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Environmental Radioactivity Proficiency Test Exercise 2009

ARVIC HARMS AND CHRIS GILLIGAN

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Arvic Harms and Chris Gilligan
Acoustics and Ionising Radiation Division

ABSTRACT

The results of NPL's fifteenth Environmental Radioactivity Proficiency Test Exercise are reported. This exercise included preparing 217 samples and distributing them to 37 participants in the UK and 37 overseas participants. Seven 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 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 six radionuclides (S). The level of performance was slightly higher than observed in the previous Exercise (2008); 71% of the results returned were in agreement with the assigned values.

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

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

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1 INTRODUCTION

This environmental radioactivity proficiency test exercise was the fifteenth 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 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. The range of sample types available for analysis has been mainly aqueous. In the 2009 exercise, seven 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) **B1**; a mixture of four β-emitting radionuclides in 500 g of very dilute NaOH solution (0.1 – 2 Bq g^{-1} per radionuclide)
(iv) **B2**; a mixture of four β-emitting radionuclides in 500 g of very dilute hydrochloric acid (0.1 – 2 Bq g^{-1} per radionuclide)
(v) **GL**; a 'low-level' mixture of eight γ-emitting radionuclides in 500 g of dilute hydrochloric acid (1 – 20 Bq kg^{-1} per radionuclide)
(vi) **GH**; a 'high-level' mixture of eight γ-emitting radionuclides in 100 g of dilute hydrochloric acid (1 – 20 Bq g^{-1} per radionuclide)
(vii) **S**; a solid SiO_2 sample containing six 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, 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 ^{232}Th, ^{237}Np, ^{238}U, ^{239}Pu, ^{241}Am and ^{244}Cm) and AH sources (containing a mixture of ^{226}Ra, ^{237}Np, ^{238}Pu, ^{239}Pu, ^{241}Am and ^{244}Cm), the B1 sources (containing a mixture of ^{3}H, ^{14}C, ^{99}Tc and ^{129}I), 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 ^{55}Fe, ^{90}Sr, ^{133}Ba, ^{134}Cs, ^{137}Cs and ^{152}Eu) 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 2008 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 2008 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 72 participants took part in the exercise (35 from the United Kingdom and 37 from overseas organisations). A full listing is given in Appendix O. The majority of the samples taken were the GL and GH (50 and 40 participants, respectively). Uptake for the AL, AH, B1, B2 and S samples was 32, 17, 23, 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:

^{65}Zn, **^{85}Sr**, **^{125}Sb**, **^{133}Ba**, **^{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.

^{89}Sr, **^{90}Sr**, **^{99}Tc** and **^{129}I** – 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 2009 12:00 UTC.* The deadline for the submission of results was 1 December 2009. 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, ^{99}Tc and ^{129}I using the CIEMAT/NIST method. Each vial contained 10 g of liquid scintillation cocktail and 1.0 g of aqueous phase (containing either the ^{89}Sr, ^{90}Sr, ^{99}Tc and ^{129}I or the ^{3}H standard source) resulting in a total volume of approximately 11 ml for

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

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 and AH samples

The nuclides listed below were the principal radionuclides present in the AL and AH samples. The composition of the AL and AH samples was different from the AL and AH samples offered in the last exercise: (i) ^{226}Ra, ^{234}U, ^{235}U and ^{238}Pu were omitted from the AL samples, whilst ^{232}Th was added and (ii) ^{234}U, ^{235}U and ^{238}U were omitted from the AH samples.

2.5.1.1 Radium-226 (AH)

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 ~35% of the ^{226}Ra activity).

2.5.1.2 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.

2.5.1.3 Neptunium-237 (AL and 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.

2.5.1.4 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.

2.5.1.5 Plutonium-238 (AH)
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).

2.5.1.6 Plutonium-239 (AL and AH)
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).

2.5.1.7 Americium-241 (AL and AH)
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.

2.5.1.8 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 slightly different from the B1 sample offered in the last exercise: ^{129}I 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 carbonate. The carbon-14 source was traceable to a national standard of radioactivity.

2.5.2.3 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).

2.5.2.4 Iodine-129

This long-lived nuclide is produced by neutron induced fission of ^{235}U and ^{239}Pu. It undergoes beta minus decay (E_{max} = 191 keV) to ^{129}Xe. It occurs widely in the marine environment as a result discharges from the nuclear industry. The ^{129}I 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 slightly different from the B2 offered in the last exercise: ^{63}Ni was omitted and ^{89}Sr was added.

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 a national standard 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: ^{22}Na, ^{95}Zr and ^{95}Nb were omitted, whilst ^{65}Zn, ^{85}Sr and ^{125}Sb were added.

2.5.4.1 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.

2.5.4.2 Zinc-65

This nuclide is produced by neutron activation of ^{64}Zn. It decays by electron capture to excited levels of ^{65}Cu and by electron capture and beta plus decay to the ground state level of ^{65}Cu. The only significant gamma-ray emission is at 1115 keV [50.22(11)%]. Zinc-65 is present in some types of nuclear waste and it is also used as a calibration nuclide. Zinc-65 was standardised using an ionisation chamber.

2.5.4.3 Strontium-85

This nuclide is produced by neutron activation of ^{84}Sr. It decays by electron capture to excited levels of ^{85}Rb. The only significant gamma-ray emission is at 514 keV [98.5(4)%]. Strontium-85 is present in some types of nuclear waste and it is also used as a calibration nuclide. Strontium-85 was standardised using an ionisation chamber.

2.5.4.4 Antimony-125

This fission product undergoes beta minus decay to excited levels of ^{125}Te. Antimony-125 is present in the environment due to discharges from the nuclear industry. There are a large number of high-energy gamma-ray emissions in its decay, some of which are coincident with one another, so some coincidence summing effects may be expected. The percentage of disintegrations to ^{125m}Te ($T_{½}$ = 57 d) is 22.9(9)%. Due to the relatively long half-life of the ^{125m}Te, the system may not be in equilibrium at the time of measurement. Antimony-125 was standardised using an ionisation chamber.

2.5.4.5 Barium-133

This nuclide decays by electron capture to excited levels of ^{133}Cs. Barium-133 is present in some types of nuclear waste (e.g., activated concrete), and it is well known as a nuclide which shows coincidence summing effects on high efficiency detectors. Barium-133 was standardised using an ionisation chamber.

2.5.4.6 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.

2.5.4.7 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.

2.5.4.8 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.

2.5.5 S samples

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

Iron-55 (see Section 2.5.3.2)

Strontium-90 (see Section 2.5.3.4)

Barium-133 (see Section 2.5.4.5)

Caesium-134 (see Section 2.5.4.6)

Caesium-137 (see Section 2.5.4.7)

Europium-152 (see Section 2.5.4.8)

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:

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

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

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

The results were evaluated by three tests:

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

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

$$z = \frac{L - N}{\sigma_p} = \frac{L - N}{R_{\mathrm{med}} N} \qquad [5]$$

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})
R_{med}	– median of the R_{L} values	

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. In cases where the data set was smaller than 10, any value of $R_{\mathrm{med}} > 0.20$ was set at 0.20, and any value of $R_{\mathrm{med}} < 0.05$ was set at 0.05.

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.

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 $\zeta = 2.576$ parabola (i.e., for which $\zeta \leq 2.576$), for which $-2.576 \leq z$-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 $\zeta = 2.576$ parabola with a z-score < –2.576*or > 2.576,
(ii) outside the $\zeta = 2.576$ parabola with $-2.576 \le z$-score ≤ 2.576 or
(iii) inside the $\zeta = 2.576$ parabola with $-2.576 \le z$-score ≤ 2.576 but inside the R_{lim} parabola (i.e., for which $R_L > R_{\mathrm{lim}}$).

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 = 32) 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 ^{133}Ba (356 keV peak), ^{134}Cs (605 keV peak), ^{137}Cs (662 keV peak) and ^{152}Eu (121 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 consensus value. More information on the homogeneity uncertainty can be found in Appendix C8.

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

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

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

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

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

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

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	

* Please note that the z-test value ≥ ($-N / \sigma_p$) by definition

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.

3 RESULTS AND DISCUSSION

3.1 AL AND AH SAMPLES

3.1.1 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, mass 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.

Fourteen results were reported for the AH samples (see Figures 8A to 8D). Ten results are in agreement with the assigned value, one result is questionable. Three results are discrepant. The reported results show no significant bias. Five participants (Labs 1, 8, 32, 86 and 115) used gamma spectrometry to determine ^{226}Ra, six participants (Labs 8, 32, 47, 88, 106 and 123) used alpha spectrometry, two participants (Labs 31 and 35) used gas-flow proportional counting and one participant (Lab 38) used liquid scintillation counting. A variety of yield tracers was used: ^{133}Ba (Labs 35, 106 and 123), ^{223}Ra (Lab 47), ^{224}Ra (Lab 32) and ^{225}Ra (Lab 88). A variety of separation techniques was used to separate ^{226}Ra from the matrix: precipitation techniques (Labs 31, 35, 106, 115 and 123), chromatography (Labs 8, 32, 47 and 88) and radon extraction (Lab 38). There is no indication that there are significant differences between the results obtained from the various techniques used.

Reported AH results:	14
In agreement with the assigned value:	10
Questionable result:	1
Discrepant from the assigned value:	3

3.1.2 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-one results were reported for the AL samples (see Figures 1A to 1D). Sixteen results are in agreement with the assigned value, while two results are questionable. Three results are discrepant. The reported results show no significant bias. Most participants used alpha spectrometry to determine ^{232}Th, while one participant (Lab 32) used mass spectrometry and one participant (Lab 42) used gamma spectrometry. Twelve participants (Labs 13, 25, 28, 32, 35, 51, 59, 65, 88, 91, 119 and 121) who used alpha spectrometry as the detection method used ion-exchange chromatography to separate the ^{232}Th from the matrix. Seven participants (Labs 26, 29, 47, 90, 106, 120 and 123) 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 (who used LaF_3) and Labs 106 and 119 (who used NdF_3) all used microprecipitation. There is some evidence that there are differences between the results obtained from the techniques used with the only gamma spectrometry result being discrepant.

Reported AL results:	21
In agreement with the assigned value:	16
Questionable results:	2
Discrepant from the assigned value:	3

3.1.3 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).

Eleven results were reported for the AL samples (see Figures 2A to 2D). Six results are in agreement with the assigned value. Five results are discrepant. The reported results show no significant bias. Six participants (Labs 65, 90, 91, 106, 119 and 120) used alpha spectrometry to determine ^{237}Np, while other participants used mass spectrometry (Labs 8 and 35) and gamma spectrometry (Labs 25, 42 and 86). There is no indication that there are significant differences between the results obtained from the various techniques used.

Reported AL results:	11
In agreement with the assigned value:	6
Questionable result:	0
Discrepant from the assigned value:	5

Eleven results were reported for the AH samples (see Figures 9A to 9D). Nine results are in agreement with the assigned value, while two results are questionable. The reported results show no significant bias. Four participants used gamma spectrometry to determine ^{237}Np (Labs 1, 32, 55 and 86), while four used mass spectrometry (Labs 8, 38, 47 and 55) and three used alpha spectrometry (Labs 1, 47 and 106). There is no indication that there are significant differences between the results obtained from the various techniques used.

Reported AH results:	11
In agreement with the assigned value:	9
Questionable result:	2
Discrepant from the assigned value:	0

3.1.4 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.

Thirty results were reported for the AL samples (see Figures 3A to 3D). Twenty-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. Most participants used alpha spectrometry to determine ^{238}U, while three participants (Labs 8, 32 and 47) used mass spectrometry and two participants (Labs 42 and 86) used gamma spectrometry. Eleven participants (Labs 4, 17, 26, 29, 47, 61, 65, 90, 106, 120 and 123) who used alpha spectrometry as the detection method used extraction chromatography to separate the ^{238}U from the matrix. Eight participants (Labs 8, 13, 25, 28, 35, 40, 59 and 121) used ion-exchange chromatography and three participants (Labs 32, 88 and 119) 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 and another participant (Lab 8) used ^{233}U parallel standards. Most participants who used alpha spectrometry as the detection method used electrodeposition to prepare the ^{238}U sources. Labs 61, 65 and 119 used microprecipitation (CeF_3 and NdF_3). There is no evidence that there are significant differences between the results obtained from the techniques used (although both gamma spectrometry results have a relatively low bias while the mass spectrometry results were in general very accurate).

Reported AL results:	30
In agreement with the assigned value:	25
Questionable results:	3
Discrepant from the assigned value:	2

3.1.5 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 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)%.

Eleven results were reported for the AH samples (see Figures 10A to 10D). Ten results are in agreement with the assigned value. One result (Lab 35) is discrepant. The ^{239}Pu results of this lab is also discrepant, indicating a systematic problem (e.g., submitting the ^{238}Pu result as ^{239}Pu and vice versa). The reported results show no significant bias. All participants used alpha spectrometry to determine ^{238}Pu. Most participants separated the ^{238}Pu from the matrix by ion-exchange chromatography. Two participants (Labs 7 and 123) used extraction chromatography, while one participant (Lab 88) used liquid-liquid extraction. One participant (Lab 32) 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.

Reported AH results:	11
In agreement with the assigned value:	10
Questionable result:	0
Discrepant from the assigned value:	1

3.1.6 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 sample.

Twenty-six results were reported for the AL samples (see Figures 4A to 4D). Eighteen results are in agreement with the assigned value, while three results are questionable. Five results are discrepant. The reported results show a significant negative bias. All participants used alpha spectrometry to determine ^{239}Pu, except Lab 100 who used mass spectrometry. Most participants used ion-exchange chromatography to separate the ^{239}Pu from the matrix. Eight participants (Labs 4, 17, 26, 31, 47, 90, 120 and 123) used extraction chromatography and one participant (Lab 119) used a combination of ion-exchange chromatography and 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 119 used microprecipitation (LaF_3 and NdF_3). There is no indication that there are significant differences between the results obtained from the various techniques used (although the mass spectrometry result showed a significant negative bias).

Reported AL results:	26
In agreement with the assigned value:	18
Questionable result:	3
Discrepant from the assigned value:	5

Thirteen results were reported for the AH samples (see Figures 11A to 11D). Ten results are in agreement with the assigned value. Three results are discrepant. The ^{238}Pu result of Lab 35 is also discrepant, indicating a systematic problem (see above). The reported results show no significant bias. All participants used alpha spectrometry to determine ^{239}Pu, except Lab 100 who used mass spectrometry. Most participants separated the ^{239}Pu from the matrix by ion-exchange chromatography. Three participants (Labs 7, 47 and 123) used extraction chromatography, while one participant (Lab 88) used liquid-liquid 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 AH results:	13
In agreement with the assigned value:	10
Questionable result:	0
Discrepant from the assigned value:	3

3.1.7 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-nine results were reported for the AL samples (see Figures 5A to 5D). 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 large majority of the participants used alpha spectrometry to determine ^{241}Am (with ^{243}Am as the yield tracer). Four participants (Labs 8, 32, 42 and 86) used gamma spectrometry. Nine participants (Labs 17, 26, 31, 47, 61, 90, 120, 121 and 123) who used alpha spectrometry as the detection method separated the ^{241}Am from the matrix by extraction chromatography. Nine participants (Labs 8, 13, 25, 28, 29, 35, 51, 59, 91) used ion-exchange chromatography and seven participants (Labs 4, 40, 62, 65, 88, 106 and 119) used a combination of ion-exchange chromatography and extraction chromatography. Most participants who used alpha spectrometry as the detection method used electrodeposition to prepare the ^{241}Am sources. Labs 65, 106 and 119 used microprecipitation (LaF_3 and NdF_3). There is no indication that there are significant differences between the results obtained from the various techniques used.

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

Seventeen results were reported for the AH samples (see Figures 12A to 12D). 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. The majority of the participants used alpha spectrometry to determine ^{241}Am (with ^{243}Am as the yield tracer). Five participants (Labs 1, 8, 32, 55 and 86) used gamma spectrometry. Five participants (Labs 7, 31, 38, 47 and 123) who used alpha spectrometry as the detection method separated ^{241}Am with extraction chromatography. Three participants (Labs 1, 8 and 35) used ion-exchange chromatography, two participants (Labs 32 and 106) used a combination of ion-exchange chromatography and extraction chromatography and one participant (Lab 88) used liquid-liquid extraction. Most participants who used alpha spectrometry as the detection method used electrodeposition to prepare the ^{241}Am sources. Lab 106 used microprecipitation (NdF_3). There is no indication that there are significant differences between the results obtained from the various techniques used.

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

3.1.8 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.

Twenty results were reported for the AL samples (see Figures 6A to 6D). Twelve results are in agreement with the assigned value, while seven results are questionable. One result is discrepant. The reported results show a significant negative bias. All participants used alpha spectrometry to determine ^{244}Cm with most sources prepared by electrodeposition (except Labs 65 and 119 who used LaF_3 and NdF_3 microprecipitation). All participants except Lab 28 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 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. However, the questionable results for ^{241}Am and ^{244}Cm of Lab 40 cannot be fully explained by this, since its normalised ^{244}Cm / ^{241}Am ratio is not significantly different from unity.

Reported AL results:	20
In agreement with the assigned value:	12
Questionable result:	7
Discrepant from the assigned value:	1

Eleven results were reported for the AH samples (see Figures 13A to 13D). Seven results are in agreement with the assigned value, while two results are questionable. Two results are discrepant. The reported results show a significant negative 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:	11
In agreement with the assigned value:	7
Questionable result:	2
Discrepant from the assigned value:	2

3.1.9 Gross alpha

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

Thirteen results were reported for the AL samples (see Figures 7A to 7D). 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. The seven results that were 'in agreement' were obtained using either alpha spectrometry (Lab 59), a ZnS scintillation detector (Labs 8, 65 and 121), liquid scintillation counting (Lab 26) or gas-flow proportional counting (Labs 113 and 123). The other results (except Lab 119), which were all either ‘questionable’ or ‘discrepant’, were all obtained using a gas-flow proportional counter.

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

Ten results were reported for the AH samples (see Figures 14A to 14D). Four results are in agreement with the assigned value, while six results are questionable. The reported results show no significant bias. The four results that were ‘in agreement’ were obtained using either gas-flow proportional counter (Labs 1 and 123), a ZnS scintillation detector (Lab 55) or liquid scintillation counting (Lab 47). The other results, which were all ‘questionable’, were obtained using a gas-flow proportional counter (Labs 31, 41, 88 and 113), a ZnS scintillation detector (Lab 8) or liquid scintillation counting (Lab 7).

Reported AH results:	10
In agreement with the assigned value:	4
Questionable result:	6
Discrepant from the assigned value:	0

3.2 B1 SAMPLES

3.2.1 Hydrogen-3

The main difficulty in measuring the tritiated water activity concentration is the need for a radiochemical separation from ^{14}C, ^{99}Tc and ^{129}I.

Twenty-three results were reported for this nuclide (see Figures 15A to 15D). Twenty-one results are in agreement with the assigned value, while one result is questionable. One result is discrepant. The reported results show no significant bias. The majority of the participants (except Labs 5, 29, 32, 35, 38, 65 and 108 who used combustion and Lab 55 who used an unspecified chemical separation) used distillation to separate tritium from the other nuclides. All participants used liquid scintillation counting as the detection method.

Reported results:	23
In agreement with the assigned value:	21
Questionable results:	1
Discrepant from the assigned value:	1

3.2.2 Carbon-14

The main difficulty in measuring the ^{14}C activity concentration is the need for a radiochemical separation from ^{3}H, ^{99}Tc and ^{129}I.

Nineteen results were reported for this nuclide (see Figures 16A to 16D). Ten results are in agreement with the assigned value, while five results are questionable. Four results are discrepant. The reported results show a significant positive 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. Other techniques used included LSC spectrum analysis (Lab 65) and $BaCO_3$ precipitation (Lab 106).

Reported results:	19
In agreement with the assigned value:	10
Questionable results:	5
Discrepant from the assigned value:	4

3.2.3 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 ^{129}I.

Sixteen results were reported for this nuclide (see Figures 17A to 17D). Twelve results are in agreement with the assigned value, while one result is questionable. Three results are discrepant. The reported results show no significant bias. There is no indication that either the detection method [mass spectrometry (Labs 8, 32, 55 and 74), liquid scintillation counting (Labs 35, 38, 55, 59, 65, 78 and 107), gas-flow proportional counting (Labs 8, 25 and 28) or low level beta GM (Lab 83)], yield tracer [^{99m}Tc (Labs 28, 35 and 74) or stable Re (Labs 13, 25, 32, 65 and 83)] or the radiochemical separation technique (a wide variety of precipitation techniques, solvent extraction, ion-exchange chromatography and extraction (TEVA) chromatography) led to any significant differences between the results.

Reported results:	16
In agreement with the assigned value:	12
Questionable result:	1
Discrepant from the assigned value:	3

3.2.4 Iodine-129

Iodine-129 can be measured with gamma spectrometry, gas-flow proportional counting and liquid scintillation counting. The main difficulty in measuring the ^{129}I activity concentration with liquid scintillation counting and gas-flow proportional counting is the need for a radiochemical separation from ^{3}H, ^{14}C and ^{99}Tc. Ten results were reported for this nuclide (see Figures 18A to 18D). Nine results are in agreement with the assigned value, while one result is questionable. The reported results show no significant bias. Most participants used gamma spectrometry as the detection method either direct (Labs 8, 38, 55 and 65) or after a sample pretreatment step: Lab 59 (ion-exchange chromatography), Labs 25 and 74 (ion-exchange chromatography followed by a PdI_2 precipitation) and Lab 107 (unspecified preconcentration). One participant (Lab 32) used liquid scintillation counting after an AgI precipitation, while one participant (Lab 78) used gas-flow proportional counting after a PdI_2 precipitation.

Reported results:	10
In agreement with the assigned value:	9
Questionable results:	1
Discrepant from the assigned value:	0

3.3 B2 SAMPLES

3.3.1 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-four results were reported for this nuclide (see Figures 19A to 19D). Fifteen results are in agreement with the assigned value, while three results are questionable. Six results are discrepant. The reported results show no significant bias. The majority of the participants (except Labs 32 and 65 who used combustion, Lab 55 who used an unspecified chemical separation and Labs 5, 31, 121 and 122 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 123 obtained discrepant (and similar) tritium results for both the B1 and B2 samples.

Reported results:	24
In agreement with the assigned value:	15
Questionable result:	3
Discrepant from the assigned value:	6

3.3.2 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).

Twelve results were reported for this nuclide (see Figures 20A to 20D). Eight results are in agreement with the assigned value, while two 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 (Labs 8, 16, 31, 32, 38, 55, 119, 120 and 121), gas-flow proportional counting (Lab 25) or X-ray spectrometry (Labs 7 and 107)] led to a significant difference between the results, although a positive bias for the gas-flow proportional counting result was observed.

Reported results:	12
In agreement with the assigned value:	8
Questionable result:	2
Discrepant from the assigned value:	2

3.3.3 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.

Fifteen results were reported for for this nuclide (see Figures 21A to 21D). Nine results are in agreement with the assigned value, while three reported results are questionable. Three results are discrepant. The reported results show a significant negative bias. There is no indication that the detection method [liquid scintillation counting or Cerenkov counting (Labs 7, 8, 26, 32, 38, 40, 55, 61, 74, 90, 91, 107 and 120) or gas-flow proportional counting (Labs 106 and 114)], the nature of the yield tracer [unknown (Labs 8 and 120), ^{85}Sr (Labs 7, 38, 40, 55, 61, 90 and 107) or stable Sr (Labs 26, 32, 74, 91, 106 and 114)], nor the radiochemical separation technique [unspecified (Labs 55 and 91), extraction chromatography (Labs 7, 8, 26, 32, 38, 40, 61, 74, 90, 107 and 120), precipitation (Lab 114) and precipitation/extraction (Lab 106)] led to any significant differences between the results.

Reported results:	15
In agreement with the assigned value:	9
Questionable results:	3
Discrepant from the assigned value:	3

3.3.4 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.

Twenty-two results were reported for this nuclide (see Figures 22A to 22D). Seventeen results are in agreement with the assigned value, while one result is questionable. Four results are discrepant. The reported results show no significant bias. Most participants used LSC or Cerenkov counting to detect ^{90}Sr or its daughter ^{90}Y, while five participants (Labs 8, 25, 106, 114 and 121) used gas flow proportional counting. Eight participants (Labs 7, 38, 40, 41, 55, 61, 90 and 107) used ^{85}Sr as the yield tracer for ^{90}Sr; eight participants (Labs 26, 32, 65, 74, 91, 106, 114 and 121) used stable Sr; one participant (Lab 25) used stable Y and no information was provided by four participants (Labs 8, 31, 120 and 123). The most popular method for separating ^{90}Sr from the matrix was extraction chromatography, with the exception of Labs 31, 55 and 91 (no information provided), Lab 123 (extraction), Labs 25, 106, 114 and 121 (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, 31, 41, 65, 121 and 123).

Reported results:	22
In agreement with the assigned value:	17
Questionable result:	1
Discrepant from the assigned value:	4

3.3.5 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 61); see Appendix C4).

Eleven results were reported for this nuclide (see Figures 23A to 23D). Four results are in agreement with the assigned value, while two results are questionable. Five results are discrepant. There is no indication that the detection method led to any significant differences between the results.

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

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’.

3.4.1 Cobalt-60

There are no specific measurement problems for this nuclide.

Forty-eight results were reported for the GL samples (see Figures 24A to 24D). Forty-one 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 GL results:	48
In agreement with the assigned value:	41
Questionable results:	4
Discrepant from the assigned value:	3
Missing results:	2

Thirty-nine results were reported for the GH samples (see Figures 32A to 32D). Twenty-nine results are in agreement with the assigned value, while two results are questionable. Eight results are discrepant. The reported results show no significant bias.

Reported GH results:	39
In agreement with the assigned value:	29
Questionable results:	2
Discrepant from the assigned value:	8
Missing results:	1

3.4.2 Zinc-65

There are no specific measurement problems for this nuclide.

Forty-six results were reported for the GL samples (see Figures 25A to 25D). Thirty-seven results are in agreement with the assigned value, while seven results are questionable. Two results are discrepant. The reported results show no significant bias.

Reported GL results:	46
In agreement with the assigned value:	37
Questionable results:	7
Discrepant from the assigned value:	2
Missing results:	4

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

Reported GH results:	38
In agreement with the assigned value:	24
Questionable results:	6
Discrepant from the assigned value:	8
Missing results:	2

3.4.3 Strontium-85

The challenge in the measurement of this nuclide is the potential interference of its main emission of 514 keV with the 511 keV annihilation peak.

Forty-seven results were reported for the GL samples (see Figures 26A to 26D). Thirty-two results are in agreement with the assigned value, while eight results are questionable. Seven results are discrepant. The reported results show no significant bias.

Reported GL results:	47
In agreement with the assigned value:	32
Questionable results:	8
Discrepant from the assigned value:	7
Missing results:	3

Thirty-seven results were reported for the GH samples (see Figures 34A to 34D). Twenty-seven results are in agreement with the assigned value, while five results are questionable. Five results are discrepant. The reported results show no significant bias.

Reported GH results:	37
In agreement with the assigned value:	27
Questionable results:	5
Discrepant from the assigned value:	5
Missing results:	3

3.4.4 Antimony-125
There are no specific measurement problems for this nuclide.

Thirty-two results were reported for the GL samples (see Figures 27A to 27D). Twenty-eight results are in agreement with the assigned value, while four results are questionable. The reported results show no significant bias.

Reported GL results:	32
In agreement with the assigned value:	28
Questionable results:	4
Discrepant from the assigned value:	0
Missing results:	18

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

Reported GH results:	37
In agreement with the assigned value:	29
Questionable results:	4
Discrepant from the assigned value:	4
Missing results:	3

3.4.5 Barium-133
The challenge in the measurement of this nuclide is the need for coincidence summing corrections.

Forty-seven results were reported for the GL samples (see Figures 28A to 28D). Forty-two results are in agreement with the assigned value, while four results are questionable. One result is discrepant. The reported results show a significant negative bias.

Reported GL results:	47
In agreement with the assigned value:	42
Questionable results:	4
Discrepant from the assigned value:	1
Missing results:	3

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

Reported GH results:	38
In agreement with the assigned value:	26
Questionable results:	2
Discrepant from the assigned value:	10
Missing results:	2

3.4.6 Caesium-134

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

Forty-nine results were reported for the GL samples (see Figures 29A to 29D). Thirty-six results are in agreement with the assigned value, while ten results are questionable. Three results are discrepant. The reported results show a significant negative bias.

Reported GL results:	49
In agreement with the assigned value:	36
Questionable results:	10
Discrepant from the assigned value:	3
Missing results:	1

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

Reported GH results:	39
In agreement with the assigned value:	25
Questionable results:	3
Discrepant from the assigned value:	11
Missing results:	1

3.4.7 Caesium-137

There are no specific measurement problems for this nuclide.

Fifty results were reported for the GL samples (see Figures 30A to 30D). Forty-four results are in agreement with the assigned value, while four results are questionable. Two results are discrepant. The reported results show no significant bias.

Reported GL results:	50
In agreement with the assigned value:	44
Questionable results:	4
Discrepant from the assigned value:	2
Missing results:	0

Forty results were reported for the GH samples (see Figures 38A to 38D). Thirty-one results are in agreement with the assigned value, while four results are questionable. Five results are discrepant. The reported results show no significant bias.

Reported GH results:	40
In agreement with the assigned value:	31
Questionable results:	4
Discrepant from the assigned value:	5
Missing results:	0

3.4.8 Europium-152

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

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

Reported GL results:	39
In agreement with the assigned value:	29
Questionable results:	8
Discrepant from the assigned value:	2
Missing results:	11

Thirty-eight results were reported for the GH samples (see Figures 39A to 39D). Twenty-seven results are in agreement with the assigned value, while three results are questionable. Eight results are discrepant. The reported results show no significant bias.

Reported GH results:	38
In agreement with the assigned value:	27
Questionable results:	3
Discrepant from the assigned value:	8
Missing results:	2

3.5 S SAMPLES

3.5.1 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).

Three results were reported for this nuclide (see Figure 40). Two results are in agreement with the assigned value. One result is discrepant. The reported results show no significant bias. The following dissolution methods were used: HF/acid (Lab 32), HNO_3 (Lab 121) and unspecified (Lab 8). Two participants (Labs 8 and 121) used precipitation and ion-exchange chromatography to separate ^{55}Fe from the concrete matrix and the other nuclides, while Lab 32 used solvent extraction. All participants used liquid scintillation counting as the detection method.

Reported results:	3
In agreement with the assigned value:	2
Questionable results:	0
Discrepant from the assigned value:	1

3.5.2 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.

Nine results were reported for this nuclide (see Figures 41A to 41E). Seven results are in agreement with the assigned value. Two results are discrepant. The reported results show no significant bias. The following dissolution methods were used: HF/acid (Labs 29, 32 and 76), HNO_3 (Lab 121) and unspecified (Labs 28, 106, 114 and 123). Five participants (Labs 28, 29, 106, 114 and 121) used gas flow proportional counting, while three participants (Labs 32, 76 and 123) used LSC or Cerenkov counting to detect ^{90}Sr or its daughter ^{90}Y. Five labs (Labs 32, 76, 106, 114 and 121) used stable Sr and/or Y as the yield tracer for ^{90}Sr, while two participants (Labs 28 and 29) used ^{85}Sr and no information was provided by one participant (Lab 123). The method for separating ^{90}Sr from the matrix varied widely: extraction chromatography (Lab 32), ion-exchange chromatography (Lab 28), liquid / liquid extraction (Labs 76 and 123) and precipitation techniques (Labs 29, 106, 114 and 121). 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, although all results involving an HF dissolution step and/or measurement by LSC were all ‘in agreement’.

Reported results:	9
In agreement with the assigned value:	7
Questionable results:	0
Discrepant from the assigned value:	2

3.5.3 Barium-133

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

Twenty-two results were reported for this nuclide (see Figures 42A to 42E). Fourteen results are in agreement with the assigned value, while four results are questionable. Four results are discrepant. The reported results show a significant negative bias. All participants used gamma spectrometry as the detection method.

Reported results:	22
In agreement with the assigned value:	14
Questionable results:	4
Discrepant from the assigned value:	4

3.5.4 Caesium-134

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

Twenty-three results were reported for this nuclide (see Figures 43A to 43E). Sixteen results are in agreement with the assigned value, while four 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:	23
In agreement with the assigned value:	16
Questionable results:	4
Discrepant from the assigned value:	3

3.5.5 Caesium-137

There are no specific measurement problems for this nuclide.

Twenty-four results were reported for this nuclide (see Figures 44A to 44E). Twenty-one 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 gamma spectrometry as the detection method.

Reported results:	24
In agreement with the assigned value:	21
Questionable results:	1
Discrepant from the assigned value:	2

3.5.6 Europium-152

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

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

Reported results:	22
In agreement with the assigned value:	15
Questionable results:	3
Discrepant from the assigned value:	4

3.6 RESULT SUMMARY

The combined results for all samples are listed below in Tables 3.1 to 3.7.

Table 3.1 – Results AL

Nuclide	In agreement	Questionable	Discrepant
^{232}Th	16 (76%)	2 (10%)	3 (14%)
^{237}Np	6 (55%)	0	5 (45%)
^{238}U	25 (83%)	3 (10%)	2 (7%)
^{239}Pu	18 (69%)	3 (12%)	5 (19%)
^{241}Am	26 (90%)	2 (7%)	1 (3%)
^{244}Cm	12 (60%)	7 (35%)	1 (5%)
gross alpha	7 (54%)	4 (31%)	2 (15%)
Total	110	21	19
Total (%)	73	14	13

Table 3.2 – Results AH

Nuclide	In agreement	Questionable	Discrepant
^{226}Ra	10 (71%)	1 (7%)	3 (21%)
^{237}Np	9 (82%)	2 (18%)	0
^{238}Pu	10 (91%)	0	1 (9%)
^{239}Pu	10 (77%)	0	3 (23%)
^{241}Am	13 (76%)	1 (6%)	3 (18%)
^{244}Cm	7 (64%)	2 (18%)	2 (18%)
gross alpha	4 (40%)	6 (60%)	0
Total	63	12	12
Total (%)	72	14	14

Table 3.3 – Results B1

Nuclide	In agreement	Questionable	Discrepant
^{3}H	21 (91%)	1 (4%)	1 (4%)
^{14}C	10 (53%)	5 (26%)	4 (21%)
^{99}Tc	12 (75%)	1 (6%)	3 (19%)
^{129}I	9 (90%)	1 (10%)	0
Total	52	8	8
Total (%)	76	12	12

Table 3.4 – Results B2

Nuclide	In agreement	Questionable	Discrepant
^{3}H	15 (63%)	3 (13%)	6 (25%)
^{55}Fe	8 (67%)	2 (17%)	2 (17%)
^{89}Sr	9 (60%)	3 (20%)	3 (20%)
^{90}Sr	17 (77%)	1 (5%)	4 (18%)
gross beta	4 (36%)	2 (18%)	5 (45%)
Total	53	11	20
Total (%)	63	13	24

Table 3.5 – Results GL

Nuclide	In agreement	Questionable	Discrepant	Missing
^{60}Co	41 (82%)	4 (8%)	3 (6%)	2 (4%)
^{65}Zn	37 (74%)	7 (14%)	2 (4%)	4 (8%)
^{85}Sr	32 (64%)	8 (16%)	7 (14%)	3 (6%)
^{125}Sb	28 (56%)	4 (8%)	0	18 (36%)
^{133}Ba	42 (84%)	4 (8%)	1 (2%)	3 (6%)
^{134}Cs	36 (72%)	10 (20%)	3 (6%)	1 (2%)
^{137}Cs	44 (88%)	4 (8%)	2 (4%)	0
^{152}Eu	29 (58%)	8 (16%)	2 (4%)	11 (22%)
Total	289	49	20	42
Total (%)	72	12	5	11

Table 3.6 – Results GH

Nuclide	In agreement	Questionable	Discrepant	Missing
^{60}Co	29 (73%)	2 (5%)	8 (20%)	1 (3%)
^{65}Zn	24 (60%)	6 (15%)	8 (20%)	2 (5%)
^{85}Sr	27 (68%)	5 (13%)	5 (13%)	3 (8%)
^{125}Sb	29 (73%)	4 (10%)	4 (10%)	3 (8%)
^{133}Ba	26 (65%)	2 (5%)	10 (25%)	2 (5%)
^{134}Cs	25 (63%)	3 (8%)	11 (28%)	1 (3%)
^{137}Cs	31 (78%)	4 (10%)	5 (13%)	0
^{152}Eu	27 (68%)	3 (8%)	8 (20%)	2 (5%)
Total	218	29	59	14
Total (%)	68	9	18	4

Table 3.7 – Results S

Nuclide	In agreement	Questionable	Discrepant
^{55}Fe	2 (67%)	0	1 (33%)
^{90}Sr	7 (78%)	0	2 (22%)
^{133}Ba	14 (64%)	4 (18%)	4 (18%)
^{134}Cs	16 (70%)	4 (17%)	3 (13%)
^{137}Cs	21 (88%)	1 (4%)	2 (8%)
^{152}Eu	15 (68%)	3 (14%)	4 (18%)
Gross beta	–	–	–
Total	75	12	16
Total (%)	73	12	16

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 3.8 – False positive identifications

Nuclide	Number of participants	Potential cause
^{40}K (GL)	2	Background
^{125}I (GL)	1	Mistaken for ^{125}Sb
^{57}Co (GL)	1	Mistaken for ^{152}Eu
^{113}Sn (GH)	1	Unknown
^{125}I (GH)	1	Mistaken for ^{125}Sb
^{129}I (GH)	1	X-ray from ^{152}Eu?

3.8 ANALYSIS OF RESULTS BY PARTICIPANT

The combined results for each participant are presented in Tables 3.9. The individual deviation results are presented in Figures 47 to 118.

Table 3.9 – Individual results

Participant	Results in agreement	Questionable results	Discrepant results	Missing results
1	7 (78%)	2 (22%)	0	0
4	4 (100%)	0	0	0
5	18 (75%)	5 (21%)	0	1 (4%)
7	9 (38%)	3 (13%)	11 (46%)	1 (4%)
8	39 (81%)	5 (10%)	3 (6%)	1 (2%)
10	14 (88%)	2 (13%)	0	0
13	16 (100%)	0	0	0
15	11 (69%)	3 (19%)	2 (13%)	0
16	3 (27%)	2 (18%)	6 (56%)	0
17	18 (75%)	3 (13%)	2 (8%)	1 (4%)
18	17 (85%)	3 (15%)	0	0
19	9 (100%)	0	0	0
23	7 (88%)	1 (13%)	0	0
25	26 (90%)	2 (7%)	1 (3%)	0
26	10 (63%)	2 (13%)	4 (25%)	0
27	10 (63%)	3 (19%)	3 (19%)	0
28	21 (72%)	4 (14%)	4 (14%)	0
29	18 (90%)	1 (5%)	1 (5%)	0
31	5 (18%)	3 (11%)	8 (29%)	12 (43%)
32	37 (95%)	2 (5%)	0	0
35	26 (72%)	2 (6%)	6 (17%)	2 (6%)
38	21 (95%)	1 (5%)	0	0
39	7 (88%)	0	1 (13%)	0
40	6 (40%)	5 (33%)	2 (13%)	2 (13%)
41	9 (64%)	1 (7%)	2 (14%)	2 (14%)
42	11 (85%)	1 (8%)	1 (8%)	0
45	7 (88%)	0	1 (13%)	0
46	16 (100%)	0	0	0
47	30 (91%)	0	1 (3%)	2 (6%)
48	9 (75%)	1 (8%)	2 (17%)	0
51	8 (62%)	2 (15%)	3 (23%)	0

continues

continued

Participant	Results in agreement	Questionable results	Discrepant results	Missing results
53	8 (100%)	0	0	0
55	23 (77%)	5 (17%)	2 (7%)	0
58	12 (60%)	0	8 (40%)	0
59	18 (69%)	3 (12%)	3 (12%)	2 (8%)
61	9 (64%)	3 (21%)	2 (14%)	0
62	7 (70%)	1 (10%)	0	2 (20%)
65	20 (91%)	1 (5%)	1 (5%)	0
72	9 (100%)	0	0	0
74	12 (75%)	1 (6%)	2 (13%)	1 (6%)
76	10 (48%)	2 (10%)	8 (38%)	1 (5%)
77	8 (100%)	0	0	0
78	1 (25%)	1 (25%)	2 (50%)	0
82	9 (56%)	7 (44%)	0	0
83	6 (33%)	0	0	12 (67%)
86	18 (82%)	1 (5%)	3 (14%)	0
88	21 (75%)	4 (14%)	2 (7%)	1 (4%)
89	14 (88%)	1 (6%)	1 (6%)	0
90	5 (56%)	0	4 (44%)	0
91	16 (94%)	1 (6%)	0	0
93	4 (50%)	0	4 (50%)	0
95	13 (93%)	1 (7%)	0	0
100	3 (14%)	6 (27%)	12 (55%)	1 (5%)
104	7 (88%)	1 (13%)	0	0
106	15 (94%)	1 (6%)	0	0
107	9 (82%)	1 (9%)	1 (9%)	0
108	7 (70%)	1 (10%)	2 (20%)	0
110	8 (100%)	0	0	0
111	4 (50%)	1 (13%)	0	3 (38%)
113	1 (25%)	1 (25%)	2 (50%)	0
114	12 (80%)	2 (13%)	1 (7%)	0
115	2 (100%)	0	0	0
116	0	0	8 (100%)	0
117	9 (56%)	6 (38%)	1 (6%)	0

continues

continued				
Participant	Results in agreement	Questionable results	Discrepant results	Missing results
118	4 (40%)	0	0	6 (60%)
119	13 (76%)	1 (6%)	3 (18%)	0
120	13 (72%)	4 (22%)	1 (6%)	0
121	13 (54%)	5 (21%)	6 (25%)	0
122	8 (89%)	0	0	1 (11%)
123	33 (87%)	1 (3%)	4 (11%)	0
124	6 (38%)	1 (6%)	7 (44%)	2 (13%)
126	1 (5%)	19 (95%)	0	0
Total	860 (71%)	142 (12%)	154 (13%)	56 (5%)

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

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

Table 3.11 – Results UK/non-UK and 2007/2008/2009 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%)
non-UK participants in 2007	69	540 (44%)
non-UK participants in 2008	66	529 (44%)
non-UK participants in 2009	69	489 (44%)
2009 participants in 2008	69	923 (77%)
2008 participants in 2009	75	840 (76%)
non-2009 participants in 2008	56	279 (23%)
non-2008 participants in 2009	59	269 (24%)
Total 2007	72	1217
Total 2008	66	1202
Total 2009	71	1109

The following conclusions can be drawn from this table:

The overall performance in 2009 was better the overall performance in 2008.
The performance of the UK participants was slightly better than the overall performance in 2009.
The performance of the participants who participated in both Exercises was better in 2009 than in 2008.
The performance of the participants who participated only in one Exercise was better in 2009 than in 2008.

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 $^{239/240}$Pu (AL), ^{244}Cm (AL and AH), ^{89}Sr (B2), gross beta L (B2), ^{133}Ba (GL), ^{134}Cs (GL and GH) and ^{133}Ba (S) were significantly lower than assigned value, while the weighted mean of the LCS for the participants' results for ^{14}C (B1) 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}			
^{232}Th (AL)	5.01(5)	4.94(6)	81	–0.94	2.70
^{237}Np	4.65(5)	4.72(18)	64	0.41	3.71
^{238}U	18.0(4)	17.99(3)	93	0.04	2.58
$^{239/240}$Pu	11.77(12)	11.02(11)	81	–4.16 D	2.63
^{241}Am	3.099(6)	3.05(3)	97	–1.62	2.76
^{244}Cm	15.41(5)	14.78(13)	90	–4.35 D	2.82
gross alpha	72(7)	66.3(16)	69	–0.81	2.58
	Bq g^{-1}	Bq g^{-1}			
^{226}Ra (AH)	15.90(21)	15.83(20)	79	–0.25	2.70
^{237}Np	4.84(5)	4.66(13)	82	–1.26	3.17
^{238}Pu	16.63(5)	16.41(19)	91	–1.07	3.17
$^{239/240}$Pu	11.31(5)	11.00(12)	85	–1.96	3.01
^{241}Am	5.356(10)	5.37(5)	82	0.38	2.98
^{244}Cm	6.980(22)	6.59(11)	73	–3.61 D	3.50
gross alpha	$8(3) \times 10^{1}$	67.1(14)	60	–0.43	2.58
^{3}H (B1)	1.688(12)	1.713(14)	96	1.35	2.66
^{14}C	0.905(6)	0.958(12)	74	3.99 D	2.88
^{99}Tc	0.1562(4)	0.153(3)	88	–1.16	3.01
^{129}I	0.1504(9)	0.1467(25)	100	–1.40	3.11
^{3}H (B2)	1.389(15)	1.359(13)	67	–1.52	2.63
^{55}Fe	1.53(3)	1.44(4)	83	–1.87	2.77
^{89}Sr	0.463(4)	0.393(8)	73	–7.78 D	2.92
^{90}Sr	1.153(10)	1.158(14)	82	0.29	2.71
gross beta P	2.769(15)	2.82(8)	50	0.71	5.84
gross beta L	5.68(4)	3.99(16)	100	–10.37 D	9.92

continues

continued					
Nuclide	Assigned value N	WM LCS	Size of the LCS (%)	Zeta test	Critical value
	Bq kg^{-1}	Bq kg^{-1}			
^{60}Co (GL)	5.035(12)	5.05(4)	96	0.39	2.66
^{65}Zn	5.50(4)	5.63(5)	93	2.07	2.62
^{85}Sr	7.01(5)	7.18(6)	85	2.19	2.62
^{125}Sb	1.366(7)	1.372(24)	97	0.25	2.72
^{133}Ba	3.571(25)	3.44(3)	98	–3.31 D	2.62
^{134}Cs	14.02(10)	13.15(7)	92	–7.12 D	2.59
^{137}Cs	4.47(3)	4.59(4)	98	2.53	2.61
^{152}Eu	1.789(12)	1.773(23)	92	–0.61	2.66
	Bq g^{-1}	Bq g^{-1}			
^{60}Co (GH)	5.418(12)	5.36(3)	85	–1.67	2.70
^{65}Zn	5.92(4)	5.92(4)	79	0.04	2.62
^{85}Sr	7.54(5)	7.60(5)	86	0.82	2.60
^{125}Sb	1.470(7)	1.438(12)	92	–2.34	2.65
^{133}Ba	3.84(3)	3.76(3)	79	–2.35	2.62
^{134}Cs	15.09(11)	14.51(9)	79	–4.11 D	2.60
^{137}Cs	4.81(4)	4.89(3)	85	1.73	2.60
^{152}Eu	1.925(13)	1.901(13)	79	–1.30	2.62
^{55}Fe (S)	4.38(13)	4.09(21)	67	–1.16	5.84
^{90}Sr	0.810(20)	0.757(17)	78	–2.01	2.72
^{133}Ba	4.91(13)	4.55(3)	82	–2.79 D	2.58
^{134}Cs	11.8(3)	11.05(5)	78	–2.38	2.58
^{137}Cs	5.05(13)	5.15(4)	88	0.78	2.58
^{152}Eu	4.84(13)	4.67(4)	82	–1.25	2.58

3.11 STANDARD DEVIATIONS FOR PROFICIENCY ASSESSMENT AND RELATIVE UNCERTAINTY OUTLIERS

The median relative uncertainties R_{med} and the outlier limit R_{lim} for the aqueous samples are listed in Table 3.13 and plotted in Figures 119 and 121. R_{med} was used to calculate the standard uncertainty for proficiency assessment σ_p and the z-score for each result (except when the data set was smaller than 10, in which case any R_{med} > 20% was set at 20% and any R_{med} < 5% was set at 5%). R_{med} values ranged from to 3.7% to 13.1%, but in general were of the order of 5% (Figure 121). 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 25 relative uncertainty results (2% of the total results). For 12 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 13 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 10% to 59% (Figure 122).

Table 3.13 – Median relative uncertainties and outlier limits aqueous samples

Nuclide	Number of results	Median relative uncertainty R_{med} (%)	Number of outliers	Outlier limit R_{lim} (%)
^{232}Th (AL)	21	6.0	1	27.3
^{237}Np	11	10.4	0	36.1
^{238}U	30	5.1	0	24.0
^{239}Pu	26	5.3	0	19.9
^{241}Am	29	7.3	0	22.9
^{244}Cm	20	4.4	0	22.0
gross alpha	13	5.2	0	33.8
^{226}Ra (AH)	14	5.9	0	28.0
^{237}Np	11	9.2	0	32.4
^{238}Pu	11	4.7	0	10.3
^{239}Pu	13	4.9	0	12.7
^{241}Am	17	5.0	0	23.8
^{244}Cm	11	5.0	0	21.8
gross alpha	10	4.6	0	21.3
^{3}H (B1)	23	5.9	0	21.1
^{14}C	19	5.0	2	14.1
^{99}Tc	16	6.7	1	21.2
^{129}I	10	7.4	0	25.8
^{3}H (B2)	24	4.0	0	17.0
^{55}Fe	12	7.0	1	22.3
^{89}Sr	15	9.6	1	55.5
^{90}Sr	22	7.2	0	27.6
continues				

continued				
Nuclide	Number of results	Median relative uncertainty R_{med} (%)	Number of outliers	Outlier limit R_{lim} (%)
gross beta	11	4.7#	0	25.6
^{60}Co (GL)	48	5.4	1	20.3
^{65}Zn	46	7.3	3	26.7
^{85}Sr	47	5.3	1	20.7
^{125}Sb	32	13.1	0	59.2
^{133}Ba	47	7.4	1	26.3
^{134}Cs	49	5.3	2	20.0
^{137}Cs	50	6.2	0	28.1
^{152}Eu	39	10.0	2	29.5
^{60}Co (GH)	39	4.0	2	15.7
^{65}Zn	38	3.9	1	14.0
^{85}Sr	37	4.2	1	15.3
^{125}Sb	37	5.1	1	20.4
^{133}Ba	38	4.6	1	16.0
^{134}Cs	39	4.1	1	16.7
^{137}Cs	40	4.1	1	15.1
^{152}Eu	38	5.0	1	18.8
^{55}Fe (S)	3	6.5	–	–
^{90}Sr	9	5.6	0	19.0
^{133}Ba	22	4.6	0	18.8
^{134}Cs	23	3.7	0	18.8
^{137}Cs	24	4.1	0	20.7
^{152}Eu	22	4.1	0	20.4

Set at a value of 5.0%

4 CONCLUSION

The 2009 proficiency test exercise was successfully completed, with all but 2 of the laboratories returning data. In total, 217 samples were shipped to 74 participants and 1160 results were submitted. All 72 data sets were submitted electronically. In total, 71% of the results was 'in agreement', 12% of the results was 'questionable', 13% of the results was 'discrepant' and 5% of the results was 'missing' [100% is represented by 1212 results]. Seven 'false positives' were received. The overall level of performance was slightly higher than observed in the previous Exercise (2008). The performance of the participants who participated in both Exercises was slightly better in 2009 than in 2008. The performance of the new participants was lower than the established participants. Thirty-two participants scored 80% or higher 'in agreement' results, 17 participants scored 90% or higher 'in agreement' results and 9 participants scored 100% 'in agreement' results.

