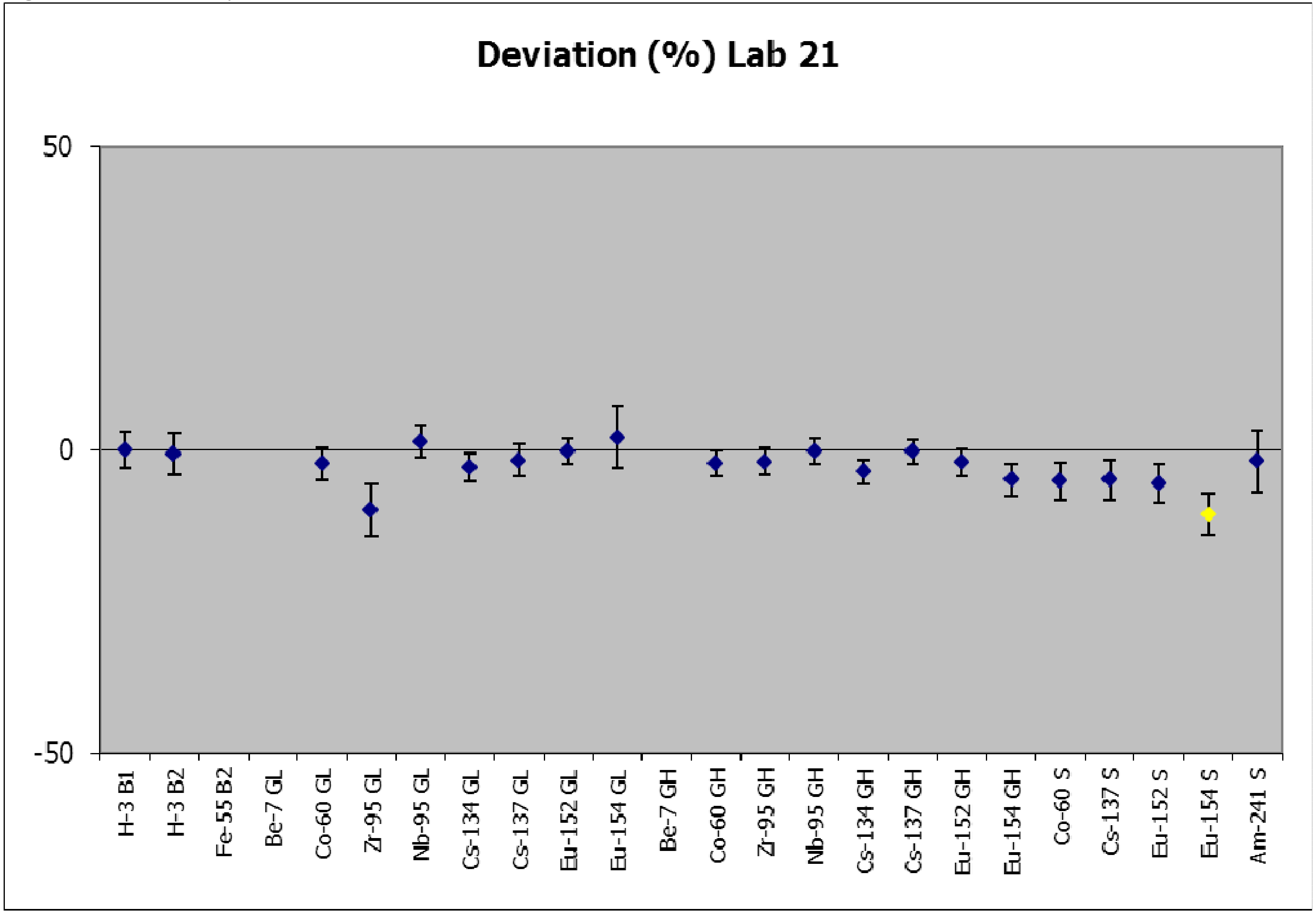


Figure 62 – Laboratory 23

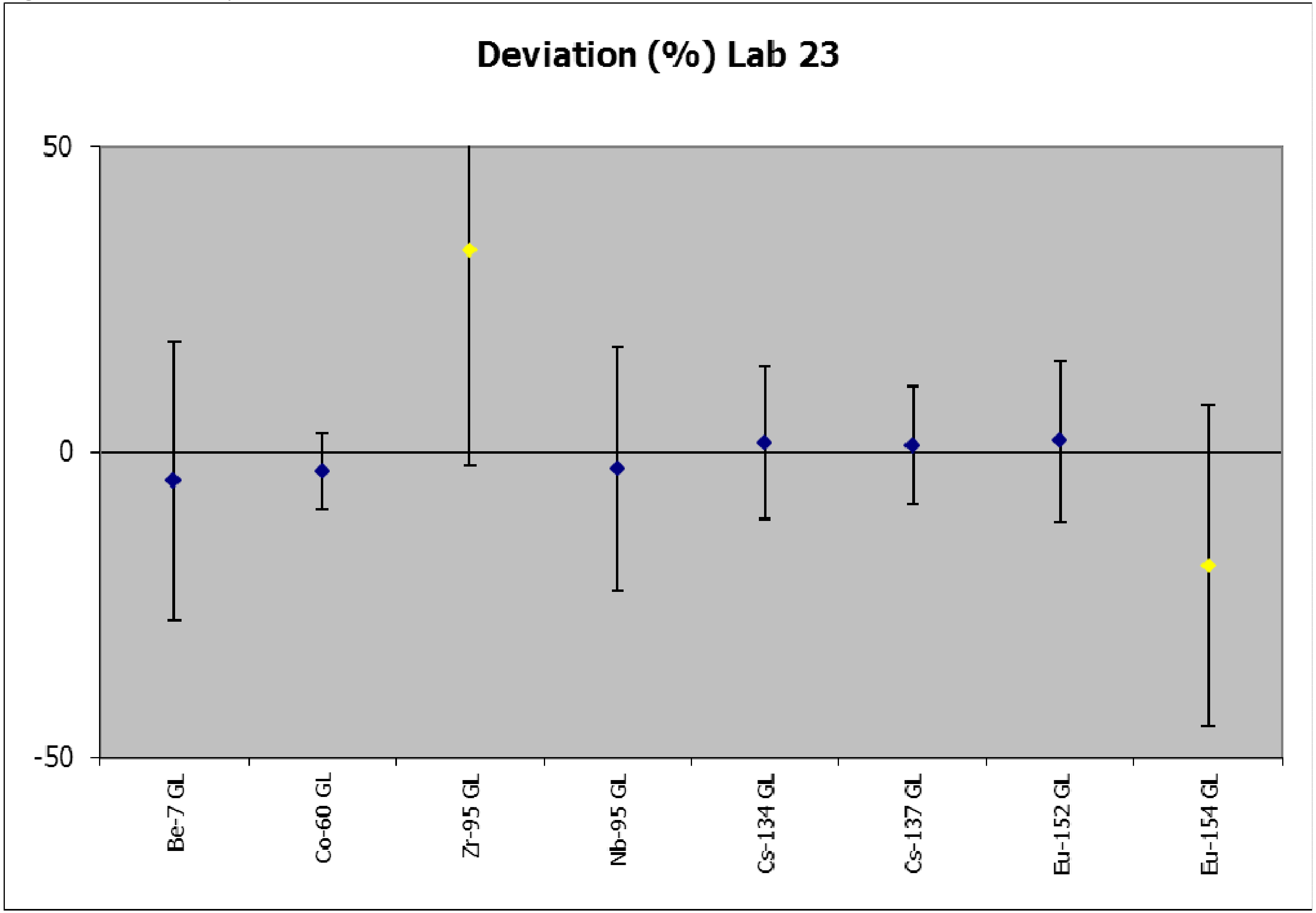


Figure 63 – Laboratory 24

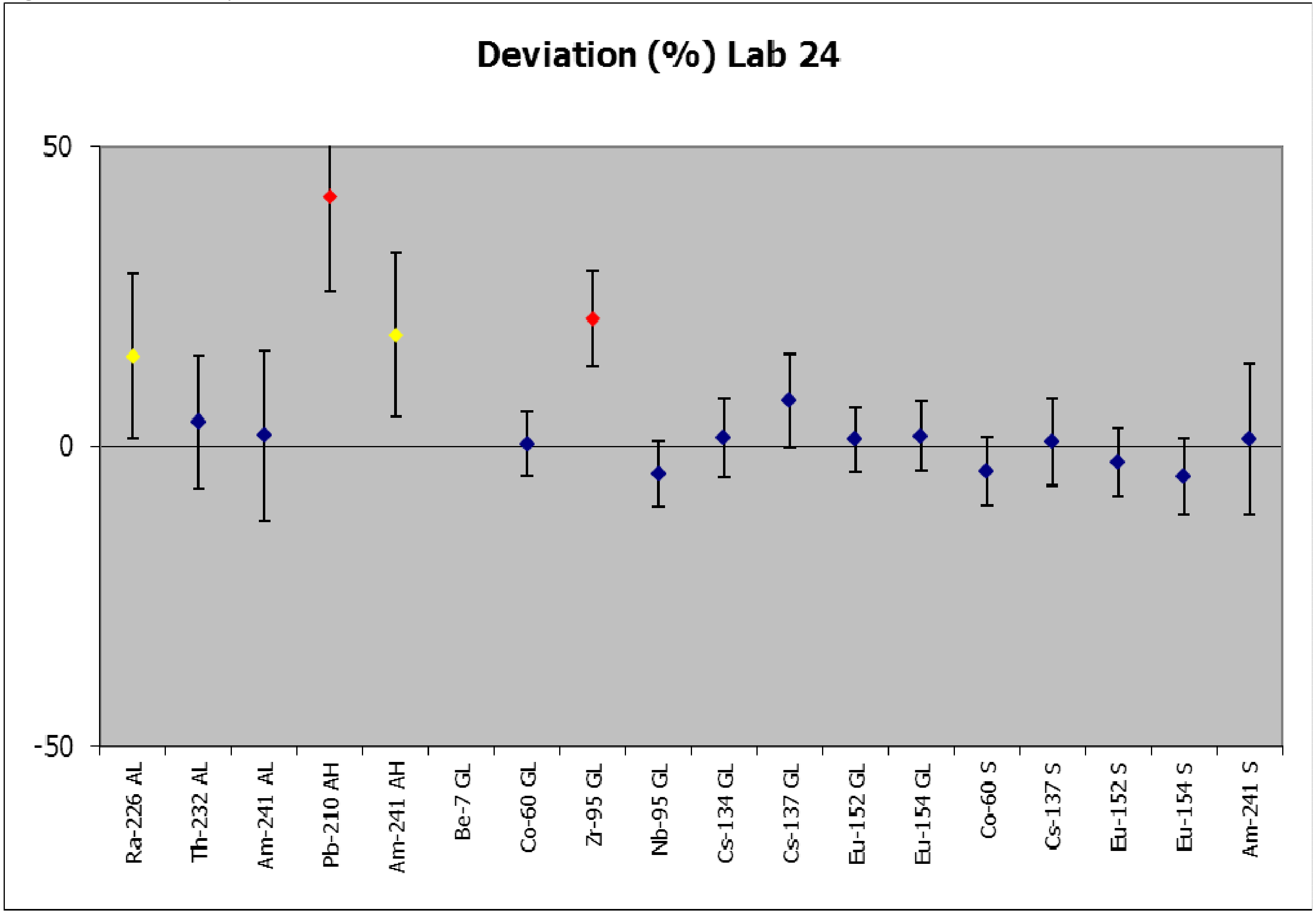


Figure 64 – Laboratory 25

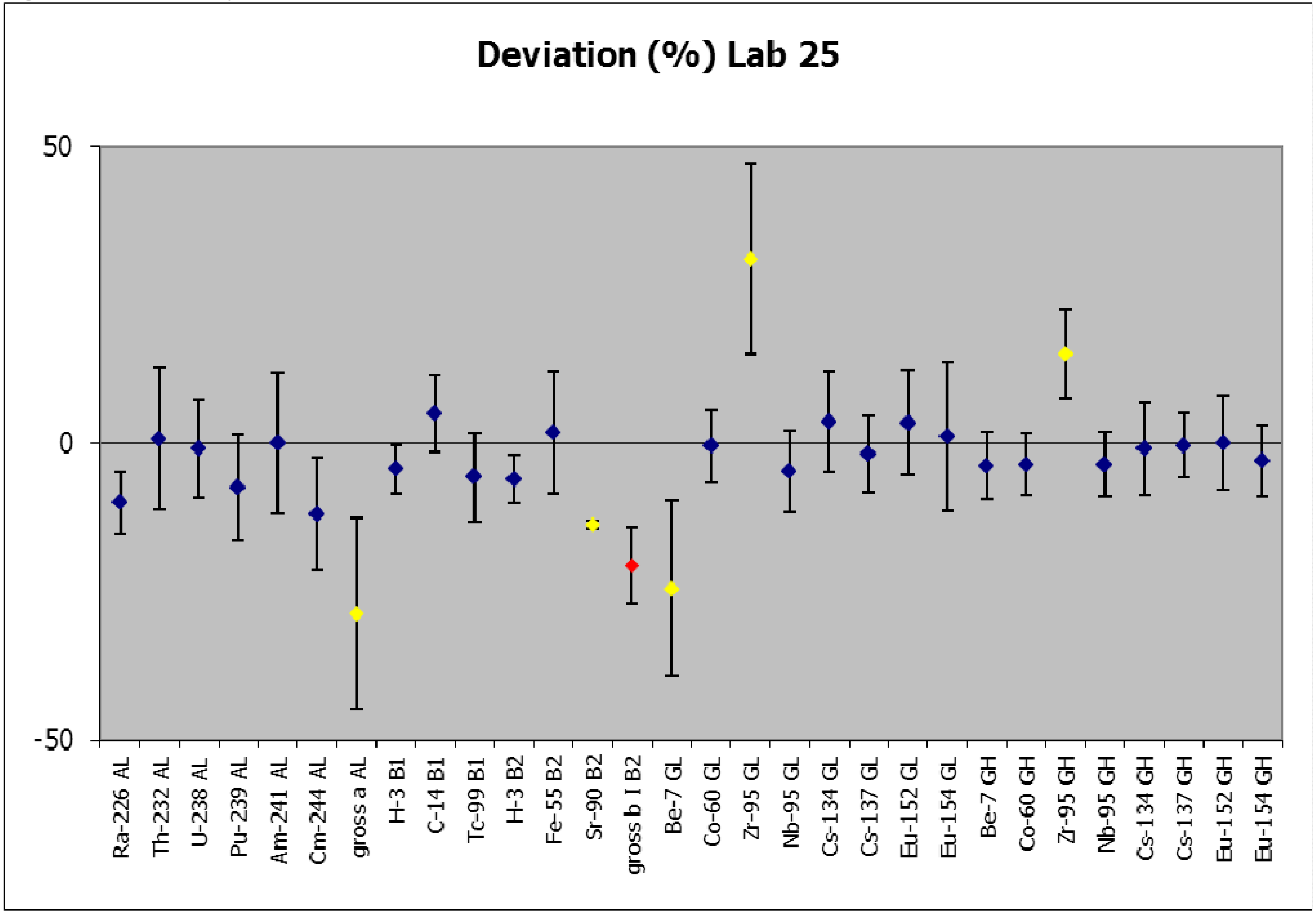


Figure 65 – Laboratory 26

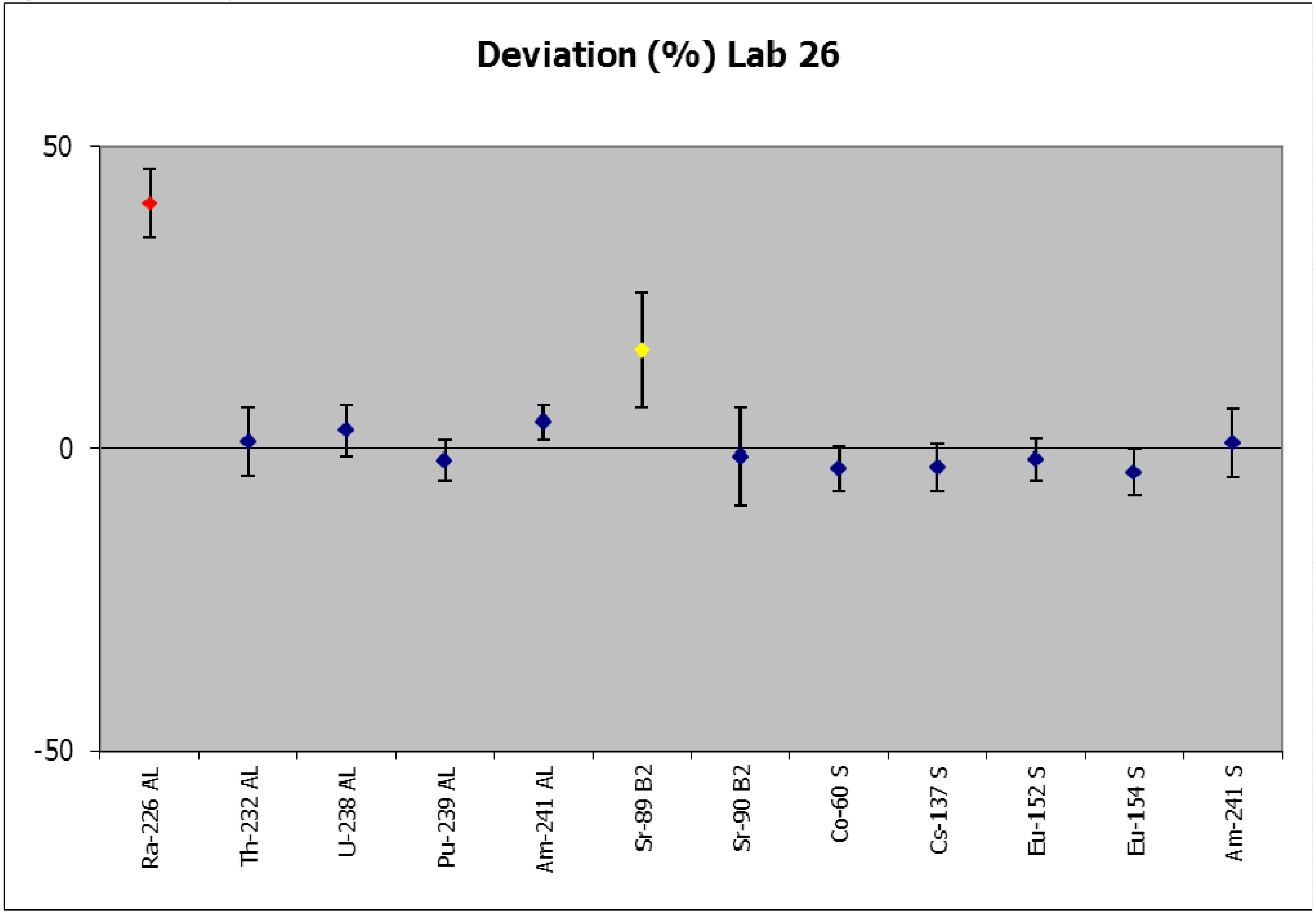


Figure 66 – Laboratory 27

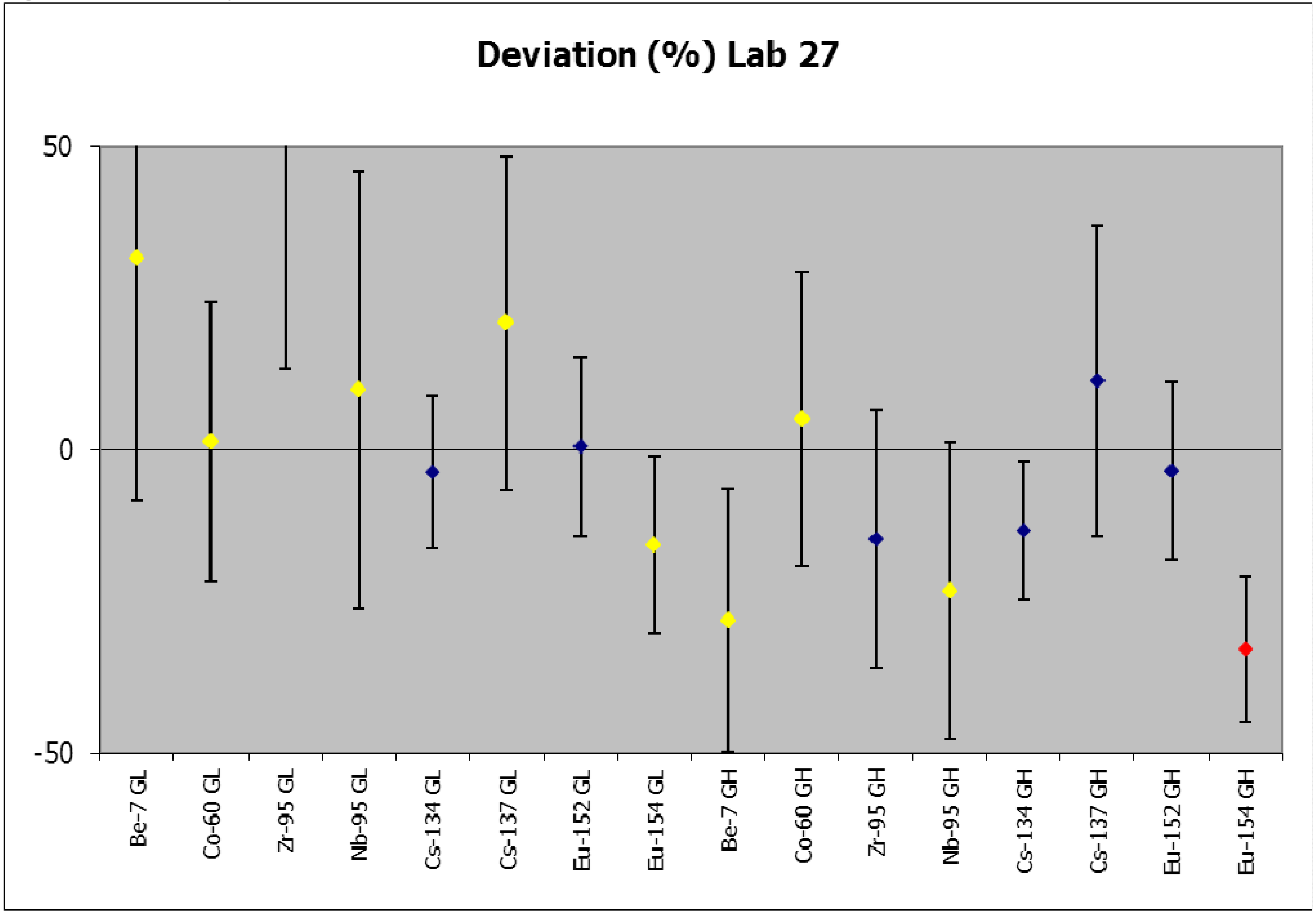


Figure 67 – Laboratory 28

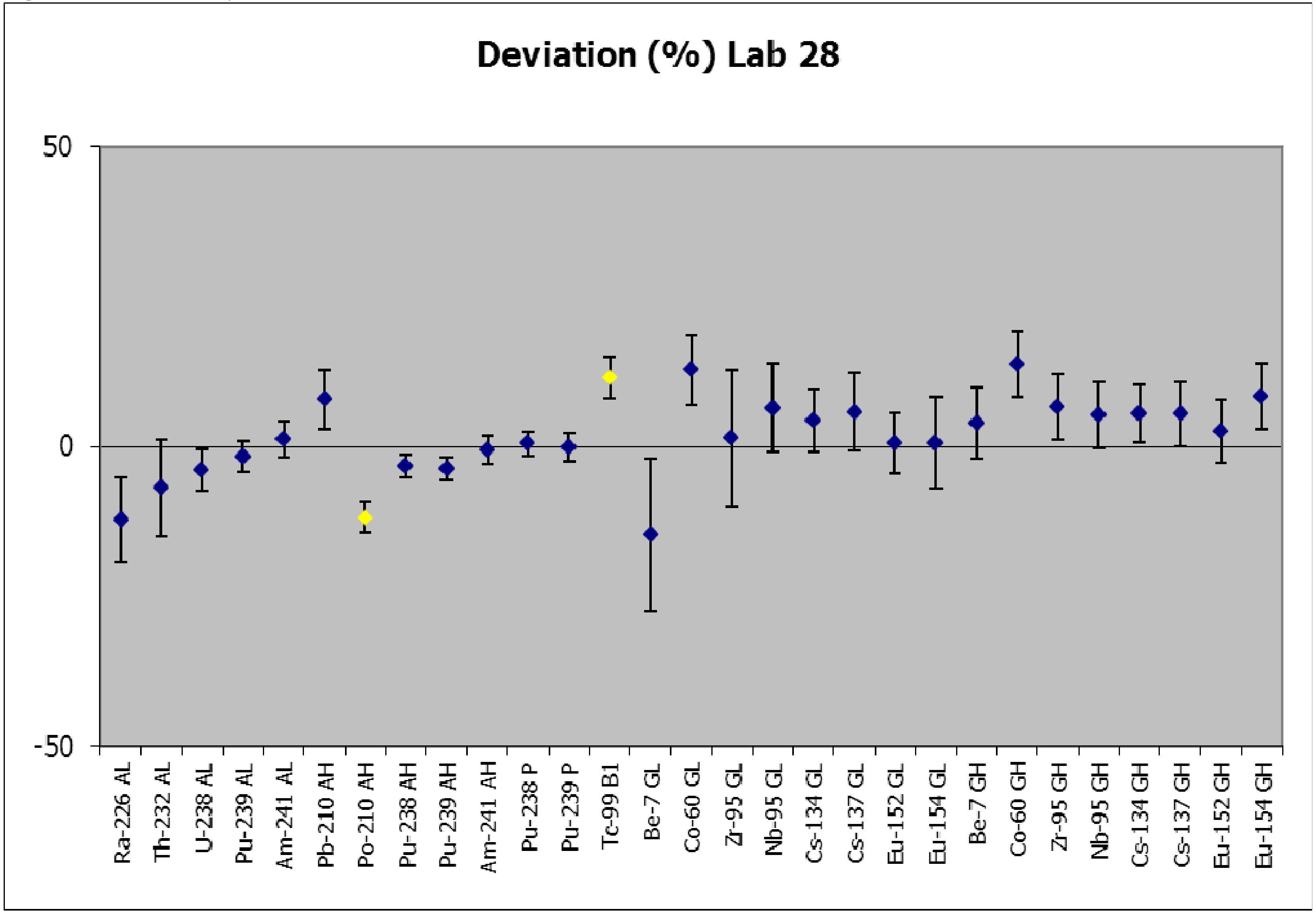


Figure 68 – Laboratory 29

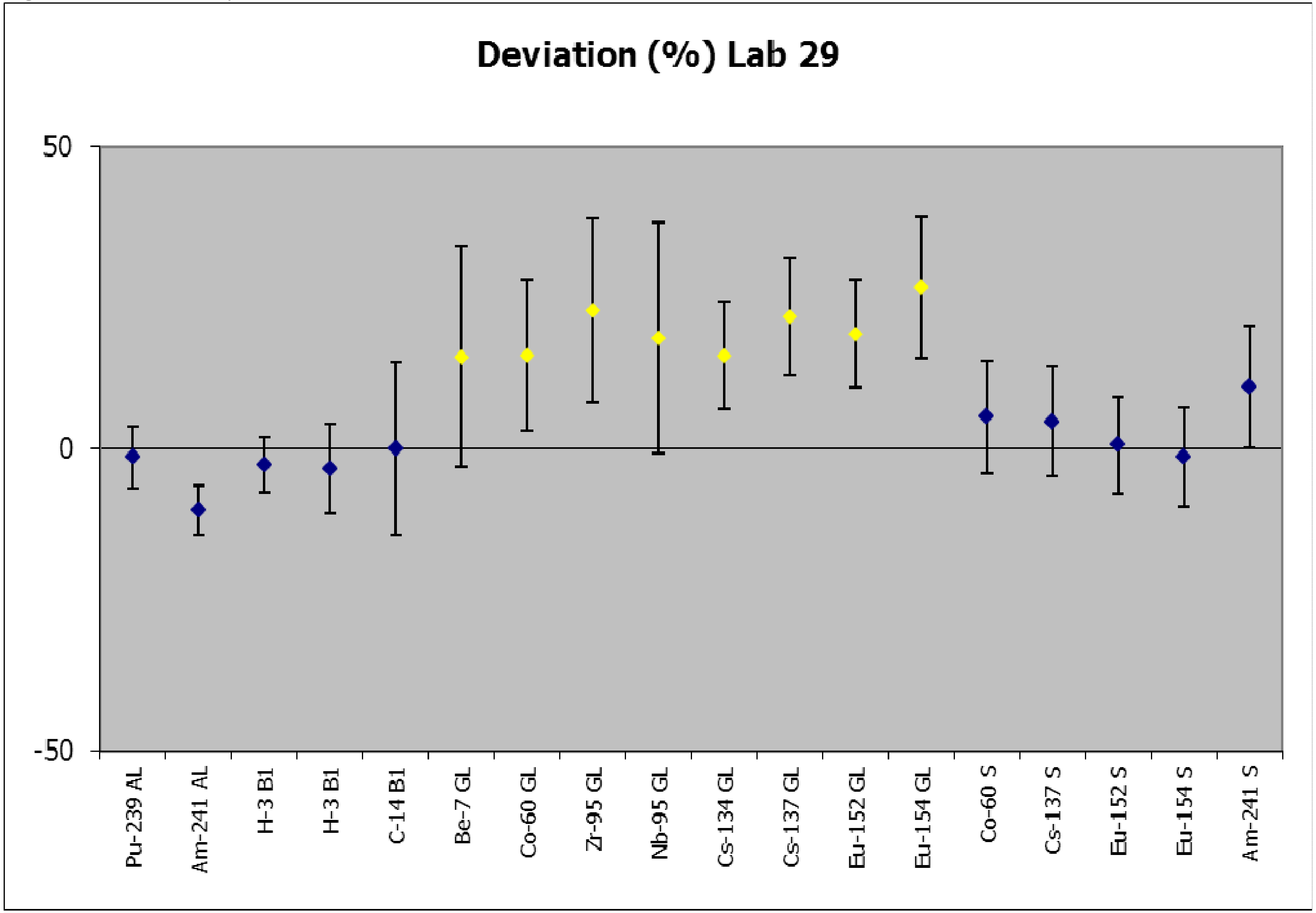


Figure 69 – Laboratory 31

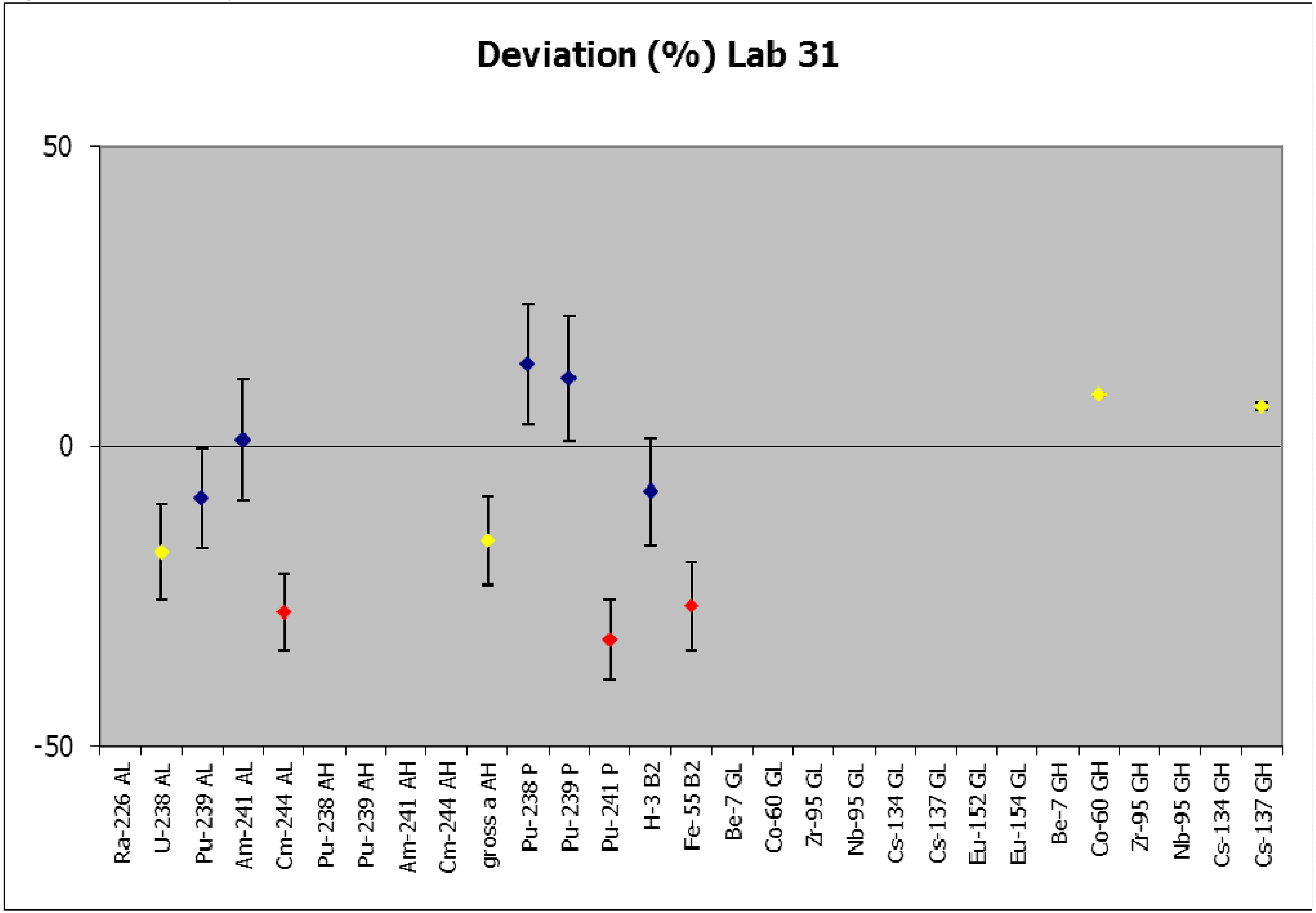


Figure 70 – Laboratory 32

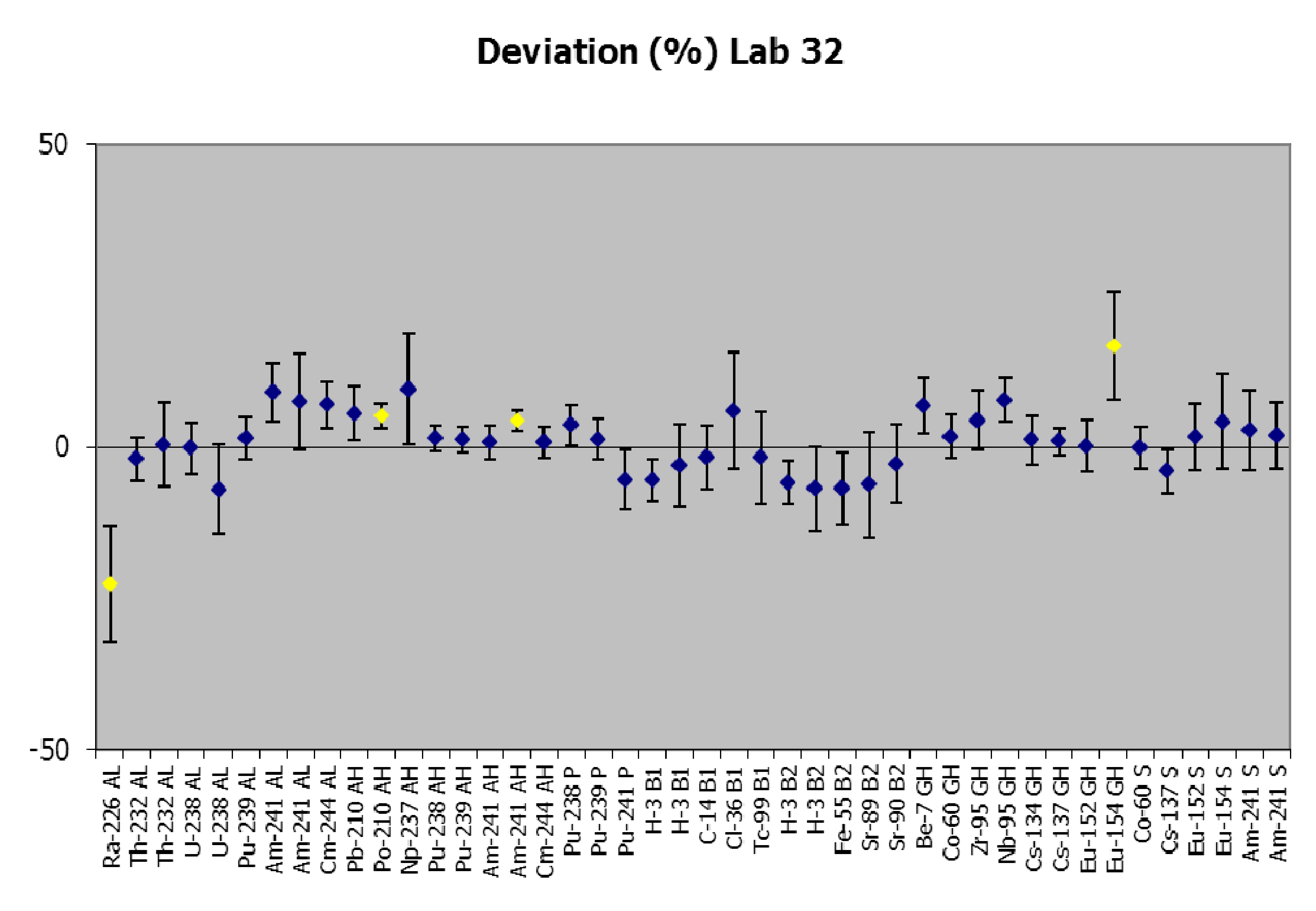


Figure 71 – Laboratory 34

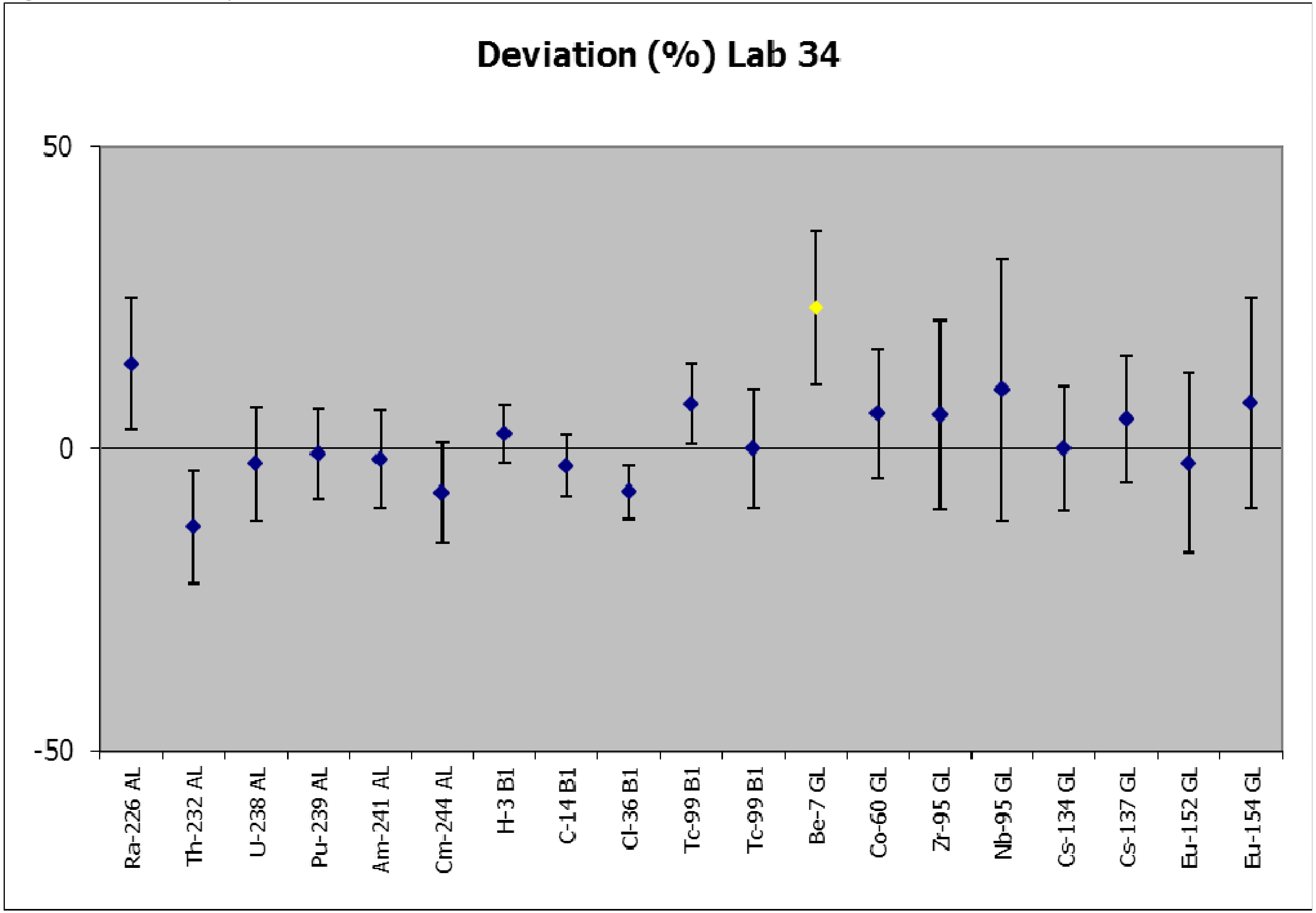


Figure 72 – Laboratory 35

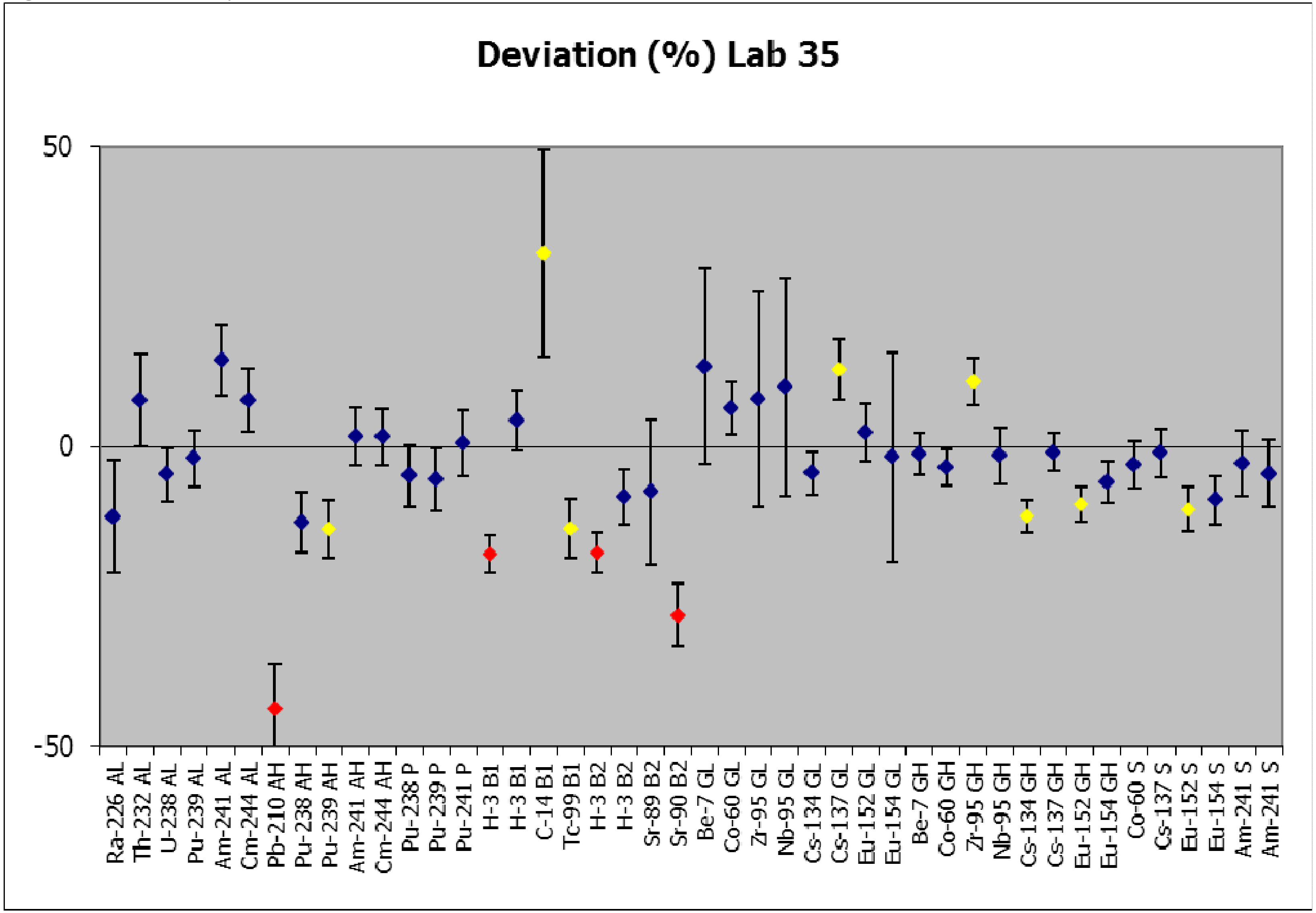


Figure 73 – Laboratory 38

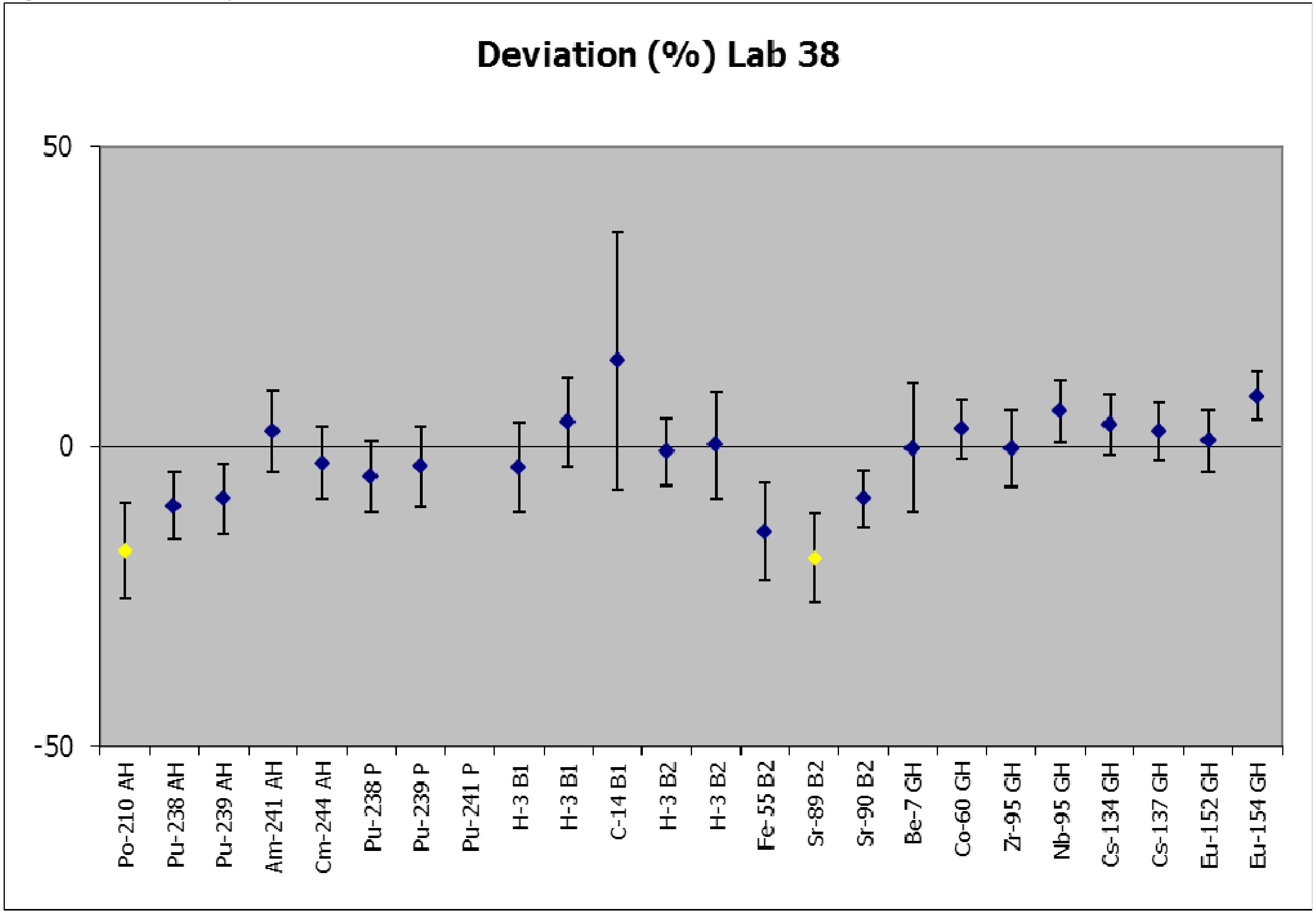


Figure 74 – Laboratory 40

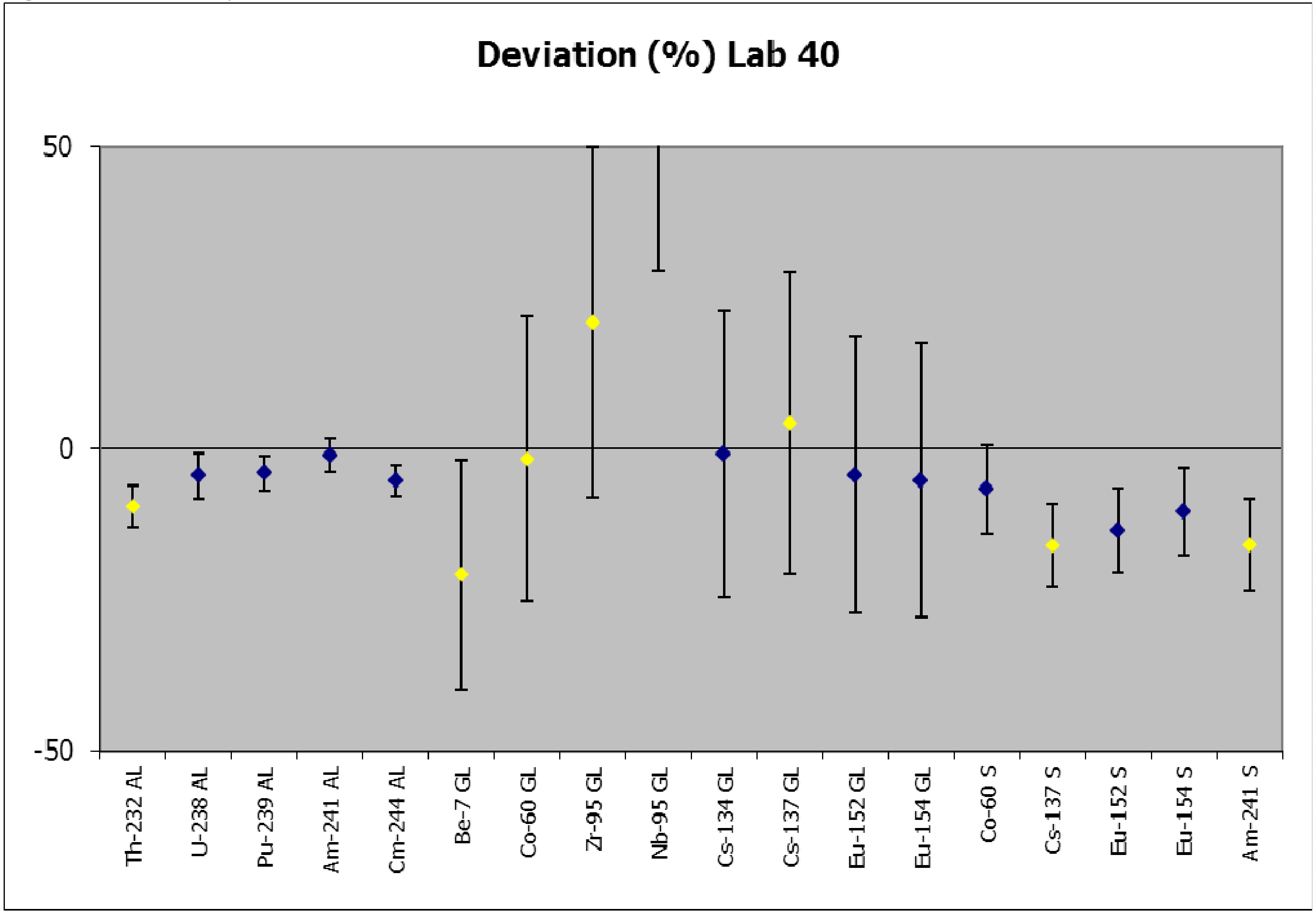


Figure 75 – Laboratory 41

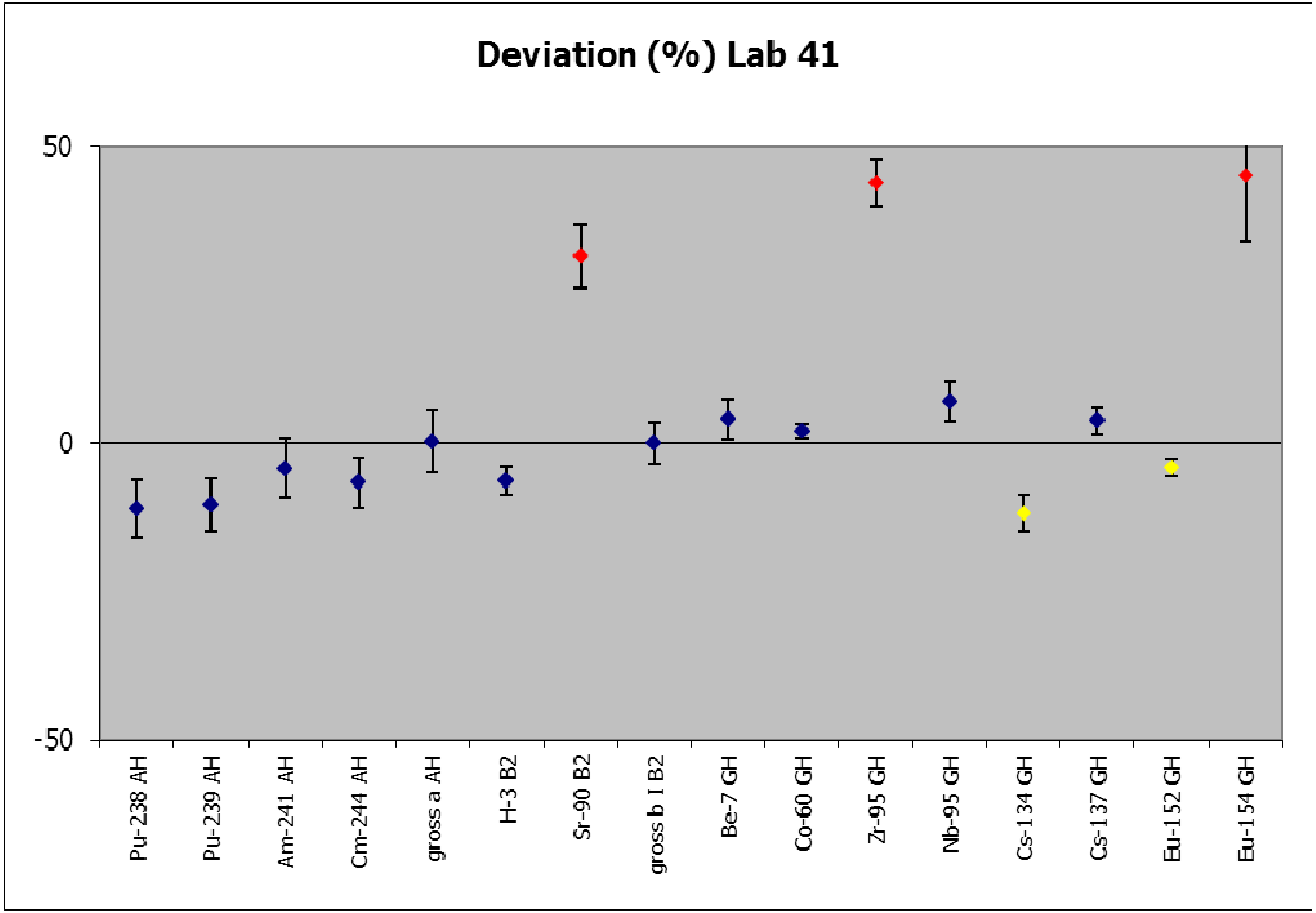


Figure 76 – Laboratory 42

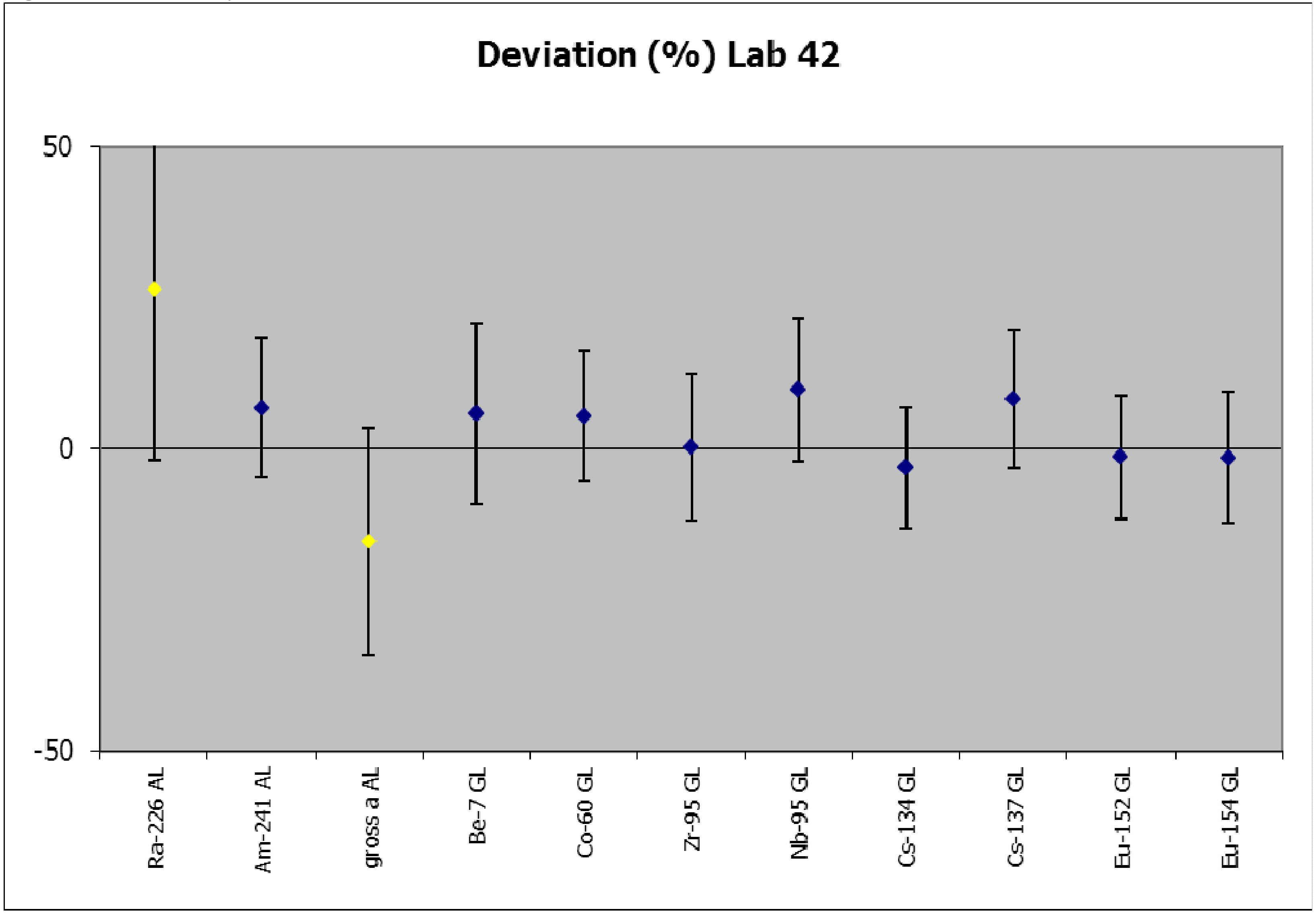


Figure 77 – Laboratory 45

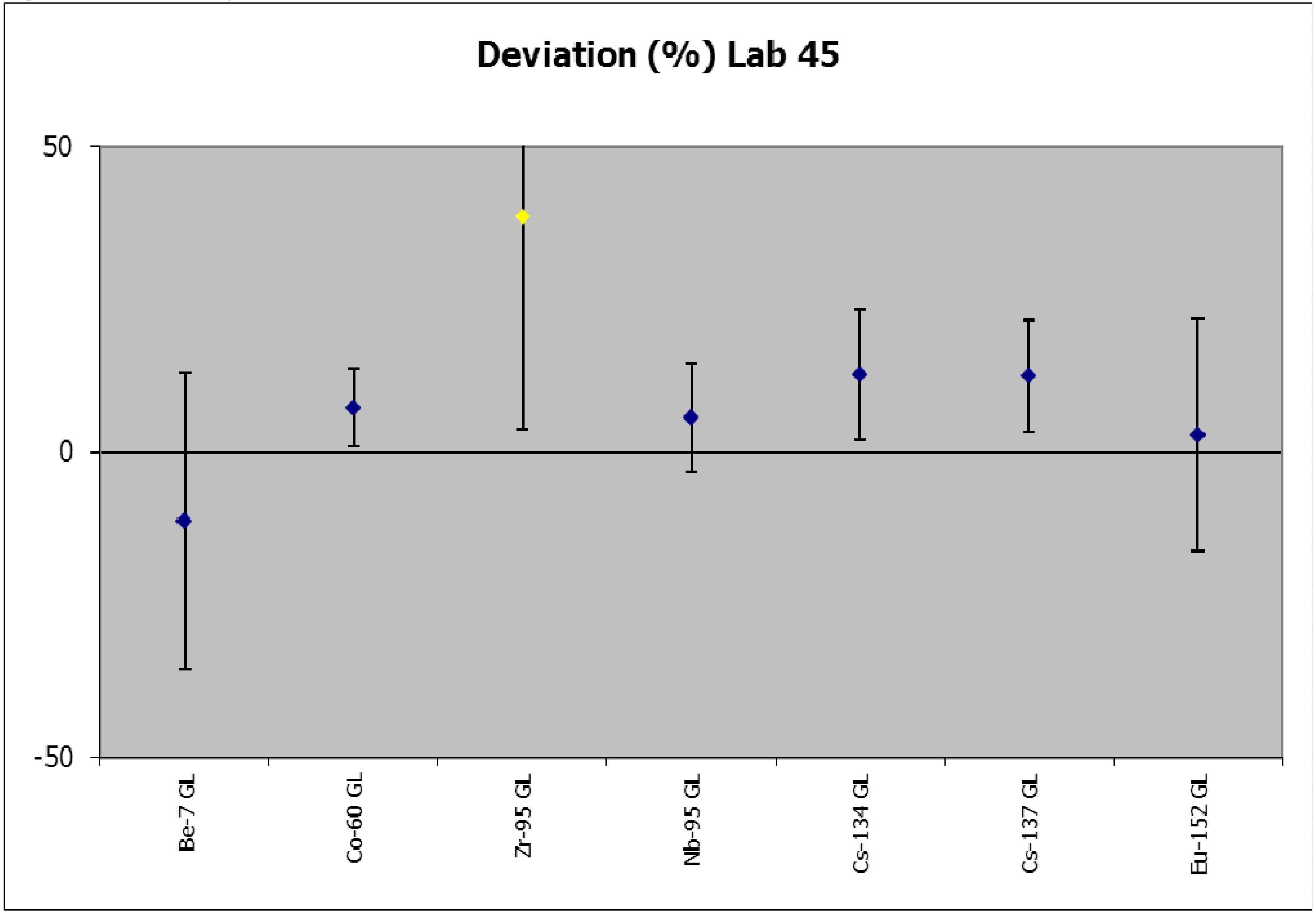


Figure 78 – Laboratory 46

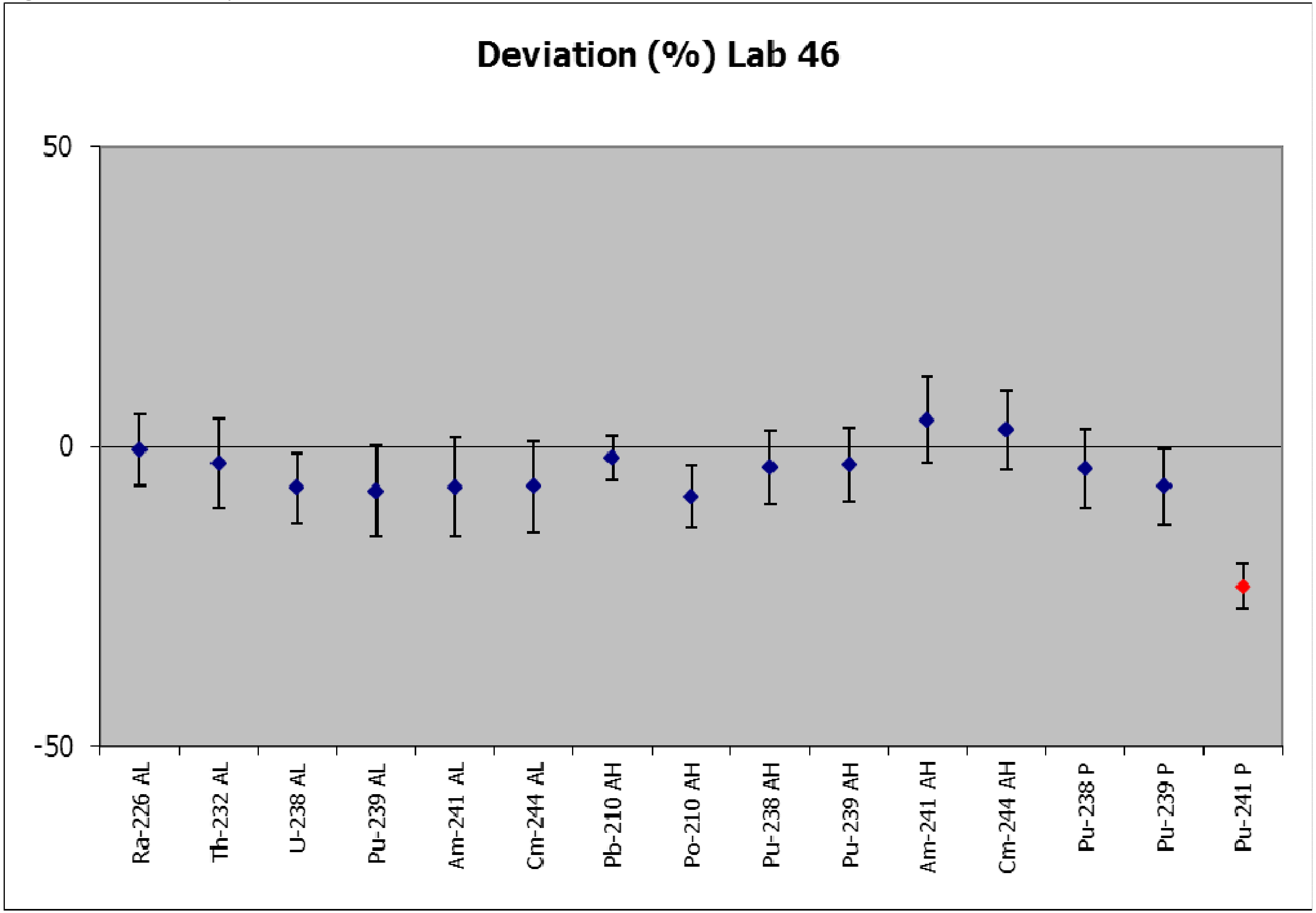


Figure 79 – Laboratory 47

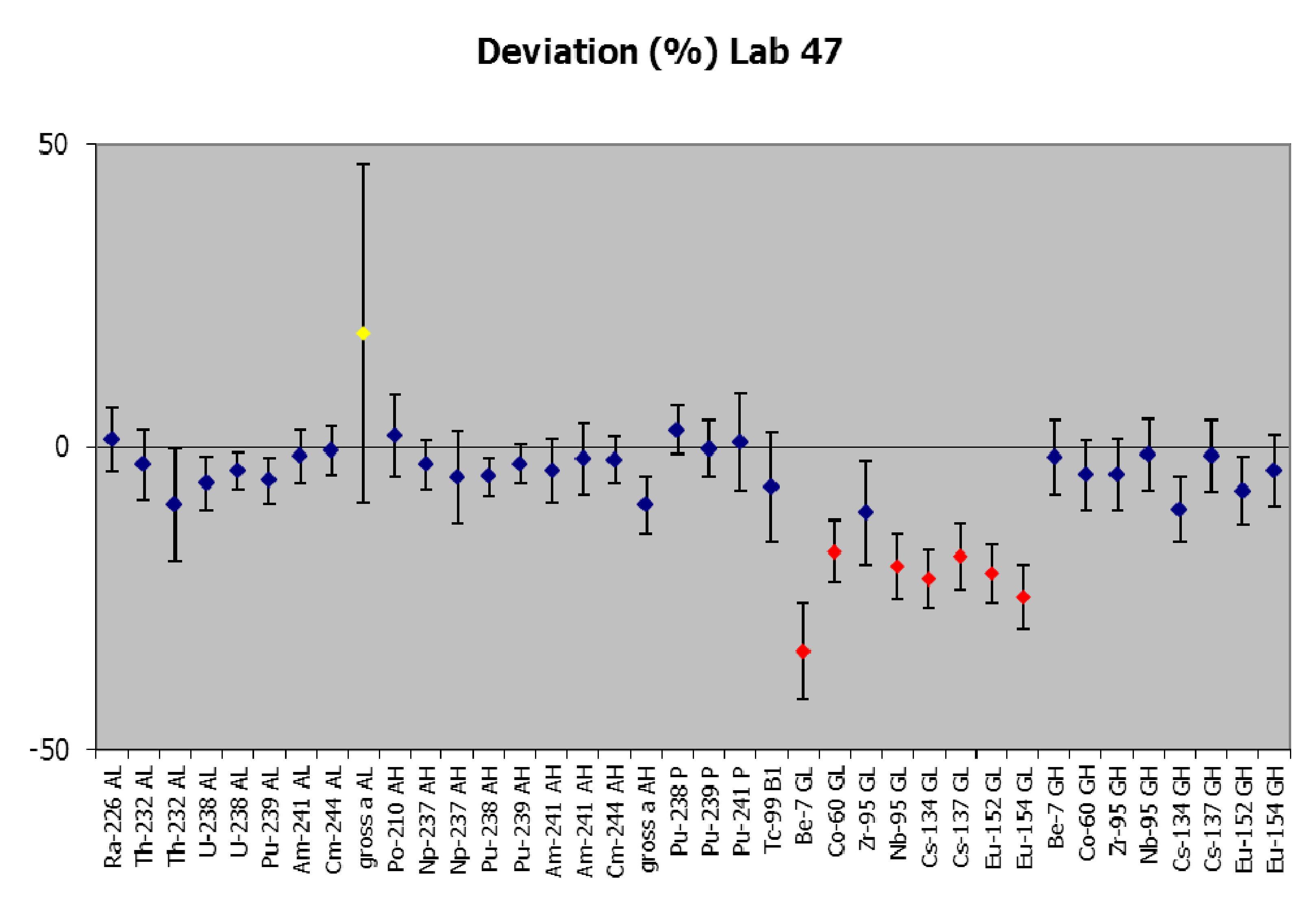


Figure 80 – Laboratory 48

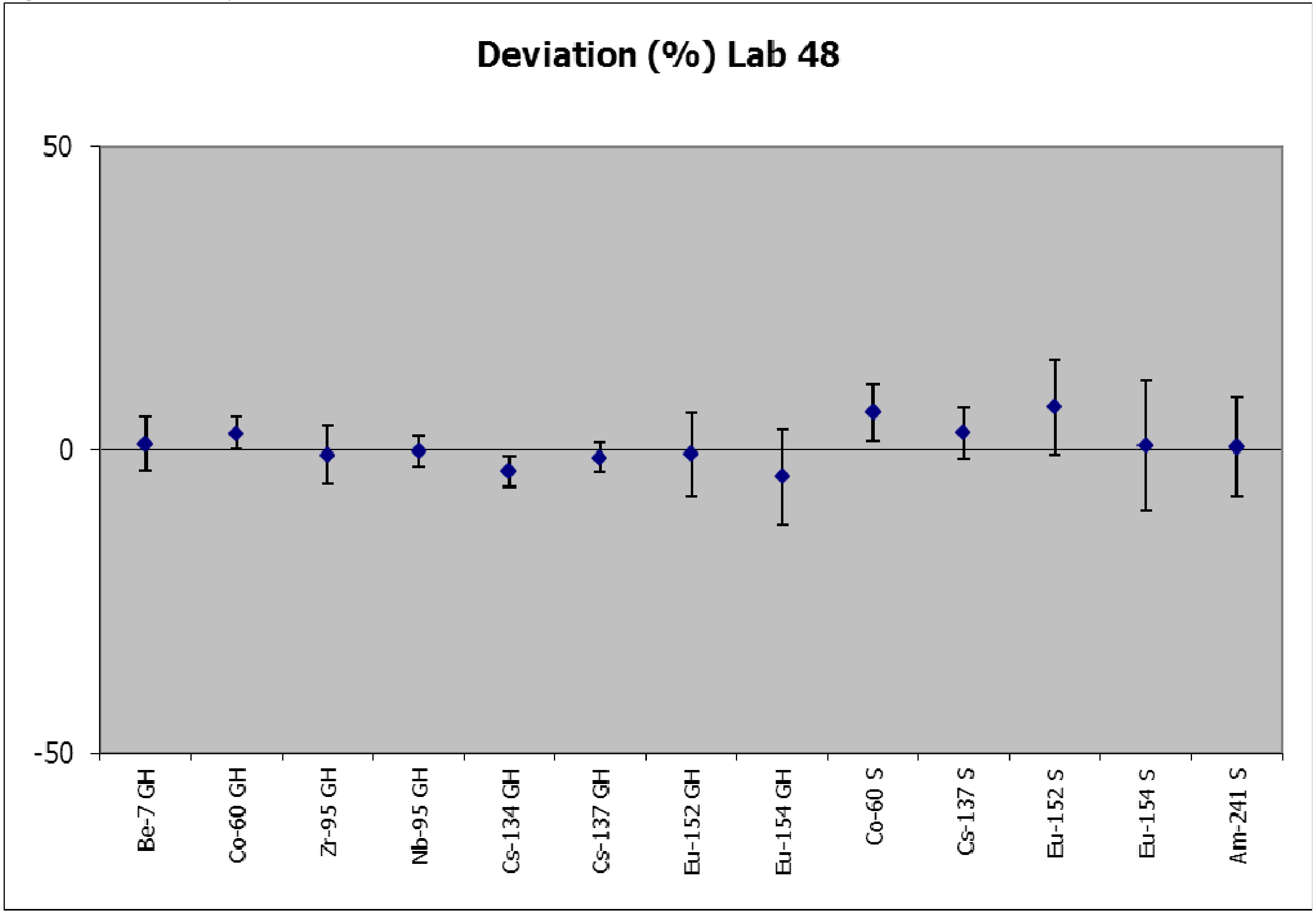


Figure 81 – Laboratory 51

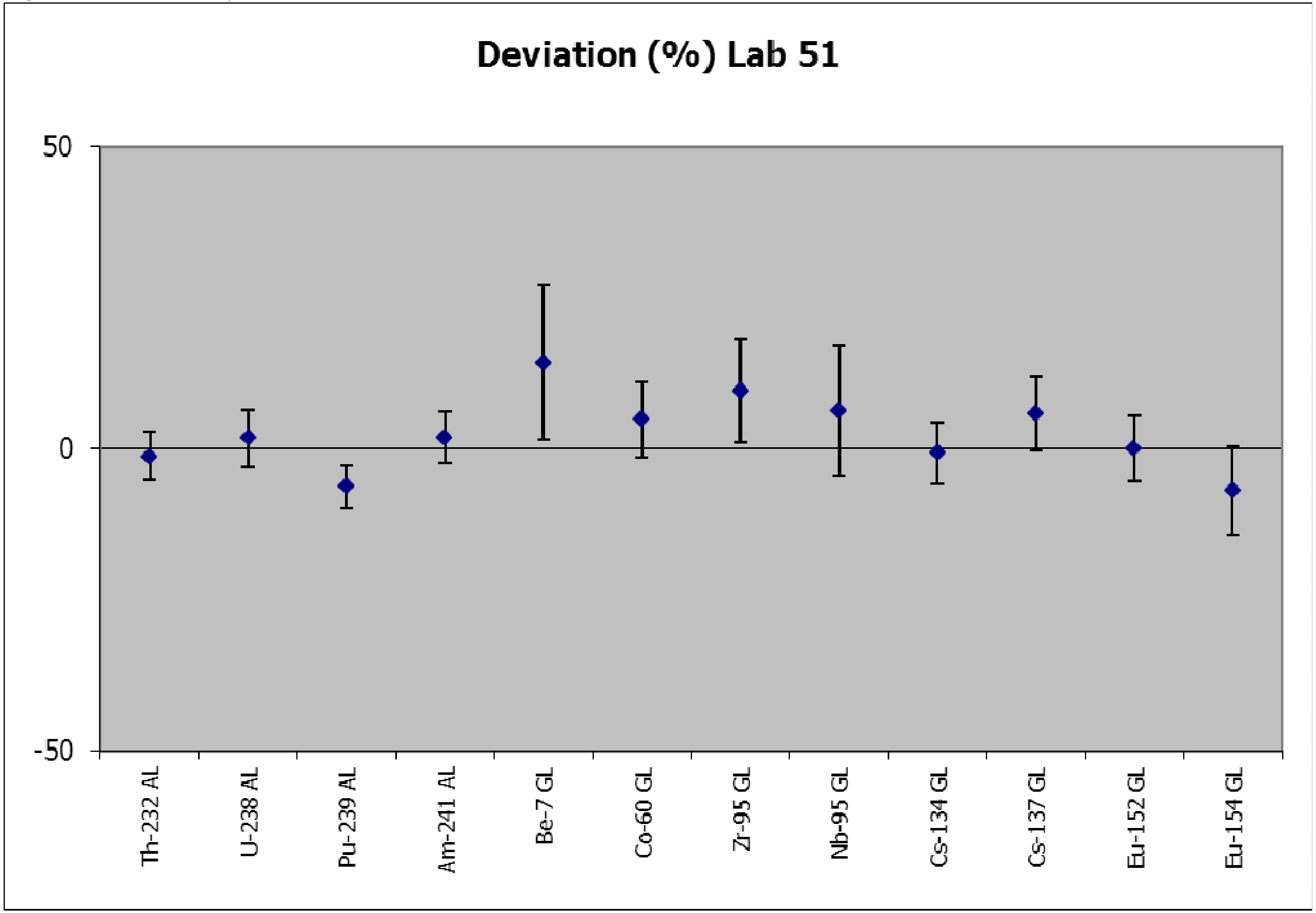


Figure 82 – Laboratory 52

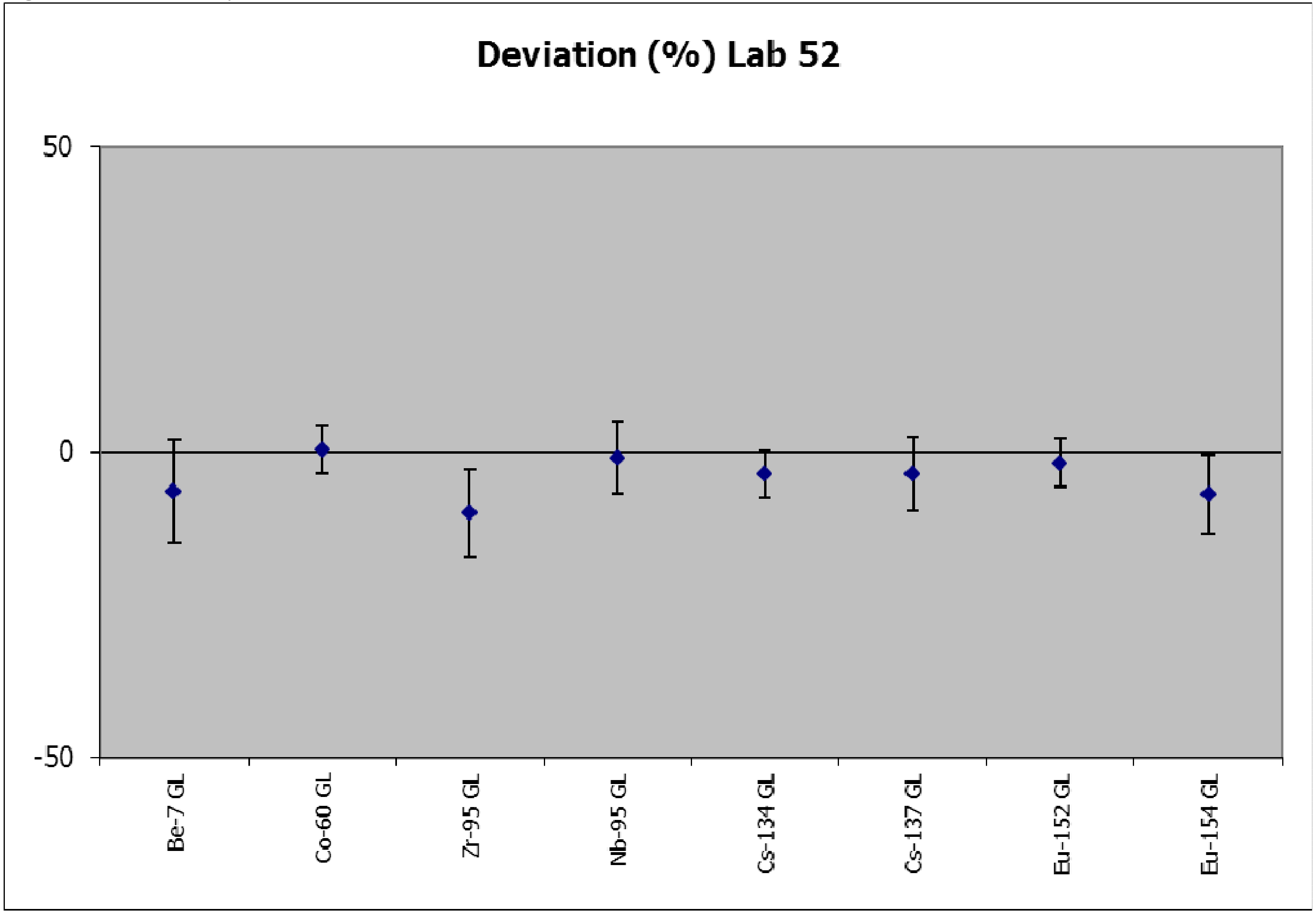


Figure 83 – Laboratory 53

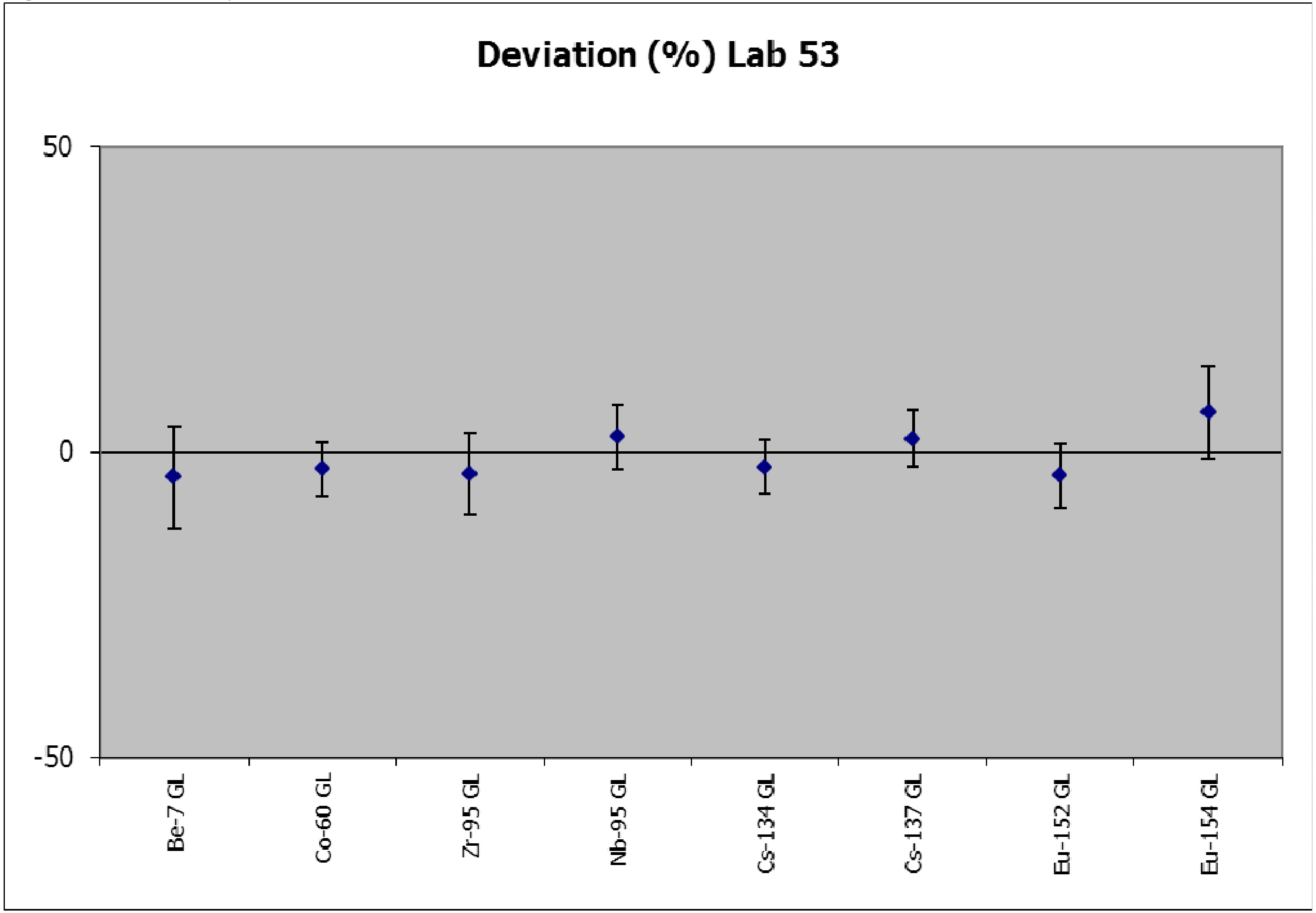


Figure 84 – Laboratory 55

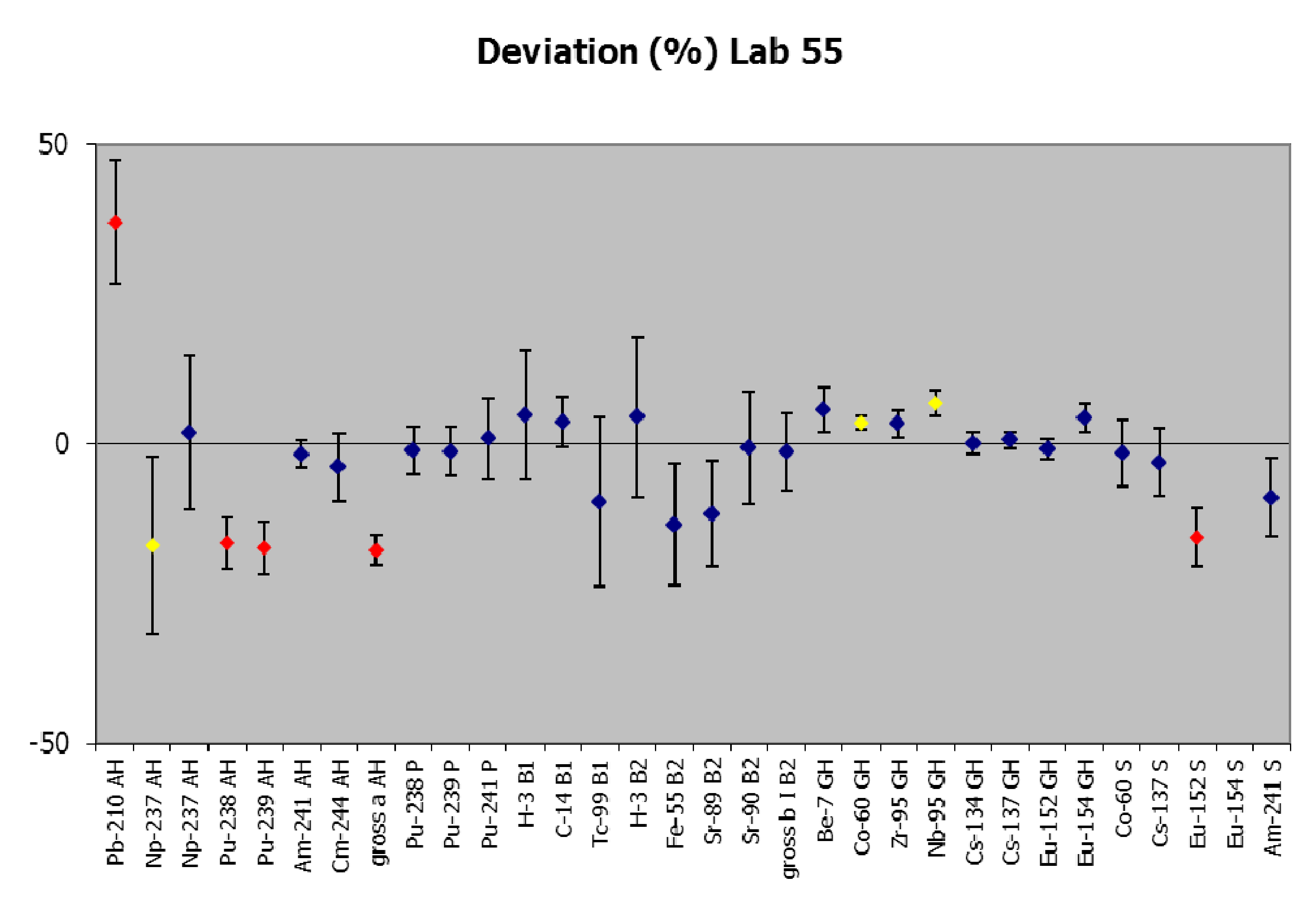


Figure 85 – Laboratory 59

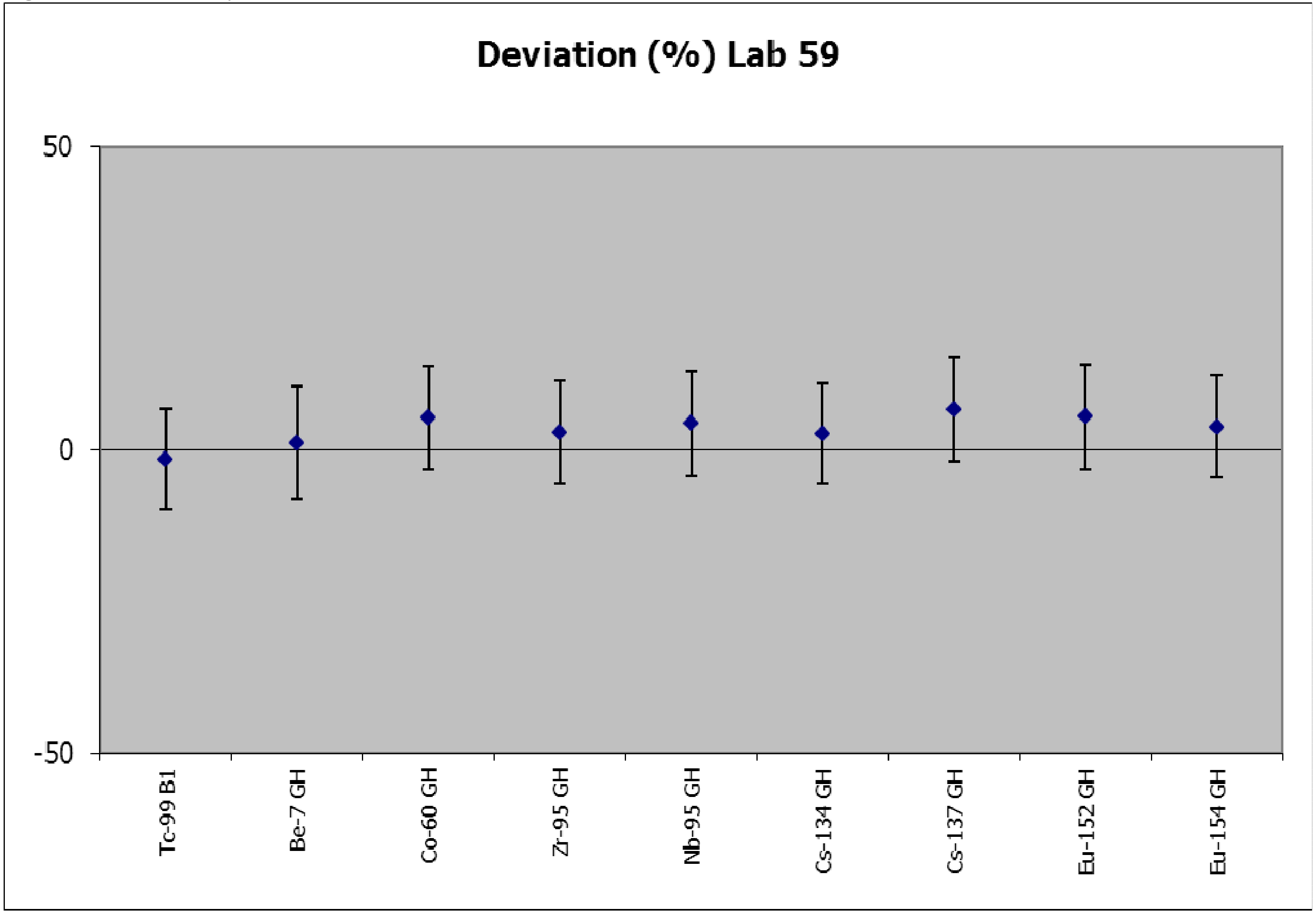


Figure 86 – Laboratory 62

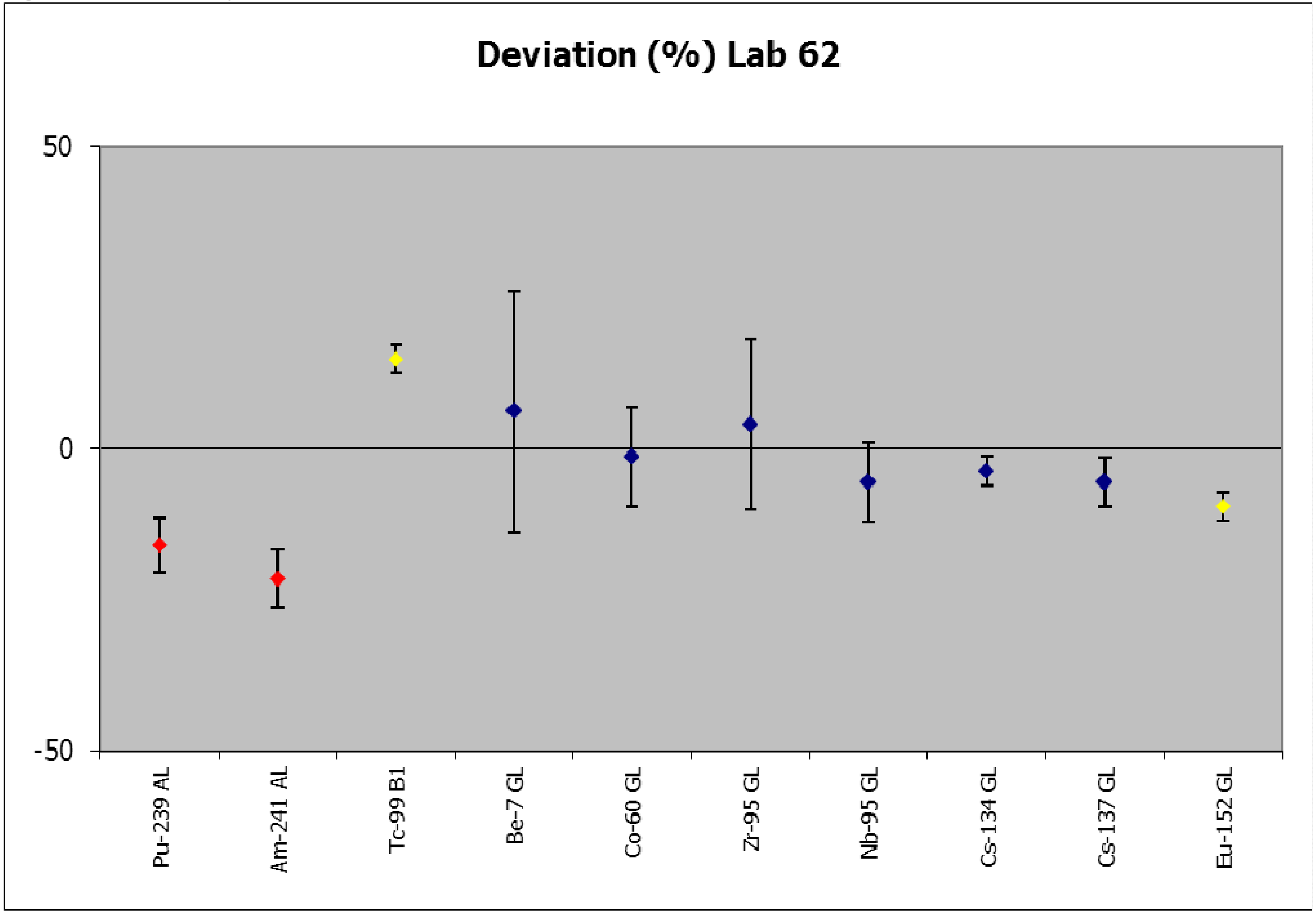


Figure 87 – Laboratory 65

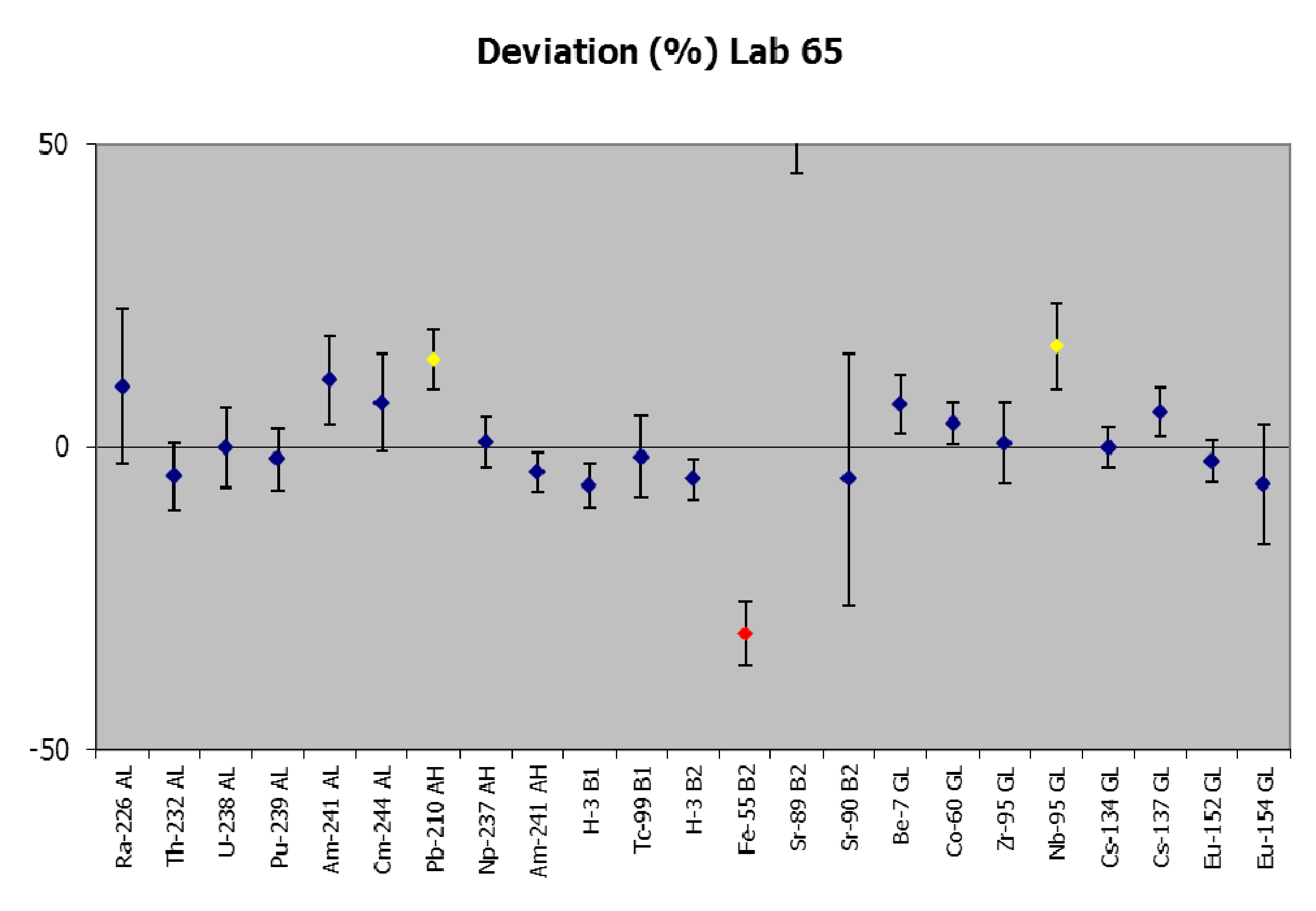