For the AL and AH samples 73% and 72% of the results were 'in agreement'. For the AL samples the most problematic nuclides were ^{237}Np, ^{244}Cm and the gross alpha measurements, while for the AH samples the most problematic nuclide was ^{244}Cm and the gross alpha measurements. There was a significant negative bias between the assigned result and the participants' results for $^{239/240}$Pu (AL) and ^{244}Cm (both AL and AH).

For the B1 samples 76% of the results were 'in agreement'. For the B1 samples the most problematic nuclide was ^{14}C. For the B2 samples 63% of the results were 'in agreement'. The most problematic nuclides were ^{89}Sr and the gross beta measurements. There was a significant negative bias between the assigned result and the participants' results for ^{89}Sr (B2) and gross beta L (B2). There was a significant positive bias between the assigned result and the participants' results for ^{14}C (B1).

Most participants were able to identify all the nuclides in the GL and GH samples. The number of 'false positives' results was 7. More than one false positive result was returned for ^{40}K (GL) (reported by 2 participants). For the GL and GH samples 72% and 68% of the results were 'in agreement'. For the GL samples the most problematic nuclides were ^{125}Sb and ^{152}Eu, while for the GH samples the most problematic nuclides were ^{65}Zn and ^{134}Cs. There was a significant negative bias between the assigned result and the participants' results for ^{133}Ba (GL) and ^{134}Cs (both GL and GH).

For the solid S samples 73% of the results were 'in agreement'. For the S samples the most problematic nuclide was ^{133}Ba. There was a significant negative bias between the assigned result and the participants' results for ^{133}Ba.

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, ^{133}Ba, ^{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 45

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 black dotted lines represent deviations corresponding to the assigned value N plus or minus 2.576 times the assigned value uncertainty u_N. Thus, a laboratory value $L = N + 2.576\ u_N$ results in a deviation $D = 100\ (2.576\ u_N / N)$ %; the corresponding zeta score is ≤ 2.576 by definition. 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 46 Homogeneity tests for ^{133}Ba (A), ^{134}Cs (B), ^{137}Cs (C) and ^{152}Eu (D). The green points represent samples sent to the participants in this Exercise. The dark blue and red points represent samples kept at NPL.

Figures 47 to 118 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 119 The medians of the relative uncertainties of the laboratory values R_{med} are represented by the light blue bars.

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 Th-232 AL

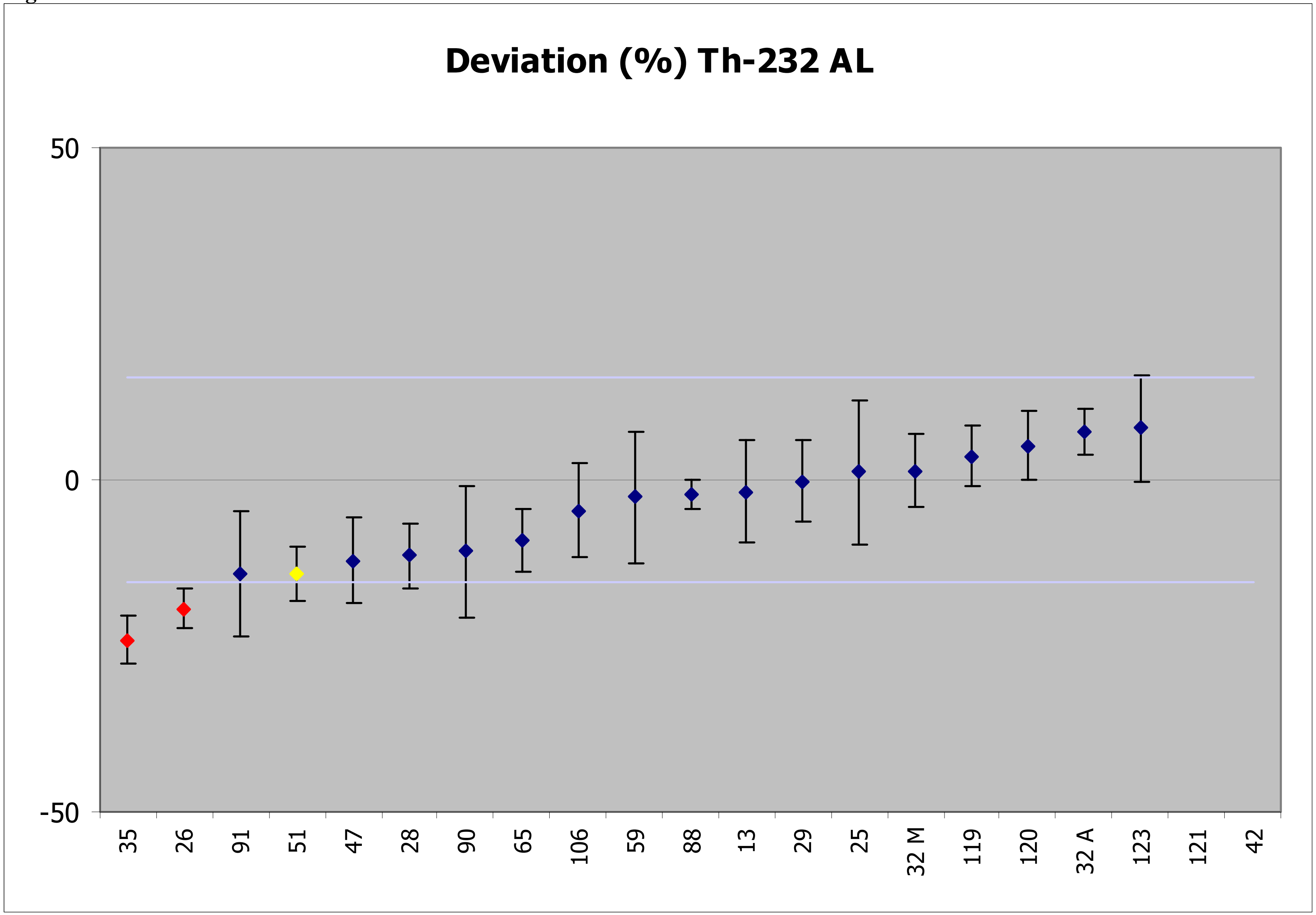


Figure 1B – Zeta score Th-232 AL

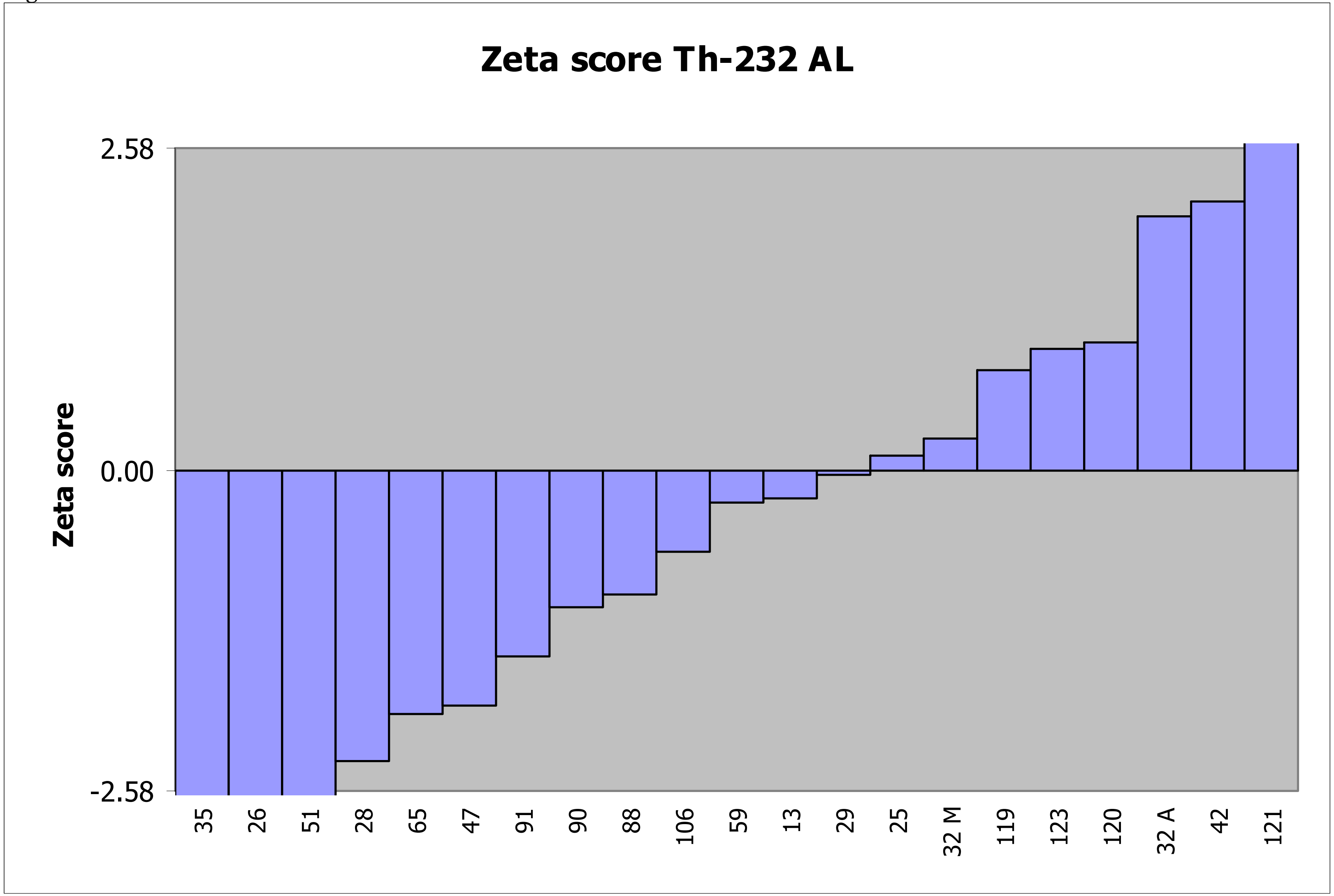


Figure 1C – Relative uncertainty Th-232 AL

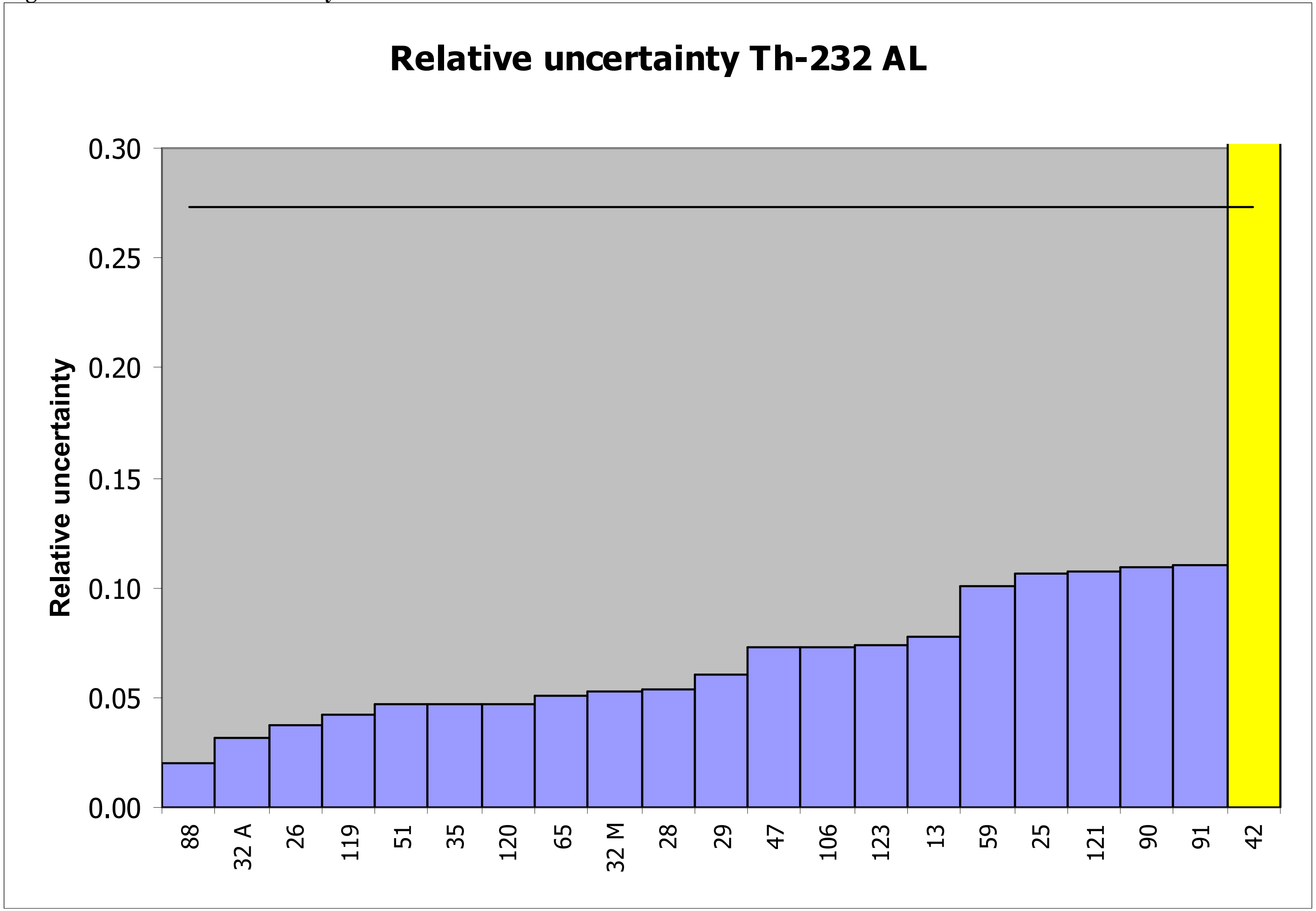


Figure 1D – Kiri plot Th-232 AL

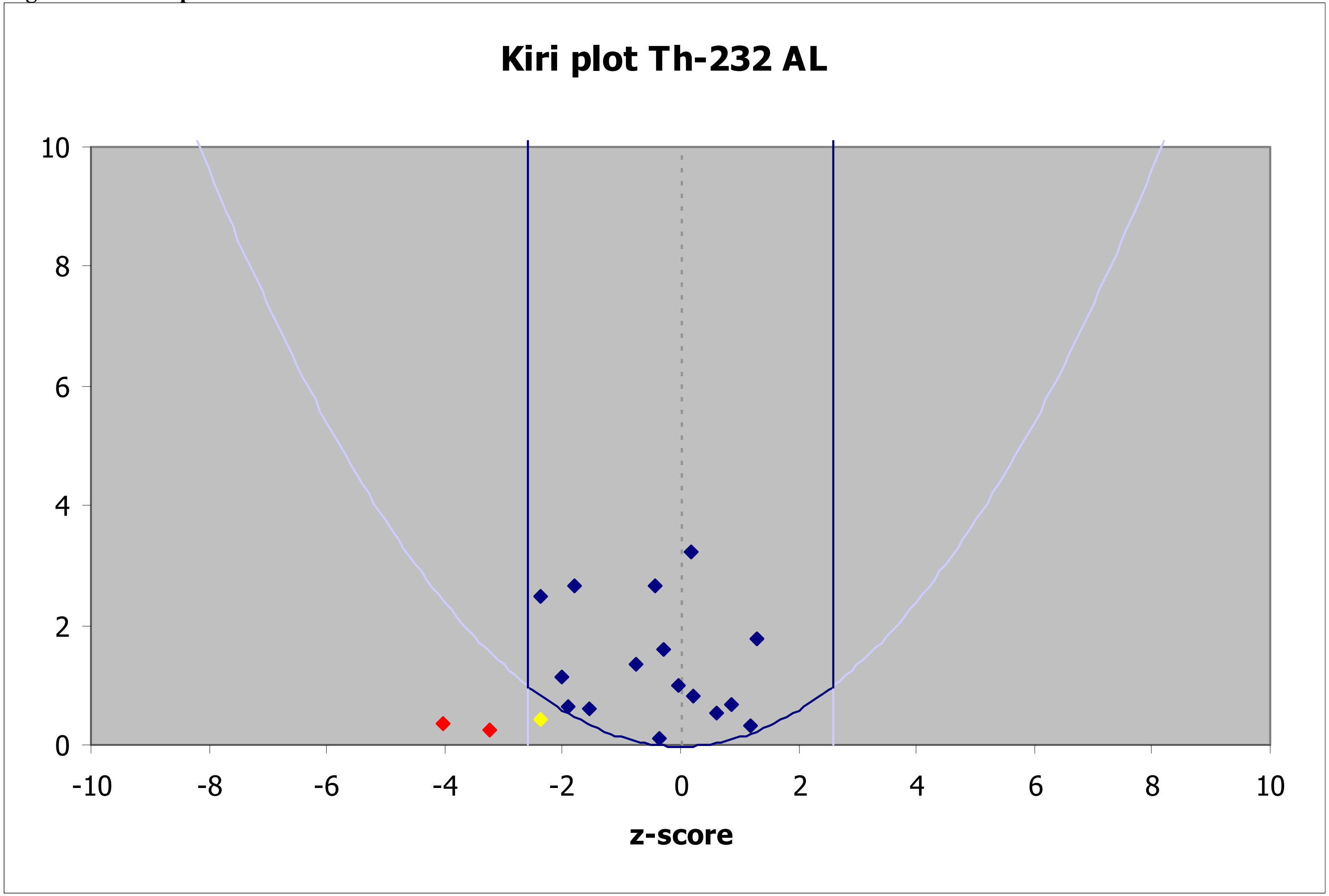


Figure 2A – Deviation Np-237 AL

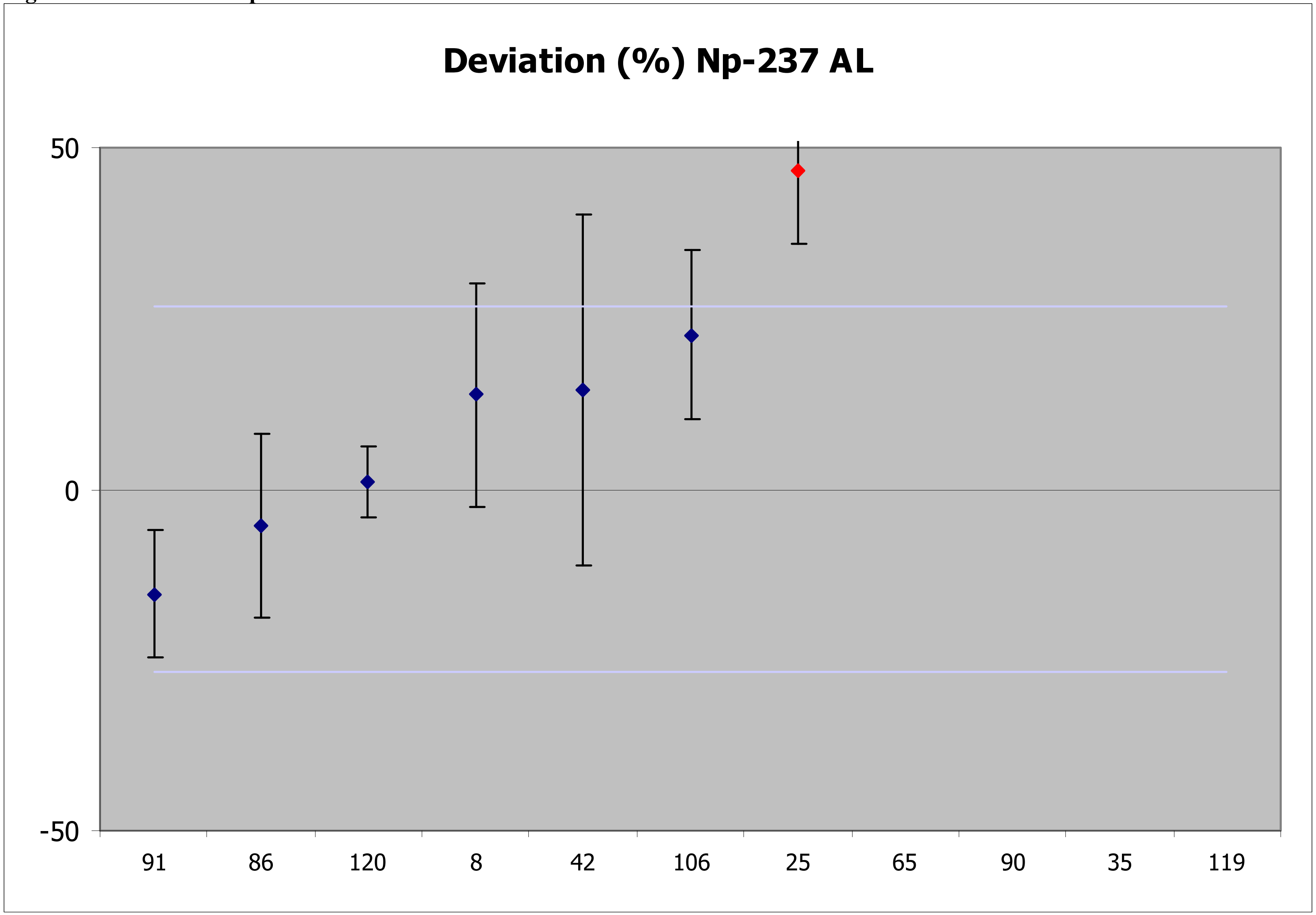


Figure 2B – Zeta score Np-237 AL

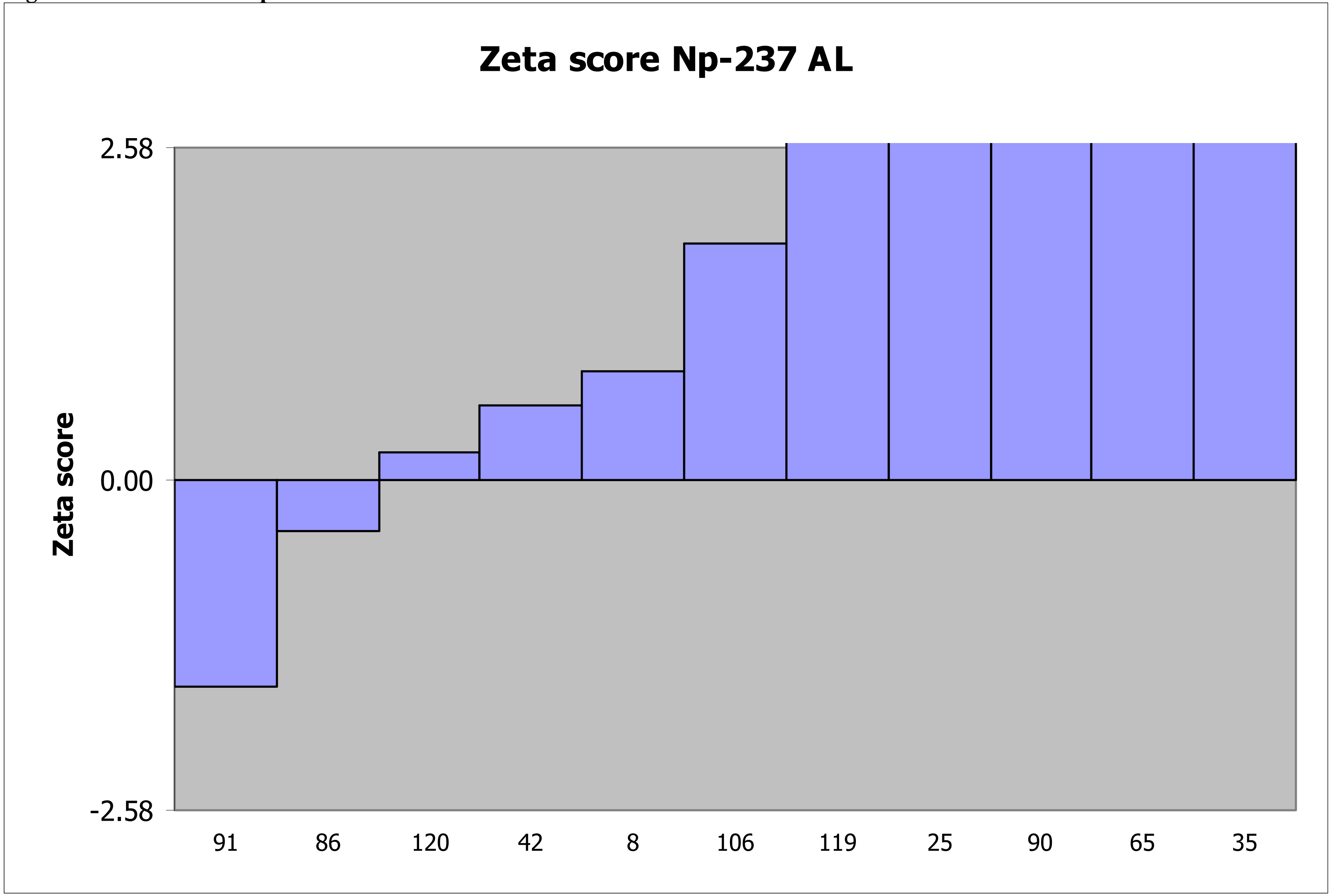


Figure 2C – Relative uncertainty Np-237 AL

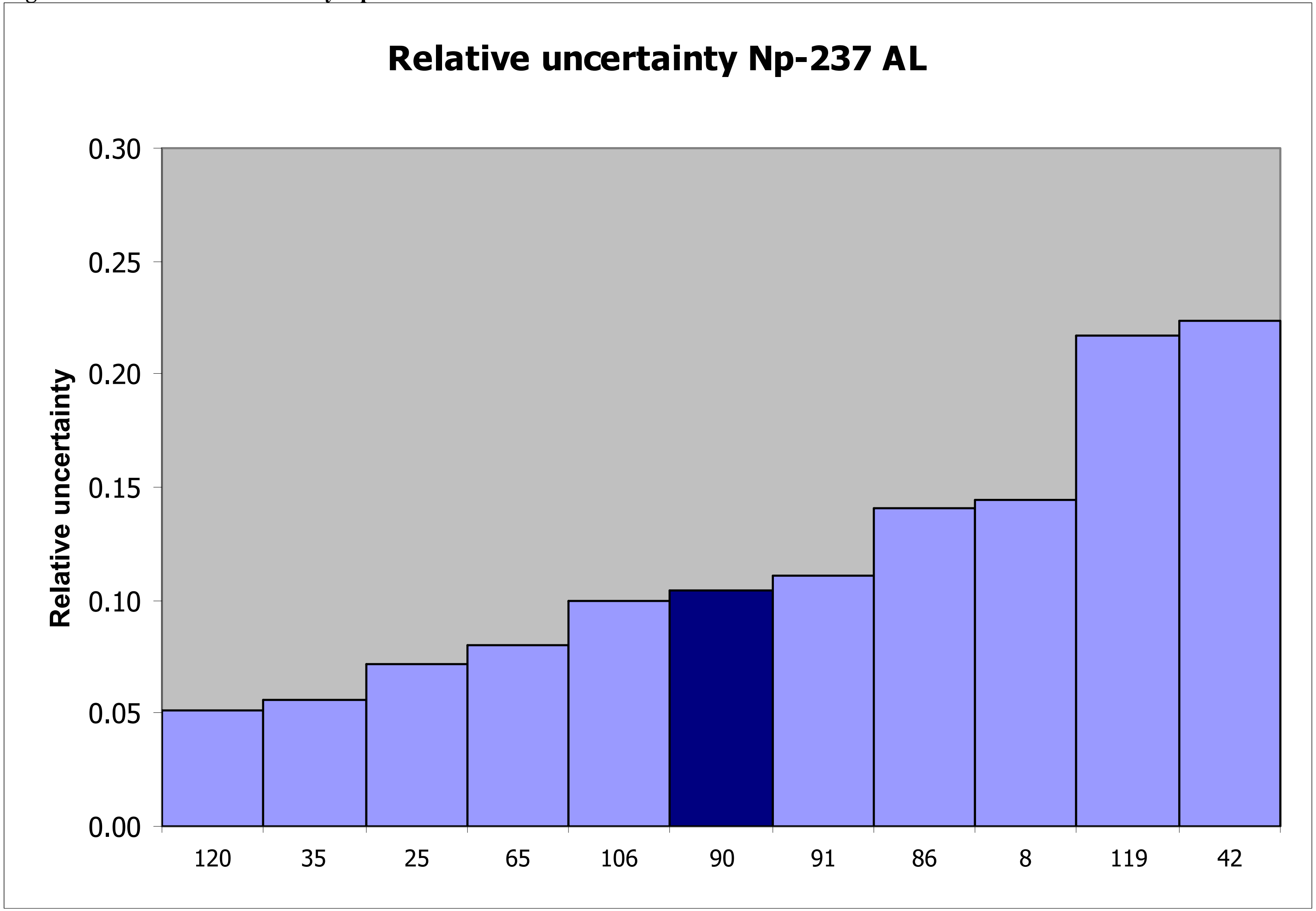


Figure 2D – Kiri plot Np-237 AL

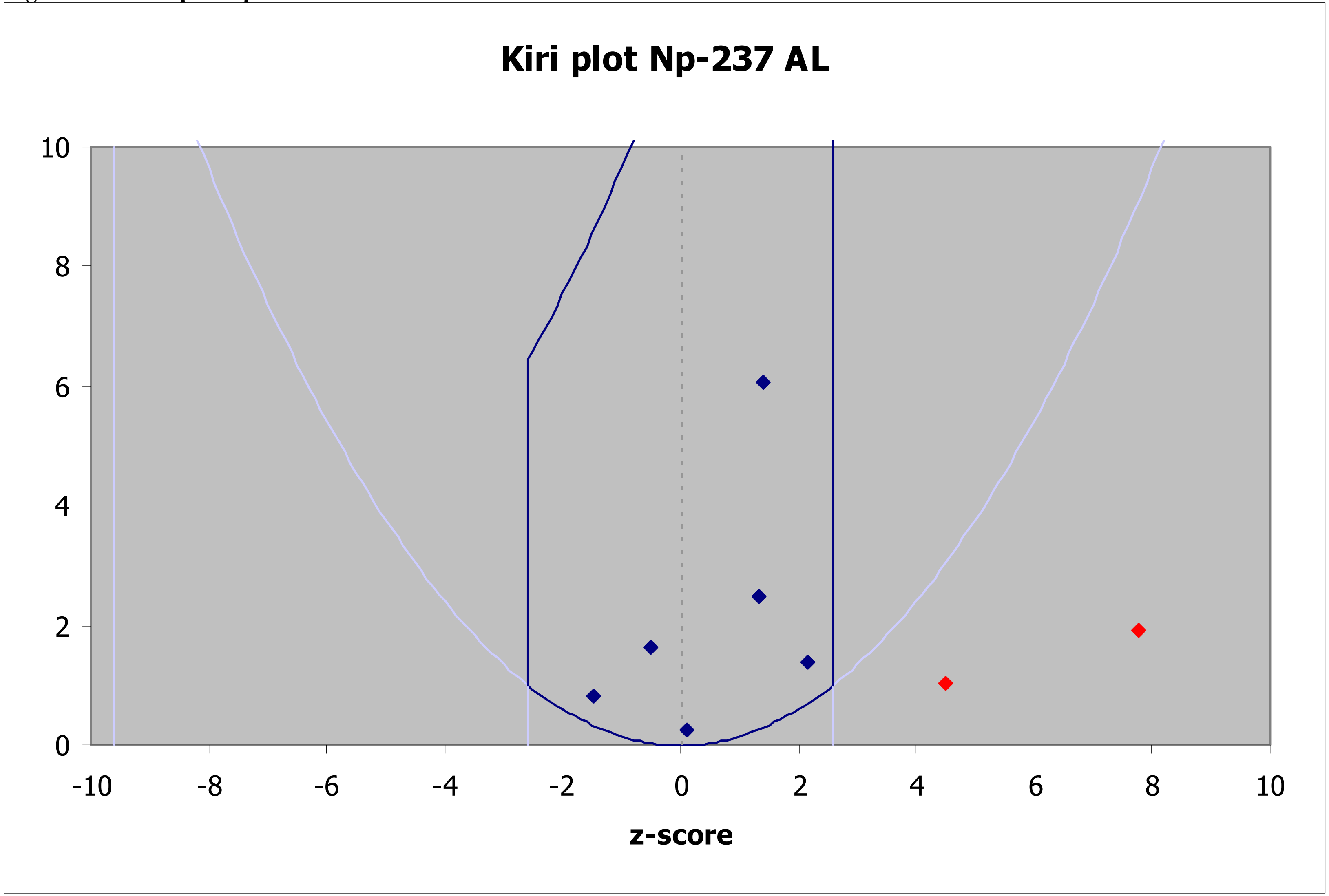


Figure 3A – Deviation U-238 AL

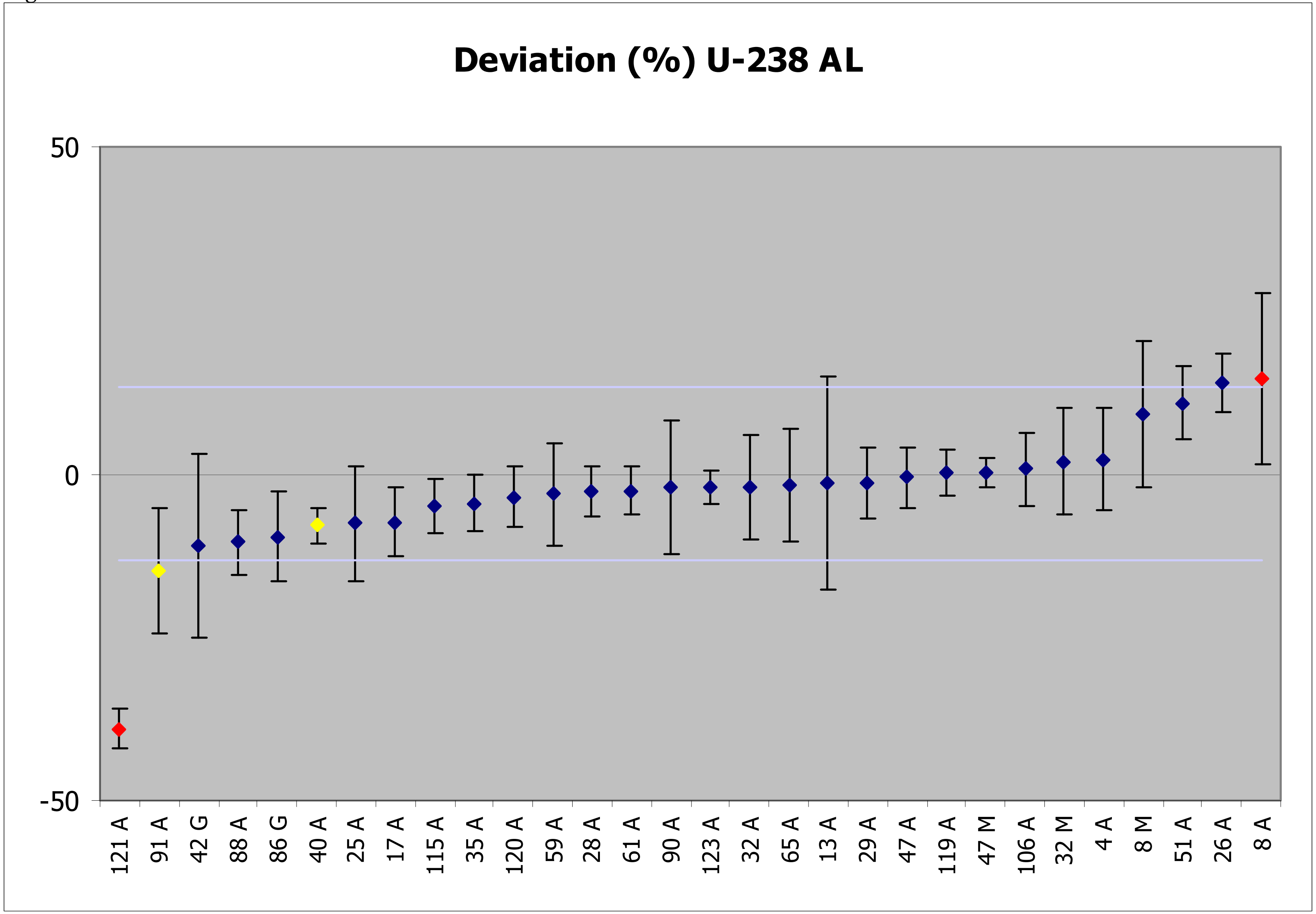


Figure 3B – Zeta score U-238 AL

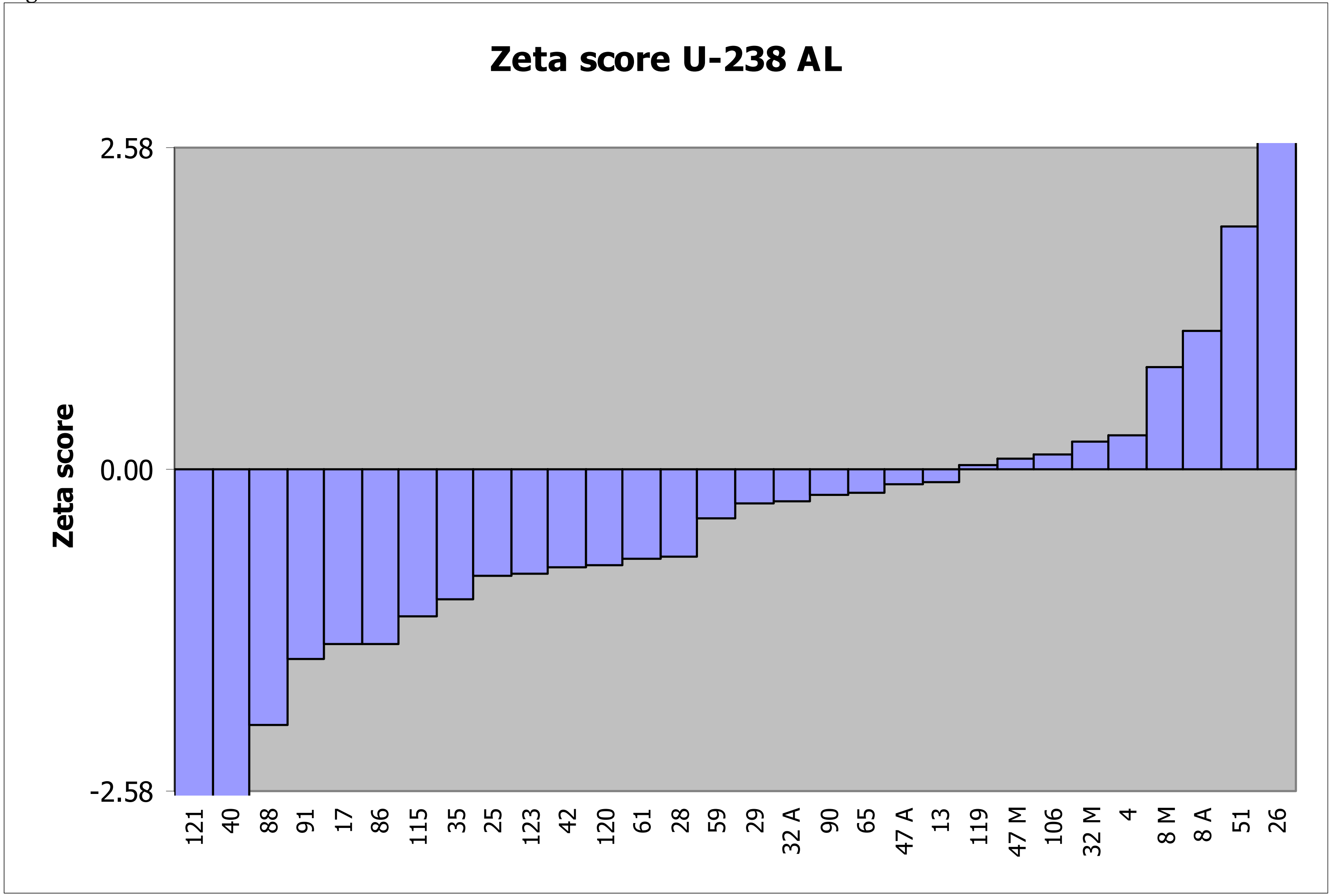


Figure 3C – Relative uncertainty U-238 AL

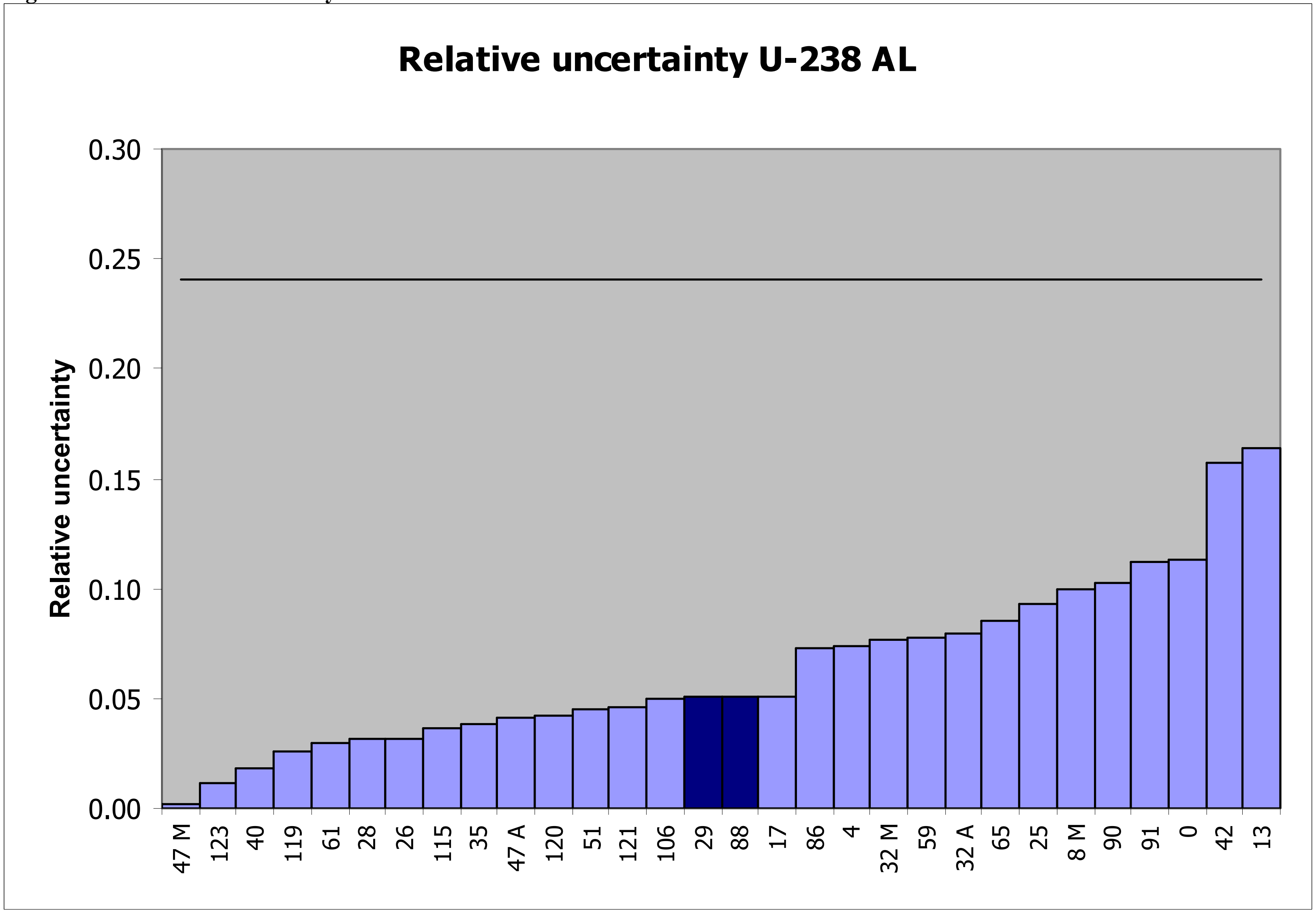


Figure 3D – Kiri plot U-238 AL

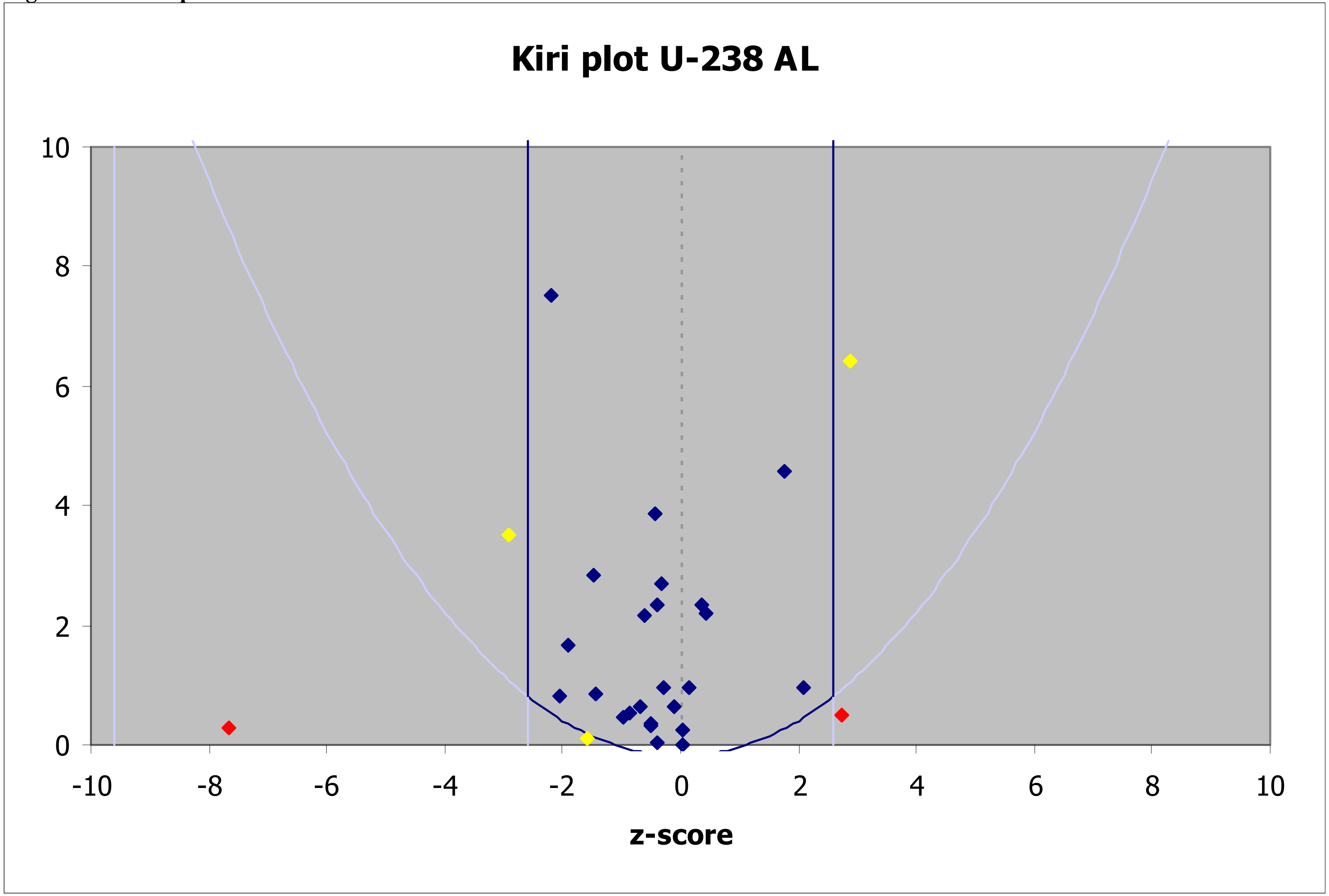


Figure 4A – Deviation Pu-239 AL

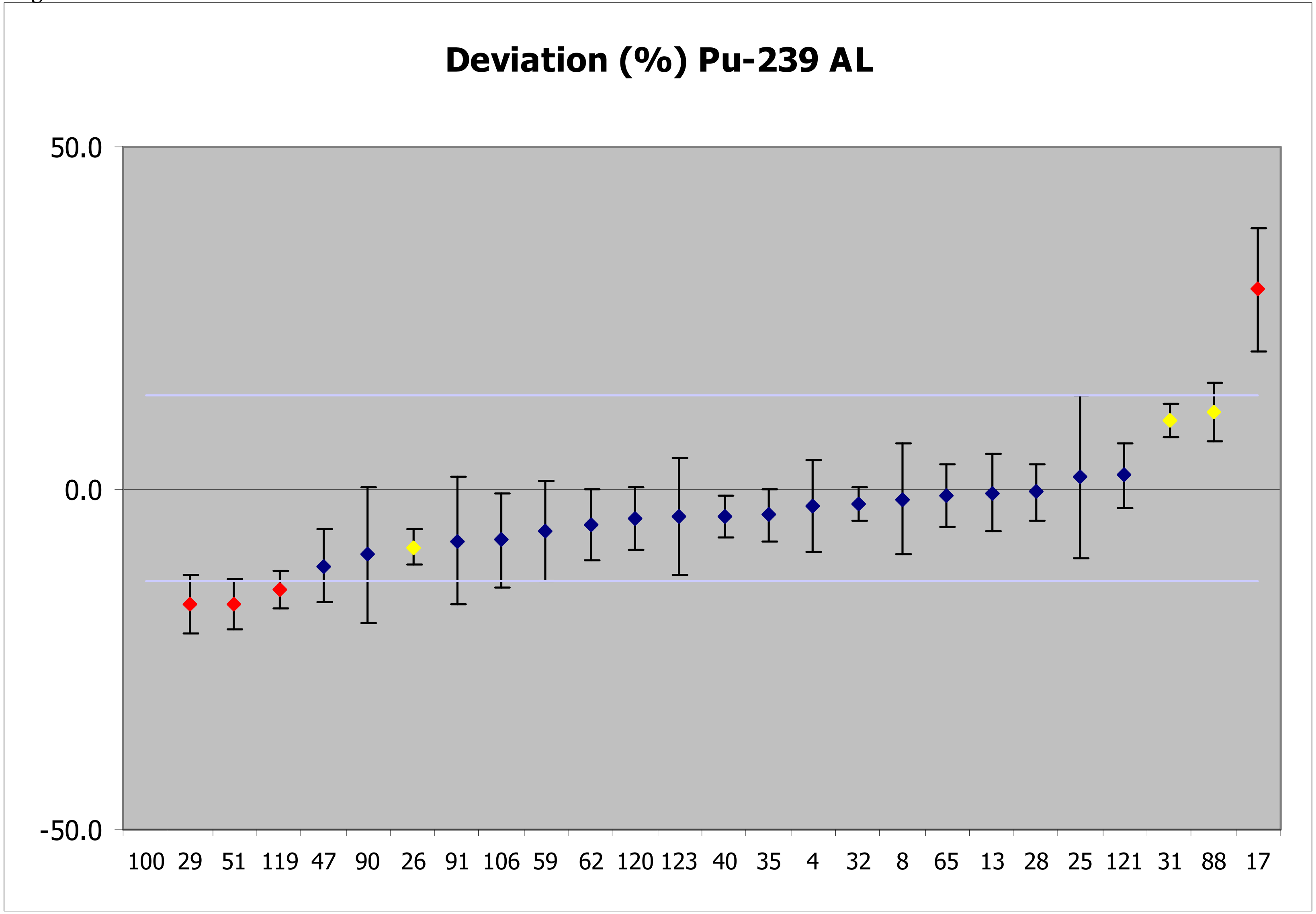


Figure 4B – Zeta score Pu-239 AL

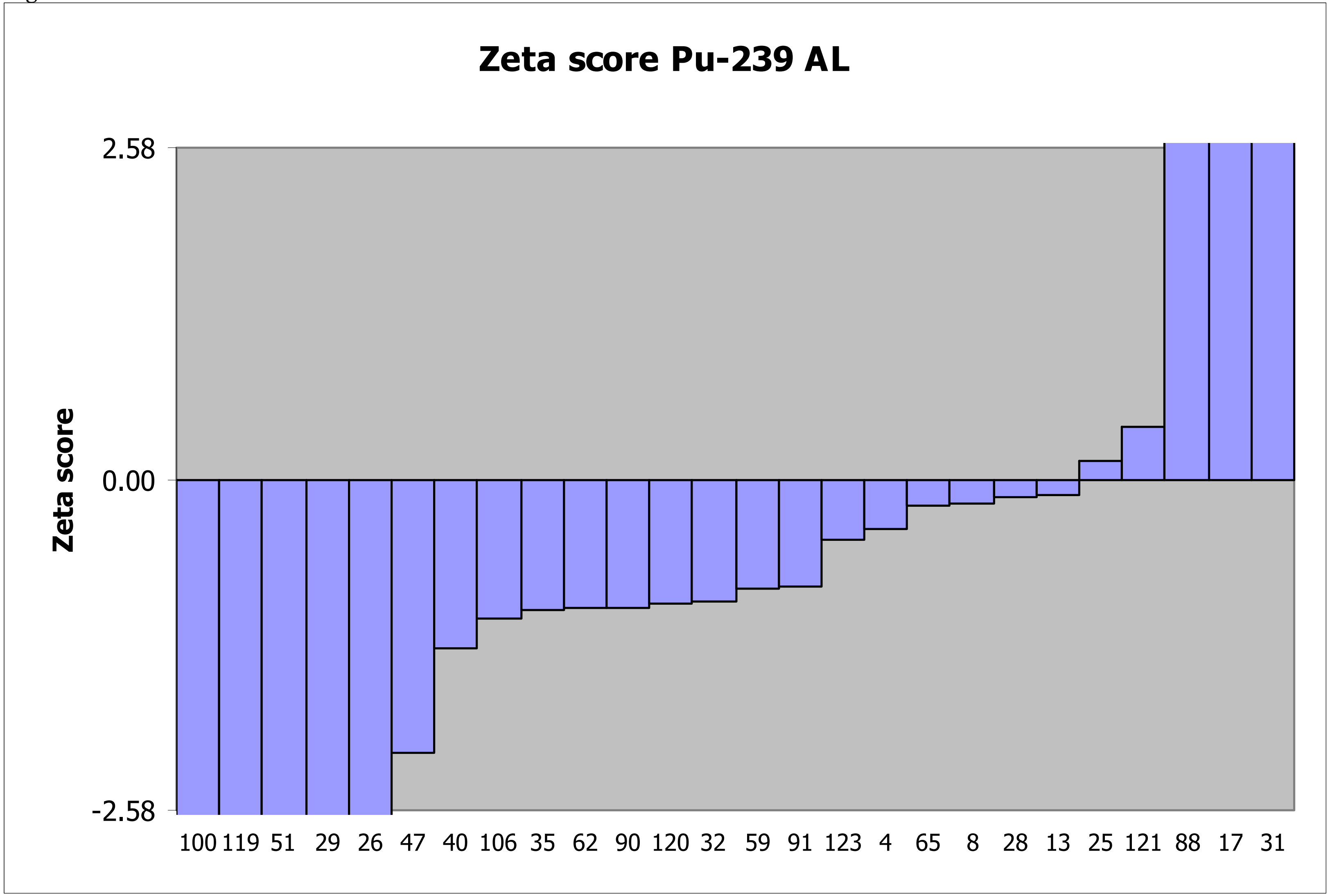


Figure 4C – Relative uncertainty Pu-239 AL

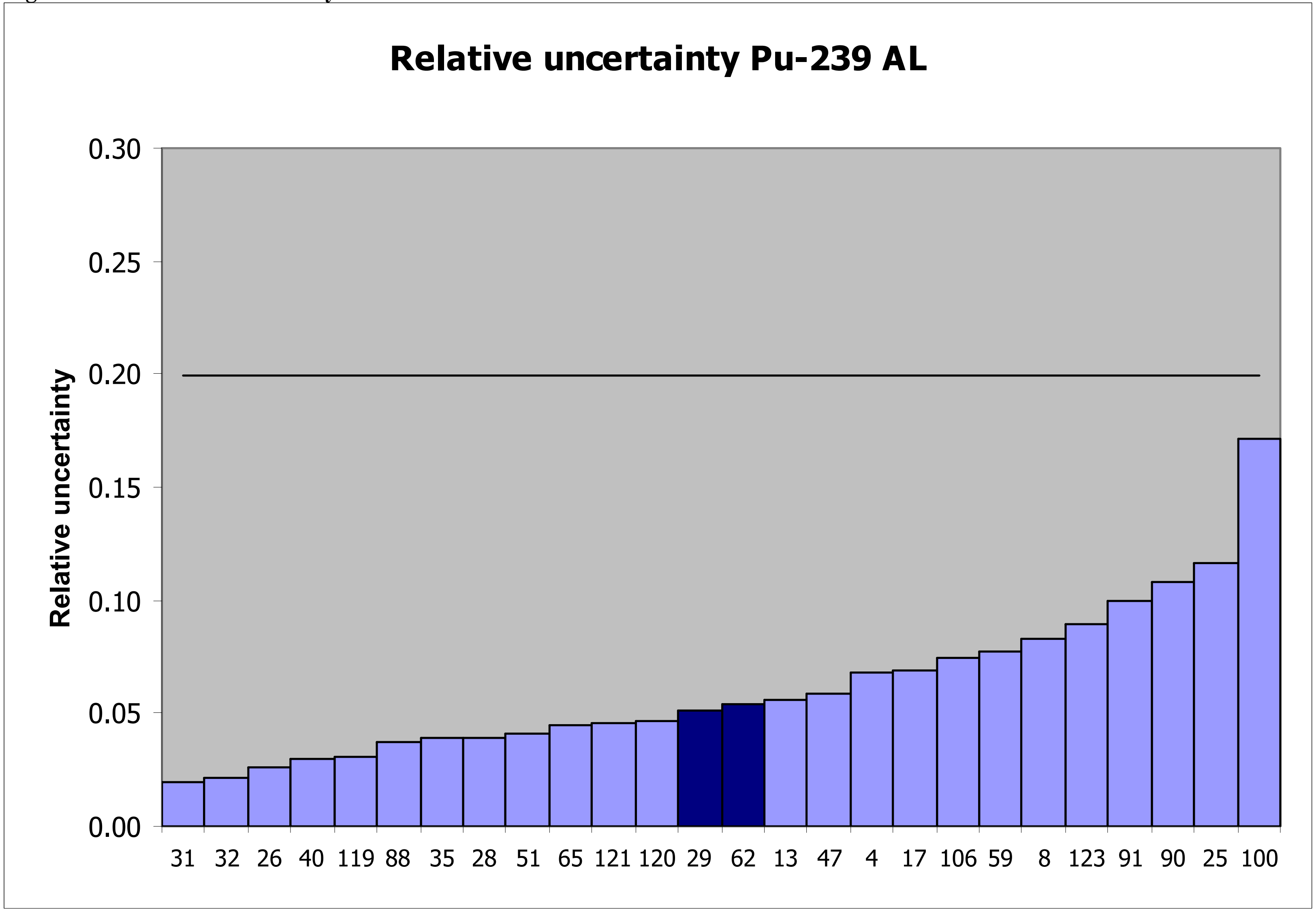


Figure 4D – Kiri plot Pu-239 AL