Figure 88 – Laboratory 72

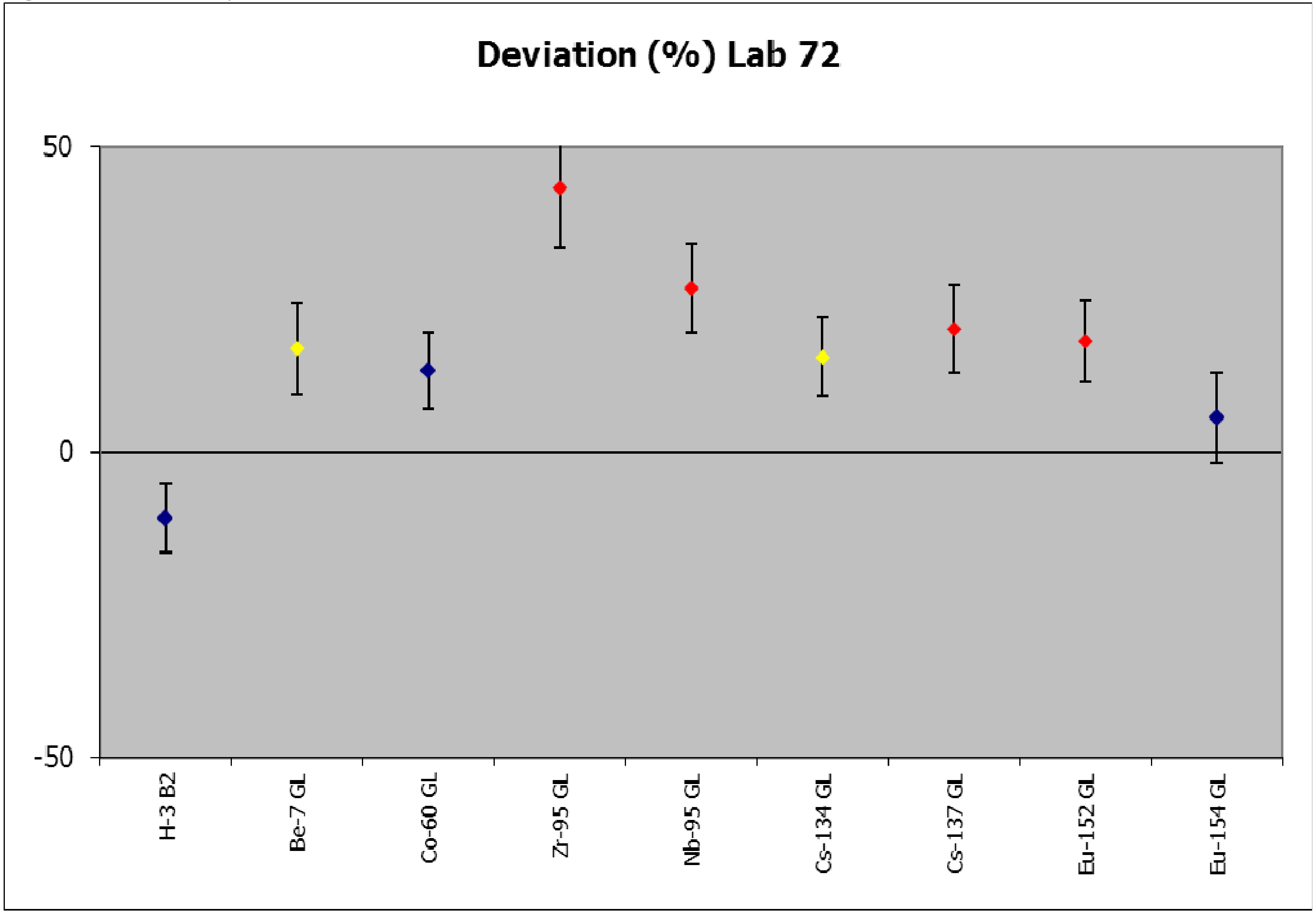


Figure 89 – Laboratory 73

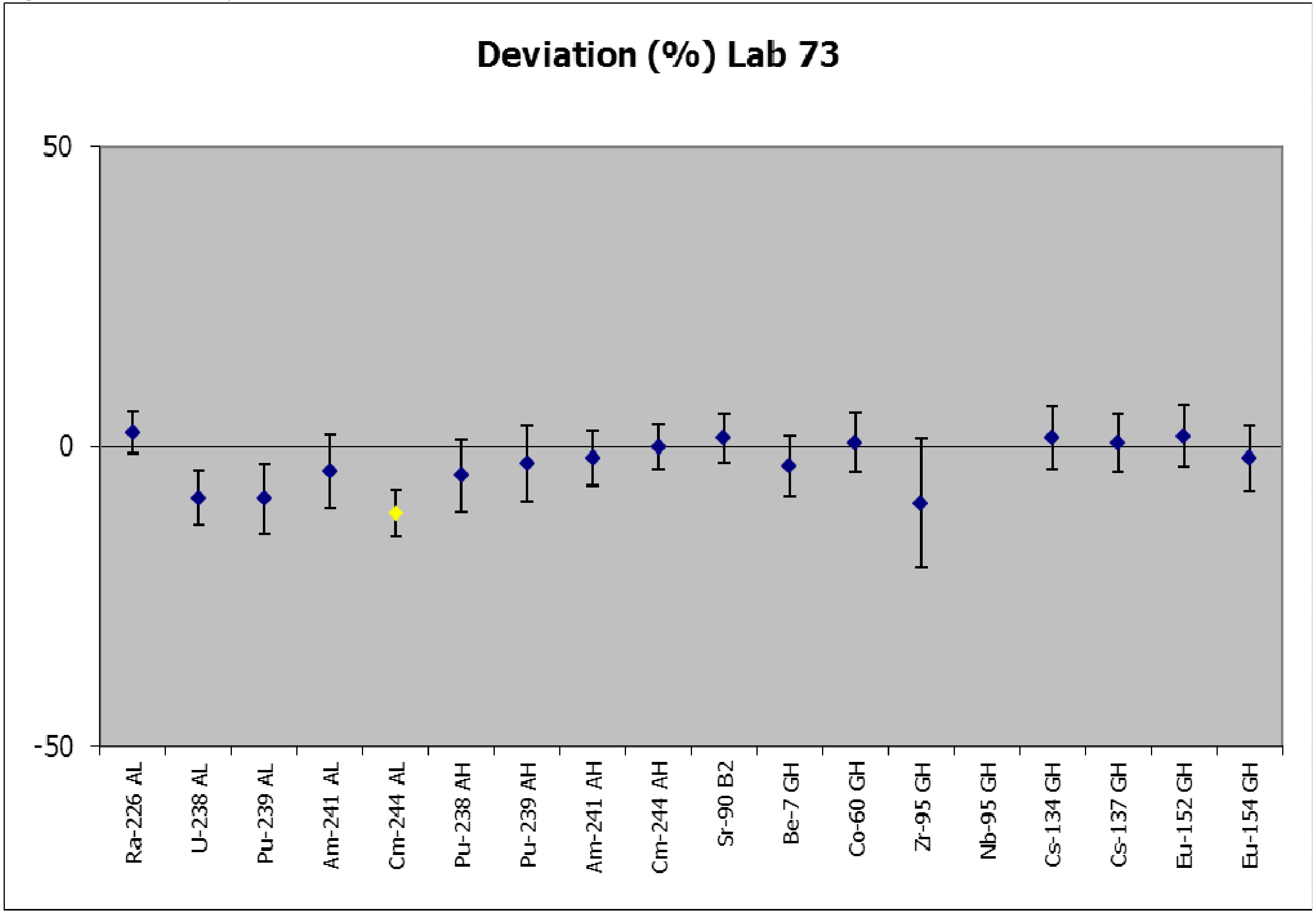


Figure 90 – Laboratory 74

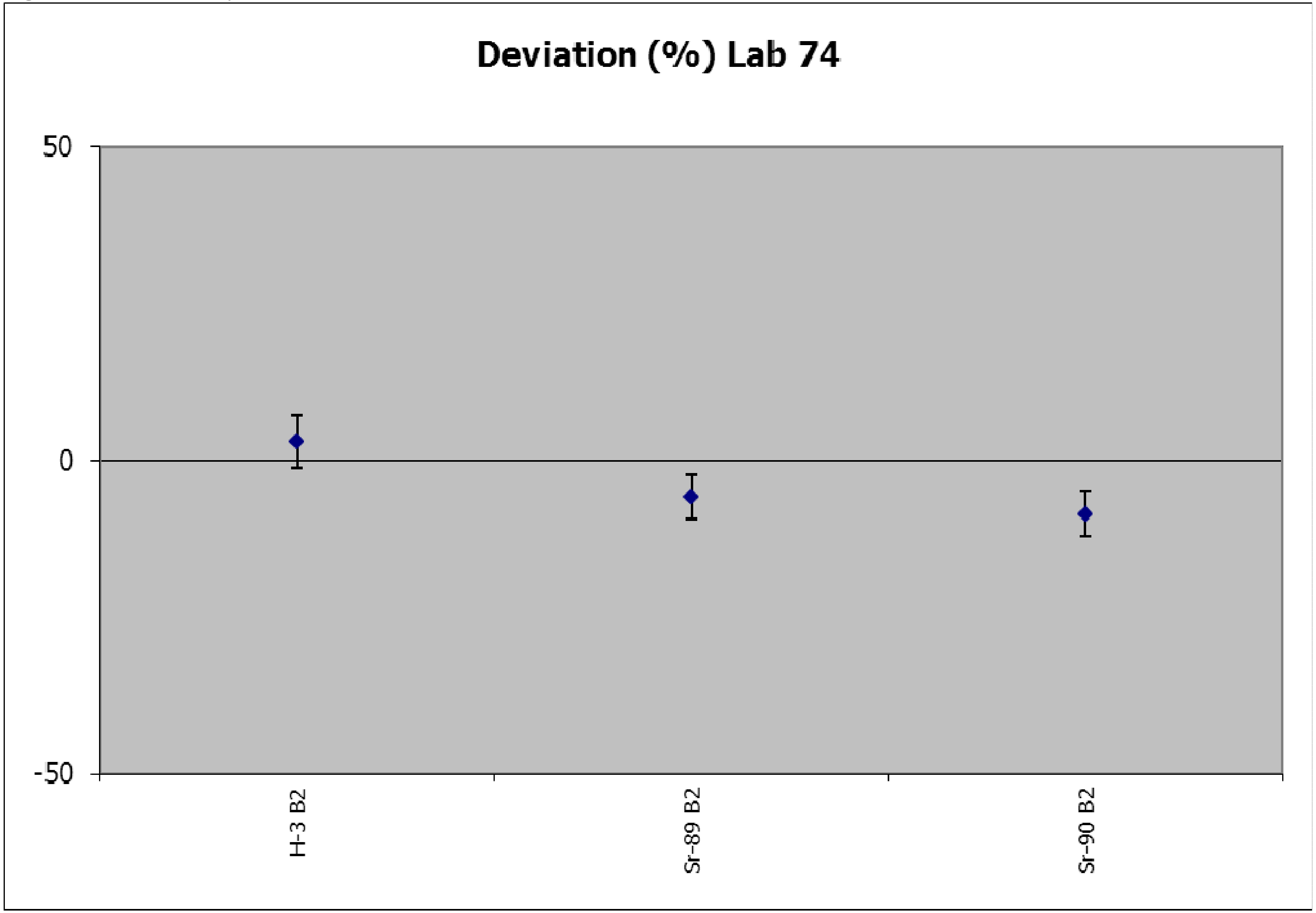


Figure 91 – Laboratory 76

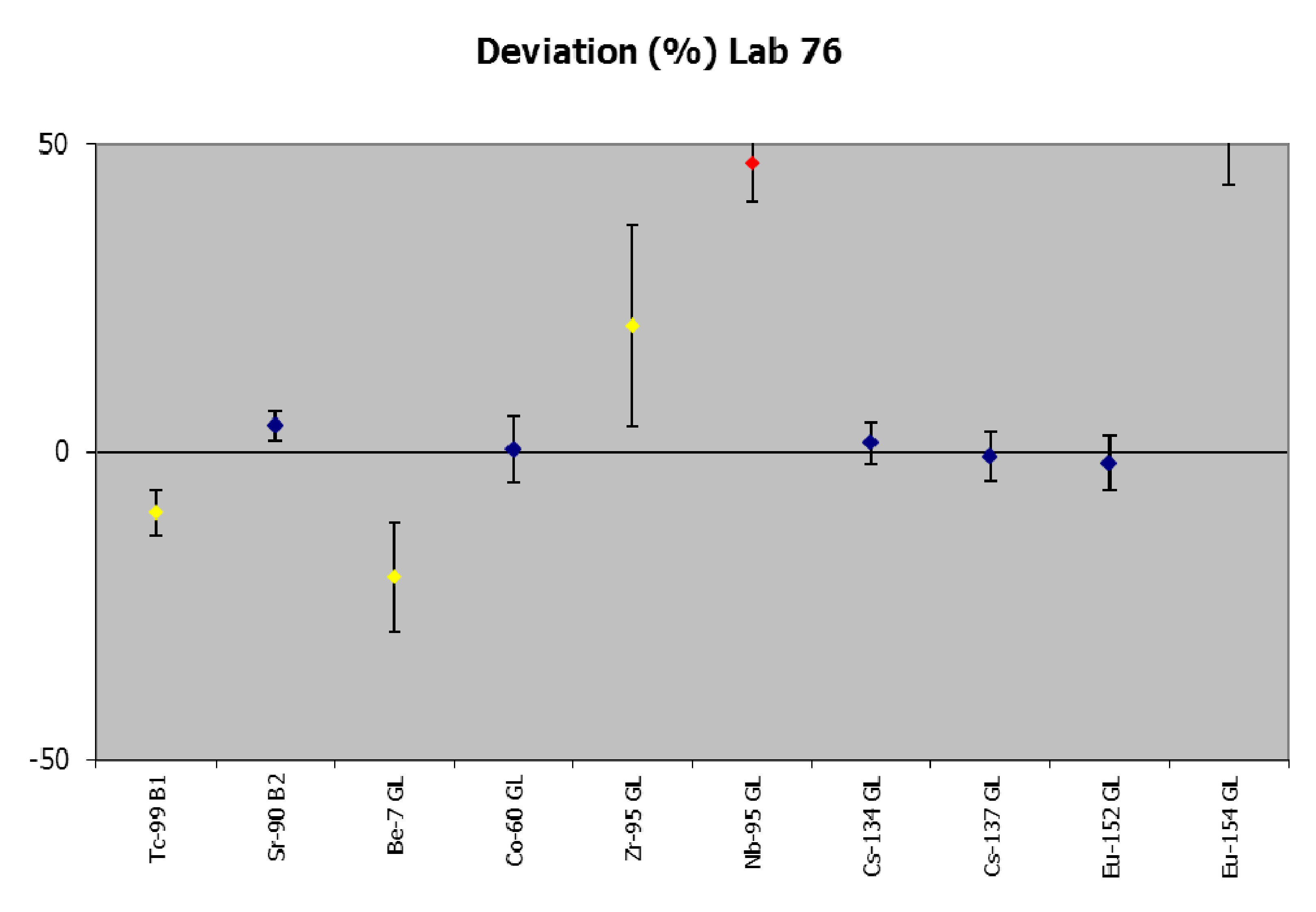


Figure 92 – Laboratory 82

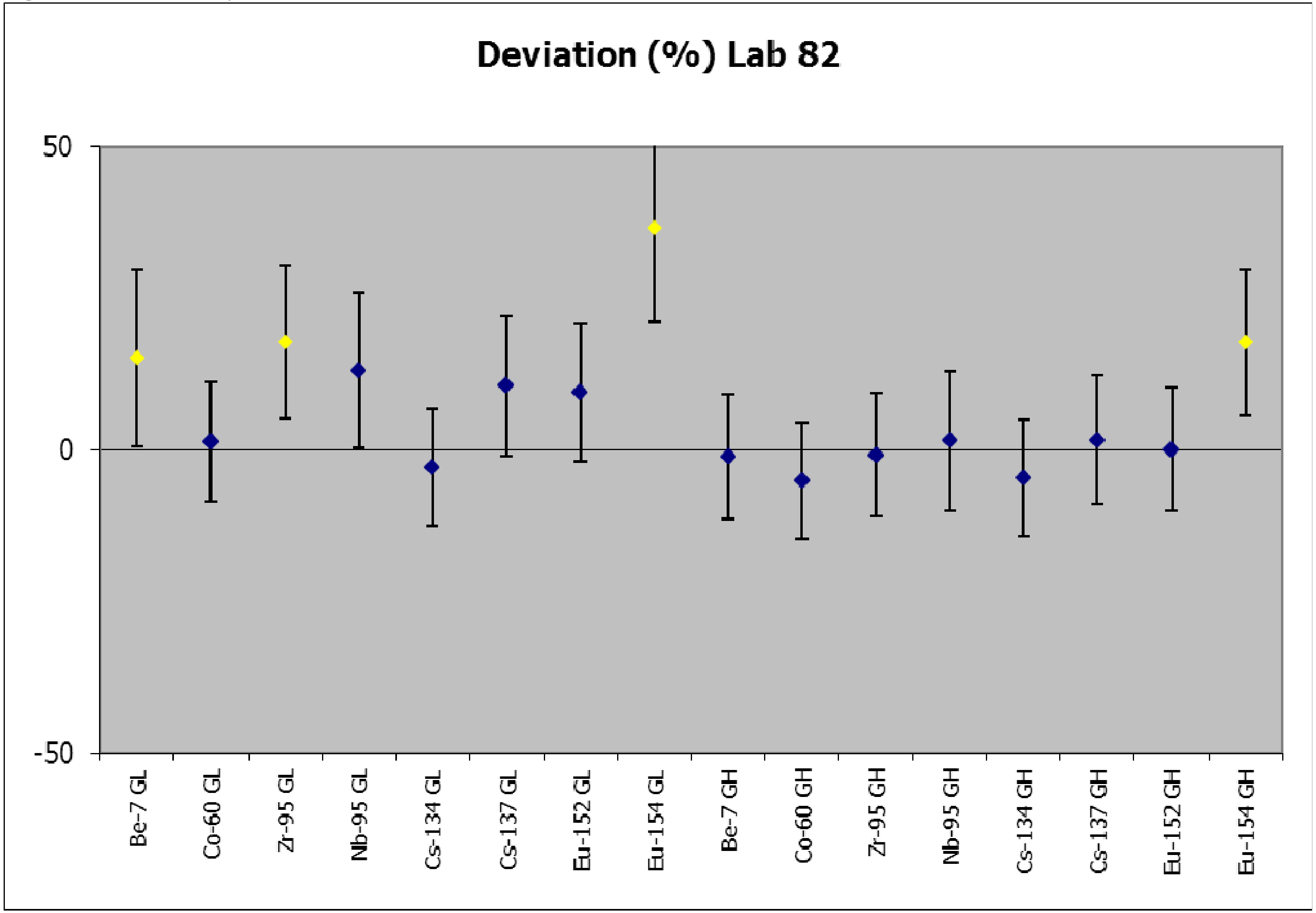


Figure 93 – Laboratory 83

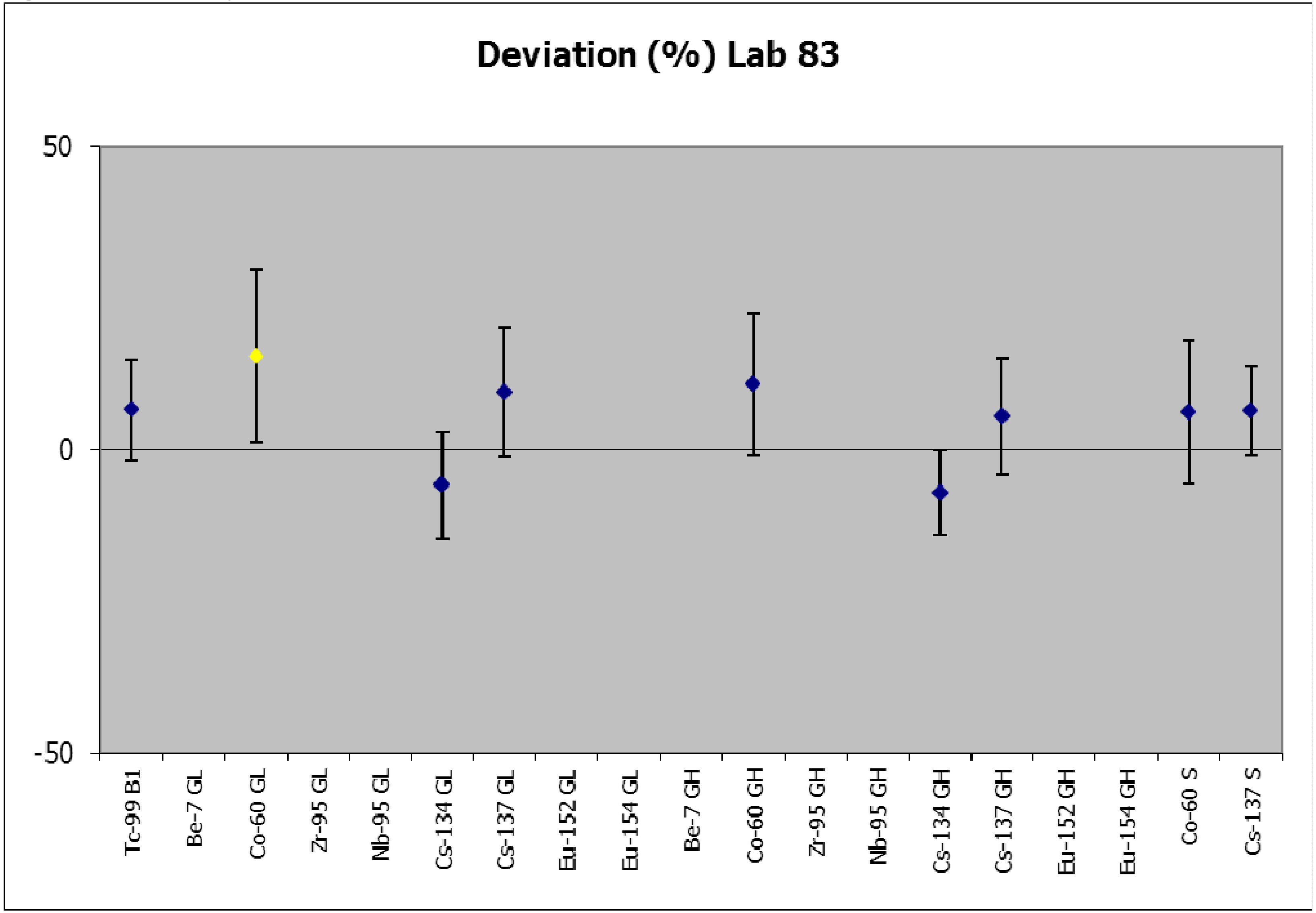


Figure 94 – Laboratory 86

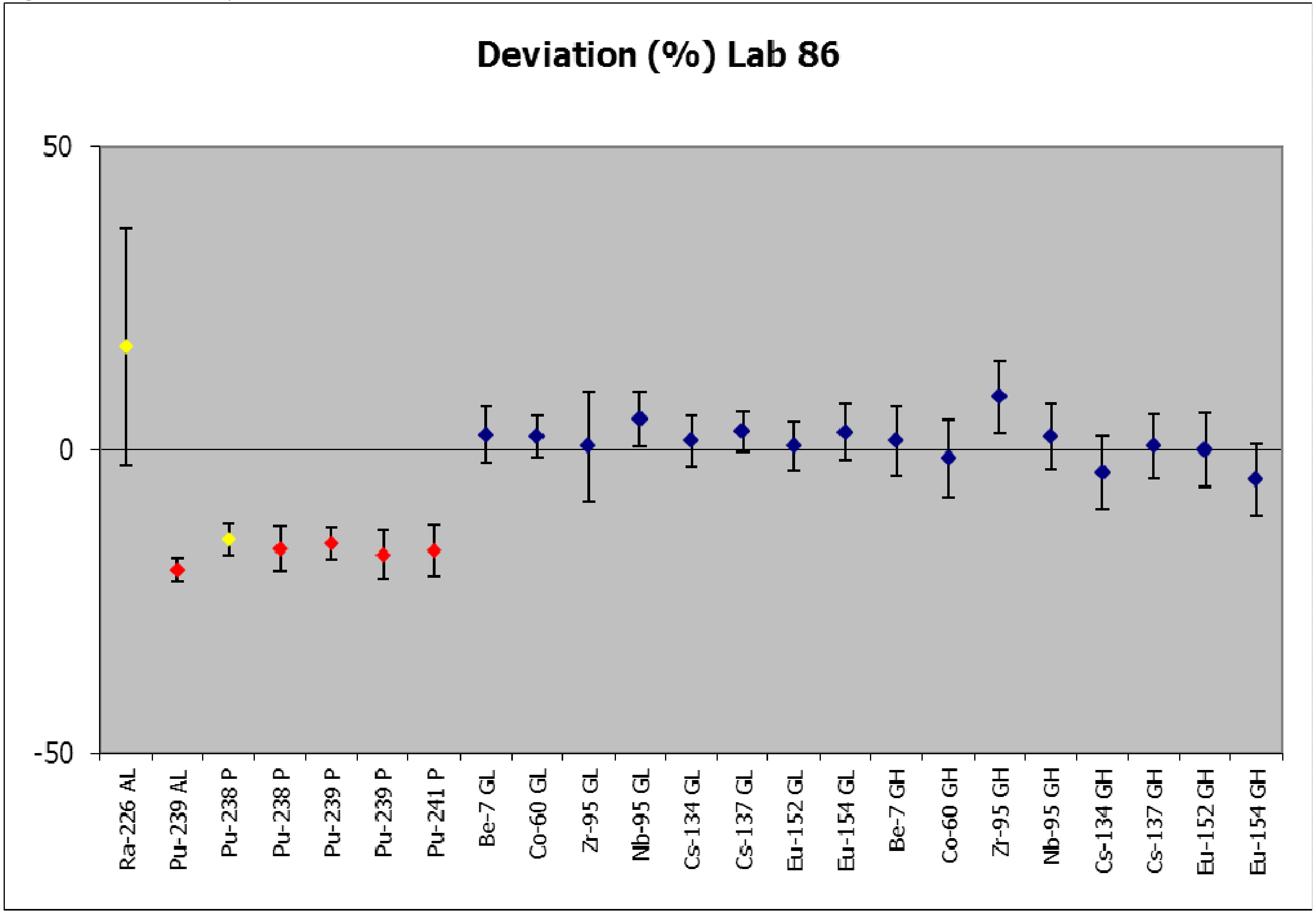


Figure 95 – Laboratory 89

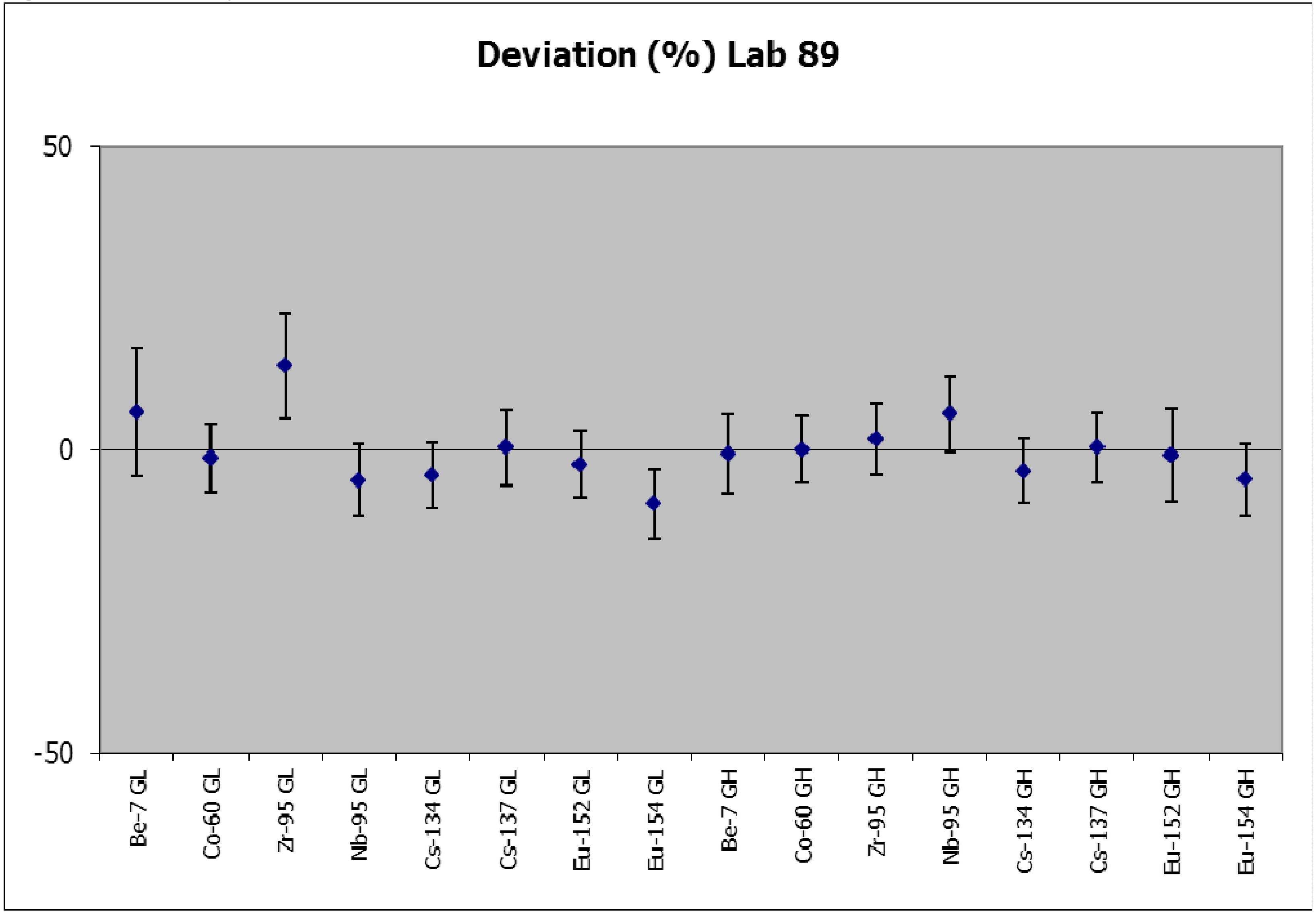


Figure 96 – Laboratory 90

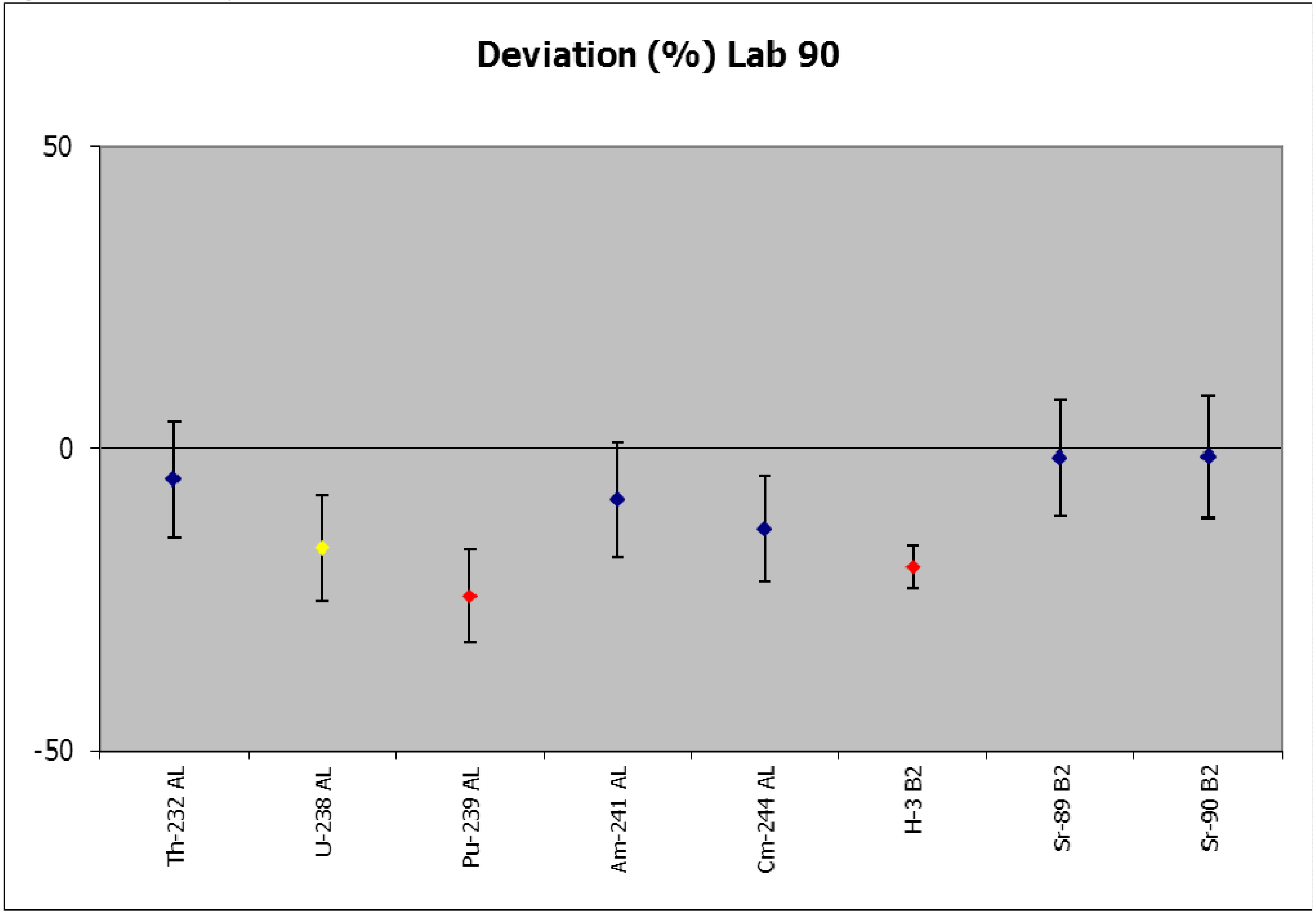


Figure 97 – Laboratory 91

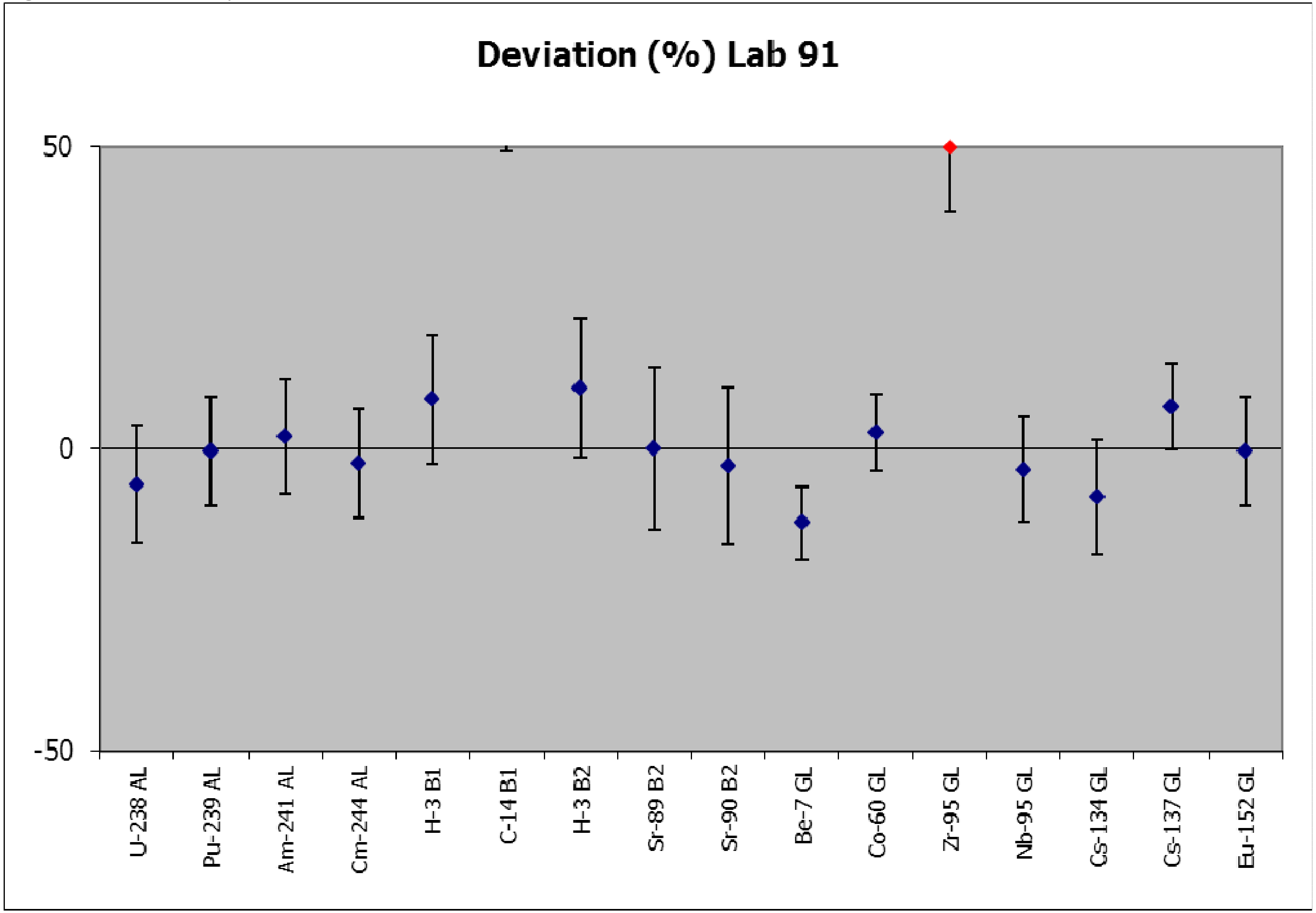


Figure 98 – Laboratory 94

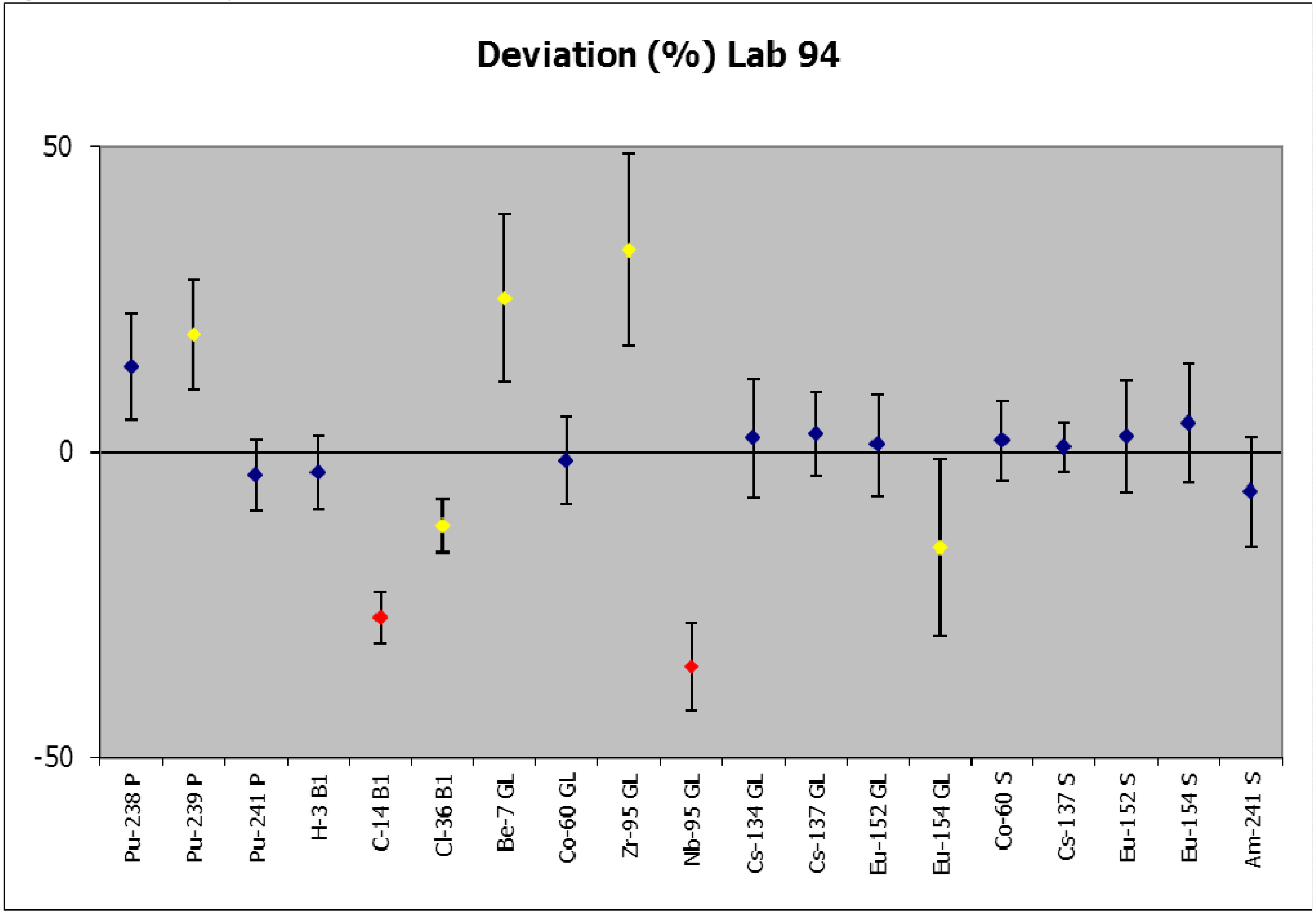


Figure 99 – Laboratory 95

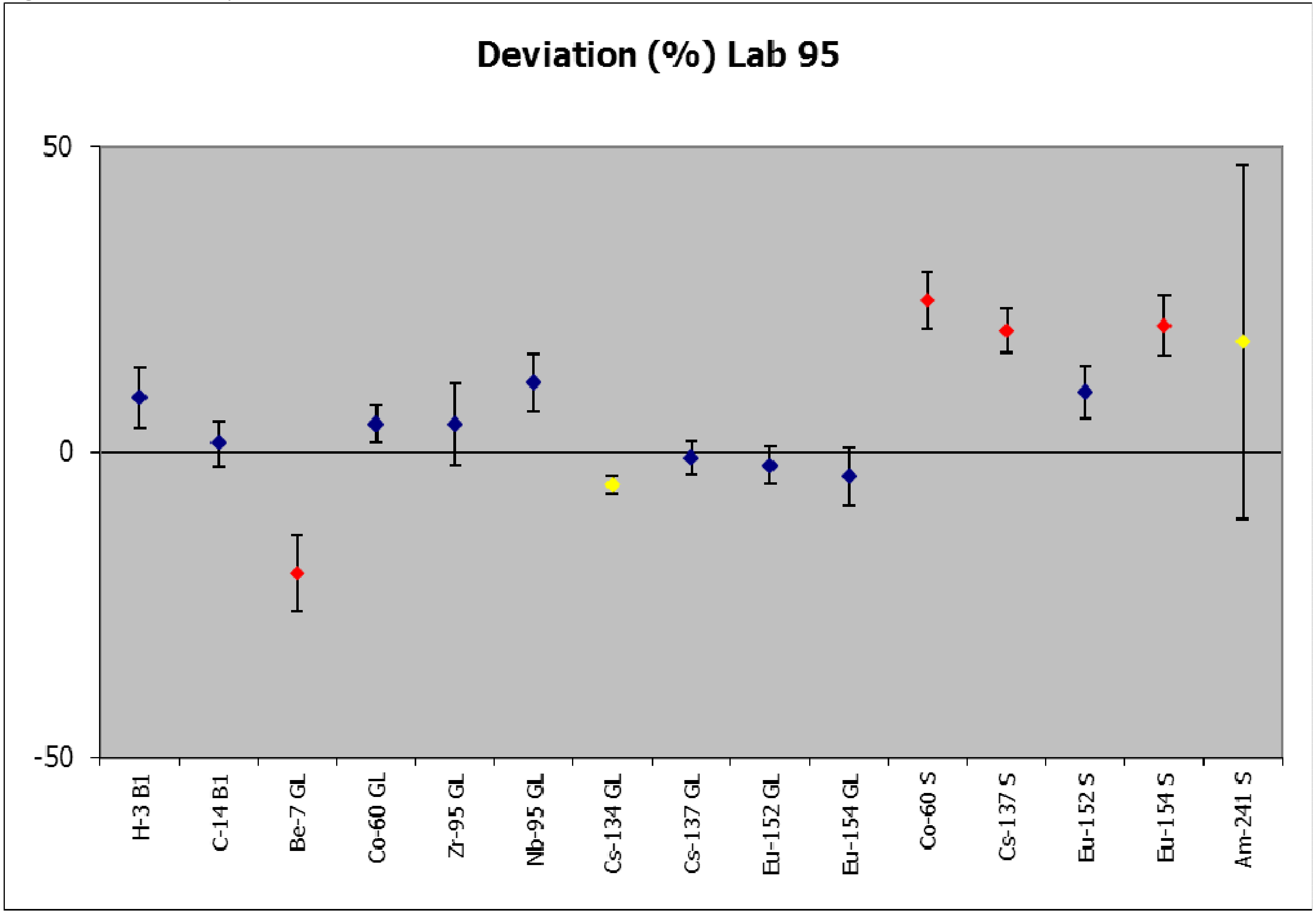


Figure 100 – Laboratory 98

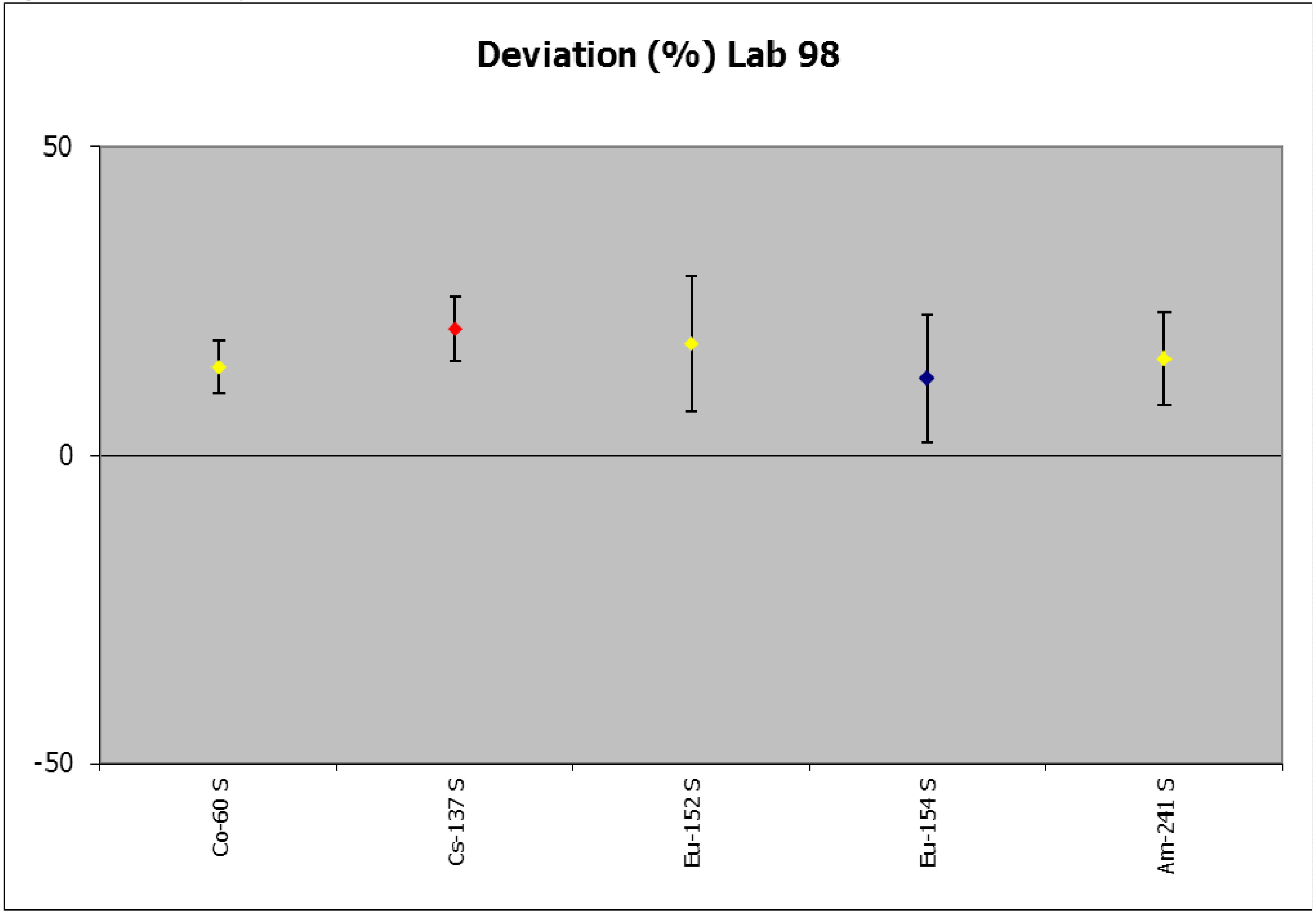


Figure 101 – Laboratory 99

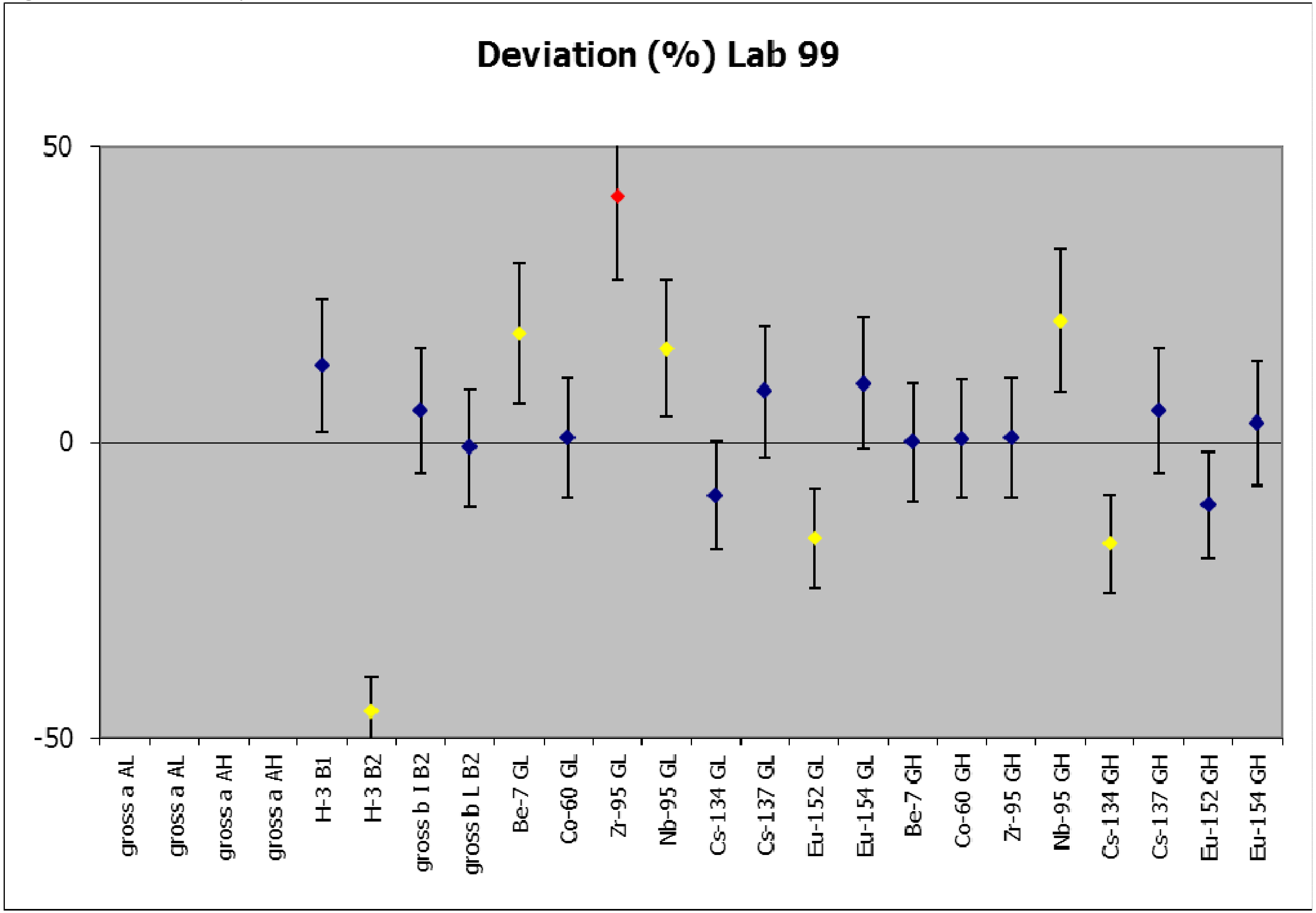


Figure 102 – Laboratory 104

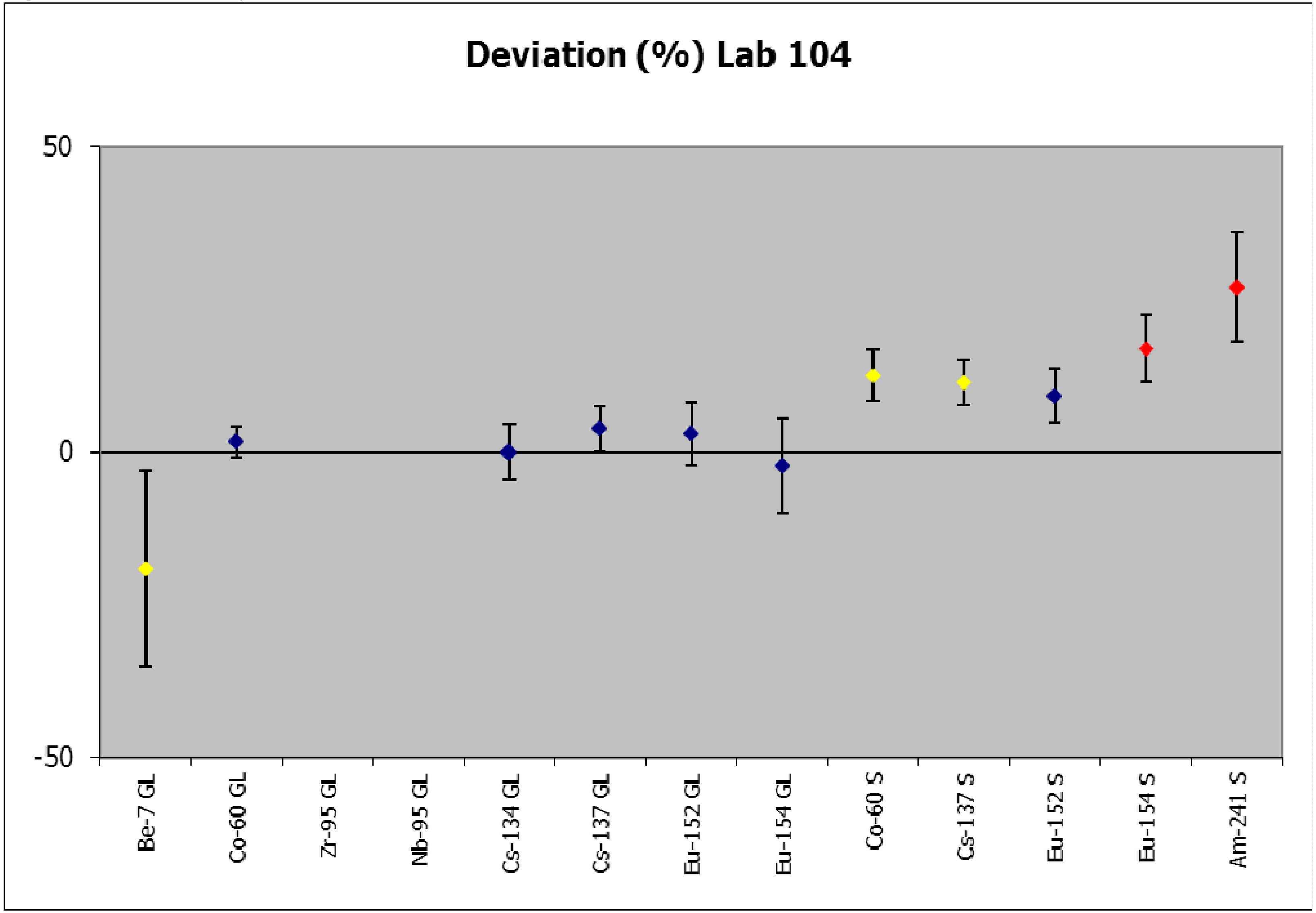


Figure 103 – Laboratory 106

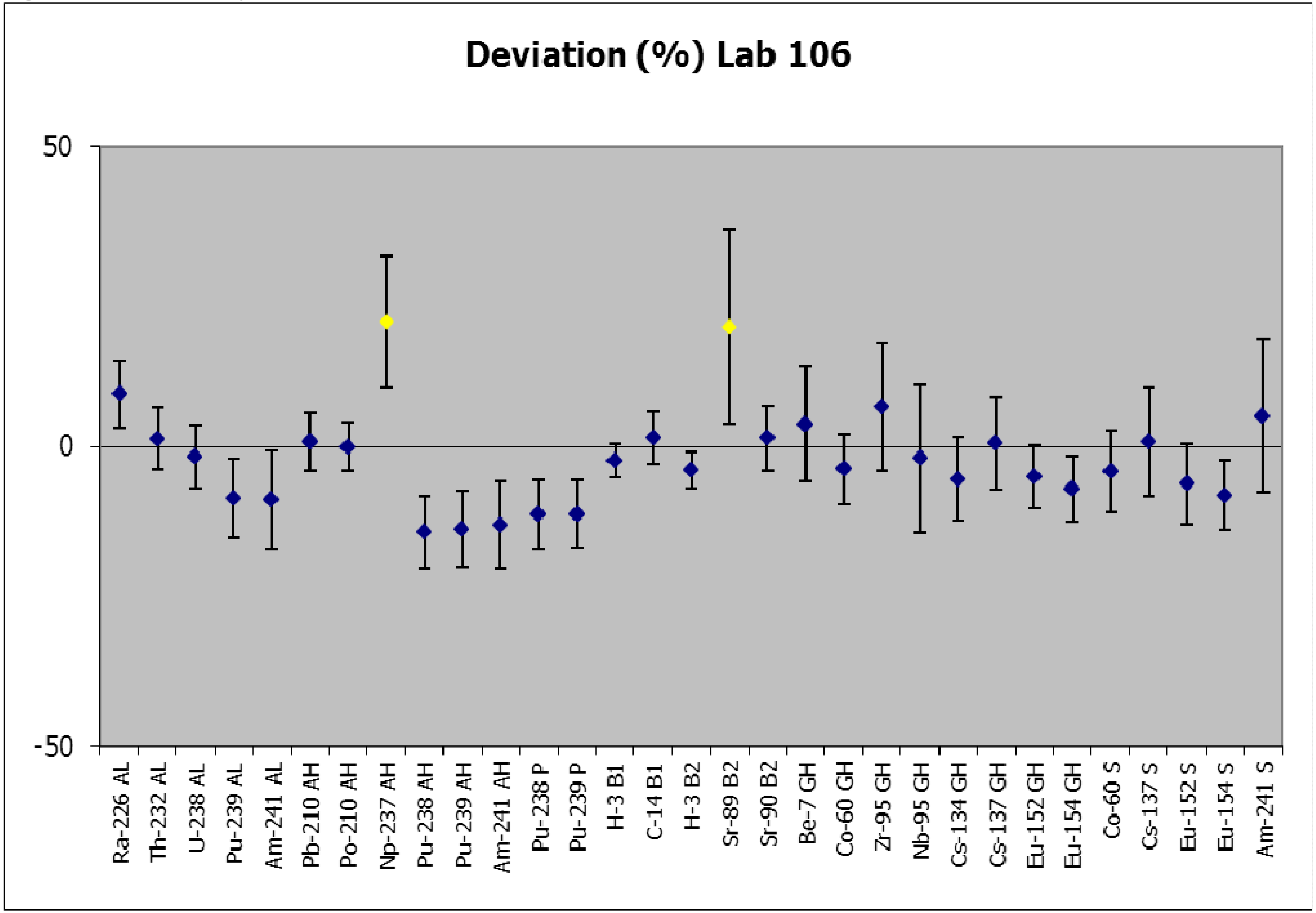


Figure 104 – Laboratory 107

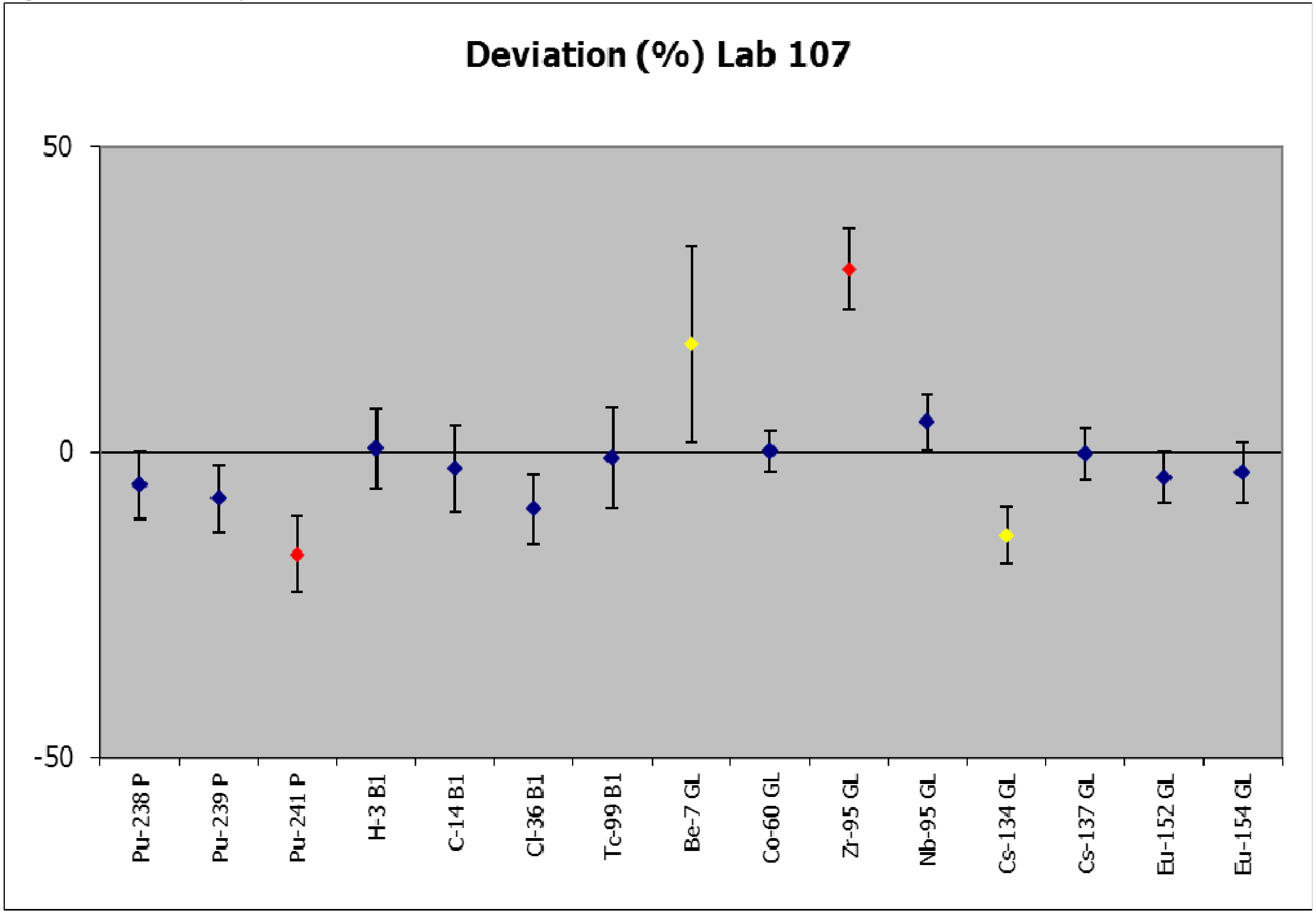


Figure 105 – Laboratory 108

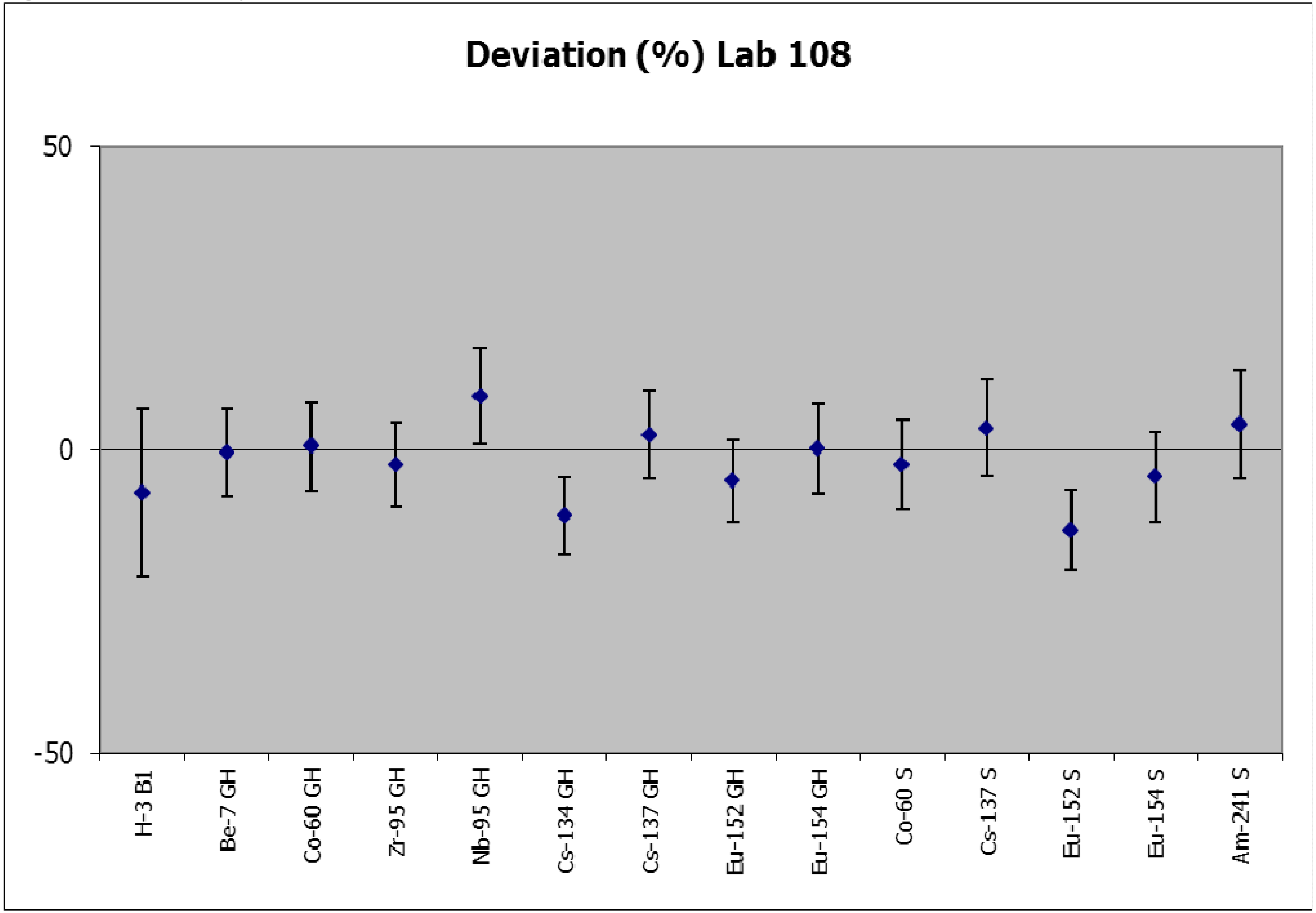


Figure 106 – Laboratory 111

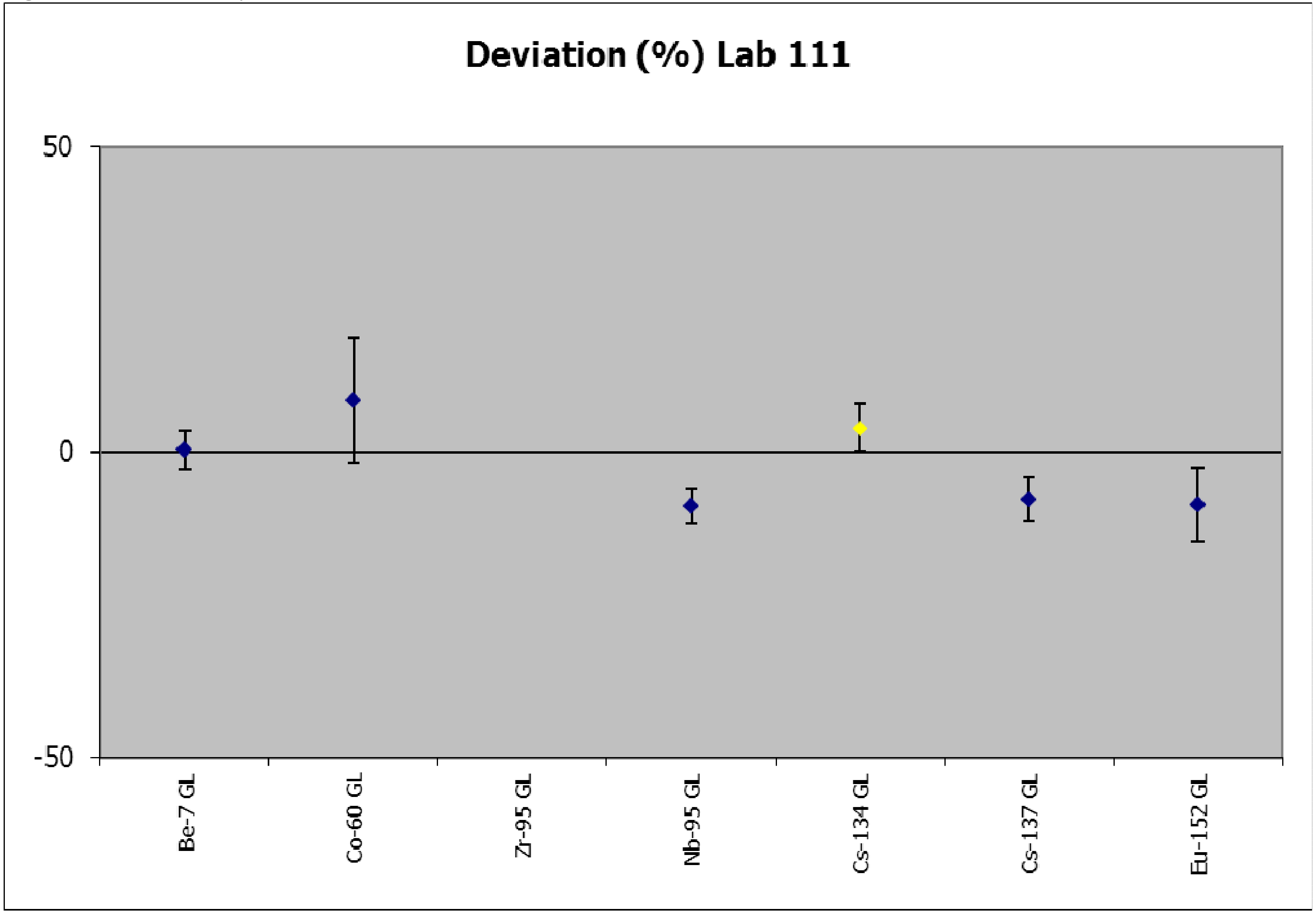


Figure 107 – Laboratory 114

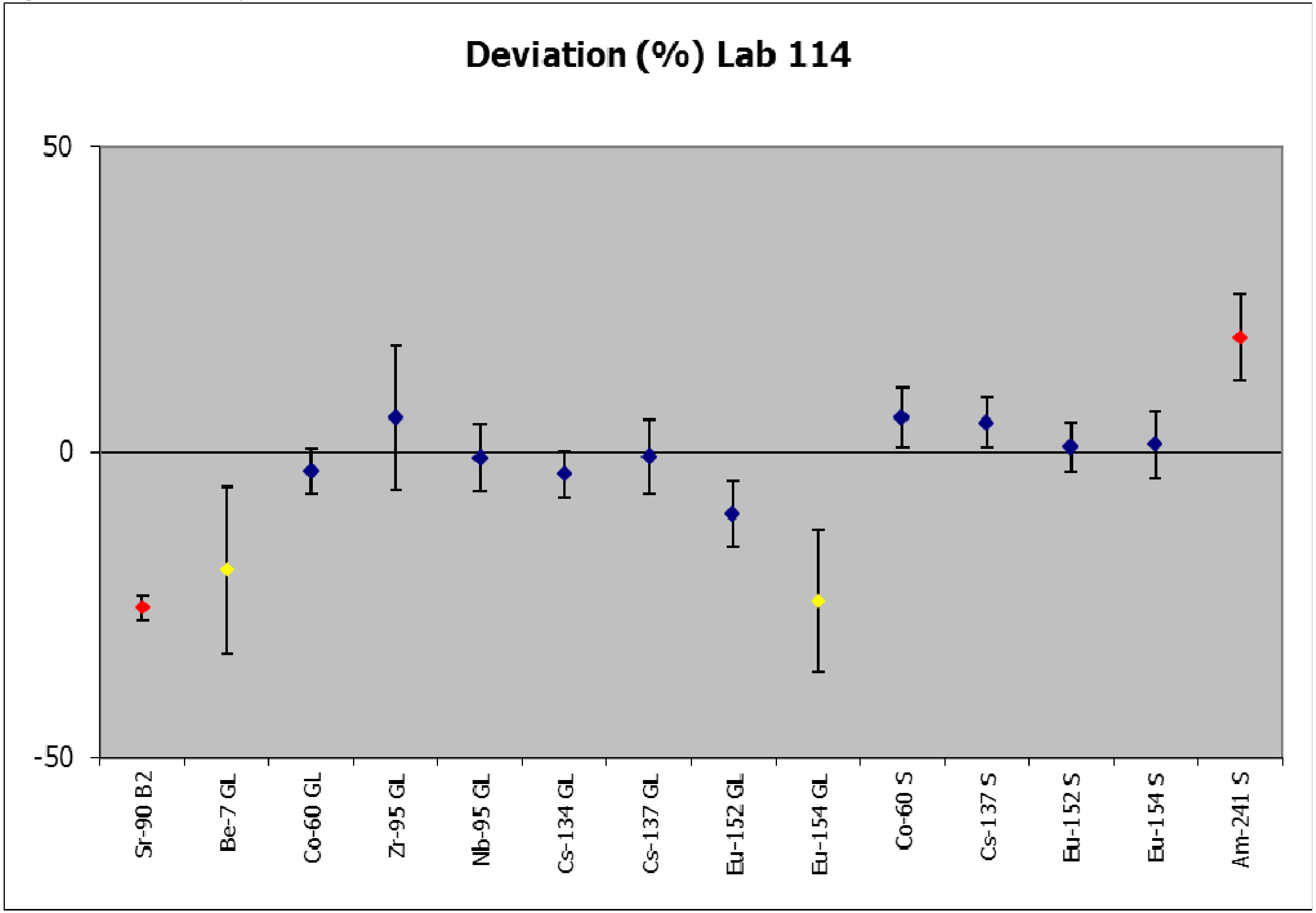


Figure 108 – Laboratory 116

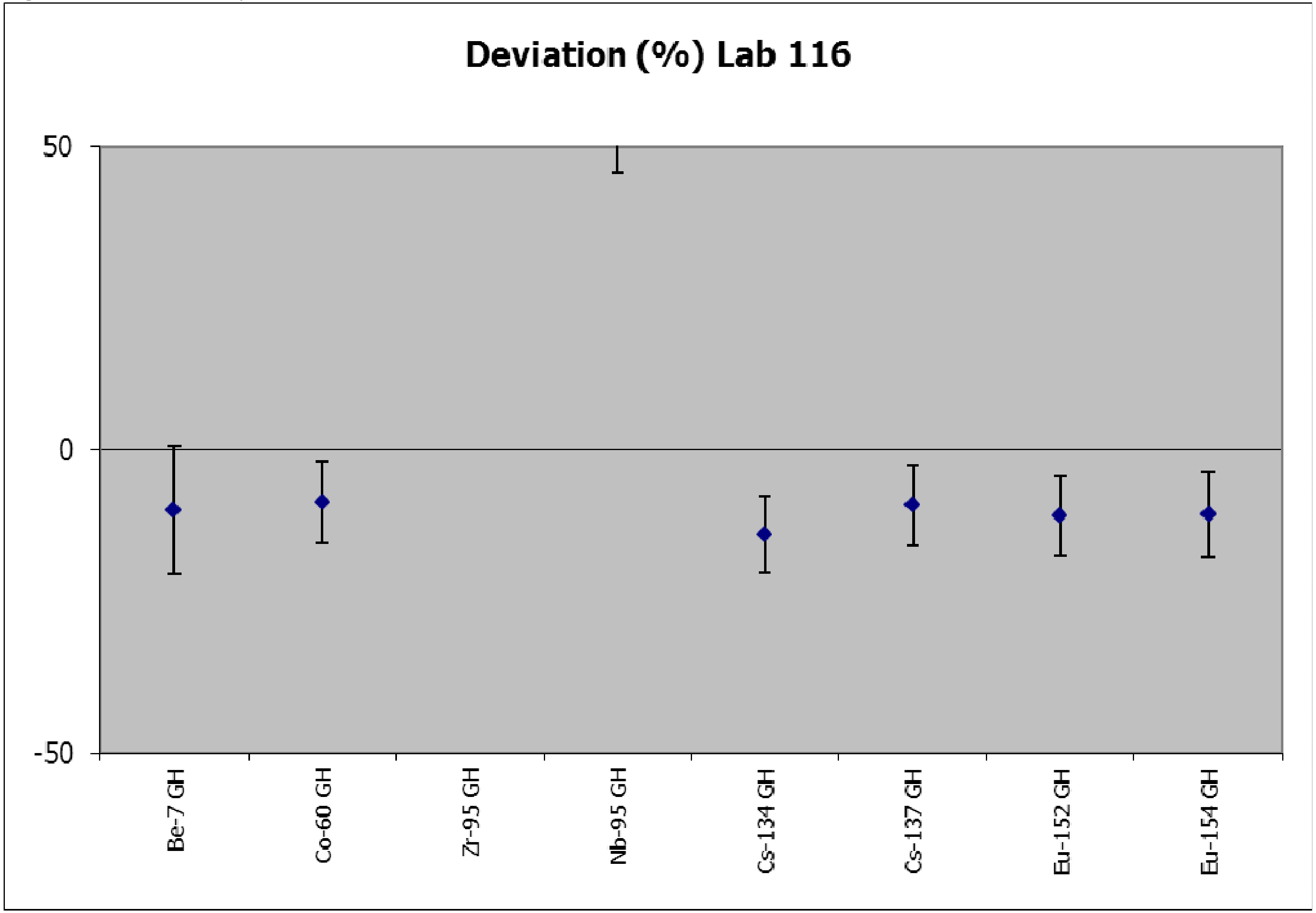


Figure 109 – Laboratory 117

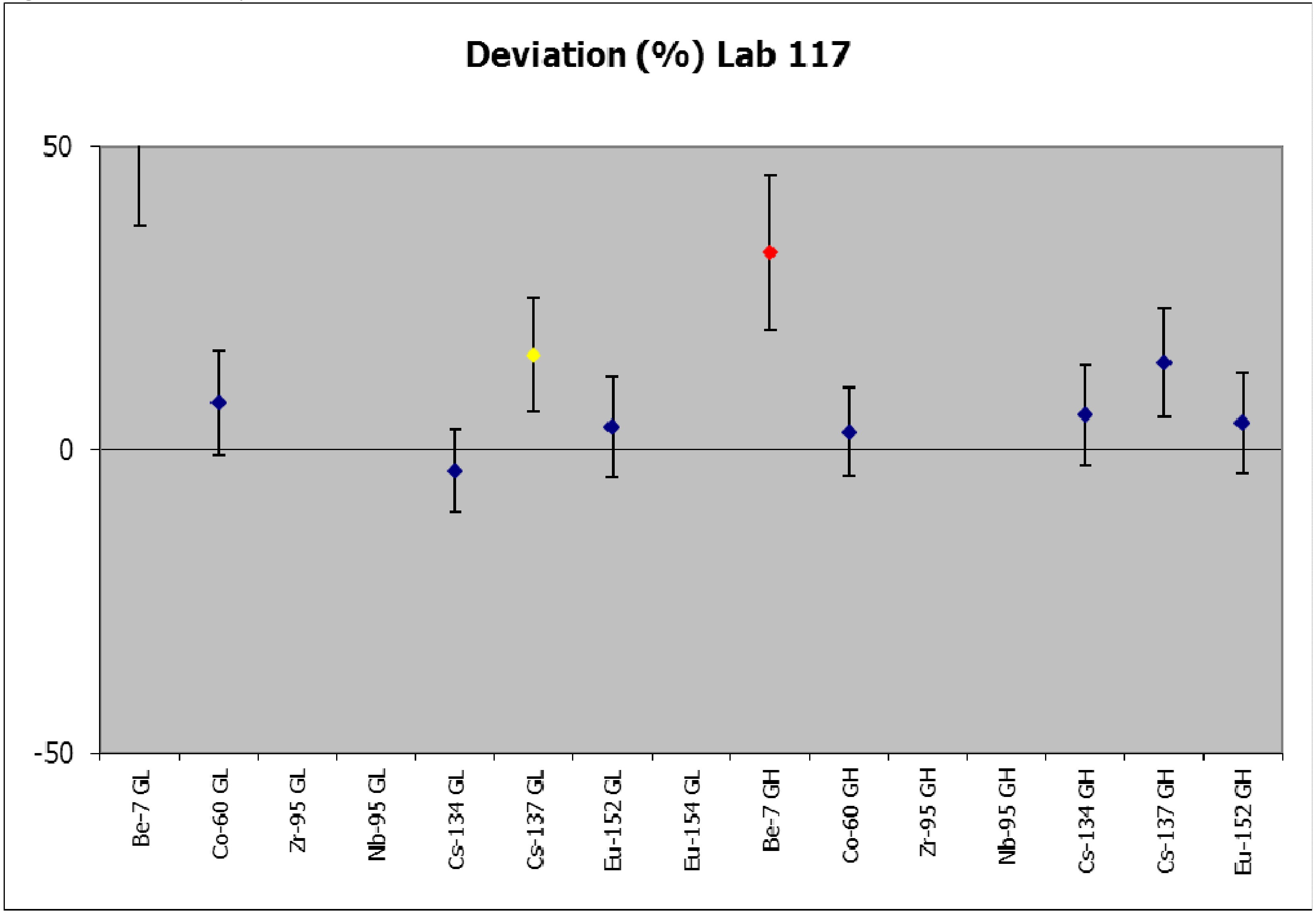


Figure 110 – Laboratory 118

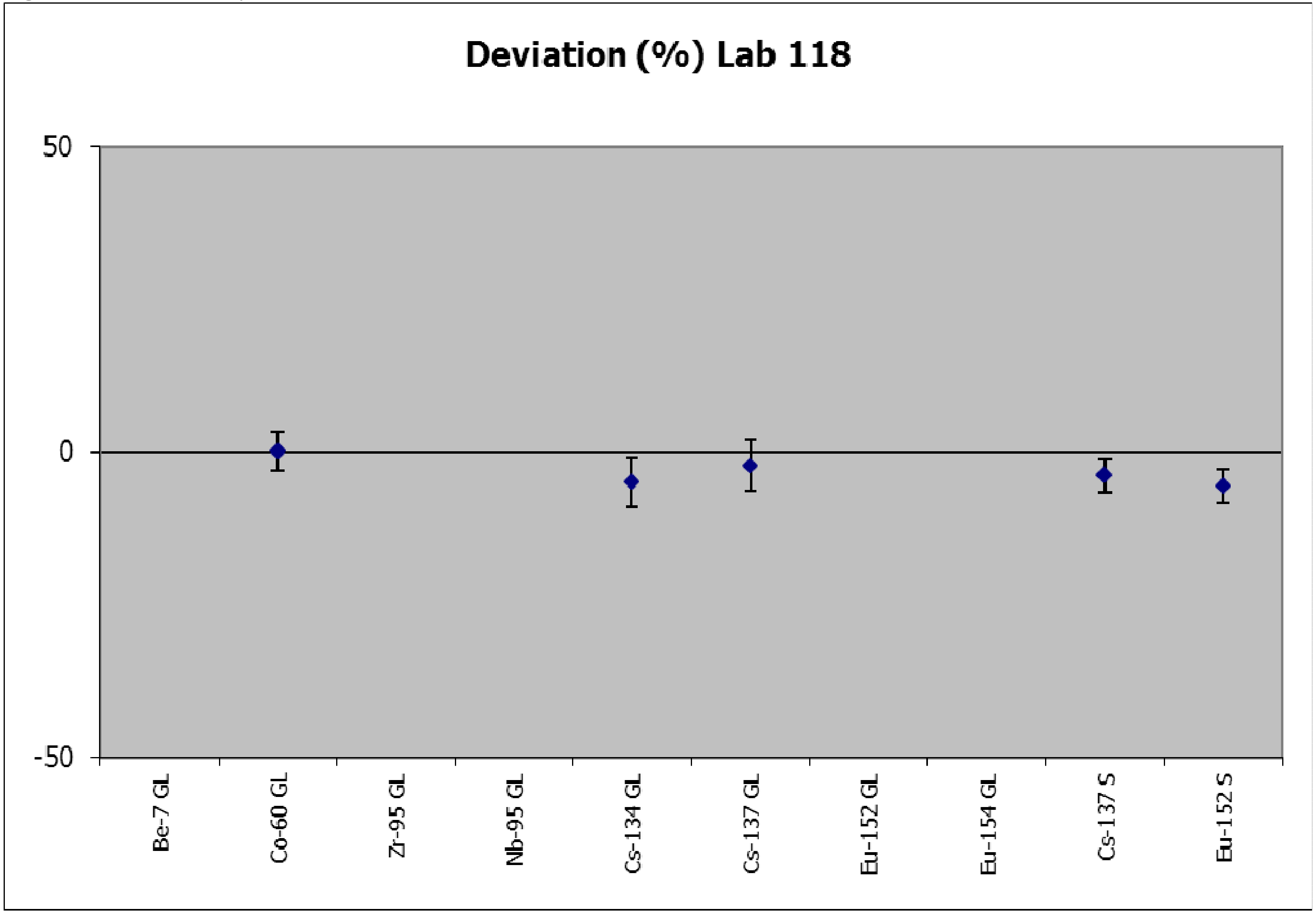


Figure 111 – Laboratory 120

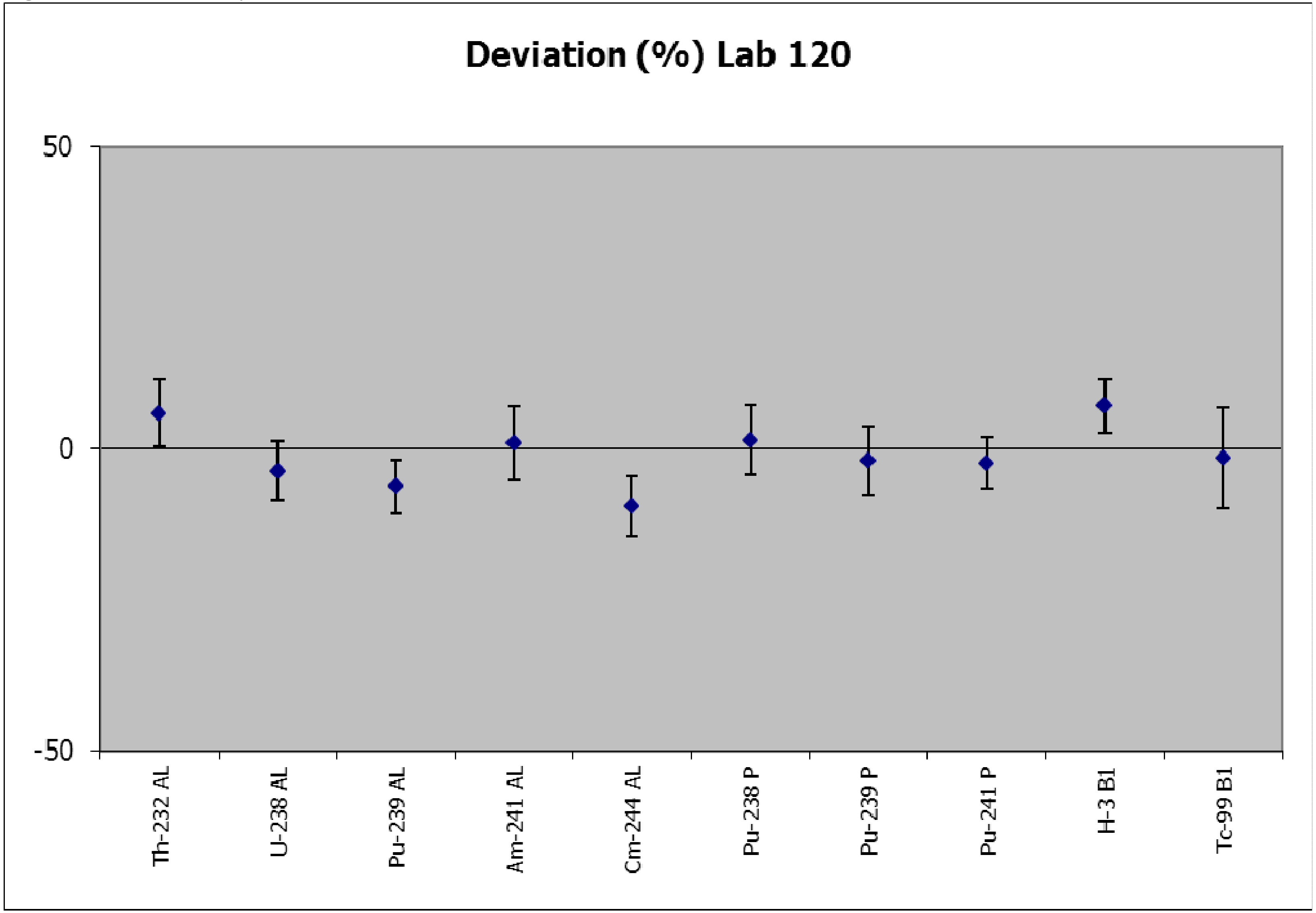


Figure 112 – Laboratory 123

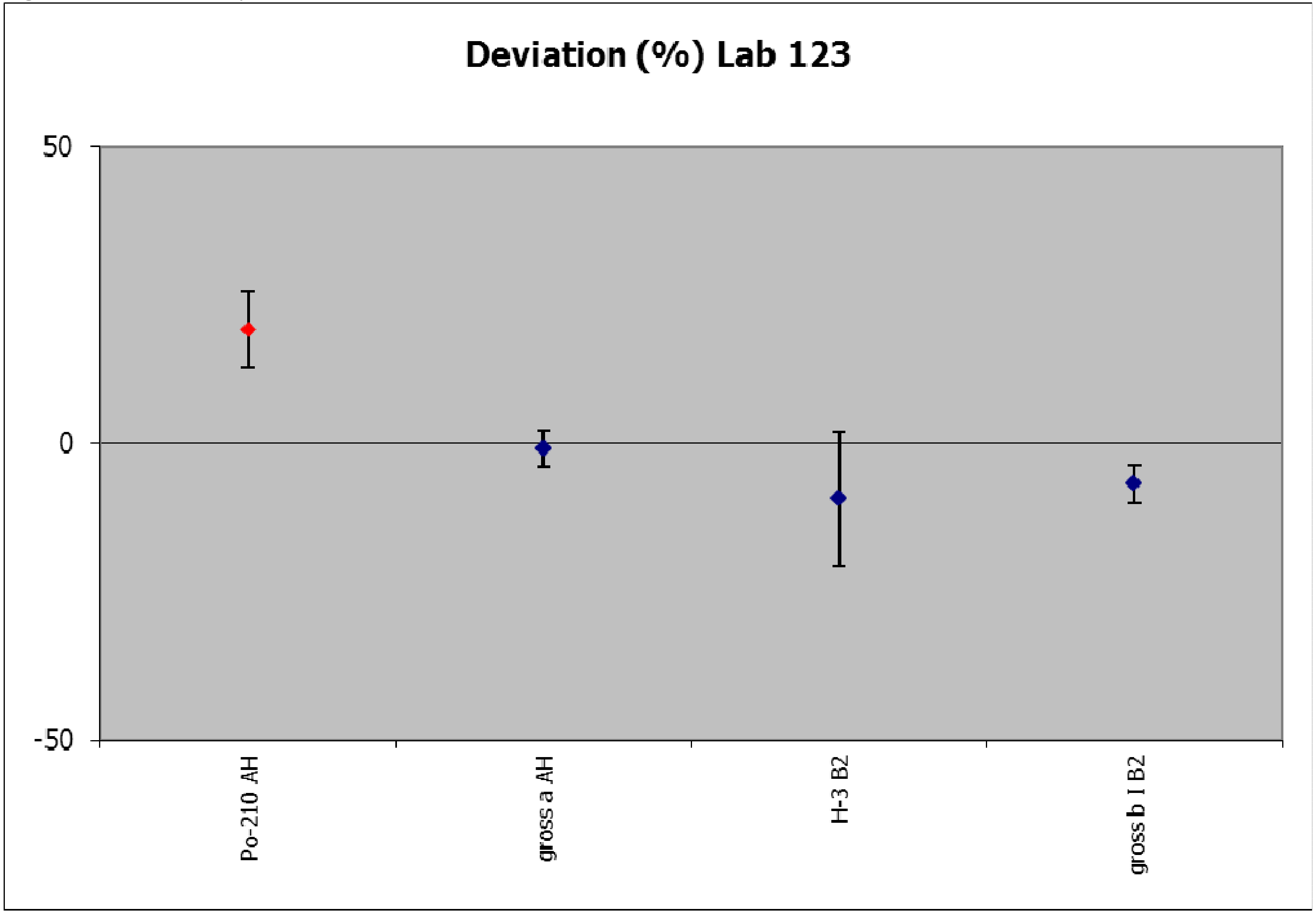


Figure 113 – Laboratory 126