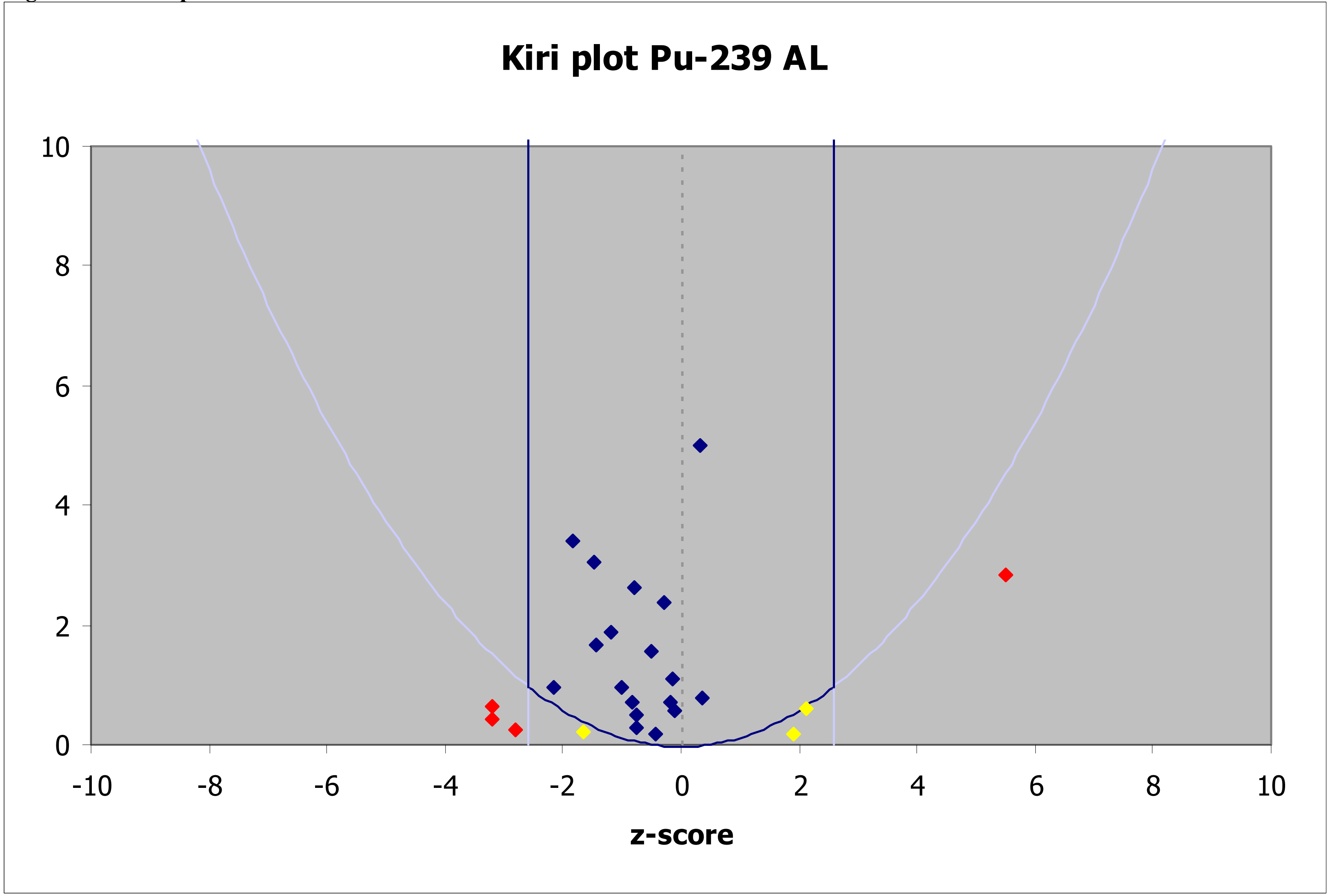


Figure 5A – Deviation Am-241 AL

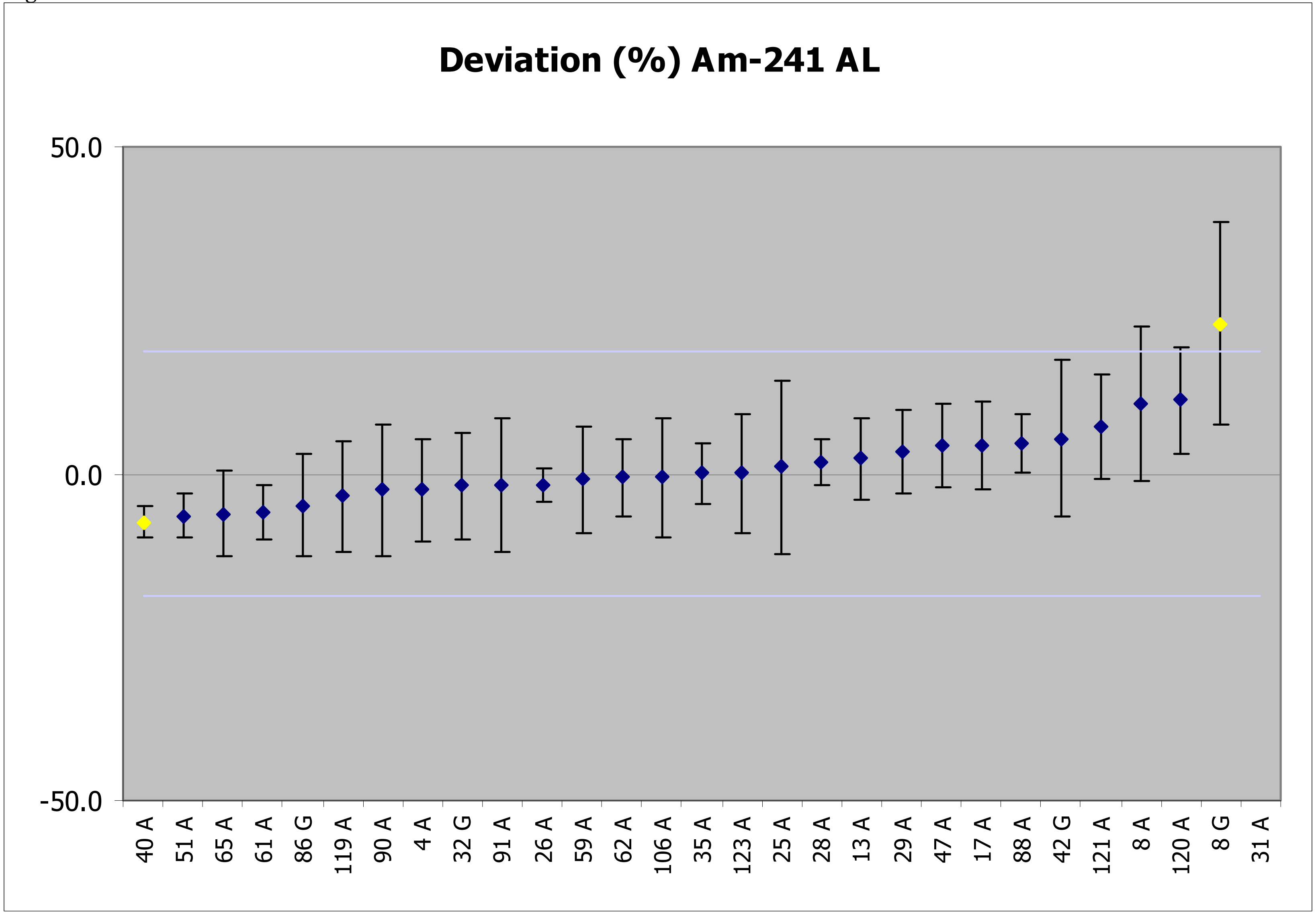


Figure 5B – Zeta score Am-241 AL

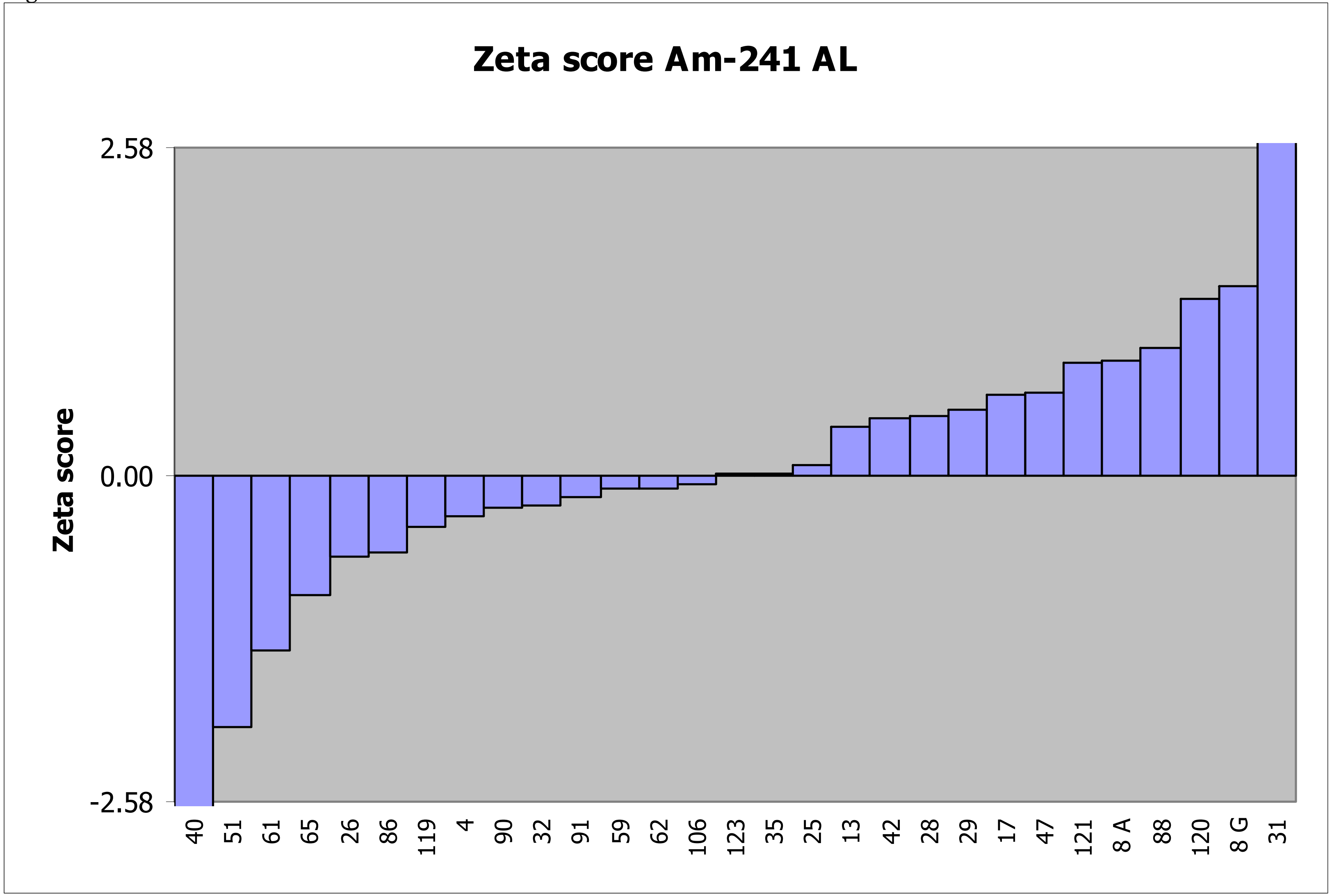


Figure 5C – Relative uncertainty Am-241 AL

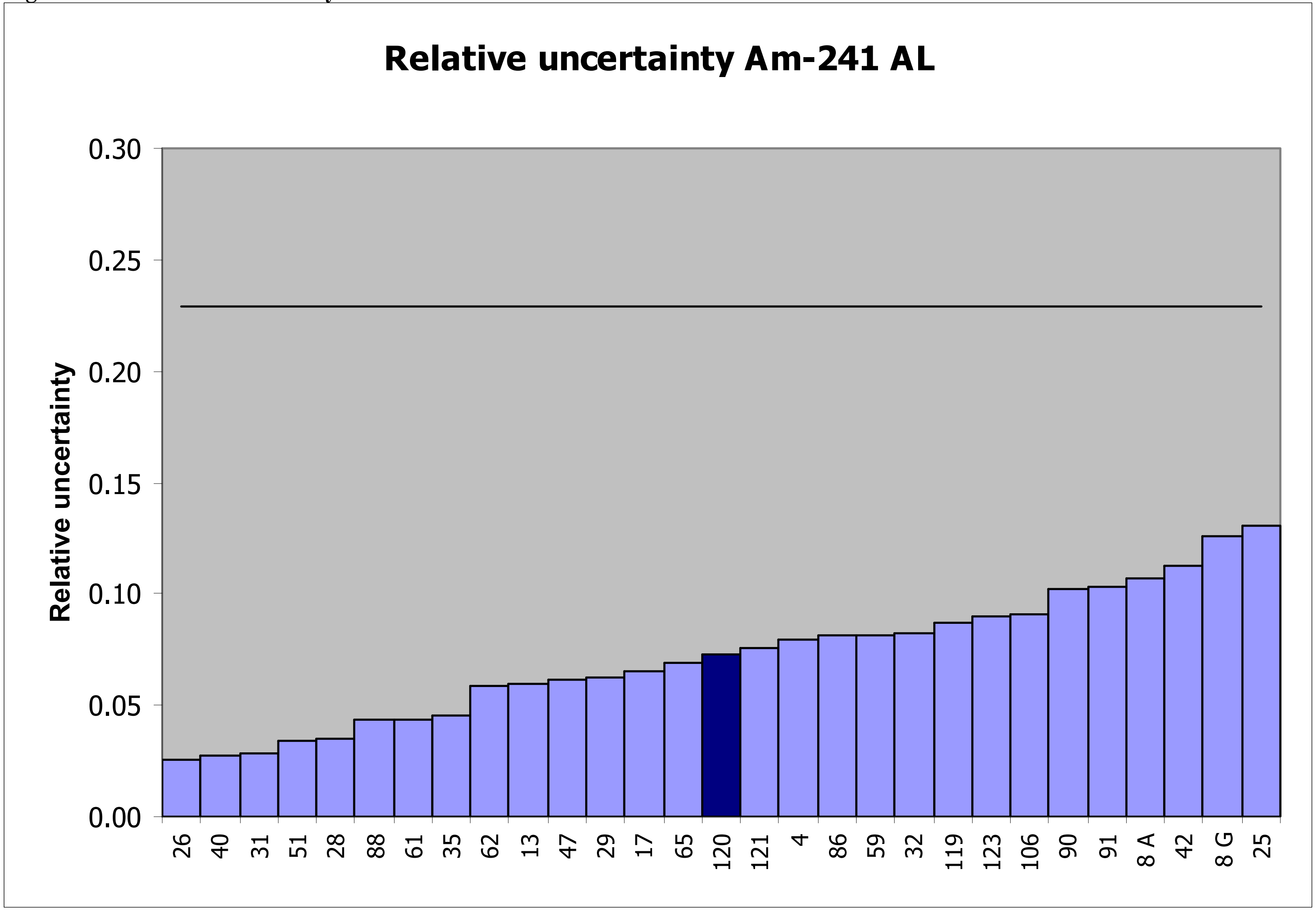


Figure 5D – Kiri plot Am-241 AL

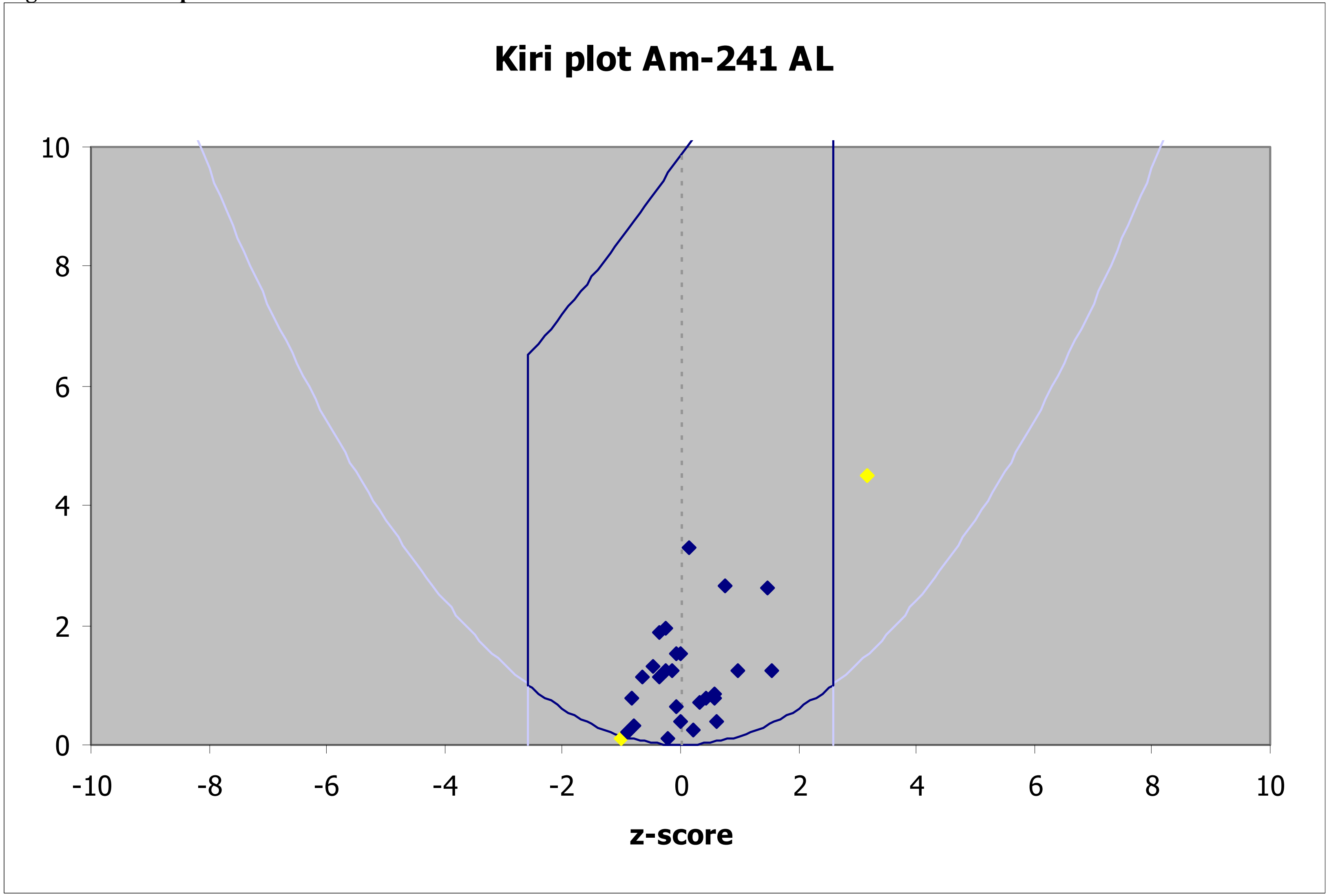


Figure 6A – Deviation Cm-244 AL

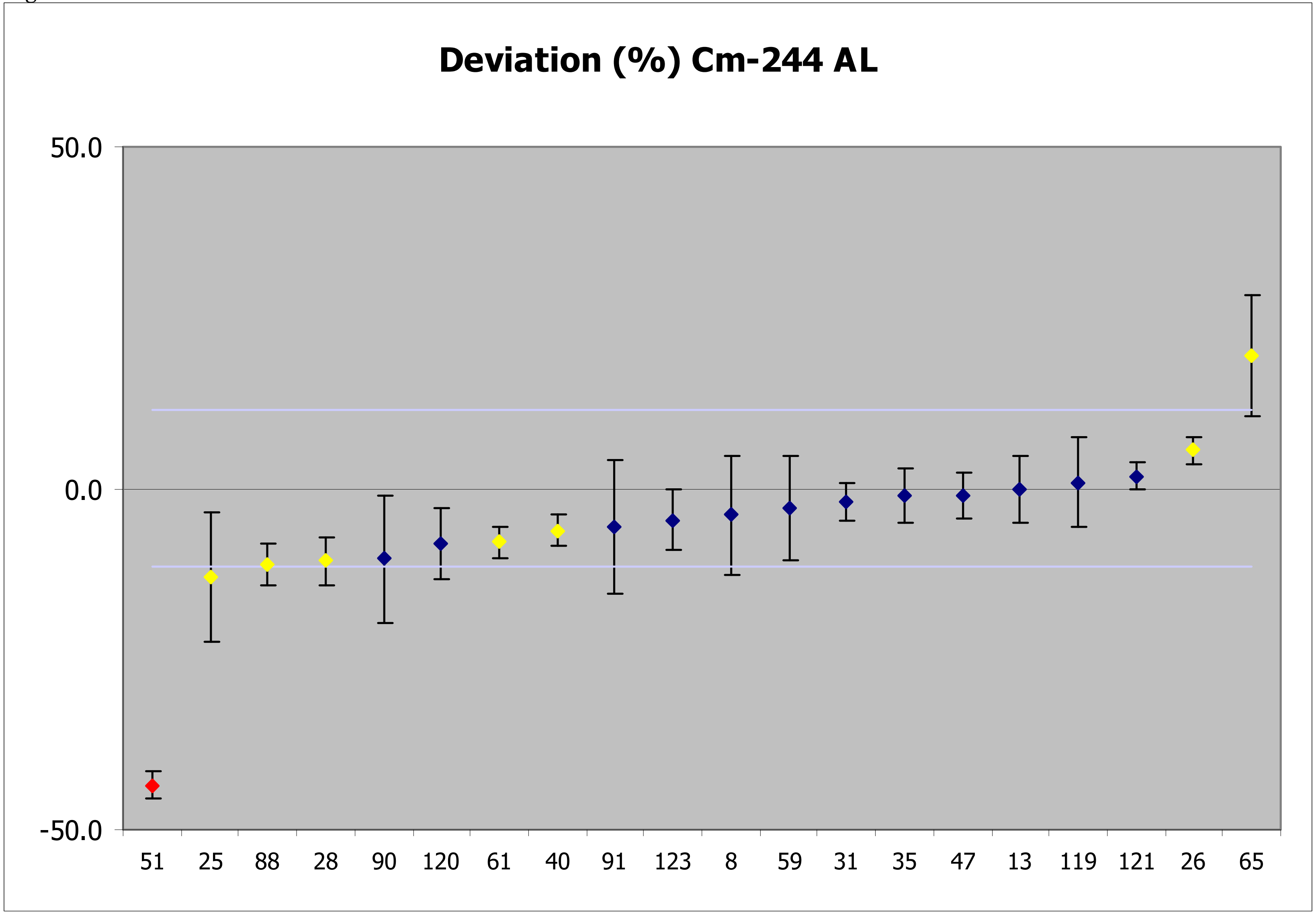


Figure 6B – Zeta score Cm-244 AL

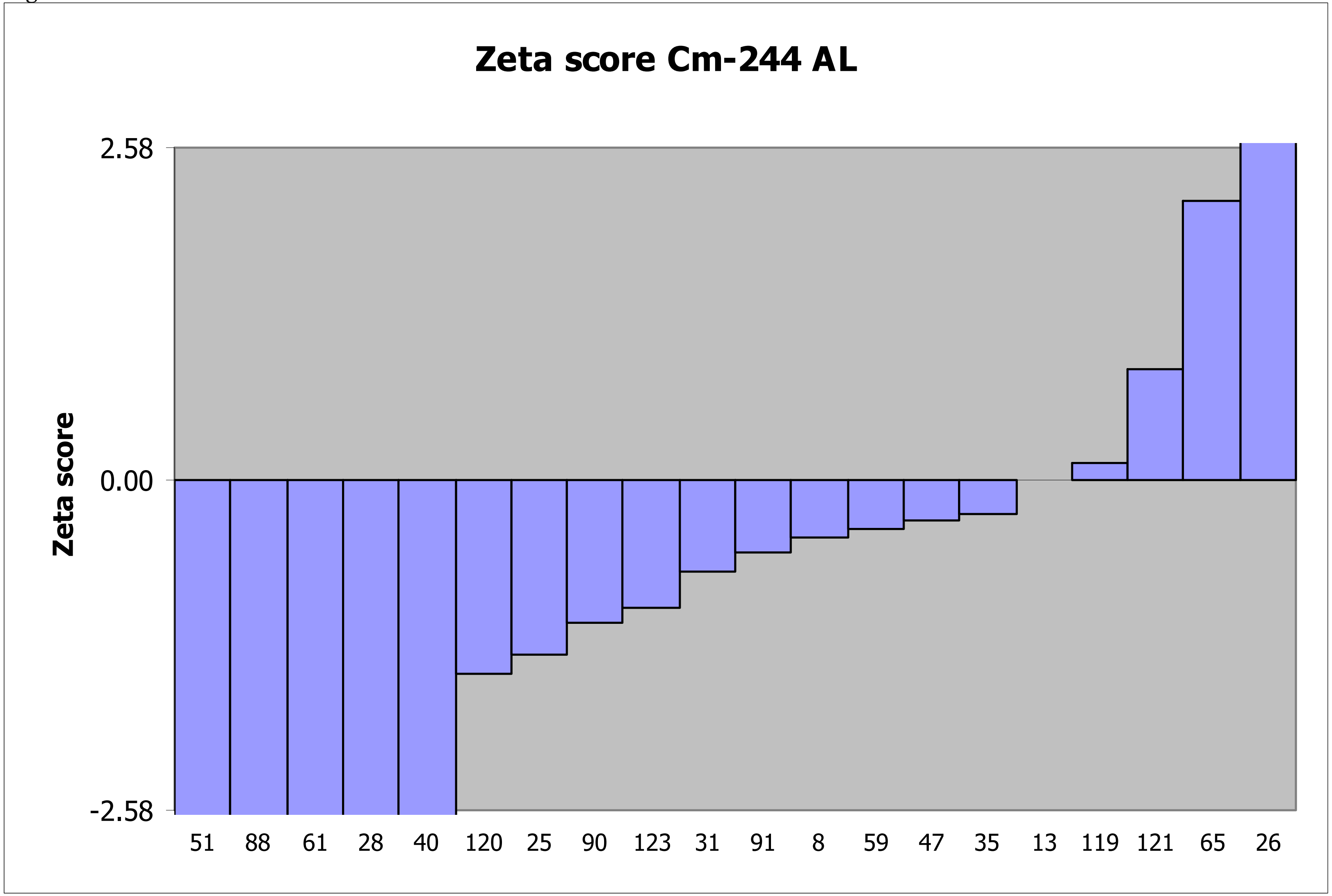


Figure 6C – Relative uncertainty Cm-244 AL

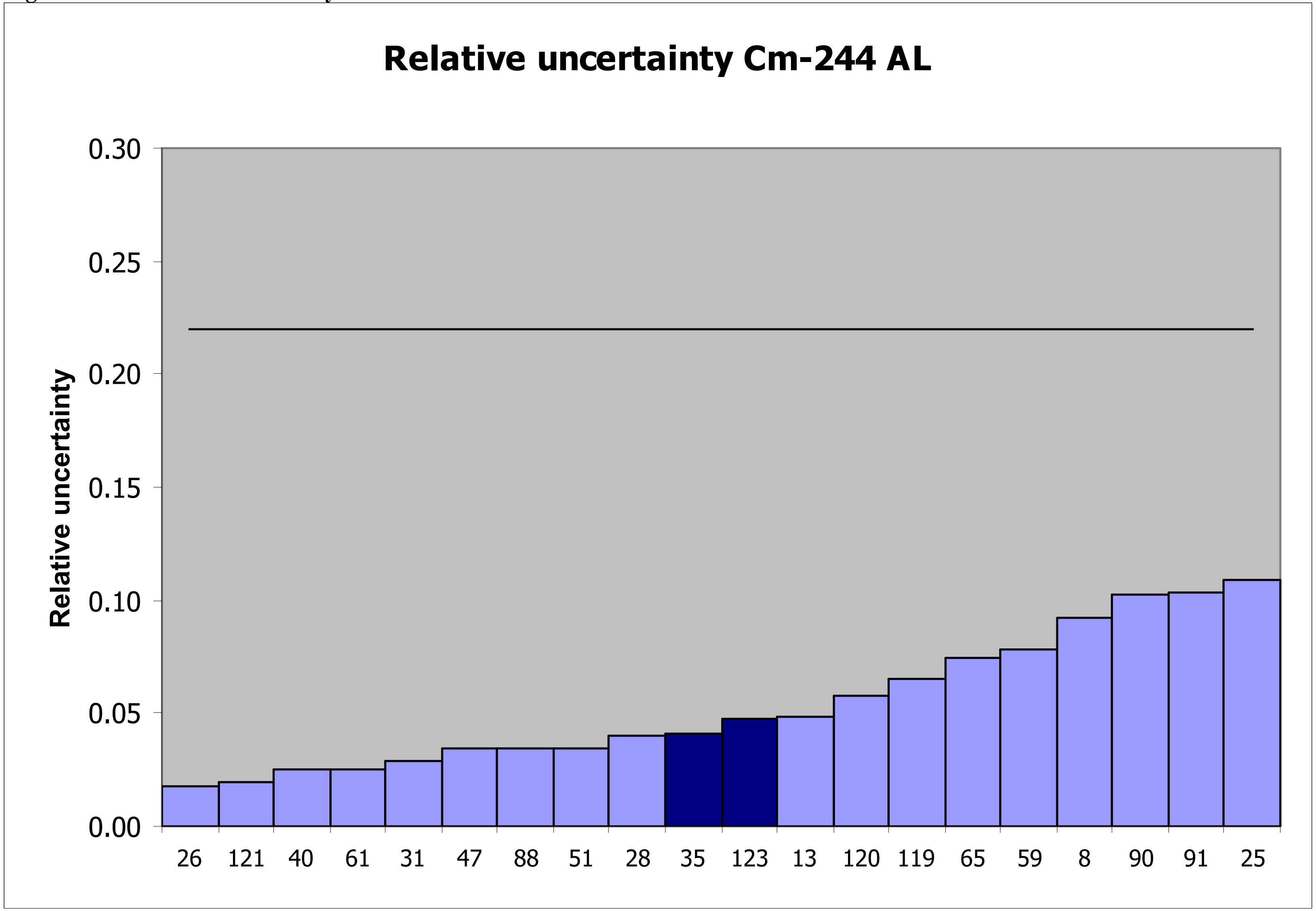


Figure 6D – Kiri plot Cm-244 AL

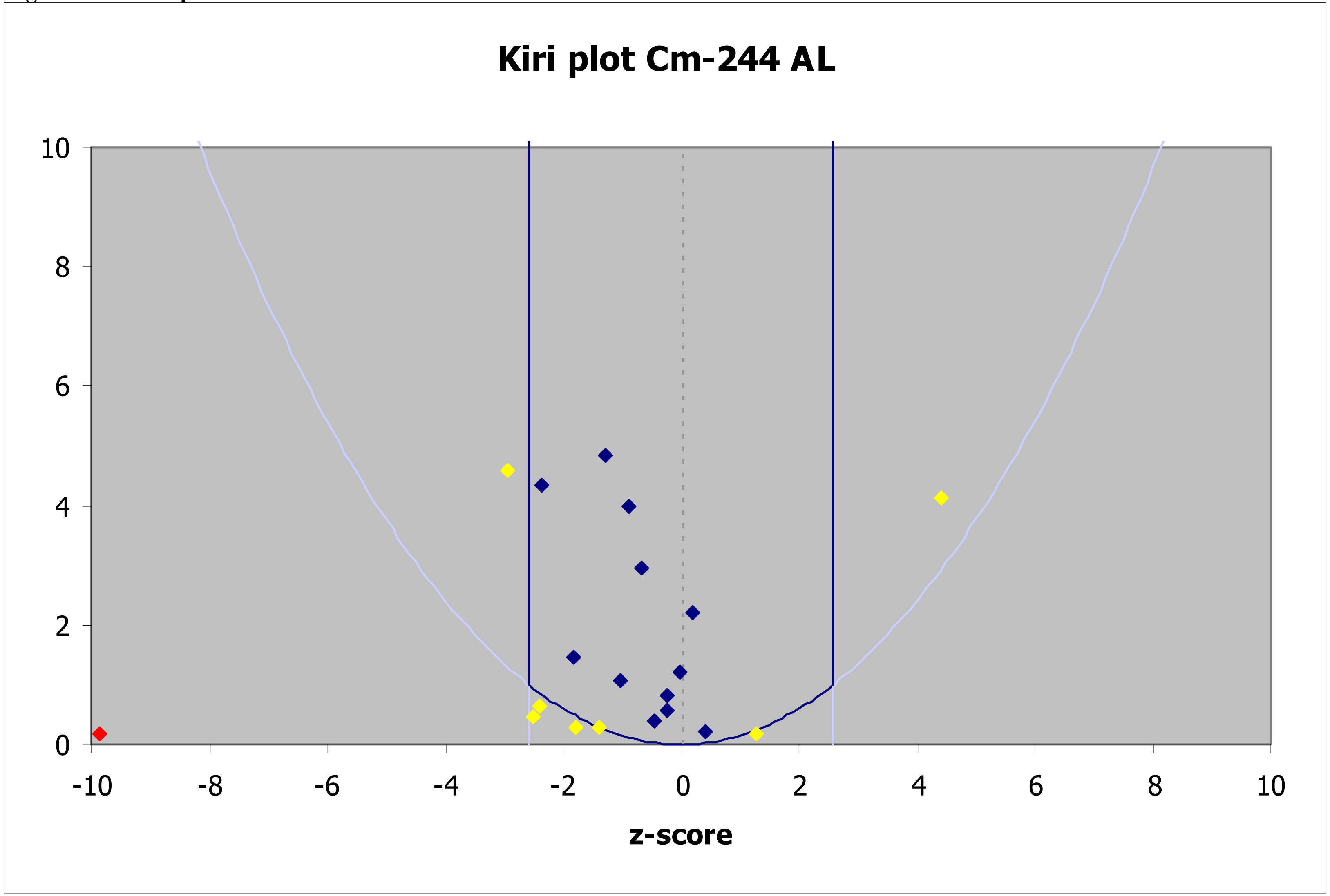


Figure 7A – Deviation gross alpha AL

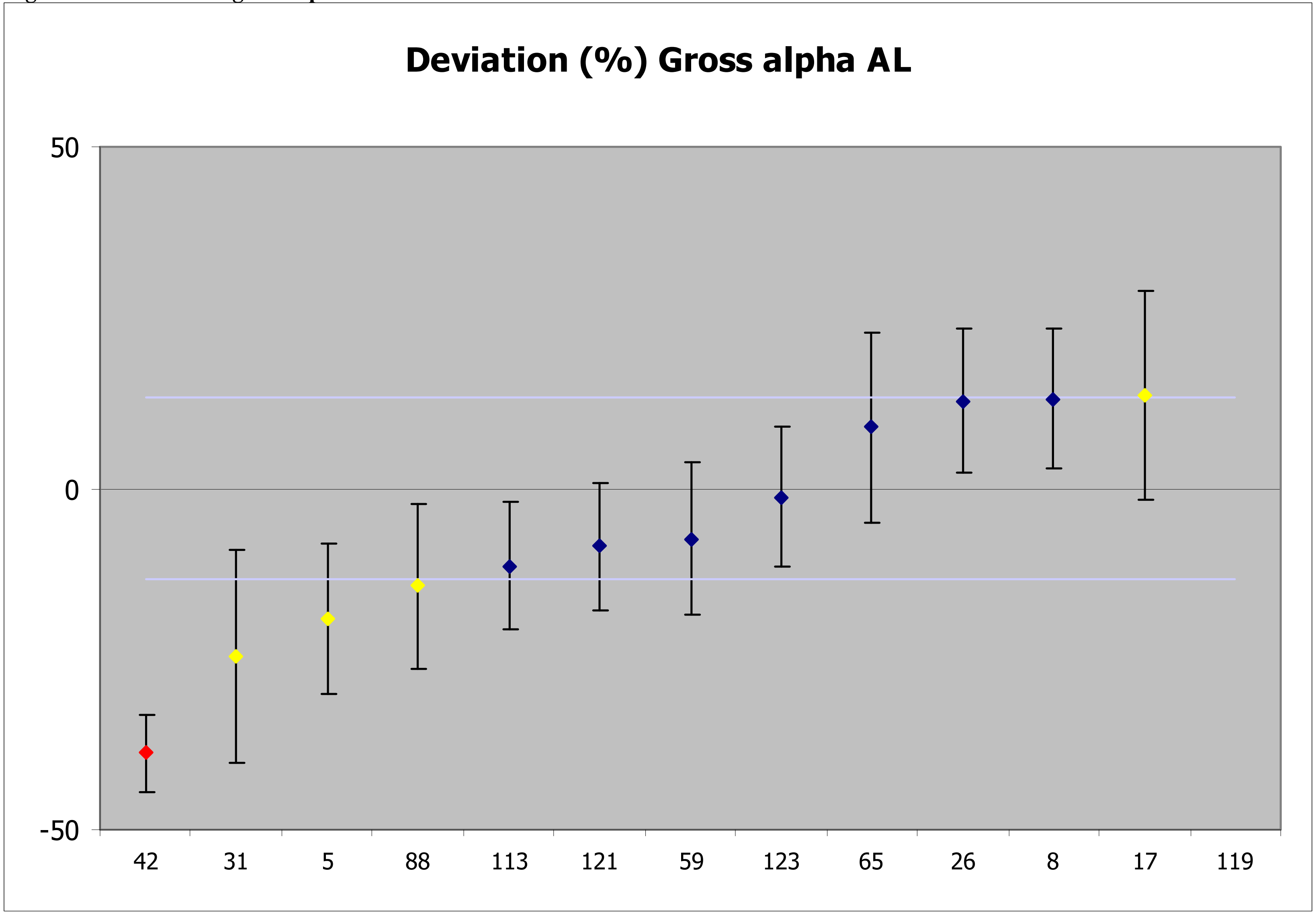


Figure 7B – Zeta score gross alpha AL

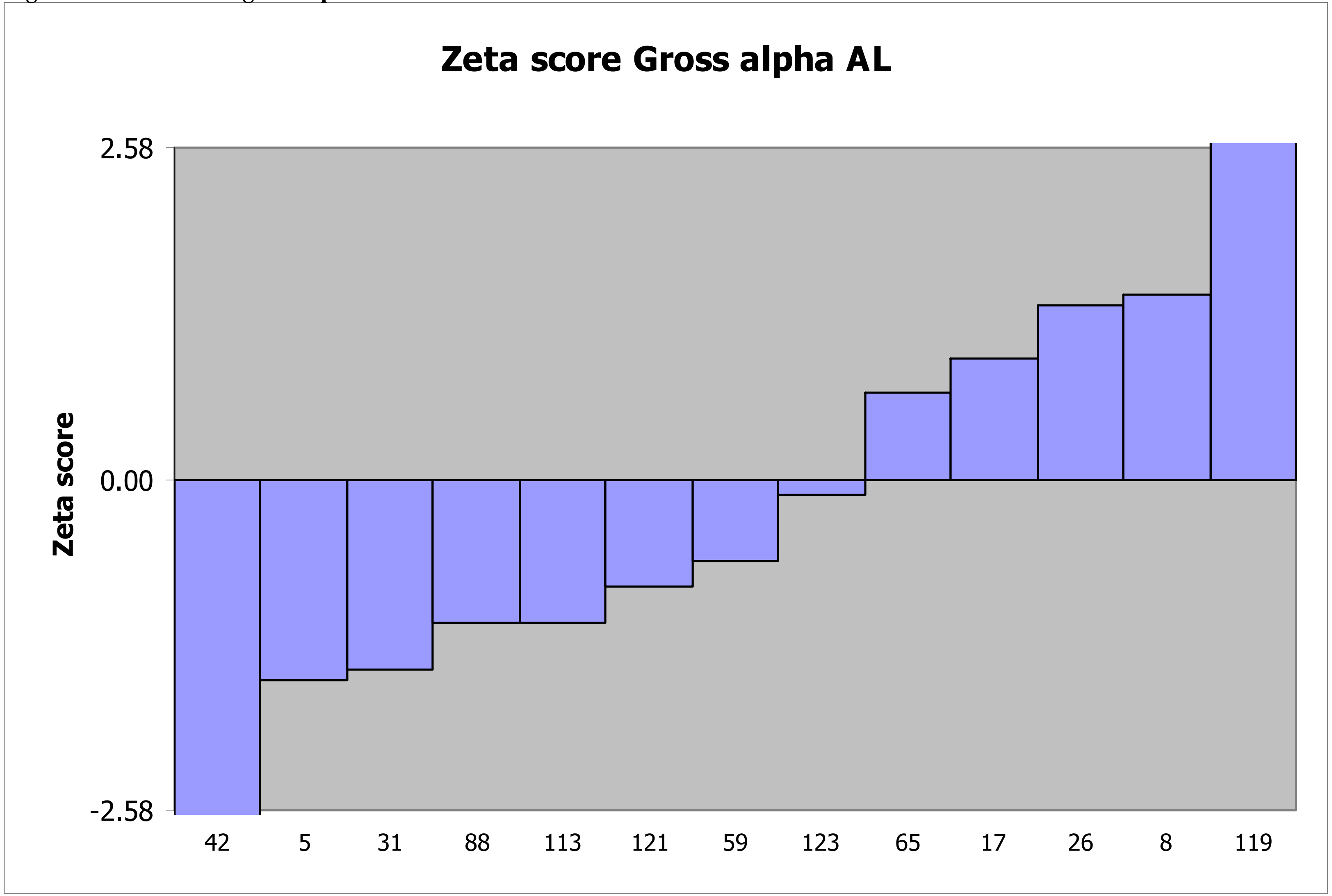


Figure 7C – Relative uncertainty gross alpha AL

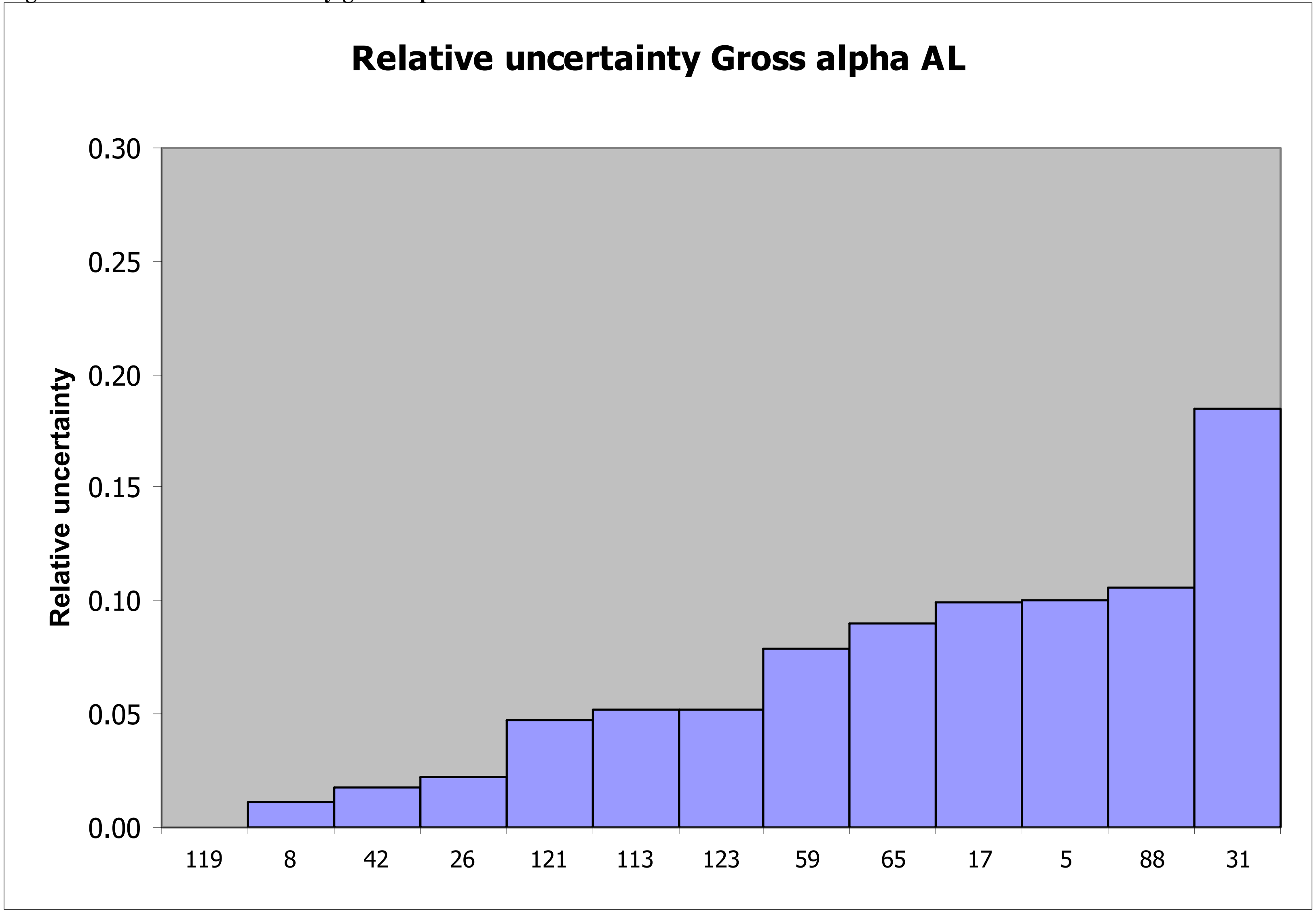


Figure 7D – Kiri plot gross alpha AL

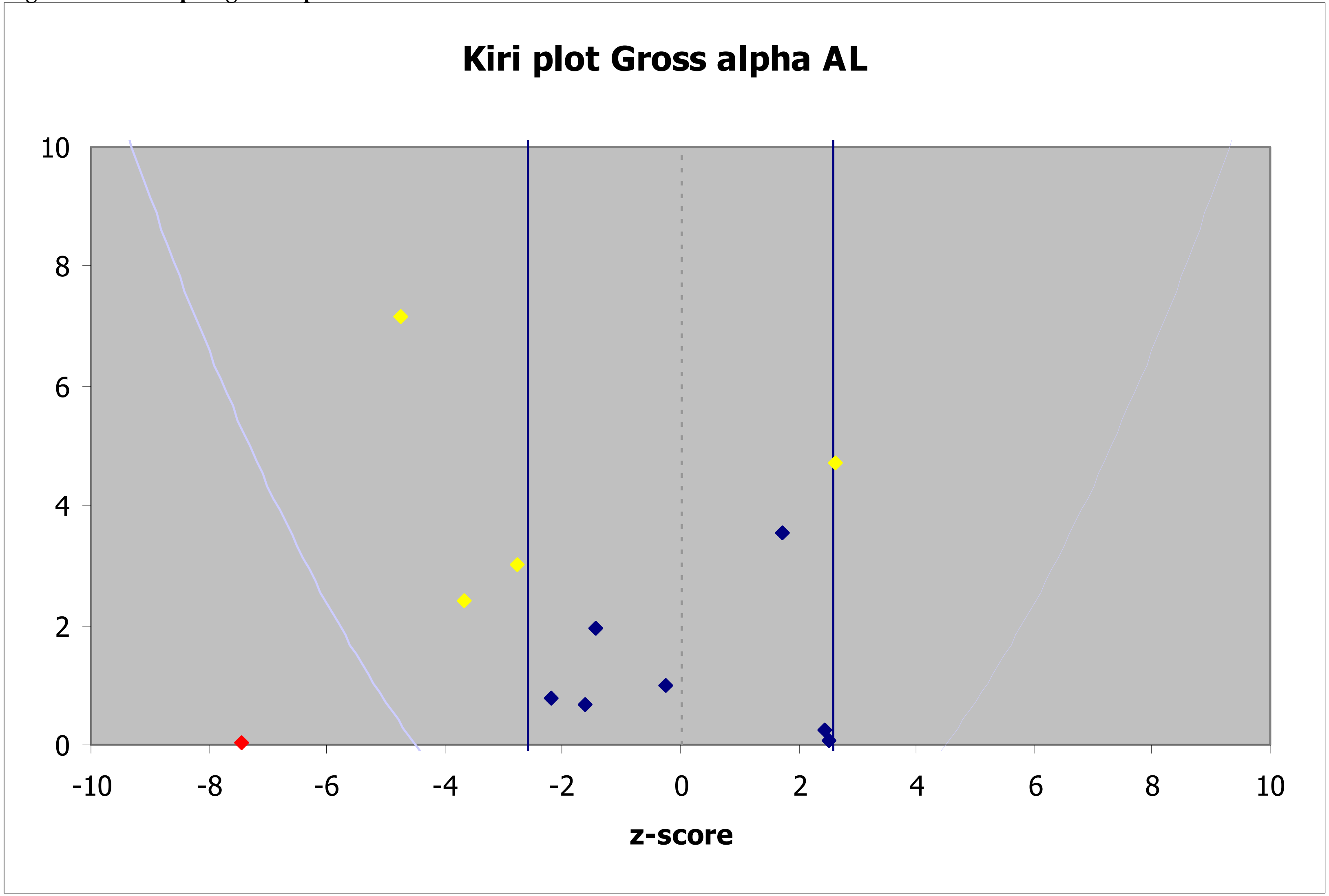


Figure 8A – Deviation Ra-226 AH

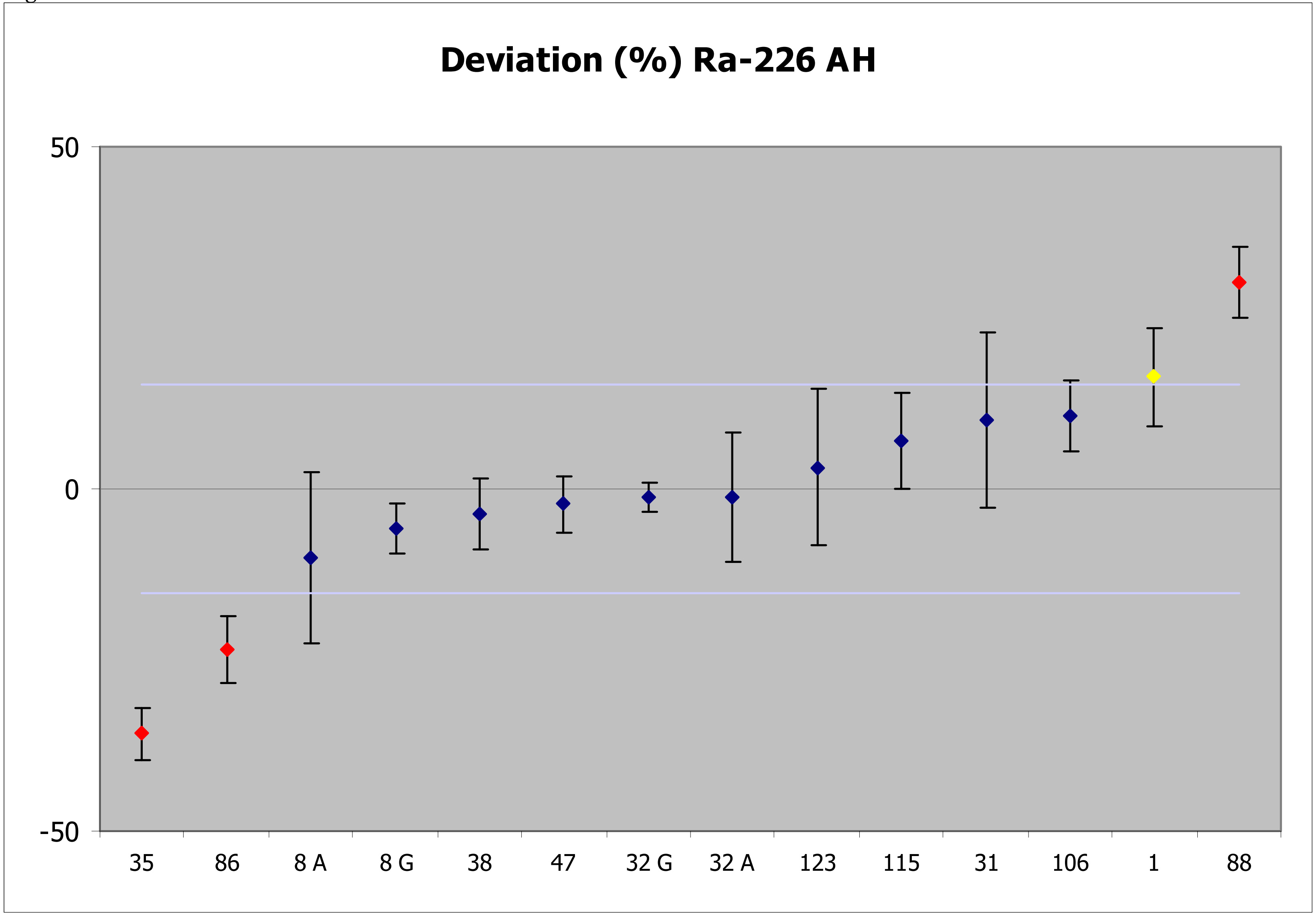


Figure 8B – Zeta score Ra-226 AH

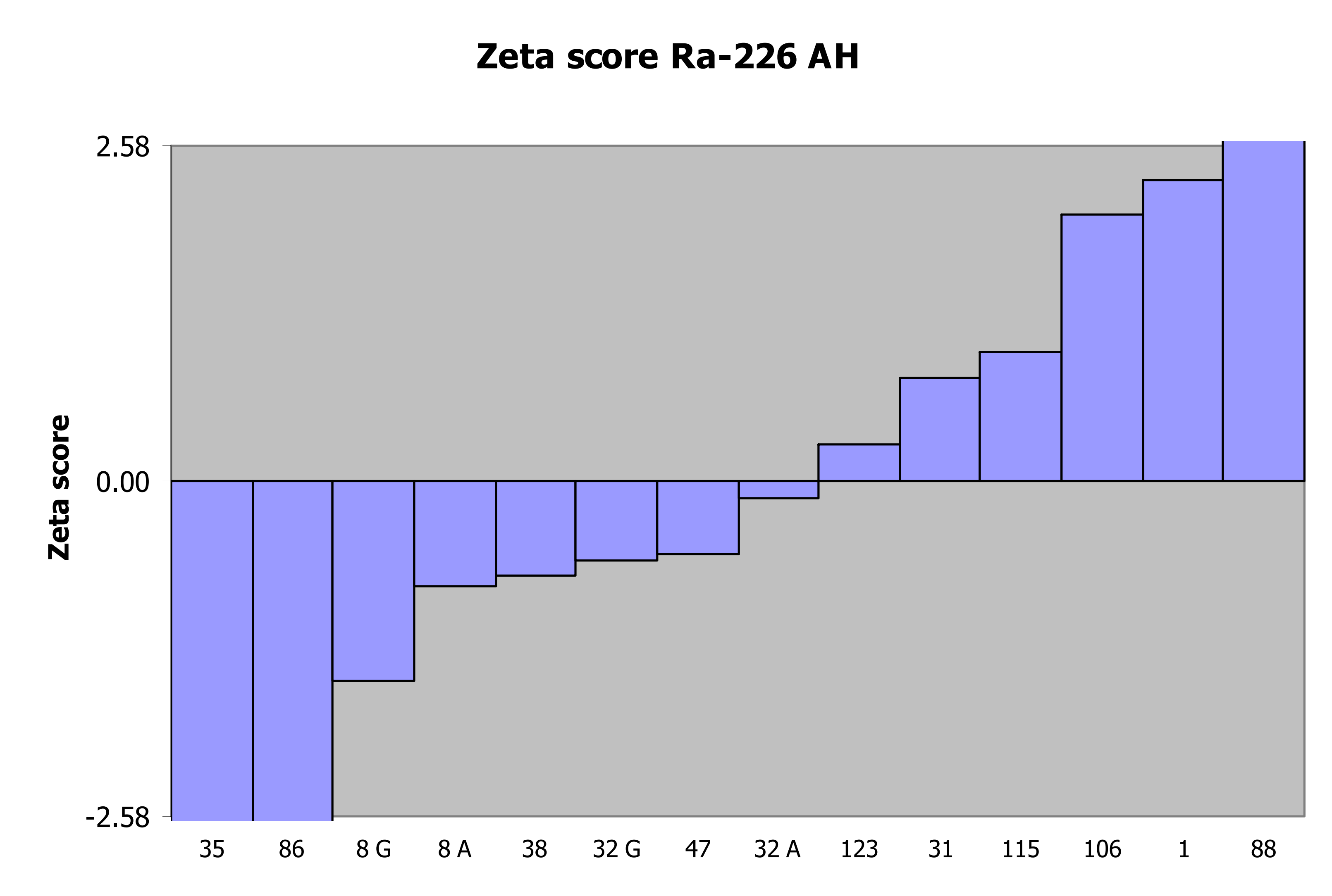


Figure 8C – Relative uncertainty Ra-226 AH

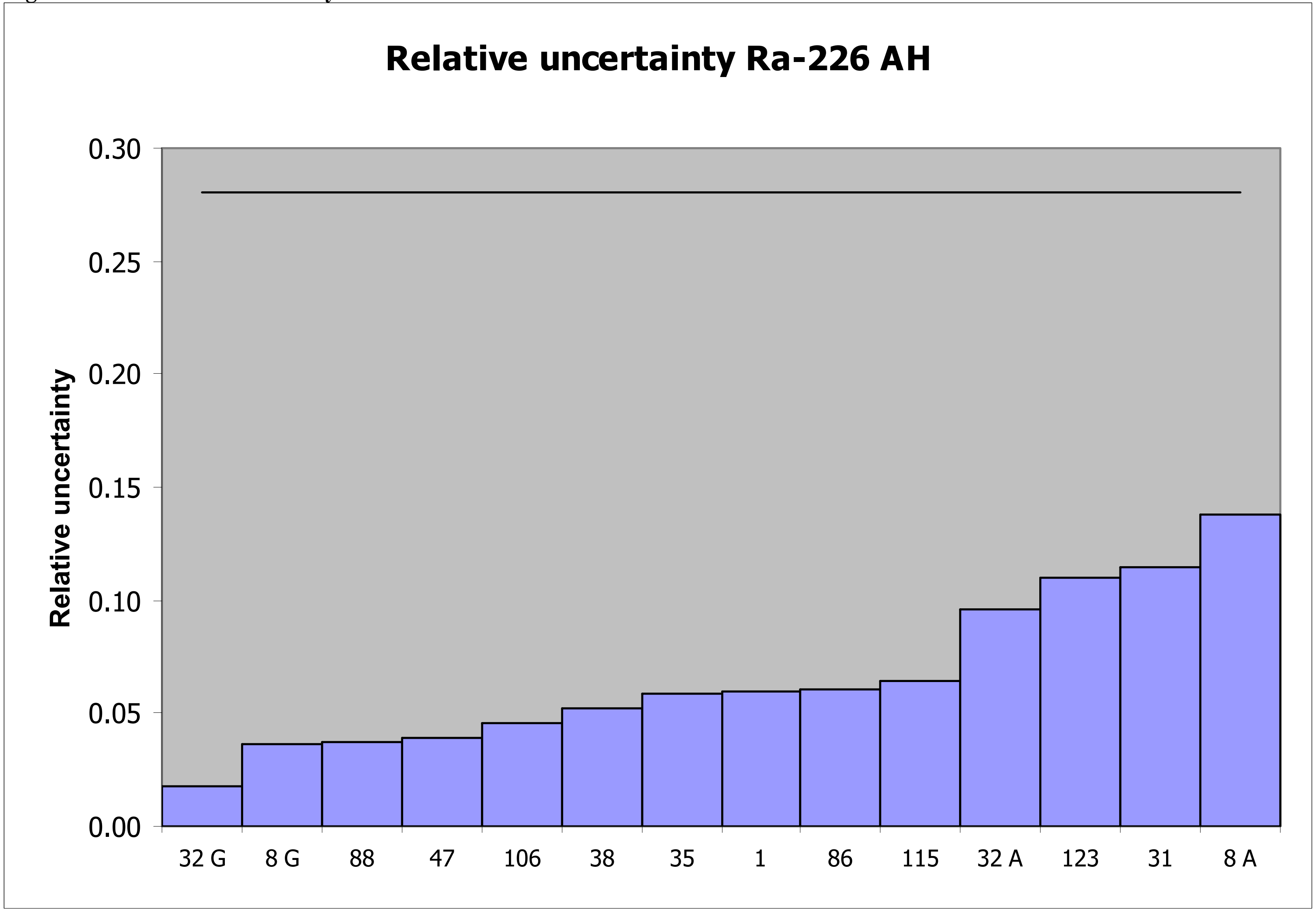


Figure 8D – Kiri plot Ra-226 AH

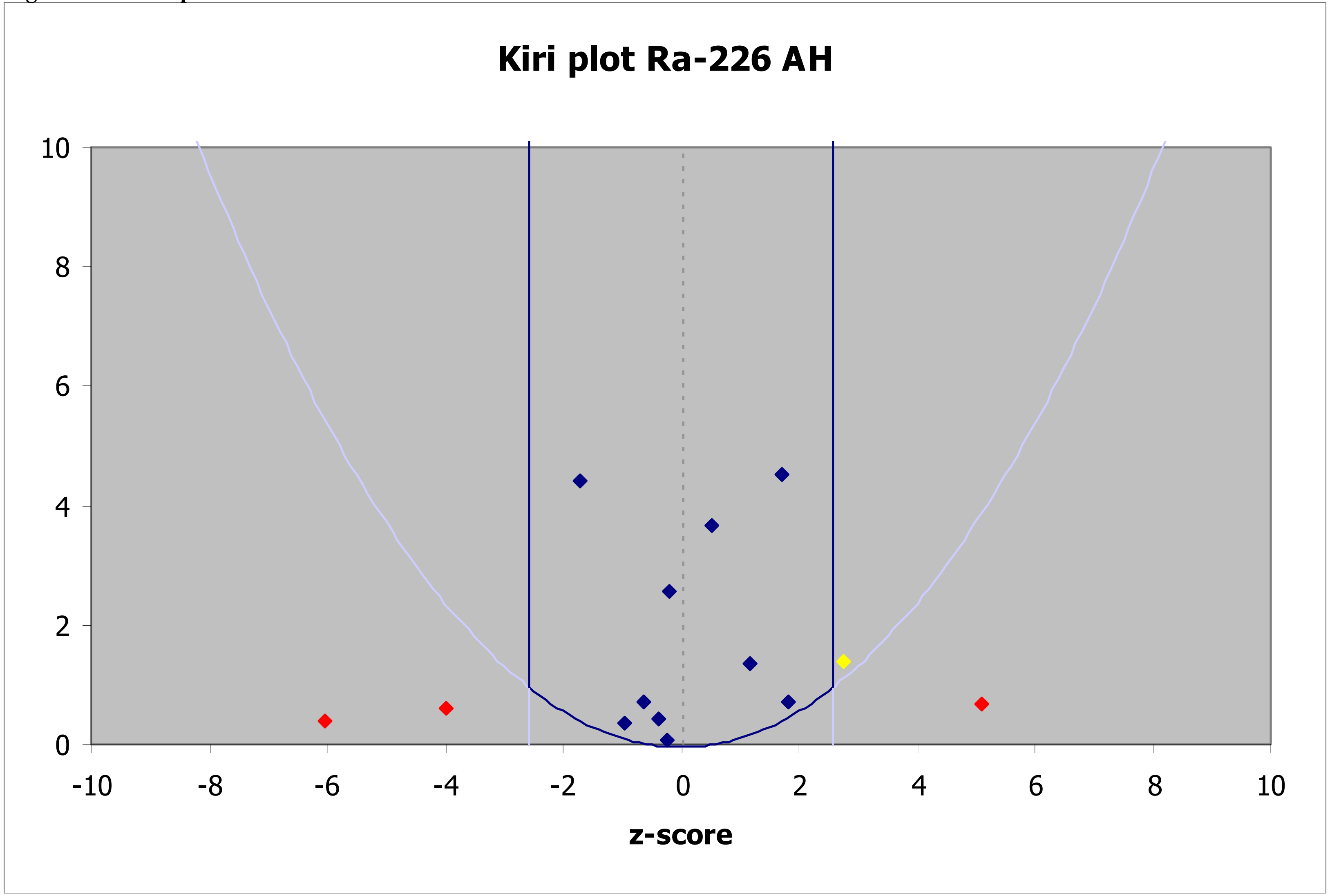


Figure 9A – Deviation Np-237 AH

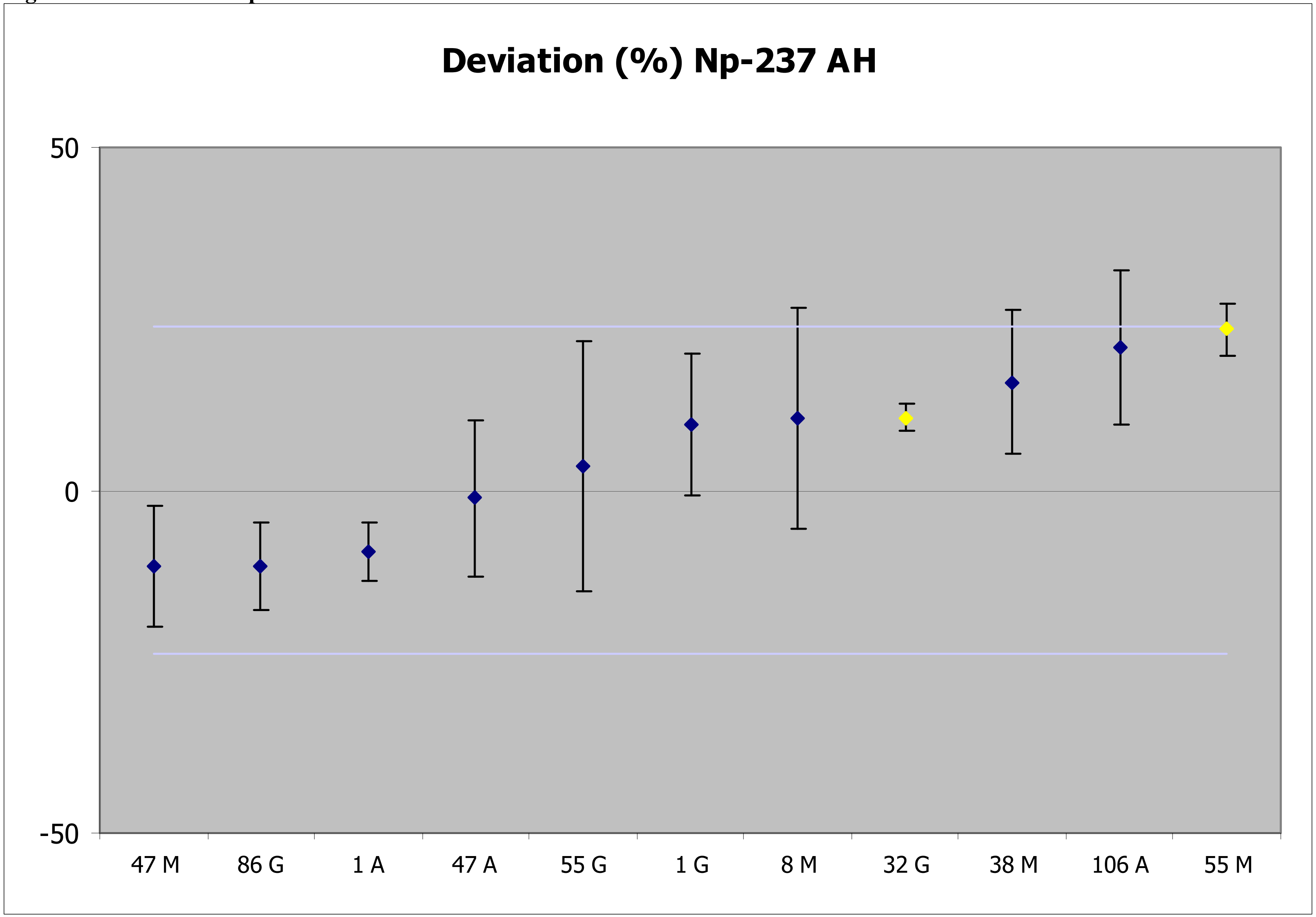


Figure 9B – Zeta score Np-237 AH

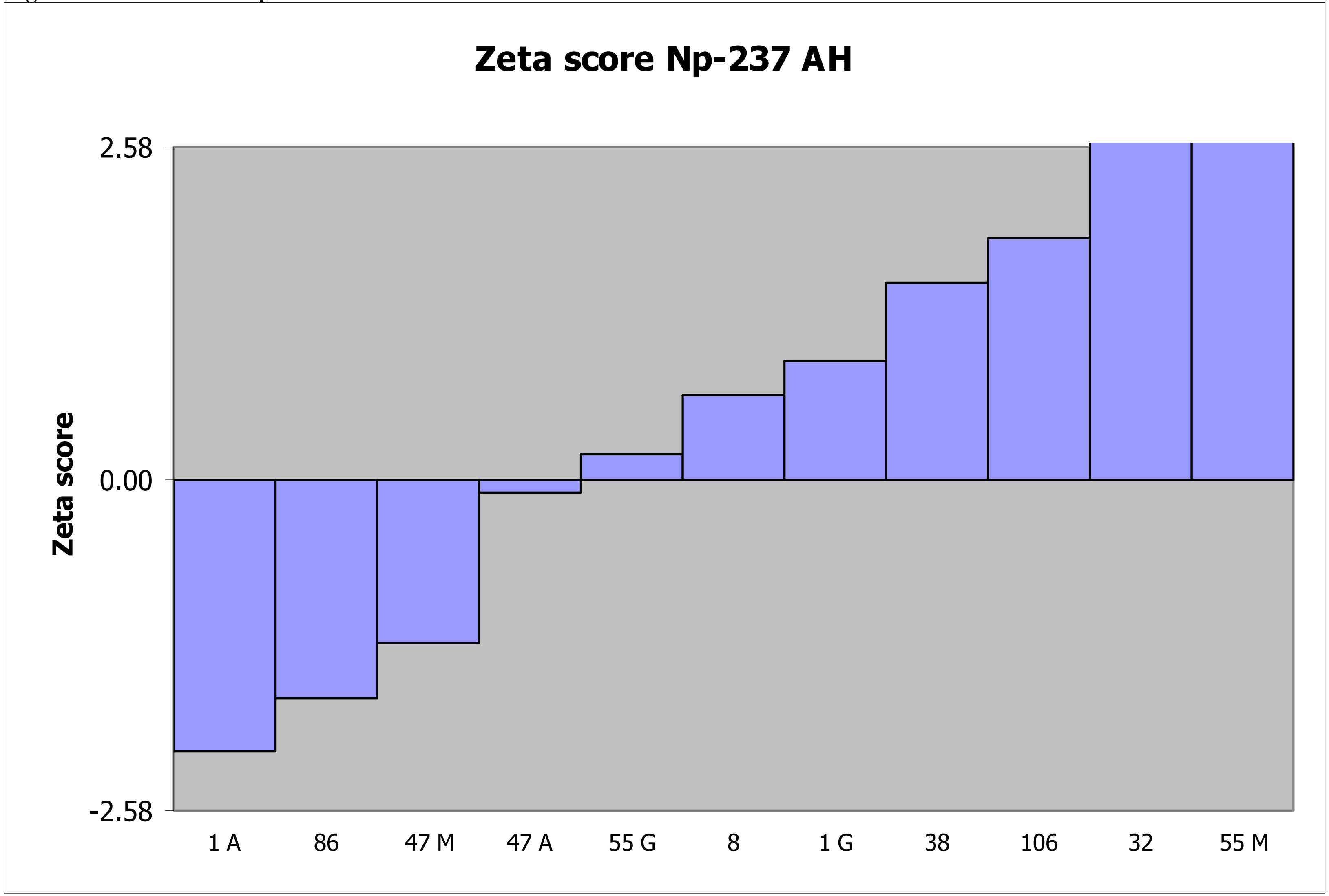


Figure 9C – Relative uncertainty Np-237 AH

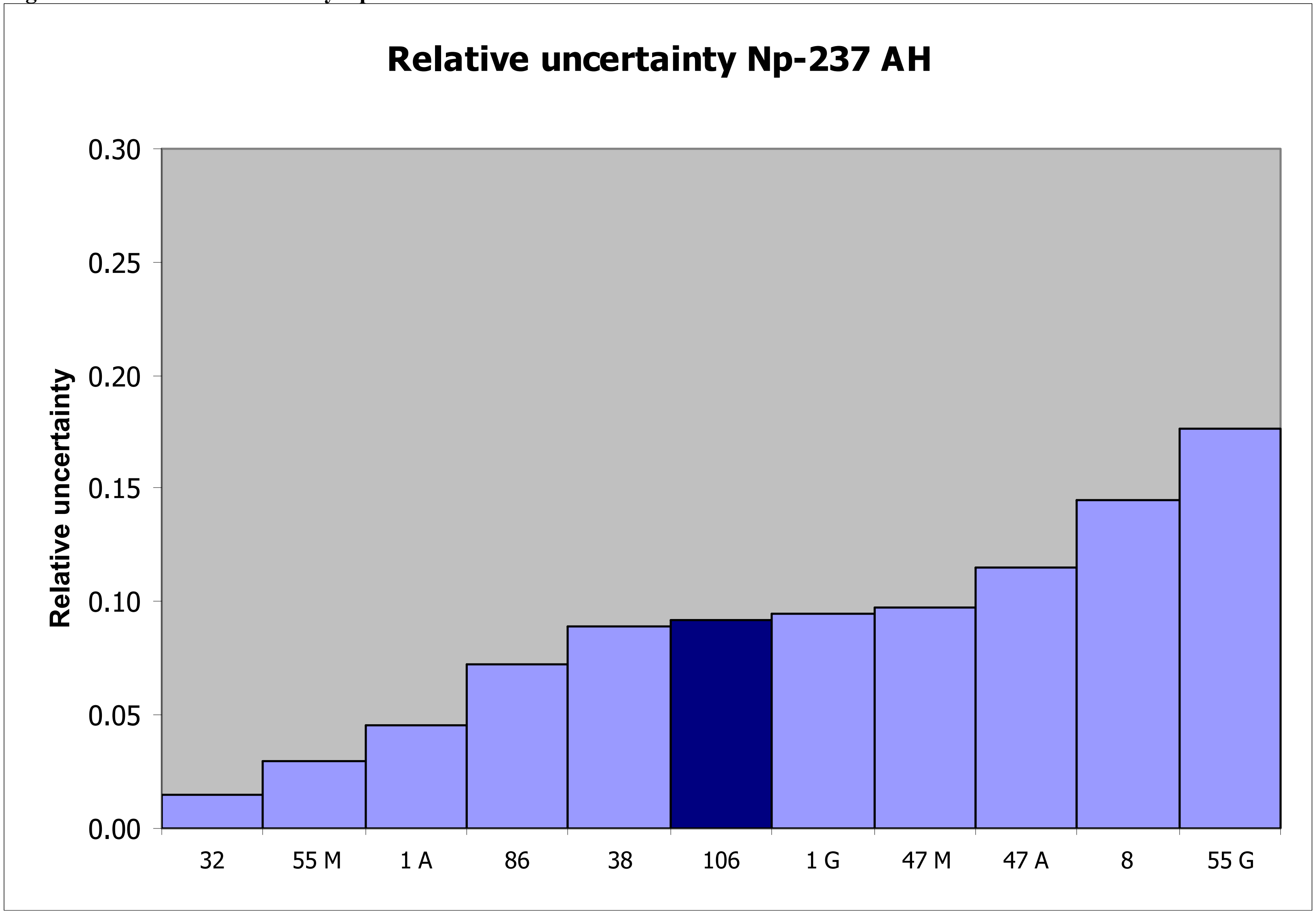


Figure 9D – Kiri plot Np-237 AH

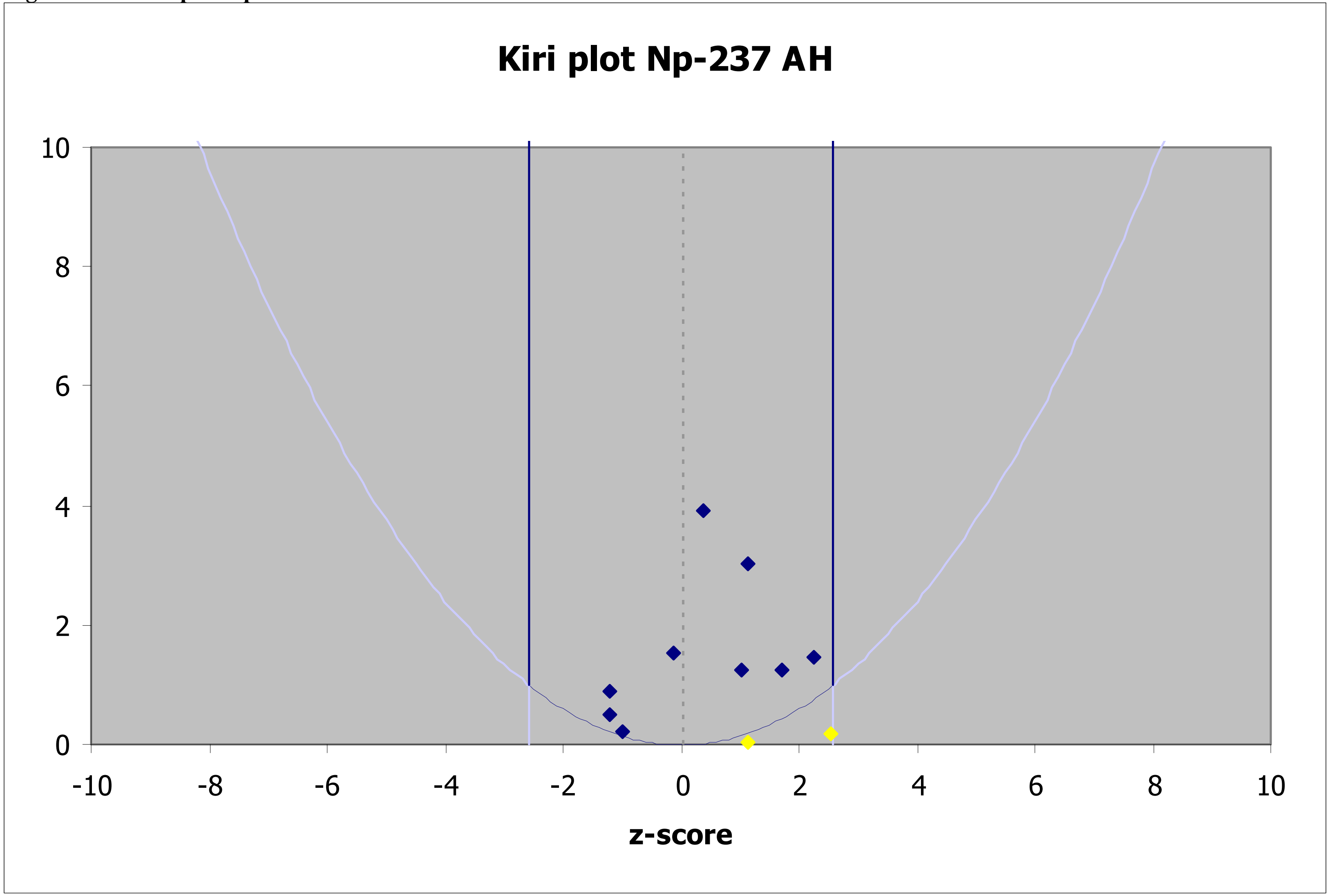


Figure 10A – Deviation Pu-238 AH

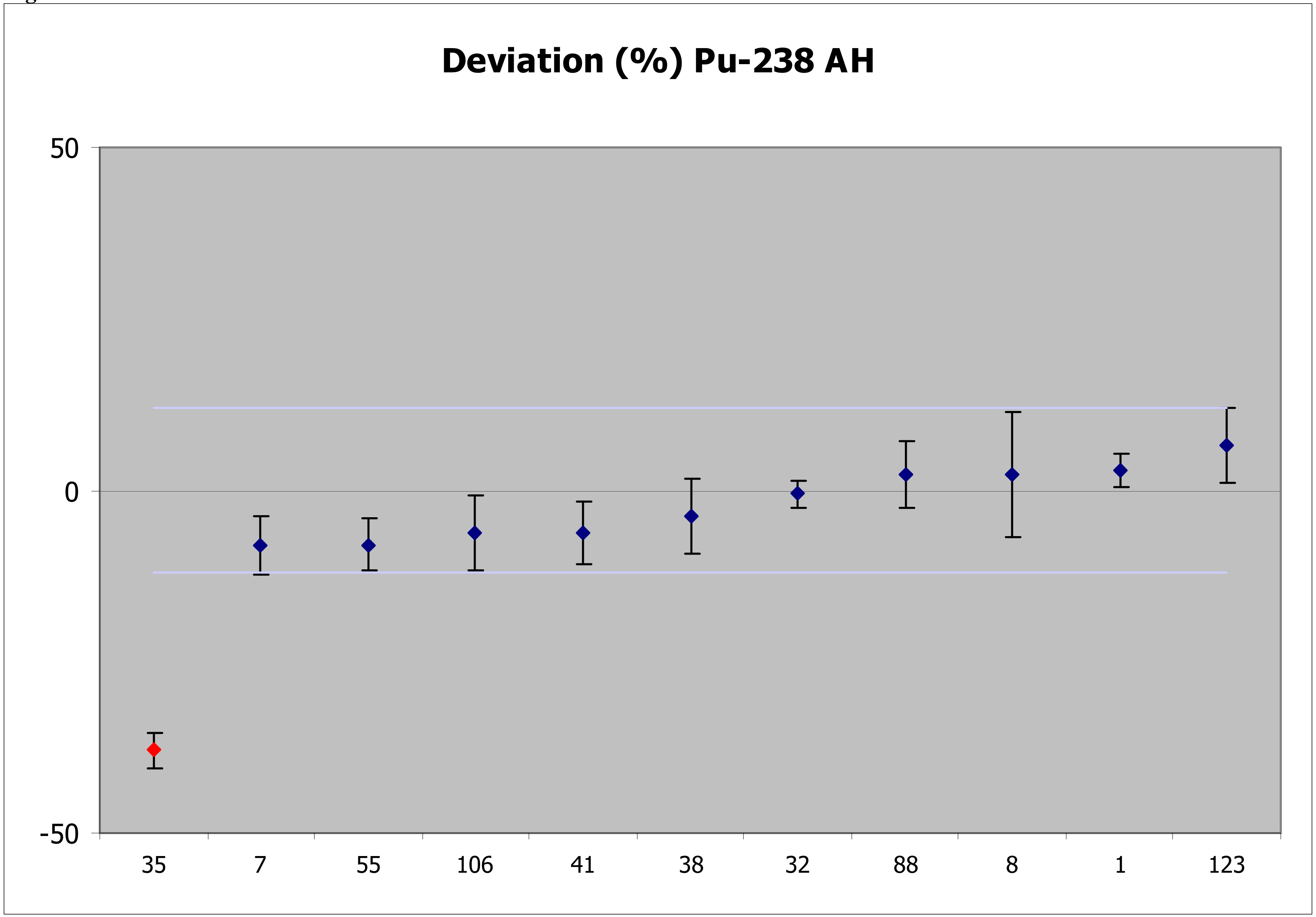


Figure 10B – Zeta score Pu-238 AH

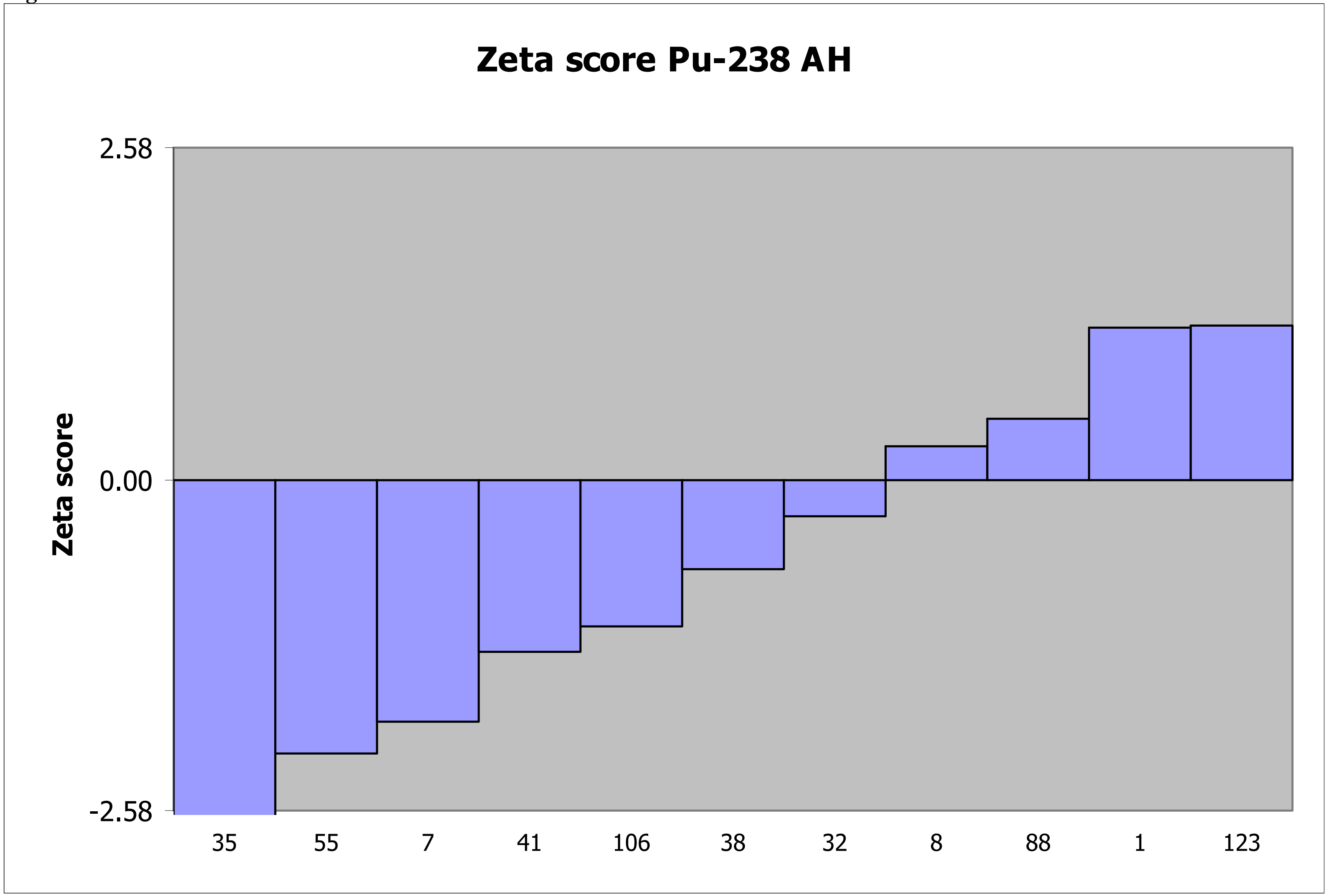


Figure 10C – Relative uncertainty Pu-238 AH

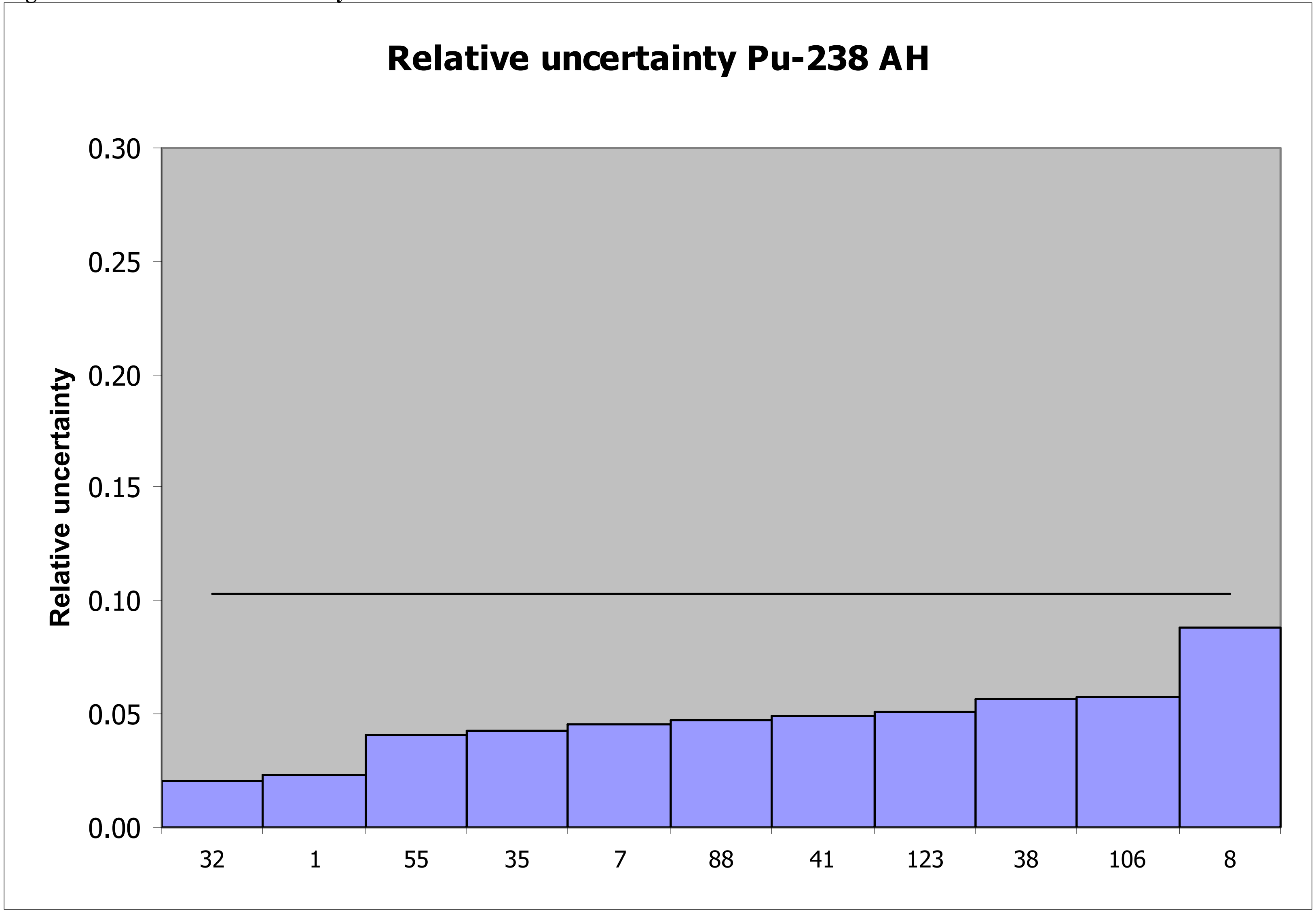


Figure 10D – Kiri plot Pu-238 AH

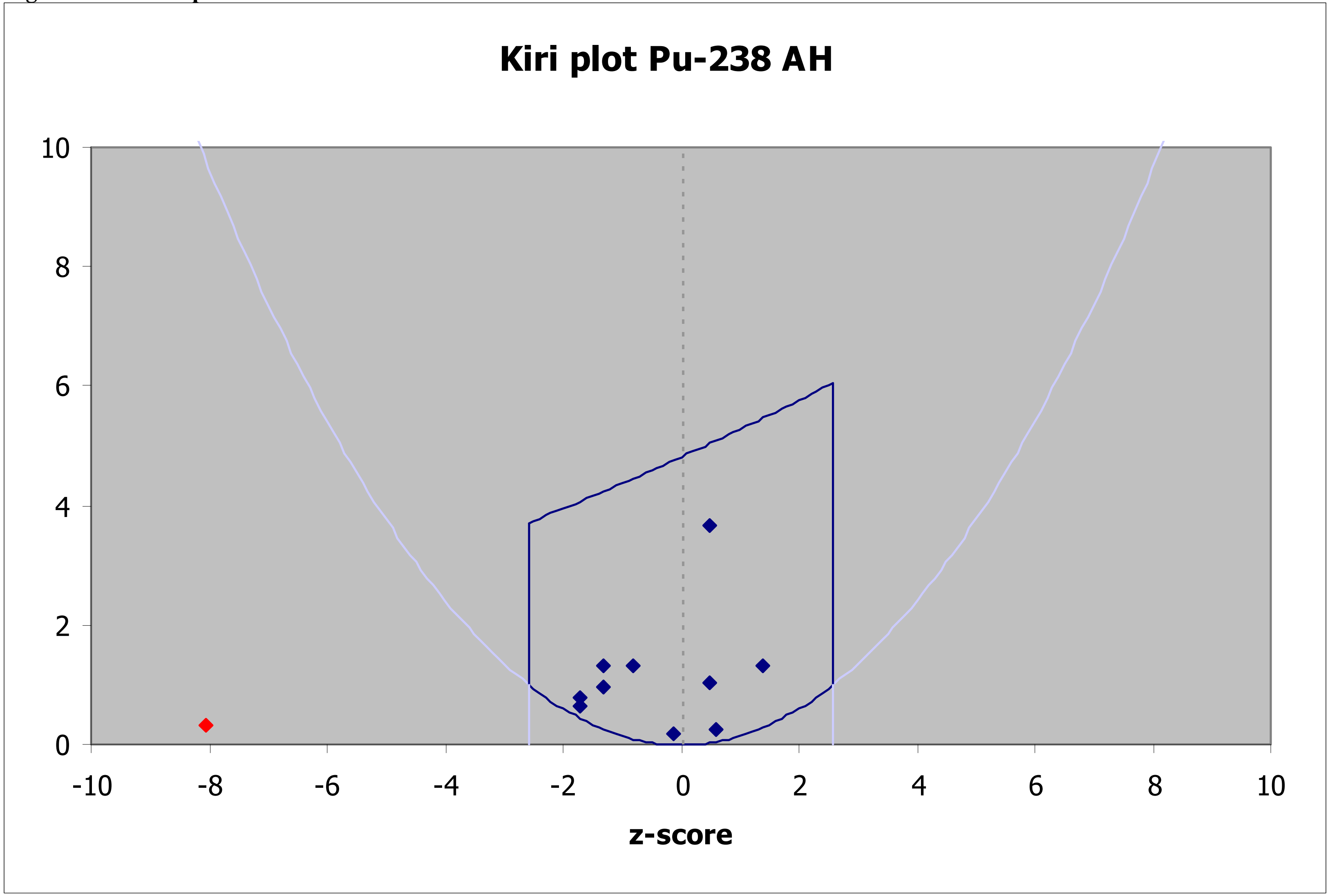


Figure 11A – Deviation Pu-239 AH

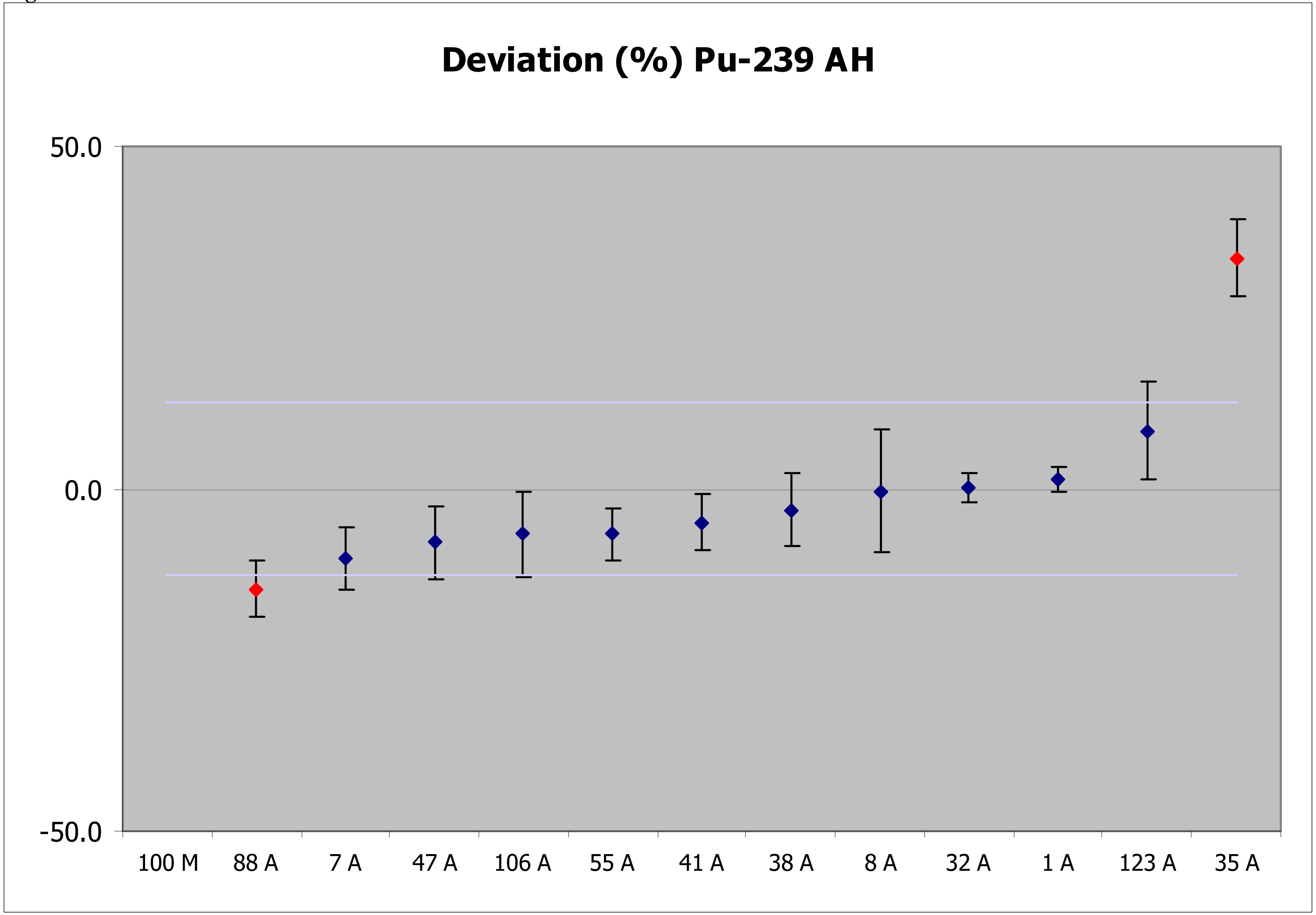


Figure 11B – Zeta score Pu-239 AH

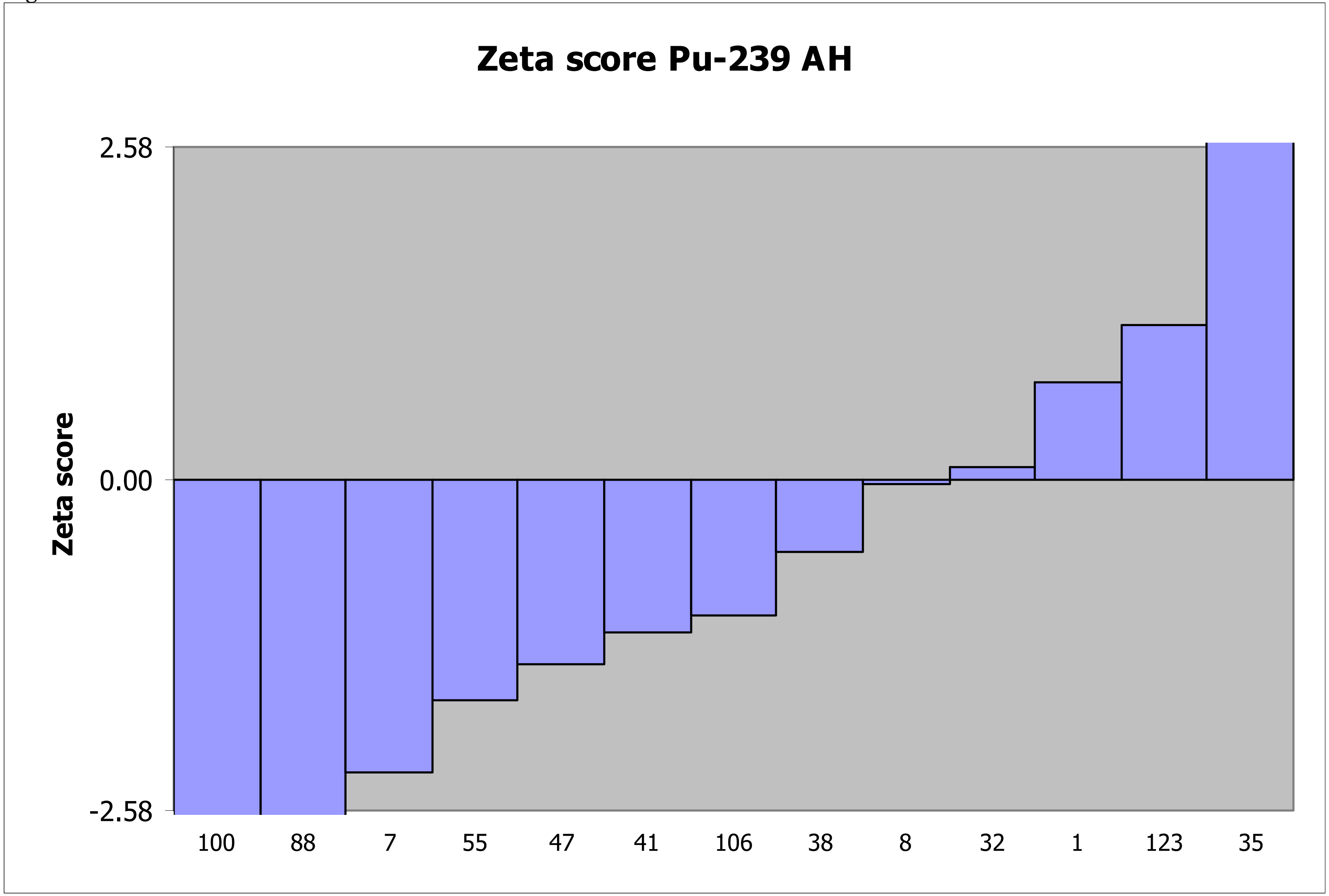


Figure 11C – Relative uncertainty Pu-239 AH

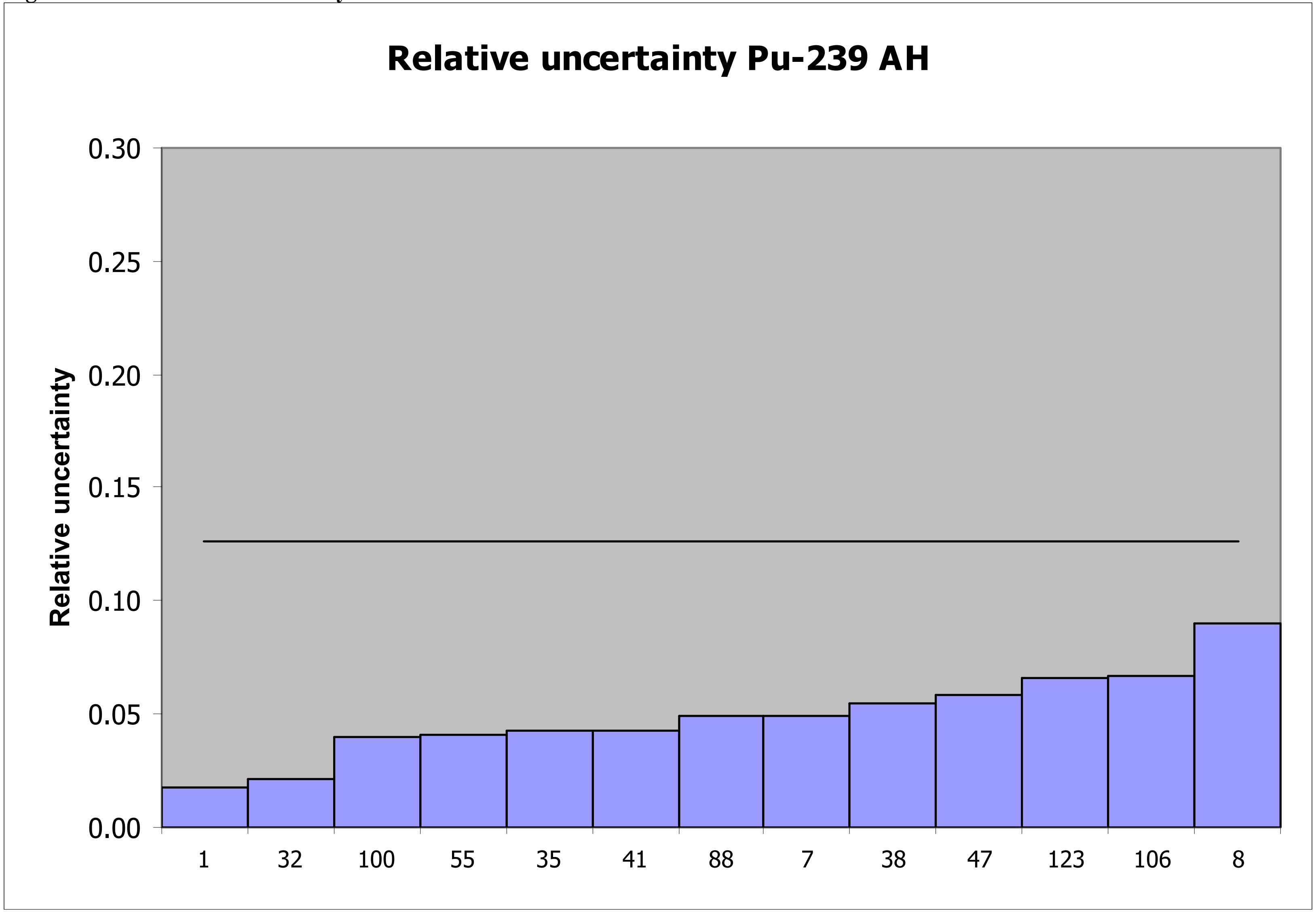


Figure 11D – Kiri plot Pu-239 AH

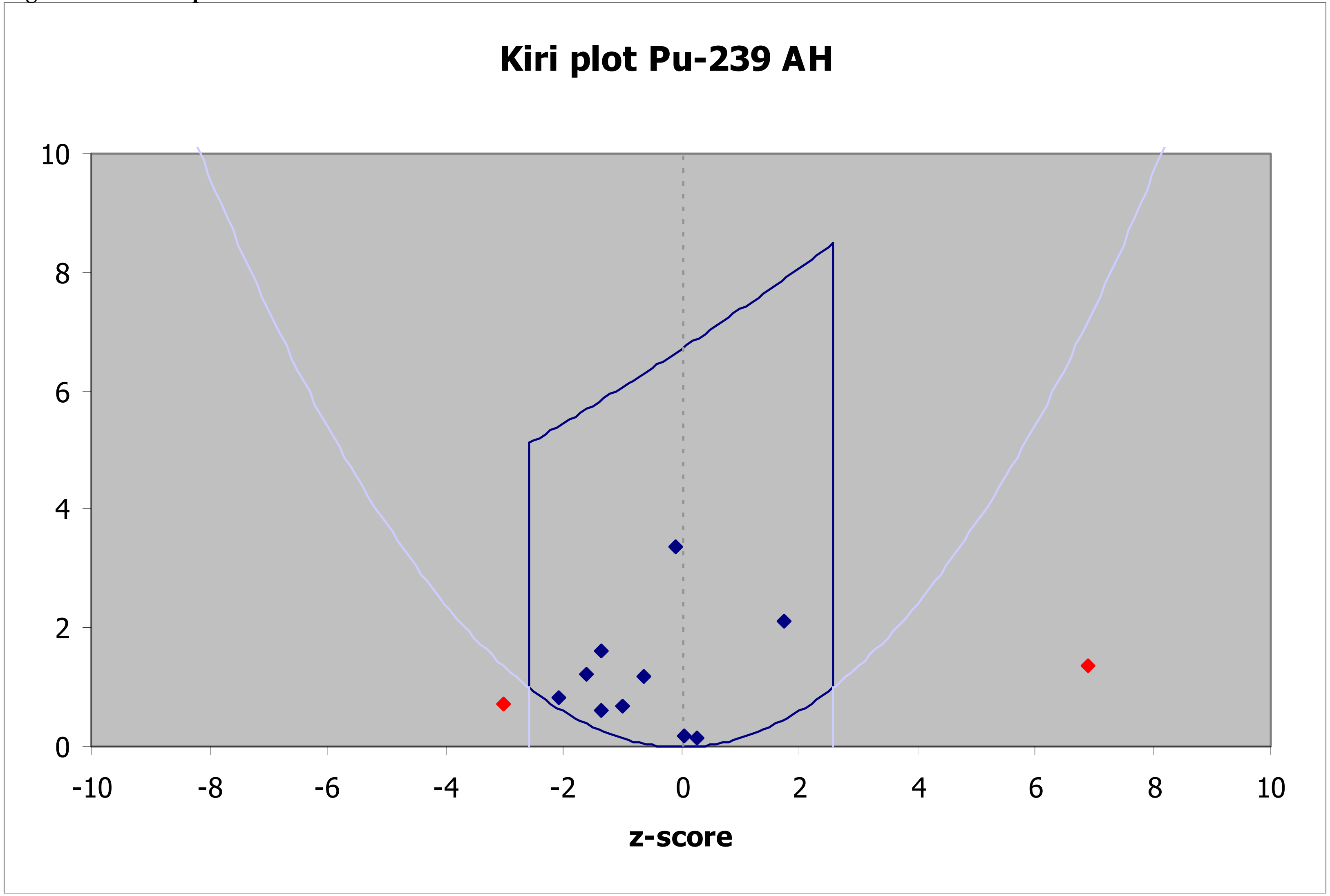


Figure 12A – Deviation Am-241 AH

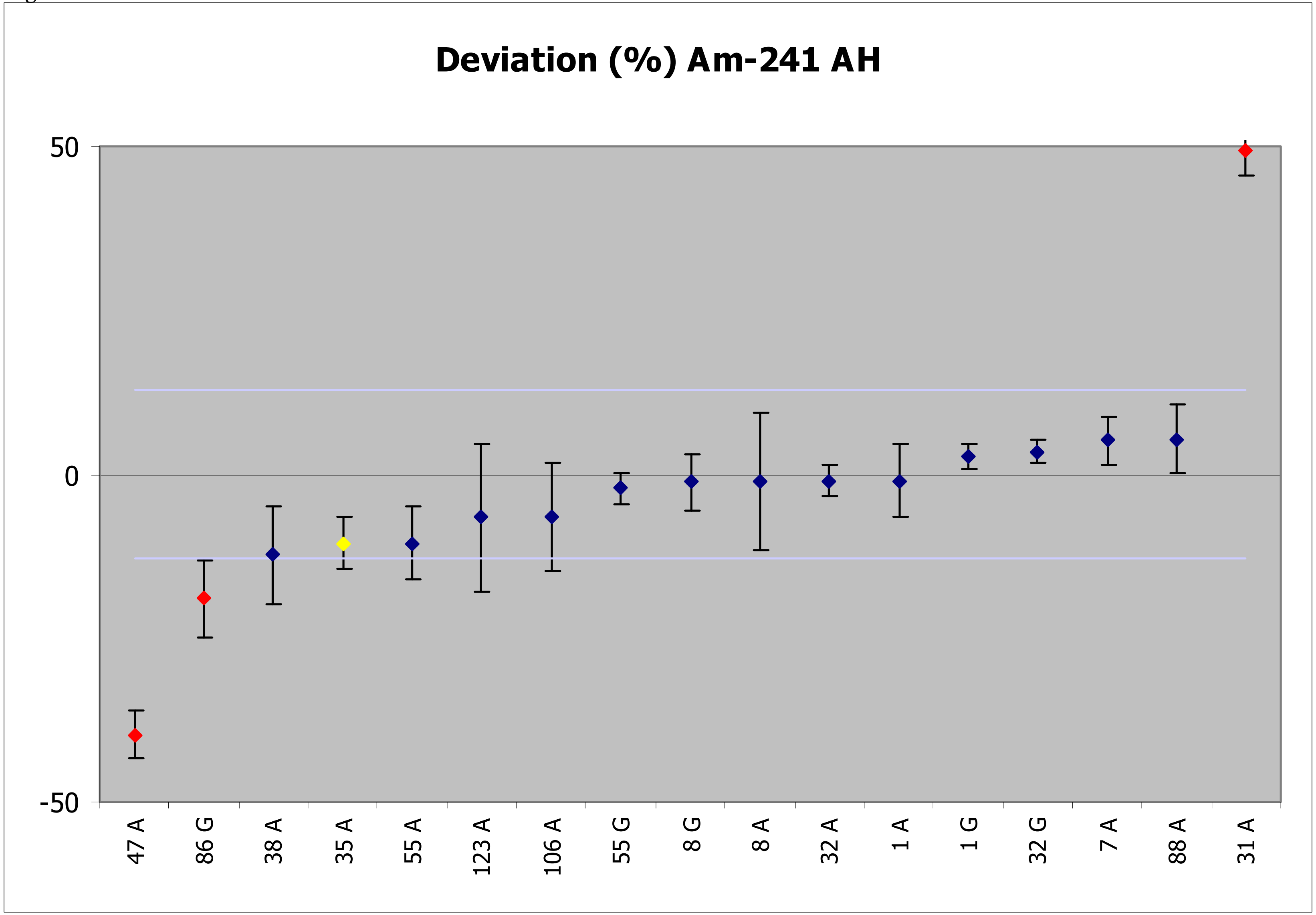


Figure 12B – Zeta score Am-241 AH

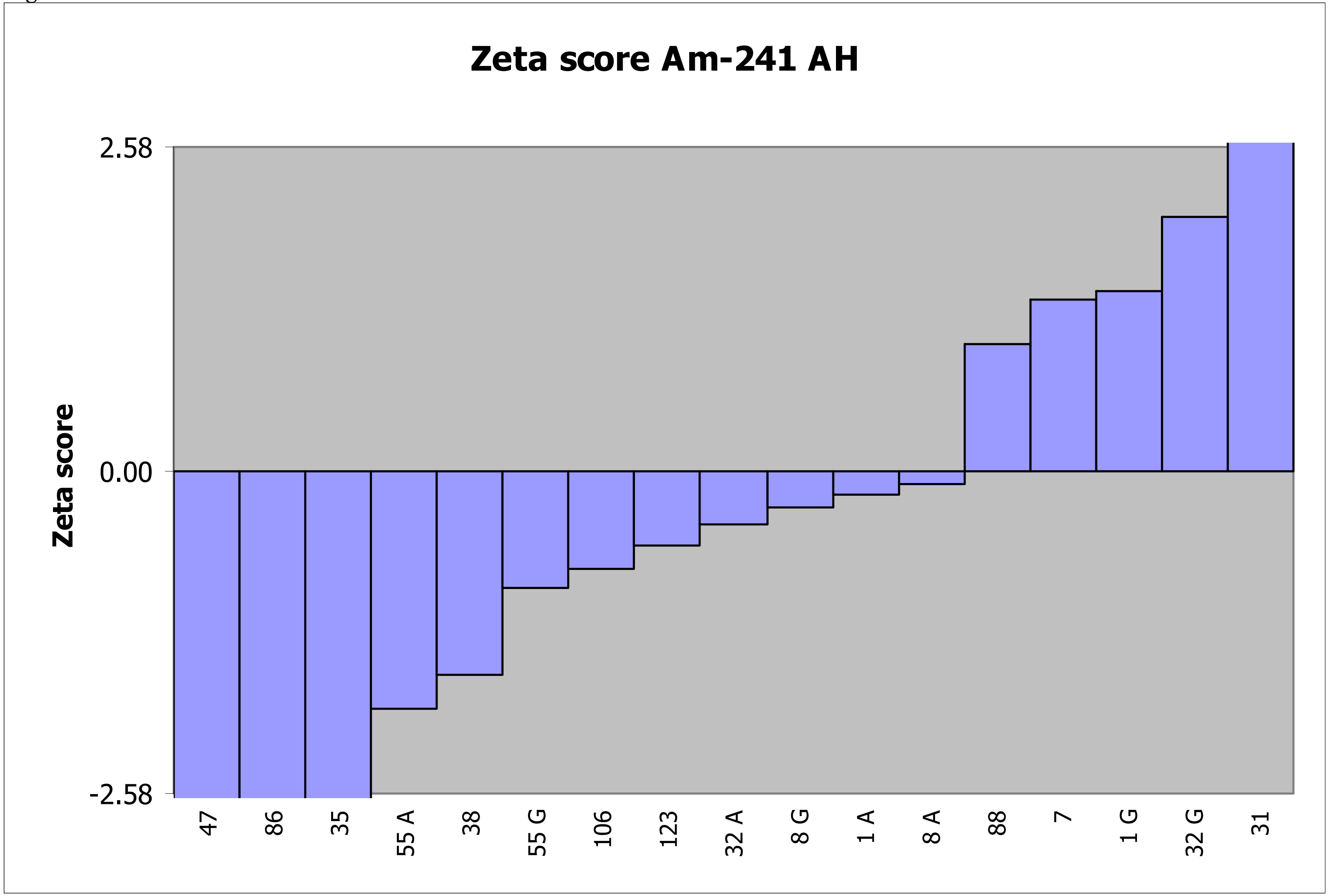


Figure 12C – Relative uncertainty Am-241 AH