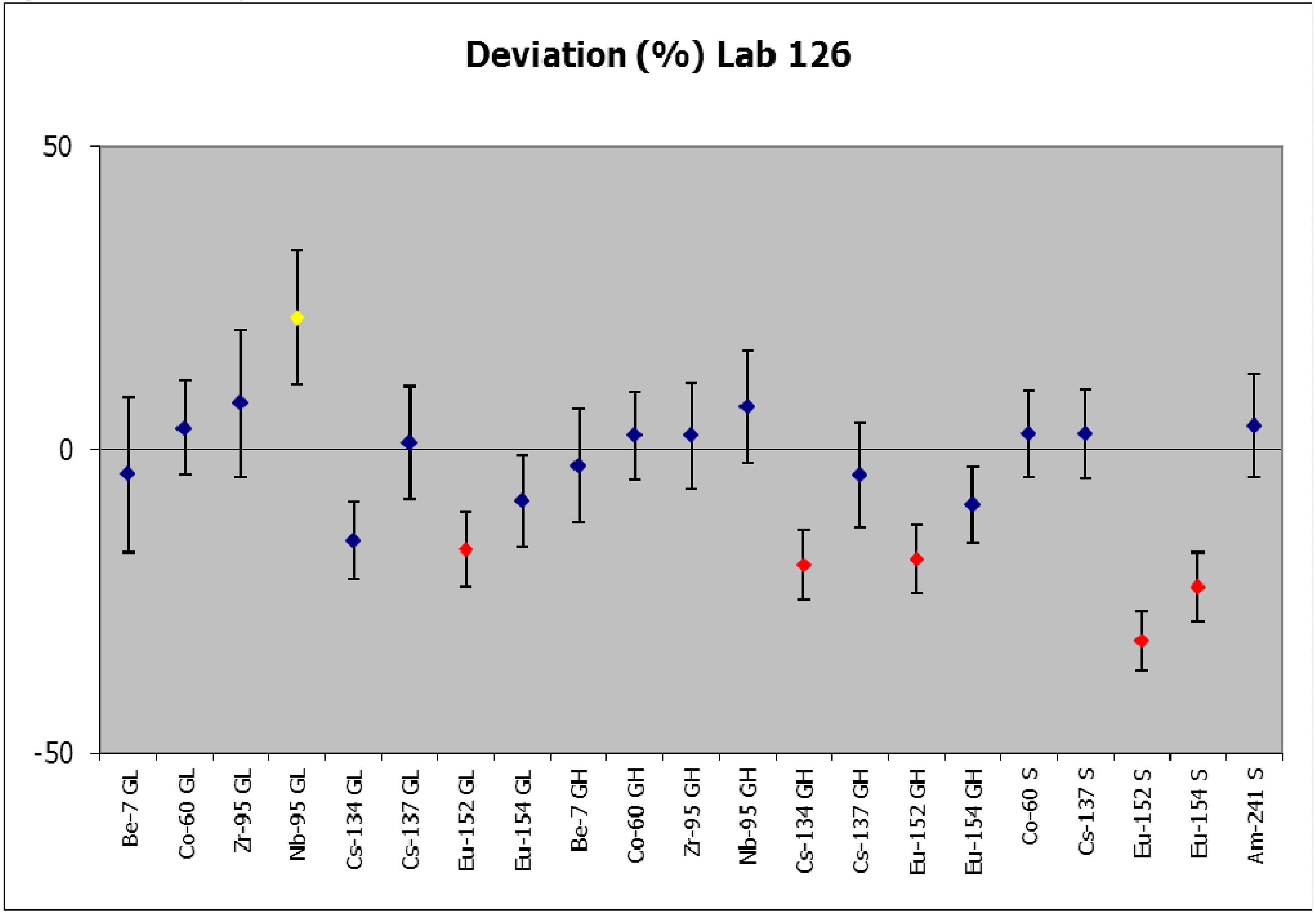


Figure 114 – Laboratory 127

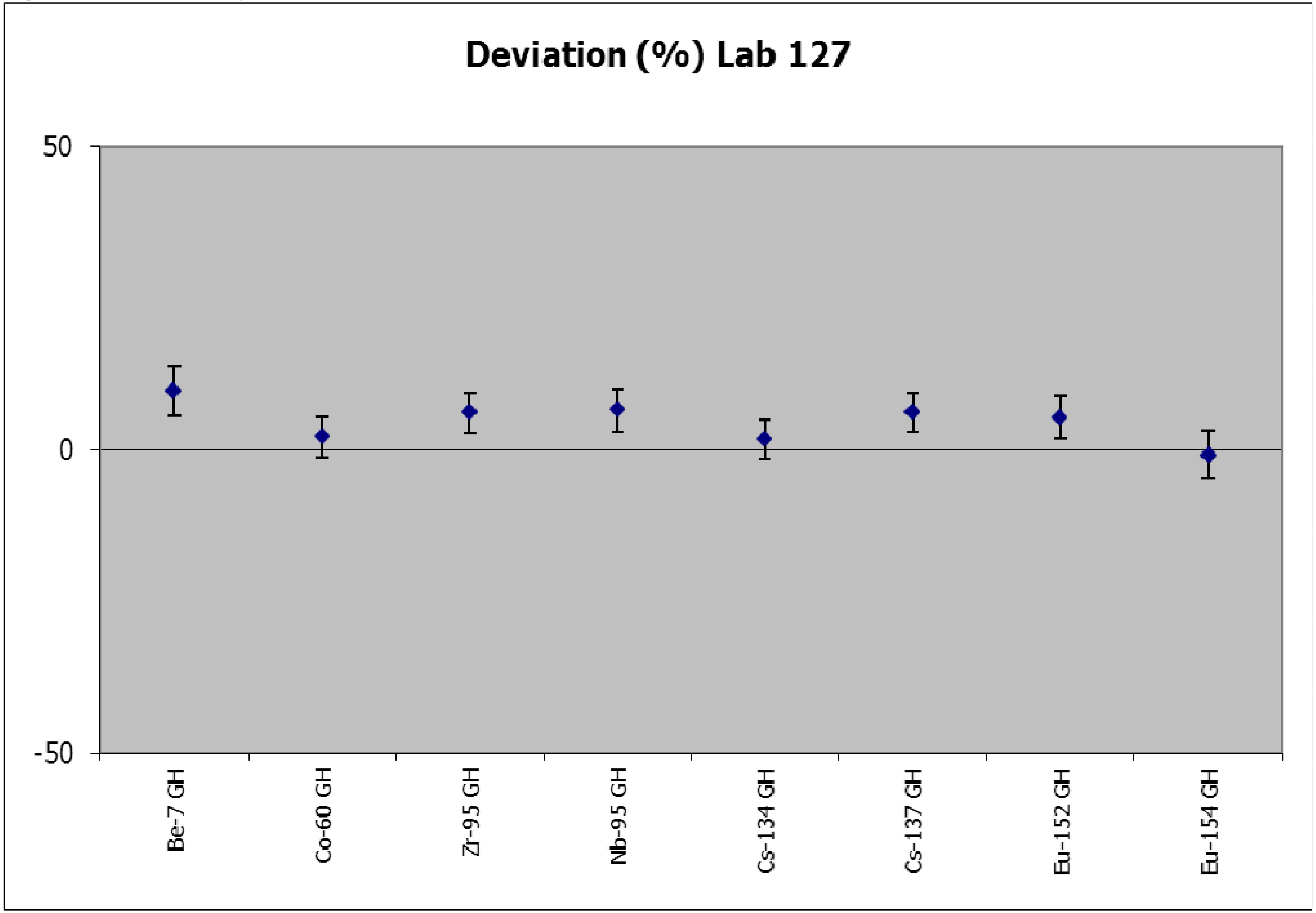


Figure 115 – Laboratory 128

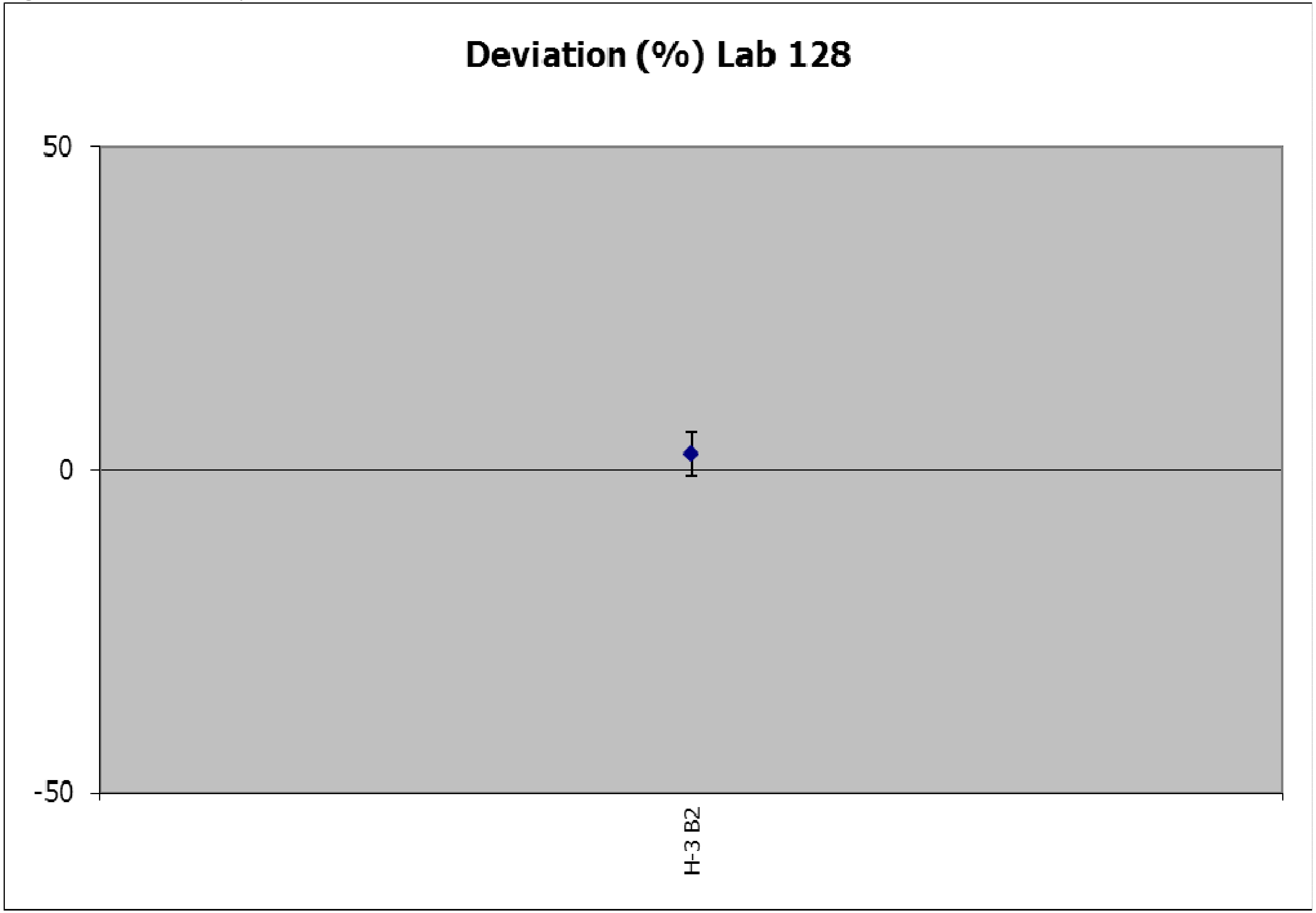


Figure 116 – Laboratory 129

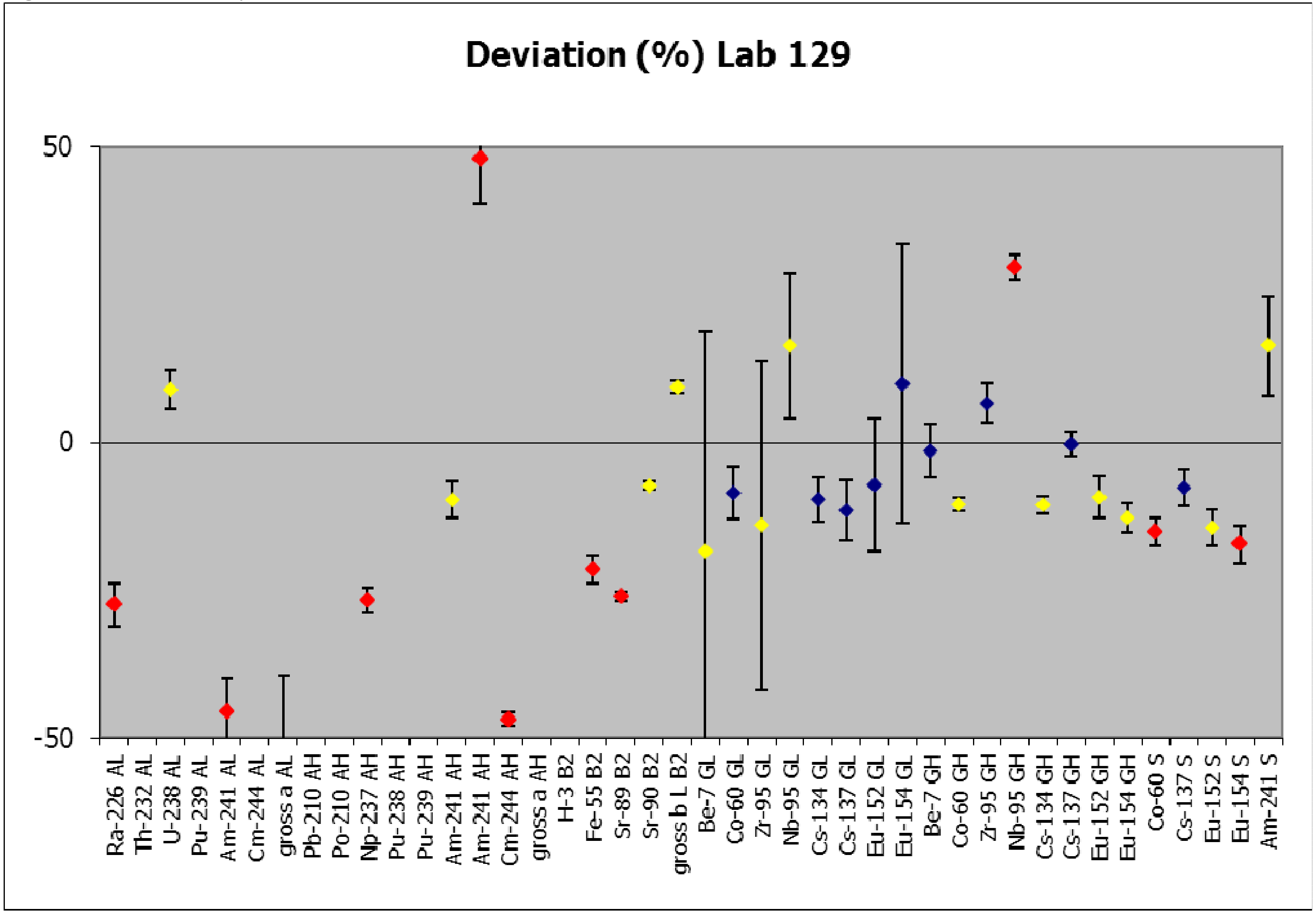


Figure 117 – Laboratory 130

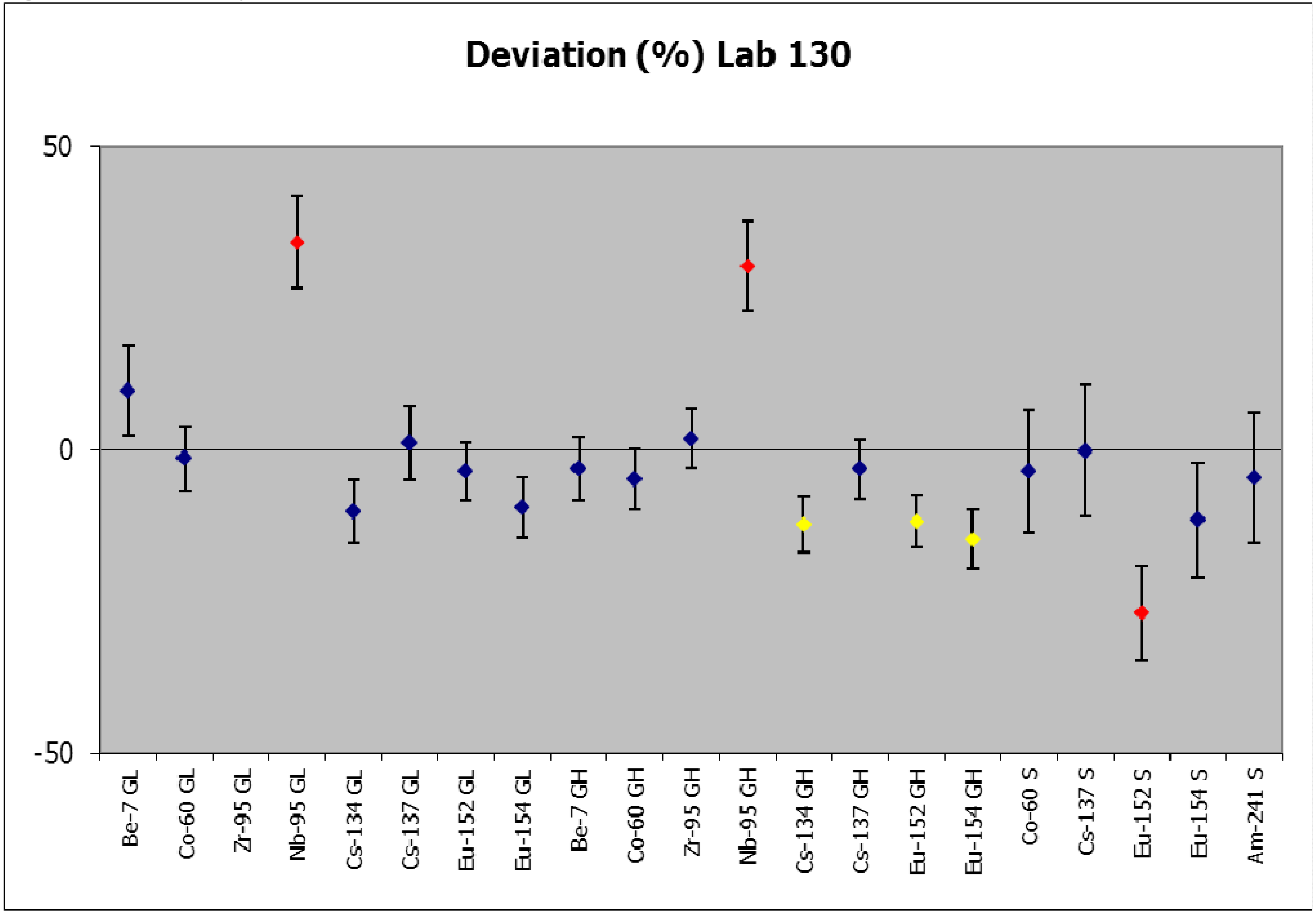


Figure 118 – Laboratory 131

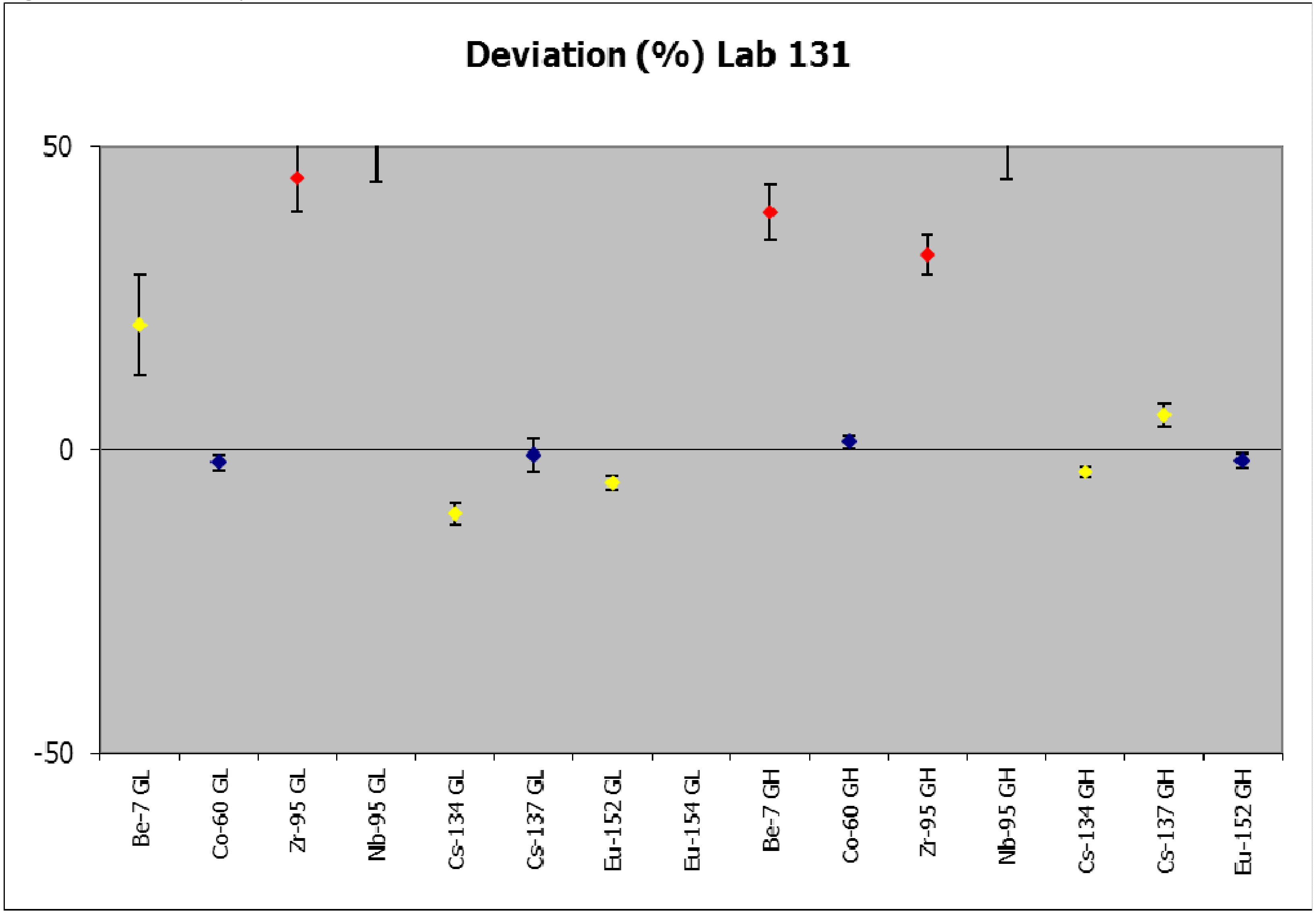


Figure 119 – Laboratory 132

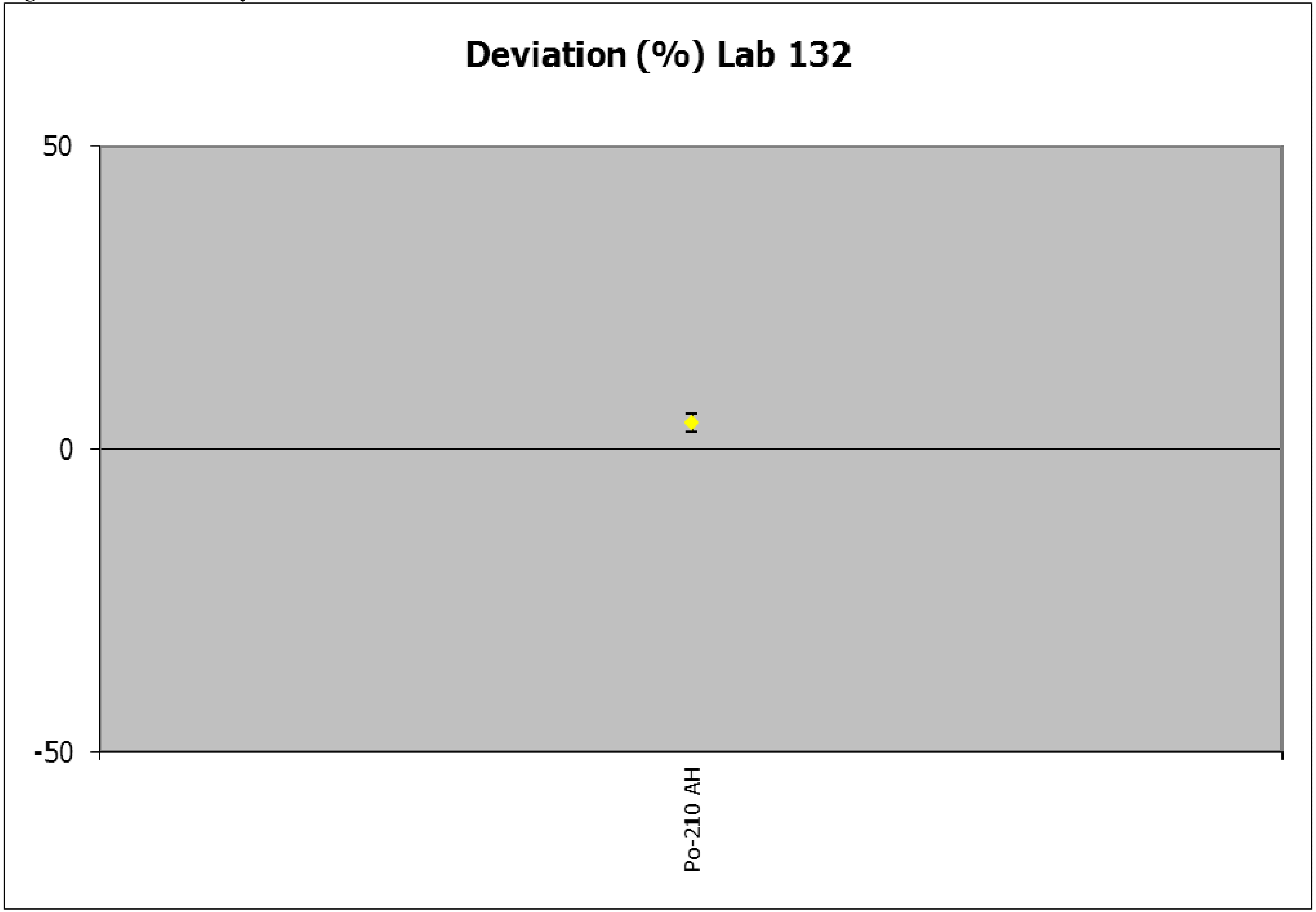


Figure 120 – Outlier limits relative uncertainties

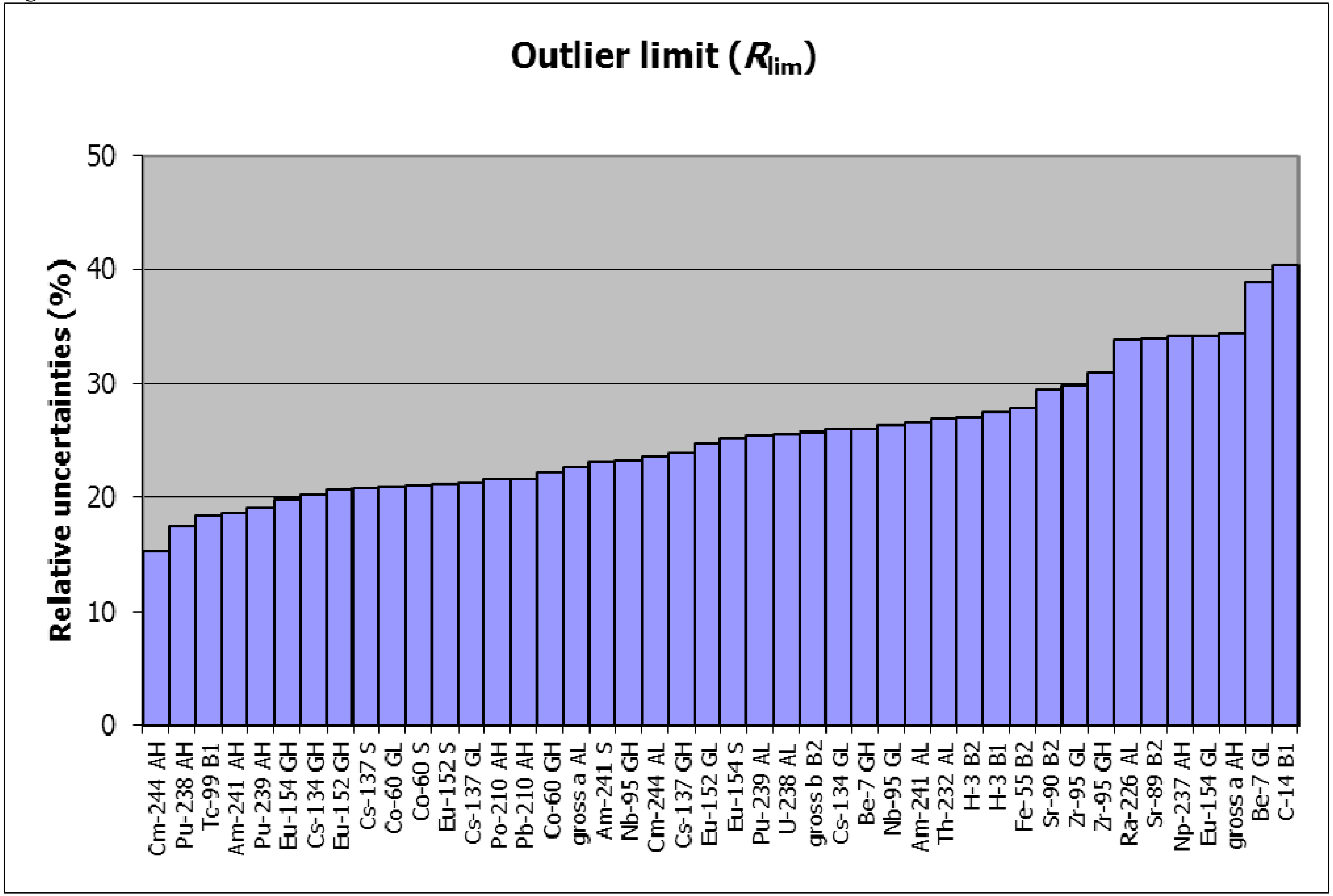


Figure 121A – Normalised ^{244}Cm / ^{241}Am ratios AL

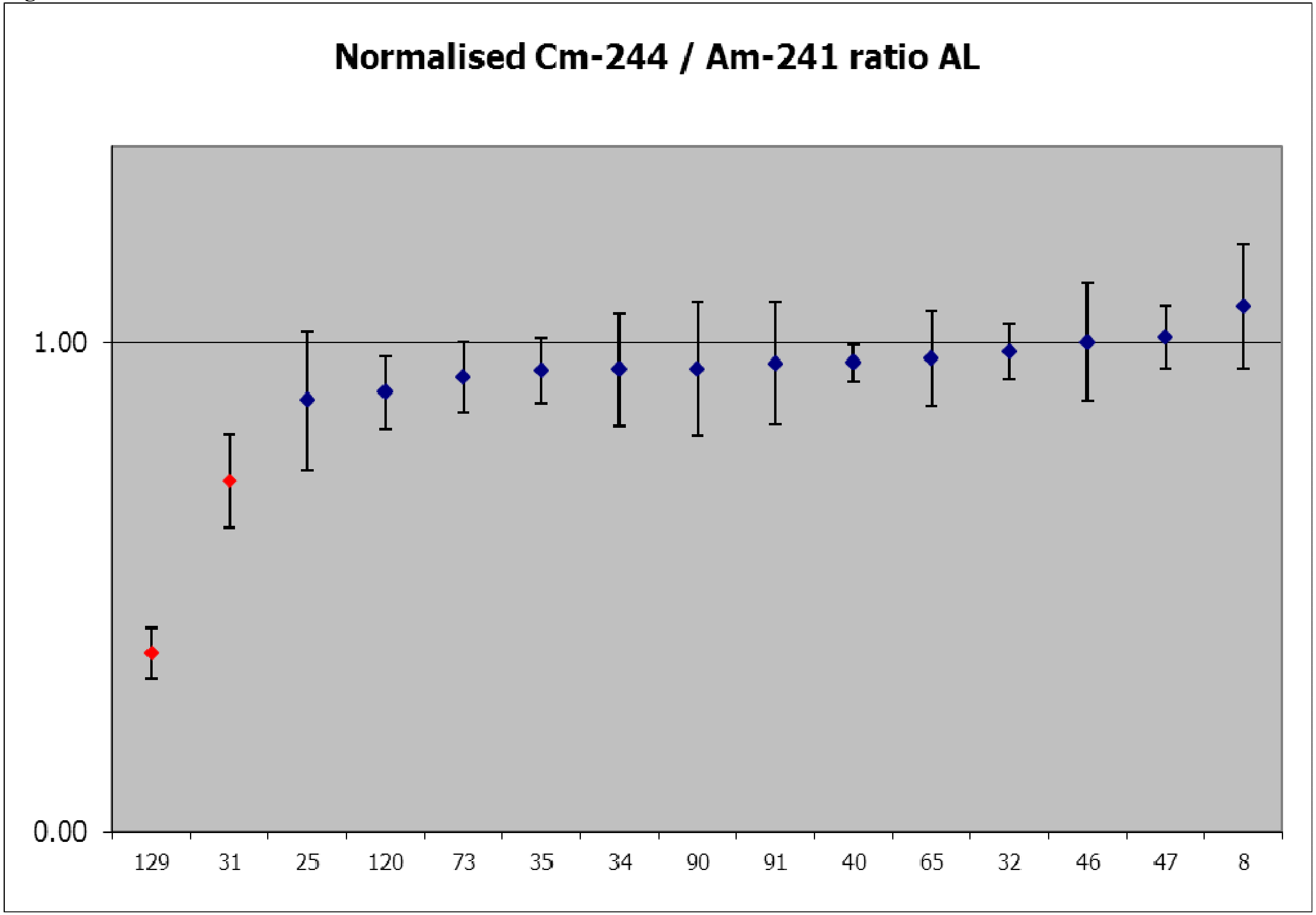
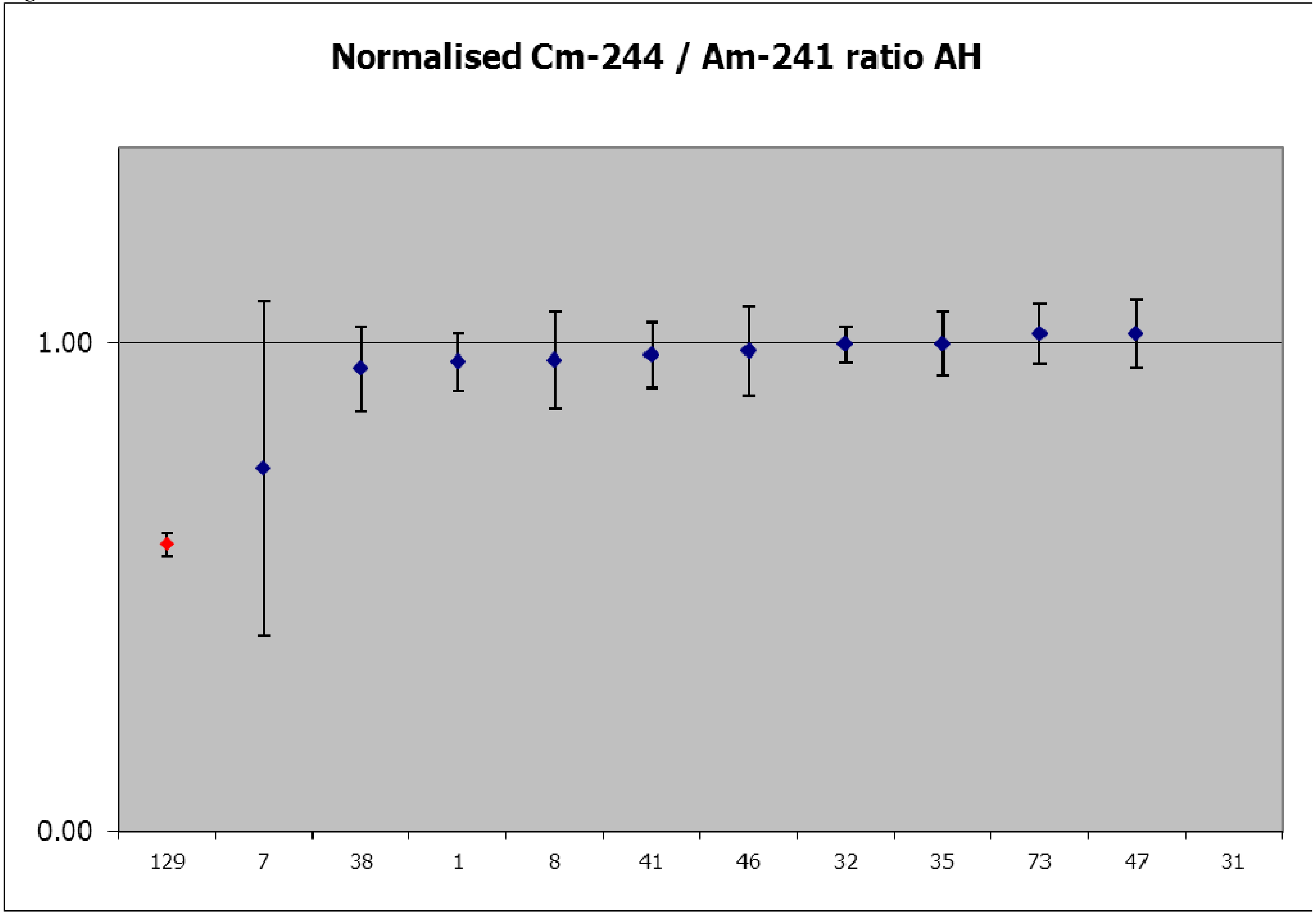


Figure 121B – Normalised ^{244}Cm / ^{241}Am ratios AH



Appendix A. Results sorted by nuclide

Table A1 – Ra-226 AL **assigned result 10.25(18) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
31	1.9(2)	–30.97 D	–13.99 D	–81.5(20)
129	7.4(4)	–7.29 D	–4.71 D	–27(4)
32	7.9(10)	–2.32	–3.87 Q	–23(10)
28	9.0(7)	–1.73	–2.09	–12(7)
35	9.1(10)	–1.23	–1.99	–12(9)
25	9.2(5)	–1.88	–1.71	–10(5)
46	10.2(6)	–0.10	–0.10	–1(6)
8	10(4)	–0.01	–0.08	0(4) × 10^{1}
47	10.4(5)	0.25	0.22	1(5)
73	10.5(3)	0.72	0.42	2(4)
106	11.2(6)	1.58	1.51	9(6)
65	11.3(13)	0.79	1.73	10(13)
34	11.7(11)	1.30	2.43	14(11)
24	11.8(14)	1.10	2.60 Q	15(14)
86	12.0(20)	0.87	2.94 Q	17(20)
42	13(3)	0.93	4.55 Q	3(3) × 10^{1}
26	14.4(5)	7.58 D	6.99 D	41(6)

Table A2 – Th-232 AL **assigned result 5.47(8) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
129	1.88(7)	–32.93 D	–11.27 D	–65.6(14)
34	4.8(5)	–1.39	–2.22	–13(9)
40	4.95(17)	–2.77 Q	–1.63	–10(4)
47 M	5.0(5)	–1.02	–1.62	–9(9)
28	5.1(5)	–0.86	–1.18	–7(8)
8	5.1(9)	–0.38	–1.05	–6(16)
90	5.2(5)	–0.52	–0.87	–5(10)
65	5.2(3)	–0.88	–0.83	–5(6)
47 A	5.3(3)	–0.48	–0.49	–3(6)
13	5.3(8)	–0.20	–0.49	–3(14)
46	5.3(4)	–0.36	–0.46	–3(8)