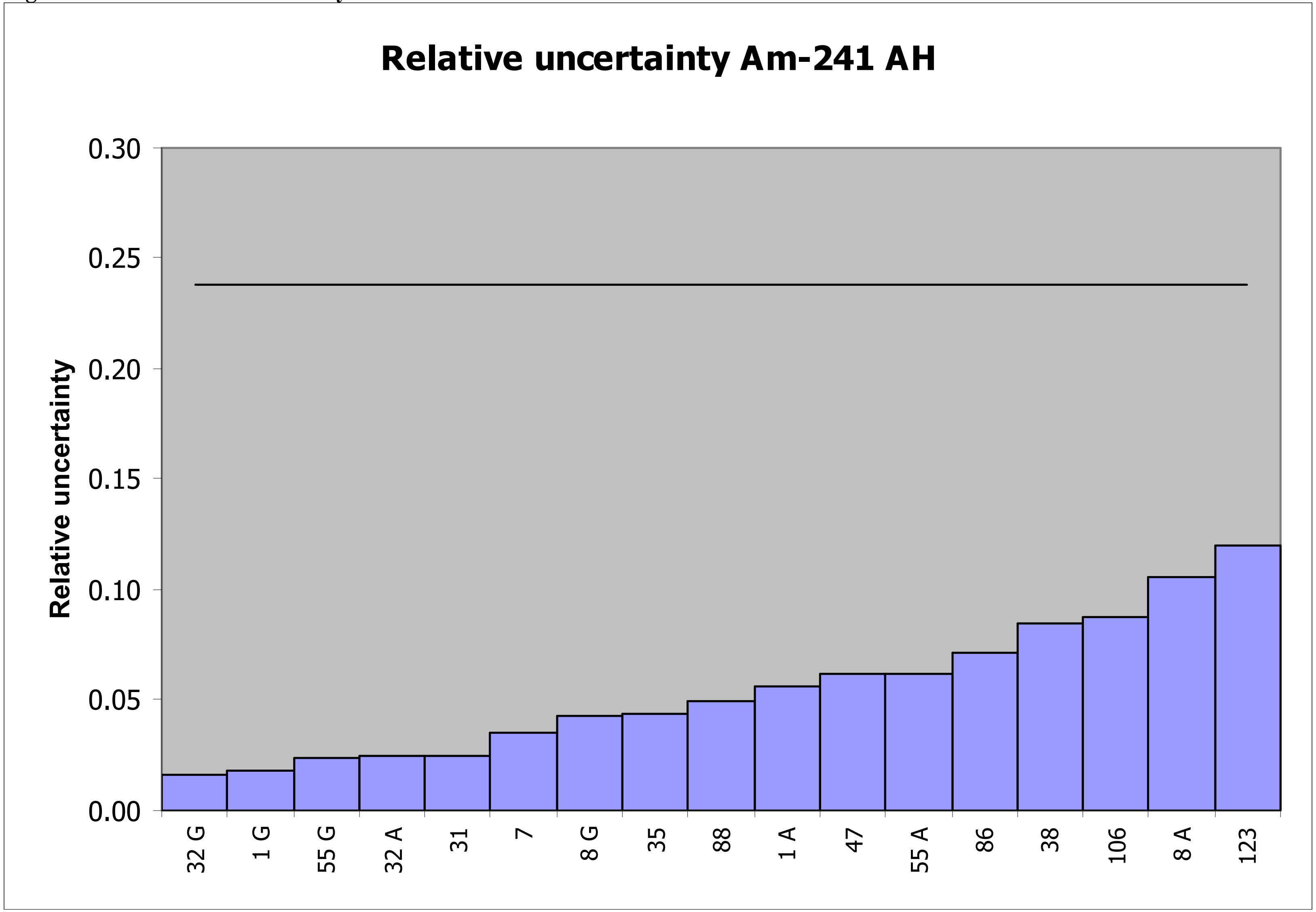


Figure 12D – Kiri plot Am-241 AH

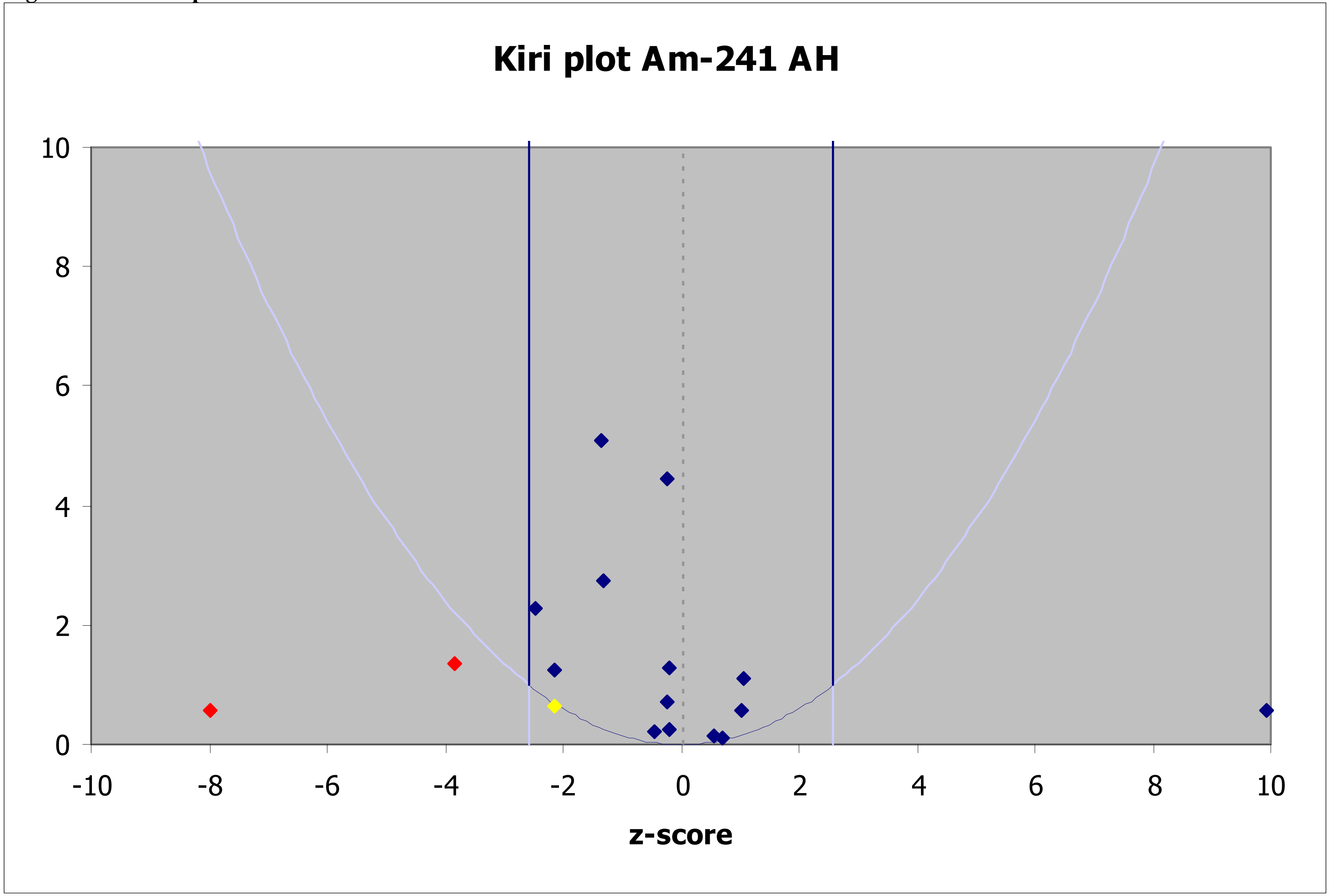


Figure 13A – Deviation Cm-244 AH

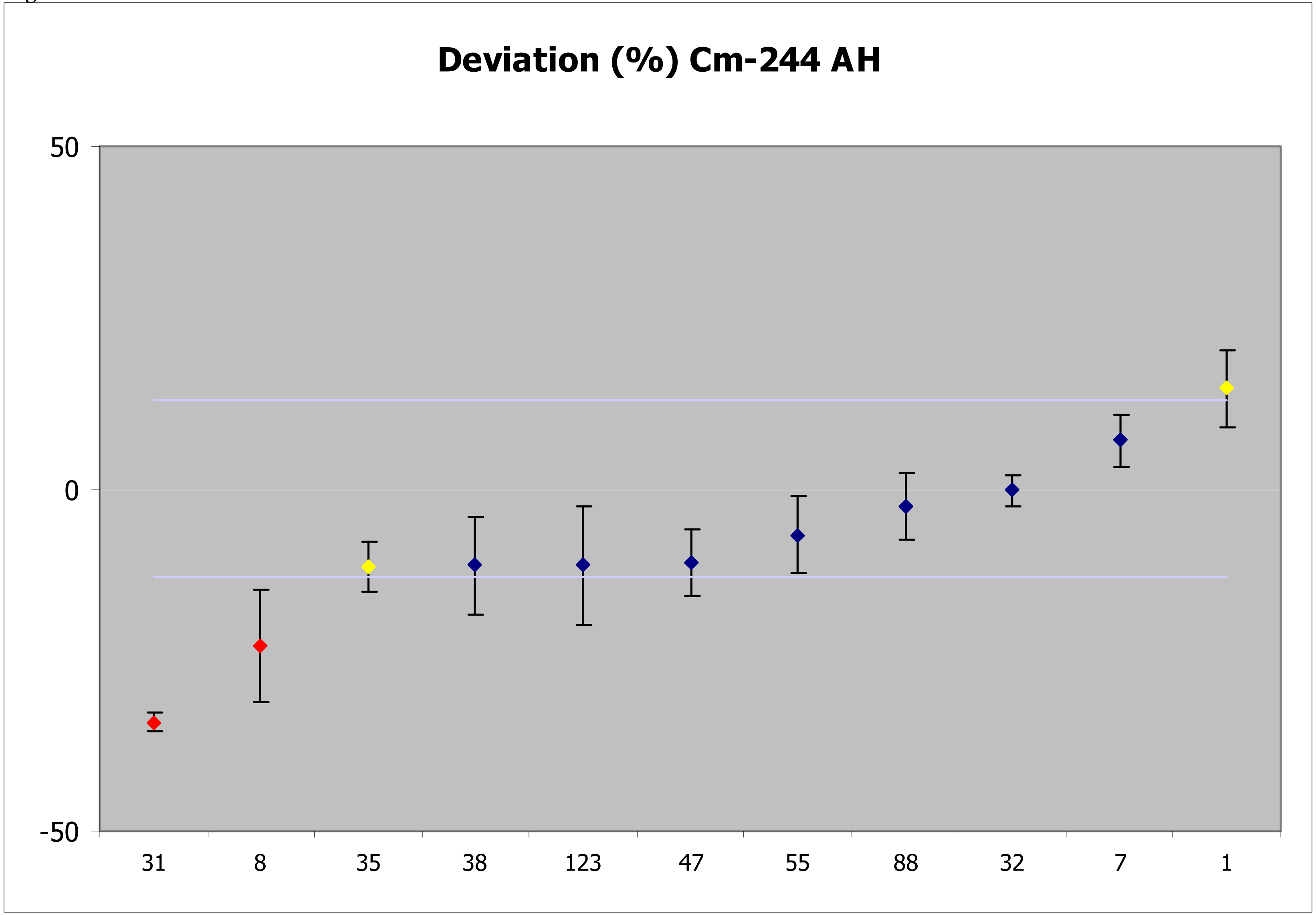


Figure 13B – Zeta score Cm-244 AH

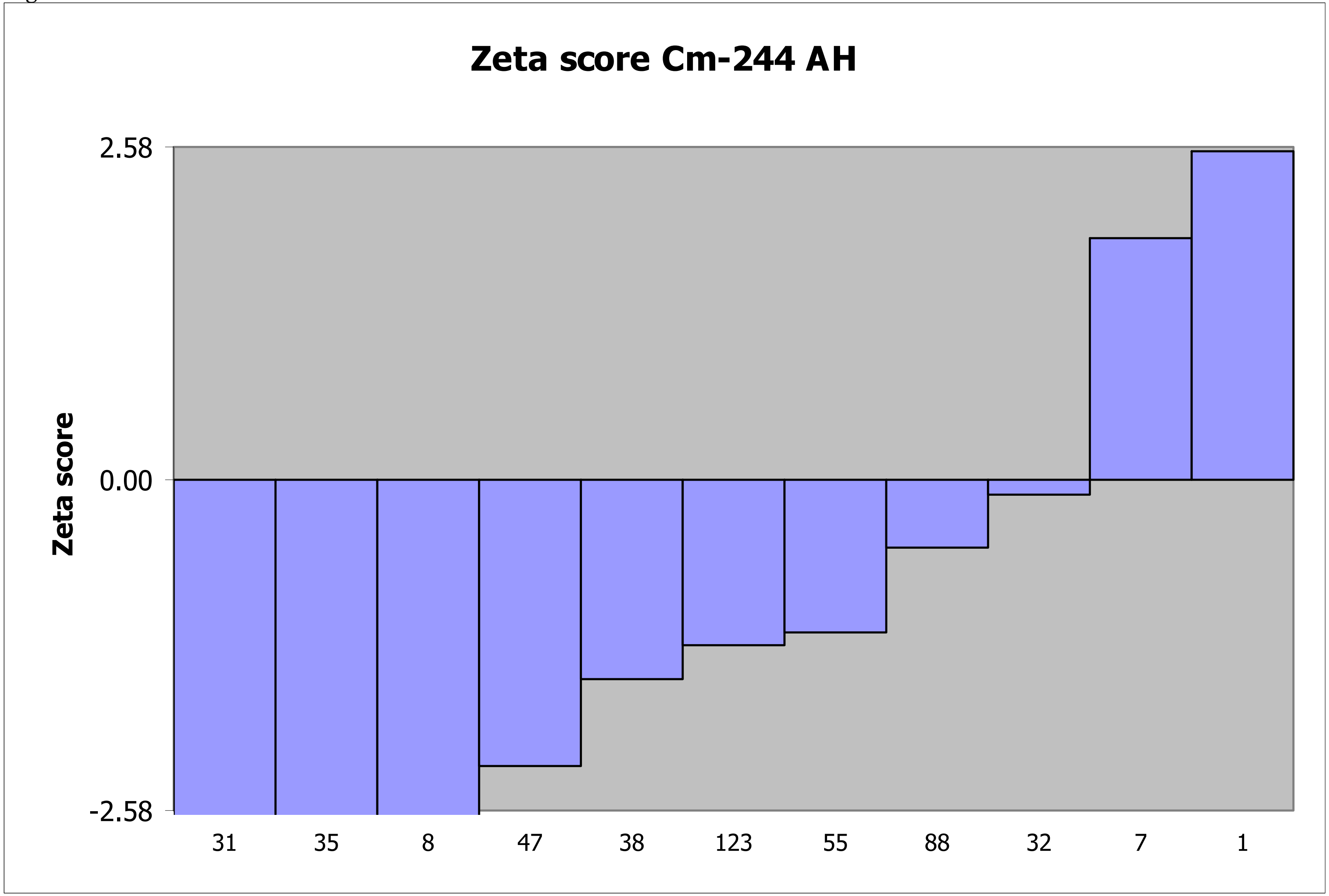


Figure 13C – Relative uncertainty Cm-244 AH

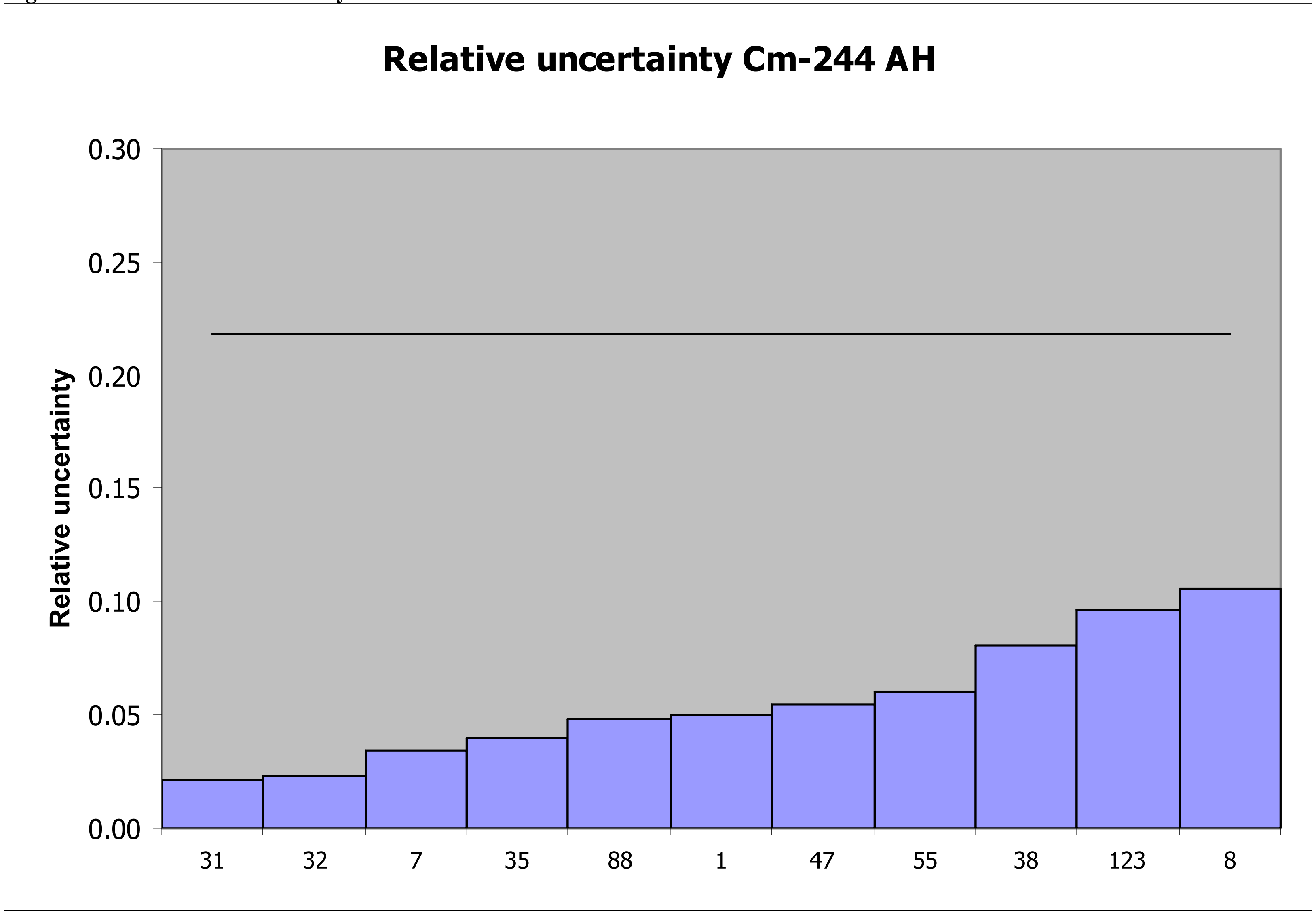


Figure 13D – Kiri plot Cm-244 AH

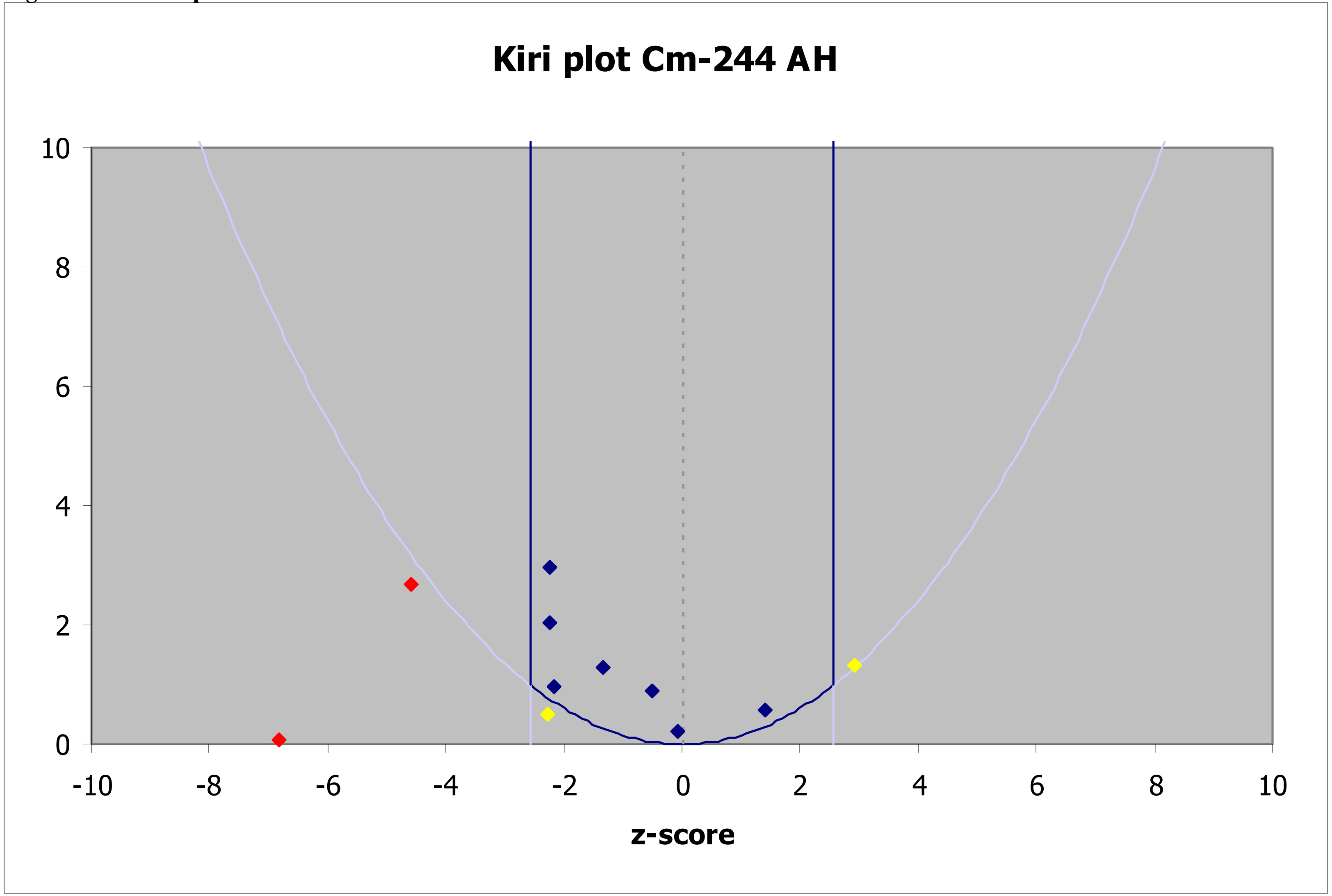


Figure 14A – Deviation gross alpha AH

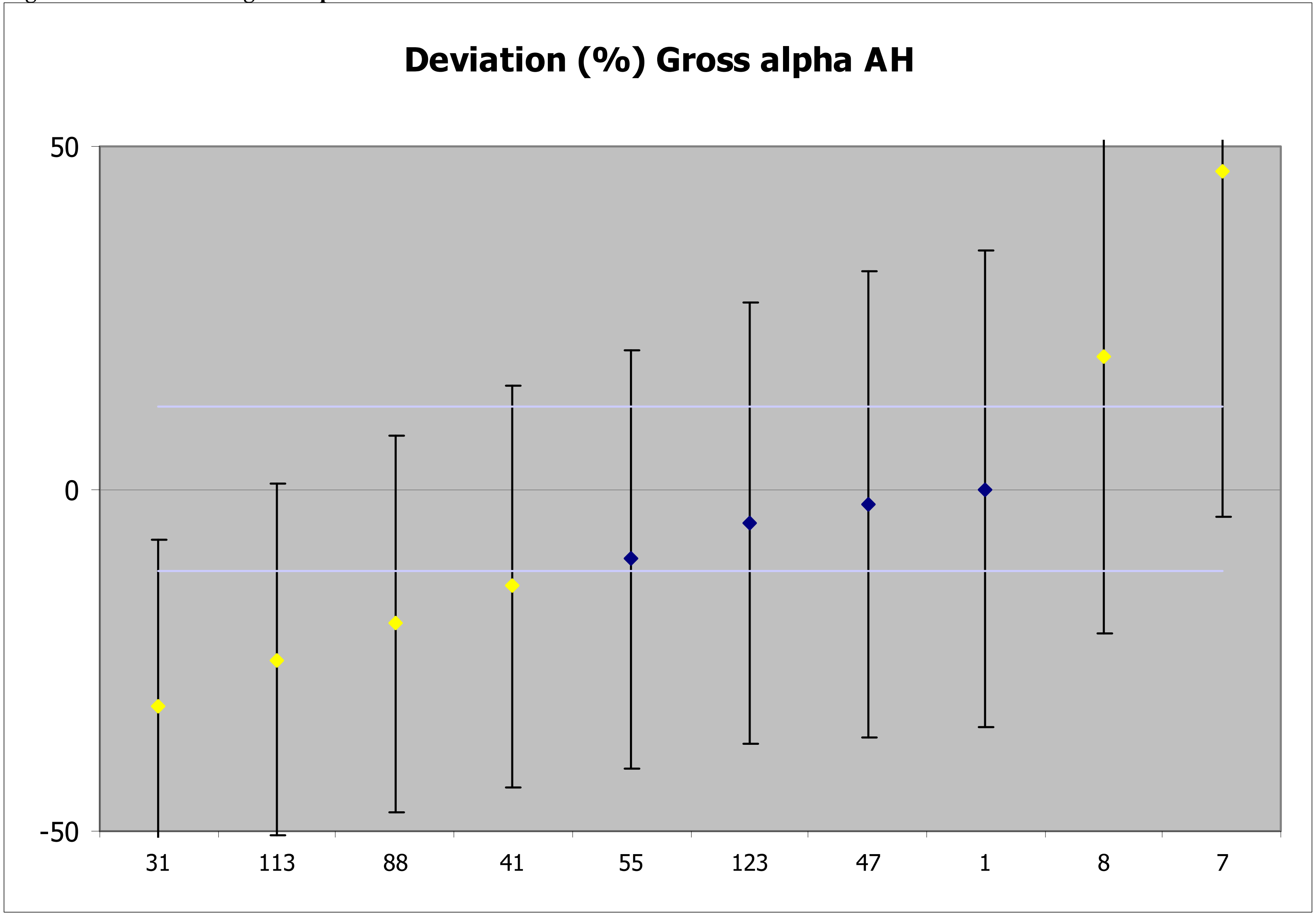


Figure 14B – Zeta score gross alpha AH

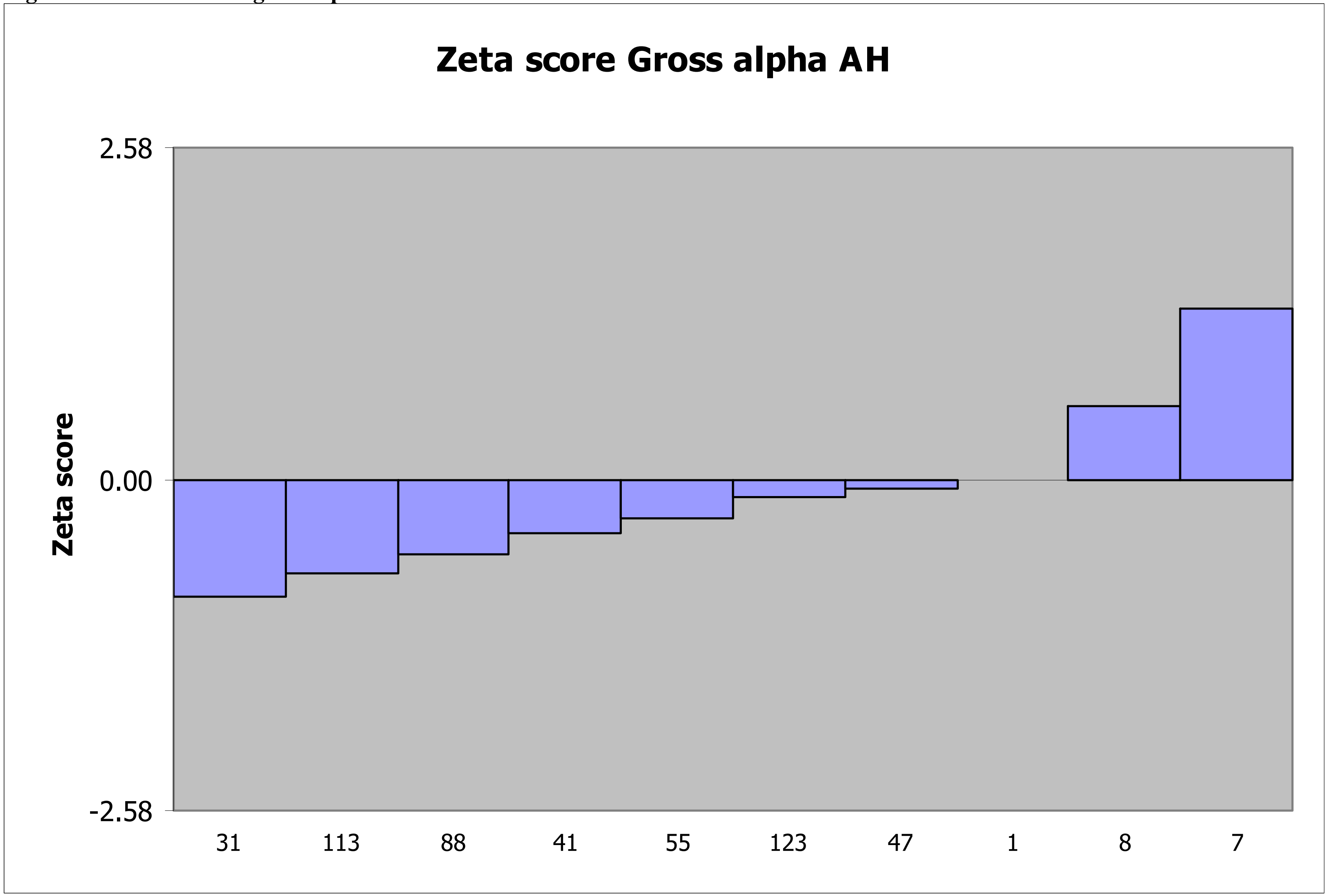


Figure 14C – Relative uncertainty gross alpha AH

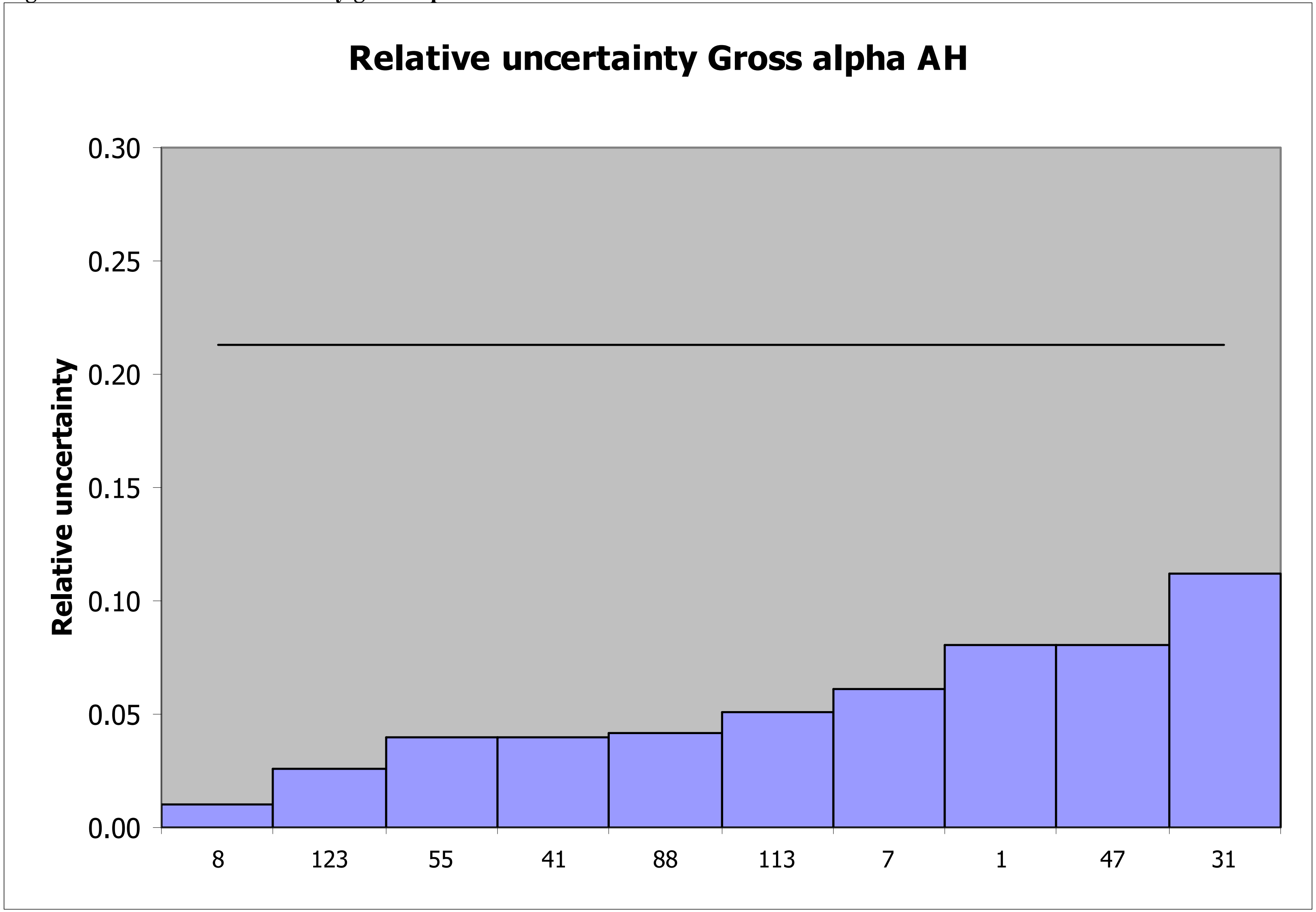


Figure 14D – Kiri plot gross alpha AH

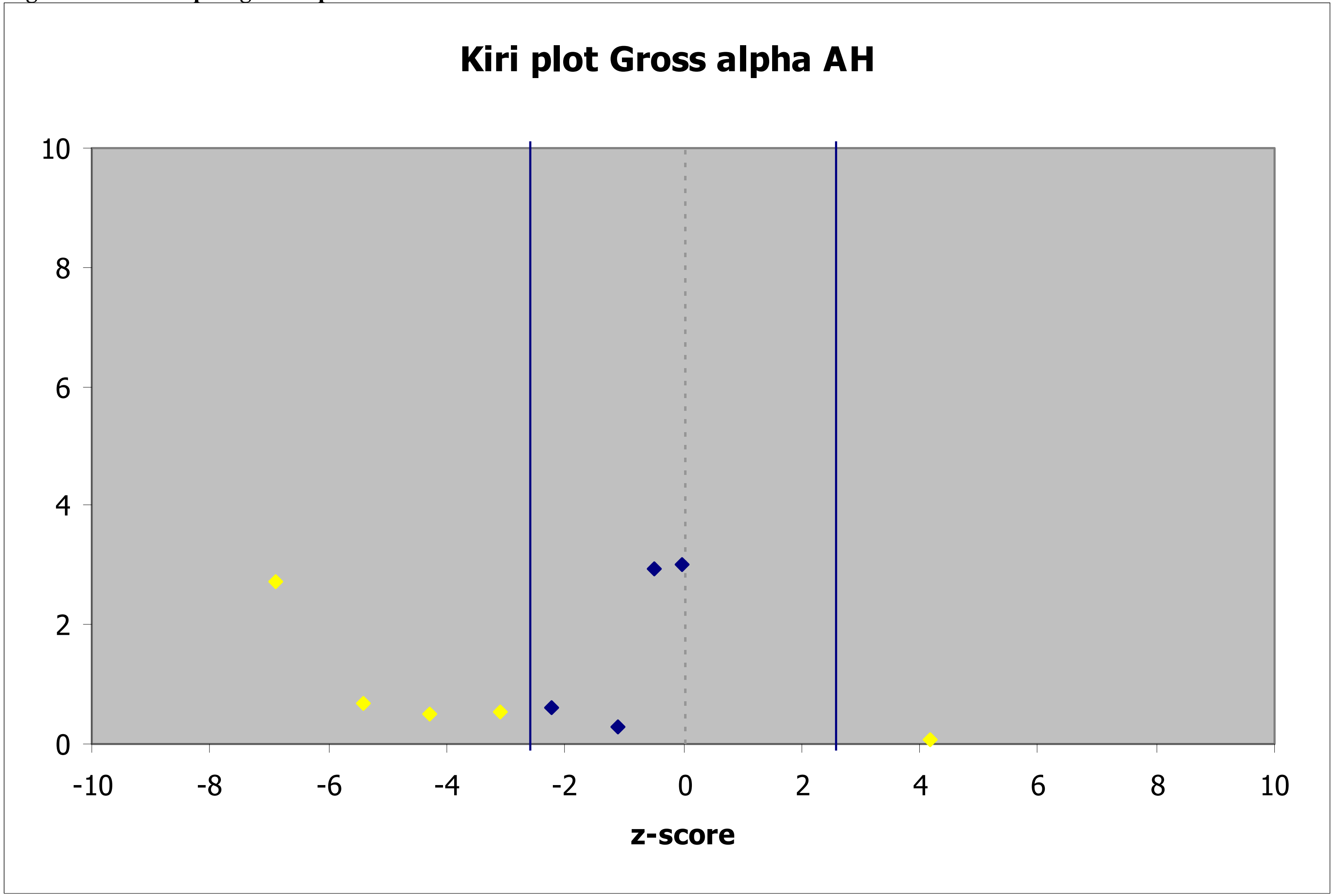


Figure 15A – Deviation H-3 B1

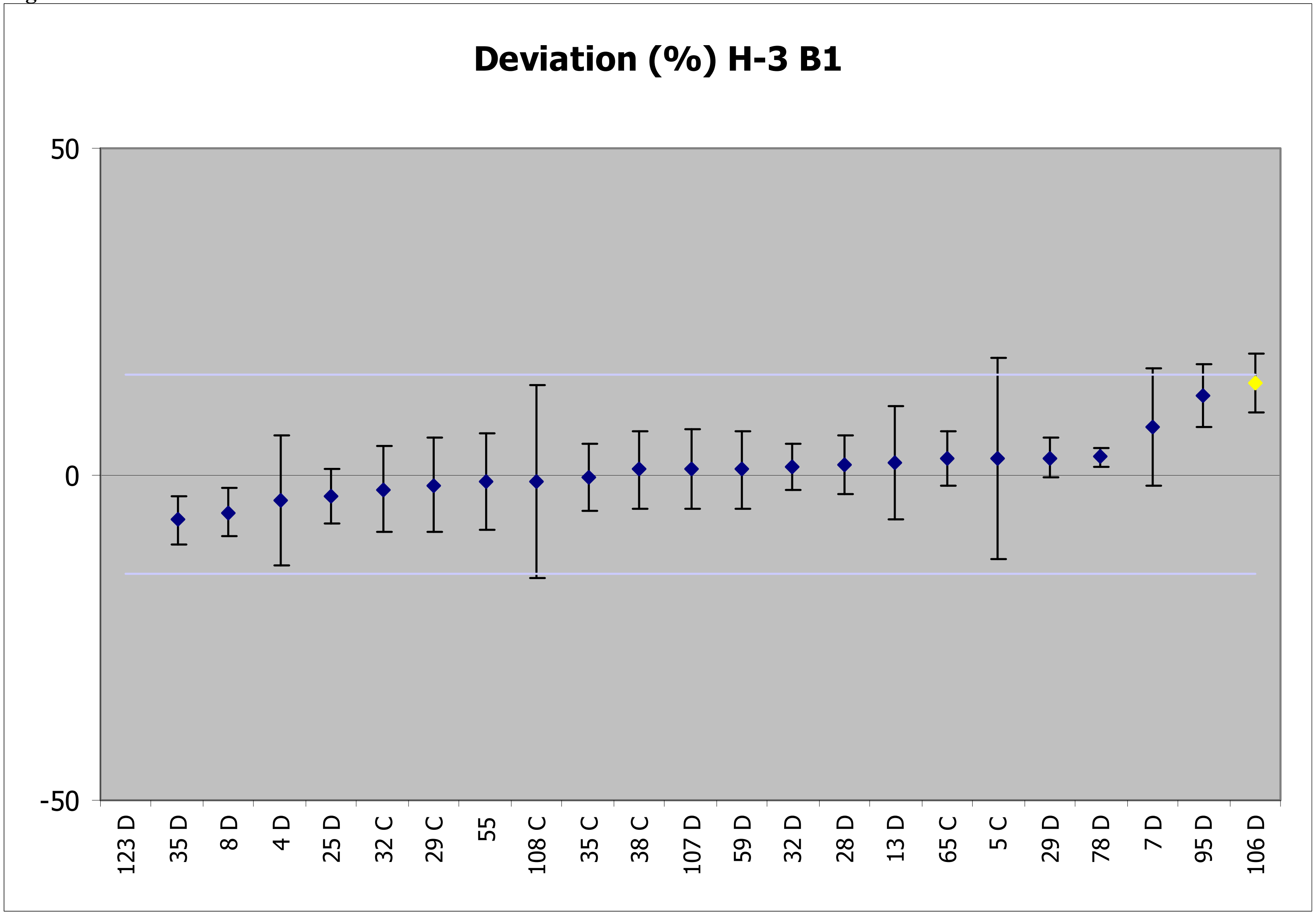


Figure 15B – Zeta score H-3 B1

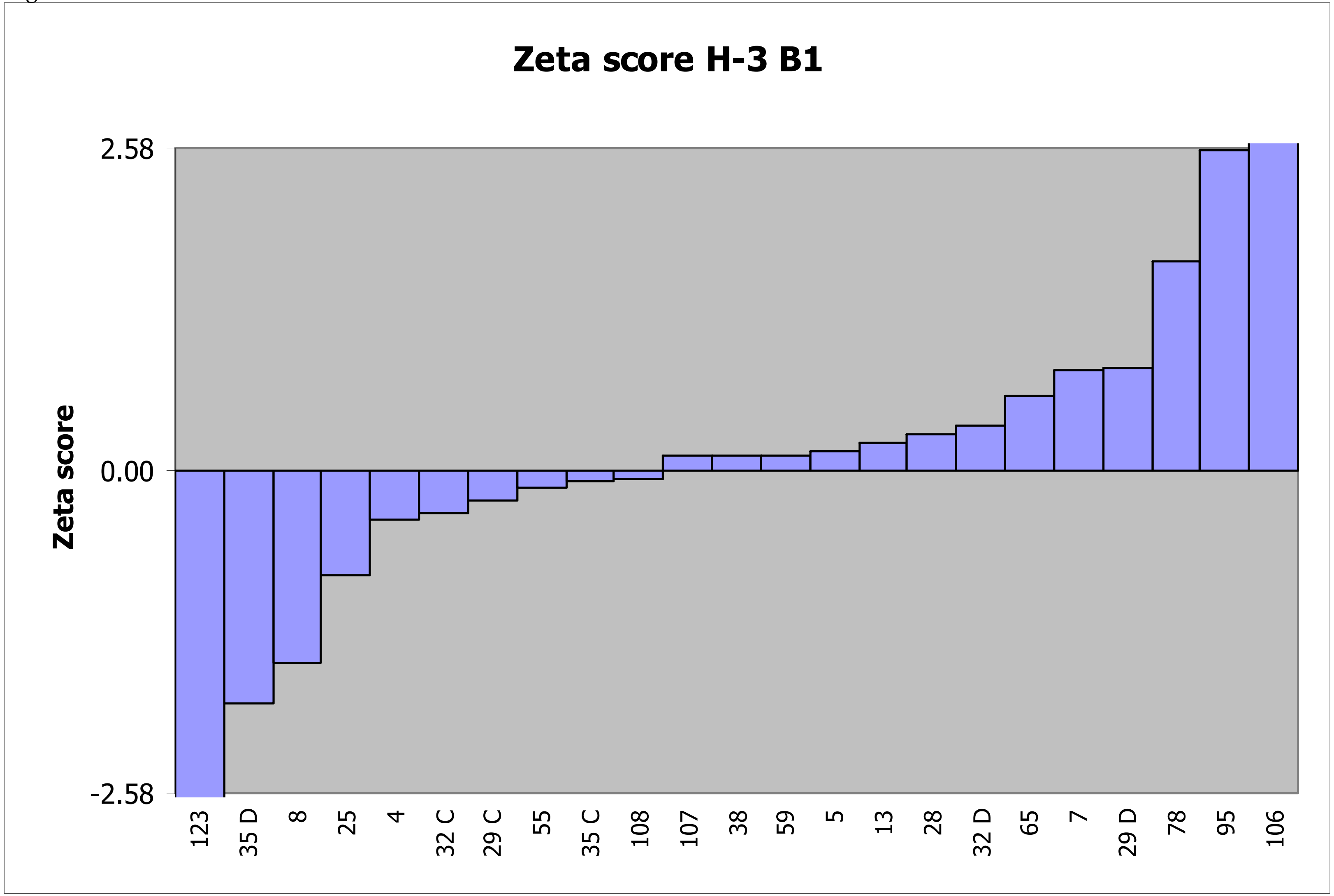


Figure 15C – Relative uncertainty H-3 B1

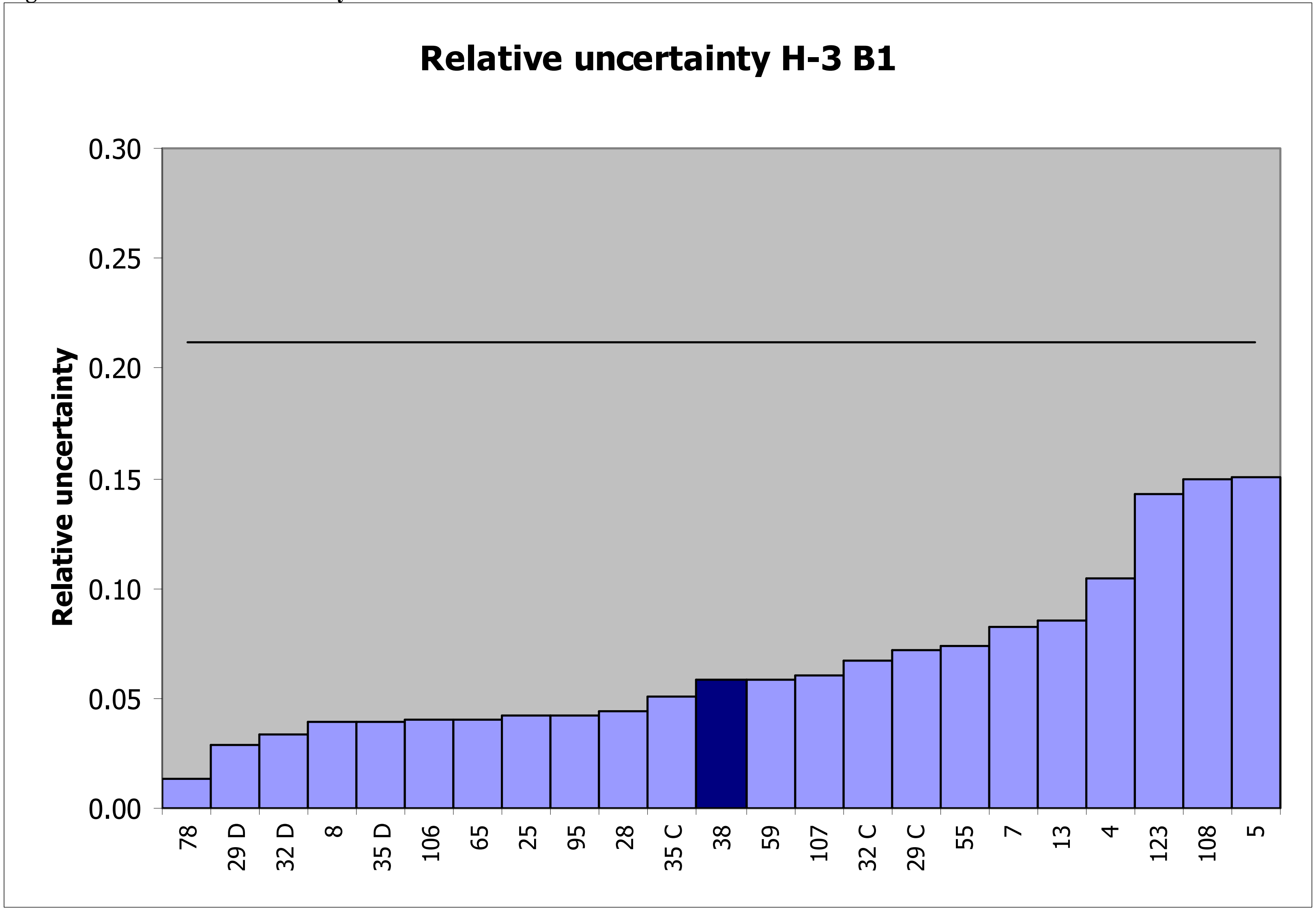


Figure 15D – Kiri plot H-3 B1

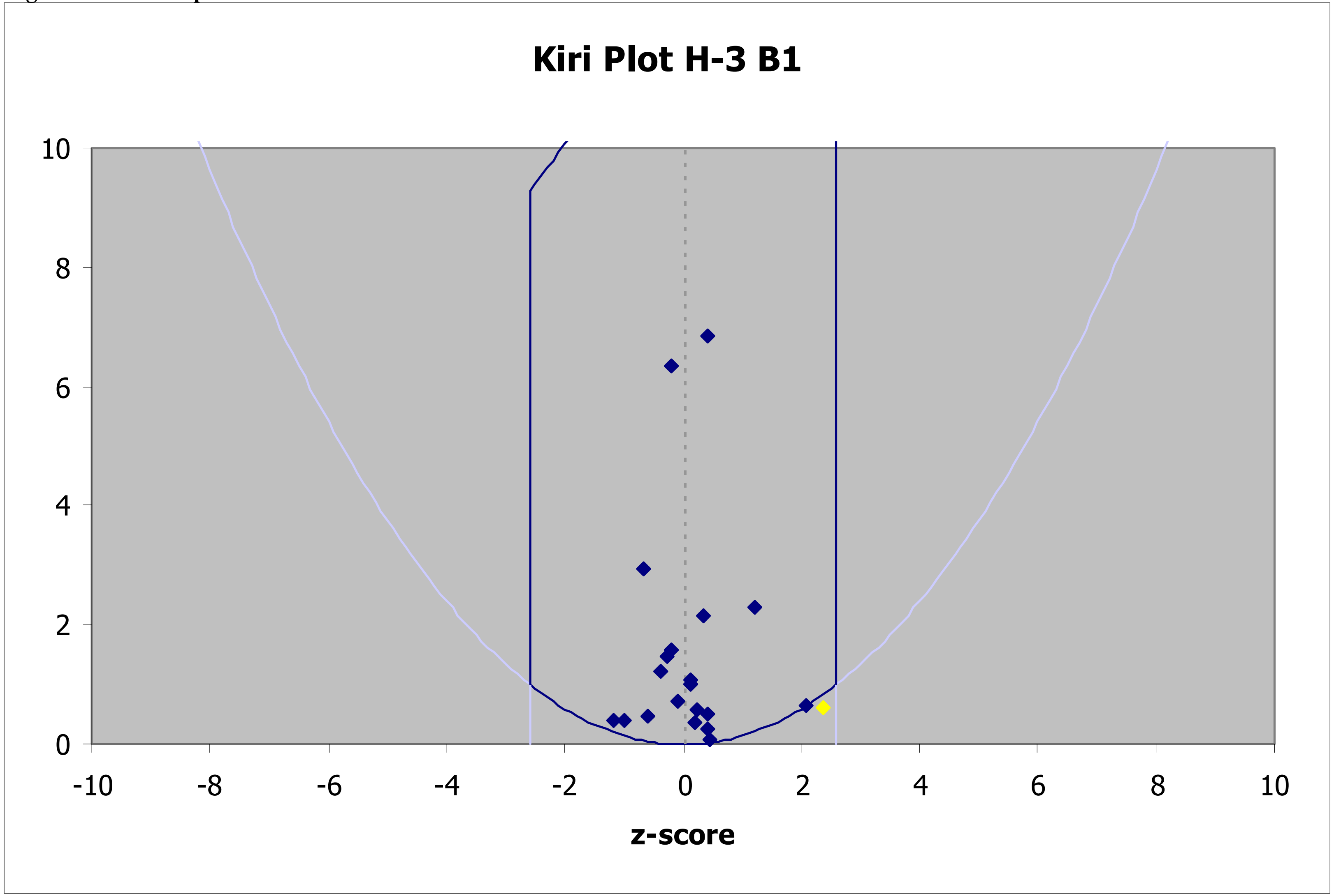


Figure 16A – Deviation C-14 B1

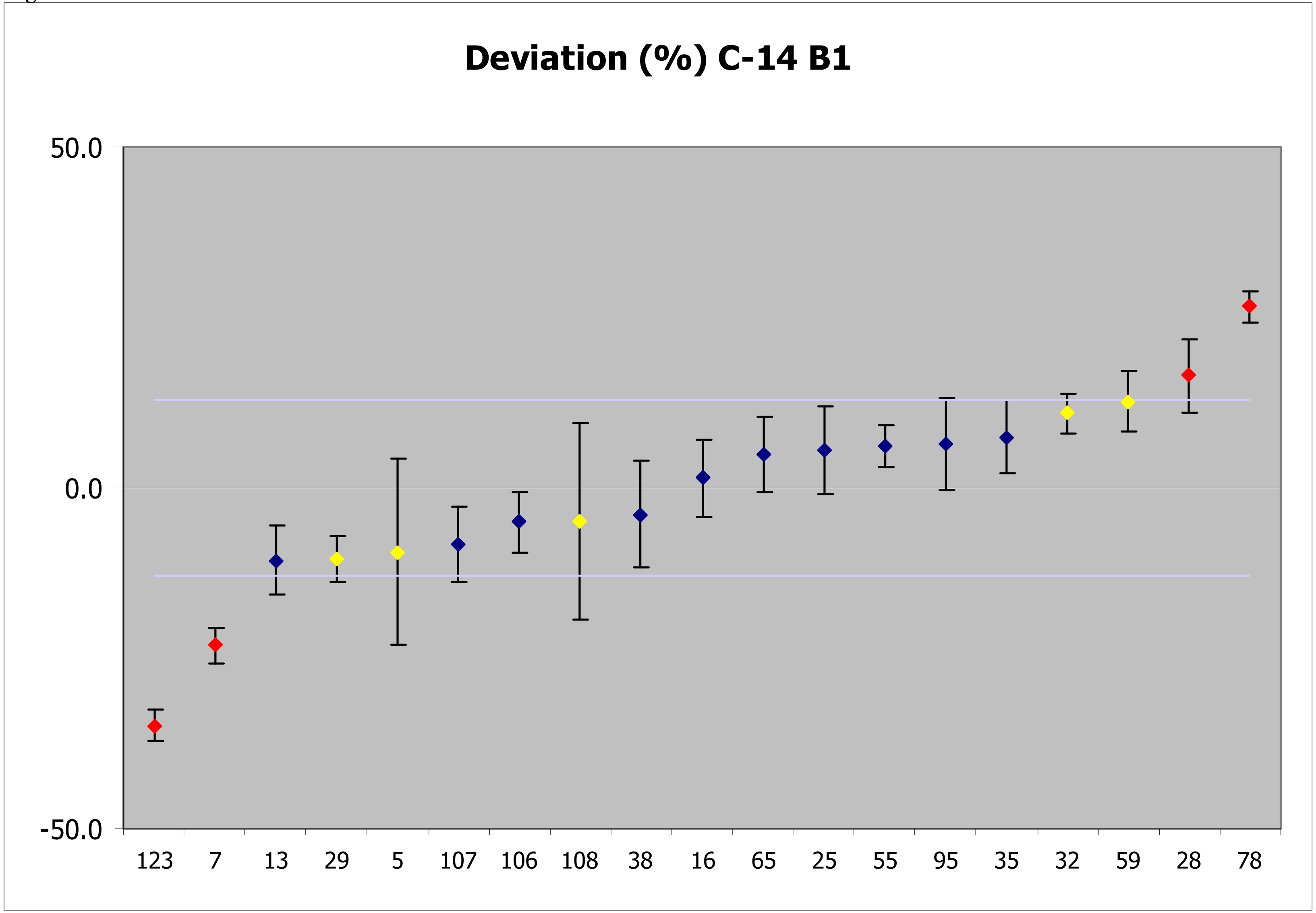


Figure 16B – Zeta score C-14 B1

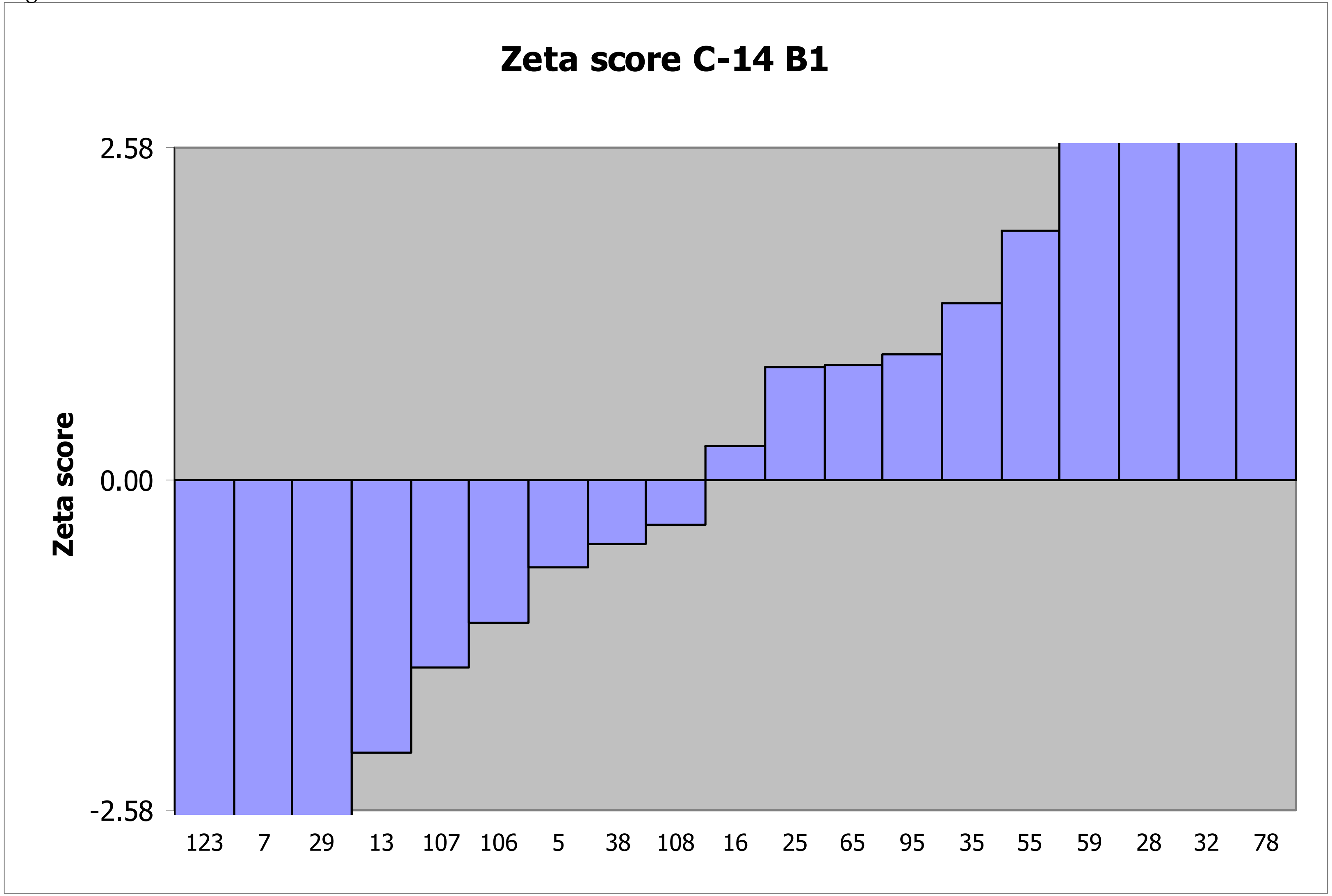


Figure 16C – Relative uncertainty C-14 B1

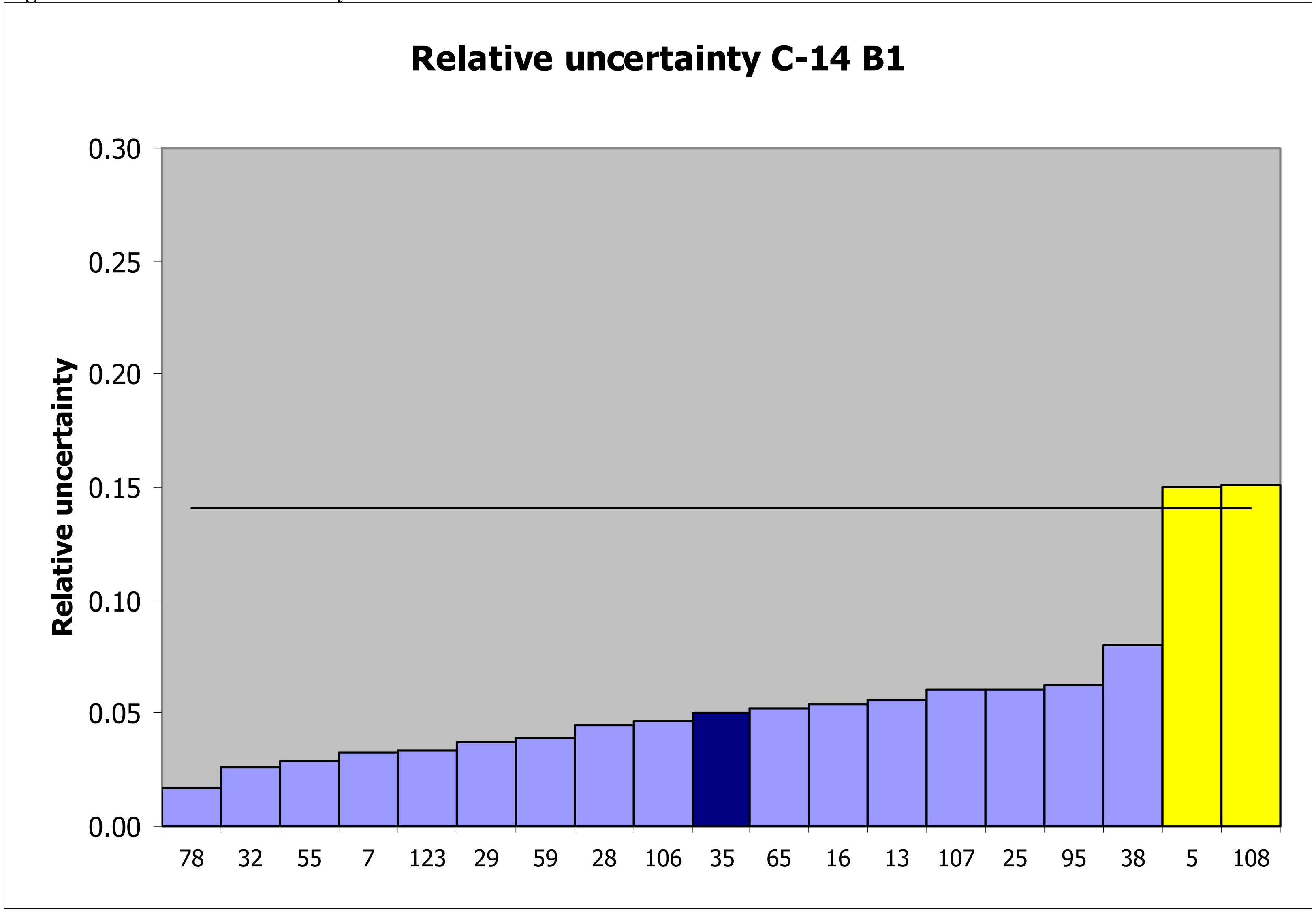


Figure 16D – Kiri plot C-14 B1

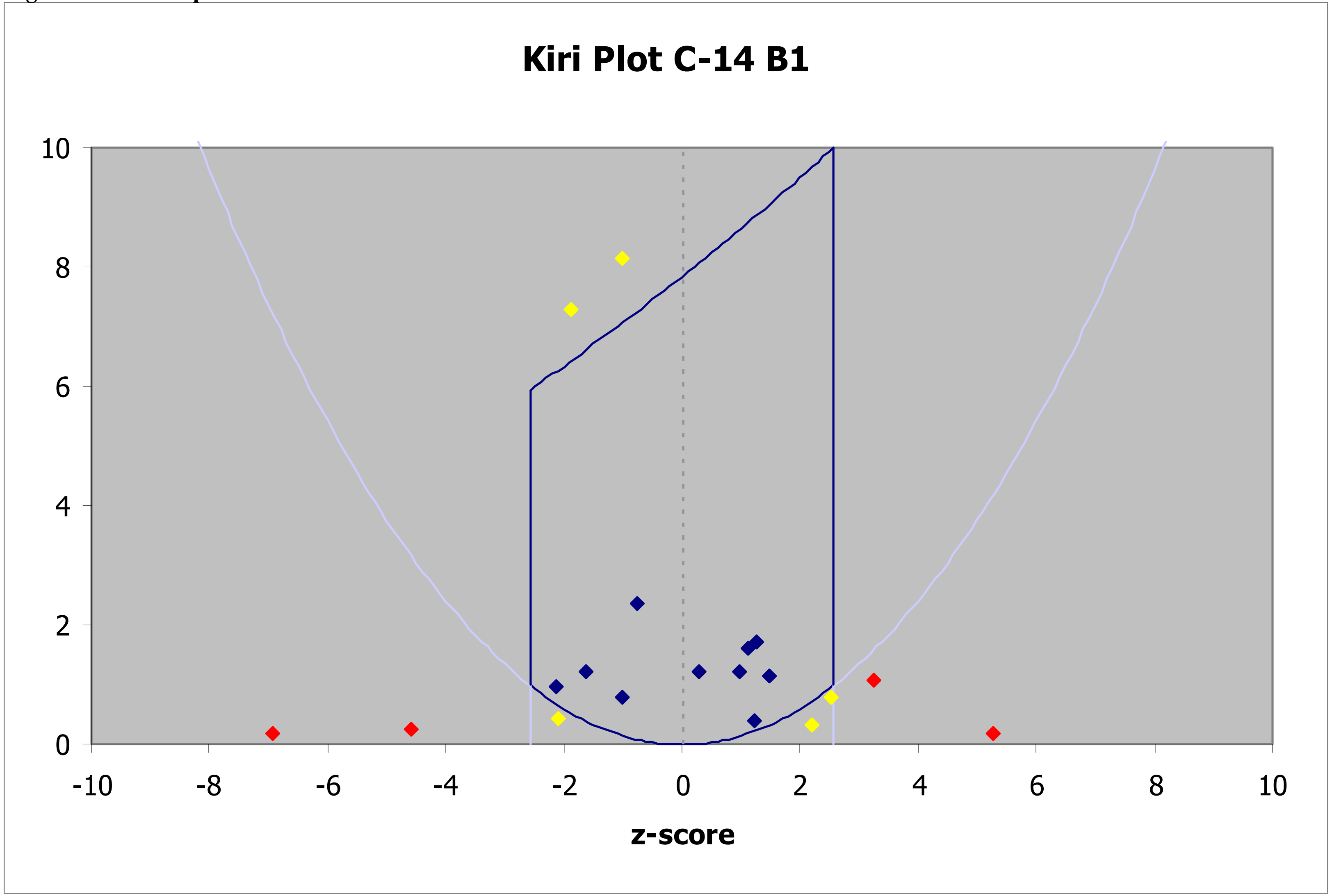


Figure 17A – Deviation Tc-99 B1

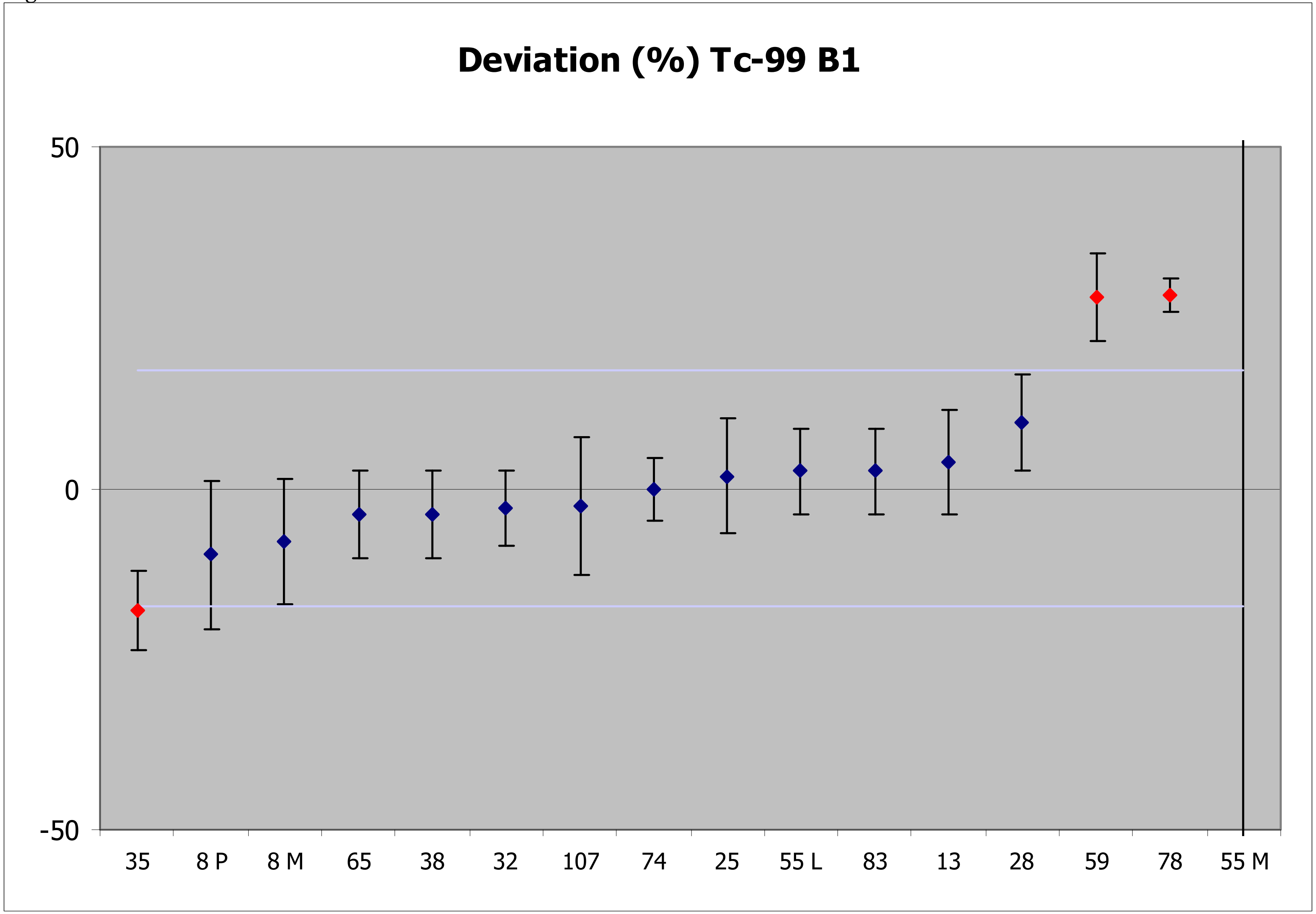


Figure 17B – Zeta score Tc-99 B1

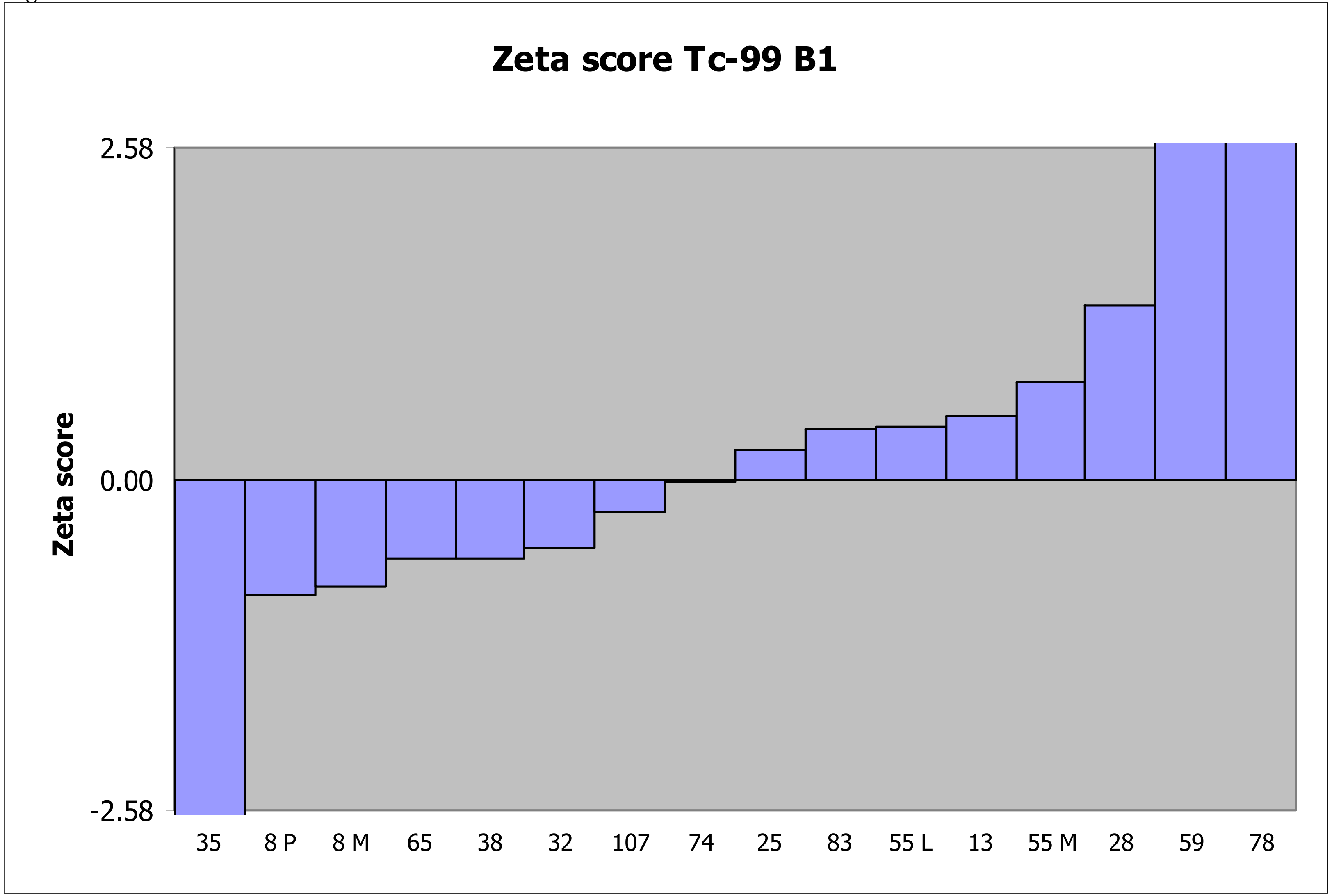


Figure 17C – Relative uncertainty Tc-99 B1

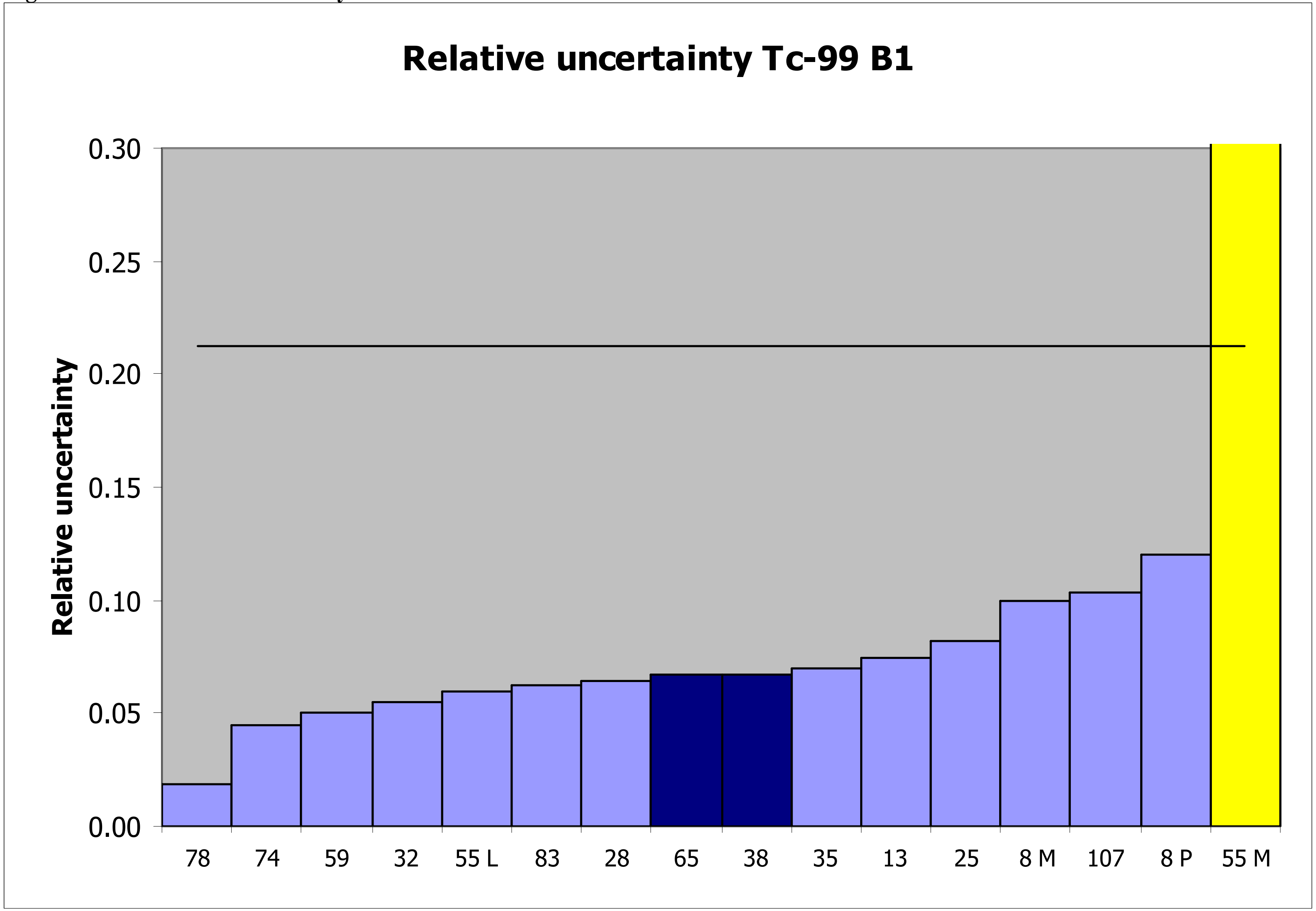


Figure 17D – Kiri plot Tc-99 B1

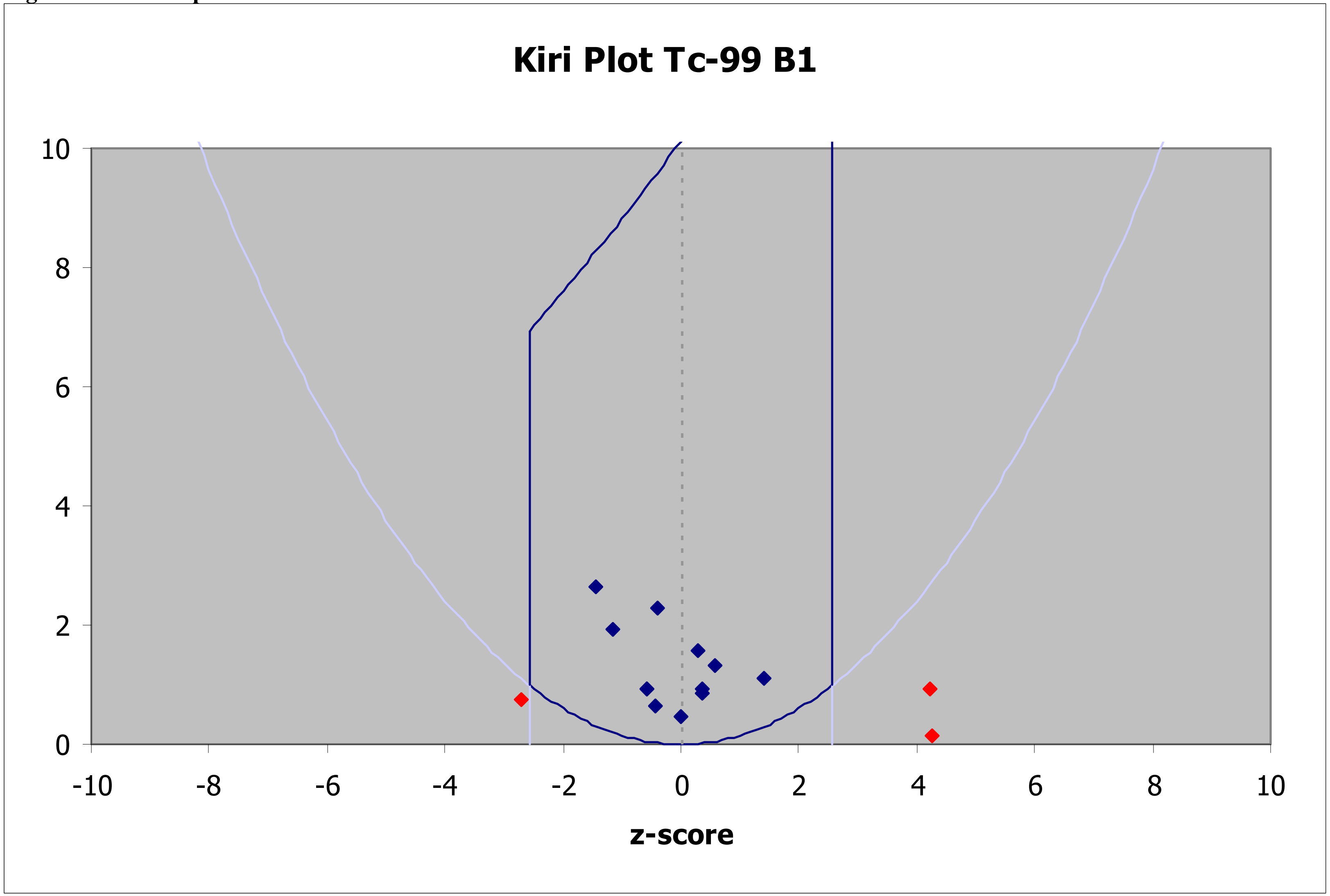


Figure 18A – Deviation I-129 B1

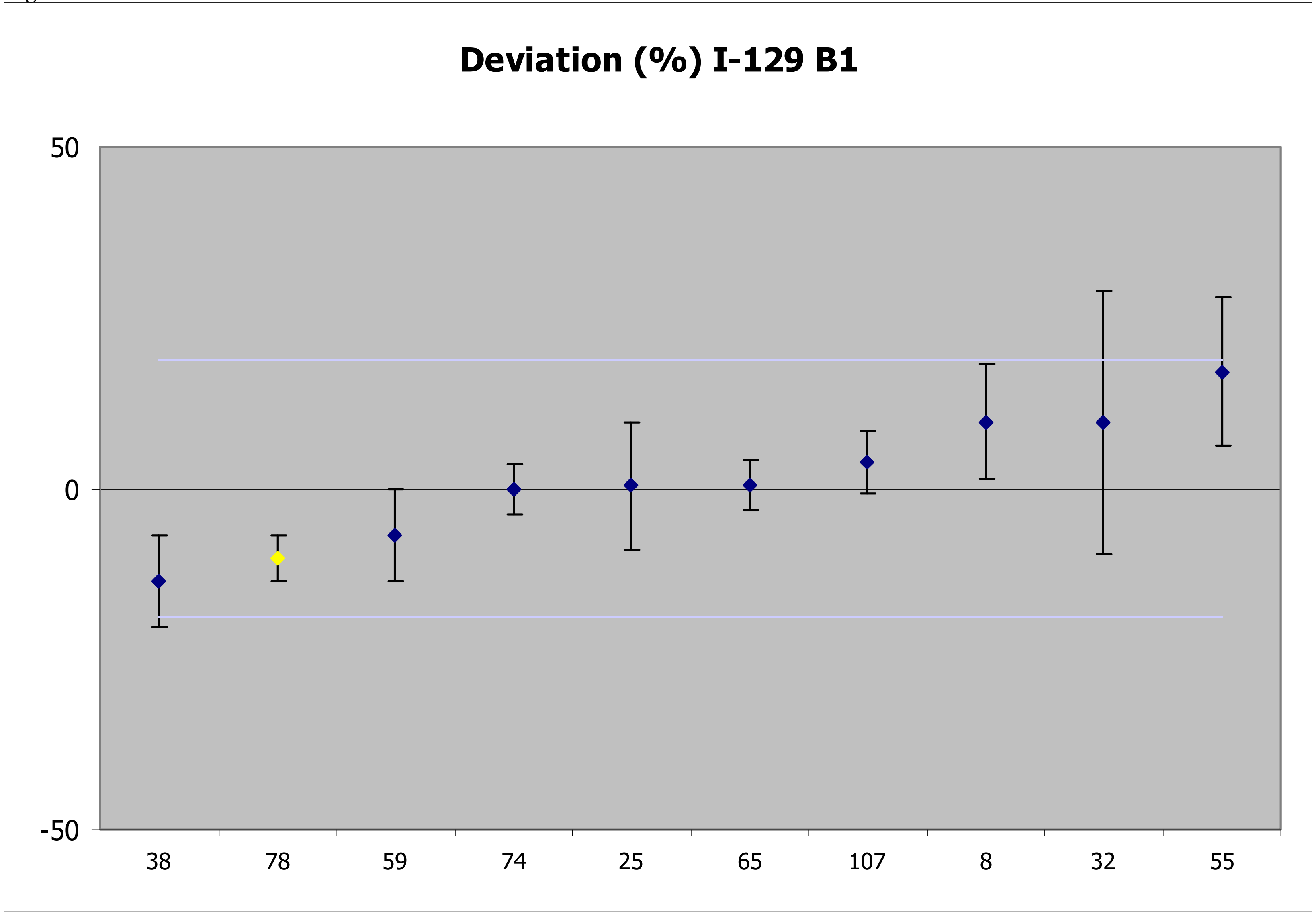


Figure 18B – Zeta score I-129 B1

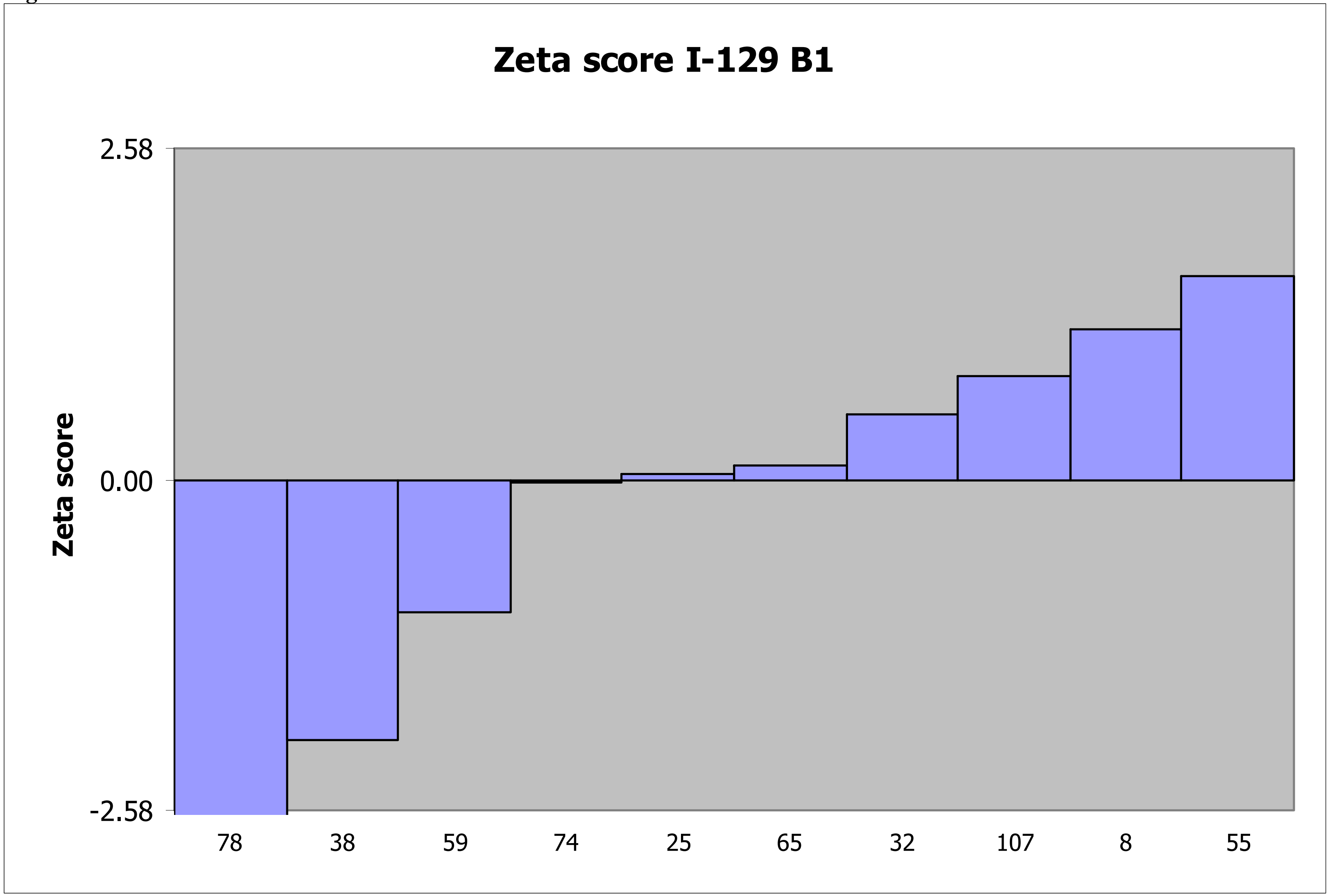


Figure 18C – Relative uncertainty I-129 B1

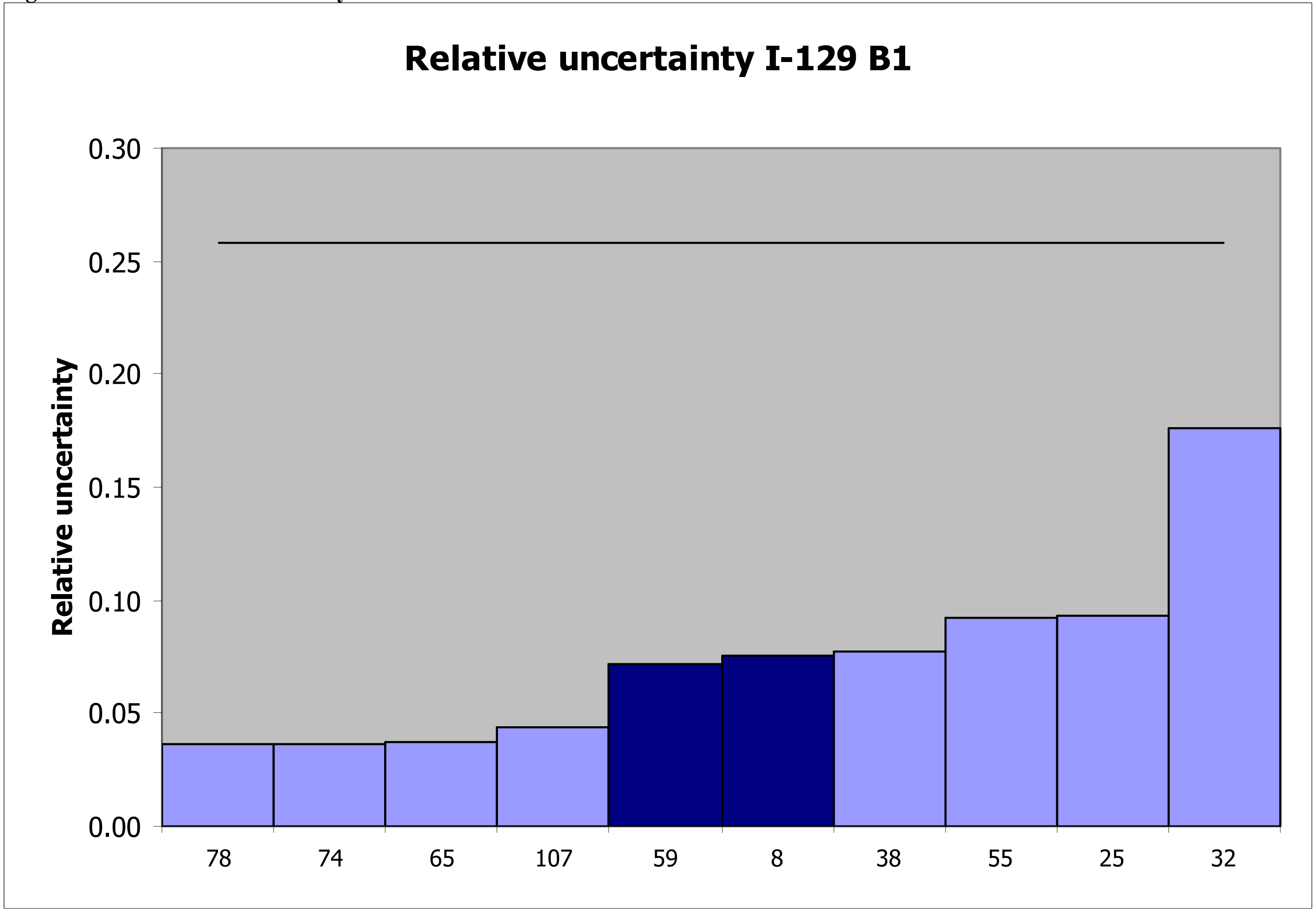


Figure 18D – Kiri plot I-129 B1

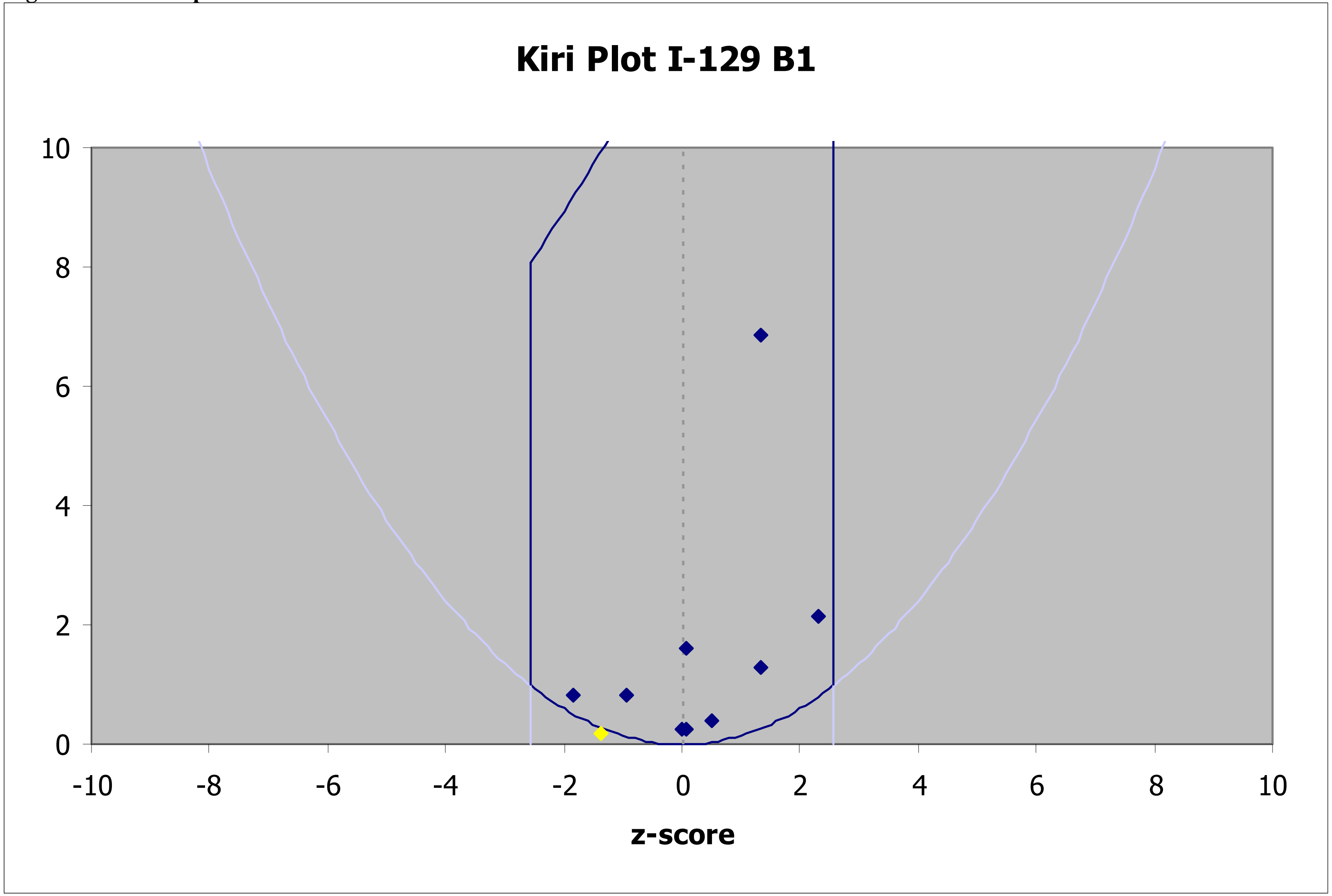


Figure 19A – Deviation H-3 B2

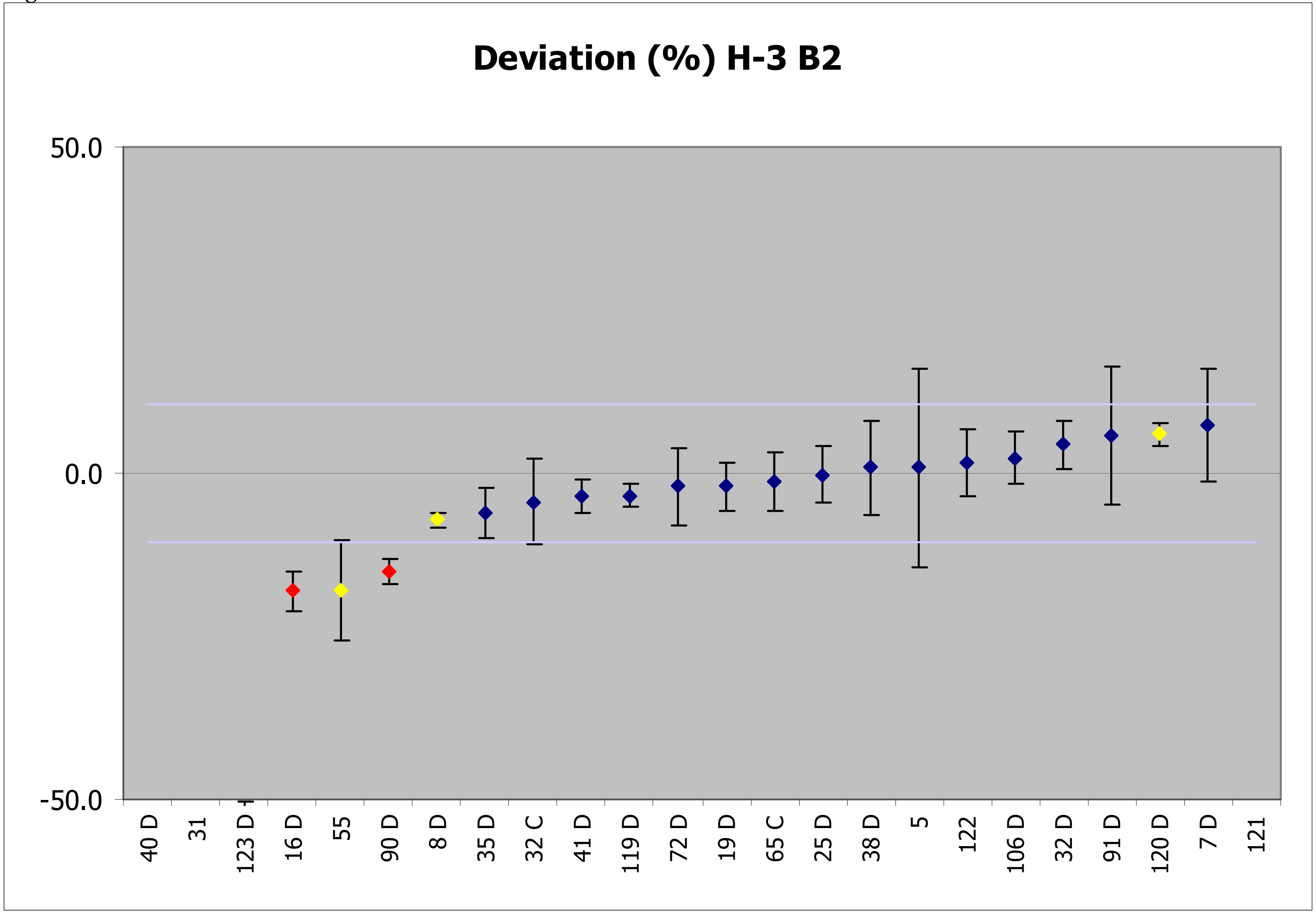


Figure 19B – Zeta score H-3 B2

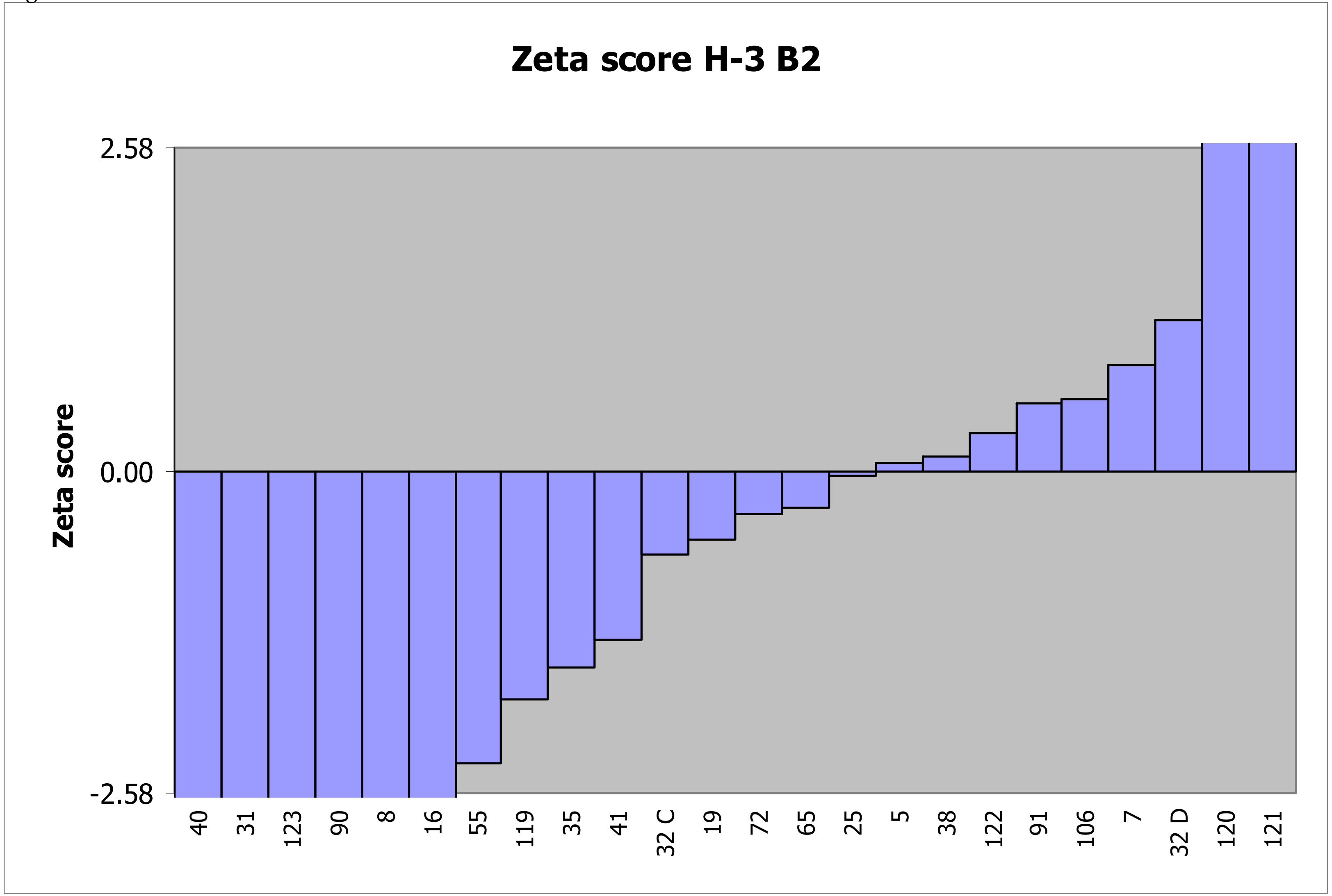


Figure 19C – Relative uncertainty H-3 B2

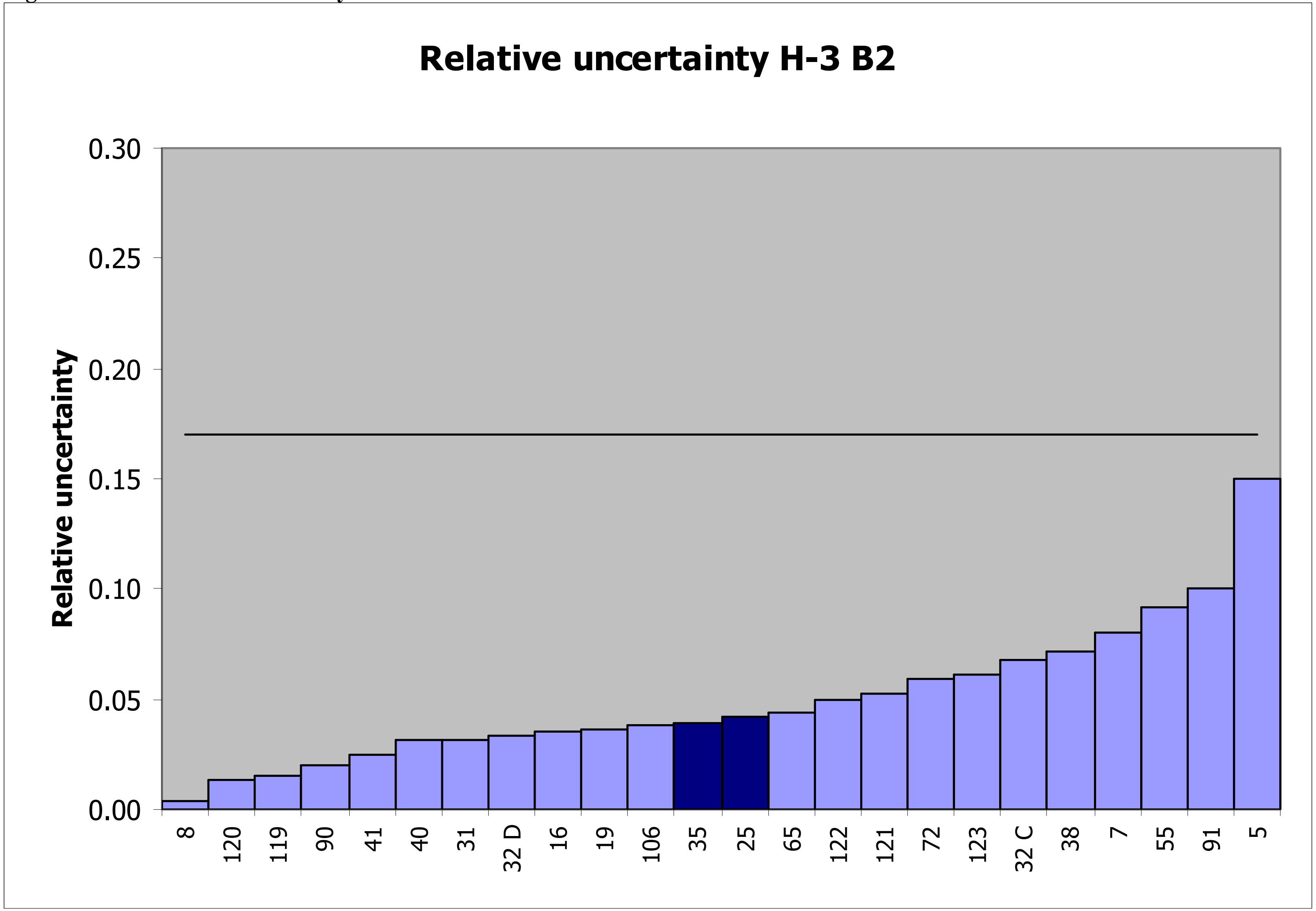


Figure 19D – Kiri plot H-3 B2

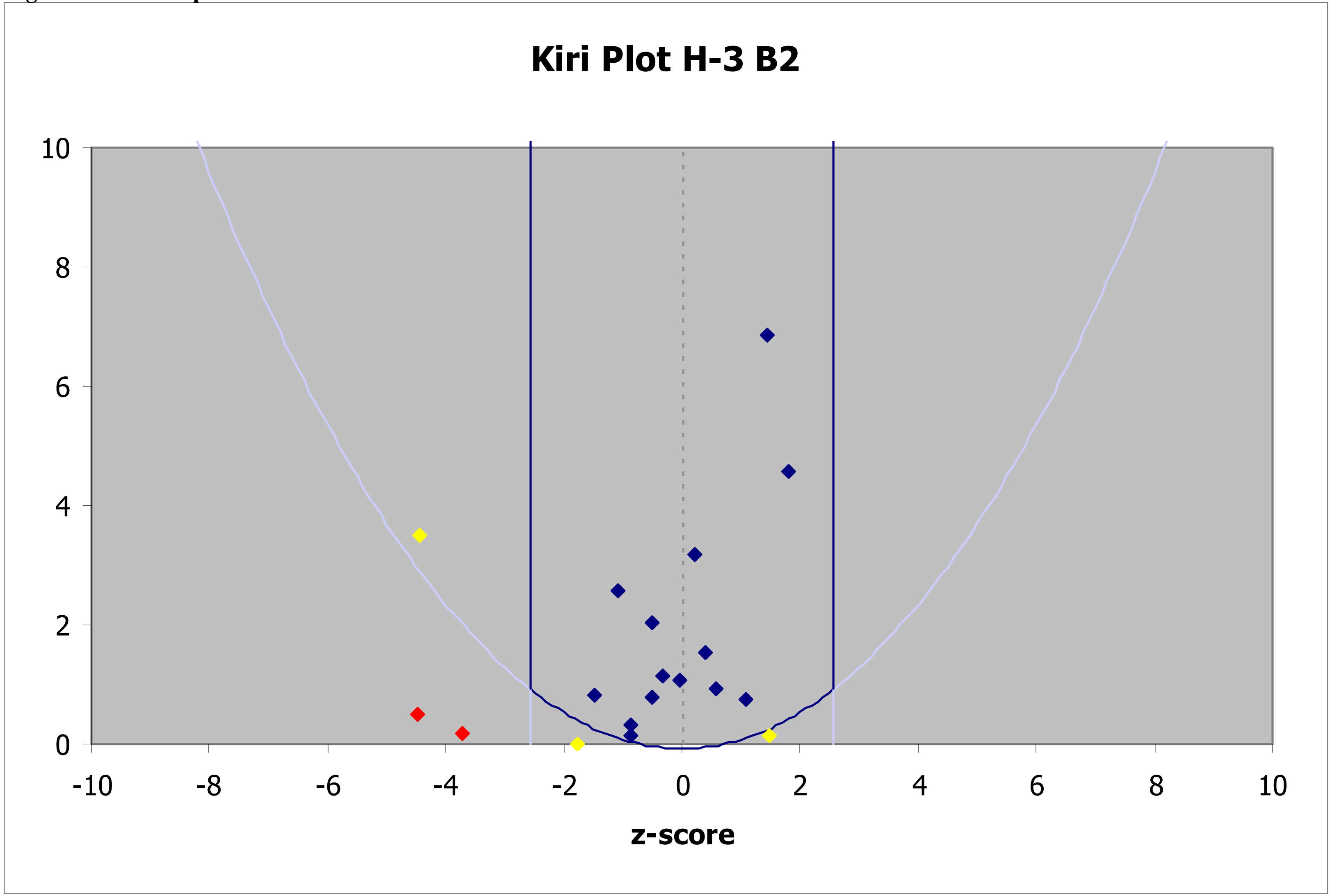


Figure 20A – Deviation Fe-55 B2

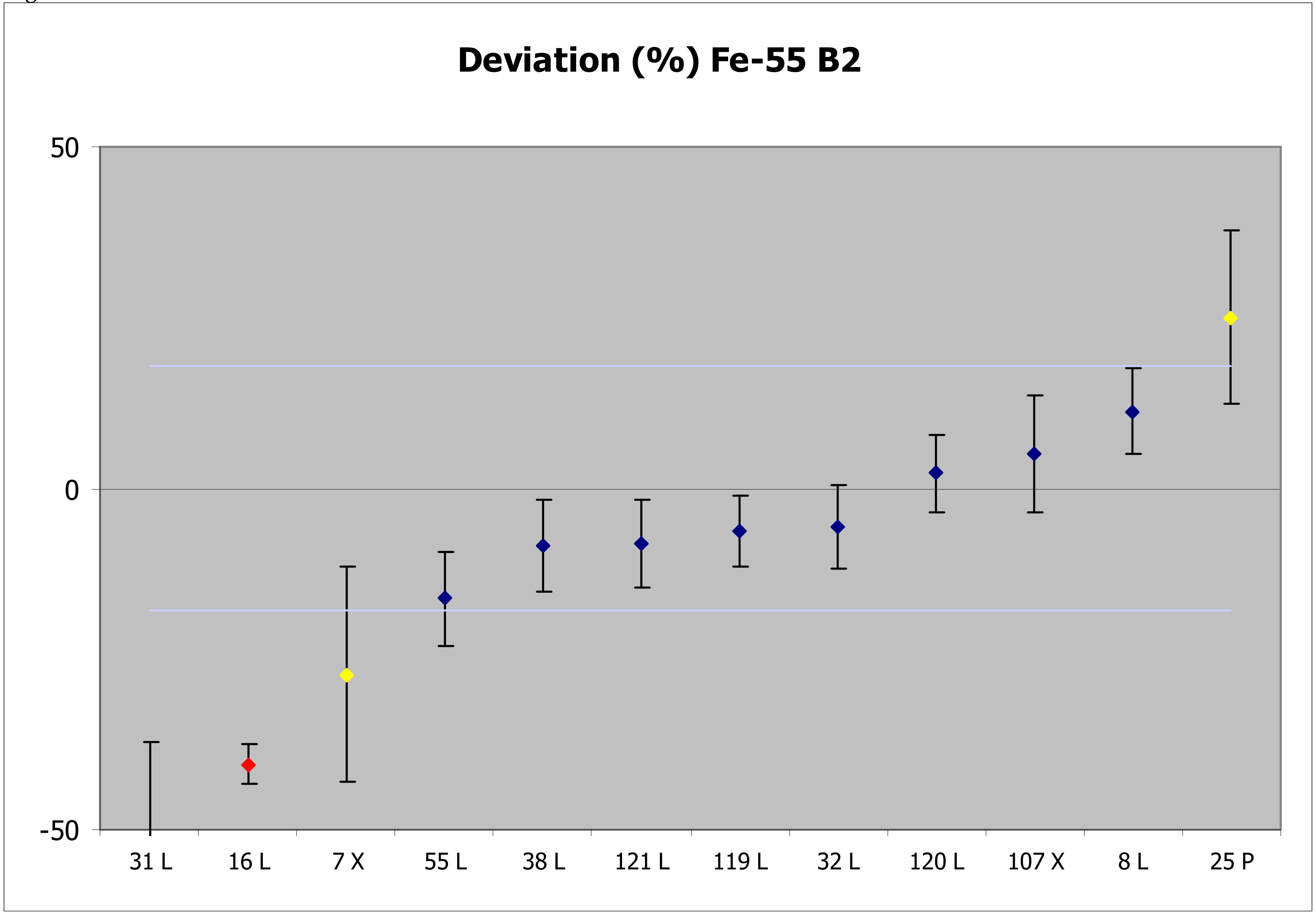


Figure 20B – Zeta score Fe-55 B2

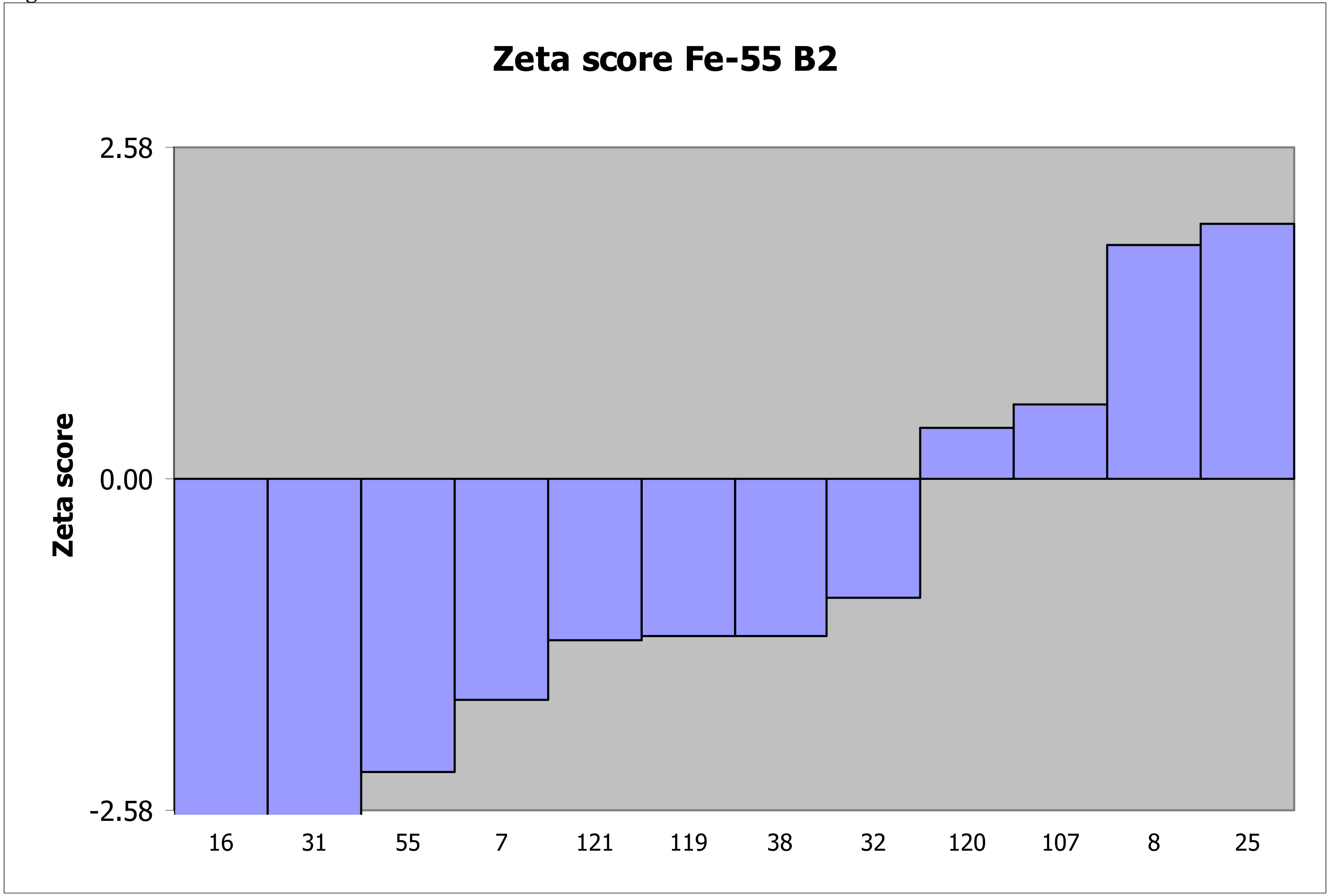