32 A	5.36(18)	–0.53	–0.33	–2(4)
51	5.40(20)	–0.30	–0.21	–1(4)
32 M	5.5(4)	0.06	0.08	0(7)
25	5.5(7)	0.07	0.14	1(12)
26	5.5(3)	0.21	0.20	1(6)
106	5.5(3)	0.26	0.23	1(5)
24	5.7(6)	0.39	0.74	4(11)
120	5.8(3)	1.08	1.02	6(6)
35	5.9(4)	1.01	1.33	8(8)

Table A3 – U-238 AL **assigned result 7.76(20) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
17	5.8(5)	–3.85 D	–4.27 D	–25(6)
31	6.4(6)	–2.15	–3.01 Q	–18(8)
90	6.5(7)	–1.84	–2.81 Q	–16(9)
8	6.6(7)	–1.73	–2.63 Q	–15(9)
73	7.1(3)	–1.84	–1.46	–9(5)
32 M	7.2(6)	–0.94	–1.19	–7(8)
46	7.2(4)	–1.16	–1.17	–7(6)
47 A	7.3(3)	–1.31	–1.02	–6(5)
91	7.3(7)	–0.60	–1.00	–6(10)
35	7.4(3)	–1.00	–0.80	–5(5)
40	7.41(21)	–1.19	–0.77	–4(4)
47 M	7.46(13)	–1.27	–0.66	–4(3)
28	7.46(19)	–1.09	–0.66	–4(4)
120	7.5(4)	–0.74	–0.62	–4(5)
13	7.5(8)	–0.30	–0.57	–3(11)
4	7.5(7)	–0.34	–0.51	–3(9)
34	7.6(7)	–0.26	–0.42	–2(9)
106	7.6(4)	–0.32	–0.29	–2(6)
25	7.7(6)	–0.11	–0.15	–1(8)
32 A	7.8(3)	–0.03	–0.02	0(5)
65	7.8(5)	0.00	0.00	0(7)
51	7.9(3)	0.39	0.31	2(5)
26	8.00(25)	0.75	0.53	3(4)
129	8.46(13)	2.96 Q	1.55	9(4)

Table A4 – Pu-239/240 AL **assigned result 12.37(19) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
129	3.34(11)	–40.98 D	–12.54 D	–73.0(10)
90	9.4(9)	–3.14 D	–4.18 D	–24(8)
86	9.92(18)	–9.33 D	–3.40 D	–19.8(19)
62	10.4(6)	–3.38 D	–2.73 D	–16(5)
106	11.3(8)	–1.30	–1.48	–9(7)
73	11.3(7)	–1.47	–1.48	–9(6)
31	11.3(10)	–1.05	–1.48	–9(8)
4	11.4(12)	–0.85	–1.37	–8(9)
25	11.5(11)	–0.83	–1.28	–7(9)
46	11.5(9)	–0.97	–1.26	–7(8)
51	11.6(4)	–1.73	–1.07	–6(4)
120	11.6(5)	–1.39	–1.07	–6(5)
47	11.7(5)	–1.44	–0.94	–5(4)
40	11.9(3)	–1.35	–0.68	–4(3)
65	12.1(6)	–0.37	–0.33	–2(5)
35	12.1(6)	–0.42	–0.33	–2(5)
26	12.1(4)	–0.57	–0.33	–2(4)
28	12.2(3)	–0.65	–0.29	–2(3)
29	12.2(6)	–0.27	–0.23	–1(5)
34	12.3(9)	–0.11	–0.14	–1(5)
91	12.3(11)	–0.03	–0.05	0(9)
32	12.6(4)	0.44	0.27	2(4)
8	13.0(12)	0.51	0.88	5(10)

Table A5 – Am-241 AL **assigned result 5.00(6) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
129	2.7(3)	–7.94 D	–7.81 D	–45(6)
62	3.93(23)	–4.51 D	–3.69 D	–21(5)
29	4.50(20)	–2.41	–1.73	–10(4)
106	4.6(4)	–1.07	–1.53	–9(8)
90	4.6(5)	–0.88	–1.42	–8(10)
46	4.7(4)	–0.81	–1.15	–7(8)
8 A	4.8(4)	–0.48	–0.70	–4(9)
73	4.8(3)	–0.67	–0.70	–4(6)
34	4.9(4)	–0.21	–0.29	–2(8)
47	4.93(22)	–0.33	–0.26	–1(5)
40	4.95(12)	–0.38	–0.18	–1(3)
25	5.0(6)	0.01	0.02	0(12)
120	5.1(3)	0.15	0.15	1(6)
31	5.1(5)	0.11	0.19	1(10)
28	5.07(14)	0.43	0.22	1(3)
24	5.1(7)	0.14	0.33	2(14)
51	5.10(20)	0.45	0.33	2(4)
91	5.1(5)	0.21	0.35	2(10)
8 G	5.1(9)	0.13	0.40	2(17)
26	5.23(13)	1.57	0.77	4(3)
42	5.3(6)	0.59	1.17	7(12)
4	5.4(5)	0.73	1.18	7(10)
32 G	5.4(4)	0.95	1.29	7(8)
32 A	5.46(23)	1.91	1.56	9(5)
65	5.6(4)	1.52	1.90	11(7)
35	5.7(3)	2.45	2.49	14(6)

Table A6 – Cm-244 AL **assigned result 15.74(19) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
129	3.1(3)	–35.27 D	–13.76 D	–80.1(19)
31	11.4(10)	–4.26 D	–4.73 D	–28(7)
90	13.6(14)	–1.50	–2.29	–13(9)
25	13.9(15)	–1.24	–2.04	–12(10)
73	14.0(6)	–2.75 Q	–1.89	–11(4)
120	14.2(8)	–1.91	–1.63	–10(5)
34	14.6(13)	–0.86	–1.24	–7(8)
46	14.7(12)	–0.87	–1.14	–7(8)
40	14.9(4)	–1.96	–0.90	–5(3)
91	15.4(14)	–0.27	–0.41	–2(9)
47	15.7(6)	–0.11	–0.08	0(4)
8	16.2(13)	0.36	0.51	3(8)
32	16.8(6)	1.83	1.21	7(4)
65	16.9(13)	0.92	1.27	7(8)
35	17.0(8)	1.48	1.33	8(6)

Table A7 – Gross alpha AL **assigned result 83(18) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
99 B	26(3)	–3.05 D	–11.75 D	–68(8)
99 A	29(3)	–2.91 D	–11.25 D	–65(9)
129	41(3)	–2.26	–8.74 Q	–51(12)
25	59.3(23)	–1.28	–4.92 Q	–29(16)
5	63(7)	–1.02	–4.13 Q	–24(19)
42	70.4(9)	–0.69	–2.62 Q	–15(19)
8	94.7(7)	0.63	2.40	14(25)
47	99(8)	0.79	3.25 Q	$2(3) \times 10^1$

Table A8 – Pb-210 AH **assigned result 2.54(3) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
35	1.43(19)	–5.77 D	–7.50 D	–44(8)
46	2.49(9)	–0.52	–0.33	–2(4)
106	2.56(12)	0.17	0.14	1(5)
32	2.68(11)	1.24	0.95	6(5)
28	2.74(12)	1.63	1.36	8(5)
65	2.91(12)	2.97 Q	2.51	15(5)
8	3.30(25)	2.98 D	5.15 D	30(10)
55	3.5(3)	3.60 D	6.36 D	37(10)
24	3.6(4)	2.65 D	7.18 D	42(16)
129	5.1(4)	6.59 D	16.98 D	99(15)

Table A9 – Po-210 AH **assigned result 2.54(3) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
129	1.09(10)	–13.95 D	–9.80 D	–57(4)
1	1.70(10)	–8.08 D	–5.67 D	–33(4)
38	2.10(20)	–2.17	–2.97 Q	–17(8)
28	2.24(6)	–4.51 Q	–2.02	–12(3)
46	2.33(13)	–1.57	–1.41	–8(5)
106	2.54(10)	0.01	0.01	0(4)
47	2.59(17)	0.30	0.34	2(7)
132	2.653(24)	3.09 Q	0.77	4.5(15)
32	2.67(4)	2.65 Q	0.91	5.3(20)
123	3.03(16)	3.02 D	3.32 D	19(7)

Table A10 – Np-237 AH **assigned result 17.45(18) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
8	1.83(21)	–57.58 D	–15.37 D	–89.5(12)
129	12.8(4)	–12.16 D	–4.58 D	–26.7(21)
55 G	15(3)	–1.14	–2.90 Q	–17(15)
47 M	16.6(13)	–0.65	–0.84	–5(8)
47 A	17.0(7)	–0.69	–0.48	–3(4)
65	17.6(7)	0.20	0.15	1(5)
55 R	17.8(22)	0.16	0.34	2(13)
32	19.1(16)	1.05	1.65	10(9)
1	20.4(13)	2.25	2.90 Q	17(8)
106	21.1(19)	1.91	3.59 Q	21(11)

Table A11 – Pu-238 AH **assigned result 18.08(6) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
129	4.80(13)	–93.37 D	–12.61 D	–73.4(7)
31	6.0(6)	–20.07 D	–11.49 D	–67(4)
55	15.1(8)	–3.80 D	–2.83 D	–16(5)
106	15.5(11)	–2.34	–2.45	–14(6)
7	15.8(10)	–2.27	–2.16	–13(6)
35	15.8(9)	–2.52	–2.15	–13(5)
41	16.1(9)	–2.26	–1.88	–11(5)
38	16.3(10)	–1.78	–1.69	–10(6)
8	16.6(13)	–1.14	–1.40	–8(7)
73	17.2(11)	–0.80	–0.83	–5(6)
47	17.2(6)	–1.52	–0.83	–5(4)
46	17.5(11)	–0.55	–0.58	–3(6)
28	17.5(4)	–1.73	–0.55	–3.2(19)
1	17.7(4)	–0.94	–0.36	–2.1(22)
32	18.4(4)	0.76	0.28	1.6(21)

Table A12 – Pu-239/240 AH **assigned result 17.29(8) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
31	6.6(6)	–17.60 D	–10.58 D	–62(4)
129	7.07(15)	–60.78 D	–10.15 D	–59.1(9)
55	14.3(8)	–3.94 D	–2.97 D	–17(5)
106	14.9(11)	–2.16	–2.37	–14(7)
35	14.9(8)	–2.83 Q	–2.34	–14(5)
7	15.0(10)	–2.35	–2.27	–13(6)
41	15.5(8)	–2.33	–1.77	–10(5)
38	15.8(10)	–1.48	–1.48	–9(6)
8	15.9(12)	–1.11	–1.38	–8(7)
28	16.7(4)	–1.87	–0.61	–3.6(19)
46	16.8(11)	–0.49	–0.52	–3(6)
73	16.8(11)	–0.44	–0.48	–3(7)
47	16.8(6)	–0.87	–0.48	–3(4)
1	17.0(4)	–0.70	–0.28	–1.6(24)
32	17.5(4)	0.61	0.22	1.3(21)

Table A13 – Am-241 AH **assigned result 4.382(10) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
31	0.095(9)	–324.61 D	–16.80 D	–97.84(21)
106	3.8(4)	–1.79	–2.24	–13(7)
129 A	3.96(13)	–3.24 Q	–1.65	–10(3)
41	4.20(22)	–0.84	–0.71	–4(5)
65	4.20(14)	–1.27	–0.71	–4(4)
47 A	4.21(23)	–0.75	–0.67	–4(6)
47 G	4.3(3)	–0.31	–0.32	–2(6)
73	4.30(20)	–0.41	–0.32	–2(5)
55	4.31(10)	–0.71	–0.28	–1.6(23)
8 G	4.36(19)	–0.12	–0.09	–1(5)
28	4.36(10)	–0.22	–0.09	–0.5(23)
7	4.4(15) Q	0.00	–0.01	0(4) × 10^{1}
32 A	4.42(12)	0.32	0.15	1(3)
35	4.46(21)	0.37	0.31	2(5)
8 A	4.5(4)	0.26	0.35	2(8)
38	4.5(3)	0.39	0.46	3(7)
32 G	4.58(8)	2.64 Q	0.77	4.5(17)
46	4.6(3)	0.64	0.78	5(7)
1	4.60(20)	1.09	0.85	5(5)
24	5.2(6)	1.36	3.21 Q	19(14)
129 G	6.5(4)	6.20 D	8.26 D	48(8)

Table A14 – Cm-244 AH **assigned result 18.29(6) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
31	0.82(8)	–175.39 D	–16.40 D	–95.5(5)
129	9.74(20)	–40.99 D	–8.03 D	–46.8(11)
7	14(4)	–1.12	–4.41 Q	–26(23)
41	17.1(8)	–1.52	–1.12	–7(5)
55	17.6(10)	–0.67	–0.65	–4(6)
38	17.8(11)	–0.45	–0.46	–3(6)
47	17.9(7)	–0.51	–0.35	–2(4)
8	18.0(13)	–0.23	–0.27	–2(7)
73	18.3(7)	0.01	0.01	0(4)
32	18.4(5)	0.29	0.13	1(3)
1	18.5(8)	0.26	0.20	1(5)
35	18.6(9)	0.36	0.29	2(5)
46	18.8(12)	0.42	0.49	3(7)

Table A15 – Gross alpha AH **assigned result 80.57(21) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
99 A	16.7(17)	–37.91 D	–13.61 D	–79.2(21)
99 B	22.2(22)	–26.18 D	–12.45 D	–72(3)
129	32(4)	–13.13 D	–10.37 D	–60(5)
7	44(5)	–7.61 D	–7.79 D	–45(6)
55	66.3(20)	–7.09 D	–3.04 D	–17.7(25)
31	68(6)	–2.09	–2.68 Q	–16(8)
47	73(4)	–2.01	–1.63	–10(5)
8	73.9(4)	–15.92 Q	–1.42	–8.3(5)
123	80.0(25)	–0.23	–0.12	–1(3)
41	81(4)	0.08	0.07	0(5)
1	82(9)	0.16	0.31	2(11)

Table A16 – Pu-238 P **assigned result 5.054(23) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
86 M	4.23(19)	–4.30 D	–2.80 D	–16(4)
86 A	4.31(13)	–5.63 Q	–2.53	–15(3)
106	4.5(3)	–1.97	–1.95	–11(6)
8	4.6(3)	–1.65	–1.47	–9(5)
107	4.8(3)	–0.99	–0.94	–5(6)
38	4.8(3)	–0.84	–0.86	–5(6)
35	4.8(3)	–0.93	–0.83	–5(5)
7	4.9(4)	–0.46	–0.62	–4(8)
46	4.9(4)	–0.55	–0.62	–4(7)
55	5.00(20)	–0.27	–0.18	–1(4)
28	5.08(10)	0.26	0.09	0.5(20)
120	5.1(3)	0.26	0.26	2(6)
47	5.20(20)	0.73	0.50	3(4)
1	5.20(20)	0.73	0.50	3(4)
32	5.24(17)	1.09	0.63	4(4)
31	5.8(5)	1.39	2.37	14(10)
94	5.8(5)	1.60	2.40	14(9)

Table A17 – Pu-239/240 P **assigned result 5.79(6) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
86 M	4.79(23)	–4.21 D	–2.97 D	–17(4)
86 A	4.90(15)	–5.51 D	–2.64 D	–15(3)
106	5.1(4)	–1.94	–1.93	–11(6)
8	5.3(3)	–1.58	–1.43	–8(6)
107	5.3(3)	–1.40	–1.31	–8(6)
46	5.4(4)	–1.04	–1.13	–7(6)
35	5.5(3)	–1.02	–0.92	–5(6)
38	5.6(4)	–0.48	–0.57	–3(7)
7	5.6(4)	–0.42	–0.51	–3(7)
120	5.7(4)	–0.34	–0.33	–2(6)
55	5.72(23)	–0.30	–0.21	–1(4)
47	5.8(3)	–0.04	–0.03	0(5)
28	5.79(12)	–0.01	0.00	0.0(23)
32	5.87(18)	0.42	0.23	1(4)
1	5.90(15)	0.67	0.32	2(3)
31	6.5(6)	1.09	1.95	11(10)
94	6.9(5)	2.18	3.32 Q	19(9)

Table A18 – Pu-241 P **assigned result 14.96(16) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
38	6.0(5)	–17.02 D	–10.28 D	–60(4)
1	9.5(12)	–4.41 D	–6.29 D	–37(8)
31	10.2(10)	–4.74 D	–5.52 D	–32(7)
46	11.5(6)	–6.06 D	–3.99 D	–23(4)
107	12.5(9)	–2.71 D	–2.88 D	–17(6)
86	12.5(6)	–3.86 D	–2.85 D	–17(5)
7	13.6(10)	–1.34	–1.56	–9(7)
32	14.2(7)	–1.10	–0.92	–5(5)
94	14.4(9)	–0.64	–0.64	–4(6)
120	14.6(6)	–0.55	–0.40	–2(5)
8	14.8(5)	–0.35	–0.18	–1(3)
35	15.1(8)	0.12	0.12	1(6)
55	15.1(10)	0.14	0.16	1(7)
47	15.1(12)	0.12	0.16	1(8)

Table A19 – H-3 B1 **assigned result 1.345(10) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
35 d	1.11(4)	–5.70 D	–3.06 D	–18(3)
4	1.19(12)	–1.29	–1.98	–12(9)
7	1.20(5)	–2.85 Q	–1.85	–11(4)
108	1.25(19)	–0.50	–1.20	–7(14)
65	1.26(5)	–1.67	–1.08	–6(4)
16 p	1.26(5)	–1.77	–1.08	–6(4)
32 d	1.27(5)	–1.52	–0.93	–5(4)
25	1.29(6)	–1.04	–0.73	–4(4)
29 p	1.30(10)	–0.45	–0.57	–3(8)
38 d	1.30(10)	–0.45	–0.57	–3(8)
94	1.30(8)	–0.56	–0.57	–3(6)
32 p	1.30(9)	–0.45	–0.52	–3(7)
29 d	1.31(6)	–0.57	–0.44	–3(5)
106	1.31(4)	–0.85	–0.39	–2(3)
5 d	1.32(13)	–0.19	–0.32	–2(10)
8	1.33(6)	–0.28	–0.19	–1(4)
21	1.35(4)	0.00	0.00	0(3)
107	1.35(9)	0.08	0.09	1(7)
16 d	1.36(4)	0.43	0.19	1(3)
34	1.38(7)	0.51	0.42	2(5)
38 p	1.40(10)	0.55	0.70	4(8)
35 p	1.41(7)	0.89	0.77	4(5)
5 p	1.41(21)	0.31	0.83	5(16)
55	1.41(15)	0.45	0.83	5(11)
120	1.44(6)	1.57	1.22	7(5)
91	1.46(14)	0.77	1.41	8(11)
95	1.47(7)	1.81	1.54	9(5)
99	1.52(15)	1.17	2.24	13(11)
17	1.55(20)	1.02	2.62 Q	15(15)

Table A20 – C-14 B1 **assigned result 0.1398(9) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
94	0.102(6)	–6.23 D	–4.65 D	–27(4)
5	0.120(18)	–1.10	–2.43	–14(13)
17	0.130(20)	–0.49	–1.21	–7(14)
16	0.130(5)	–1.93	–1.21	–7(4)
34	0.136(7)	–0.54	–0.47	–3(5)
107	0.136(10)	–0.37	–0.46	–3(7)
32	0.137(7)	–0.33	–0.30	–2(6)
29	0.140(20)	0.01	0.02	0(14)
95	0.142(5)	0.38	0.24	1(4)
106	0.142(6)	0.36	0.27	2(5)
55	0.145(6)	0.88	0.64	4(5)
25	0.147(9)	0.79	0.88	5(7)
8	0.155(10)	1.52	1.86	11(7)
38	0.16(3)	0.67	2.48	14(21)
35	0.185(24)	1.88	5.55 Q	32(17)
91	0.24(3)	3.38 D	12.03 D	70(21)
7	0.294(22)	7.00 D	18.94 D	110(16)

Table A21 – Cl-36 B1 **assigned result 0.4544(18) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
94	0.400(20)	–2.71 Q	–2.06	–12(5)
107	0.41(3)	–1.63	–1.60	–9(6)
34	0.422(20)	–1.61	–1.22	–7(5)
7	0.478(7)	3.26 Q	0.89	5.2(16)
32	0.48(5)	0.63	1.04	6(10)
8	0.49(5)	0.65	1.27	7(11)

Table A22 – Tc-99 B1 **assigned result 0.1218(11) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
35	0.105(6)	–2.76 Q	–2.33	–14(5)
76	0.110(5)	–2.63 Q	–1.68	–10(4)
55	0.110(17)	–0.69	–1.67	–10(14)
13	0.110(9)	–1.31	–1.67	–10(8)
47	0.114(11)	–0.71	–1.11	–6(9)
8 M	0.115(13)	–0.52	–0.96	–6(11)
25	0.115(9)	–0.76	–0.96	–6(8)
32	0.120(9)	–0.22	–0.29	–2(8)
59	0.120(10)	–0.18	–0.26	–2(8)
65	0.120(8)	–0.23	–0.26	–2(7)
120	0.120(10)	–0.18	–0.26	–2(8)
107	0.121(10)	–0.11	–0.16	–1(8)
34 GM	0.122(12)	0.01	0.02	0(10)
83	0.130(10)	0.81	1.15	7(8)
34 L	0.131(8)	1.13	1.29	8(7)
28	0.136(4)	3.41 Q	1.99	12(4)
62	0.1400(25)	6.65 Q	2.56	14.9(23)

Table A23 – H-3 B2 **assigned result 0.897(7) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
99	0.49(5)	–8.08 D	–7.79 D	–45(6)
90	0.72(3)	–5.71 D	–3.35 D	–20(4)
35 d	0.74(3)	–5.16 D	–3.03 D	–18(4)
7	0.76(3)	–4.49 D	–2.72 D	–16(4)
72	0.80(5)	–1.93	–1.86	–11(6)
123	0.81(10)	–0.81	–1.59	–9(11)
35 p	0.82(4)	–1.81	–1.44	–8(5)
31	0.83(8)	–0.84	–1.29	–7(9)
32 p	0.84(6)	–0.98	–1.17	–7(7)
41	0.841(21)	–2.53	–1.08	–6.3(25)
25	0.84(4)	–1.45	–1.02	–6(4)
32 d	0.85(4)	–1.60	–1.00	–6(4)
65	0.85(3)	–1.54	–0.90	–5(4)
19	0.85(3)	–1.41	–0.83	–5(4)
106	0.86(3)	–1.28	–0.65	–4(3)
8	0.864(4)	–4.55 Q	–0.63	–3.7(8)
16	0.89(4)	–0.18	–0.14	–1(5)
38 d	0.89(5)	–0.14	–0.14	–1(6)
21	0.89(3)	–0.20	–0.12	–1(4)
38 p	0.90(8)	0.04	0.05	0(9)
13	0.92(4)	0.45	0.34	2(5)
128	0.92(3)	0.74	0.44	3(4)
74	0.92(4)	0.73	0.51	3(4)
55	0.94(12)	0.34	0.78	5(13)
5 d	0.94(9)	0.47	0.82	5(10)
5 p	0.97(15)	0.49	1.39	8(17)
91	0.99(10)	0.89	1.74	10(11)
129	1.85(4)	23.53 D	18.24 D	106(5)

Table A24 – Fe-55 B2 **assigned result 1.235(22) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
65	0.86(6)	–5.69 D	–5.27 D	–31(5)
31	0.91(9)	–3.53 D	–4.55 D	–26(8)
129	0.971(23)	–8.39 D	–3.67 D	–21.4(23)
7	1.05(11)	–1.65	–2.57	–15(9)
38	1.06(10)	–1.71	–2.43	–14(8)
55	1.07(12)	–1.31	–2.30	–13(10)
8	1.11(4)	–2.75 Q	–1.74	–10(4)
32	1.15(7)	–1.12	–1.16	–7(6)
25	1.26(13)	0.18	0.32	2(10)
16	1.49(19)	1.33	3.54 Q	21(16)
21	2.3(3)	3.54 D	14.81 D	86(25)

Table A25 – Sr-89 B2 **assigned result 0.822(3) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
129	0.608(6)	–32.69 D	–4.47 D	–26.0(8)
38	0.67(6)	–2.53	–3.18 Q	–18(7)
8	0.69(9)	–1.42	–2.76 Q	–16(11)
55	0.73(7)	–1.32	–1.99	–12(9)
35	0.76(10)	–0.62	–1.30	–8(12)
32	0.77(7)	–0.71	–1.07	–6(9)
74	0.77(3)	–1.65	–1.00	–6(4)
7	0.81(4)	–0.43	–0.36	–2(5)
90	0.81(8)	–0.15	–0.25	–1(10)
91	0.82(11)	0.01	0.02	0(13)
26	0.96(8)	1.73	2.82 Q	16(10)
106	0.99(13)	1.23	3.45 Q	20(16)
65	1.42(23)	2.66 D	12.49 D	7(3) × 10^{1}

Table A26 – Sr-90 B2 **assigned result 1.488(4) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
35	1.07(8)	–5.36 D	–4.83 D	–28(5)
114	1.11(3)	–12.53 D	–4.36 D	–25.4(20)
25	1.286(9)	–21.11 Q	–2.33	–13.6(7)
8 L	1.34(18)	–0.82	–1.71	–10(12)
38	1.36(7)	–1.83	–1.48	–9(5)
74	1.36(6)	–2.38	–1.46	–8(4)
129	1.380(10)	–10.29 Q	–1.25	–7.3(7)
7	1.38(4)	–2.70 Q	–1.25	–7(3)
65	1.4(3)	–0.25	–0.90	–5(21)
8 P	1.41(3)	–2.56	–0.90	–5.3(21)
91	1.45(19)	–0.21	–0.48	–3(13)
32	1.45(10)	–0.41	–0.45	–3(7)
90	1.47(15)	–0.12	–0.21	–1(10)
26	1.47(12)	–0.15	–0.21	–1(8)
55	1.48(14)	–0.06	–0.09	–1(9)
73	1.51(6)	0.36	0.25	1(4)
106	1.51(8)	0.27	0.25	1(6)
76	1.55(4)	1.79	0.72	4.2(24)
41	1.96(8)	5.89 D	5.44 D	32(6)

Table A27 – Gross beta B2

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
7	3.3(3)	–9.96 D	–7.53 D	–44(5)
25	3.02(24)	–3.22 D	–3.52 D	–20(7)
1	3.30(20)	–2.49	–2.25	–13(6)
123	3.54(12)	–2.15	–1.17	–7(4)
8	3.590(11)	–17.09 Q	–0.94	–5.5(4)
55	3.75(24)	–0.20	–0.22	–1(7)
99 X	5.9(6)	–0.09	–0.15	–1(10)
41	3.80(13)	0.01	0.01	0(4)
99 P	4.0(4)	0.50	0.91	5(11)
129	6.49(6)	8.67 Q	1.62	9.4(11)

Assigned results **3.799(6)** Bq g^{-1} (ISO 9697:2008) and **5.931(23)** Bq g^{-1} (LSC and window less gas-flow proportional counting)

Table A28 – Be-7 GL **assigned result 11.02(13) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
47	7.3(9)	–4.21 D	–5.78 D	–34(8)
25	8.3(16)	–1.64	–4.19 Q	–24(15)
40	8.7(21)	–1.09	–3.57 Q	–21(19)
76	8.8(10)	–2.26	–3.49 Q	–20(9)
95	8.8(7)	–3.16 D	–3.41 D	–20(6)
114	8.9(15)	–1.41	–3.30 Q	–19(14)
104	8.9(18)	–1.19	–3.29 Q	–19(16)
129	9(4) Q	–0.49	–3.15 Q	–2(4) × 10^{1}
28	9.4(14)	–1.15	–2.52	–15(13)
91	9.7(7)	–2.03	–2.10	–12(6)
45	10(3)	–0.46	–1.93	–11(24)
52	10.3(9)	–0.76	–1.12	–7(9)
8	10.4(8)	–0.84	–1.03	–6(7)
23	10.5(25)	–0.21	–0.81	–5(23)
53	10.6(9)	–0.49	–0.70	–4(8)
126	10.6(14)	–0.31	–0.70	–4(13)
86	11.3(5)	0.55	0.44	3(5)
15	11.5(11)	0.39	0.69	4(10)
19	11.6(6)	0.92	0.91	5(6)
42	11.7(16)	0.39	1.00	6(15)
62	11.7(22)	0.31	1.06	6(20)
89	11.7(12)	0.60	1.08	6(11)
65	11.8(5)	1.46	1.22	7(5)
130	12.1(8)	1.33	1.69	10(8)
35	12.5(18)	0.82	2.31	13(16)
51	12.6(14)	1.13	2.47	14(13)
82	12.7(16)	1.05	2.62 Q	15(15)
29	12.7(20)	0.84	2.62 Q	15(18)
72	12.9(8)	2.28	2.92 Q	17(8)
107	13.0(18)	1.11	3.04 Q	18(16)
99	13.1(13)	1.55	3.18 Q	19(12)
131	13.3(9)	2.51	3.56 Q	21(8)
34	13.6(14)	1.84	4.02 Q	23(13)

continues

continued				
	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
94	13.8(15)	1.85	4.34 Q	25(14)
16	14.2(19)	1.67	4.96 Q	29(17)
27	15(5)	0.79	5.43 Q	$3(4) \times 10^1$
117	16.7(16)	3.57 D	8.89 D	52(15)
5	17.8(18)	3.82 D	10.63 D	62(16)

Table A29 – Co-60 GL **assigned result 11.252(25) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
31	1.5(0)	–396.51 D	–14.90 D	–86.76(3)
47	9.3(6)	–3.34 D	–2.96 D	–17(5)
129	10.3(5)	–1.90	–1.45	–8(5)
15	10.68(25)	–2.28	–0.87	–5.1(22)
23	10.9(7)	–0.50	–0.54	–3(6)
114	10.9(4)	–0.88	–0.54	–3(4)
53	10.9(5)	–0.64	–0.48	–3(5)
21	11.0(3)	–0.84	–0.38	–2(3)
131	11.02(15)	–1.52	–0.35	–2.1(14)
40	11(3)	–0.07	–0.28	–2(24)
94	11.1(8)	–0.19	–0.23	–1(7)
130	11.1(6)	–0.25	–0.23	–1(6)
62	11.1(9)	–0.16	–0.23	–1(8)
89	11.1(6)	–0.22	–0.22	–1(6)
25	11.2(7)	–0.07	–0.08	0(6)
19	11.2(4)	–0.09	–0.05	0(4)
118	11.3(4)	0.05	0.03	0(4)
107	11.3(4)	0.05	0.03	0(4)
24	11.3(6)	0.08	0.07	0(6)
111	11.3(4)	0.13	0.07	0(4)
76	11.3(6)	0.08	0.07	0(6)
52	11.3(5)	0.11	0.07	0(4)
99	11.4(11)	0.09	0.15	1(10)
82	11.4(11)	0.13	0.23	1(10)
27	11(3)	0.06	0.23	1(23)
104	11.4(3)	0.67	0.29	1.7(25)
86	11.5(4)	0.64	0.38	2(4)
5	11.5(12)	0.24	0.42	2(10)
91	11.6(7)	0.42	0.46	3(7)
8	11.60(19)	1.82	0.53	3.1(17)
126	11.7(9)	0.47	0.62	4(8)
65	11.7(4)	1.15	0.68	4(4)
95	11.8(4)	1.52	0.79	5(3)

continues

continued				
	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
51	11.8(7)	0.78	0.84	5(6)
42	11.9(12)	0.50	0.93	5(11)
34	11.9(12)	0.54	0.99	6(11)
35	12.0(5)	1.46	1.10	6(5)
17	12.0(8)	0.99	1.20	7(7)
45	12.1(7)	1.14	1.25	7(7)
117	12.1(10)	0.91	1.34	8(9)
16	12.5(3)	4.78 Q	1.91	11.1(23)
28	12.7(7)	2.23	2.21	13(6)
72	12.8(7)	2.14	2.29	13(6)
83	13.0(16)	1.09	2.67 Q	16(14)
29	13.0(14)	1.25	2.67 Q	16(12)

Table A30 – Zr-95 GL **assigned result 2.551(20) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
129	2.2(7) Q	–0.49	–2.36	–1(3) × 10^{1}
47	2.28(22)	–1.23	–1.82	–11(9)
52	2.30(18)	–1.38	–1.69	–10(7)
21	2.30(11)	–2.24	–1.69	–10(5)
53	2.46(17)	–0.53	–0.61	–4(7)
42	2.6(3)	0.03	0.06	0(12)
86	2.57(23)	0.08	0.13	1(9)
65	2.57(17)	0.11	0.13	1(7)
28	2.6(3)	0.13	0.26	2(11)
62	2.7(4)	0.30	0.74	4(14)
95	2.67(17)	0.70	0.80	5(7)
114	2.7(3)	0.50	1.00	6(12)
34	2.7(4)	0.37	1.00	6(16)
19	2.72(13)	1.29	1.14	7(5)
126	2.8(3)	0.64	1.34	8(12)
35	2.8(5)	0.45	1.41	8(18)
111	2.8(3)	0.84	1.48	9(10)
51	2.80(22)	1.13	1.68	10(9)
89	2.91(22)	1.63	2.42	14(9)
8	2.98(23)	1.86	2.89 Q	17(9)
82	3.0(4)	1.43	3.09 Q	18(13)
76	3.1(4)	1.26	3.56 Q	21(16)
40	3.1(8)	0.73	3.63 Q	2(3) × 10^{1}
24	3.10(20)	2.73 D	3.70 D	22(8)
29	3.1(4)	1.51	3.97 Q	23(15)
107	3.32(17)	4.49 D	5.18 D	30(7)
25	3.4(4)	1.95	5.38 Q	31(16)
94	3.4(4)	2.12	5.72 Q	33(16)
23	3.4(9)	0.94	5.72 Q	3(4) × 10^{1}
45	3.5(9)	1.11	6.66 Q	4(4) × 10^{1}
99	3.6(4)	2.97 D	7.20 D	42(14)
72	3.66(25)	4.42 D	7.47 D	43(10)
131	3.70(14)	8.12 D	7.74 D	45(6)

continues

continued				
	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
5	3.7(4)	3.18 D	7.94 D	46(15)
91	3.8(3)	4.72 D	8.61 D	50(11)
27	3.9(10)	1.35	9.08 Q	5(4) × 10^{1}
16	4.19(4)	3.99 D	11.04 D	64(16)
117	5.2(5)	5.51 D	17.84 D	104(19)

Table A31 – Nb-95 GL **assigned result 5.55(5) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
94	3.6(4)	–4.84 D	–6.03 D	–35(7)
5	4.3(5)	–2.82 D	–3.77 D	–22(8)
47	4.5(3)	–3.59 D	–3.37 D	–20(6)
15	4.66(14)	–6.03 D	–2.75 D	–16(3)
16	4.98(18)	–3.06 Q	–1.76	–10(4)
62	5.2(4)	–0.85	–0.96	–6(7)
89	5.3(4)	–0.84	–0.86	–5(6)
25	5.3(4)	–0.68	–0.80	–5(7)
24	5.3(3)	–0.82	–0.77	–4(6)
91	5.4(5)	–0.39	–0.59	–3(9)
23	5.4(11)	–0.14	–0.46	–3(20)
114	5.5(3)	–0.16	–0.15	–1(6)
52	5.5(4)	–0.15	–0.15	–1(6)
21	5.63(14)	0.55	0.25	1(3)
19	5.65(18)	0.54	0.31	2(4)
53	5.7(3)	0.48	0.44	3(6)
107	5.82(25)	1.07	0.84	5(5)
86	5.83(25)	1.10	0.87	5(5)
45	5.9(5)	0.63	0.96	6(9)
51	5.9(6)	0.58	1.09	6(11)
28	5.9(4)	0.87	1.12	7(8)
8	6.1(4)	1.64	1.64	10(6)
42	6.1(7)	0.83	1.67	10(12)
34	6.1(12)	0.46	1.70	10(22)
35	6.1(10)	0.55	1.70	10(18)
27	6.1(20) Q	0.28	1.70	1(4) × 10^{1}
95	6.2(3)	2.39	1.95	11(5)
82	6.3(7)	1.03	2.26	13(13)
99	6.4(7)	1.37	2.73 Q	16(12)
129	6.5(7)	1.34	2.82 Q	16(12)
65	6.5(4)	2.37	2.88 Q	17(7)
29	6.6(11)	0.96	3.16 Q	18(19)
126	6.8(6)	1.98	3.75 Q	22(11)

continues

continued				
	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
72	7.0(4)	3.70 D	4.61 D	27(7)
130	7.5(4)	4.50 D	5.88 D	34(8)
76	8.2(4)	7.40 D	8.08 D	47(7)
131	8.7(7)	4.49 D	9.75 D	57(13)
111	9.4(4)	9.28 D	11.86 D	69(8)
40	9.5(23)	1.73	12.07 Q	$7(4) \times 10^{1}$
117	10.5(9)	5.44 D	15.17 D	88(16)

Table A32 – Cs-134 GL **assigned result 13.59(10) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
47	10.6(7)	–4.49 D	–3.73 D	–22(5)
126	11.6(9)	–2.35	–2.57	–15(7)
107	11.7(6)	–2.95 Q	–2.34	–14(5)
19	12.1(4)	–3.85 Q	–1.91	–11(3)
17	12.1(6)	–2.77 Q	–1.89	–11(4)
131	12.17(21)	–6.10 Q	–1.80	–10.5(17)
130	12.2(7)	–1.97	–1.76	–10(5)
129	12.3(5)	–2.54	–1.64	–10(4)
99	12.4(12)	–0.98	–1.53	–9(9)
111	12.4(4)	–3.04 Q	–1.51	–9(3)
91	12.5(13)	–0.83	–1.35	–8(9)
5	12.7(13)	–0.73	–1.17	–7(9)
83	12.8(12)	–0.66	–1.00	–6(9)
95	12.87(17)	–3.65 Q	–0.92	–5.3(14)
118	12.9(6)	–1.23	–0.85	–5(4)
35	13.0(5)	–1.21	–0.75	–4(4)
89	13.0(8)	–0.76	–0.71	–4(6)
52	13.1(5)	–0.93	–0.62	–4(4)
27	13.1(17)	–0.29	–0.62	–4(13)
114	13.1(5)	–0.97	–0.62	–4(4)
62	13.1(4)	–1.47	–0.62	–3.6(25)
117	13.1(9)	–0.49	–0.59	–3(7)
42	13.2(14)	–0.31	–0.54	–3(10)
82	13.2(13)	–0.30	–0.50	–3(10)
21	13.2(3)	–1.25	–0.50	–2.9(23)
53	13.3(6)	–0.55	–0.41	–2(5)
16	13.4(10)	–0.19	–0.25	–1(8)
40	13(4)	–0.04	–0.14	–1(24)
51	13.5(7)	–0.13	–0.12	–1(5)
104	13.6(6)	–0.01	–0.01	0(5)
34	13.6(14)	0.00	0.01	0(10)
65	13.6(5)	0.01	0.01	0(4)
8	13.7(7)	0.19	0.16	1(5)

continues

continued				
	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
24	13.8(9)	0.23	0.26	2(7)
86	13.8(6)	0.35	0.26	2(5)
76	13.8(5)	0.44	0.26	2(4)
23	13.8(17)	0.12	0.26	2(13)
94	13.9(13)	0.23	0.39	2(10)
25	14.1(12)	0.44	0.64	4(9)
15	14.2(3)	1.93	0.75	4.4(23)
28	14.2(7)	0.86	0.76	4(5)
45	15.3(14)	1.19	2.17	13(11)
29	15.7(12)	1.75	2.66 Q	15(9)
72	15.7(9)	2.44	2.67 Q	16(7)

Table A33 – Cs-137 GL **assigned result 10.58(21) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
31	5.14(0)	–26.41 D	–8.83 D	–51.4(10)
47	8.7(6)	–3.24 D	–3.08 D	–18(6)
129	9.4(5)	–2.16	–1.96	–11(5)
17	9.5(5)	–2.11	–1.79	–10(5)
62	10.0(4)	–1.34	–0.96	–6(4)
52	10.2(6)	–0.58	–0.62	–4(6)
118	10.4(4)	–0.51	–0.37	–2(5)
25	10.4(7)	–0.27	–0.29	–2(7)
21	10.40(20)	–0.63	–0.29	–2(3)
95	10.48(20)	–0.35	–0.16	–1(3)
131	10.49(21)	–0.31	–0.15	–1(3)
76	10.5(4)	–0.19	–0.13	–1(4)
114	10.5(6)	–0.13	–0.13	–1(6)
107	10.6(4)	–0.07	–0.05	0(5)
89	10.6(6)	0.06	0.06	0(6)
130	10.7(6)	0.19	0.19	1(6)
23	10.7(10)	0.12	0.19	1(10)
126	10.7(10)	0.13	0.21	1(9)
53	10.8(5)	0.47	0.37	2(5)
19	10.8(4)	0.65	0.42	2(4)
86	10.9(3)	0.94	0.52	3(4)
94	10.9(7)	0.44	0.52	3(7)
104	11.0(4)	1.03	0.65	4(4)
111	11.0(4)	1.01	0.68	4(4)
8	11.0(7)	0.65	0.73	4(7)
40	11(3)	0.17	0.75	4(25)
34	11.1(11)	0.46	0.84	5(11)
28	11.2(7)	0.91	1.01	6(7)
65	11.2(4)	1.46	1.01	6(4)
51	11.2(6)	0.98	1.01	6(6)
91	11.3(7)	0.99	1.20	7(7)
24	11.4(8)	0.99	1.33	8(8)
42	11.5(12)	0.73	1.43	8(11)

continues

continued				
	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
99	11.5(12)	0.79	1.49	9(11)
83	11.6(11)	0.91	1.65	10(11)
15	11.66(25)	3.33 Q	1.75	10(4)
82	11.7(12)	0.92	1.82	11(12)
16	11.90(25)	4.07 Q	2.14	12(4)
45	11.9(9)	1.39	2.14	12(9)
35	12.0(5)	2.67 Q	2.22	13(5)
5	12.2(12)	1.33	2.68 Q	16(12)
117	12.2(10)	1.67	2.69 Q	16(12)
72	12.7(7)	2.89 D	3.47 D	20(7)
27	13(3)	0.76	3.60 Q	2(3) × 10^{1}
29	12.9(10)	2.27	3.76 Q	22(10)

Table A34 – Eu-152 GL **assigned result 16.80(11) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
47	13.3(8)	–4.28 D	–3.58 D	–21(5)
126	14.0(10)	–2.71 D	–2.82 D	–16(6)
99	14.1(14)	–1.91	–2.77 Q	–16(9)
114	15.1(9)	–1.87	–1.74	–10(6)
62	15.2(4)	–3.93 Q	–1.63	–9.5(24)
19	15.4(5)	–2.78 Q	–1.46	–8(3)
111	15.5(6)	–2.19	–1.33	–8(4)
129	15.6(19)	–0.63	–1.22	–7(11)
131	15.89(17)	–4.43 Q	–0.93	–5.4(12)
40	16(4)	–0.19	–0.74	–4(23)
107	16.1(7)	–1.00	–0.71	–4(4)
5	16.1(16)	–0.41	–0.68	–4(10)
53	16.1(9)	–0.75	–0.67	–4(5)
130	16.2(8)	–0.74	–0.61	–4(5)
17	16.3(11)	–0.42	–0.48	–3(7)
34	16.4(25)	–0.16	–0.41	–2(15)
65	16.4(6)	–0.68	–0.41	–2(4)
89	16.4(9)	–0.43	–0.41	–2(6)
95	16.4(5)	–0.73	–0.38	–2(3)
52	16.5(7)	–0.44	–0.30	–2(4)
76	16.5(7)	–0.40	–0.30	–2(5)
42	16.6(17)	–0.13	–0.22	–1(10)
91	16.7(15)	–0.04	–0.06	0(9)
21	16.8(4)	–0.10	–0.04	–0.2(21)
51	16.8(9)	0.00	0.00	0(6)
27	16.9(25)	0.04	0.11	1(15)
28	16.9(9)	0.12	0.11	1(5)
86	16.9(7)	0.15	0.11	1(4)
24	17.0(9)	0.22	0.21	1(6)
94	17.0(14)	0.14	0.21	1(8)
8	17.1(6)	0.40	0.26	2(4)
23	17.1(22)	0.14	0.31	2(13)
35	17.2(8)	0.51	0.42	2(5)

continues

continued				
	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
45	17(4)	0.15	0.47	3(19)
104	17.3(9)	0.58	0.52	3(5)
25	17.4(15)	0.41	0.62	4(9)
117	17.4(14)	0.46	0.65	4(8)
16	17.8(12)	0.82	1.03	6(7)
15	18.1(4)	3.01 Q	1.31	7.6(25)
82	18.4(19)	0.84	1.64	10(11)
72	19.9(11)	2.69 D	3.12 D	18(7)
29	20.0(15)	2.13	3.27 Q	19(9)

Table A35 – Eu-154 GL **assigned result 3.437(25) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
5	2.42(24)	–4.22 D	–5.08 D	–30(7)
47	2.59(18)	–4.66 D	–4.23 D	–25(6)
114	2.6(4)	–2.09	–4.18 Q	–24(12)
23	2.8(9)	–0.71	–3.18 Q	–2(3) × 10^{1}
27	2.9(5)	–1.07	–2.69 Q	–16(15)
94	2.9(5)	–1.07	–2.69 Q	–16(15)
130	3.11(17)	–1.91	–1.64	–10(5)
89	3.13(20)	–1.53	–1.54	–9(6)
111	3.14(21)	–1.41	–1.49	–9(6)
126	3.2(3)	–1.10	–1.44	–8(8)
51	3.20(25)	–0.94	–1.19	–7(7)
52	3.20(22)	–1.07	–1.19	–7(7)
65	3.2(4)	–0.61	–1.04	–6(10)
40	3.3(8)	–0.23	–0.89	–5(23)
95	3.30(16)	–0.85	–0.69	–4(5)
107	3.32(17)	–0.68	–0.59	–3(5)
104	3.4(3)	–0.29	–0.39	–2(8)
35	3.4(6)	–0.10	–0.29	–2(17)
42	3.4(4)	–0.13	–0.24	–1(11)
15	3.44(22)	0.01	0.01	0(7)
28	3.5(3)	0.09	0.11	1(8)
25	3.5(5)	0.10	0.21	1(13)
24	3.50(20)	0.31	0.31	2(6)
21	3.51(17)	0.42	0.36	2(5)
86	3.54(16)	0.63	0.51	3(5)
8	3.63(24)	0.80	0.96	6(7)
72	3.63(25)	0.77	0.96	6(7)
16	3.7(4)	0.56	1.06	6(11)
17	3.7(6)	0.40	1.06	6(15)
53	3.7(3)	0.85	1.11	6(8)
34	3.7(6)	0.44	1.31	8(17)
19	3.71(19)	1.42	1.36	8(6)
99	3.8(4)	0.90	1.71	10(11)

continues

continued				
	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
129	3.8(8)	0.42	1.71	10(24)
29	4.4(4)	2.30	4.61 Q	27(12)
82	4.7(6)	2.38	6.31 Q	37(15)
76	5.5(5)	3.87 D	10.05 D	59(15)

Table A36 – Be-7 GH **assigned result 4.24(8) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
27	3.1(9)	–1.29	–4.81 Q	–28(22)
116	3.8(5)	–0.94	–1.69	–10(11)
17	4.01(15)	–1.36	–0.92	–5(4)
7	4.06(22)	–0.77	–0.72	–4(6)
25	4.08(23)	–0.65	–0.64	–4(6)
73	4.10(20)	–0.65	–0.56	–3(5)
130	4.11(21)	–0.57	–0.52	–3(5)
126	4.1(4)	–0.27	–0.44	–3(9)
5	4.1(4)	–0.23	–0.40	–2(10)
47	4.17(25)	–0.26	–0.27	–2(6)
129	4.18(18)	–0.30	–0.23	–1(5)
35	4.19(13)	–0.32	–0.19	–1(4)
82	4.2(5)	–0.11	–0.19	–1(10)
89	4.2(3)	–0.10	–0.11	–1(7)
15	4.22(11)	–0.13	–0.07	0(3)
108	4.22(3)	–0.06	–0.07	0(7)
38	4.2(5)	–0.02	–0.03	0(11)
99	4.2(4)	0.01	0.01	0(10)
9	4.25(18)	0.06	0.05	0(5)
48	4.28(17)	0.23	0.17	1(5)
59	4.3(4)	0.13	0.21	1(9)
86	4.30(23)	0.26	0.25	1(6)
8	4.36(21)	0.55	0.50	3(6)
106	4.4(4)	0.40	0.66	4(10)
28	4.41(24)	0.69	0.70	4(6)
41	4.41(12)	1.22	0.70	4(4)
55	4.48(14)	1.53	0.98	6(4)
32	4.53(18)	1.50	1.18	7(5)
127	4.65(15)	2.47	1.67	10(4)
16	5.5(10)	10.07 D	5.07 D	30(4)
117	5.6(6)	2.58 D	5.60 D	33(13)
131	5.90(16)	9.43 D	6.74 D	39(5)

Table A37 – Co-60 GH **assigned result 3.427(8) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
15	3.04(5)	–7.64 Q	–1.94	–11.3(15)
17	3.06(8)	–4.56 Q	–1.84	–10.7(23)
129	3.07(4)	–8.75 Q	–1.79	–10.4(12)
116	3.13(23)	–1.29	–1.49	–9(7)
7	3.18(18)	–1.37	–1.24	–7(6)
82	3.3(4)	–0.54	–0.89	–5(10)
130	3.26(17)	–0.98	–0.84	–5(5)
47	3.27(20)	–0.78	–0.79	–5(6)
5	3.3(4)	–0.42	–0.69	–4(10)
106	3.30(20)	–0.63	–0.64	–4(6)
35	3.31(10)	–1.17	–0.59	–3(3)
25	3.31(18)	–0.65	–0.59	–3(6)
9	3.35(14)	–0.55	–0.39	–2(4)
21	3.35(7)	–1.09	–0.39	–2.2(21)
86	3.38(22)	–0.21	–0.24	–1(7)
89	3.43(19)	0.02	0.01	0(6)
108	3.45(25)	0.09	0.12	1(7)
73	3.45(17)	0.13	0.12	1(5)
99	3.5(4)	0.07	0.12	1(10)
8	3.46(6)	0.54	0.17	1.0(18)
131	3.47(4)	1.05	0.22	1.3(12)
32	3.49(12)	0.52	0.32	2(4)
41	3.50(4)	1.79	0.37	2.1(12)
127	3.50(11)	0.66	0.37	2(4)
126	3.51(25)	0.33	0.42	2(7)
48	3.52(9)	1.03	0.47	3(3)
38	3.53(17)	0.60	0.52	3(5)
117	3.53(25)	0.41	0.52	3(7)
55	3.55(4)	3.01 Q	0.62	3.6(12)
27	3.6(8) Q	0.21	0.87	5(24)
59	3.6(3)	0.63	0.92	5(9)
16	3.64(4)	5.22 Q	1.07	6.2(12)
31	3.73(0)	37.20 Q	1.52	8.8(3)

continues

continued				
83	3.8(4)	0.93	1.87	11(12)
28	3.90(19)	2.49	2.37	14(6)

Table A38 – Zr-95 GH **assigned result 1.875(15) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
27	1.6(4)	–0.69	–2.52	–15(21)
73	1.70(20)	–0.87	–1.61	–9(11)
47	1.79(11)	–0.77	–0.78	–5(6)
108	1.83(13)	–0.35	–0.41	–2(7)
21	1.84(4)	–0.83	–0.32	–1.9(23)
48	1.86(9)	–0.17	–0.14	–1(5)
82	1.86(19)	–0.08	–0.14	–1(10)
38	1.87(12)	–0.04	–0.05	0(7)
7	1.88(21)	0.02	0.04	0(11)
99	1.89(19)	0.08	0.13	1(10)
8	1.9(9) Q	0.02	0.13	0(5) × 10^{1}
130	1.91(9)	0.38	0.32	2(5)
89	1.91(11)	0.31	0.32	2(6)
126	1.92(16)	0.28	0.41	2(9)
59	1.93(16)	0.34	0.50	3(9)
55	1.94(4)	1.52	0.59	3.4(23)
32	1.96(9)	0.93	0.78	5(5)
127	1.99(6)	1.85	1.05	6(4)
129	2.00(6)	2.02	1.14	7(4)
106	2.00(20)	0.62	1.14	7(11)
28	2.00(10)	1.23	1.14	7(6)
17	2.02(6)	2.34	1.32	8(4)
86	2.04(11)	1.48	1.51	9(6)
5	2.07(21)	0.92	1.78	10(11)
35	2.08(7)	2.86 Q	1.87	11(4)
9	2.09(9)	2.35	1.97	11(5)
25	2.16(14)	2.02	2.61 Q	15(8)
16	2.38(2)	20.22 D	4.62 D	26.9(15)
131	2.48(6)	9.78 D	5.54 D	32(4)
41	2.70(7)	11.52 D	7.55 D	44(4)
117	3.6(3)	6.47 D	15.43 D	90(14)

Table A39 – Nb-95 GH **assigned result 4.08(4) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
27	3.1(10)	–0.95	–4.00 Q	–23(25)
15	3.17(6)	–13.19 D	–3.83 D	–22.3(16)
17	3.61(11)	–4.08 Q	–1.98	–12(3)
5	3.9(4)	–0.36	–0.59	–3(10)
25	3.94(22)	–0.63	–0.59	–3(6)
9	3.97(16)	–0.67	–0.46	–3(4)
7	3.98(18)	–0.54	–0.42	–2(5)
106	4.0(5)	–0.16	–0.34	–2(12)
35	4.02(19)	–0.31	–0.25	–1(5)
47	4.03(24)	–0.21	–0.21	–1(6)
21	4.07(8)	–0.11	–0.04	–0.2(21)
48	4.07(10)	–0.09	–0.04	0(3)
82	4.1(5)	0.13	0.25	1(12)
86	4.17(22)	0.41	0.38	2(6)
8	4.18(18)	0.55	0.42	2(5)
59	4.3(4)	0.51	0.76	4(9)
28	4.30(22)	0.99	0.93	5(6)
38	4.32(21)	1.13	1.01	6(5)
89	4.32(25)	0.95	1.01	6(6)
127	4.35(14)	1.88	1.14	7(4)
55	4.36(8)	3.22 Q	1.18	6.9(22)
126	4.4(4)	0.78	1.22	7(9)
41	4.37(13)	2.16	1.22	7(4)
32	4.40(14)	2.22	1.35	8(4)
16	4.44(4)	6.86 Q	1.52	8.8(13)
108	4.4(4)	1.12	1.52	9(8)
99	4.9(5)	1.71	3.54 Q	21(12)
129	5.29(8)	13.92 D	5.09 D	29.7(22)
130	5.3(3)	4.11 D	5.22 D	30(8)
131	6.4(5)	4.63 D	9.77 D	57(12)
116	6.4(5)	4.88 D	9.89 D	58(12)
117	8.6(8)	6.05 D	18.86 D	110(18)

Table A40 – Cs-134 GH **assigned result 5.81(5) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
17	4.46(14)	–9.15 D	–3.99 D	–23.2(25)
126	4.7(4)	–3.30 D	–3.25 D	–19(6)
99	4.8(5)	–2.05	–2.92 Q	–17(8)
7	4.8(4)	–2.91 D	–2.87 D	–17(6)
116	5.0(4)	–2.17	–2.39	–14(7)
27	5.0(7)	–1.16	–2.27	–13(11)
130	5.1(3)	–2.59 Q	–2.10	–12(5)
41	5.13(17)	–3.86 Q	–2.01	–12(3)
5	5.1(5)	–1.33	–2.01	–12(9)
35	5.14(15)	–4.27 Q	–1.98	–12(3)
108	5.2(4)	–1.69	–1.86	–11(7)
129	5.20(8)	–6.60 Q	–1.80	–10.5(15)
47	5.2(3)	–1.91	–1.77	–10(6)
9	5.32(8)	–2.28	–1.45	–8(4)
83	5.4(4)	–1.02	–1.21	–7(7)
106	5.5(4)	–0.77	–0.91	–5(7)
82	5.5(6)	–0.48	–0.80	–5(10)
86	5.6(4)	–0.62	–0.65	–4(6)
48	5.60(14)	–1.42	–0.62	–3.6(25)
131	5.60(3)	–3.81 Q	–0.62	–3.6(9)
21	5.60(11)	–1.76	–0.62	–3.6(20)
89	5.6(3)	–0.64	–0.59	–3(6)
16	5.66(20)	–0.73	–0.44	–3(4)
25	5.8(5)	–0.11	–0.15	–1(8)
8	5.79(21)	–0.09	–0.06	0(4)
15	5.82(10)	0.10	0.03	0.2(19)
55	5.82(9)	0.10	0.03	0.2(17)
32	5.88(23)	0.30	0.21	1(4)
73	5.9(3)	0.30	0.27	2(5)
127	5.91(18)	0.54	0.30	2(4)
59	6.0(5)	0.33	0.47	3(8)
38	6.0(3)	0.75	0.65	4(5)
28	6.1(3)	1.13	0.95	6(5)
117	6.1(5)	0.69	0.98	6(8)

Table A41 – Cs-137 GH **assigned result 10.43(7) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
116	9.5(7)	–1.37	–1.56	–9(7)
17	9.8(3)	–2.14	–0.98	–6(3)
126	10.0(9)	–0.47	–0.70	–4(9)
130	10.1(5)	–0.65	–0.54	–3(5)
7	10.1(7)	–0.45	–0.54	–3(7)
47	10.3(6)	–0.24	–0.24	–1(6)
48	10.30(24)	–0.51	–0.21	–1.2(24)
5	10.3(10)	–0.12	–0.21	–1(10)
35	10.3(3)	–0.28	–0.15	–1(3)
25	10.4(6)	–0.05	–0.05	0(6)
21	10.40(20)	–0.13	–0.05	–0.3(20)
129	10.40(20)	–0.13	–0.05	–0.3(20)
89	10.5(6)	0.07	0.07	0(6)
86	10.5(6)	0.11	0.10	1(6)
73	10.5(5)	0.14	0.12	1(5)
106	10.5(8)	0.09	0.12	1(8)
55	10.50(12)	0.51	0.12	0.7(13)
32	10.53(23)	0.42	0.17	1.0(23)
82	10.6(11)	0.16	0.28	2(11)
108	10.7(8)	0.34	0.43	3(7)
38	10.7(5)	0.54	0.45	3(5)
8	10.7(7)	0.42	0.45	3(6)
15	10.78(19)	1.73	0.58	3.4(20)
9	10.8(5)	0.74	0.61	4(5)
41	10.83(23)	1.67	0.66	3.9(23)
99	11.0(11)	0.51	0.93	5(11)
83	11.0(10)	0.57	0.94	5(10)
28	11.0(6)	1.03	0.94	5(6)
131	11.03(19)	2.96 Q	0.99	5.8(20)
127	11.1(4)	1.93	1.07	6(4)
31	11.13(0)	9.71 Q	1.16	6.7(8)
59	11.1(9)	0.78	1.16	7(9)
16	11.50(11)	8.14 Q	1.77	10.3(13)
27	12(3)	0.45	1.96	$1(3) \times 10^1$
117	11.9(9)	1.59	2.47	14(9)

Table A42 – Eu-152 GH **assigned result 11.78(13) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
126	9.7(7)	–3.14 D	–3.08 D	–18(6)
17	9.7(3)	–6.31 D	–3.01 D	–18(3)
7	10.2(6)	–2.85 Q	–2.31	–13(5)
130	10.4(5)	–2.68 Q	–2.02	–12(5)
116	10.5(8)	–1.63	–1.86	–11(7)
99	10.5(11)	–1.18	–1.81	–11(9)
35	10.7(4)	–3.25 Q	–1.64	–10(3)
129	10.7(4)	–2.58 Q	–1.58	–9(4)
47	10.9(7)	–1.27	–1.23	–7(6)
9	11.0(5)	–1.52	–1.14	–7(5)
108	11.2(8)	–0.76	–0.88	–5(7)
106	11.2(6)	–0.95	–0.85	–5(5)
41	11.32(12)	–2.61 Q	–0.68	–3.9(15)
27	11.4(17)	–0.24	–0.59	–3(15)
21	11.54(23)	–0.92	–0.36	–2.1(22)
131	11.58(8)	–1.33	–0.30	–1.7(13)
8	11.6(4)	–0.47	–0.25	–1(4)
89	11.7(9)	–0.12	–0.15	–1(8)
48	11.7(8)	–0.10	–0.12	–1(7)
55	11.70(15)	–0.43	–0.12	–0.7(17)
5	11.7(12)	–0.06	–0.09	–1(10)
86	11.8(7)	0.01	0.01	0(6)
25	11.8(9)	0.02	0.02	0(8)
82	11.8(12)	0.01	0.02	0(10)
32	11.8(5)	0.05	0.04	0(5)
38	11.9(6)	0.19	0.17	1(5)
15	11.94(21)	0.63	0.23	1.3(21)
16	12.00(15)	1.08	0.31	1.8(17)
73	12.0(6)	0.35	0.31	2(5)
28	12.1(6)	0.51	0.46	3(5)
117	12.3(10)	0.53	0.75	4(8)
127	12.4(4)	1.51	0.93	5(4)
59	12.4(10)	0.64	0.94	5(9)

Table A43 – Eu-154 GH **assigned result 1.94(4) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
27	1.30(23)	–2.73 D	–5.64 D	–33(12)
17	1.47(5)	–7.71 D	–4.13 D	–24(3)
130	1.65(9)	–2.97 Q	–2.53	–15(5)
129	1.69(4)	–4.69 Q	–2.17	–13(3)
116	1.73(13)	–1.53	–1.82	–11(7)
126	1.76(12)	–1.40	–1.55	–9(7)
7	1.78(16)	–0.95	–1.38	–8(9)
106	1.80(10)	–1.28	–1.20	–7(6)
35	1.82(6)	–1.67	–1.02	–6(4)
89	1.84(11)	–0.83	–0.84	–5(6)
86	1.84(11)	–0.83	–0.84	–5(6)
16	1.84(8)	–1.09	–0.84	–5(5)
21	1.84(4)	–1.82	–0.84	–5(3)
48	1.85(15)	–0.55	–0.75	–4(8)
15	1.85(3)	–1.89	–0.75	–4.4(23)
47	1.86(11)	–0.65	–0.67	–4(6)
8	1.86(4)	–1.43	–0.67	–4(3)
5	1.86(19)	–0.39	–0.67	–4(10)
9	1.87(8)	–0.75	–0.58	–3(5)
25	1.88(11)	–0.48	–0.49	–3(6)
73	1.90(10)	–0.33	–0.31	–2(6)
127	1.92(7)	–0.19	–0.13	–1(4)
108	1.94(14)	0.03	0.04	0(8)
99	2.00(20)	0.32	0.58	3(10)
59	2.01(16)	0.46	0.67	4(9)
55	2.02(3)	1.88	0.75	4.4(24)
38	2.10(7)	2.12	1.46	9(4)
28	2.10(10)	1.56	1.46	9(6)
32	2.26(17)	1.88	2.88 Q	17(9)
82	2.28(23)	1.48	3.06 Q	18(12)
41	2.81(21)	4.11 D	7.77 D	45(11)

Table A44 – Co-60 S **assigned result 7.82(20) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
129	6.64(9)	–5.42 D	–2.59 D	–15.1(24)
7	6.9(8)	–1.18	–2.06	–12(10)
13	7.2(4)	–1.43	–1.32	–8(6)
40	7.3(6)	–0.90	–1.15	–7(8)
21	7.42(15)	–1.61	–0.88	–5(3)
106	7.5(5)	–0.59	–0.70	–4(7)
24	7.5(4)	–0.72	–0.70	–4(6)
130	7.5(8)	–0.36	–0.61	–4(10)
26	7.56(21)	–0.90	–0.57	–3(4)
8	7.59(12)	–0.98	–0.50	–3(3)
35	7.59(23)	–0.76	–0.50	–3(4)
108	7.6(6)	–0.33	–0.42	–2(8)
55	7.7(4)	–0.27	–0.26	–2(6)
17	7.72(22)	–0.34	–0.22	–1(4)
32	7.81(19)	–0.04	–0.02	0(4)
94	8.0(5)	0.27	0.31	2(7)
126	8.0(6)	0.37	0.46	3(7)
5	8.1(8)	0.30	0.55	3(11)
29	8.2(7)	0.58	0.92	5(9)
114	8.3(4)	1.17	0.97	6(5)
83	8.3(9)	0.52	1.05	6(12)
48	8.3(3)	1.34	1.05	6(5)
104	8.80(24)	3.15 Q	2.15	13(4)
98	8.94(24)	3.60 Q	2.46	14(5)
95	9.8(3)	5.91 D	4.28 D	25(5)

Table A45 – Cs-137 S **assigned result 10.5(3) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
40	8.8(7)	–2.32	–2.74 Q	–16(7)
13	9.5(6)	–1.68	–1.66	–10(6)
7	9.7(16)	–0.52	–1.38	–8(15)
129	9.72(15)	–2.40	–1.30	–8(3)
21	10.00(20)	–1.45	–0.84	–5(4)
32	10.10(24)	–1.09	–0.68	–4(4)
118	10.12(7)	–1.31	–0.65	–4(3)
55	10.2(5)	–0.53	–0.52	–3(6)
26	10.2(3)	–0.78	–0.52	–3(4)
8	10.4(5)	–0.20	–0.19	–1(6)
35	10.4(3)	–0.25	–0.17	–1(4)
130	10.5(11)	–0.01	–0.03	0(11)
24	10.6(7)	0.11	0.14	1(7)
94	10.6(3)	0.20	0.14	1(4)
106	10.6(9)	0.09	0.14	1(9)
126	10.8(7)	0.37	0.46	3(8)
48	10.8(4)	0.70	0.50	3(4)
17	10.9(4)	0.76	0.56	3(5)
108	10.9(8)	0.46	0.63	4(8)
29	11.0(9)	0.51	0.79	5(9)
114	11.0(3)	1.17	0.82	5(4)
83	11.2(7)	0.90	1.12	6(8)
104	11.72(20)	3.37 Q	1.96	11(4)
5	11.9(12)	1.14	2.29	13(12)
95	12.61(16)	6.20 D	3.42 D	20(4)
98	12.7(4)	4.21 D	3.53 D	21(5)

Table A46 – Eu-152 S **assigned result 16.0(5) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
126	11.0(7)	–5.92 D	–5.41 D	–31(5)
130	11.7(12)	–3.35 D	–4.61 D	–27(8)
7	12.7(16)	–1.98	–3.53 Q	–21(10)
55	13.5(7)	–3.03 D	–2.67 D	–16(5)
129	13.7(3)	–4.25 Q	–2.46	–14(3)
40	13.8(10)	–1.90	–2.31	–13(7)
108	13.9(10)	–1.94	–2.26	–13(7)
17	14.0(5)	–3.20 Q	–2.14	–12(4)
35	14.3(5)	–2.69 Q	–1.79	–10(4)
13	14.5(9)	–1.45	–1.61	–9(7)
106	15.0(10)	–0.90	–1.06	–6(7)
118	15.10(15)	–1.88	–0.96	–6(3)
21	15.1(3)	–1.65	–0.96	–6(4)
24	15.6(8)	–0.43	–0.42	–2(6)
8	15.6(5)	–0.61	–0.42	–2(4)
26	15.7(4)	–0.50	–0.31	–2(4)
5	16.0(16)	0.03	0.05	0(10)
29	16.1(12)	0.09	0.12	1(8)
114	16.1(5)	0.22	0.15	1(4)
32	16.3(8)	0.33	0.31	2(6)
94	16.4(14)	0.28	0.44	3(9)
48	17.1(12)	0.90	1.21	7(8)
104	17.5(5)	2.16	1.59	9(5)
95	17.6(5)	2.40	1.68	10(5)
98	18.9(17)	1.68	3.10 Q	18(11)

Table A47 – Eu-154 S **assigned result 1.96(6) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
17	0.84(4)	–15.56 D	–9.80 D	–57.1(24)
126	1.52(10)	–3.74 D	–3.87 D	–23(6)
129	1.62(4)	–4.69 D	–2.96 D	–17(4)
130	1.73(18)	–1.20	–1.99	–12(10)
21	1.75(4)	–2.88 Q	–1.81	–11(4)
40	1.76(13)	–1.40	–1.77	–10(7)
13	1.76(10)	–1.69	–1.73	–10(6)
35	1.78(6)	–2.12	–1.53	–9(4)
106	1.80(10)	–1.35	–1.38	–8(6)
8	1.84(4)	–1.71	–1.03	–6(4)
24	1.86(11)	–0.77	–0.85	–5(7)
108	1.87(14)	–0.58	–0.75	–4(8)
26	1.88(5)	–1.01	–0.67	–4(4)
7	1.9(4)	–0.19	–0.59	–3(18)
29	1.93(15)	–0.17	–0.24	–1(8)
48	1.97(20)	0.06	0.12	1(11)
114	1.98(9)	0.21	0.20	1(6)
32	2.04(14)	0.55	0.73	4(8)
94	2.05(18)	0.49	0.82	5(10)
5	2.09(21)	0.61	1.17	7(11)
98	2.20(19)	1.22	2.13	12(10)
104	2.29(8)	3.29 D	2.91 D	17(6)
95	2.36(7)	4.65 D	3.56 D	21(5)
55	18.60(10)	147.39 D	146.06 D	85(3) × 10^{1}

Table A48 – Am-241 S **assigned result 2.57(12) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
5	1.41(14)	–6.19 D	–7.74 D	–45(6)
8	2.04(15)	–2.72 D	–3.53 D	–21(7)
40	2.16(16)	–2.00	–2.72 Q	–16(8)
7	2.2(6) Q	–0.58	–2.32	–14(23)
13	2.34(13)	–1.26	–1.52	–9(7)
55	2.34(12)	–1.31	–1.52	–9(7)
94	2.40(20)	–0.71	–1.12	–7(9)
17	2.45(10)	–0.74	–0.78	–5(6)
130	2.45(25)	–0.42	–0.78	–5(11)
35 RC	2.45(9)	–0.76	–0.76	–4(6)
35 GS	2.50(8)	–0.49	–0.48	–3(6)
21	2.52(5)	–0.35	–0.32	–2(5)
48	2.58(17)	0.06	0.09	1(8)
26	2.59(8)	0.16	0.16	1(6)
24	2.6(3)	0.10	0.22	1(13)
32 RC	2.62(7)	0.36	0.33	2(6)
32 GS	2.64(11)	0.44	0.49	3(7)
126	2.67(18)	0.47	0.67	4(9)
108	2.68(19)	0.48	0.73	4(9)
106	2.7(3)	0.41	0.89	5(13)
29	2.83(22)	1.04	1.76	10(10)
98	2.97(13)	2.24	2.70 Q	16(8)
129	2.99(16)	2.09	2.83 Q	16(8)
95	3.0(7)	0.63	3.11 Q	2(3) × 10^{1}
114	3.05(11)	2.91 D	3.23 D	19(7)
104	3.26(17)	3.29 D	4.64 D	27(9)

Appendix B. Results sorted by laboratory

Table B1 – Laboratory 1

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Po-210 AH	1.70(10)	2.54(3)	–8.08 D	–5.67 D	–33(4)
Np-237 AH	20.4(13)	17.45(18)	2.25	2.90 Q	17(8)
Pu-238 AH	17.7(4)	18.08(6)	–0.94	–0.36	–2.1(22)
Pu-239 AH	17.0(4)	17.29(8)	–0.70	–0.28	–1.6(24)
Am-241 AH	4.60(20)	4.382(10)	1.09	0.85	5(5)
Cm-244 AH	18.5(8)	18.29(6)	0.26	0.20	1(5)
gross a AH	82(9)	80.57(21)	0.16	0.31	2(11)
Pu-238 P	5.20(20)	5.054(23)	0.73	0.50	3(4)
Pu-239 P	5.9(15)	5.79(6)	0.67	0.32	2(3)
Pu-241 P	9.5(12)	14.96(16)	–4.41 D	–6.29 D	–37(8)
gross b I B2	3.30(20)	3.799(6)	–2.49	–2.25	–13(6)

Table B2 – Laboratory 4

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
U-238 AL	7.5(7)	7.76(20)	–0.34	–0.51	–3(9)
Pu-239 AL	11.4(12)	12.37(19)	–0.85	–1.37	–8(9)
Am-241 AL	5.4(5)	5.00(6)	0.73	1.18	7(10)
	Bq g^{-1}	Bq g^{-1}			
H-3 B1	1.19(12)	1.345(10)	–1.29	–1.98	–12(9)

Table B3 – Laboratory 5

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
gross a AL	63(7)	83(18)	–1.02	–4.13 Q	–24(19)
	Bq g^{-1}	Bq g^{-1}			
H-3 B1	1.32(13)	1.345(10)	–0.19	–0.32	–2(10)
H-3 B1	1.41(21)	1.345(10)	0.31	0.83	5(16)
C-14 B1	0.120(18)	0.1398(9)	–1.10	–2.43	–14(13)
H-3 B2	0.94(9)	0.897(7)	0.47	0.82	5(10)
H-3 B2	0.97(15)	0.897(7)	0.49	1.39	8(17)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	17.8(18)	11.02(13)	3.82 D	10.63 D	62(16)
Co-60 GL	11.5(12)	11.252(25)	0.24	0.42	2(10)
Zr-95 GL	3.7(4)	2.551(20)	3.18 D	7.94 D	46(15)
Nb-95 GL	4.3(5)	5.55(5)	–2.82 D	–3.77 D	–22(8)
Cs-134 GL	12.7(13)	13.59(10)	–0.73	–1.17	–7(9)
Cs-137 GL	12.2(12)	10.58(21)	1.33	2.68 Q	16(12)
Eu-152 GL	16.1(16)	16.80(11)	–0.41	–0.68	–4(10)
Eu-154 GL	2.42(24)	3.437(25)	–4.22 D	–5.08 D	–30(7)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.1(4)	4.24(8)	–0.23	–0.40	–2(10)
Co-60 GH	3.3(4)	3.427(8)	–0.42	–0.69	–4(10)
Zr-95 GH	2.07(21)	1.875(15)	0.92	1.78	10(11)
Nb-95 GH	3.9(4)	4.08(4)	–0.36	–0.59	–3(10)
Cs-134 GH	5.1(5)	5.81(5)	–1.33	–2.01	–12(9)
Cs-137 GH	10.3(10)	10.43(7)	–0.12	–0.21	–1(10)
Eu-152 GH	11.7(12)	11.78(13)	–0.06	–0.09	–1(10)
Eu-154 GH	1.86(19)	1.94(4)	–0.39	–0.67	–4(10)
Co-60 S	8.1(8)	7.82(20)	0.30	0.55	3(11)
Cs-137 S	11.9(12)	10.5(3)	1.14	2.29	13(12)
Eu-152 S	16.0(16)	16.0(5)	0.03	0.05	0(10)
Eu-154 S	2.09(21)	1.96(6)	0.61	1.17	7(11)
Am-241 S	1.41(14)	2.57(12)	–6.19 D	–7.74 D	–45(6)

Table B4 – Laboratory 7

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Pu-238 AH	15.8(10)	18.08(6)	–2.27	–2.16	–13(6)
Pu-239 AH	15.0(10)	17.29(8)	–2.35	–2.27	–13(6)
Am-241 AH	4.4(15) Q	4.382(10)	0.00	–0.01	0(4) × 10^1
Cm-244 AH	14(4)	18.29(6)	–1.12	–4.41 Q	–26(23)
gross a AH	44(5)	80.57(21)	–7.61 D	–7.79 D	–45(6)
Pu-238 P	4.9(4)	5.054(23)	–0.46	–0.62	–4(8)
Pu-239 P	5.6(4)	5.79(6)	–0.42	–0.51	–3(7)
Pu-241 P	13.6(10)	14.96(16)	–1.34	–1.56	–9(7)
H-3 B1	1.20(5)	1.345(10)	–2.85 Q	–1.85	–11(4)
C-14 B1	0.294(22)	0.1398(9)	7.00 D	18.94 D	110(16)
Cl-36 B1	0.478(7)	0.4544(18)	3.26 Q	0.89	5.2(16)
H-3 B2	0.76(3)	0.897(7)	–4.49 D	–2.72 D	–16(4)
Fe-55 B2	1.05(11)	1.235(22)	–1.65	–2.57	–15(9)
Sr-89 B2	0.81(4)	0.822(3)	–0.45	–0.36	–2(5)
Sr-90 B2	1.38(4)	1.488(4)	–2.70 Q	–1.25	–7(3)
gross b L B2	3.3(3)	5.931(23)	–9.96 D	–7.53 D	–44(5)
Be-7 GH	4.06(22)	4.24(8)	–0.77	–0.72	–4(6)
Co-60 GH	3.18(18)	3.427(8)	–1.37	–1.24	–7(6)
Zr-95 GH	1.88(21)	1.875(15)	0.02	0.04	0(11)
Nb-95 GH	3.98(18)	4.08(4)	–0.54	–0.42	–2(5)
Cs-134 GH	4.8(4)	5.81(5)	–2.91 D	–2.87 D	–17(6)
Cs-137 GH	10.1(7)	10.43(7)	–0.45	–0.54	–3(7)
Eu-152 GH	10.2(6)	11.78(13)	–2.85 Q	–2.31	–13(5)
Eu-154 GH	1.78(16)	1.94(4)	–0.95	–1.38	–8(9)
Co-60 S	6.9(8)	7.82(20)	–1.18	–2.06	–12(10)
Cs-137 S	9.7(16)	10.5(3)	–0.52	–1.38	–8(15)
Eu-152 S	12.7(16)	16.0(5)	–1.98	–3.53 Q	–21(10)
Eu-154 S	1.9(4)	1.96(6)	–0.19	–0.59	–3(18)
Am-241 S	2.2(6) Q	2.57(12)	–0.58	–2.32	–14(23)

Table B5 – Laboratory 8

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Ra-226 AL	10(4)	10.25(18)	–0.01	–0.08	0(4) × 10^{1}
Th-232 AL	5.1(9)	5.47(8)	–0.38	–1.05	–6(16)
U-238 AL	6.6(7)	7.76(20)	–1.73	–2.63 Q	–15(9)
Pu-239 AL	13.0(12)	12.37(19)	0.51	0.88	5(10)
Am-241 AL	4.8(4)	5.00(6)	–0.48	–0.70	–4(9)
Am-241 AL	5.1(9)	5.00(6)	0.13	0.40	2(17)
Cm-244 AL	16.2(13)	15.74(19)	0.36	0.51	3(8)
gross a AL	94.7(7)	83(18)	0.63	2.40	14(25)
	Bq g^{-1}	Bq g^{-1}			
Pb-210 AH	3.30(25)	2.54(3)	2.98 D	5.15 D	30(10)
Np-237 AH	1.83(21)	17.45(18)	–57.58 D	–15.37 D	–89.5(12)
Pu-238 AH	16.6(13)	18.08(6)	–1.14	–1.40	–8(7)
Pu-239 AH	15.9(12)	17.29(8)	–1.11	–1.38	–8(7)
Am-241 AH	4.5(4)	4.382(10)	0.26	0.35	2(8)
Am-241 AH	4.36(19)	4.382(10)	–0.12	–0.09	–1(5)
Cm-244 AH	18.0(13)	18.29(6)	–0.23	–0.27	–2(8)
gross a AH	73.9(4)	80.57(21)	–15.92 Q	–1.42	–8.3(5)
Pu-238 P	4.6(3)	5.054(23)	–1.65	–1.47	–9(5)
Pu-239 P	5.3(3)	5.79(6)	–1.58	–1.43	–8(6)
Pu-241 P	14.8(5)	14.96(16)	–0.35	–0.18	–1(3)
H-3 B1	1.33(6)	1.345(10)	–0.28	–0.19	–1(4)
C-14 B1	0.155(10)	0.1398(9)	1.52	1.86	11(7)
Cl-36 B1	0.49(5)	0.4544(18)	0.65	1.27	7(11)
Tc-99 B1	0.115(10)	0.1218(11)	–0.52	–0.96	–6(11)
H-3 B2	0.864(4)	0.897(7)	–4.55 Q	–0.63	–3.7(8)
Fe-55 B2	1.11(4)	1.235(22)	–2.75 Q	–1.74	–10(4)
Sr-89 B2	0.69(9)	0.822(3)	–1.42	–2.76 Q	–16(11)
Sr-90 B2	1.34(18)	1.488(4)	–0.82	–1.71	–10(12)
Sr-90 B2	1.41(3)	1.488(4)	–2.56	–0.05	–5.3(21)
gross b I B2	3.590(11)	3.799(6)	–17.06 Q	–0.94	–5.5(4)

continues

continued					
	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	10.4(8)	11.02(13)	–0.84	–1.03	–6(7)
Co-60 GL	11.60(19)	11.252(25)	1.82	0.53	3.1(17)
Zr-95 GL	2.98(23)	2.551(20)	1.86	2.89 Q	17(9)
Nb-95 GL	6.1(4)	5.55(5)	1.64	1.64	10(6)
Cs-134 GL	13.7(7)	13.59(10)	0.19	0.16	1(5)
Cs-137 GL	11.0(7)	10.58(21)	0.65	0.73	4(7)
Eu-152 GL	17.1(6)	16.80(11)	0.40	0.26	2(4)
Eu-154 GL	3.63(24)	3.437(25)	0.80	0.96	6(7)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.36(21)	4.24(8)	0.55	0.50	3(6)
Co-60 GH	3.46(6)	3.427(8)	0.54	0.17	1.0(18)
Zr-95 GH	1.9(9) Q	1.875(15)	0.02	0.13	0(5) × 10^{1}
Nb-95 GH	4.18(18)	4.08(4)	0.55	0.42	2(5)
Cs-134 GH	5.79(21)	5.81(5)	–0.09	–0.06	0(4)
Cs-137 GH	10.7(7)	10.43(7)	0.42	0.45	3(6)
Eu-152 GH	11.6(4)	11.78(13)	–0.47	–0.25	–1(4)
Eu-154 GH	1.86(4)	1.94(4)	–1.43	–0.67	–4(3)
Co-60 S	7.59(12)	7.82(20)	–0.98	–0.50	–3(3)
Cs-137 S	10.4(5)	10.5(3)	–0.20	–0.19	–1(6)
Eu-152 S	15.6(5)	16.0(5)	–0.61	–0.42	–2(4)
Eu-154 S	1.84(4)	1.96(6)	–1.71	–1.03	–6(4)
Am-241 S	2.04(15)	2.57(12)	–2.72 D	–3.53 D	–21(7)

Table B6 – Laboratory 9

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.25(18)	4.24(8)	0.06	0.05	0(5)
Co-60 GH	3.35(14)	3.427(8)	–0.55	–0.39	–2(4)
Zr-95 GH	2.09(9)	1.875(15)	2.35	1.97	11(5)
Nb-95 GH	3.97(16)	4.08(4)	–0.67	–0.46	–3(4)
Cs-134 GH	5.32(21)	5.81(5)	–2.28	–1.45	–8(4)
Cs-137 GH	10.8(5)	10.43(7)	0.74	0.61	4(5)
Eu-152 GH	11.0(5)	11.78(13)	–1.52	–1.14	–7(5)
Eu-154 GH	1.87(8)	1.94(4)	–0.75	–0.58	–3(5)

Table B7 – Laboratory 13

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Th-232 AL	5.3(8)	5.47(8)	–0.20	–0.49	–3(14)
U-238 AL	7.5(8)	7.76(20)	–0.30	–0.57	–3(11)
	Bq g^{-1}	Bq g^{-1}			
Tc-99 B1	0.110(9)	0.1218(11)	–1.31	–1.67	–10(8)
H-3 B2	0.92(4)	0.897(7)	0.45	0.34	2(5)
Co-60 S	7.2(4)	7.82(20)	–1.43	–1.32	–8(6)
Cs-137 S	9.5(6)	10.5(3)	–1.68	–1.66	–10(6)
Eu-152 S	14.5(9)	16.0(5)	–1.45	–1.61	–9(7)
Eu-154 S	1.76(10)	1.96(6)	–1.69	–1.73	–10(6)
Am-241 S	2.34(13)	2.57(12)	–1.26	–1.52	–9(7)

Table B8 – Laboratory 15

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	11.5(11)	11.02(13)	0.39	0.69	4(10)
Co-60 GL	10.68(25)	11.252(25)	–2.28	–0.87	–5.1(22)
Zr-95 GL	–	2.551(20)	–	–	–
Nb-95 GL	4.66(14)	5.55(5)	–6.03 D	–2.75 D	–16(3)
Cs-134 GL	14.2(3)	13.59(10)	1.93	0.75	4.4(23)
Cs-137 GL	11.66(25)	10.58(21)	3.33 Q	1.75	10(4)
Eu-152 GL	18.1(4)	16.80(11)	3.01 Q	1.31	7.6(25)
Eu-154 GL	3.44(22)	3.437(25)	0.01	0.01	0(7)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.22(11)	4.24(8)	–0.13	–0.07	0(3)
Co-60 GH	3.04(5)	3.427(8)	–7.64 Q	–1.94	–11.3(15)
Zr-95 GH	–	1.875(15)	–	–	–
Nb-95 GH	3.17(6)	4.08(4)	–13.19 D	–3.83 D	–22.3(16)
Cs-134 GH	5.82(10)	5.81(5)	0.10	0.03	0.2(19)
Cs-137 GH	10.78(19)	10.43(7)	1.73	0.58	3.4(20)
Eu-152 GH	11.94(21)	11.78(13)	0.63	0.23	1.3(21)
Eu-154 GH	1.85(3)	1.94(4)	–1.89	–0.75	–4.4(23)

Table B9 – Laboratory 16

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
H-3 B1	1.36(4)	1.345(10)	0.43	0.19	1(3)
H-3 B2	1.26(5)	1.345(10)	–1.77	–1.08	–6(4)
C-14 B1	0.130(5)	0.1398(9)	–1.93	–1.21	–7(4)
H-3 B2	0.89(4)	0.897(7)	–0.18	–0.14	–1(5)
Fe-55 B2	1.49(19)	1.235(22)	1.33	3.54 Q	21(16)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	14.2(19)	11.02(13)	1.67	4.96 Q	29(17)
Co-60 GL	12.5(3)	11.252(25)	4.78 Q	1.91	11.1(23)
Zr-95 GL	4.2(4)	2.551(20)	3.99 D	11.04 D	64(16)
Nb-95 GL	4.98(18)	5.55(5)	–3.06 Q	–1.76	–10(4)
Cs-134 GL	13.4(10)	13.59(10)	–0.19	–0.25	–1(8)
Cs-137 GL	11.90(25)	10.58(21)	4.07 Q	2.14	12(4)
Eu-152 GL	17.8(12)	16.80(11)	0.82	1.03	6(7)
Eu-154 GL	3.7(4)	3.437(25)	0.56	1.06	6(11)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	5.49(10)	4.24(8)	10.07 D	5.07 D	30(4)
Co-60 GH	3.64(4)	3.427(8)	5.22 Q	1.07	6.2(12)
Zr-95 GH	2.380(20)	1.875(15)	20.22 D	4.62 D	26.9(15)
Nb-95 GH	4.44(4)	4.08(4)	6.86 Q	1.52	8.8(13)
Cs-134 GH	5.66(20)	5.81(5)	–0.73	–0.44	–3(4)
Cs-137 GH	11.50(11)	10.43(7)	8.14 Q	1.77	10.3(13)
Eu-152 GH	12.00(15)	11.78(13)	1.08	0.31	1.8(17)
Eu-154 GH	1.84(8)	1.94(4)	–1.09	–0.84	–5(5)

Table B10 – Laboratory 17

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
U-238 AL	5.8(5)	7.76(20)	–3.85 D	–4.27 D	–25(6)
	Bq g^{-1}	Bq g^{-1}			
H-3 B1	1.55(20)	1.345(10)	1.02	2.62 Q	15(15)
C-14 B1	0.130(20)	0.1398(9)	–0.49	–1.21	–7(14)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	–	11.02(13)	–	–	–
Co-60 GL	12.0(8)	11.252(25)	0.99	1.20	7(7)
Zr-95 GL	–	2.551(20)	–	–	–
Nb-95 GL	–	5.55(5)	–	–	–
Cs-134 GL	12.1(6)	13.59(10)	–2.77 Q	–1.89	–11(4)
Cs-137 GL	9.5(5)	10.58(21)	–2.11	–1.79	–10(5)
Eu-152 GL	16.3(11)	16.80(11)	–0.42	–0.48	–3(7)
Eu-154 GL	3.7(6)	3.437(25)	0.40	1.06	6(15)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.01(15)	4.24(8)	–1.36	–0.92	–5(4)
Co-60 GH	3.06(8)	3.427(8)	–4.56 Q	–1.84	–10.7(23)
Zr-95 GH	2.02(6)	1.875(15)	2.34	1.32	8(4)
Nb-95 GH	3.61(11)	4.08(4)	–4.08 Q	–1.98	–12(3)
Cs-134 GH	4.46(14)	5.81(5)	–9.15 D	–3.99 D	–23.2(25)
Cs-137 GH	9.8(3)	10.43(7)	–2.14	–0.98	–6(3)
Eu-152 GH	9.7(3)	11.78(13)	–6.31 D	–3.01 D	–18(3)
Eu-154 GH	1.47(5)	1.94(4)	–7.71 D	–4.13 D	–24(3)
Co-60 S	7.72(22)	7.82(20)	–0.34	–0.22	–1(4)
Cs-137 S	10.9(4)	10.5(3)	0.76	0.56	3(5)
Eu-152 S	14.0(5)	16.0(5)	–3.20 Q	–2.14	–12(4)
Eu-154 S	0.84(4)	1.96(6)	–15.56 D	–9.80 D	–57.1(24)
Am-241 S	2.45(10)	2.57(12)	–0.74	–0.78	–5(6)

Table B11 – Laboratory 19

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
H-3 B2	0.85(3)	0.897(7)	–1.41	–0.83	–5(4)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	11.6(6)	11.02(13)	0.92	0.91	5(6)
Co-60 GL	11.2(4)	11.252(25)	–0.09	–0.05	0(4)
Zr-95 GL	2.72(13)	2.551(20)	1.29	1.14	7(5)
Nb-95 GL	5.65(18)	5.55(5)	0.54	0.31	2(4)
Cs-134 GL	12.1(4)	13.59(10)	–3.85 Q	–1.91	–11(3)
Cs-137 GL	10.8(4)	10.58(21)	0.65	0.42	2(4)
Eu-152 GL	15.4(5)	16.80(11)	–2.78 Q	–1.46	–8(3)
Eu-154 GL	3.71(19)	3.437(25)	1.42	1.36	8(6)

Table B12 – Laboratory 21

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
H-3 B1	1.35(4)	1.345(10)	0.00	0.00	0(3)
H-3 B2	0.89(3)	0.897(7)	–0.20	–0.12	–1(4)
Fe-55 B2	2.3(3)	1.235(22)	3.54 D	14.81 D	86(25)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	–	11.02(13)	–	–	–
Co-60 GL	11.0(3)	11.252(25)	–0.84	–0.38	–2(3)
Zr-95 GL	2.30(11)	2.551(20)	–2.24	–1.69	–10(5)
Nb-95 GL	5.63(14)	5.55(5)	0.55	0.25	1(3)
Cs-134 GL	13.2(3)	13.59(10)	–1.25	–0.50	–2.9(23)
Cs-137 GL	10.40(20)	10.58(21)	–0.63	–0.29	–2(3)
Eu-152 GL	16.8(4)	16.80(11)	–0.10	–0.04	–0.2(21)
Eu-154 GL	3.51(17)	3.437(25)	0.42	0.36	2(5)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	–	4.24(8)	–	–	–
Co-60 GH	3.35(7)	3.427(8)	–1.09	–0.39	–2.2(21)
Zr-95 GH	1.84(4)	1.875(15)	–0.83	–0.32	–1.9(23)
Nb-95 GH	4.07(8)	4.08(4)	–0.11	–0.04	–0.2(21)
Cs-134 GH	5.60(11)	5.81(5)	–1.76	–0.62	–3.6(20)
Cs-137 GH	10.40(20)	10.43(7)	–0.13	–0.05	–0.3(20)
Eu-152 GH	11.54(23)	11.78(13)	–0.92	–0.36	–2.1(22)
Eu-154 GH	1.84(4)	1.94(4)	–1.82	–0.84	–5(3)
Co-60 S	7.42(15)	7.82(20)	–1.61	–0.88	–5(3)
Cs-137 S	10.00(20)	10.5(3)	–1.45	–0.84	–5(4)
Eu-152 S	15.1(3)	16.0(5)	–1.65	–0.96	–6(4)
Eu-154 S	1.75(4)	1.96(6)	–2.88 Q	–1.81	–11(4)
Am-241 S	2.52(5)	2.57(12)	–0.35	–0.32	–2(5)

Table B13 – Laboratory 23

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	10.5(25)	11.02(13)	–0.21	–0.81	–5(23)
Co-60 GL	10.9(7)	11.252(25)	–0.50	–0.54	–3(6)
Zr-95 GL	3.4(9)	2.551(20)	0.94	5.72 Q	3(4) × 10^{1}
Nb-95 GL	5.4(11)	5.55(5)	–0.14	–0.46	–3(20)
Cs-134 GL	13.8(17)	13.59(10)	0.12	0.26	2(13)
Cs-137 GL	10.7(10)	10.58(21)	0.12	0.19	1(10)
Eu-152 GL	17.1(22)	16.80(11)	0.14	0.31	2(13)
Eu-154 GL	2.8(9)	3.437(25)	–0.71	–3.18 Q	–2(3) × 10^{1}

Table B14 – Laboratory 24

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Ra-226 AL	11.8(14)	10.25(18)	1.10	2.60 Q	15(14)
Th-232 AL	5.7(6)	5.47(8)	0.39	0.74	4(11)
Am-241 AL	5.1(7)	5.00(6)	0.14	0.33	2(14)
	Bq g^{-1}	Bq g^{-1}			
Pb-210 AH	3.6(4)	2.54(3)	2.65 D	7.18 D	42(16)
Am-241 AH	5.2(6)	4.382(10)	1.36	3.21 Q	19(14)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	–	11.02(13)	–	–	–
Co-60 GL	11.3(6)	11.252(25)	0.08	0.07	0(6)
Zr-95 GL	3.10(20)	2.551(20)	2.73 D	3.70 D	22(8)
Nb-95 GL	5.3(3)	5.55(5)	–0.82	–0.77	–4(6)
Cs-134 GL	13.8(9)	13.59(10)	0.23	0.26	2(7)
Cs-137 GL	11.4(8)	10.58(21)	0.99	1.33	8(8)
Eu-152 GL	17.0(9)	16.80(11)	0.22	0.21	1(6)
Eu-154 GL	3.50(20)	3.437(25)	0.31	0.31	2(6)
	Bq g^{-1}	Bq g^{-1}			
Co-60 S	7.5(4)	7.82(20)	–0.72	–0.70	–4(6)
Cs-137 S	10.6(7)	10.5(3)	0.11	0.14	1(7)
Eu-152 S	15.6(8)	16.0(5)	–0.43	–0.42	–2(6)
Eu-154 S	1.86(11)	1.96(6)	–0.77	–0.85	–5(7)
Am-241 S	2.6(3)	2.57(12)	0.10	0.22	1(13)

Table B15 – Laboratory 25

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Ra-226 AL	9.2(5)	10.25(18)	–1.88	–1.71	–10(5)
Th-232 AL	5.5(7)	5.47(8)	0.07	0.14	1(12)
U-238 AL	7.7(6)	7.76(20)	–0.11	–0.15	–1(8)
Pu-239 AL	11.5(11)	12.37(19)	–0.83	–1.28	–7(9)
Am-241 AL	5.0(6)	5.00(6)	0.01	0.02	0(12)
Cm-244 AL	13.9(15)	15.74(19)	–1.24	–2.04	–12(10)
gross a AL	59.3(23)	83(18)	–1.28	–4.92 Q	–29(16)
	Bq g^{-1}	Bq g^{-1}			
H-3 B1	1.29(6)	1.345(10)	–1.04	–0.73	–4(4)
C-14 B1	0.147(9)	0.1398(9)	0.79	0.88	5(7)
Tc-99 B1	0.115(9)	0.1218(11)	–0.76	–0.96	–6(8)
H-3 B2	0.84(4)	0.897(7)	–1.45	–1.02	–6(4)
Fe-55 B2	1.26(13)	1.235(22)	0.18	0.32	2(10)
Sr-90 B2	1.286(9)	1.488(4)	–21.11 Q	–2.33	–13.6(7)
gross b I B2	3.02(24)	3.799(6)	–3.22 D	–3.52 D	–20(7)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	8.3(16)	11.02(13)	–1.64	–4.19 Q	–24(15)
Co-60 GL	11.2(7)	11.252(25)	–0.07	–0.08	0(6)
Zr-95 GL	3.4(4)	2.551(20)	1.95	5.38 Q	31(16)
Nb-95 GL	5.3(4)	5.55(5)	–0.68	–0.80	–5(7)
Cs-134 GL	14.1(12)	13.59(10)	0.44	0.64	4(9)
Cs-137 GL	10.4(7)	10.58(21)	–0.27	–0.29	–2(7)
Eu-152 GL	17.4(15)	16.80(11)	0.41	0.62	4(9)
Eu-154 GL	3.5(5)	3.437(25)	0.10	0.21	1(13)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.08(23)	4.24(8)	–0.65	–0.64	–4(6)
Co-60 GH	3.31(18)	3.427(8)	–0.65	–0.59	–3(6)
Zr-95 GH	2.16(14)	1.875(15)	2.02	2.61 Q	15(8)
Nb-95 GH	3.94(22)	4.08(4)	–0.63	–0.59	–3(6)
Cs-134 GH	5.8(5)	5.81(5)	–0.11	–0.15	–1(8)
Cs-137 GH	10.4(6)	10.43(7)	–0.05	–0.05	0(6)

continues

continued					
Eu-152 GH	11.8(9)	11.78(13)	0.02	0.02	0(8)
Eu-154 GH	1.88(11)	1.94(4)	–0.48	–0.49	–3(6)

Table B16 – Laboratory 26

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Ra-226 AL	14.4(5)	10.25(18)	7.58 D	6.99 D	41(6)
Th-232 AL	5.5(3)	5.47(8)	0.21	0.20	1(6)
U-238 AL	8.00(25)	7.76(20)	0.75	0.53	3(4)
Pu-239 AL	12.1(4)	12.37(19)	–0.57	–0.33	–2(4)
Am-241 AL	5.23(13)	5.00(6)	1.57	0.77	4(3)
	Bq g^{-1}	Bq g^{-1}			
Sr-89 B2	0.96(8)	0.822(3)	1.73	2.82 Q	16(10)
Sr-90 B2	1.47(12)	1.488(4)	–0.15	–0.21	–1(8)
Co-60 S	7.56(21)	7.82(20)	–0.90	–0.57	–3(4)
Cs-137 S	10.2(3)	10.5(3)	–0.78	–0.52	–3(4)
Eu-152 S	15.7(4)	16.0(5)	–0.50	–0.31	–2(4)
Eu-154 S	1.88(5)	1.96(6)	–1.01	–0.67	–4(4)
Am-241 S	2.59(8)	2.57(12)	0.16	0.16	1(6)

Table B17 – Laboratory 27

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	15(5)	11.02(13)	0.79	5.43 Q	3(4) × 10^{1}
Co-60 GL	11(3) Q	11.252(25)	0.06	0.23	1(23)
Zr-95 GL	3.9(10)	2.551(20)	1.35	9.08 Q	5(4) × 10^{1}
Nb-95 GL	6.1(20) Q	5.55(5)	0.28	1.70	1(4) × 10^{1}
Cs-134 GL	13.1(17)	13.59(10)	–0.29	–0.62	–4(13)
Cs-137 GL	13(3)	10.58(21)	0.76	3.60 Q	2(3) × 10^{1}
Eu-152 GL	16.9(25)	16.80(11)	0.04	0.11	1(15)
Eu-154 GL	2.9(5)	3.437(25)	–1.07	–2.69 Q	–16(15)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	3.1(9)	4.24(8)	–1.29	–4.81 Q	–28(22)
Co-60 GH	3.6(8) Q	3.427(8)	0.21	0.87	5(24)
Zr-95 GH	1.6(4)	1.875(15)	–0.69	–2.52	–15(21)
Nb-95 GH	3.1(10)	4.08(4)	–0.95	–4.00 Q	–23(25)
Cs-134 GH	5.0(7)	5.81(5)	–1.16	–2.27	–13(11)
Cs-137 GH	12(3)	10.43(7)	0.45	1.96	1(3) × 10^{1}
Eu-152 GH	11.4(17)	11.78(13)	–0.24	–0.59	–3(15)
Eu-154 GH	1.30(23)	1.94(4)	–2.73 D	–5.64 D	–33(12)

Table B18 – Laboratory 28

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Ra-226 AL	9.0(7)	10.25(18)	–1.73	–2.09	–12(7)
Th-232 AL	5.1(5)	5.47(8)	–0.86	–1.18	–7(8)
U-238 AL	7.46(19)	7.76(20)	–1.09	–0.66	–4(4)
Pu-239 AL	12.2(3)	12.37(19)	–0.65	–0.29	–2(3)
Am-241 AL	5.07(14)	5.00(6)	0.43	0.22	1(3)
	Bq g^{-1}	Bq g^{-1}			
Pb-210 AH	2.74(12)	2.54(3)	1.63	1.36	8(5)
Po-210 AH	2.24(6)	2.54(3)	–4.51 Q	–2.02	–12(3)
Pu-238 AH	17.5(4)	18.08(6)	–1.73	–0.55	–3.2(19)
Pu-239 AH	16.7(4)	17.29(8)	–1.87	–0.61	–3.6(19)
Am-241 AH	4.36(10)	4.382(10)	–0.22	–0.09	–0.5(23)
Pu-238 P	5.08(10)	5.054(23)	0.26	0.09	0.5(20)
Pu-239 P	5.79(12)	5.79(6)	–0.01	0.00	0.0(23)
Tc-99 B1	0.136(4)	0.1218(11)	3.41 Q	1.99	12(4)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	9.4(14)	11.02(13)	–1.15	–2.52	–15(13)
Co-60 GL	12.7(7)	11.252(25)	2.23	2.21	13(6)
Zr-95 GL	2.6(3)	2.551(20)	0.13	0.26	2(11)
Nb-95 GL	5.9(4)	5.55(5)	0.87	1.12	7(8)
Cs-134 GL	14.2(7)	13.59(10)	0.86	0.76	4(5)
Cs-137 GL	11.2(7)	10.58(21)	0.91	1.01	6(7)
Eu-152 GL	16.9(9)	16.80(11)	0.12	0.11	1(5)
Eu-154 GL	3.5(3)	3.437(25)	0.09	0.11	1(8)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.41(24)	4.24(8)	0.69	0.70	4(6)
Co-60 GH	3.90(19)	3.427(8)	2.49	2.37	14(6)
Zr-95 GH	2.00(10)	1.875(15)	1.23	1.14	7(6)
Nb-95 GH	4.30(22)	4.08(4)	0.99	0.93	5(6)
Cs-134 GH	6.1(3)	5.81(5)	1.13	0.95	6(5)
Cs-137 GH	11.0(6)	10.43(7)	1.03	0.94	5(6)
Eu-152 GH	12.1(6)	11.78(13)	0.51	0.46	3(5)
Eu-154 GH	2.10(10)	1.94(4)	1.56	1.46	9(6)

Table B19 – Laboratory 29

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Pu-239 AL	12.2(6)	12.37(19)	–0.27	–0.23	–1(5)
Am-241 AL	4.50(20)	5.00(6)	–2.41	–1.73	–10(4)
	Bq g^{-1}	Bq g^{-1}			
H-3 B1	1.31(6)	1.345(10)	–0.57	–0.44	–3(5)
H-3 B1	1.30(10)	1.345(10)	–0.45	–0.57	–3(8)
C-14 B1	0.140(20)	0.1398(9)	0.01	0.02	0(14)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	12.7(20)	11.02(13)	0.84	2.62 Q	15(18)
Co-60 GL	13.0(14)	11.252(25)	1.25	2.67 Q	16(12)
Zr-95 GL	3.1(4)	2.551(20)	1.51	3.97 Q	23(15)
Nb-95 GL	6.6(11)	5.55(5)	0.96	3.16 Q	18(19)
Cs-134 GL	15.7(12)	13.59(10)	1.75	2.66 Q	15(9)
Cs-137 GL	12.9(10)	10.58(21)	2.27	3.76 Q	22(10)
Eu-152 GL	20.0(15)	16.80(11)	2.13	3.27 Q	19(9)
Eu-154 GL	4.4(4)	3.437(25)	2.30	4.61 Q	27(12)
	Bq g^{-1}	Bq g^{-1}			
Co-60 S	8.2(7)	7.82(20)	0.58	0.92	5(9)
Cs-137 S	11.0(9)	10.5(3)	0.51	0.79	5(9)
Eu-152 S	16.1(12)	16.0(5)	0.09	0.12	1(8)
Eu-154 S	1.93(15)	1.96(6)	–0.17	–0.24	–1(8)
Am-241 S	2.83(22)	2.57(12)	1.04	1.76	10(10)

Table B20 – Laboratory 31

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Ra-226 AL	1.90(20)	10.25(18)	–30.97 D	–13.99 D	–81.5(20)
U-238 AL	6.4(6)	7.76(20)	–2.15	–3.01 Q	–18(8)
Pu-239 AL	11.3(10)	12.37(19)	–1.05	–1.48	–9(8)
Am-241 AL	5.1(5)	5.00(6)	0.11	0.19	1(10)
Cm-244 AL	11.4(10)	15.74(19)	–4.26 D	–4.73 D	–28(7)
	Bq g^{-1}	Bq g^{-1}			
Pu-238 AH	6.0(6)	18.08(6)	–20.07 D	–11.49 D	–67(4)
Pu-239 AH	6.6(6)	17.29(8)	–17.60 D	–10.58 D	–62(4)
Am-241 AH	0.095(9)	4.382(10)	–324.61 D	–16.80 D	–97.84(21)
Cm-244 AH	0.82(8)	18.29(6)	–175.39 D	–16.40 D	–95.5(5)
gross a AH	68(6)	80.57(21)	–2.09	–2.68 Q	–16(8)
Pu-238 P	5.8(5)	5.054(23)	1.39	2.37	14(10)
Pu-239 P	6.5(6)	5.79(6)	1.09	1.95	11(10)
Pu-241 P	10.2(10)	14.96(16)	–4.74 D	–5.52 D	–32(7)
H-3 B2	0.83(8)	0.897(7)	–0.84	–1.29	–7(9)
Fe-55 B2	0.91(9)	1.235(22)	–3.53 D	–4.55 D	–26(8)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	–	11.02(13)	–	–	–
Co-60 GL	1.49(0)	11.252(25)	–396.51 D	–14.90 D	–86.76(3)
Zr-95 GL	–	2.551(20)	–	–	–
Nb-95 GL	–	5.55(5)	–	–	–
Cs-134 GL	–	13.59(10)	–	–	–
Cs-137 GL	5.14(0)	10.58(21)	–26.41 D	–8.83 D	–51.4(10)
Eu-152 GL	–	16.80(11)	–	–	–
Eu-154 GL	–	3.437(25)	–	–	–
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	–	4.24(8)	–	–	–
Co-60 GH	3.73(0)	3.427(8)	37.20 Q	1.52	8.8(3)
Zr-95 GH	–	1.875(15)	–	–	–
Nb-95 GH	–	4.08(4)	–	–	–
Cs-134 GH	–	5.81(5)	–	–	–

continues

continued					
Cs-137 GH	11.13(0)	10.43(7)	9.71 Q	1.16	6.7(8)
Eu-152 GH	–	11.78(13)	–	–	–
Eu-154 GH	–	1.94(4)	–	–	–

Table B21 – Laboratory 32

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Ra-226 AL	7.9(10)	10.25(18)	–2.32	–3.87 Q	–23(10)
Th-232 AL	5.36(18)	5.47(8)	–0.53	–0.33	–2(4)
Th-232 AL	5.5(4)	5.47(8)	0.06	0.08	0(7)
U-238 AL	7.8(3)	7.76(20)	–0.03	–0.02	0(5)
U-238 AL	7.2(6)	7.76(20)	–0.94	–1.19	–7(8)
Pu-239 AL	12.6(4)	12.37(19)	0.44	0.27	2(4)
Am-241 AL	5.46(23)	5.00(6)	1.91	1.56	9(5)
Am-241 AL	5.4(4)	5.00(6)	0.95	1.29	7(8)
Cm-244 AL	16.8(6)	15.74(19)	1.83	1.21	7(4)
	Bq g^{-1}	Bq g^{-1}			
Pb-210 AH	2.68(11)	2.54(3)	1.24	0.95	6(5)
Po-210 AH	2.67(4)	2.54(3)	2.65 Q	0.91	5.3(20)
Np-237 AH	19.1(16)	17.45(18)	1.05	1.65	10(9)
Pu-238 AH	18.4(4)	18.08(6)	0.76	0.28	1.6(21)
Pu-239 AH	17.5(4)	17.29(8)	0.61	0.22	1.3(21)
Am-241 AH	4.42(12)	4.382(10)	0.32	0.15	1(3)
Am-241 AH	4.58(8)	4.382(10)	2.64 Q	0.77	4.5(17)
Cm-244 AH	18.4(5)	18.29(6)	0.29	0.13	1(3)
Pu-238 P	5.24(17)	5.054(23)	1.09	0.63	4(4)
Pu-239 P	5.87(18)	5.79(6)	0.42	0.23	1(4)
Pu-241 P	14.2(7)	14.96(16)	–1.10	–0.92	–5(5)
H-3 B1	1.27(5)	1.345(10)	–1.52	–0.93	–5(4)
H-3 B1	1.30(9)	1.345(10)	–0.45	–0.52	–3(7)
C-14 B1	0.137(8)	0.1398(9)	–0.33	–0.30	–2(6)
Cl-36 B1	0.48(5)	0.4544(18)	0.63	1.04	6(10)
Tc-99 B1	0.120(9)	0.1218(11)	–0.22	–0.29	–2(8)
H-3 B2	0.85(4)	0.897(7)	–1.60	–1.00	–6(4)
H-3 B2	0.84(6)	0.897(7)	–0.98	–1.17	–7(7)
Fe-55 B2	1.15(7)	1.235(22)	–1.12	–1.16	–7(6)
Sr-89 B2	0.77(7)	0.822(3)	–0.71	–1.07	–6(9)
Sr-90 B2	1.45(10)	1.488(4)	–0.41	–0.45	–3(7)

continues

continued					
	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
Be-7 GH	4.53(18)	4.24(8)	1.50	1.18	7(5)
Co-60 GH	3.49(12)	3.427(8)	0.52	0.32	2(4)
Zr-95 GH	1.96(9)	1.875(15)	0.93	0.78	5(5)
Nb-95 GH	4.40(14)	4.08(4)	2.22	1.35	8(4)
Cs-134 GH	5.88(23)	5.81(5)	0.30	0.21	1(4)
Cs-137 GH	10.53(23)	10.43(7)	0.42	0.17	1.0(23)
Eu-152 GH	11.8(5)	11.78(13)	0.05	0.04	0(5)
Eu-154 GH	2.26(17)	1.94(4)	1.88	2.88 Q	17(9)
Co-60 S	7.81(19)	7.82(20)	–0.04	–0.02	0(4)
Cs-137 S	10.10(24)	10.5(3)	–1.09	–0.68	–4(4)
Eu-152 S	16.3(8)	16.0(5)	0.33	0.31	2(6)
Eu-154 S	2.04(14)	1.96(6)	0.55	0.73	4(8)
Am-241 S	2.64(11)	2.57(12)	0.44	0.49	3(7)
Am-241 S	2.62(7)	2.57(12)	0.36	0.33	2(6)

Table B22 – Laboratory 34

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Ra-226 AL	11.7(11)	10.25(18)	1.30	2.43	14(11)
Th-232 AL	4.8(5)	5.47(8)	–1.39	–2.22	–13(9)
U-238 AL	7.6(7)	7.76(20)	–0.26	–0.42	–2(9)
Pu-239 AL	12.3(9)	12.37(19)	–0.11	–0.14	–1(8)
Am-241 AL	4.9(4)	5.00(6)	–0.21	–0.29	–2(8)
Cm-244 AL	14.6(13)	15.74(19)	–0.86	–1.24	–7(8)
	Bq g^{-1}	Bq g^{-1}			
H-3 B1	1.38(7)	1.345(10)	0.51	0.42	2(5)
C-14 B1	0.136(7)	0.1398(9)	–0.54	–0.47	–3(5)
Cl-36 B1	0.422(20)	0.4544(18)	–1.61	–1.22	–7(5)
Tc-99 B1	0.131(8)	0.1218(11)	1.13	1.29	8(7)
Tc-99 B1	0.122(12)	0.1218(11)	0.01	0.02	0(10)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	13.6(14)	11.02(13)	1.84	4.02 Q	23(13)
Co-60 GL	11.9(12)	11.252(25)	0.54	0.99	6(11)
Zr-95 GL	2.7(4)	2.551(20)	0.37	1.00	6(16)
Nb-95 GL	6.1(12)	5.55(5)	0.46	1.70	10(22)
Cs-134 GL	13.6(14)	13.59(10)	0.00	0.01	0(10)
Cs-137 GL	11.1(11)	10.58(21)	0.46	0.84	5(11)
Eu-152 GL	16.4(25)	16.80(11)	–0.16	–0.41	–2(15)
Eu-154 GL	3.7(6)	3.437(25)	0.44	1.31	8(17)

Table B23 – Laboratory 35

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Ra-226 AL	9.1(10)	10.25(18)	–1.23	–1.99	–12(9)
Th-232 AL	5.9(4)	5.47(8)	1.01	1.33	8(8)
U-238 AL	7.4(3)	7.76(20)	–1.00	–0.80	–5(5)
Pu-239 AL	12.1(6)	12.37(19)	–0.42	–0.33	–2(5)
Am-241 AL	5.7(3)	5.00(6)	2.45	2.49	14(6)
Cm-244 AL	17.0(8)	15.74(19)	1.48	1.33	8(6)
	Bq g^{-1}	Bq g^{-1}			
Pb-210 AH	1.43(19)	2.54(3)	–5.77 D	–7.50 D	–44(8)
Pu-238 AH	15.8(9)	18.08(6)	–2.52	–2.15	–13(5)
Pu-239 AH	14.9(8)	17.29(8)	–2.83 Q	–2.34	–14(5)
Am-241 AH	4.46(21)	4.382(10)	0.37	0.31	2(5)
Cm-244 AH	18.6(9)	18.29(6)	0.36	0.29	2(5)
Pu-238 P	4.8(3)	5.054(23)	–0.93	–0.83	–5(5)
Pu-239 P	5.5(3)	5.79(6)	–1.02	–0.92	–5(6)
Pu-241 P	15.1(8)	14.96(16)	0.12	0.12	1(6)
H-3 B1	1.11(4)	1.345(10)	–5.70 D	–3.06 D	–18(3)
H-3 B1	1.41(7)	1.345(10)	0.89	0.77	4(5)
C-14 B1	0.185(24)	0.1398(9)	1.88	5.55 Q	32(17)
Tc-99 B1	0.105(6)	0.1218(11)	–2.76 Q	–2.33	–14(5)
H-3 B2	0.74(3)	0.897(7)	–5.16 D	–3.03 D	–18(4)
H-3 B2	0.82(4)	0.897(7)	–1.81	–1.44	–8(5)
Sr-89 B2	0.76(10)	0.822(3)	–0.62	–1.30	–8(12)
Sr-90 B2	1.07(8)	1.488(4)	–5.36 D	–4.83 D	–28(5)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	12.5(18)	11.02(13)	0.82	2.31	13(16)
Co-60 GL	12.0(5)	11.252(25)	1.46	1.10	6(5)
Zr-95 GL	2.8(5)	2.551(20)	0.45	1.41	8(18)
Nb-95 GL	6.1(10)	5.55(5)	0.55	1.70	10(18)
Cs-134 GL	13.0(5)	13.59(10)	–1.21	–0.75	–4(4)
Cs-137 GL	12.0(5)	10.58(21)	2.67 Q	2.22	13(5)
Eu-152 GL	17.2(8)	16.80(11)	0.51	0.42	2(5)

continues

continued					
Eu-154 GL	3.4(6)	3.437(25)	–0.10	–0.29	–2(17)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.19(13)	4.24(8)	–0.32	–0.19	–1(4)
Co-60 GH	3.31(10)	3.427(8)	–1.17	–0.59	–3(3)
Zr-95 GH	2.08(7)	1.875(15)	2.86 Q	1.87	11(4)
Nb-95 GH	4.02(19)	4.08(4)	–0.31	–0.25	–1(5)
Cs-134 GH	5.14(15)	5.81(5)	–4.27 Q	–1.98	–12(3)
Cs-137 GH	10.3(3)	10.43(7)	–0.28	–0.15	–1(3)
Eu-152 GH	10.7(4)	11.78(13)	–3.25 Q	–1.64	–10(3)
Eu-154 GH	1.82(6)	1.94(4)	–1.67	–1.02	–6(4)
Co-60 S	7.59(23)	7.82(20)	–0.76	–0.50	–3(4)
Cs-137 S	10.4(3)	10.5(3)	–0.25	–0.17	–1(4)
Eu-152 S	14.3(5)	16.0(5)	–2.69 Q	–1.79	–10(4)
Eu-154 S	1.78(6)	1.96(6)	–2.12	–1.53	–9(4)
Am-241 S	2.50(8)	2.57(12)	–0.49	–0.48	–3(6)
Am-241 S	2.45(9)	2.57(12)	–0.76	–0.76	–4(6)

Table B24 – Laboratory 38

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Po-210 AH	2.10(20)	2.54(3)	–2.17	–2.97 Q	–17(8)
Pu-238 AH	16.3(10)	18.08(6)	–1.78	–1.69	–10(6)
Pu-239 AH	15.8(10)	17.29(8)	–1.48	–1.48	–9(6)
Am-241 AH	4.5(3)	4.382(10)	0.39	0.46	3(7)
Cm-244 AH	17.8(11)	18.29(6)	–0.45	–0.46	–3(6)
Pu-238 P	4.8(3)	5.054(23)	–0.84	–0.86	–5(6)
Pu-239 P	5.6(4)	5.79(6)	–0.48	–0.57	–3(7)
Pu-241 P	6.0(5)	14.96(16)	–17.02 D	–10.28 D	–60(4)
H-3 B1	1.30(10)	1.345(10)	–0.45	–0.57	–3(8)
H-3 B1	1.40(10)	1.345(10)	0.55	0.70	4(8)
C-14 B1	0.16(3)	0.1398(9)	0.67	2.48	14(21)
H-3 B2	0.89(5)	0.897(7)	–0.14	–0.14	–1(6)
H-3 B2	0.90(8)	0.897(7)	0.04	0.05	0(9)
Fe-55 B2	1.06(10)	1.235(22)	–1.71	–2.43	–14(21)
Sr-89 B2	0.67(6)	0.822(3)	–2.53	–3.18 Q	–18(7)
Sr-90 B2	1.36(7)	1.488(4)	–1.83	–1.48	–9(5)
Be-7 GH	4.2(5)	4.24(8)	–0.02	–0.03	0(11)
Co-60 GH	3.53(17)	3.427(8)	0.60	0.52	3(5)
Zr-95 GH	1.87(12)	1.875(15)	–0.04	–0.05	0(7)
Nb-95 GH	4.32(21)	4.08(4)	1.13	1.01	6(5)
Cs-134 GH	6.0(3)	5.81(5)	0.75	0.65	4(5)
Cs-137 GH	10.7(5)	10.43(7)	0.54	0.45	3(5)
Eu-152 GH	11.9(6)	11.78(13)	0.19	0.17	1(5)
Eu-154 GH	2.10(7)	1.94(4)	2.12	1.46	9(4)

Table B25 – Laboratory 40

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Th-232 AL	4.95(17)	5.47(8)	–2.77 Q	–1.63	–10(4)
U-238 AL	7.41(21)	7.76(20)	–1.19	–0.77	–4(4)
Pu-239 AL	11.9(3)	12.37(19)	–1.35	–0.68	–4(3)
Am-241 AL	4.95(12)	5.00(6)	–0.38	–0.18	–1(3)
Cm-244 AL	14.9(4)	15.74(19)	–1.96	–0.90	–5(3)
Be-7 GL	8.7(21)	11.02(13)	–1.09	–3.57 Q	–21(19)
Co-60 GL	11(3) Q	11.252(25)	–0.07	–0.28	–2(24)
Zr-95 GL	3.1(8)	2.551(20)	0.73	3.63 Q	2(3) × 10^{1}
Nb-95 GL	9.5(23)	5.55(5)	1.73	12.07 Q	7(4) × 10^{1}
Cs–134 GL	13(4)	13.59(10)	–0.04	–0.14	–1(24)
Cs-137 GL	11(3) Q	10.58(21)	0.17	0.75	4(25)
Eu-152 GL	16(4)	16.80(11)	–0.19	–0.74	–4(23)
Eu-154 GL	3.3(8)	3.437(25)	–0.23	–0.89	–5(23)
	Bq g^{-1}	Bq g^{-1}			
Co-60 S	7.3(6)	7.82(20)	–0.90	–1.15	–7(8)
Cs-137 S	8.8(7)	10.5(3)	–2.32	–2.74 Q	–16(7)
Eu-152 S	13.8(10)	16.0(5)	–1.90	–2.31	–13(7)
Eu-154 S	1.76(13)	1.96(6)	–1.40	–1.77	–10(7)
Am-241 S	2.16(16)	2.57(12)	–2.00	–2.72 Q	–16(8)

Table B26 – Laboratory 41

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Pu-238 AH	16.1(9)	18.08(6)	–2.26	–1.88	–11(5)
Pu-239 AH	15.5(8)	17.29(8)	–2.33	–1.77	–10(5)
Am-241 AH	4.20(22)	4.382(10)	–0.84	–0.71	–4(5)
Cm-244 AH	17.1(8)	18.29(6)	–1.52	–1.12	–7(5)
gross a AH	81(4)	80.57(21)	0.08	0.07	0(5)
H-3 B2	0.841(21)	0.897(7)	–2.53	–1.08	–6.3(25)
Sr-90 B2	1.96(8)	1.488(4)	5.89 D	5.44 D	32(6)
gross b I B2	3.80(13)	3.799(6)	0.01	0.01	0(4)
Be-7 GH	4.41(12)	4.24(8)	1.22	0.70	4(4)
Co-60 GH	3.50(4)	3.427(8)	1.79	0.37	2.1(12)
Zr-95 GH	2.70(7)	1.875(15)	11.52 D	7.55 D	44(4)
Nb-95 GH	4.37(13)	4.08(4)	2.16	1.22	7(4)
Cs-134 GH	5.13(17)	5.81(5)	–3.86 Q	–2.01	–12(3)
Cs-137 GH	10.83(23)	10.43(7)	1.67	0.66	3.9(23)
Eu-152 GH	11.32(12)	11.78(13)	–2.61 Q	–0.68	–3.9(15)
Eu-154 GH	2.81(21)	1.94(4)	4.11 D	7.77 D	45(11)

Table B27 – Laboratory 42

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Ra-226 AL	13(3)	10.25(18)	0.93	4.55 Q	3(3) × 10^{1}
Am-241 AL	5.3(6)	5.00(6)	0.59	1.17	7(12)
gross a AL	70.4(9)	83(18)	–0.69	–2.62 Q	–15(19)
Be-7 GL	11.7(16)	11.02(13)	0.39	1.00	6(15)
Co-60 GL	11.9(12)	11.252(25)	0.50	0.93	5(11)
Zr-95 GL	2.6(3)	2.551(20)	0.03	0.06	0(12)
Nb-95 GL	6.1(7)	5.55(5)	0.83	1.67	10(12)
Cs-134 GL	13.2(14)	13.59(10)	–0.31	–0.54	–3(10)
Cs-137 GL	11.5(12)	10.58(21)	0.73	1.43	8(11)
Eu-152 GL	16.6(17)	16.80(11)	–0.13	–0.22	–1(10)
Eu-154 GL	3.4(4)	3.437(25)	–0.13	–0.24	–1(11)

Table B28 – Laboratory 45

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	10(3)	11.02(13)	–0.46	–1.93	–11(24)
Co-60 GL	12.1(7)	11.252(25)	1.14	1.25	7(7)
Zr-95 GL	3.5(9)	2.551(20)	1.11	6.66 Q	4(4) × 10^{1}
Nb-95 GL	5.9(5)	5.55(5)	0.63	0.96	6(9)
Cs-134 GL	15.3(14)	13.59(10)	1.19	2.17	13(11)
Cs-137 GL	11.9(9)	10.58(21)	1.39	2.14	12(9)
Eu-152 GL	17(4)	16.80(11)	0.15	0.47	3(19)
Eu-154 GL	–	3.437(25)	–	–	–

Table B29 – Laboratory 46

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Ra-226 AL	10.2(6)	10.25(18)	–0.10	–0.10	–1(6)
Th-232 AL	5.3(4)	5.47(8)	–0.36	–0.46	–3(8)
U-238 AL	7.2(4)	7.76(20)	–1.16	–1.17	–7(6)
Pu-239 AL	11.5(9)	12.37(19)	–0.97	–1.26	–7(8)
Am-241 AL	4.7(4)	5.00(6)	–0.81	–1.15	–7(8)
Cm-244 AL	14.7(12)	15.74(19)	–0.87	–1.14	–7(8)
	Bq g^{-1}	Bq g^{-1}			
Pb-210 AH	2.49(9)	2.54(3)	–0.52	–0.33	–2(4)
Po-210 AH	2.33(13)	2.54(3)	–1.57	–1.41	–8(5)
Pu-238 AH	17.5(11)	18.08(6)	–0.55	–0.58	–3(6)
Pu-239 AH	16.8(11)	17.29(8)	–0.49	–0.52	–3(6)
Am-241 AH	4.6(3)	4.382(10)	0.64	0.78	5(7)
Cm-244 AH	18.8(12)	18.29(6)	0.42	0.49	3(7)
Pu-238 P	4.9(4)	5.054(23)	–0.55	–0.62	–4(7)
Pu-239 P	5.4(4)	5.79(6)	–1.04	–1.13	–7(6)
Pu-241 P	11.5(6)	14.96(16)	–6.06 D	–3.99 D	–23(4)

Table B30 – Laboratory 47

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Ra-226 AL	10.4(5)	10.25(18)	0.25	0.22	1(5)
Th-232 AL	5.3(3)	5.47(8)	–0.48	–0.49	–3(6)
Th-232 AL	5.0(5)	5.47(8)	–1.02	–1.62	–9(9)
U-238 AL	7.3(3)	7.76(20)	–1.31	–1.02	–6(5)
U-238 AL	7.46(13)	7.76(20)	–1.27	–0.66	–4(3)
Pu-239 AL	11.7(5)	12.37(19)	–1.44	–0.94	–5(4)
Am-241 AL	4.93(22)	5.00(6)	–0.33	–0.26	–1(5)
Cm-244 AL	15.7(6)	15.74(19)	–0.11	–0.08	0(4)
gross a AL	99(8)	83(18)	0.79	3.25 Q	2(3) × 10^{1}
	Bq g^{-1}	Bq g^{-1}			
Po-210 AH	2.59(17)	2.54(3)	0.30	0.34	2(7)
Np-237 AH	17.0(7)	17.45(18)	–0.69	–0.48	–3(4)
Np-237 AH	16.6(13)	17.45(18)	–0.65	–0.84	–5(8)
Pu-238 AH	17.2(6)	18.08(6)	–1.52	–0.83	–5(4)
Pu-239 AH	16.8(6)	17.29(8)	–0.87	–0.48	–3(4)
Am-241 AH	4.21(23)	4.382(10)	–0.75	–0.67	–4(6)
Am-241 AH	4.3(3)	4.382(10)	–0.31	–0.32	–2(6)
Cm-244 AH	17.9(7)	18.29(6)	–0.51	–0.35	–2(4)
gross a AH	73(4)	80.57(21)	–2.01	–1.63	–10(5)
Pu-238 P	5.20(20)	5.054(23)	0.73	0.50	3(4)
Pu-239 P	5.8(3)	5.79(6)	–0.04	–0.03	0(5)
Pu-241 P	15.1(12)	14.96(16)	0.12	0.16	1(8)
Tc-99 B1	0.114(11)	0.1218(11)	–0.71	–1.11	–6(9)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	7.3(9)	11.02(13)	–4.21 D	–5.78 D	–34(8)
Co-60 GL	9.3(6)	11.252(25)	–3.34 D	–2.96 D	–17(5)
Zr-95 GL	2.28(22)	2.551(20)	–1.23	–1.82	–11(9)
Nb-95 GL	4.5(3)	5.55(5)	–3.59 D	–3.37 D	–20(6)
Cs-134 GL	10.6(7)	13.59(10)	–4.49 D	–3.73 D	–22(5)
Cs-137 GL	8.7(6)	10.58(21)	–3.24 D	–3.08 D	–18(6)
Eu-152 GL	13.3(8)	16.80(11)	–4.28 D	–3.58 D	–21(5)

continues

continued					
Eu-154 GL	2.59(18)	3.437(25)	–4.66 D	–4.23 D	–25(6)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.17(25)	4.24(8)	–0.26	–0.27	–2(6)
Co-60 GH	3.27(20)	3.427(8)	–0.78	–0.79	–5(6)
Zr-95 GH	1.79(11)	1.875(15)	–0.77	–0.78	–5(6)
Nb-95 GH	4.03(24)	4.08(4)	–0.21	–0.21	–1(6)
Cs-134 GH	5.2(3)	5.81(5)	–1.91	–1.77	–10(6)
Cs-137 GH	10.3(6)	10.43(7)	–0.24	–0.24	–1(6)
Eu-152 GH	10.9(7)	11.78(13)	–1.27	–1.23	–7(6)
Eu-154 GH	1.86(11)	1.94(4)	–0.65	–0.67	–4(6)

Table B31 – Laboratory 48

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.28(17)	4.24(8)	0.23	0.17	1(5)
Co-60 GH	3.52(9)	3.427(8)	1.03	0.47	3(3)
Zr-95 GH	1.86(9)	1.875(15)	–0.17	–0.14	–1(5)
Nb-95 GH	4.07(10)	4.08(4)	–0.09	–0.04	0(3)
Cs-134 GH	5.60(14)	5.81(5)	–1.42	–0.62	–3.6(25)
Cs-137 GH	10.30(24)	10.43(7)	–0.51	–0.21	–1.2(24)
Eu-152 GH	11.7(8)	11.78(13)	–0.10	–0.12	–1(7)
Eu-154 GH	1.85(15)	1.94(4)	–0.55	–0.75	–4(8)
Co-60 S	8.3(3)	7.82(20)	1.34	1.05	6(5)
Cs-137 S	10.8(4)	10.5(3)	0.70	0.50	3(4)
Eu-152 S	17.1(12)	16.0(5)	0.90	1.21	7(8)
Eu-154 S	1.97(20)	1.96(6)	0.06	0.12	1(11)
Am-241 S	2.58(17)	2.57(12)	0.06	0.09	1(8)

Table B32 – Laboratory 51

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Th-232 AL	5.40(20)	5.47(8)	–0.30	–0.21	–1(4)
U-238 AL	7.9(3)	7.76(20)	0.39	0.31	2(5)
Pu-239 AL	11.6(4)	12.37(19)	–1.73	–1.07	–6(4)
Am-241 AL	5.10(20)	5.00(6)	0.45	0.33	2(4)
Be-7 GL	12.6(14)	11.02(13)	1.13	2.47	14(13)
Co-60 GL	11.8(7)	11.252(25)	0.78	0.84	5(6)
Zr-95 GL	2.80(22)	2.551(20)	1.13	1.68	10(9)
Nb-95 GL	5.9(6)	5.55(5)	0.58	1.09	6(11)
Cs-134 GL	13.5(7)	13.59(10)	–0.13	–0.12	–1(5)
Cs-137 GL	11.2(6)	10.58(21)	0.98	1.01	6(11)
Eu-152 GL	16.8(9)	16.80(11)	0.00	0.00	0(6)
Eu-154 GL	3.20(25)	3.437(25)	–0.94	–1.19	–7(7)

Table B33 – Laboratory 52

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	10.3(9)	11.02(13)	–0.76	–1.12	–7(9)
Co-60 GL	11.3(5)	11.252(25)	0.11	0.07	0(4)
Zr-95 GL	2.30(18)	2.551(20)	–1.38	–1.69	–10(7)
Nb-95 GL	5.5(4)	5.55(5)	–0.15	–0.15	–1(6)
Cs-134 GL	13.1(5)	13.59(10)	–0.93	–0.62	–4(4)
Cs-137 GL	10.2(6)	10.58(21)	–0.58	–0.62	–4(6)
Eu-152 GL	16.5(7)	16.80(11)	–0.44	–0.30	–2(4)
Eu-154 GL	3.20(22)	3.437(25)	–1.07	–1.19	–7(7)

Table B34 – Laboratory 53

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	10.6(9)	11.02(13)	–0.49	–0.70	–4(8)
Co-60 GL	10.9(5)	11.252(25)	–0.64	–0.48	–3(5)
Zr-95 GL	2.46(17)	2.551(20)	–0.53	–0.61	–4(7)
Nb-95 GL	5.7(3)	5.55(5)	0.48	0.44	3(6)
Cs-134 GL	13.3(6)	13.59(10)	–0.55	–0.41	–2(5)
Cs-137 GL	10.8(5)	10.58(21)	0.47	0.37	2(5)
Eu-152 GL	16.1(9)	16.80(11)	–0.75	–0.67	–4(5)
Eu-154 GL	3.7(3)	3.437(25)	0.85	1.11	6(8)

Table B35 – Laboratory 55

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Pb-210 AH	3.5(3)	2.54(3)	3.60 D	6.36 D	37(10)
Np-237 AH	15(3)	17.45(18)	–1.14	–2.90 Q	–17(15)
Np-237 AH	17.8(22)	17.45(18)	0.16	0.34	2(13)
Pu-238 AH	15.1(8)	18.08(6)	–3.80 D	–2.83 D	–16(5)
Pu-239 AH	14.3(8)	17.29(8)	–3.94 D	–2.97 D	–17(5)
Am-241 AH	4.31(10)	4.382(10)	–0.71	–0.28	–1.6(23)
Cm-244 AH	17.6(10)	18.29(6)	–0.67	–0.65	–4(6)
gross a AH	66.3(20)	80.57(21)	–7.09 D	–3.04 D	–17.7(25)
Pu-238 P	5.00(20)	5.054(23)	–0.27	–0.18	–1(4)
Pu-239 P	5.72(23)	5.79(6)	–0.30	–0.21	–1(4)
Pu-241 P	15.1(10)	14.96(16)	0.14	0.16	1(7)
H-3 B1	1.41(15)	1.345(10)	0.45	0.83	5(11)
C-14 B1	0.145(6)	0.1398(9)	0.88	0.64	4(5)
Tc-99 B1	0.110(17)	0.1218(11)	–0.69	–1.67	–10(14)
H-3 B2	0.94(12)	0.897(7)	0.34	0.78	5(13)
Fe-55 B2	1.07(12)	1.235(22)	–1.31	–2.30	–13(10)
Sr-89 B2	0.73(7)	0.822(3)	–1.32	–1.99	–12(9)
Sr-90 B2	1.48(14)	1.488(4)	–0.06	–0.09	–1(9)
gross b I B2	3.75(24)	3.799(6)	–0.20	–0.22	–1(7)
Be-7 GH	4.48(14)	4.24(8)	1.53	0.98	6(4)
Co-60 GH	3.55(4)	3.427(8)	3.01 Q	0.62	3.6(12)
Zr-95 GH	1.94(4)	1.875(15)	1.52	0.59	3.4(23)
Nb-95 GH	4.36(8)	4.08(4)	3.22 Q	1.18	6.9(22)
Cs-134 GH	5.82(9)	5.81(5)	0.10	0.03	0.2(17)
Cs-137 GH	10.50(12)	10.43(7)	0.51	0.12	0.7(13)
Eu-152 GH	11.70(15)	11.78(13)	–0.43	–0.12	–0.7(17)
Eu-154 GH	2.02(3)	1.94(4)	1.88	0.75	4.4(24)
Co-60 S	7.7(4)	7.82(20)	–0.27	–0.26	–2(6)
Cs-137 S	10.2(5)	10.5(3)	–0.53	–0.52	–3(6)
Eu-152 S	13.5(7)	16.0(5)	–3.03 D	–2.67 D	–16(5)
Eu-154 S	18.60(10)	1.96(6)	147.39 D	146.06 D	85(3) × 10^1
Am-241 S	2.34(12)	2.57(12)	–1.31	–1.52	–9(7)

Table B36 – Laboratory 59

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Tc-99 B1	0.120(10)	0.1218(11)	–0.18	–0.26	–2(8)
Be-7 GH	4.3(4)	4.24(8)	0.13	0.21	1(9)
Co-60 GH	3.6(3)	3.427(8)	0.63	0.92	5(9)
Zr-95 GH	1.93(16)	1.875(15)	0.34	0.50	3(9)
Nb-95 GH	4.3(4)	4.08(4)	0.51	0.76	4(9)
Cs-134 GH	6.0(5)	5.81(5)	0.33	0.47	3(8)
Cs-137 GH	11.1(9)	10.43(7)	0.78	1.16	7(9)
Eu-152 GH	12.4(10)	11.78(13)	0.64	0.94	5(9)
Eu-154 GH	2.01(16)	1.94(4)	0.46	0.67	4(9)

Table B37 – Laboratory 62

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Pu-239 AL	10.4(6)	12.37(19)	–3.38 D	–2.73 D	–16(5)
Am-241 AL	3.93(23)	5.00(6)	–4.51 D	–3.69 D	–21(5)
	Bq g^{-1}	Bq g^{-1}			
Tc-99 B1	0.1400(25)	0.1218(11)	6.65 Q	2.56	14.9(23)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	11.7(22)	11.02(13)	0.31	1.06	6(20)
Co-60 GL	11.1(9)	11.252(25)	–0.16	–0.23	–1(8)
Zr-95 GL	2.7(4)	2.551(20)	0.30	0.74	4(14)
Nb-95 GL	5.2(4)	5.55(5)	–0.85	–0.96	–6(7)
Cs-134 GL	13.1(4)	13.59(10)	–1.47	–0.62	–3.6(25)
Cs-137 GL	10.0(4)	10.58(21)	–1.34	–0.96	–6(4)
Eu-152 GL	15.2(4)	16.80(11)	–3.93 Q	–1.63	–9.5(24)
Eu-154 GL	–	3.437(25)	–	–	–

Table B38 – Laboratory 65

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Ra-226 AL	11.3(13)	10.25(18)	0.79	1.73	10(13)
Th-232 AL	5.2(3)	5.47(8)	–0.88	–0.83	–5(6)
U-238 AL	7.8(5)	7.76(20)	0.00	0.00	0(7)
Pu-239 AL	12.1(6)	12.37(19)	–0.37	–0.33	–2(5)
Am-241 AL	5.6(4)	5.00(6)	1.52	1.90	11(7)
Cm-244 AL	16.9(13)	15.74(19)	0.92	1.27	7(8)
	Bq g^{-1}	Bq g^{-1}			
Pb-210 AH	2.91(12)	2.54(3)	2.97 Q	2.51	15(5)
Np-237 AH	17.6(7)	17.45(18)	0.20	0.15	1(5)
Am-241 AH	4.20(14)	4.382(10)	–1.27	–0.71	–4(4)
H-3 B1	1.26(5)	1.345(10)	–1.67	–1.08	–6(4)
Tc-99 B1	0.120(8)	0.1218(11)	–0.23	–0.26	–2(7)
H-3 B2	0.85(3)	0.897(7)	–1.54	–0.90	–5(4)
Fe-55 B2	0.86(6)	1.235(22)	–5.69 D	–5.27 D	–31(5)
Sr-89 B2	1.42(23)	0.822(3)	2.66 D	12.49 D	7(3) × 10^{1}
Sr-90 B2	1.4(3)	1.488(4)	–0.25	–0.90	–5(21)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	11.8(5)	11.02(13)	1.46	1.22	7(5)
Co-60 GL	11.7(4)	11.252(25)	1.15	0.68	4(4)
Zr-95 GL	2.57(17)	2.551(20)	0.11	0.13	1(7)
Nb-95 GL	6.5(4)	5.55(5)	2.37	2.88 Q	17(7)
Cs-134 GL	13.6(5)	13.59(10)	0.01	0.01	0(4)
Cs-137 GL	11.2(4)	10.58(21)	1.46	1.01	6(4)
Eu-152 GL	16.4(6)	16.80(11)	–0.68	–0.41	–2(4)
Eu-154 GL	3.2(4)	3.437(25)	–0.61	–1.04	–6(10)

Table B39 – Laboratory 72

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
H-3 B2	0.80(5)	0.897(7)	–1.93	–1.86	–11(6)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	12.9(8)	11.02(13)	2.28	2.92 Q	17(8)
Co-60 GL	12.8(7)	11.252(25)	2.14	2.29	13(6)
Zr-95 GL	3.66(25)	2.551(20)	4.42 D	7.47 D	43(10)
Nb-95 GL	7.0(4)	5.55(5)	3.70 D	4.61 D	27(7)
Cs-134 GL	15.7(9)	13.59(10)	2.44	2.67 Q	16(7)
Cs-137 GL	12.7(7)	10.58(21)	2.89 D	3.47 D	20(7)
Eu-152 GL	19.9(11)	16.80(11)	2.69 D	3.12 D	18(7)
Eu-154 GL	3.63(25)	3.437(25)	0.77	0.96	6(7)

Table B40 – Laboratory 73

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Ra-226 AL	10.5(3)	10.25(18)	0.72	0.42	2(4)
U-238 AL	7.1(3)	7.76(20)	–1.84	–1.46	–9(5)
Pu-239 AL	11.3(7)	12.37(19)	–1.47	–1.48	–9(6)
Am-241 AL	4.8(3)	5.00(6)	–0.67	–0.70	–4(6)
Cm-244 AL	14.0(6)	15.74(19)	–2.75 Q	–1.89	–11(4)
	Bq g^{-1}	Bq g^{-1}			
Pu-238 AH	17.2(11)	18.08(6)	–0.80	–0.83	–5(6)
Pu-239 AH	16.8(11)	17.29(8)	–0.44	–0.48	–3(7)
Am-241 AH	4.30(20)	4.382(10)	–0.41	–0.32	–2(5)
Cm-244 AH	18.3(7)	18.29(6)	0.01	0.01	0(4)
Sr-90 B2	1.51(6)	1.488(4)	0.36	0.25	1(4)
Be-7 GH	4.10(20)	4.24(8)	–0.65	–0.56	–3(5)
Co-60 GH	3.45(17)	3.427(8)	0.13	0.12	1(5)
Zr-95 GH	1.70(20)	1.875(15)	–0.87	–1.61	–9(11)
Nb-95 GH	–	4.08(4)	–	–	–
Cs-134 GH	5.9(3)	5.81(5)	0.30	0.27	2(5)
Cs-137 GH	10.5(5)	10.43(7)	0.14	0.12	1(5)
Eu-152 GH	12.0(6)	11.78(13)	0.35	0.31	2(5)
Eu-154 GH	1.90(10)	1.94(4)	–0.33	–0.31	–2(6)

Table B41 – Laboratory 74

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
H-3 B2	0.92(4)	0.897(7)	0.73	0.51	3(4)
Sr-89 B2	0.77(3)	0.822(3)	–1.65	–1.00	–6(4)
Sr-90 B2	1.36(6)	1.488(4)	–2.38	–1.46	–8(4)

Table B42 – Laboratory 76

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Tc-99 B1	0.110(5)	0.1218(11)	–2.63 Q	–1.68	–10(4)
Sr-90 B2	1.55(4)	1.488(4)	1.79	0.72	4.2(24)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	8.8(10)	11.02(13)	–2.26	–3.49 Q	–20(9)
Co-60 GL	11.3(6)	11.252(25)	0.08	0.07	0(6)
Zr-95 GL	3.1(4)	2.551(20)	1.26	3.56 Q	21(16)
Nb-95 GL	8.2(4)	5.55(5)	7.40 D	8.08 D	47(7)
Cs-134 GL	13.8(5)	13.59(10)	0.44	0.26	2(4)
Cs-137 GL	10.5(4)	10.58(21)	–0.19	–0.13	–1(4)
Eu-152 GL	16.5(7)	16.80(11)	–0.40	–0.30	–2(5)
Eu-154 GL	5.5(5)	3.437(25)	3.87 D	10.05 D	59(15)

Table B43 – Laboratory 82

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	12.7(16)	11.02(13)	1.05	2.62 Q	15(15)
Co-60 GL	11.4(11)	11.252(25)	0.13	0.23	1(10)
Zr-95 GL	3.0(4)	2.551(20)	1.43	3.09 Q	18(13)
Nb-95 GL	6.3(7)	5.55(5)	1.03	2.26	13(13)
Cs-134 GL	13.2(13)	13.59(10)	–0.30	–0.50	–3(10)
Cs-137 GL	11.7(12)	10.58(21)	0.92	1.82	11(12)
Eu-152 GL	18.4(19)	16.80(11)	0.84	1.64	10(11)
Eu-154 GL	4.7(6)	3.437(25)	2.38	6.31 Q	37(15)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.2(5)	4.24(8)	–0.11	–0.19	–1(10)
Co-60 GH	3.3(4)	3.427(8)	–0.54	–0.89	–5(10)
Zr-95 GH	1.86(19)	1.875(15)	–0.08	–0.14	–1(10)
Nb-95 GH	4.1(5)	4.08(4)	0.13	0.25	1(12)
Cs-134 GH	5.5(6)	5.81(5)	–0.48	–0.80	–5(10)
Cs-137 GH	10.6(11)	10.43(7)	0.16	0.28	2(11)
Eu-152 GH	11.8(12)	11.78(13)	0.01	0.02	0(10)
Eu-154 GH	2.28(23)	1.94(4)	1.48	3.06 Q	18(12)

Table B44 – Laboratory 83

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Tc-99 B1	0.130(10)	0.1218(11)	0.81	1.15	7(8)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	–	11.02(13)	–	–	–
Co-60 GL	13.0(16)	11.252(25)	1.09	2.67 Q	16(14)
Zr-95 GL	–	2.551(20)	–	–	–
Nb-95 GL	–	5.55(5)	–	–	–
Cs-134 GL	12.8(12)	13.59(10)	–0.66	–1.00	–6(9)
Cs-137 GL	11.6(11)	10.58(21)	0.91	1.65	10(11)
Eu-152 GL	–	16.80(11)	–	–	–
Eu-154 GL	–	3.437(25)	–	–	–
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	–	4.24(8)	–	–	–
Co-60 GH	3.8(4)	3.427(8)	0.93	1.87	11(12)
Zr-95 GH	–	1.875(15)	–	–	–
Nb-95 GH	–	4.08(4)	–	–	–
Cs-134 GH	5.4(4)	5.81(5)	–1.02	–1.21	–7(7)
Cs-137 GH	11.0(10)	10.43(7)	0.57	0.94	5(10)
Eu-152 GH	–	11.78(13)	–	–	–
Eu-154 GH	–	1.94(4)	–	–	–
Co-60 S	8.3(9)	7.82(20)	0.52	1.05	6(12)
Cs-137 S	11.2(7)	10.5(3)	0.90	1.12	6(7)

Table B45 – Laboratory 86

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Ra-226 AL	12.0(20)	10.25(18)	0.87	2.94 Q	17(20)
Pu-239 AL	9.92(18)	12.37(19)	–9.33 D	–3.40 D	–19.8(19)
	Bq g^{-1}	Bq g^{-1}			
Pu-238 P	4.31(13)	5.054(23)	–5.63 Q	–2.53	–15(3)
Pu-238 P	4.23(19)	5.054(23)	–4.30 D	–2.80 D	–16(4)
Pu-239 P	4.90(15)	5.79(6)	–5.51 D	–2.64 D	–15(3)
Pu-239 P	4.79(23)	5.79(6)	–4.21 D	–2.97 D	–17(4)
Pu-241 P	12.5(6)	14.96(16)	–3.86 D	–2.85 D	–17(4)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	11.3(5)	11.02(13)	0.55	0.44	3(5)
Co-60 GL	11.5(4)	11.252(25)	0.64	0.38	2(4)
Zr-95 GL	2.57(23)	2.551(20)	0.08	0.13	1(9)
Nb-95 GL	5.83(25)	5.55(5)	1.10	0.87	5(5)
Cs-134 GL	13.8(6)	13.59(10)	0.35	0.26	2(5)
Cs-137 GL	10.9(3)	10.58(21)	0.94	0.52	3(4)
Eu-152 GL	16.9(7)	16.80(11)	0.15	0.11	1(4)
Eu-154 GL	3.54(16)	3.437(25)	0.63	0.51	3(5)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.30(23)	4.24(8)	0.26	0.25	1(6)
Co-60 GH	3.38(22)	3.427(8)	–0.21	–0.24	–1(7)
Zr-95 GH	2.04(11)	1.875(15)	1.48	1.51	9(6)
Nb-95 GH	4.17(22)	4.08(4)	0.41	0.38	2(6)
Cs-134 GH	5.6(4)	5.81(5)	–0.62	–0.65	–4(6)
Cs-137 GH	10.5(6)	10.43(7)	0.11	0.10	1(6)
Eu-152 GH	11.8(7)	11.78(13)	0.01	0.01	0(6)
Eu-154 GH	1.84(11)	1.94(4)	–0.83	–0.84	–5(6)

Table B46 – Laboratory 89

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	11.7(12)	11.02(13)	0.60	1.08	6(11)
Co-60 GL	11.1(6)	11.252(25)	–0.22	–0.22	–1(6)
Zr-95 GL	2.91(22)	2.551(20)	1.63	2.42	14(9)
Nb-95 GL	5.3(4)	5.55(5)	–0.84	–0.86	–5(6)
Cs-134 GL	13.0(8)	13.59(10)	–0.76	–0.71	–4(6)
Cs-137 GL	10.6(6)	10.58(21)	0.06	0.06	0(6)
Eu-152 GL	16.4(9)	16.80(11)	–0.43	–0.41	–2(6)
Eu-154 GL	3.13(20)	3.437(25)	–1.53	–1.54	–9(6)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.2(3)	4.24(8)	–0.10	–0.11	–1(7)
Co-60 GH	3.43(19)	3.427(8)	0.02	0.01	0(6)
Zr-95 GH	1.91(11)	1.875(15)	0.31	0.32	2(6)
Nb-95 GH	4.32(25)	4.08(4)	0.95	1.01	6(6)
Cs-134 GH	5.6(3)	5.81(5)	–0.64	–0.59	–3(6)
Cs-137 GH	10.5(6)	10.43(7)	0.07	0.07	0(6)
Eu-152 GH	11.7(9)	11.78(13)	–0.12	–0.15	–1(8)
Eu-154 GH	1.84(11)	1.94(4)	–0.83	–0.84	–5(6)

Table B47 – Laboratory 90

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Th-232 AL	5.2(5)	5.47(8)	–0.52	–0.87	–5(10)
U-238 AL	6.5(7)	7.76(20)	–1.84	–2.81 Q	–16(9)
Pu-239 AL	9.4(9)	12.37(19)	–3.14 D	–4.18 D	–24(8)
Am-241 AL	4.6(5)	5.00(6)	–0.88	–1.42	–8(10)
Cm-244 AL	13.6(14)	15.74(19)	–1.50	–2.29	–13(9)
	Bq g^{-1}	Bq g^{-1}			
H-3 B2	0.72(3)	0.897(7)	–5.71 D	–3.35 D	–20(4)
Sr-89 B2	0.81(8)	0.822(3)	–0.15	–0.25	–1(10)
Sr-90 B2	1.47(15)	1.488(4)	–0.12	–0.21	–1(10)

Table B48 – Laboratory 91

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
U-238 AL	7.3(7)	7.76(20)	–0.60	–1.00	–6(10)
Pu-239 AL	12.3(11)	12.37(19)	–0.03	–0.05	0(9)
Am-241 AL	5.1(5)	5.00(6)	0.21	0.35	2(10)
Cm-244 AL	15.4(14)	15.74(19)	–0.27	–0.41	–2(9)
	Bq g^{-1}	Bq g^{-1}			
H-3 B1	1.46(14)	1.345(10)	0.77	1.41	8(11)
C-14 B1	0.24(3)	0.1398(9)	3.38 D	12.03 D	70(21)
H-3 B2	0.99(10)	0.897(7)	0.89	1.74	10(11)
Sr-89 B2	0.82(11)	0.822(3)	0.01	0.02	0(13)
Sr-90 B2	1.45(19)	1.488(4)	–0.21	–0.48	–3(13)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	9.7(7)	11.02(13)	–2.03	–2.10	–12(6)
Co-60 GL	11.6(7)	11.252(25)	0.42	0.46	3(7)
Zr-95 GL	3.8(3)	2.551(20)	4.72 D	8.61 D	50(11)
Nb-95 GL	5.4(5)	5.55(5)	–0.39	–0.59	–3(9)
Cs-134 GL	12.5(13)	13.59(10)	–0.83	–1.35	–8(9)
Cs-137 GL	11.3(7)	10.58(21)	0.99	1.20	7(7)
Eu-152 GL	16.7(15)	16.80(11)	–0.04	–0.06	0(9)
Eu-154 GL	–	3.437(25)	–	–	–

Table B49 – Laboratory 94

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Pu-238 P	5.8(5)	5.054(23)	1.60	2.40	14(9)
Pu-239 P	6.9(5)	5.79(6)	2.18	3.32 Q	19(9)
Pu-241 P	14.4(9)	14.96(16)	–0.64	–0.64	–4(6)
H-3 B1	1.30(8)	1.345(10)	–0.56	–0.57	–3(6)
C-14 B1	0.102(6)	0.1398(9)	–6.23 D	–4.65 D	–27(5)
Cl-36 B1	0.400(20)	0.4544(18)	–2.71 Q	–2.06	–12(5)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	13.8(15)	11.02(13)	1.85	4.34 Q	25(14)
Co-60 GL	11.1(8)	11.252(25)	–0.19	–0.23	–1(7)
Zr-95 GL	3.4(4)	2.551(20)	2.12	5.72 Q	33(16)
Nb-95 GL	3.6(4)	5.55(5)	–4.84 D	–6.03 D	–35(7)
Cs-134 GL	13.9(13)	13.59(10)	0.23	0.39	2(10)
Cs-137 GL	10.9(7)	10.58(21)	0.44	0.52	3(7)
Eu-152 GL	17.0(14)	16.80(11)	0.14	0.21	1(8)
Eu-154 GL	2.9(5)	3.437(25)	–1.07	–2.69 Q	–16(15)
	Bq g^{-1}	Bq g^{-1}			
Co-60 S	8.0(5)	7.82(20)	0.27	0.31	2(7)
Cs-137 S	10.6(3)	10.5(3)	0.20	0.14	1(4)
Eu-152 S	16.4(14)	16.0(5)	0.28	0.44	3(9)
Eu-154 S	2.05(18)	1.96(6)	0.49	0.82	5(10)
Am-241 S	2.40(20)	2.57(12)	–0.71	–1.12	–7(9)

Table B50 – Laboratory 95

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
H-3 B1	1.47(7)	1.345(10)	1.81	1.54	9(5)
C-14 B1	0.142(5)	0.1398(9)	0.38	0.24	1(4)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	8.8(7)	11.02(13)	–3.16 D	–3.41 D	–20(6)
Co-60 GL	11.8(4)	11.252(25)	1.52	0.79	5(3)
Zr-95 GL	2.67(17)	2.551(20)	0.70	0.80	5(7)
Nb-95 GL	6.2(3)	5.55(5)	2.39	1.95	11(5)
Cs-134 GL	12.87(17)	13.59(10)	–3.65 Q	–0.92	–5.3(14)
Cs-137 GL	10.48(20)	10.58(21)	–0.35	–0.16	–1(3)
Eu-152 GL	16.4(5)	16.80(11)	–0.73	–0.38	–2(3)
Eu-154 GL	3.30(16)	3.437(25)	–0.85	–0.69	–4(5)
	Bq g^{-1}	Bq g^{-1}			
Co-60 S	9.8(3)	7.82(20)	5.91 D	4.28 D	25(5)
Cs-137 S	12.61(16)	10.5(3)	6.20 D	3.42 D	20(4)
Eu-152 S	17.6(5)	16.0(5)	2.40	1.68	10(5)
Eu-154 S	2.36(7)	1.96(6)	4.65 D	3.56 D	21(5)
Am-241 S	3.0(7)	2.57(12)	0.63	3.11 Q	2(3) × 10^1

Table B51 – Laboratory 98

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Co-60 S	8.94(24)	7.82(20)	3.60 Q	2.46	14(5)
Cs-137 S	12.7(4)	10.5(3)	4.21 D	3.53 D	21(5)
Eu-152 S	18.9(17)	16.0(5)	1.68	3.10 Q	18(11)
Eu-154 S	2.20(19)	1.96(6)	1.22	2.13	12(10)
Am-241 S	2.97(13)	2.57(12)	2.24	2.70 Q	16(8)

Table B52 – Laboratory 99

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
gross a AL	29(3)	83(18)	–2.91 D	–11.25 D	–65(9)
gross a AL	26(3)	83(18)	–3.05 D	–11.75 D	–68(8)
	Bq g^{-1}	Bq g^{-1}			
gross a AH	16.7(17)	80.57(21)	–37.91 D	–13.61 D	–79.2(21)
gross a AH	22.2(22)	80.57(21)	–26.18 D	–12.45 D	–72(3)
H-3 B1	1.52(15)	1.345(10)	1.17	2.24	13(11)
H-3 B2	0.49(5)	0.897(7)	–8.08 D	–7.79 D	–45(6)
gross b I B2	4.0(4)	3.799(6)	0.50	0.91	5(11)
gross b L B2	5.9(6)	5.931(23)	–0.09	–0.15	–1(10)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	13.1(13)	11.02(13)	1.55	3.18 Q	19(12)
Co-60 GL	11.4(11)	11.252(25)	0.09	0.15	1(10)
Zr-95 GL	3.6(4)	2.551(20)	2.97 D	7.20 D	42(14)
Nb-95 GL	6.4(7)	5.55(5)	1.37	2.73 Q	16(12)
Cs-134 GL	12.4(12)	13.59(10)	–0.98	–1.53	–9(9)
Cs-137 GL	11.5(12)	10.58(21)	0.79	1.49	9(11)
Eu-152 GL	14.1(14)	16.80(11)	–1.91	–2.77 Q	–16(9)
Eu-154 GL	3.8(4)	3.437(25)	0.90	1.71	10(11)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.2(4)	4.24(8)	0.01	0.01	0(10)
Co-60 GH	3.5(4)	3.427(8)	0.07	0.12	1(10)
Zr-95 GH	1.89(19)	1.875(15)	0.08	0.13	1(10)
Nb-95 GH	4.9(5)	4.08(4)	1.71	3.54 Q	21(12)
Cs-134 GH	4.8(5)	5.81(5)	–2.05	–2.92 Q	–17(8)
Cs-137 GH	11.0(11)	10.43(7)	0.51	0.93	5(11)
Eu-152 GH	10.5(11)	11.78(13)	–1.18	–1.81	–11(9)
Eu-154 GH	2.00(20)	1.94(4)	0.32	0.58	3(10)

Table B53 – Laboratory 104

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	8.9(18)	11.02(13)	–1.19	–3.29 Q	–19(16)
Co-60 GL	11.4(3)	11.252(25)	0.67	0.29	1.7(25)
Zr-95 GL	–	2.551(20)	–	–	–
Nb-95 GL	–	5.55(5)	–	–	–
Cs-134 GL	13.6(6)	13.59(10)	–0.01	–0.01	0(5)
Cs-137 GL	11.0(4)	10.58(21)	1.03	0.65	4(4)
Eu-152 GL	17.3(9)	16.80(11)	0.58	0.52	3(5)
Eu-154 GL	3.4(3)	3.437(25)	–0.29	–0.39	–2(8)
	Bq g^{-1}	Bq g^{-1}			
Co-60 S	8.80(24)	7.82(20)	3.15 Q	2.15	13(4)
Cs-137 S	11.72(20)	10.5(3)	3.37 Q	1.96	11(4)
Eu-152 S	17.5(5)	16.0(5)	2.16	1.59	9(5)
Eu-154 S	2.29(8)	1.96(6)	3.29 D	2.91 D	17(6)
Am-241 S	3.26(17)	2.57(12)	3.29 D	4.64 D	27(9)

Table B54 – Laboratory 106

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Ra-226 AL	11.2(6)	10.25(18)	1.58	1.51	9(6)
Th-232 AL	5.5(3)	5.47(8)	0.26	0.23	1(5)
U-238 AL	7.6(4)	7.76(20)	–0.32	–0.29	–2(6)
Pu-239 AL	11.3(8)	12.37(19)	–1.30	–1.48	–9(7)
Am-241 AL	4.6(4)	5.00(6)	–1.07	–1.53	–9(8)
	Bq g^{-1}	Bq g^{-1}			
Pb-210 AH	2.56(12)	2.54(3)	0.17	0.14	1(5)
Po-210 AH	2.54(10)	2.54(3)	0.01	0.01	0(4)
Np-237 AH	21.1(19)	17.45(18)	1.91	3.59 Q	21(11)
Pu-238 AH	15.5(11)	18.08(6)	–2.34	–2.45	–14(6)
Pu-239 AH	14.9(11)	17.29(8)	–2.16	–2.37	–14(7)
Am-241 AH	3.8(4)	4.382(10)	–1.79	–2.24	–13(7)
Pu-238 P	4.5(3)	5.054(23)	–1.97	–1.95	–11(6)
Pu-239 P	5.1(4)	5.79(6)	–1.94	–1.93	–11(6)
H-3 B1	1.31(4)	1.345(10)	–0.85	–0.39	–2(3)
C-14 B1	0.142(6)	0.1398(9)	0.36	0.27	2(5)
H-3 B2	0.86(3)	0.897(7)	–1.28	–0.65	–4(3)
Sr-89 B2	0.99(13)	0.822(3)	1.23	3.45 Q	20(16)
Sr-90 B2	1.51(8)	1.488(4)	0.27	0.25	1(6)
Be-7 GH	4.4(4)	4.24(8)	0.40	0.66	4(10)
Co-60 GH	3.30(20)	3.427(8)	–0.63	–0.64	–4(6)
Zr-95 GH	2.00(20)	1.875(15)	0.62	1.14	7(11)
Nb-95 GH	4.0(5)	4.08(4)	–0.16	–0.34	–2(12)
Cs-134 GH	5.5(4)	5.81(5)	–0.77	–0.91	–5(5)
Cs-137 GH	10.5(8)	10.43(7)	0.09	0.12	1(8)
Eu-152 GH	11.2(6)	11.78(13)	–0.95	–0.85	–5(5)
Eu-154 GH	1.80(10)	1.94(4)	–1.28	–1.20	–7(6)
Co-60 S	7.5(5)	7.82(20)	–0.59	–0.70	–4(7)
Cs-137 S	10.6(9)	10.5(3)	0.09	0.14	1(9)
Eu-152 S	15.0(10)	16.0(5)	–0.90	–1.06	–6(7)
Eu-154 S	1.80(10)	1.96(6)	–1.35	–1.38	–8(6)
Am-241 S	2.7(3)	2.57(12)	0.41	0.89	5(13)

Table B55 – Laboratory 107

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Pu-238 P	4.8(3)	5.054(23)	–0.99	–0.94	–5(6)
Pu-239 P	5.3(3)	5.79(6)	–1.40	–1.31	–8(6)
Pu-241 P	12.5(9)	14.96(16)	–2.71 D	–2.88 D	–17(6)
H-3 B1	1.35(9)	1.345(10)	0.08	0.09	1(7)
C-14 B1	0.136(10)	0.1398(9)	–0.37	–0.46	–3(7)
Cl-36 B1	0.41(3)	0.4544(18)	–1.63	–1.60	–9(6)
Tc-99 B1	0.121(10)	0.1218(11)	–0.11	–0.16	–1(8)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	13.0(18)	11.02(13)	1.11	3.04 Q	18(16)
Co-60 GL	11.3(4)	11.252(25)	0.05	0.03	0(4)
Zr-95 GL	3.32(17)	2.551(20)	4.49 D	5.18 D	30(7)
Nb-95 GL	5.82(25)	5.55(5)	1.07	0.84	5(5)
Cs-134 GL	11.7(6)	13.59(10)	–2.95 Q	–2.34	–14(5)
Cs-137 GL	10.6(4)	10.58(21)	–0.07	–0.05	0(5)
Eu-152 GL	16.1(7)	16.80(11)	–1.00	–0.71	–4(4)
Eu-154 GL	3.32(17)	3.437(25)	–0.68	–0.59	–3(5)

Table B56 – Laboratory 108

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
H-3 B1	1.25(19)	1.345(10)	–0.50	–1.20	–7(14)
Be-7 GH	4.2(3)	4.24(8)	–0.06	–0.07	0(8)
Co-60 GH	3.45(25)	3.427(8)	0.09	0.12	1(8)
Zr-95 GH	1.83(13)	1.875(15)	–0.35	–0.41	–2(7)
Nb-95 GH	4.4(4)	4.08(4)	1.12	1.52	9(8)
Cs-134 GH	5.2(4)	5.81(5)	–1.69	–1.86	–11(7)
Cs-137 GH	10.7(8)	10.43(7)	0.34	0.43	3(8)
Eu-152 GH	11.2(8)	11.78(13)	–0.76	–0.88	–5(7)
Eu-154 GH	1.94(14)	1.94(4)	0.03	0.04	0(8)
Co-60 S	7.6(6)	7.82(20)	–0.33	–0.42	–2(8)
Cs-137 S	10.9(8)	10.5(3)	0.46	0.63	4(8)
Eu-152 S	13.9(10)	16.0(5)	–1.94	–2.26	–13(7)
Eu-154 S	1.87(14)	1.96(6)	–0.58	–0.75	–4(8)
Am-241 S	2.68(19)	2.57(12)	0.48	0.73	4(9)

Table B57 – Laboratory 111

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	–	11.02(13)	–	–	–
Co-60 GL	11.3(4)	11.252(25)	0.13	0.07	0(4)
Zr-95 GL	2.8(3)	2.551(20)	0.84	1.48	9(10)
Nb-95 GL	9.4(4)	5.55(5)	9.28 D	11.86 D	69(8)
Cs-134 GL	12.4(4)	13.59(10)	–3.04 Q	–1.51	–9(3)
Cs-137 GL	11.0(4)	10.58(21)	1.01	0.68	4(4)
Eu-152 GL	15.5(6)	16.80(11)	–2.19	–1.33	–8(4)
Eu-154 GL	3.14(21)	3.437(25)	–1.41	–1.49	–9(6)

Table B58 – Laboratory 114

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Sr-90 B2	1.11(3)	1.488(4)	–12.53 D	–4.36 D	–25.4(20)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	8.9(15)	11.02(13)	–1.41	–3.30 Q	–19(14)
Co-60 GL	10.9(4)	11.252(25)	–0.88	–0.54	–3(4)
Zr-95 GL	2.7(3)	2.551(20)	0.50	1.00	6(12)
Nb-95 GL	5.5(3)	5.55(5)	–0.16	–0.15	–1(6)
Cs-134 GL	13.1(5)	13.59(10)	–0.97	–0.62	–4(4)
Cs-137 GL	10.5(6)	10.58(21)	–0.13	–0.13	–1(6)
Eu-152 GL	15.1(9)	16.80(11)	–1.87	–1.74	–10(6)
Eu-154 GL	2.6(4)	3.437(25)	–2.09	–4.18 Q	–24(12)
	Bq g^{-1}	Bq g^{-1}			
Co-60 S	8.3(4)	7.82(20)	1.17	0.97	6(5)
Cs-137 S	11.0(3)	10.5(3)	1.17	0.82	5(4)
Eu-152 S	16.1(5)	16.0(5)	0.22	0.15	1(4)
Eu-154 S	1.98(9)	1.96(6)	0.21	0.20	1(6)
Am-241 S	3.05(11)	2.57(12)	2.91 D	3.23 D	19(7)

Table B59 – Laboratory 116

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	3.8(5)	4.24(8)	–0.94	–1.69	–10(11)
Co-60 GH	3.13(23)	3.427(8)	–1.29	–1.49	–9(7)
Zr-95 GH	–	1.875(15)	–	–	–
Nb-95 GH	6.4(5)	4.08(4)	4.88 D	9.89 D	58(12)
Cs-134 GH	5.0(4)	5.81(5)	–2.17	–2.39	–14(7)
Cs-137 GH	9.5(7)	10.43(7)	–1.37	–1.56	–9(7)
Eu-152 GH	10.5(8)	11.78(13)	–1.63	–1.86	–11(7)
Eu-154 GH	1.73(13)	1.94(4)	–1.53	–1.82	–11(7)

Table B60 – Laboratory 117

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	16.7(16)	11.02(13)	3.57 D	8.89 D	52(15)
Co-60 GL	12.1(10)	11.252(25)	0.91	1.34	8(9)
Zr-95 GL	5.2(5)	2.551(20)	5.51 D	17.84 D	104(19)
Nb-95 GL	10.5(9)	5.55(5)	5.44 D	15.17 D	88(16)
Cs-134 GL	13.1(9)	13.59(10)	–0.49	–0.59	–3(7)
Cs-137 GL	12.2(10)	10.58(21)	1.67	2.69 Q	16(9)
Eu-152 GL	17.4(14)	16.80(11)	0.46	0.65	4(8)
Eu-154 GL	–	3.437(25)	–	–	–
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	5.6(6)	4.24(8)	2.58 D	5.60 D	33(13)
Co-60 GH	3.53(25)	3.427(8)	0.41	0.52	3(7)
Zr-95 GH	3.6(3)	1.875(15)	6.47 D	15.43 D	90(14)
Nb-95 GH	8.6(8)	4.08(4)	6.05 D	18.86 D	110(18)
Cs-134 GH	6.1(5)	5.81(5)	0.69	0.98	6(8)
Cs-137 GH	11.9(9)	10.43(7)	1.59	2.47	14(9)
Eu-152 GH	12.3(10)	11.78(13)	0.53	0.75	4(8)
Eu-154 GH	–	1.94(4)	–	–	–

Table B61 – Laboratory 118

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	–	11.02(13)	–	–	–
Co-60 GL	11.3(4)	11.252(25)	0.05	0.03	0(4)
Zr-95 GL	–	2.551(20)	–	–	–
Nb-95 GL	–	5.55(5)	–	–	–
Cs-134 GL	12.9(6)	13.59(10)	–1.23	–0.85	–5(4)
Cs-137 GL	10.4(4)	10.58(21)	–0.51	–0.37	–2(5)
Eu-152 GL	–	16.80(11)	–	–	–
Eu-154 GL	–	3.437(25)	–	–	–
	Bq g^{-1}	Bq g^{-1}			
Cs-137 S	10.12(7)	10.5(3)	–1.31	–0.65	–4(3)
Eu-152 S	15.10(15)	16.0(5)	–1.88	–0.96	–6(3)

Table B62 – Laboratory 120

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Th-232 AL	5.8(3)	5.47(8)	1.08	1.02	6(6)
U-238 AL	7.5(4)	7.76(20)	–0.74	–0.62	–4(5)
Pu-239 AL	11.6(5)	12.37(19)	–1.39	–1.07	–6(5)
Am-241 AL	5.1(3)	5.00(6)	0.15	0.15	1(6)
Cm-244 AL	14.2(8)	15.74(19)	–1.91	–1.63	–10(5)
	Bq g^{-1}	Bq g^{-1}			
Pu-238 P	5.1(3)	5.054(23)	0.26	0.26	2(6)
Pu-239 P	5.7(4)	5.79(6)	–0.34	–0.33	–2(6)
Pu-241 P	14.6(6)	14.96(16)	–0.55	–0.40	–2(5)
H-3 B1	1.44(6)	1.345(10)	1.57	1.22	7(5)
Tc-99 B1	0.120(10)	0.1218(11)	–0.18	–0.26	–2(8)

Table B63 – Laboratory 123

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Po-210 AH	3.03(16)	2.54(3)	3.02 D	3.32 D	19(7)
gross a AH	80.0(25)	80.57(21)	–0.23	–0.12	–1(3)
H-3 B2	0.81(10)	0.897(7)	–0.81	–1.59	–9(11)
gross b I B2	3.54(12)	3.799(6)	–2.15	–1.17	–7(4)

Table B64 – Laboratory 126

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	10.6(14)	11.02(13)	–0.31	–0.70	–4(13)
Co-60 GL	11.7(9)	11.252(25)	0.47	0.62	4(8)
Zr-95 GL	2.8(3)	2.551(20)	0.64	1.34	8(12)
Nb-95 GL	6.8(6)	5.55(5)	1.98	3.75 Q	22(11)
Cs-134 GL	11.6(9)	13.59(10)	–2.35	–2.57	–15(7)
Cs-137 GL	10.7(10)	10.58(21)	0.13	0.21	1(9)
Eu-152 GL	14.0(10)	16.80(11)	–2.71 D	–2.82 D	–16(6)
Eu-154 GL	3.2(3)	3.437(25)	–1.10	–1.44	–8(8)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.1(4)	4.24(8)	–0.27	–0.44	–3(9)
Co-60 GH	3.51(25)	3.427(8)	0.33	0.42	2(7)
Zr-95 GH	1.92(16)	1.875(15)	0.28	0.41	2(9)
Nb-95 GH	4.4(4)	4.08(4)	0.78	1.22	7(9)
Cs-134 GH	4.7(4)	5.81(5)	–3.30 D	–3.25 D	–19(6)
Cs-137 GH	10.0(9)	10.43(7)	–0.47	–0.70	–4(9)
Eu-152 GH	9.7(7)	11.78(13)	–3.14 D	–3.08 D	–18(6)
Eu-154 GH	1.76(12)	1.94(4)	–1.40	–1.55	–9(7)
Co-60 S	8.0(6)	7.82(20)	0.37	0.46	3(7)
Cs-137 S	10.8(7)	10.5(3)	0.37	0.46	3(8)
Eu-152 S	11.0(7)	16.0(5)	–5.92 D	–5.41 D	–31(5)
Eu-154 S	1.52(10)	1.96(6)	–3.74 D	–3.87 D	–23(6)
Am-241 S	2.67(18)	2.57(12)	0.47	0.67	4(9)

Table B65 – Laboratory 127

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.65(15)	4.24(8)	2.47	1.67	10(4)
Co-60 GH	3.50(11)	3.427(8)	0.66	0.37	2(4)
Zr-95 GH	1.99(6)	1.875(15)	1.85	1.05	6(4)
Nb-95 GH	4.35(14)	4.08(4)	1.88	1.14	7(4)
Cs-134 GH	5.91(18)	5.81(5)	0.54	0.30	2(4)
Cs-137 GH	11.1(4)	10.43(7)	1.93	1.07	6(4)
Eu-152 GH	12.4(4)	11.78(13)	1.51	0.93	5(4)
Eu-154 GH	1.92(7)	1.94(4)	–0.19	–0.13	–1(4)

Table B66 – Laboratory 128

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
H-3 B2	0.92(3)	0.897(7)	0.74	0.44	3(4)

Table B67 – Laboratory 129

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Ra-226 AL	7.4(4)	10.25(18)	–7.29 D	–4.71 D	–27(4)
Th-232 AL	1.88(7)	5.47(8)	–32.93 D	–11.27 D	–65.6(14)
U-238 AL	8.46(13)	7.76(20)	2.96 Q	1.55	9(4)
Pu-239 AL	3.34(11)	12.37(19)	–40.98 D	–12.54 D	–73.0(10)
Am-241 AL	2.7(3)	5.00(6)	–7.94 D	–7.81 D	–45(6)
Cm-244 AL	3.1(3)	15.74(19)	–35.27 D	–13.76 D	–80.1(19)
gross a AL	41(3)	83(18)	–2.26	–8.74 Q	–51(12)
	Bq g^{-1}	Bq g^{-1}			
Pb-210 AH	5.1(4)	2.54(3)	6.59 D	16.98 D	99(15)
Po-210 AH	1.09(10)	2.54(3)	–13.95 D	–9.80 D	–57(4)
Np-237 AH	12.8(4)	17.45(18)	–12.16 D	–4.58 D	–26.7(21)
Pu-238 AH	4.80(13)	18.08(6)	–93.37 D	–12.61 D	–73.4(7)
Pu-239 AH	7.07(15)	17.29(8)	–60.78 D	–10.15 D	–59.1(9)
Am-241 AH	3.96(13)	4.382(10)	–3.24 Q	–1.65	–10(3)
Am-241 AH	6.5(4)	4.382(10)	6.20 D	8.26 D	48(8)
Cm-244 AH	9.74(20)	18.29(6)	–40.99 D	–8.03 D	–46.8(11)
gross a AH	32(4)	80.57(21)	–13.13 D	–10.37 D	–60(5)
H-3 B2	1.85(4)	0.897(7)	23.53 D	18.24 D	106(5)
Fe-55 B2	0.971(23)	1.235(22)	–8.39 D	–3.67 D	–21.4(23)
Sr-89 B2	0.608(6)	0.822(3)	–32.69 D	–4.47 D	–26.0(8)
Sr-90 B2	1.380(10)	1.488(4)	–10.29 Q	–1.25	–7.3(7)
gross b L B2	6.49(6)	5.931(23)	8.67 Q	1.62	9.4(11)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	9(4)	11.02(13)	–0.49	–3.15 Q	–2(4) × 10^{1}
Co-60 GL	10.3(5)	11.252(25)	–1.90	–1.45	–8(5)
Zr-95 GL	2.2(7) Q	2.551(20)	–0.49	–2.36	–1(3) × 10^{1}
Nb-95 GL	6.5(7)	5.55(5)	1.34	2.82 Q	16(12)
Cs-134 GL	12.3(5)	13.59(10)	–2.54	–1.64	–10(4)
Cs-137 GL	9.4(5)	10.58(21)	–2.16	–1.96	–11(5)
Eu-152 GL	15.6(19)	16.80(11)	–0.63	–1.22	–7(11)
Eu-154 GL	3.8(8)	3.437(25)	0.42	1.71	10(24)

continues

continued					
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.18(18)	4.24(8)	–0.30	–0.23	–1(5)
Co-60 GH	3.07(4)	3.427(8)	–8.75 Q	–1.79	–10.4(12)
Zr-95 GH	2.00(6)	1.875(15)	2.02	1.14	7(4)
Nb-95 GH	5.29(8)	4.08(4)	13.92 D	5.09 D	29.7(22)
Cs-134 GH	5.20(8)	5.81(5)	–6.60 Q	–1.80	–10.5(15)
Cs-137 GH	10.40(20)	10.43(7)	–0.13	–0.05	–0.3(20)
Eu-152 GH	10.7(4)	11.78(13)	–2.58 Q	–1.58	–9(4)
Eu-154 GH	1.69(4)	1.94(4)	–4.69 Q	–2.17	–13(3)
Co-60 S	6.64(9)	7.82(20)	–5.42 D	–2.59 D	–15.1(24)
Cs-137 S	9.72(15)	10.5(3)	–2.40	–1.30	–8(3)
Eu-152 S	13.7(3)	16.0(5)	–4.25 Q	–2.46	–14(3)
Eu-154 S	1.62(4)	1.96(6)	–4.69 D	–2.96 D	–17(4)
Am-241 S	2.99(16)	2.57(12)	2.09	2.83 Q	16(8)

Table B68 – Laboratory 130

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	12.1(8)	11.02(13)	1.33	1.69	10(8)
Co-60 GL	11.1(6)	11.252(25)	–0.25	–0.23	–1(6)
Zr-95 GL	–	2.551(20)	–	–	–
Nb-95 GL	7.5(4)	5.55(5)	4.50 D	5.88 D	34(8)
Cs-134 GL	12.2(7)	13.59(10)	–1.97	–1.76	–10(5)
Cs-137 GL	10.7(6)	10.58(21)	0.19	0.19	1(6)
Eu-152 GL	16.2(8)	16.80(11)	–0.74	–0.61	–4(5)
Eu-154 GL	3.11(17)	3.437(25)	–1.91	–1.64	–10(5)
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	4.11(21)	4.24(8)	–0.57	–0.52	–3(5)
Co-60 GH	3.26(17)	3.427(8)	–0.98	–0.84	–5(5)
Zr-95 GH	1.91(9)	1.875(15)	0.38	0.32	2(5)
Nb-95 GH	5.3(3)	4.08(4)	4.11 D	5.22 D	30(8)
Cs-134 GH	5.1(3)	5.81(5)	–2.59	–2.10	–12(5)
Cs-137 GH	10.1(5)	10.43(7)	–0.65	–0.54	–3(5)
Eu-152 GH	10.4(5)	11.78(13)	–2.68 Q	–2.02	–12(5)
Eu-154 GH	1.65(9)	1.94(4)	–2.97 Q	–2.53	–15(5)
Co-60 S	7.5(8)	7.82(20)	–0.36	–0.61	–4(10)
Cs-137 S	10.5(11)	10.5(3)	–0.01	–0.03	0(11)
Eu-152 S	11.7(12)	16.0(5)	–3.35 D	–4.61 D	–27(8)
Eu-154 S	1.73(18)	1.96(6)	–1.20	–1.99	–12(10)
Am-241 S	2.45(25)	2.57(12)	–0.42	–0.78	–5(11)

Table B69 – Laboratory 131

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq kg^{-1}	Bq kg^{-1}			
Be-7 GL	13.3(9)	11.02(13)	2.51	3.56 Q	21(8)
Co-60 GL	11.02(15)	11.252(25)	–1.52	–0.35	–2.1(14)
Zr-95 GL	3.70(14)	2.551(20)	8.12 D	7.74 D	45(6)
Nb-95 GL	8.7(7)	5.55(5)	4.49 D	9.75 D	57(13)
Cs-134 GL	12.17(21)	13.59(10)	–6.10 Q	–1.80	–10.5(17)
Cs-137 GL	10.49(21)	10.58(21)	–0.31	–0.15	–1(3)
Eu-152 GL	15.89(17)	16.80(11)	–4.43 Q	–0.93	–5.4(12)
Eu-154 GL	–	3.437(25)	–	–	–
	Bq g^{-1}	Bq g^{-1}			
Be-7 GH	5.90(16)	4.24(8)	9.43 D	6.74 D	39(5)
Co-60 GH	3.47(4)	3.427(8)	1.05	0.22	1.3(12)
Zr-95 GH	2.48(6)	1.875(15)	9.78 D	5.54 D	32(4)
Nb-95 GH	6.4(5)	4.08(4)	4.63 D	9.77 D	57(12)
Cs-134 GH	5.60(3)	5.81(5)	–3.81 Q	–0.62	–3.6(9)
Cs-137 GH	11.03(19)	10.43(7)	2.96 Q	0.99	5.8(20)
Eu-152 GH	11.58(8)	11.78(13)	–1.33	–0.30	–1.7(13)
Eu-154 GH	–	1.94(4)	–	–	–

Table B70 – Laboratory 132

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	Bq g^{-1}	Bq g^{-1}			
Po-210 AH	2.653(24)	2.54(3)	3.09 Q	0.77	4.5(15)

Appendix C. Source preparation

C1 AL samples

A mixed radionuclide solution (B10238) was prepared by mixing standardised solutions of the individual nuclides (Table C1). The chemical form of the AL samples was 2.0 M HNO_3.

Table C1 – Starting material B10238

Nuclide	Source identifier	Activity conc. (Bq g^{-1})	Gravimetric Dilution Factor AL GDF1	B10238 Act. Conc. (Bq g^{-1})
^{226}Ra	A10135	103.6(13)	100.270(9)	1.033(13)
^{232}Th	E4589	10.72(10)	19.4523(23)	0.551(6)
^{238}U	A09885	101.5(23)	129.778(15)	0.782(18)
^{239}Pu	A09533	49.6(5)	40.072(13)	1.237(12)
^{240}Pu*	A09533	0.22	40.072(13)	0.0054
^{241}Pu*	A09533	0.25	40.072(13)	0.0062
^{241}Am	A09981	9.91(3)	19.641(4)	0.5045(15)
^{244}Cm	E4368	31.44(10)	19.8261(19)	1.586(5)
^{240}Pu*	E4368	0.077	19.8261(19)	0.0039

The B10238 solution was diluted once to produce the AL sample in B10239 (Table C2). All dilutions were validated using liquid scintillation counting (see Appendix D). In total, 20.10 kg of AL sample was produced.

Table C2 – Preparation of solution for AL source B10239

Nuclide	Gravimetric Dilution Factor AL GDF2	B10239 Act. Conc. (Bq kg^{-1})
^{226}Ra	100.8(12)#	10.25(18)
^{232}Th	100.8(12)#	5.47(8)
^{238}U	100.8(12)#	7.76(20)
^{239}Pu	100.8(12)#	12.28(19)
^{240}Pu*	100.8(12)#	0.093
^{241}Pu*	100.8(12)#	0.061
^{241}Am	100.8(12)#	5.00(6)
^{244}Cm	100.8(12)#	15.74(19)
Gross alpha	–	83(18)

inflated from 100.79(4)

The gross alpha activity concentration was calculated by combining the activity concentrations of all the nuclides listed above (except ^{241}Pu) plus contributions from the progenies of ^{226}Ra and ^{232}Th. The ^{210}Po contribution is estimated as 37% of the ^{226}Ra activity concentration (based on the time elapsed since the last purification of the ^{226}Ra starting material), while the ^{222}Rn, ^{218}Po and ^{214}Po contributions are each estimated as 25% of the ^{226}Ra activity concentration (which is based on the solubility of ^{222}Rn in aqueous solutions at 20 °C). The contributions of ^{220}Rn, ^{216}Po and $^{212}Bi/^{212}Po$ are estimated as 25% of the ^{224}Ra activity concentration, which is based on the solubility of ^{222}Rn in aqueous solutions at 20 °C. The gross alpha activity concentration uncertainty is dominated by the uncertainty of the ^{222}Rn, ^{220}Rn, ^{218}Po, ^{216}Po, ^{214}Po, $^{212}Bi/^{212}Po$ and ^{210}Po activity concentrations.

C2 AH samples

A mixed radionuclide solution (B10313) was prepared by mixing standardised solutions of the individual nuclides (Table C3). The chemical form of the AH samples was 2.0 M HNO_3.

Table C3 – Starting material B10313

Nuclide	Source identifier	Activity conc. (kBq g^{-1})	Gravimetric Dilution Factor AH GDF1	B10313 Act. Conc. (kBq g^{-1})
$^{210}Pb/^{210}Po$	A10307	0.335(4)	3.60579(19)	0.0928(10)
^{237}Np	A09524	9.11(9)	14.2751(7)	0.638(7)
^{238}Pu	A10470	16.99(5)	25.695(11)	0.6611(20)
^{239}Pu	A10471	19.88(9)	31.677(5)	0.628(3)
^{240}Pu*	A10471	0.087	31.677(5)	0.0028
^{241}Pu*	A10471	0.099	31.677(5)	0.0031
^{241}Am	A06191	0.3029(6)	1.89022(9)	0.1602(4)
^{244}Cm	A09527	12.58(4)	18.8109(10)	0.6689(21)
^{240}Pu*	A09527	0.031	18.8109(10)	0.0016

The B10313 solution was diluted once to produce the AH sample in B10314 (Table C4). The dilution was validated using liquid scintillation counting (see Appendix D). In total, 0.664 kg of AH sample was produced.

Table C4 – Preparation of solution for AH source B10314

Nuclide	Gravimetric Dilution Factor AH GDF2	B10314 Act. Conc. (Bq g^{-1})
$^{210}Pb/^{210}Po$	36.57(4)	2.54(3)
^{237}Np	36.57(4)	17.45(18)
^{238}Pu	36.57(4)	18.08(6)
^{239}Pu	36.57(4)	17.16(8)
^{240}Pu*	36.57(4)	0.12
^{241}Pu*	36.57(4)	0.086
^{241}Am	36.57(4)	4.382(10)
^{244}Cm	36.57(4)	18.29(6)
Gross alpha	–	80.57(21)

The gross alpha activity concentration was calculated by combining of the activity concentrations of all the nuclides listed above (except ^{241}Pu) plus a ^{210}Po contribution (estimated as 100% of the ^{210}Pb activity concentration).

C3 P samples

A mixed radionuclide solution (B10286) was prepared by mixing standardised solutions of the individual nuclides (Table C5). The chemical form of the P samples was 2.0 M HNO_3.

Table C5 – Starting material B10286

Nuclide	Source identifier	Activity conc. (kBq g^{-1})	Gravimetric Dilution Factor AH GDF1	B10286 Act. Conc. (kBq g^{-1})
^{238}Pu	A09561	16.99(5)	82.2(3)	0.2067(9)
^{239}Pu	A09525	19.88(9)	84.3(8)	0.2359(25)
^{240}Pu*	A09525	0.087	84.3(8)	0.0010
^{241}Pu*	A09525	0.099	84.3(8)	0.0012
^{241}Pu	A10326	4.28(5)	7.008(5)	0.611(7)

The B10286 solution was diluted once to produce the P sample in B10287 (Table C6). The dilution was validated using liquid scintillation counting (see Appendix D). In total, 0.66 kg of P sample was produced.

Table C6 – Preparation of solution for P source B10287

Nuclide	Gravimetric Dilution Factor AH GDF2	B10287 Act. Conc. (Bq g^{-1})
^{238}Pu	40.911(21)	5.054(23)
^{239}Pu	40.911(21)	5.77(6)
^{240}Pu*	40.911(21)	0.025
^{241}Pu	40.911(21)	14.96(16)

C4 B1 samples

A mixed radionuclide solution (B10344) was prepared by mixing standardised solutions of the individual nuclides (Table C7). The chemical form of the B1 samples was 0.011 M NaOH containing 0.019 mg g^{-1} C (as carbonate) and 0.108 mg g^{-1} Cl.

Table C7 – Starting material B10344

Nuclide	Source identifier	Activity conc. (kBq g^{-1})	Gravimetric Dilution Factor GDF1	B10344 Act. Conc. (Bq g^{-1})
^{3}H	A091010	4.82(4)	79.51(8)	60.7(5)
^{14}C	E2990, E3017 and E3018	0.1058(7)	16.7906(11)	6.30(4)
^{36}Cl	B10043	1.002(4)	48.918(4)	20.48(8)
^{99}Tc	A09456, A09453 and A09454	0.0994(9)	18.0977(15)	5.49(5)

The solution in B10344 was diluted once to produce the B1 sample in B10345 (Table C8). The dilutions were validated using liquid scintillation counting (see Appendix D). In total, 22.70 kg of B1 sample was produced.

Table C8 – Preparation of solution for B1 source B10345

Nuclide	Gravimetric Dilution Factor B1 GDF2	B10345 Act. Conc. (Bq g^{-1})
^{3}H	45.100(14)	1.345(10)
^{14}C	45.077(14)	0.1398(9)
^{36}Cl	45.077(14)	0.4544(18)
^{99}Tc	45.077(14)	0.1218(11)

C5 B2 samples

A mixed radionuclide solution (B10386) was prepared by mixing standardised solutions of the individual nuclides (Table C9). The chemical form of the B2 samples was 0.10 M HCl (containing 0.0097 mg g^{-1} Fe and 0.0094 mg g^{-1} Sr).

Table C9 – Starting material B10386

Nuclide	Source identifier	Activity conc. (kBq g^{-1})	Gravimetric Dilution Factor B2 GDF1	B10386 Act. Conc. (kBq g^{-1})
^{3}H	A10476	4.82(4)	3.5226(3)	1.369(10)
^{55}Fe	A09536	154(3)	81.874(12)	1.88(4)
^{89}Sr	A10251	27.87(7)	17.4588(11)	1.253(4)
^{90}Sr	A10022	36.92(7)	16.2819(16)	2.268(5)

The B10386 solution was diluted twice to produce the B2 sample in B10401 (Table C10). All dilutions were validated using liquid scintillation counting (see Appendix D). In total, 21.03 kg of B2 sample was produced.

Table C10 – Preparation of solution for B2 source B10401

Nuclide	Gravimetric Dilution Factor B2 GDF2	Gravimetric Dilution Factor B2 GDF3	B10401 Act. Conc. (Bq g^{-1})
^{3}H	40.02(5)	38.130(9)	0.897(7)
^{55}Fe	39.98(5)	38.114(9)	1.235(22)
^{89}Sr	39.98(5)	38.114(9)	0.822(3)
^{90}Sr	39.98(5)	38.114(9)	1.488(4)
Gross beta ISO 9697	–	–	3.799(6)
Gross beta LSC	–	–	5.931(23)

The gross beta activity concentration for methods following ISO 9697:2008 (gas-flow proportional counting; non-volatile beta emitters with beta max energies > 0.3 MeV) was calculated by combining of the activity concentrations of ^{89}Sr and ^{90}Sr plus the ^{90}Y contribution (estimated as 100% of the ^{90}Sr activity concentration). The gross beta activity concentration for liquid scintillation counting was calculated by combining the ^{3}H, ^{55}Fe, ^{89}Sr and ^{90}Sr activity concentrations plus the ^{90}Y contribution.

C6 GL samples

A mixed radionuclide solution (B10114) was prepared by mixing and diluting standardised solutions of the individual nuclides (Table C11). The chemical form of the GL was 2.0 M HCl / 0.4 mM oxalic acid containing 0.0104 mg g^{-1} Co, 0.0120 mg g^{-1} Cs, 0.0112 mg g^{-1} Eu, 0.0108 mg g^{-1} Zn and 0.0109 mg g^{-1} Zr. The dilutions were validated using gamma-ray spectrometry (see Appendix D).

Table C11 – Starting material B10114

Nuclide	Source identifier	Activity conc. (kBq g^{-1})	Gravimetric Dilution Factor GDF1	B10114 Act. Conc. (kBq g^{-1})
^{7}Be	A10274	61.0(7)	26.268(7)	2.32(3)
^{60}Co	A10193	223.1(5)	94.13(3)	2.370(5)
^{95}Zr	A10250	10.92(9)	20.3291(14)	0.537(5)
^{95}Nb	A10250	23.76(20)	20.3291(14)	1.169(10)
^{134}Cs	A10311	25.73(18)	8.9869(4)	2.864(20)
^{137}Cs	A10314	207.6(14)	93.14(5)	2.229(15)
^{152}Eu	A10277	308.6(21)	87.83(3)	3.513(24)
^{154}Eu	A10310	15.14(11)	20.9122(16)	0.724(6)
^{152}Eu*	A10310	0.52(5)	20.9122(16)	0.0250(21)

The solution in B10114 was diluted three times to produce the GL sample in B10121 (Table C12). The dilutions were validated using gamma-ray spectrometry (see Appendix D). In total, 30.79 kg of GL sample was produced.

Table C12 – Preparation of solutions for GL source B10121

Nuclide	Gravimetric Dilution Factor GL GDF2	Gravimetric Dilution Factor GL GDF3	Gravimetric Dilution Factor GL GDF4	B10121 Act. Conc. (Bq kg^{-1})
^{7}Be	59.930(12)	59.910(22)	58.667(19)	11.02(13)
^{60}Co	59.930(12)	59.910(22)	58.667(19)	11.252(25)
^{95}Zr	59.930(12)	59.910(22)	58.667(19)	2.551(20)
^{95}Nb	59.930(12)	59.910(22)	58.667(19)	5.55(5)
^{134}Cs	59.930(12)	59.910(22)	58.667(19)	13.59(9)
^{137}Cs	59.930(12)	59.910(22)	58.667(19)	10.58(7)
^{152}Eu	59.930(12)	59.910(22)	58.667(19)	16.80(11)
^{154}Eu	59.930(12)	59.910(22)	58.667(19)	3.437(25)

Six samples were tested with gamma spectrometry for homogeneity (see Table C13).

Table C13 – Homogeneity tests GL

Nuclide	u_{bb} (%)	u_{meas} (%)	u_{int} (%)	u_{hom} (%)	u_{N*} (%)	u_N (%)
^{7}Be	2.39	4.71*	4.47	0.00	1.19	1.19
^{60}Co	1.34	1.45*	1.16	0.00	0.22	0.22
^{95}Zr	1.85	4.03*	3.74	0.00	0.80	0.80
^{95}Nb	1.24	1.22	1.35*	0.00	0.83	0.83
^{134}Cs	1.10	0.93	1.05*	0.32	0.68	0.76
^{137}Cs	2.34	1.47*	1.24	1.82	0.68	1.95
^{152}Eu	1.37	1.25	1.58*	0.00	0.68	0.68
^{154}Eu	5.51	6.08*	5.65	0.00	0.68	0.68

*value used to estimate homogeneity uncertainty (see Section 2.7)

C7 GH samples

A mixed radionuclide solution (B10115) was prepared by mixing and diluting standardised solutions of the individual nuclides (Table C14). The chemical form of the GH samples was 2.0 M HCl / 0.4 mM oxalic acid containing 0.0104 mg g^{-1} Co, 0.0120 mg g^{-1} Cs, 0.0112 mg g^{-1} Eu, 0.0108 mg g^{-1} Zn and 0.0109 mg g^{-1} Zr. The dilutions were validated using gamma-ray spectrometry (see Appendix D).

Table C14 – Starting material B10115

Nuclide	Source identifier	Activity conc. (kBq g^{-1})	Gravimetric Dilution Factor GDF1	B10115 Act. Conc. (kBq g^{-1})
^{7}Be	A10274	61.0(7)	35.907(5)	1.698(20)
^{60}Co	A10193	223.1(5)	162.48(17)	1.373(4)
^{95}Zr	A10250	10.92(9)	14.538(3)	0.751(6)
^{95}Nb	A10250	23.76(20)	14.538(3)	1.634(14)
^{134}Cs	A10311	25.73(18)	11.0569(11)	2.327(16)
^{137}Cs	A10314	207.6(14)	49.69(7)	4.18(3)
^{152}Eu	A10277	308.6(21)	65.73(8)	4.69(4)
^{154}Eu	A10308	15.14(11)	19.532(7)	0.775(6)
^{152}Eu*	A10308	0.52(5)	19.532(7)	0.0268(23)

The solution in B10115 was diluted twice to produce the GH sample in B10185 (Table C15). The dilutions were validated using gamma-ray spectrometry (see Appendix D). In total, 5.10 kg of GH sample was produced.

Table C15 – Preparation of solutions for GH source B10185

Nuclide	Gravimetric Dilution Factor GH GDF2	Gravimetric Dilution Factor GH GDF3	B10185 Act. Conc. (Bq g^{-1})
^{7}Be	19.997(7)	20.0351(20)	4.24(5)
^{60}Co	19.997(7)	20.0351(20)	3.427(8)
^{95}Zr	19.997(7)	20.0351(20)	1.875(15)
^{95}Nb	19.997(7)	20.0351(20)	4.08(4)
^{134}Cs	19.997(7)	20.0351(20)	5.81(4)
^{137}Cs	19.997(7)	20.0351(20)	10.43(7)
^{152}Eu	19.997(7)	20.0351(20)	11.78(8)
^{154}Eu	19.997(7)	20.0351(20)	1.935(14)

Six samples were tested with gamma spectrometry for homogeneity (see Table C16).

Table C16 – Homogeneity tests GH

Nuclide	u_{bb} (%)	u_{meas} (%)	u_{int} (%)	u_{hom} (%)	u_{N*} (%)	u_N (%)
^{7}Be	2.52	1.13	2.17*	1.28	1.19	1.74
^{60}Co	0.95	0.98*	0.79	0.00	0.24	0.24
^{95}Zr	0.64	0.65	1.13*	0.00	0.80	0.80
^{95}Nb	0.42	1.08*	0.50	0.00	0.83	0.83
^{134}Cs	0.81	0.70*	0.60	0.41	0.68	0.79
^{137}Cs	0.32	0.48*	0.41	0.00	0.69	0.69
^{152}Eu	1.13	0.70*	0.60	0.88	0.69	1.12
^{154}Eu	2.71	2.20*	2.14	1.58	0.74	1.74

*value used to estimate homogeneity uncertainty (see Section 2.7)

C8 S samples

A mixed radionuclide solution (B10113) was prepared by mixing standardised solutions of the individual nuclides (Table C17). The chemical form was 2.0 M HCl / 0.4 mM oxalic acid containing 0.0104 mg g^{-1} Co, 0.0120 mg g^{-1} Cs, 0.0112 mg g^{-1} Eu, 0.0108 mg g^{-1} Zn and 0.0109 mg g^{-1} Zr.

Table C17 – Starting material B10113

Nuclide	Source identifier	Activity conc. (kBq g^{-1})	Gravimetric Dilution Factor GDF1	B10113 Act. Conc. (kBq g^{-1})
^{60}Co	A10193	223.1(5)	24.586(10)	9.074(19)
^{137}Cs	A10314	207.6(14)	17.0103(17)	12.20(8)
^{152}Eu	A10277	308.6(21)	16.7015(12)	18.48(13)
^{154}Eu	A10310	15.14(11)	6.6687(8)	2.271(17)
^{152}Eu*	A10310	0.52(5)	6.6687(8)	0.079(7)
^{241}Am	A10187	289.9(5)	97.33(13)	2.979(7)

The solid samples (SiO_2) were synthesized by hydrolysing a liquid mixture of tetraethyl orthosilicate (TEOS), ethanol and a mixed radionuclide solution (B10113 containing ^{60}Co, ^{137}Cs, ^{152}Eu, ^{154}Eu and ^{241}Am in 2.0 M hydrochloric acid) by adding 1.0 M hydrochloric acid. The resulting SiO_2 crystals were crushed, heated, mixed and sieved to <0.50 mm to form a powder (4.1 kg). Subsequently, 76 samples (50 g each) were prepared (see Table C18 for the NPL assigned values). Stability tests indicated that the SiO_2 powder was slightly hydroscopic (an uncertainty component of 2.5% was included in the relative uncertainty of the assigned value u_N).

Table C18 – Preparation of S samples

Nuclide	Activity conc. (Bq g^{-1})
^{60}Co	7.82(20)
^{137}Cs	10.5(3)
^{152}Eu	16.0(5)
^{154}Eu	1.96(6)
^{241}Am	2.57(12)

All samples were tested with gamma spectrometry for homogeneity (see Table C19).

Table C19 – Homogeneity tests S

Nuclide	u_{bb} (%)	u_{meas} (%)	u_{int} (%)	u_{hom} (%)	u_{N*} (%)	u_{stab} (%)	u_N (%)
^{60}Co	1.43	1.39*	0.71	0.35	0.21	2.5	2.5
^{137}Cs	1.52	1.05*	0.51	1.10	0.68	2.5	2.8
^{152}Eu	1.46	0.96*	0.55	1.10	0.68	2.5	2.8
^{154}Eu	3.27	2.64	2.87*	1.58	0.74	2.5	3.0
^{241}Am	5.63	3.77	3.83*	4.12	0.22	2.5	4.8

*value used to estimate homogeneity uncertainty (see Section 2.7)

Appendix D. Dilution and stability checks

Table D1 – Dilution checks AL, AH and P samples

	AL	AH	P
GDF2 vs. RDF2	100.79(4)* vs. 98.5(5)	36.57(4) vs. 36.53(7)	40.911(21) vs. 41.00(10)
zeta score DF2	**5.41**	**0.47**	**–0.90**

* inflated to 100.8(12)

Table D2 – Dilution checks B1 and B2 samples

	B1	B2
GDF2 vs. RDF2	45.077(14) vs. 46.4(11)	39.98(5) vs. 39.72(17)
zeta score DF2	**–1.28**	**1.53**
GDF2 vs. RDF2 (^{3}H)	45.100(14) vs. 46.4(11)	40.02(5) vs. 39.72(17)
zeta score DF2 (^{3}H)	**–1.26**	**1.76**
GDF3 vs. RDF3	–	38.114(9) vs. 38.15(10)
zeta score DF3	**–**	**0.32**
GDF3 vs. RDF3 (^{3}H)	–	38.130(9) vs. 38.15(10)
zeta score DF3 (^{3}H)	**–**	**0.17**

Table D3 – Dilution checks GL and GH samples

	GL	GH
GDF2 vs. RDF2	–	19.997(7) vs. 19.92(17)
zeta score DF2	**–**	**0.45**
GDF3 vs. RDF3	59.910(22) vs. 59.3(8)	20.0351(20) vs. 19.88(7)
zeta score DF3	**0.84**	**2.28**
GDF4 vs. RDF4	58.667(19) vs. 59.9(8)	–
zeta score DF4	**–1.58**	**–**

For the stability testing (ST), the solid S samples were tested for hygroscopicity (which resulted in an increase of the sample weight; see Section C8), while sub-samples of the aqueous samples containing alpha and beta emitters (sample types AL, AH, P, B1 and B2) and the aqueous samples containing gamma ray emitters (GL and GH) were measured on a regular basis by liquid scintillation counting and gamma ray spectrometry, respectively, to test for radionuclide precipitation and container wall adsorption.

Table D4 – Stability checks AL, AH, P, B1 and B2 samples

	ST 1	ST 2	ST 3	ST 4
Prepared on 16/07/2010	05/08/2010	13/10/2010	25/01/2011	04/03/2011
Sample type **AL** (cpm g^{-1})	10.3(10)	9.8(10)	10.2(10)	8.9(9)
Prepared on 21/07/2010	07/08/2010	17/10/2010	10/12/2010	04/03/2011
Sample type **AH** (cpm g^{-1})	6152(5)	6132(7)	6120(7)	6179(4)
Prepared on 20/07/2010	18/08/2010	07/10/2010	10/12/2010	04/03/2011
Sample type **P** (cpm g^{-1})	662(8)	651.4(13)	649.4(12)	648.6(13)
Prepared on 22/07/2010	13/08/2010	08/10/2010	10/12/2010	22/02/2011
Sample type **B1** (cpm g^{-1})	67.6(5)	66.5(5)	66.8(5)	66.8(5)
Prepared on 23/07/2010	13/08/2010	09/10/2010	10/12/2010	05/01/2011
Sample type **B2** (cpm g^{-1})	315.4(9)	260.6(8)	238.6(7)	225.9(7)
B2 (cpm g^{-1}) decay corrected*	315.4(9)	312(3)	318(4)	309(3)

* the decay correction to ST1 applied assumes the following efficiencies for liquid scintillation counting: ^{3}H: 40%, ^{55}Fe: 40%, ^{89}Sr: 100% and ^{90}Sr: 200%. No decay correction was performed for the AL, AH, P and B1 sample types because of the relatively long half-lives of the radionuclides present in these sample types.

Table D5 – Stability checks GL samples

	ST 1	ST 2	ST 3	ST 4
GL prepared on 14/07/2010	20/08/2010	16/10/2010	16/12/2010	25/02/2011
^{7}Be (cps kg^{-1})	0.0159(8)	0.0113(10)	0.0098(21)	0.0148(25)
^{60}Co (cps kg^{-1})	0.0776(10)	0.0787(10)	0.0796(10)	0.0769(10)
^{95}Zr (cps kg^{-1})	0.0139(5)	0.0142(8)	0.0158(14)	0.0136(17)
^{95}Nb(cps kg^{-1})	0.0571(8)	0.0587(14)	0.057(7)	0.084(25)
^{134}Cs (cps kg^{-1})	0.1342(15)	0.1361(15)	0.1322(16)	0.1352(13)
^{137}Cs (cps kg^{-1})	0.0982(12)	0.1022(13)	0.0994(12)	0.1018(13)
^{152}Eu (cps kg^{-1})	0.1228(19)	0.1276(19)	0.1255(17)	0.1244(18)
^{154}Eu (cps kg^{-1})	0.0083(5)	0.0081(5)	0.0086(5)	0.0093(5)

Table D6 – Stability checks GH samples

	ST 1	ST 2	ST 3	ST 4
GH prepared on 16/07/2010	12/08/2010	18/10/2010	15/12/2010	25/02/2011
^{7}Be (cps g^{-1})	0.0149(3)	0.0148(7)	0.0165(7)	0.0173(13)
^{60}Co (cps g^{-1})	0.0492(4)	0.0492(5)	0.0490(5)	0.0497(5)
^{95}Zr (cps g^{-1})	0.0239(3)	0.0236(4)	0.0227(5)	0.0255(11)
^{95}Nb(cps g^{-1})	0.0950(5)	0.0939(9)	0.0964(24)	0.076(14)
^{134}Cs (cps g^{-1})	0.1259(8)	0.1274(8)	0.1252(8)	0.1293(8)
^{137}Cs (cps g^{-1})	0.2247(9)	0.2290(9)	0.2246(9)	0.2308(10)
^{152}Eu (cps g^{-1})	0.2097(12)	0.2128(13)	0.2096(11)	0.2099(12)
^{154}Eu (cps g^{-1})	0.00990(22)	0.01068(23)	0.01013(24)	0.01071(23)

Appendix E. Sample details

Lab code	AL	AH	P	B1	B2	GL	GH	S	Date results received
1		x	x		x				1 December 2010
4	x			x					30 November 2010
5	x			x	x	x	x	x	7 December 2010
7		x	x	x	x		x	x	7 January 2011
8	x	x	x	x	x	x	x	x	3 December 2010
9							x		30 November 2010
13	x			x	x			x	25 November 2010
15						x	x		1 December 2010
16				x	x	x	x		19 January 2011
17	x			x		x	x	x	1 December 2010
19					x	x			6 January 2011
21				x	x	x	x	x	1 December 2010
23						x			8 November 2010
24	x	x				x		x	3 January 2011
25	x			x	x	x	x		1 December 2010
26	x				x			x	1 December 2010
27						x	x		25 November 2010
28	x	x	x	x		x	x		1 December 2010
29	x			x		x		x	29 November 2010
31	x	x	x		x	x	x		14 January 2011
32	x	x	x	x	x		x	x	16 December 2010
34	x			x		x			1 December 2010
35	x	x	x	x	x	x	x	x	2 December 2010
38		x	x	x	x		x		15 December 2010
40	x					x		x	1 December 2010
41		x			x		x		26 November 2010
42	x					x			29 November 2010
45						x			29 November 2010
46	x	x	x						23 November 2010
47	x	x	x	x		x	x		5 November 2010
48							x	x	19 November 2010
51	x					x			30 November 2010
52						x			5 November 2010
53						x			24 November 2010
55		x	x	x	x		x	x	1 December 2010
59				x			x		2 December 2010
62	x			x		x			2 December 2010
65	x	x		x	x	x			30 November 2010
72					x	x			25 November 2010
73	x	x			x		x		3 January 2011
74					x				7 December 2010
76				x	x	x			1 December 2010
82						x	x		6 December 2010
83				x		x	x	x	1 December 2010
86	x		x			x	x		1 December 2010
89						x	x		19 November 2010
90	x				x				29 November 2010
91	x			x	x	x			3 December 2010

continues

continued									
Lab code	AL	AH	P	B1	B2	GL	GH	S	Date results received
94			x	x		x		x	30 November 2010
95				x		x		x	18 November 2010
98								x	29 November 2010
99	x	x		x	x	x	x		17 December 2010
104						x		x	7 December 2010
106	x	x	x	x	x		x	x	30 November 2010
107			x	x		x			30 November 2010
108				x			x	x	23 December 2010
111						x			1 December 2010
114					x	x		x	30 November 2010
116							x		30 November 2010
117						x	x		1 December 2010
118						x		x	30 November 2010
120	x		x	x					26 November 2010
123		x			x				15 December 2010
126						x	x	x	30 November 2010
127							x		23 November 2010
128					x				1 December 2010
129	x	x			x	x	x	x	29 November 2010
130						x	x	x	1 December 2010
131						x	x		6 December 2010
132		x							26 November 2010
Total	29	20	16	30	29	45	35	26	(230)

Appendix F. Example Kiri plot

The following example illustrates the use of a Kiri plot. Consider the following ten hypothetical results.

Figure F1. Deviation plot example

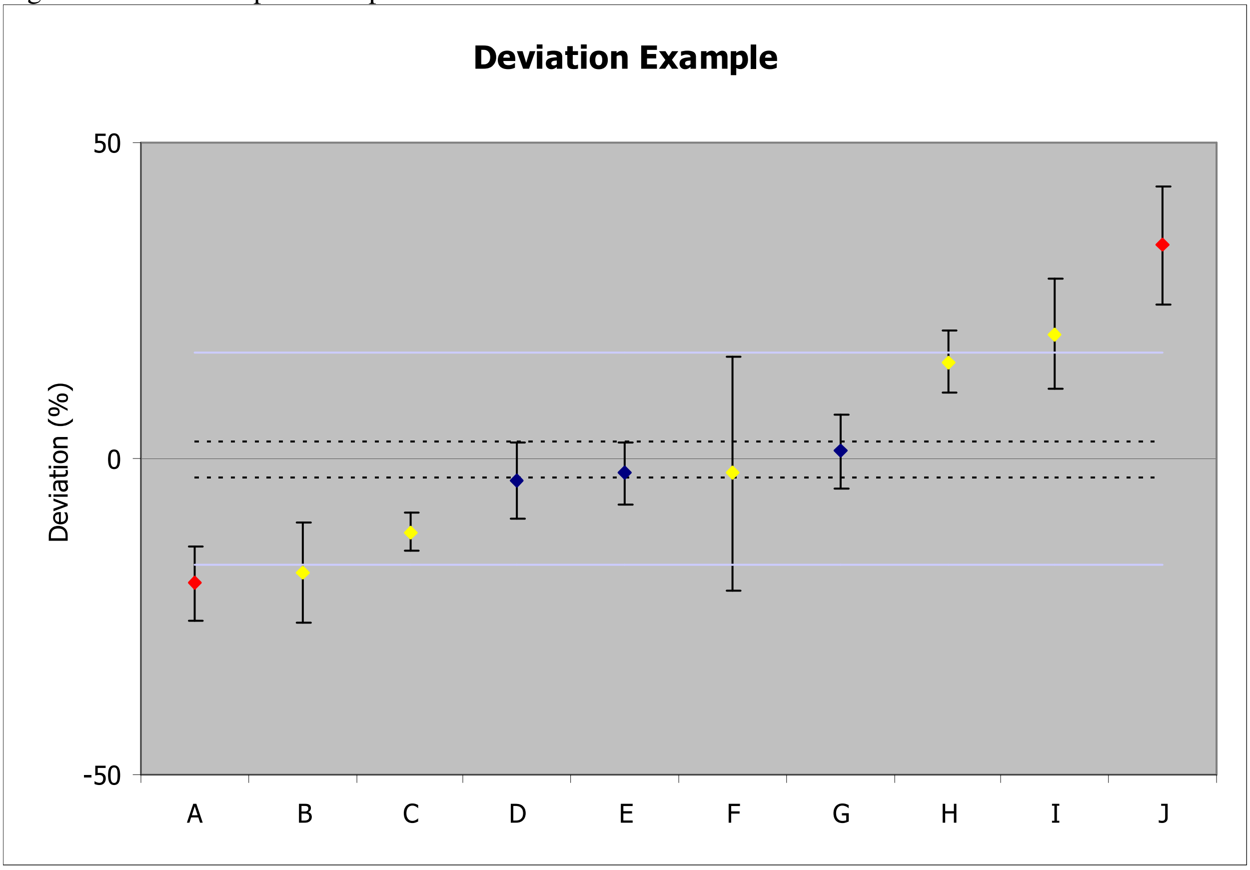


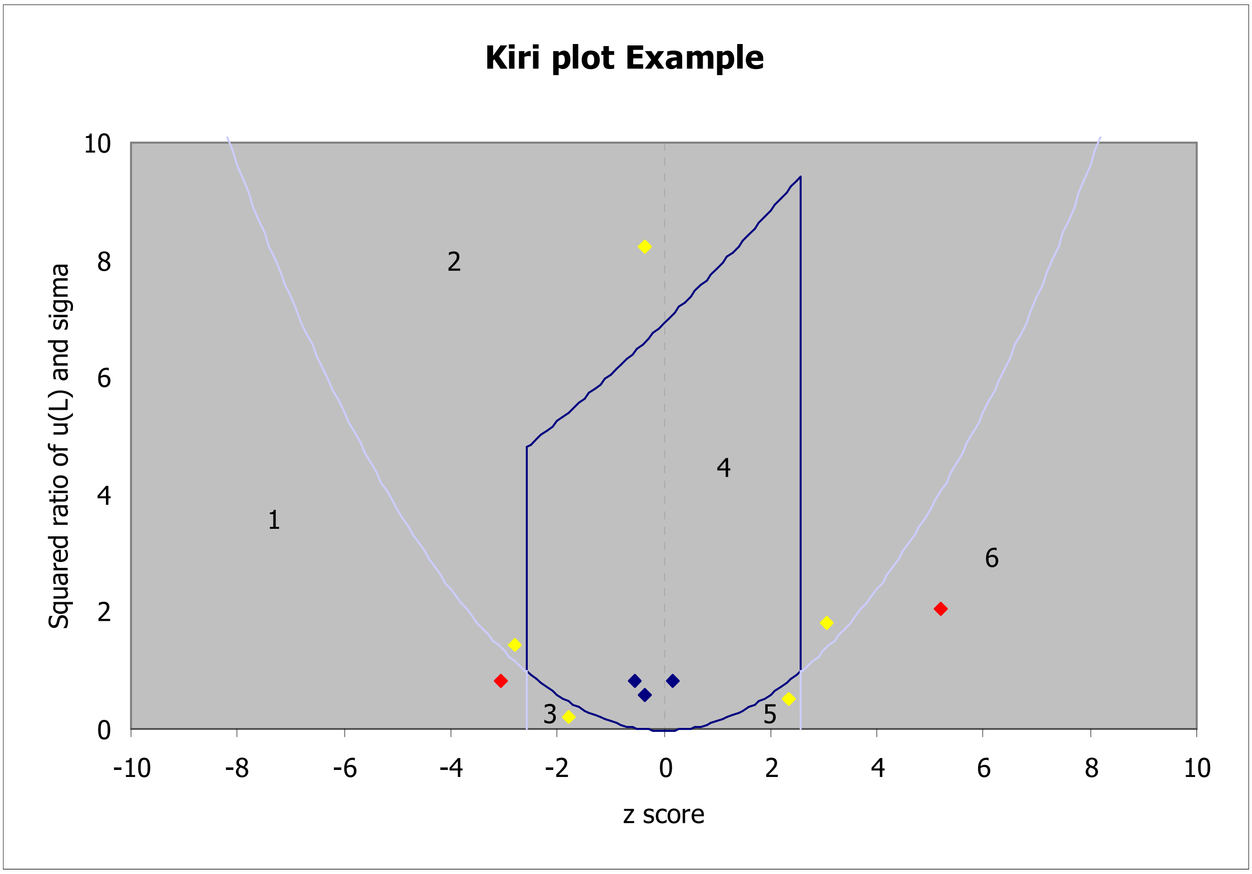
Table F1 – Data classification

Lab	Zeta test	R_L outlier test	z test	Verdict
A	fail	pass	fail	D
B	pass	pass	fail	Q
C	fail	pass	pass	Q
D	pass	pass	pass	A
E	pass	pass	pass	A
F	pass	fail	pass	Q
G	pass	pass	pass	A
H	fail	pass	pass	Q
I	pass	pass	fail	Q
J	fail	pass	fail	D

A Kiri plot relates the z-score (a measure how close a result is to the assigned value) with the squared ratio of the uncertainty of laboratory value and the uncertainty for proficiency assessment. A "perfect" result (i.e., the assigned value with an unrealistically low uncertainty of value 0) will have a z-score of 0 and normalised squared uncertainty of 0 (point 0,0). A Kiri plot consists of six zones (Zones 1 and 6 "Discrepant"; Zones 2, 3 and 5 "Questionable"; Zone 4 "In agreement") whose areas are defined by the three tests used above to classify the data. The areas of Zones 1, 3, 4 and 5 are finite, while the areas of Zones 2 and 6 are infinite.

The Kiri plot for the values used for Figure F2 is shown below.

Figure F2. Kiri plot example



Lab A is not close to the assigned value and its uncertainty is too small to pass the zeta test (verdict: "Discrepant"; Kiri plot Zone 1).
Lab B and I are not close to the assigned value, but their uncertainties are large enough to pass the zeta test (verdict: "Questionable"; Kiri plot Zone 2)
Lab C is close enough to the assigned value, but its uncertainty is too small to pass the zeta test (verdict: Questionable; Kiri plot Zone 3)
Lab D, E and G are close to the assigned value (verdict: "In agreement"; Kiri plot Zone 4)
Lab F is close to the assigned value, but its uncertainty is too large to pass the R_L outlier test (verdict: "Questionable"; Kiri plot Zone 2)
Lab H is close enough to the assigned value, but its uncertainty is too small to pass the zeta test (verdict: "Questionable"; Kiri plot Zone 5)
Lab J is not close to the assigned value and its uncertainty is too small to pass the zeta test (verdict: "Discrepant"; Kiri plot Zone 6)

Appendix G. Outliers

The following procedure was used to detect outliers in both the relative uncertainty data set. Data points greater than the upper quartile (75%), Q_U, plus three times the interquartile range are classified as outliers. This method is unable to identify outliers if the data set contains fewer than 7 results.

Upper critical value: $c_U = Q_U + 3\ IQR = Q_U + 3\left(Q_U - Q_L\right) = 4\ Q_U - 3\ Q_L$

Example
Dataset: 1, 7, 8, 8, 9, 10 and 25
$Q_L = 7$ and $Q_U = 10$; $c_U = 10 + 3\ (10 - 7) = 19$
The data point with a value of 25 is therefore an outlier.

Relative uncertainty outliers

Nuclide	Laboratory	Relative uncertainty (%)	Critical value (%)
^{241}Am (AH)	7*	34.2	18.7
^{244}Cm (AH)	7	30.9	15.3
^{7}Be (GL)	129	45.6	39.0
^{60}Co (GL)	27*	22.8	20.9
	40*	23.9	20.9
^{95}Zr (GL)	129*	32.3	29.8
^{95}Nb (GL)	27*	32.8	26.3
^{137}Cs (GL)	27	22.7	21.2
	40*	23.9	21.2
^{7}Be (GH)	27	30.2	26.0
^{60}Co (GH)	27*	23.1	22.2
^{95}Zr (GH)	8*	48.1	31.0
^{95}Nb (GH)	27	31.9	23.2
^{241}Am (S)	95	24.1	23.0
	7*	26.6	23.0

*affects the evaluation

Appendix H. Largest consistent subset (LCS)

This method is based on a paper by Maurice Cox (2007)*. The best LCS is obtained as follows by numerical approximation. Let

$$x_{\min} = \min_i L_i \qquad x_{\max} = \max_i L_i$$

Calculate:

$$e_i(x) = \left(\frac{L_i - x}{u_{\mathrm{L}}} \right)^2 \qquad r = 1, \ldots, p$$

for (at least) 200 evenly spaced values of x between $x_{\min}$ and $x_{\max}$, and subsequently arrange the $e_i(x)$ in ascending order (at least 200 columns of p rows). Denote for each of the at least 200 values of x the terms so obtained by $e_{\ell i}(x)$ and $i = 1, \ldots, p$, so that

$e_{\ell 1}(x), \leq \ldots \leq e_{\ell p}(x)$

Calculate p truncated sum of squares (TSS) $F_{\mathrm{r}}(x)$ functions for each of these (at least) 200 values of x according to:

$$F_{\mathrm{r}}(x) = \sum_{i=1}^{r} e_{\ell i}(x) \qquad r = 1, \ldots, p$$

Starting with $r = p$ (i.e., the whole data set), select the calculus minimum for which $F_{\mathrm{r}}(x)$ is least. If that value is no greater than:

$$\chi^2_{r-1,0.01}$$

accept it as the best solution for a subset containing r results. If this is not the case, continue with $r = p - 1$, $p - 2$, ….. until $r = 0.75\ p$. Once the members of the LCS have been identified, calculate the weighted mean and the (internal) uncertainty. A simplified example illustrating these calculations, using only 12 evenly spaced values of x between $x_{\min}$ and $x_{\max}$, is given below.

* Cox, M.G., 2007. Metrologia 44 187-200

Appendix H. Example (simplified) calculation of the Largest Consistent Subset (LCS)

	L	u_L	3	4	5	6	7	8	9	10	11	12	13	14
A	3.5	1.0	0.3	0.3	2.3	6.3	12.3	20.3	30.3	42.3	56.3	72.3	90.3	110.3
B*	5.8	2.0	2.0	0.8	0.2	0.0	0.4	1.2	**2.6**	4.4	6.8	9.6	13.0	16.8
C*	8.2	0.7	54.1	35.1	20.3	9.4	2.7	0.0	**1.5**	7.0	16.6	30.3	48.0	69.8
D*	8.8	1.0	33.4	22.8	14.3	7.7	3.2	0.6	**0.0**	1.5	4.9	10.4	17.8	27.2
E*	9.0	0.7	73.5	51.0	32.7	18.4	8.2	2.0	**0.0**	2.0	8.2	18.4	32.7	51.0
F*	9.9	1.1	39.3	28.8	19.8	12.6	7.0	3.0	**0.7**	0.0	1.0	3.6	7.9	13.9
G*	11.1	1.3	38.8	29.8	22.0	15.4	9.9	5.7	**2.6**	0.7	0.0	0.5	2.1	5.0
H	11.3	0.5	275.6	213.2	158.8	112.4	74.0	43.6	21.2	6.8	0.4	2.0	11.6	29.2
I*	13.0	5.0	4.0	3.2	2.6	2.0	1.4	1.0	**0.6**	0.4	0.2	0.0	0.0	0.0
	N	u_N												
	8.9	**0.4**	0.3	0.3	0.2	0.0	0.4	0.0	**0.0**	0.0	0.0	0.0	0.0	0.0
			2.0	0.8	2.3	2.0	1.4	0.6	**0.0**	0.4	0.2	0.5	2.1	5.0
			4.0	3.2	2.6	6.3	2.7	1.0	**0.6**	0.7	0.4	2.0	7.9	13.9
			33.4	22.8	14.3	7.7	3.2	1.2	**0.7**	1.5	1.0	3.6	11.6	16.8
			38.8	28.8	19.8	9.4	7.0	2.0	**1.5**	2.0	4.9	9.6	13.0	27.2
			39.3	29.8	20.3	12.6	8.2	3.0	**2.6**	4.4	6.8	10.4	17.8	29.2
			54.1	35.1	22.0	15.4	9.9	5.7	**2.6**	6.8	8.2	18.4	32.7	51.0
			73.5	51.0	32.7	18.4	12.3	20.3	21.2	7.0	16.6	30.3	48.0	69.8
			275.6	213.2	158.8	112.4	74.0	43.6	30.3	42.3	56.3	72.3	90.3	110.3
$F_r(x)$ min	$\chi^2_{r-1,0.01}$	r												
0.0	**–**	**1***	0.3	0.3	0.2	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
0.0	**6.6**	**2***	2.2	1.1	2.4	2.0	1.8	0.7	0.0	0.4	0.2	0.5	2.1	5.0
0.5	**9.2**	**3***	6.2	4.3	5.0	8.2	4.5	1.7	0.7	1.1	0.5	2.5	10.1	18.9
1.4	**11.3**	**4***	39.6	27.1	19.3	15.9	7.7	2.9	1.4	2.6	1.5	6.1	21.6	35.7
2.8	**13.3**	**5***	78.4	55.9	39.1	25.4	14.6	4.9	2.8	4.6	6.5	15.7	34.6	63.0
5.4	**15.1**	**6***	117.8	85.7	59.4	38.0	22.8	7.9	5.4	9.0	13.2	26.1	52.4	92.1
8.0	**16.8**	**7***	171.9	120.9	81.4	53.3	32.7	13.6	**8.0**	15.8	21.4	44.5	85.1	143.1
22.8	18.5	8	245.4	171.9	114.0	71.7	45.0	33.8	29.2	22.8	38.0	74.7	133.1	213.0
59.4	20.1	9	520.9	385.1	272.8	184.1	118.9	77.4	59.4	65.0	94.2	147.0	223.3	323.2

Appendix I. Nuclear data

Half-lives

Nuclide	Half-life (d)	Reference
^{3}H	4497(9)	DDEP
^{7}Be	53.22(6)	DDEP
^{14}C	$2.082(11) \times 10^{6}$	DDEP
^{36}Cl	$1.099(11) \times 10^{8}$	DDEP
^{55}Fe	1003(3)	DDEP
^{60}Co	1925.2(3)	DDEP
^{89}Sr	50.57(3)	DDEP
^{90}Sr	10520(30)	DDEP
^{95}Zr	64.032(6)	DDEP
^{95}Nb	34.991(6)	DDEP
^{99}Tc	$7.8(3) \times 10^{7}$	DDEP
^{134}Cs	753.5(10)	IAEA
^{137}Cs	10976(30)	DDEP
^{152}Eu	4939(6)	DDEP
^{154}Eu	3141.5(14)	DDEP
^{210}Pb	8120(50)	DDEP
^{226}Ra	$5.844(25) \times 10^{5}$	DDEP
^{232}Th	$5.132(22) \times 10^{12}$	DDEP
^{237}Np	$7.82(4) \times 10^{8}$	DDEP
^{238}U	$1.6319(18) \times 10^{12}$	DDEP
^{238}Pu	32046(11)	DDEP
^{239}Pu	$8.802(4) \times 10^{6}$	DDEP
^{241}Pu	5234(15)	DDEP
^{241}Am	$1.5800(22) \times 10^{5}$	DDEP
^{244}Cm	6615(11)	DDEP

DDEP – Decay Data Evaluation Project (DDEP): www.nucleide.org/DDEP_WG/DDEPdata.htm
IAEA – http://www-nds.iaea.org/xgamma_standards/

Appendix J. Critical values for Student's t-test

Degrees of freedom	Critical t value (99%)
1	63.656
2	9.925
3	5.841
4	4.604
5	4.032
6	3.707
7	3.499
8	3.355
9	3.250
10	3.169
11	3.106
12	3.055
13	3.012
14	2.977
15	2.947
16	2.921
17	2.898
18	2.878
19	2.861
20	2.845
21	2.831
22	2.819
23	2.807
24	2.797
25	2.787
26	2.779
27	2.771
28	2.763
29	2.756
30	2.750
∞	2.576

Appendix K. Acknowledgements

The authors thank Arzu Arinc, Eleanor Bakhshandeiar, Sean Collins, Andy Fenwick, Simon Jerome, Lena Johansson, Lynsey Keightley, Andy Pearce and Jean Wong for much appreciated help with standardisations, discussions, source preparations, sample despatches and administrative work. This work was partly supported by the National Measurement System.

Appendix L. Literature

Cox, M.G., 2007. The evaluation of key comparison data: determining the largest consistent subset. Metrologia 44 187-200.

Harms, A., Gilligan, C., 2009. Environmental Radioactivity Comparison Exercise 2008. NPL Report IR 15. Available at www.npl.co.uk

Harms, A., 2009. A new Approach for Proficiency Test Exercise Data Evaluation. Accreditation and Quality Assurance, 14, 253-261.

Harms, A., 2009. Visualisation of Proficiency Test Exercise Results in Kiri plots. Accreditation and Quality Assurance, 14, 307-311.

ISO 13528:2005. Statistical methods for use in proficiency testing by interlaboratory comparisons.

Thompson, M., Ellison, S.L.R., Wood, R., 2006. The international harmonized protocol for the proficiency testing of analytical chemistry laboratories (IUPAC Technical Report). Pure Appl. Chem. 78 145-196.

Appendix M. Assigned NPL values

Nuclide	Assigned value *N*
	Bq kg^{-1}
^{226}Ra **(AL)**	10.25(18)
^{232}Th	5.47(8)
^{238}U	7.76(20)
$^{239/240}$Pu	12.37(19)
^{241}Am	5.00(6)
^{244}Cm	15.74(19)
gross alpha	83(18)
	Bq g^{-1}
^{210}Pb/^{210}Po **(AH)**	2.54(3)
^{237}Np	17.45(18)
^{238}Pu	18.08(6)
$^{239/240}$Pu	17.29(8)
^{241}Am	4.382(10)
^{244}Cm	18.29(6)
gross alpha	80.57(21)
^{238}Pu **(P)**	5.054(23)
$^{239/240}$Pu	5.79(6)
^{241}Pu	14.96(16)
^{3}H **(B1)**	1.345(10)
^{14}C	0.1398(9)
^{36}Cl	0.4544(18)
^{99}Tc	0.1218(11)
^{3}H **(B2)**	0.897(7)
^{55}Fe	1.235(22)
^{89}Sr	0.822(3)
^{90}Sr	1.488(4)
gross beta P	3.799(6)
gross beta L	5.931(23)
	Bq kg^{-1}
^{7}Be **(GL)**	11.02(13)
^{60}Co	11.252(25)
continues	

continued	
^{95}Zr	2.551(20)
^{95}Nb	5.55(5)
^{134}Cs	13.59(10)
^{137}Cs	10.58(21)
^{152}Eu	16.80(11)
^{154}Eu	3.437(25)
	Bq g^{-1}
^{7}Be **(GH)**	4.24(8)
^{60}Co	3.427(8)
^{95}Zr	1.875(15)
^{95}Nb	4.08(4)
^{134}Cs	5.81(5)
^{137}Cs	10.43(7)
^{152}Eu	11.78(13)
^{154}Eu	1.94(4)
^{60}Co **(S)**	7.82(20)
^{137}Cs	10.5(3)
^{152}Eu	16.0(5)
^{154}Eu	1.96(6)
^{241}Am	2.57(12)

Appendix N. List of participating laboratories

ARGENTINA

J. Diodati
Autoridad Regulatoria Nuclear
Av. Del Libertador 8250
Ciudad Autónoma de Buenos Aires (1429)
Buenos Aires
Argentina

AUSTRALIA

L. Mokhber-Shahin
ANSTO
Institute for Environmental Research
New Illawarra Road
Lucas Heights
NSW 2234
Australia

BULGARIA

V. Avramov
Kozloduy NPP Plc.
Radioecological Monitoring Section
Safety Division
3321 Kozloduy
Bulgaria

G. Neshovska
Kozloduy NPP Plc.
Radiochemistry Section
3321 Kozloduy
Bulgaria

DENMARK

S. Nielsen
Radiation Research Division,
Risø National Laboratory for Sustainable Energy
Technical University of Denmark
Denmark

J. Soegaard-Hansen
Danish Decommissioning
Section of Radiation and Nuclear Safety
P.O. Box 320
4000 Roskilde
Denmark

FRANCE

D. Lhuillier
CEA-SPHN
Centre de Saclay
Orme des Merisiers
Batiment 703 Piece 30B
F-91191 Gif-sur-Yvette
France

M. Osmond
IRSN/DEI/STEME
31 Rue de l'Ecluse
BP 40035
78116 Le Vésinet Cedex
France

IRELAND

J. Wong
Radiological Protection Insitute of Ireland
3 Clonskeagh Square
Dublin 14
Ireland

ISLE OF MAN

P. McKenna
Isle of Man Government
Government Laboratory
Ballakermeen Road
Douglas IM1 4BR
Isle of Man

ISRAEL

H. Nassar
Ministry of Environmental Protection
Str. Knafei Nesharim 3
95464 Jerusalem
Israel

LITHUANIA

A. Gudelis
Center for Physical Sciences and Technology
Savanoriu Ave. 231
LT-02300
Vilnius
Lithuania

MALAYSIA

Z. Laili
Malaysian Nuclear Agency (Nuclear Malaysia)
Waste & Environmental Technology Division
Block 32
Bangi
43000 Kajang
Selangor Darul Ehsan
Malaysia

THE NETHERLANDS

J.M. Kok
Nuclear Research & Consultancy Group (NRG)
Westerduinweg 3
1755 ZG Petten
The Netherlands

NEW ZEALAND

J.-G. Decaillon
National Radiation Laboratory
108 Victoria Street
Christchurch
New Zealand

NORWAY

A. Mauring
Norwegian Radiation Protection Agency
Grini Naeringspark 13
1332 Østerås
Norway

A. Mehus
Isophysics as
Tonafjellet 23
N-5355 Knarrevik
Norway

B. Møller
Norwegian Radiation Protection Authority
(Statens strålevern)
Svanhovd Emergency Preparedness Unit
N-9925 Svanvik
Norway

A. Nalbandyan
Norwegian Radiation Protection Authority
Polar Environmental Centre
Hjalmar Johansens gate 14
9296 Tromsø
Norway

I. Sværen
Institute of Marine Research
Nordnesgaten 50
5817 Bergen
Norway

PORTUGAL

M. Reis
Instituto Tecnológico e Nuclear
Estrada Nacional 10
2686-953 Sacavém
Portugal

ROMANIA

M. Bărăitaru
Dosimetry Laboratory
CNE-Cernavodă Nuclear Power Plant
Strada Medgidiei 2
905200 Cernavodă
Romania

C. Bucur
SNN-Cernavodă Nuclear Power Plant
Environmental Laboratory
Strada Medgidiei 1
905200 Cernavodă
Romania

SLOVAKIA

R. Janovsky
Wert Ltd.
Jerichova 4
917 01 Trnava
Slovakia

SLOVENIA

M. Giacomelli
Institute of Occupational Health
Chengdujska cesta 25
1000 Ljubljana
Slovenia

M. Štrok
Jožef Stefan Institute
Jamova 39
1000 Ljubljana
Slovenia

M. Tisler
Jožef Stefan Institute
Jamova 39
1000 Ljubljana
Slovenia

SOUTH AFRICA

I. Louw
South African Nuclear Energy Corporation
RadioAnalysis
Building 1600
Necsa
Pelindaba Site
Church Street West Extension
Pretoria
South Africa

P. Maleka
iThemba Labs
Old Faure Road
Faure
Western Cape
7131
South Africa

SOUTH KOREA

H.R. Kim
Nuclear Environment Safety Research Center
Korea Atomic Energy Research Institute
(150-1 Deokjin-Dong) 1045 Daedeokdaero, Yuseong, Daejeon 305-353
South Korea

TURKEY

H. Haznedaroglu
Turkish Atomic Energy Authority
Nuclear Research And Training Center
Yarimburgaz Mah
Nukleer Arastirma Yolu No: 10
34303 Kucukcekmece
Istanbul
Turkey

N. Kaya
Turkish Atomic Energy Authority
Saraykoy Nuclear Research and Training Centre
06983 Ankara
Turkey

UNITED ARAB EMIRATES

R. Shareef
Abu Dhabi Food Control Authority
13 Delma Street
Abu Dhabi
United Arab Emirates

UNITED KINGDOM

L. Anderson
DSRL Ltd
Dounreay
Thurso
Caithness KW14 7TZ
United Kingdom

P. Angus
AWE Aldermaston
Reading
Berkshire RG7 4PR
United Kingdom

N.M. Baghini
Imperial College Reactor Centre
Silwood Park
Ascot
Berkshire SL5 7TE
United Kingdom

R. Benzing
Scientifics Limited
551 South Becquerel Avenue
Harwell International Business Centre
Didcot
Oxfordshire OX11 0TB
United Kingdom

G. Bird
LGC Limited
Queens Road
Teddington
Middlesex TW11 0LY
United Kingdom

K. Bradshaw
AMEC Nuclear UK Ltd.
601 Faraday Street
Birchwood Park
Birchwood
Cheshire WA3 6GN
United Kingdom

K. Bulloch
Health Protection Agency Scotland
155 Hardgate Road
Glasgow G51 4LS
United Kingdom

J. Burnett and A. Davies
AWE Aldermaston
Reading
Berkshire RG7 4PR
United Kingdom

J. Caborn
National Nuclear Laboratory
Springfields
Preston
Lancashire PR4 0XJ
United Kingdom

M. Curtis
Veterinary Laboratories Agency - Weybridge
New Haw
Addlestone
Surrey KT15 3NB
United Kingdom

F. Dal-Molin
Corus RD & T
Swinden Technology Centre
Environment Department
Moorgate Road
Rotherham
S60 3AR
United Kingdom

C. Dale
AMEC Nuclear UK Ltd
Waste Quality Checking Laboratory
Building A512, RSRL Winfrith Site
Winfrith Newburgh
Dorchester
Dorset DT2 8WQ
United Kingdom

A. Deans
Research Sites Restoration Ltd.
B175 Curie Avenue
Harwell Science and Innovation Campus
Didcot
Oxfordshire OX11 0QQ
United Kingdom

T. Gingell
DSTL
Radiation Protection Service
Crescent Road
Gosport
Hampshire PO12 2RD
United Kingdom

G. Ham
Health Protection Agency
Chilton
Didcot
Oxfordshire OX11 0RQ
United Kingdom

C. Hardy
Babcock Marine
Reactorchemistry Section
Rosyth Dockyard
Rosyth
Dunfermline KY11 2YD
United Kingdom

J. Hattink
INUTEC
B44 Winfrith
Dorchester
Dorset DT2 8WQ
United Kingdom

M. John
Springfields Fuels Ltd
Preston
Lancashire PR4 0XJ
United Kingdom

C. Kinloch
Babcock Marine
APF
HMNB Clyde
Faslane
Argyll and Bute
G84 8HL
United Kingdom

J. Lavender
BAE SYSTEMS Submarine Solutions
Chemistry Laboratory
Building D07
Barrow-in-Furness
Cumbria LA14 1AF
United Kingdom

G. Lewis
Glasgow Scientific Services
Land and Environmental Services
Colston Laboratory
64 Everard Drive
Glasgow G21 1XG
United Kingdom

F. Low
DSRL Ltd
Dounreay
Thurso
Caithness KW14 7TZ
United Kingdom

S. Marshalsea
Lab 91, B229
Sellafield Ltd.
Seascale
Cumbria CA20 1PG
United Kingdom

K. McKay
Hunterston B
EDF Energy
West Kilbride
Ayrshire KA23 9QJ
United Kingdom

A. Morgan
Babcock
Westlakes Science and Technology Park
Moor Row
Cumbria CA24 3HZ
United Kingdom

G. Shephard
Babcock Marine
Reactor Chemistry Section (PC950)
Devonport Royal Dockyard
Devonport
Devon PL1 5SG
United Kingdom

S. Shepherd
Urenco UK Limited
Capenhurst
Chester
Cheshire CH1 6ER
United Kingdom

P. Smedley
CEFAS
Lowestoft Laboratory
Pakefield Road
Lowestoft
Suffolk NR33 0HT
United Kingdom

B. Taylor
Sizewell A Site
Leiston
Suffolk IP16 4UE
United Kingdom

A. Tyler
School of Biological and Environmental Sciences
University of Stirling
Stirling FK9 4LA
United Kingdom

S.A. Waldren
ASc Radiochemical Sciences
AWE Aldermaston
Reading
Berkshire RG7 4PR
United Kingdom

P.E. Warwick
GAU-Radioanalytical
National Oceanography Centre
European Way
Southampton SO14 3ZH
United Kingdom

C. Wells
CEH Lancaster
Lancaster Environment Centre
Library Avenue
Bailrigg, Lancaster LA1 4AP
United Kingdom

J. Whitehead
United Utilities NW
Lingley Mere Laboratory
Ullswater House
Lingley Green Avenue
Great Sankey
Warrington WA5 3LP
United Kingdom

K. Whitehead
Health Protection Agency
Occupational Services Department
Hospital Lane
Cookridge
Leeds LS16 6RW
United Kingdom

S. Wilson
The Agri-Food and Biosciences Institute
Agriculture Food and Environmental Science Division
Newforge Lane
Belfast BT9 5PX
United Kingdom

A. Wright
Magnox South Limited
Dungeness Station
Romney Marsh
Kent TN29 9PP
United Kingdom