Figure 20C – Relative uncertainty Fe-55 B2

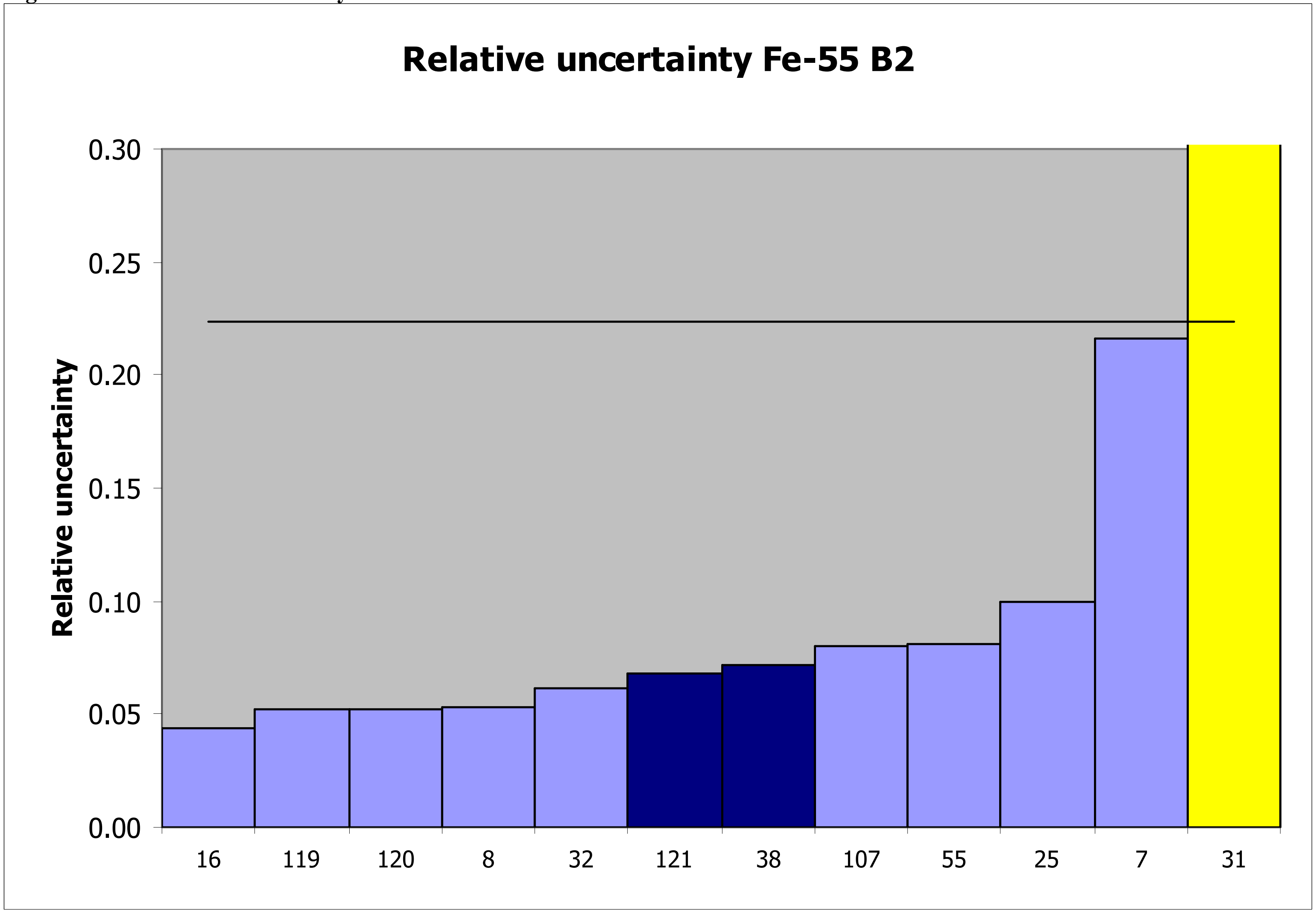


Figure 20D – Kiri plot Fe-55 B2

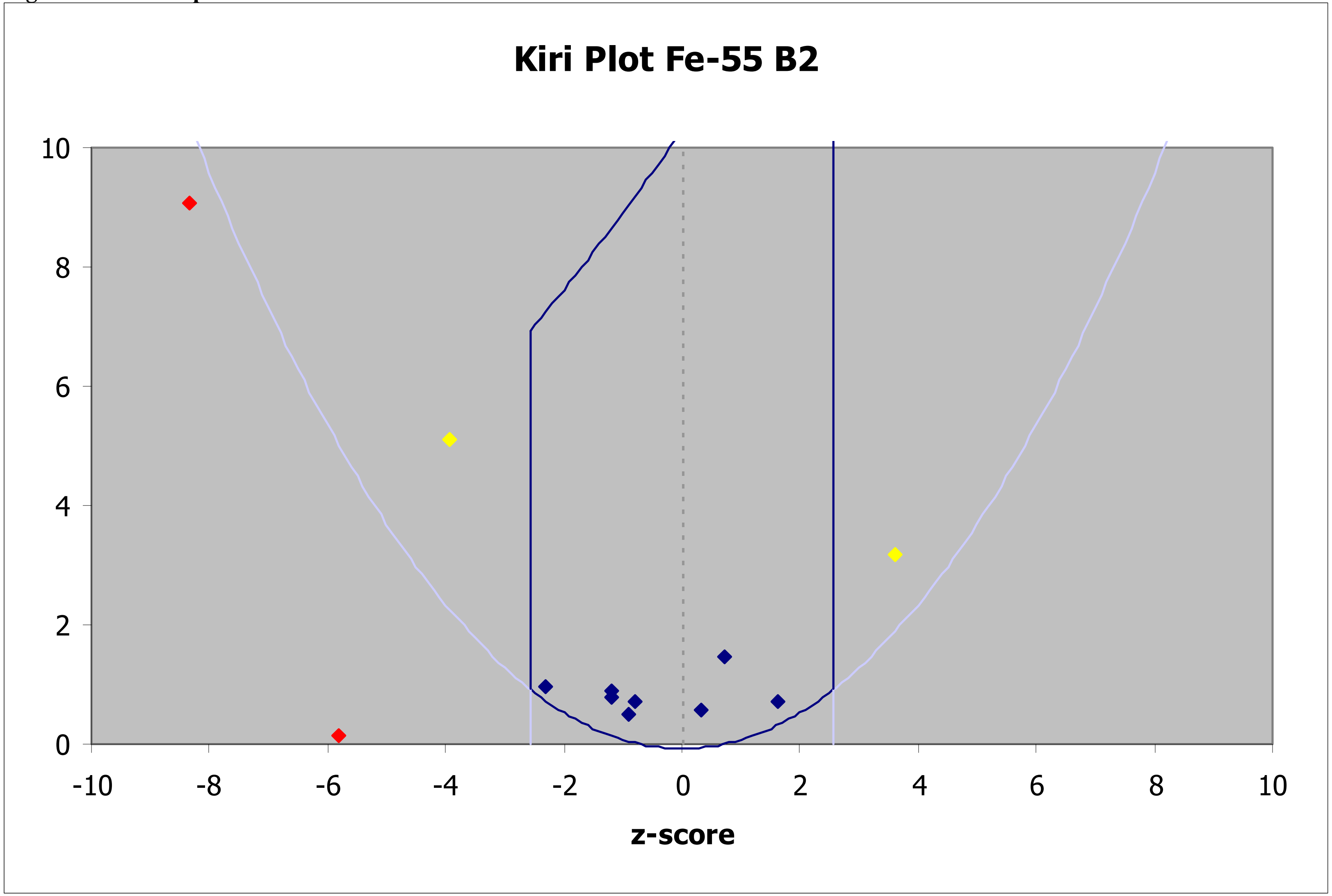


Figure 21A – Deviation Sr-89 B2

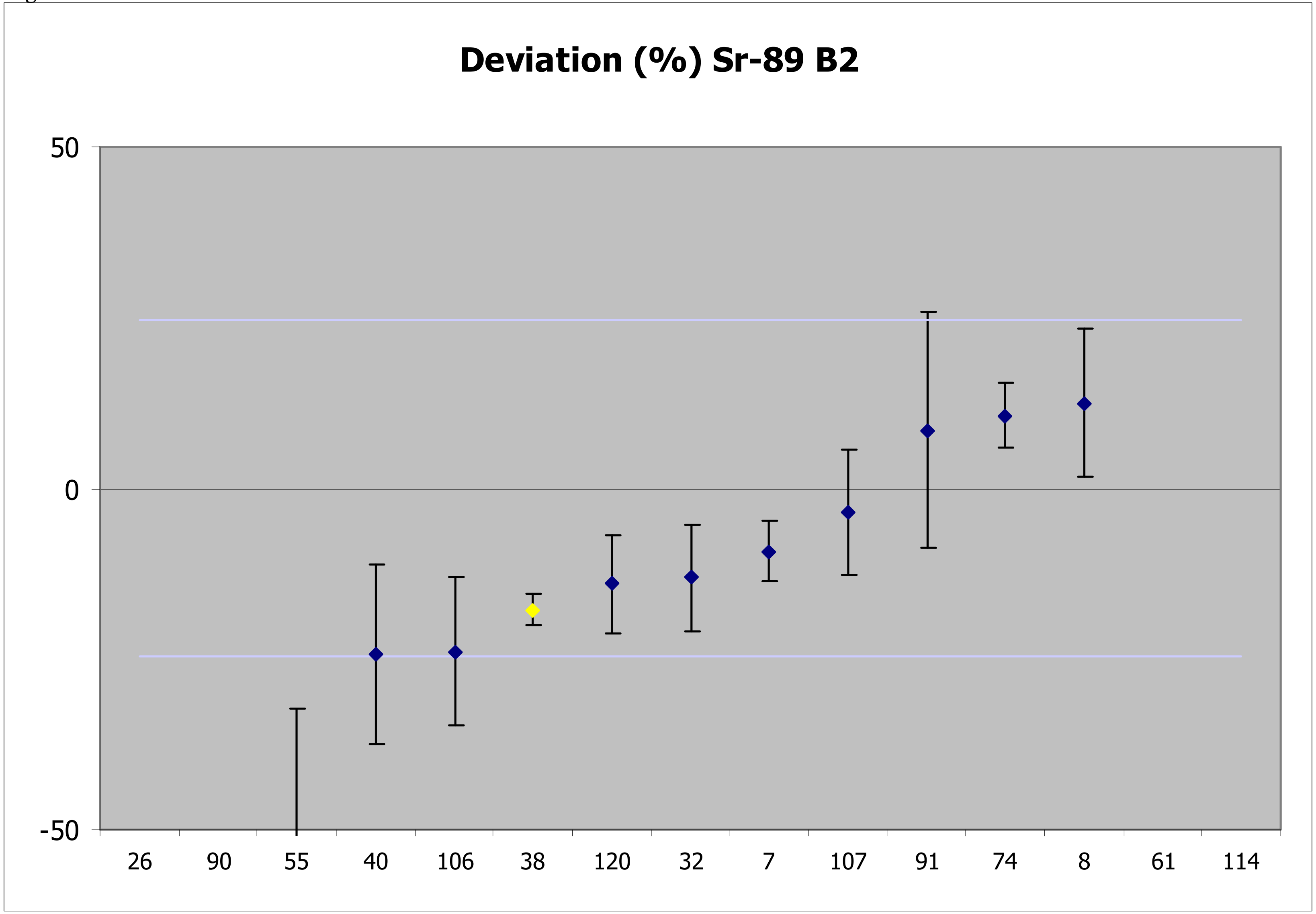


Figure 21B – Zeta score Sr-89 B2

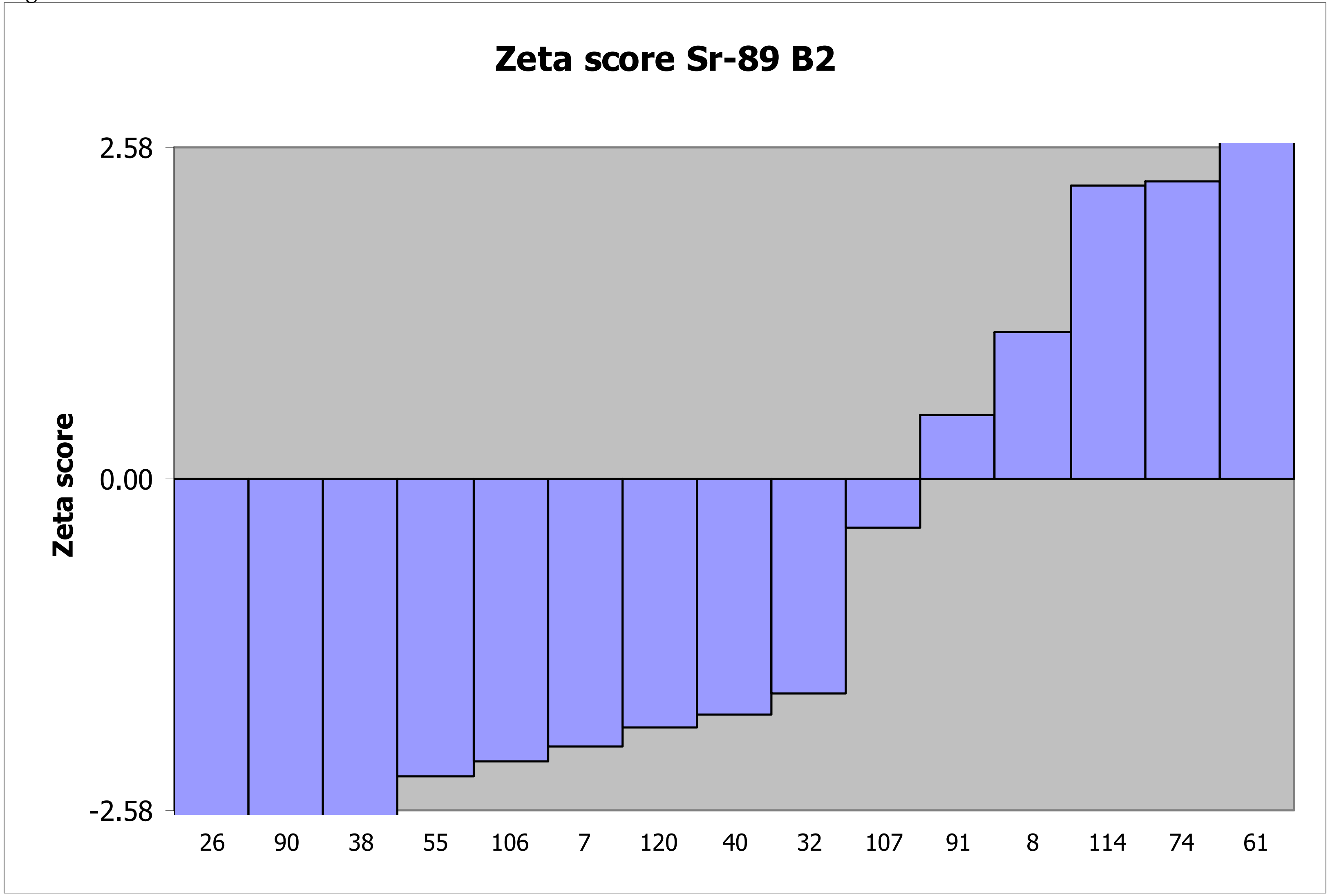


Figure 21C – Relative uncertainty Sr-89 B2

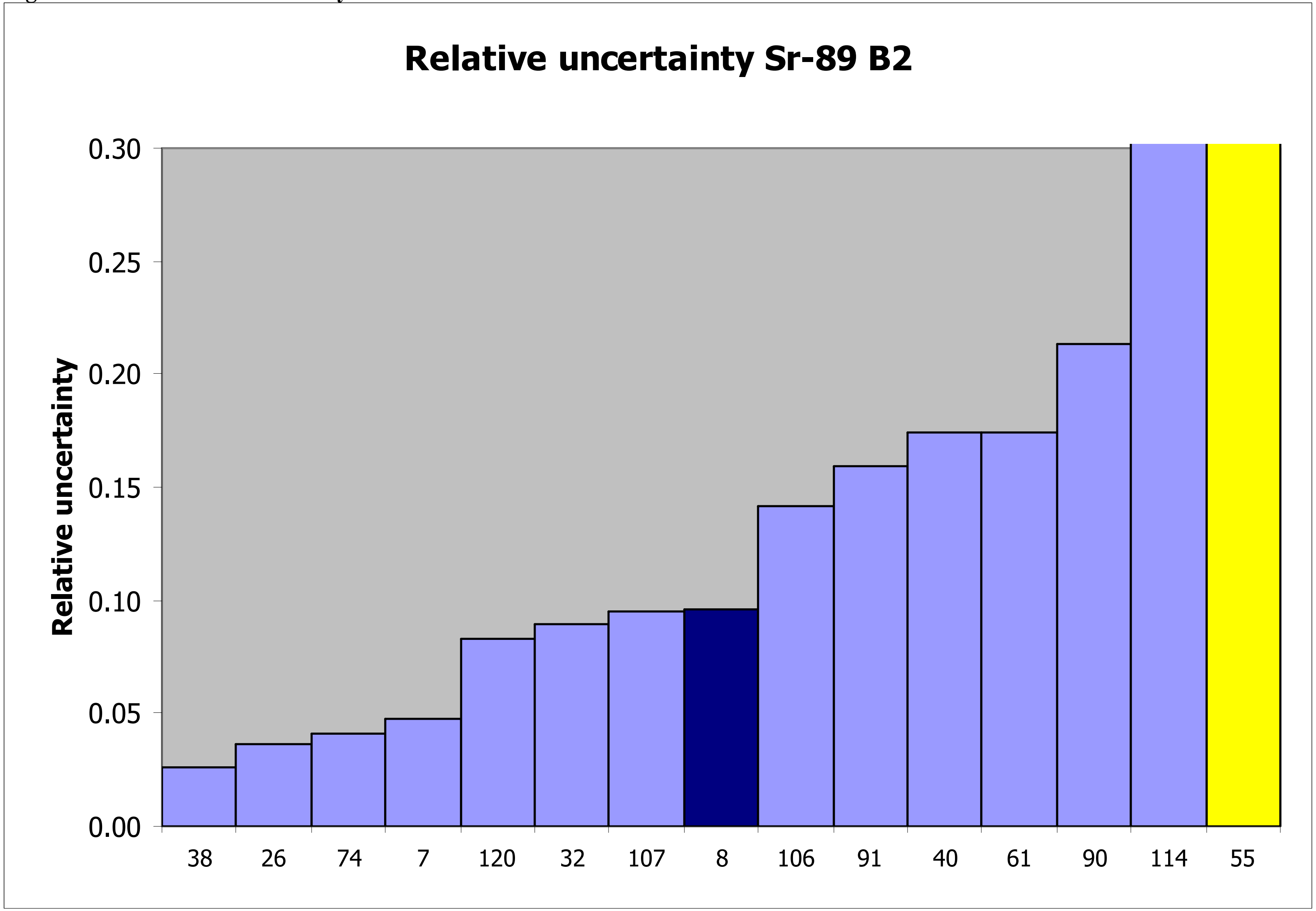


Figure 21D – Kiri plot Sr-89 B2

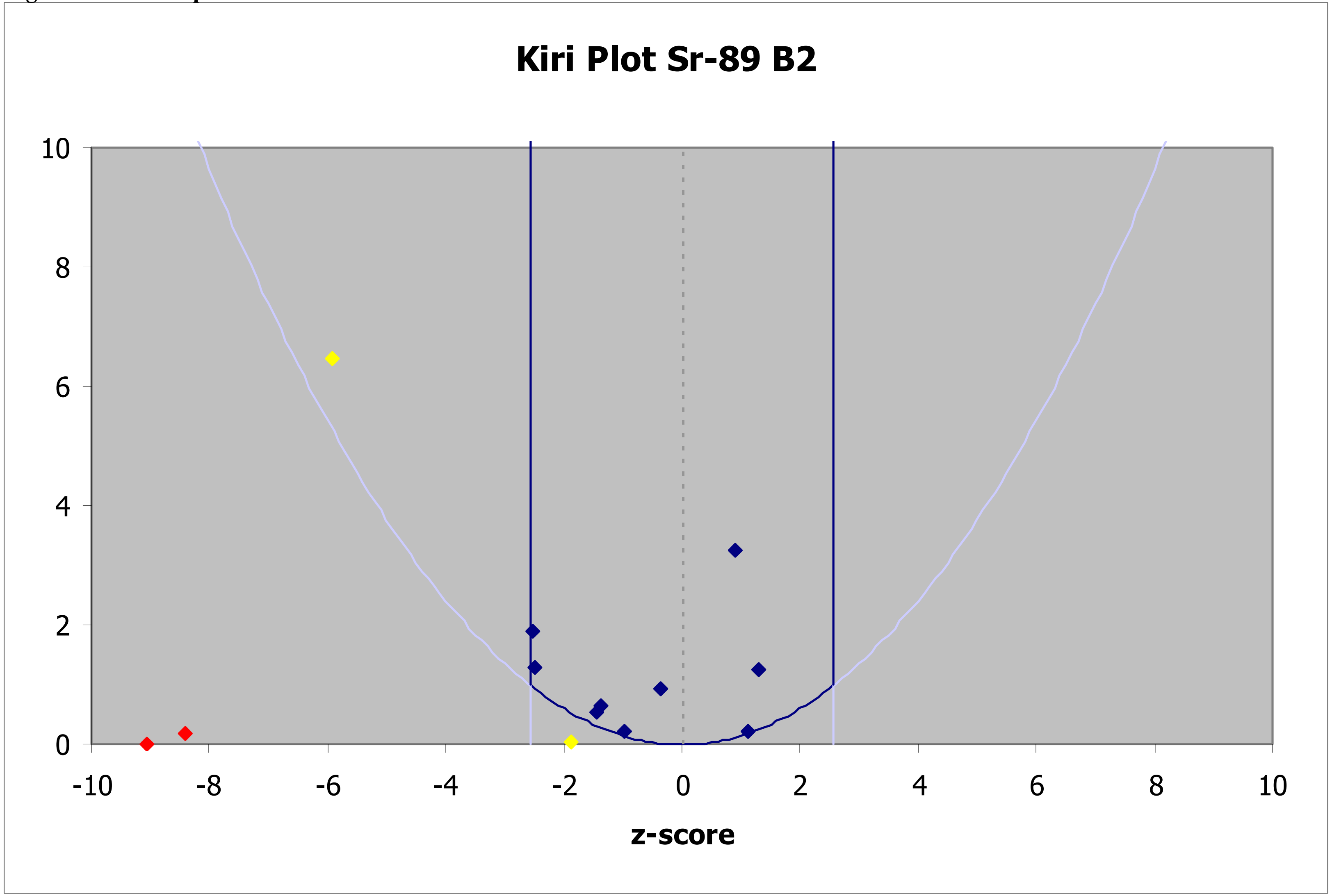


Figure 22A – Deviation Sr-90 B2

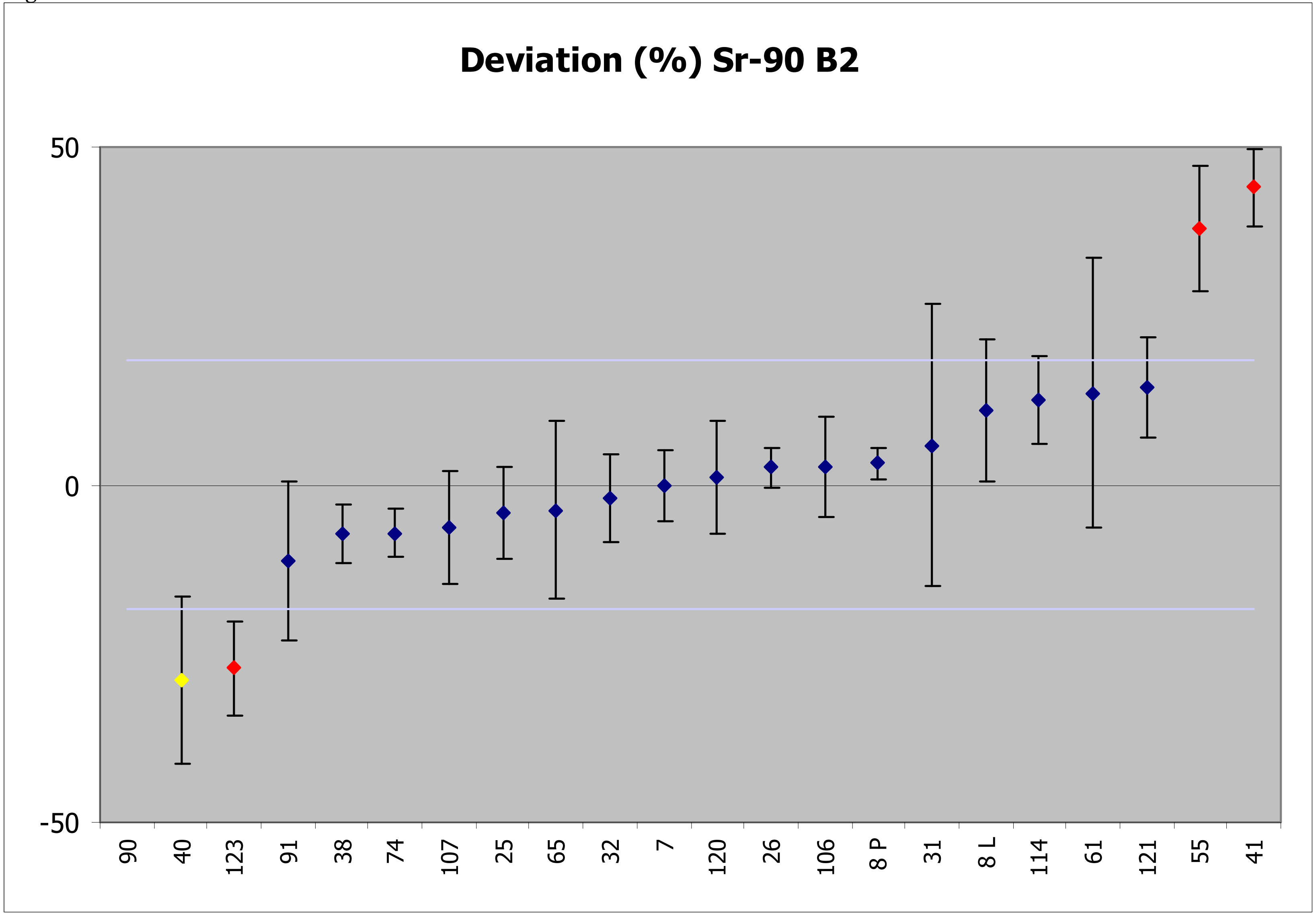


Figure 22B – Zeta score Sr-90 B2

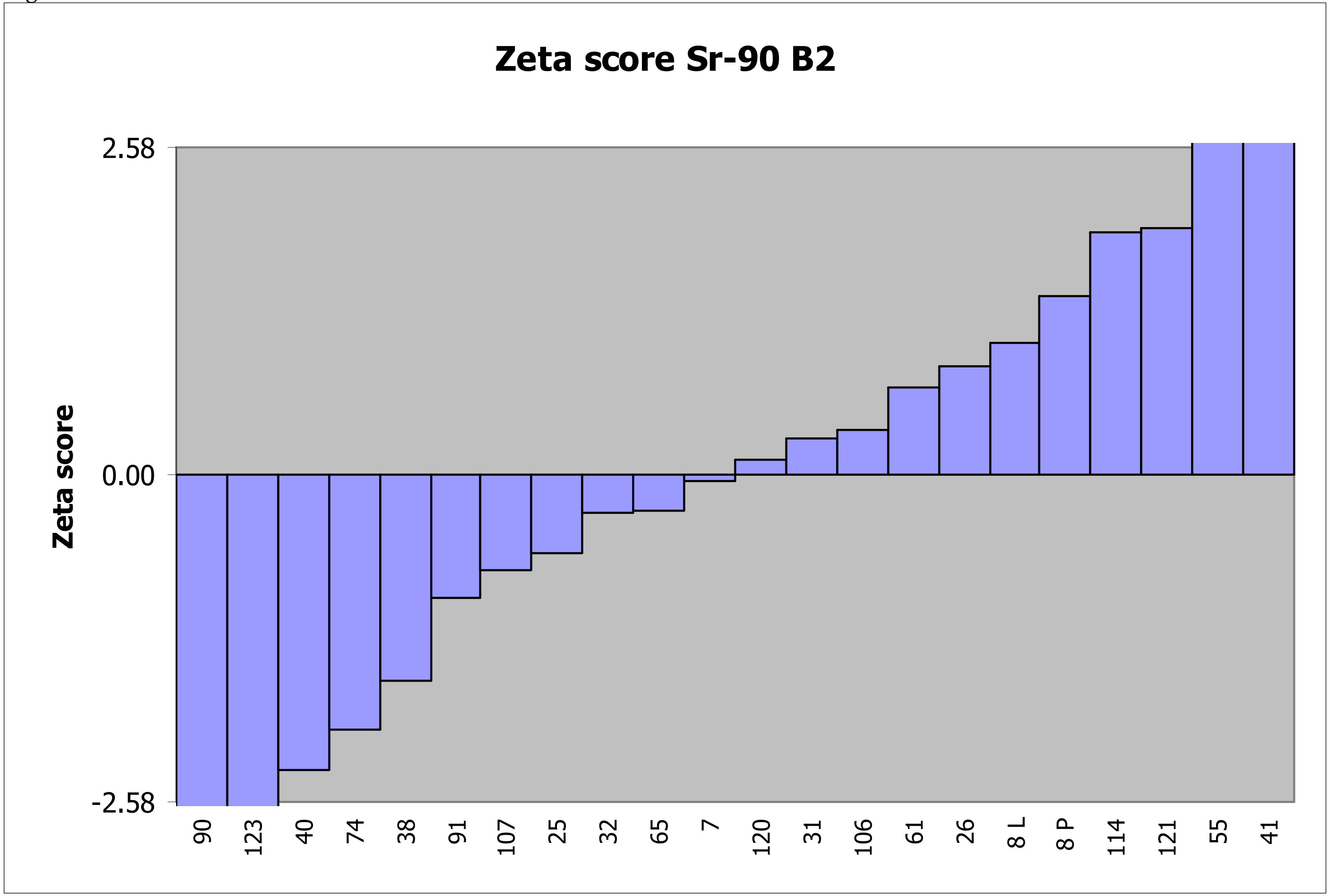


Figure 22C – Relative uncertainty Sr-90 B2

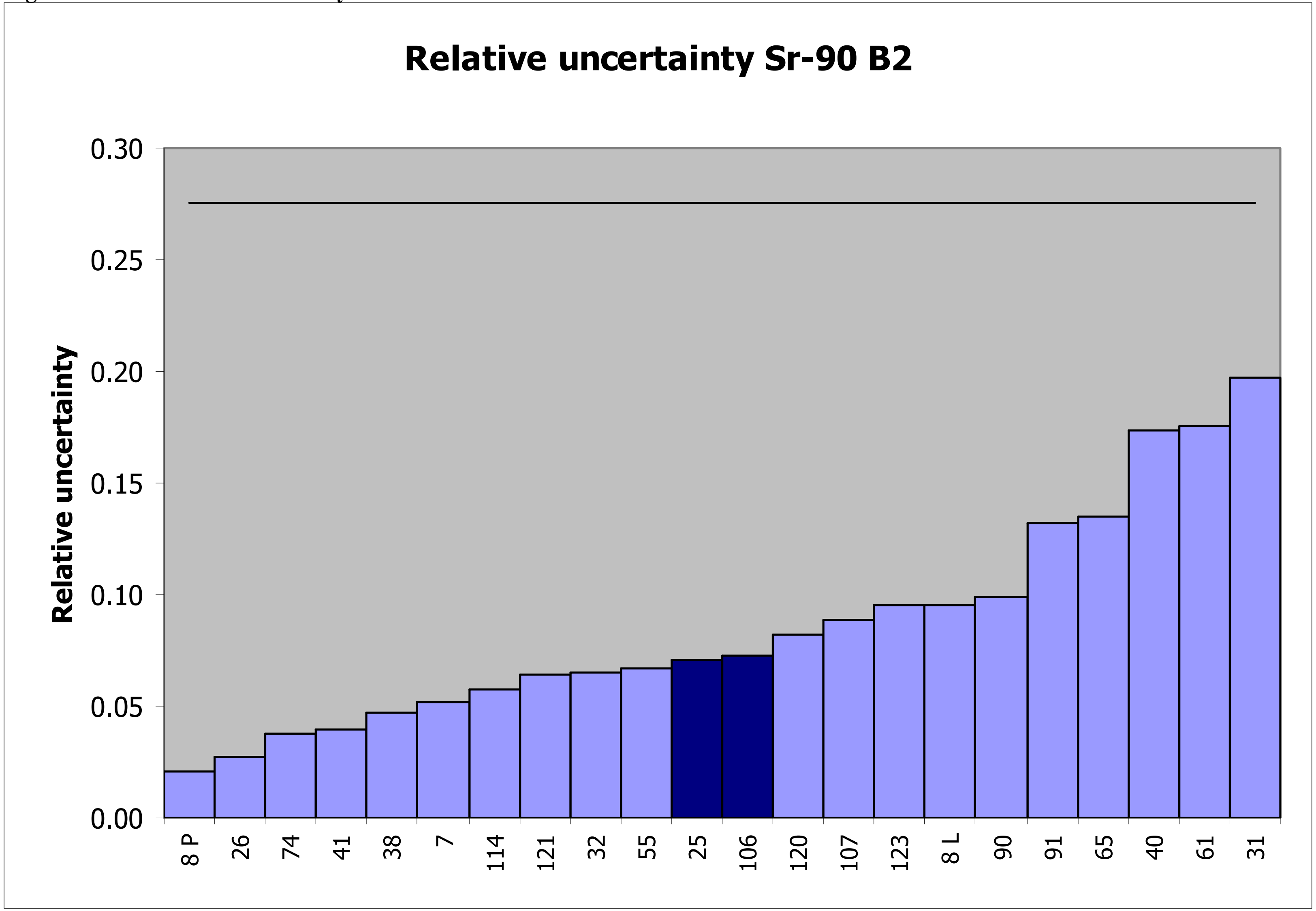


Figure 22D – Kiri plot Sr-90 B2

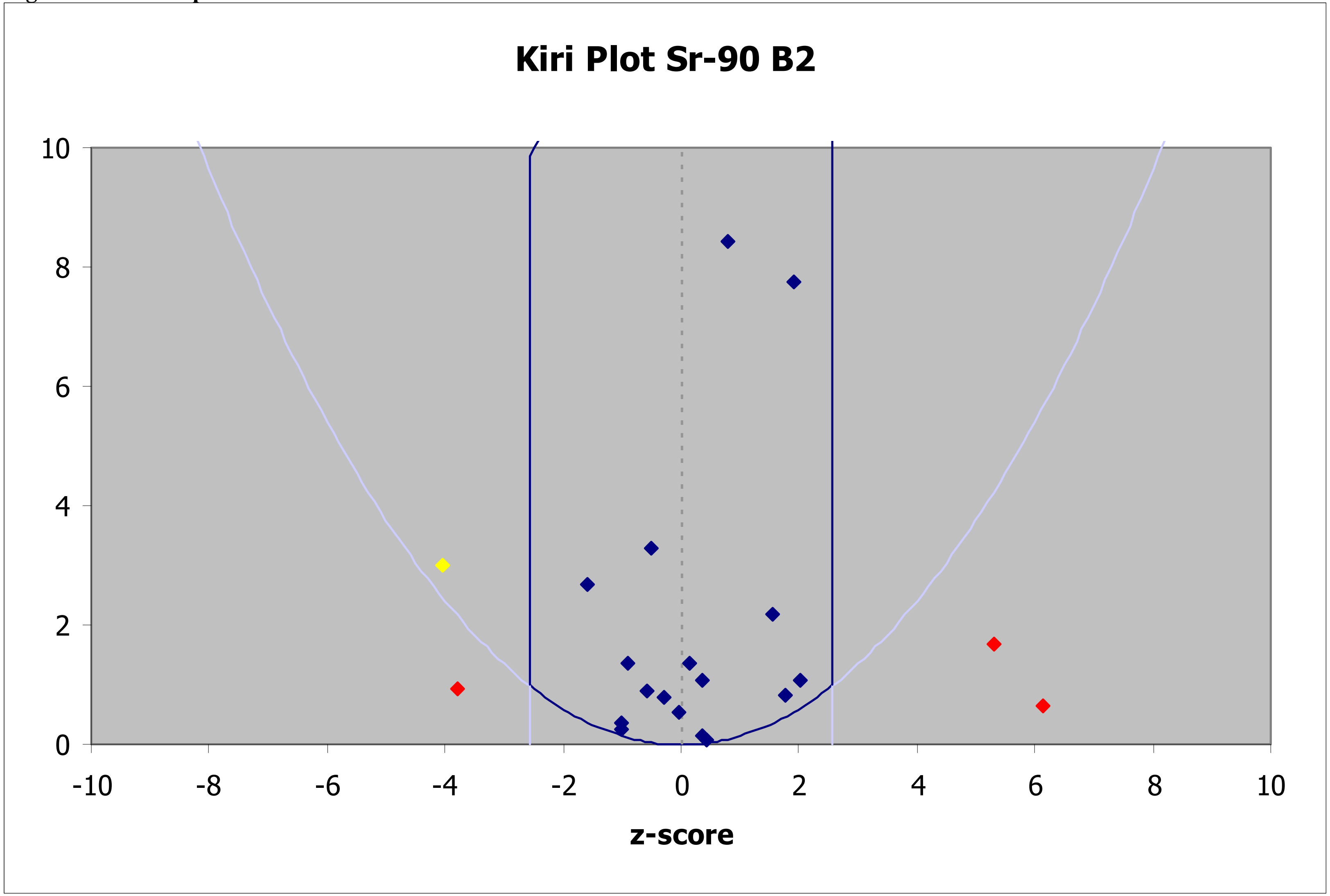


Figure 23A – Deviation gross beta B2

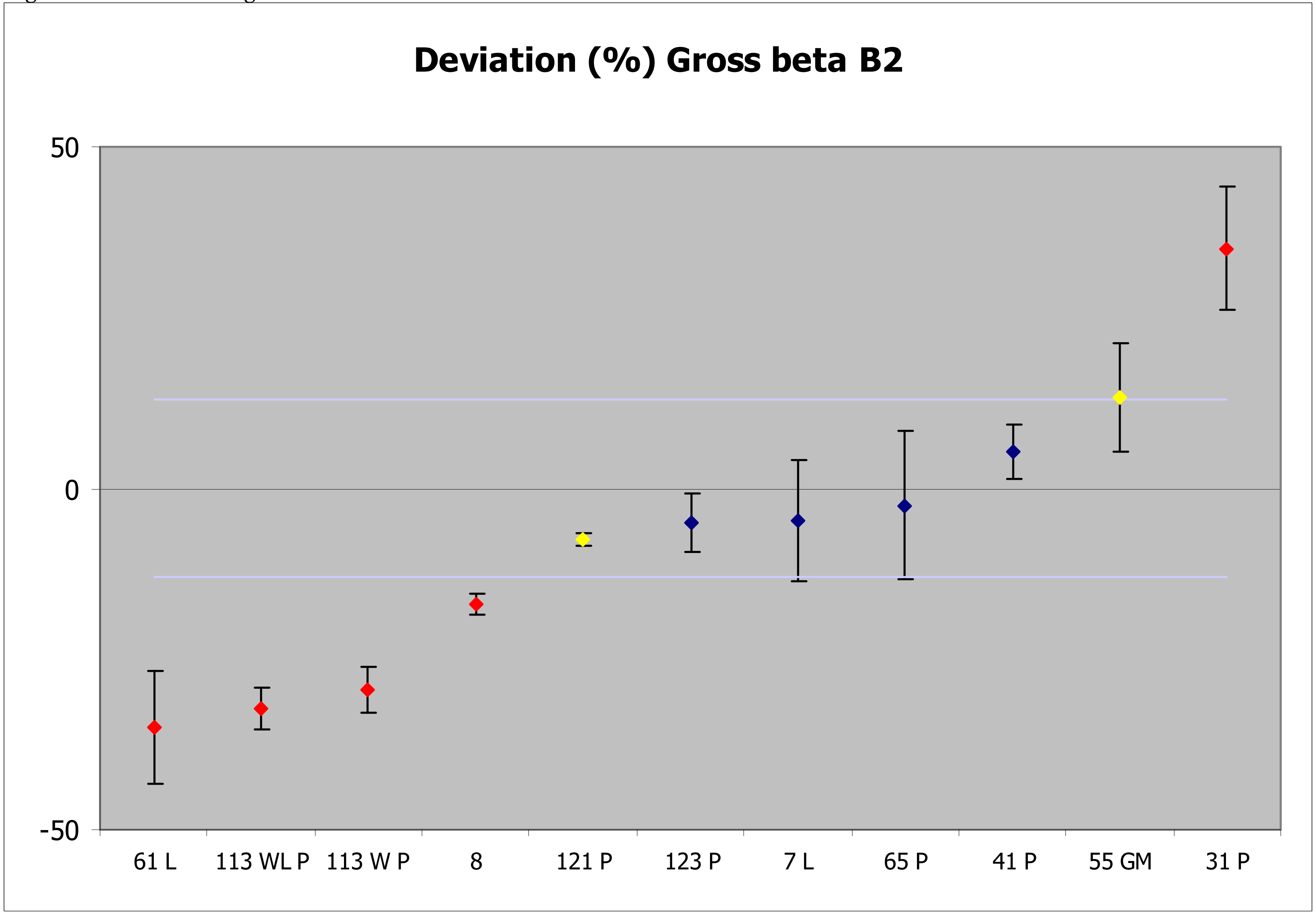


Figure 23B – Zeta score gross beta B2

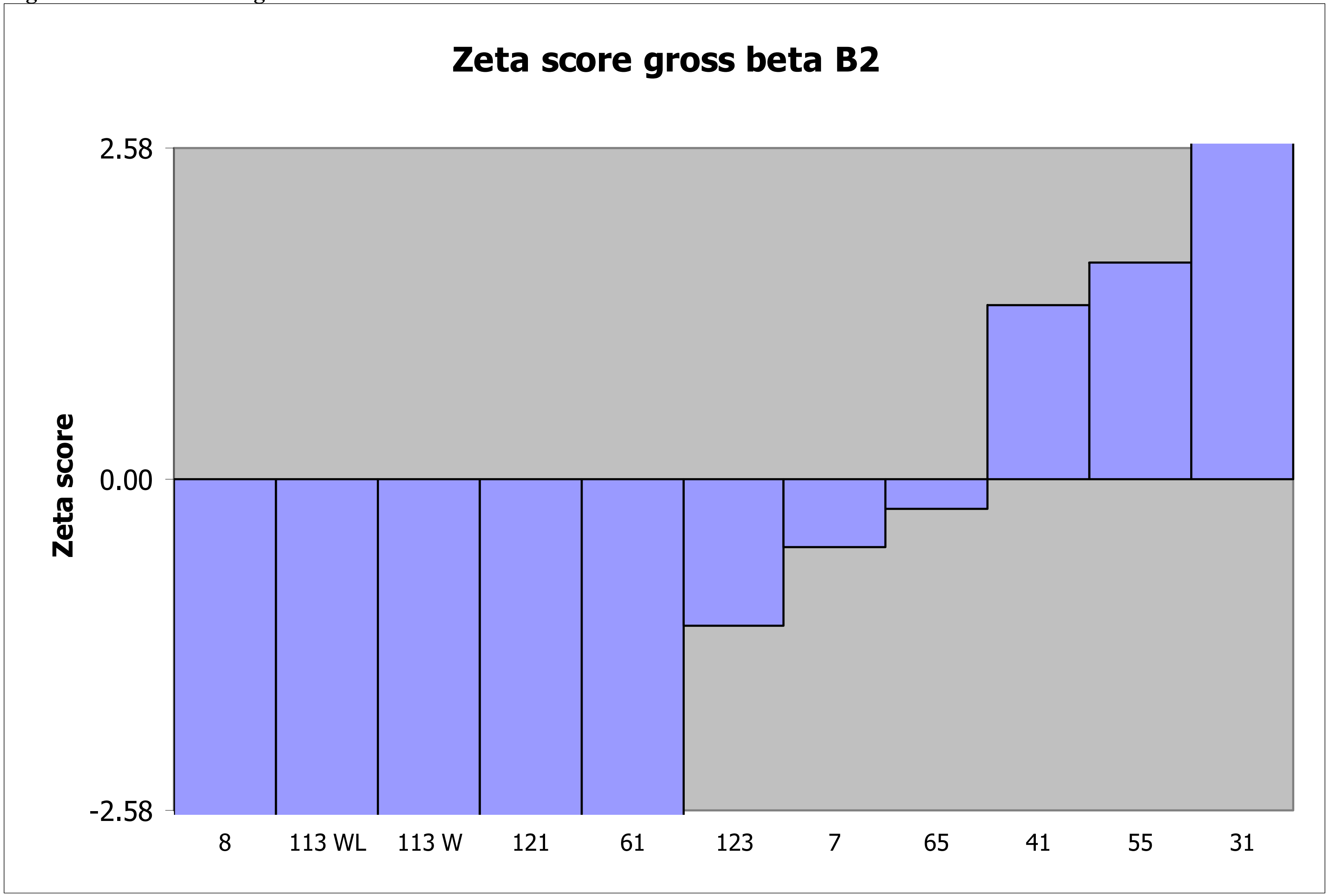


Figure 23C – Relative uncertainty gross beta B2

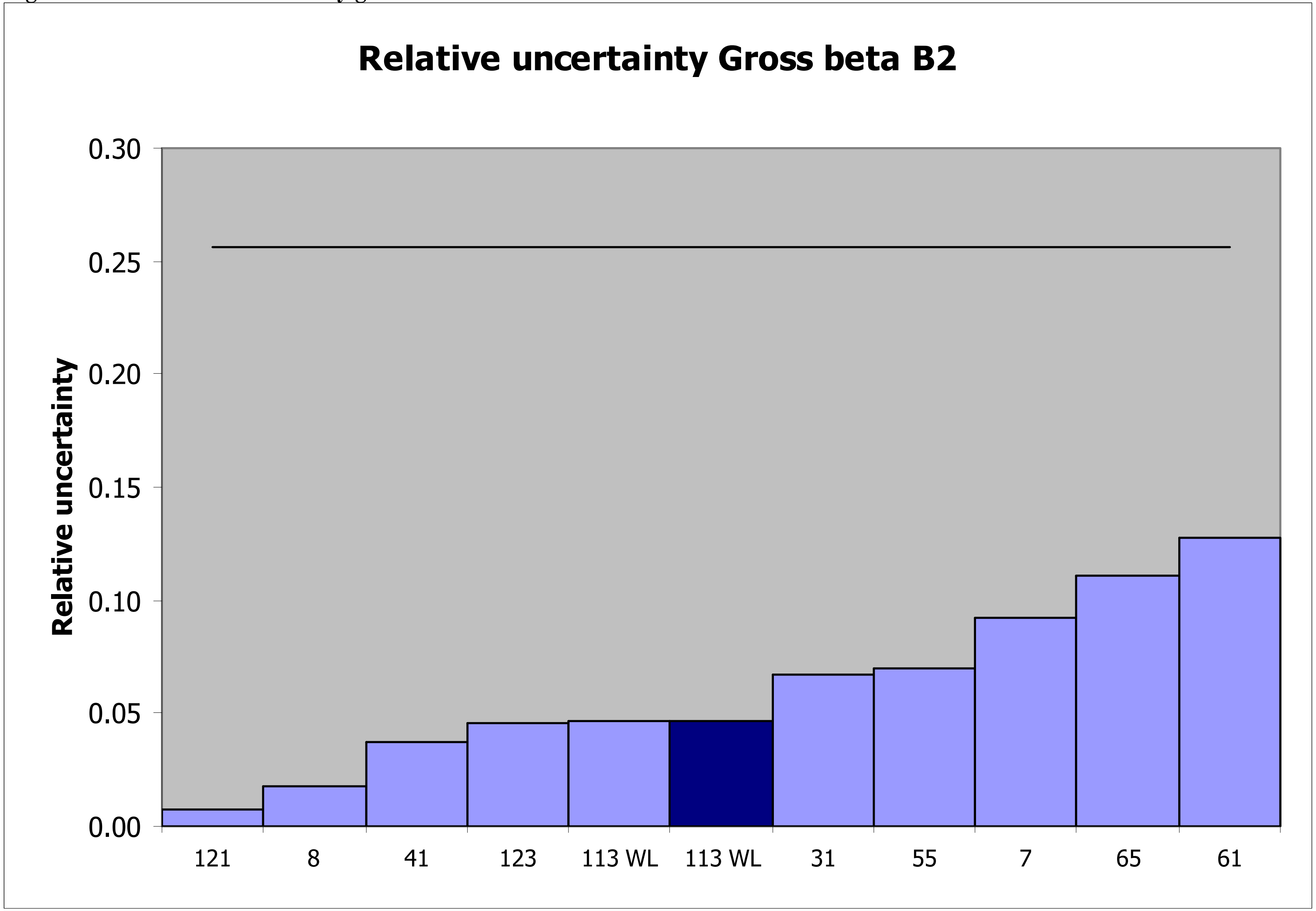


Figure 23D – Kiri plot gross beta B2

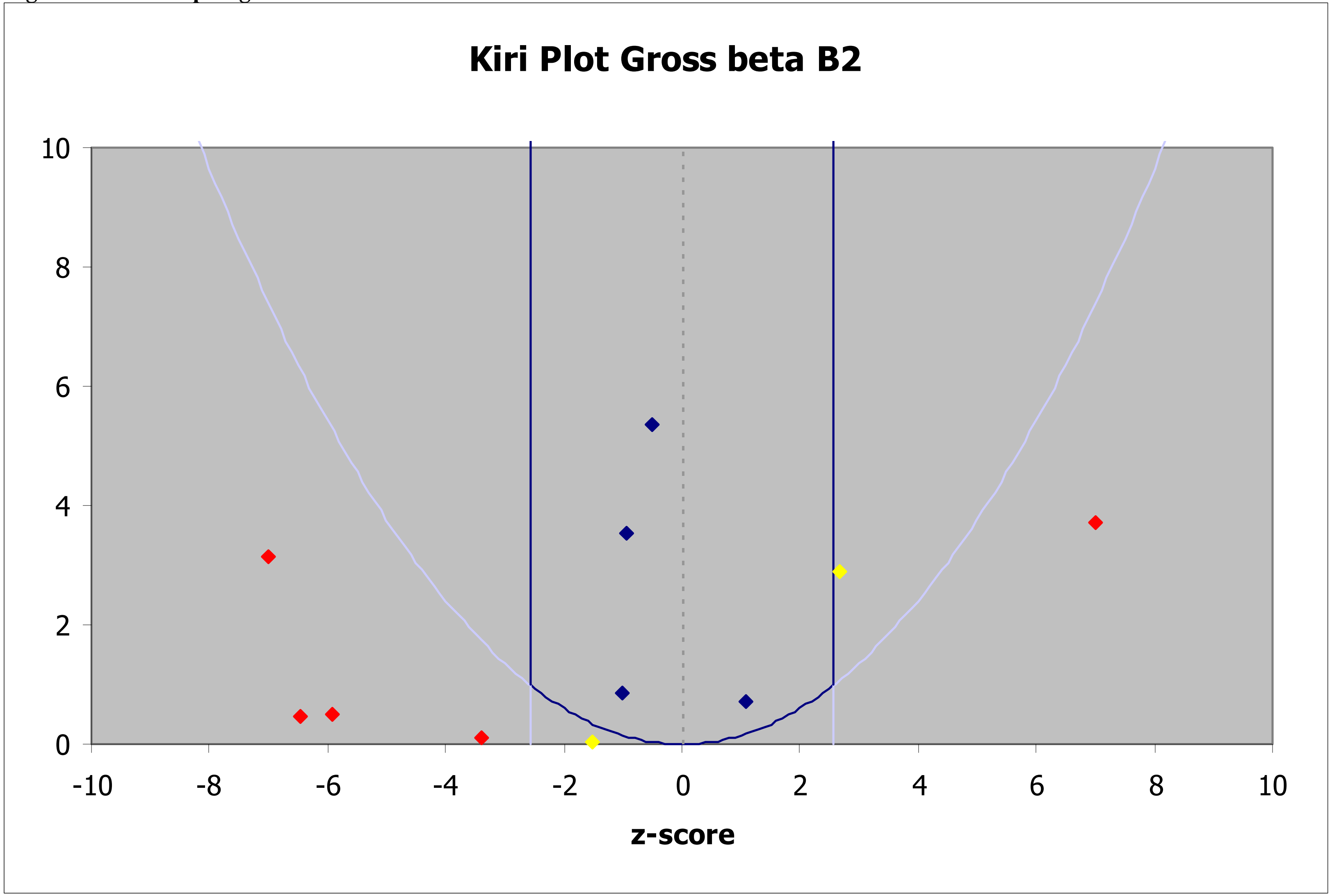


Figure 24A – Deviation Co-60 GL

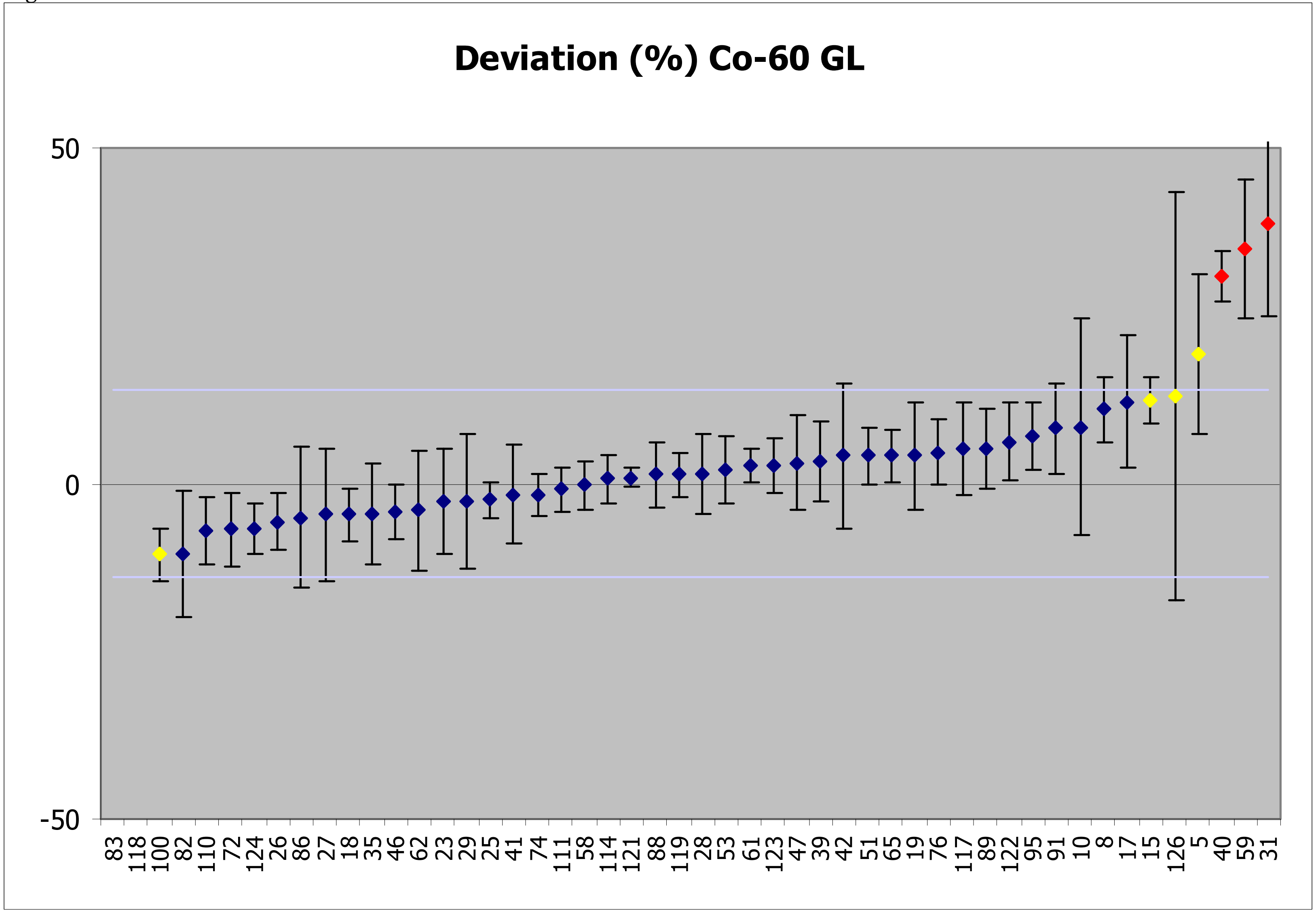


Figure 24B – Zeta score Co-60 GL

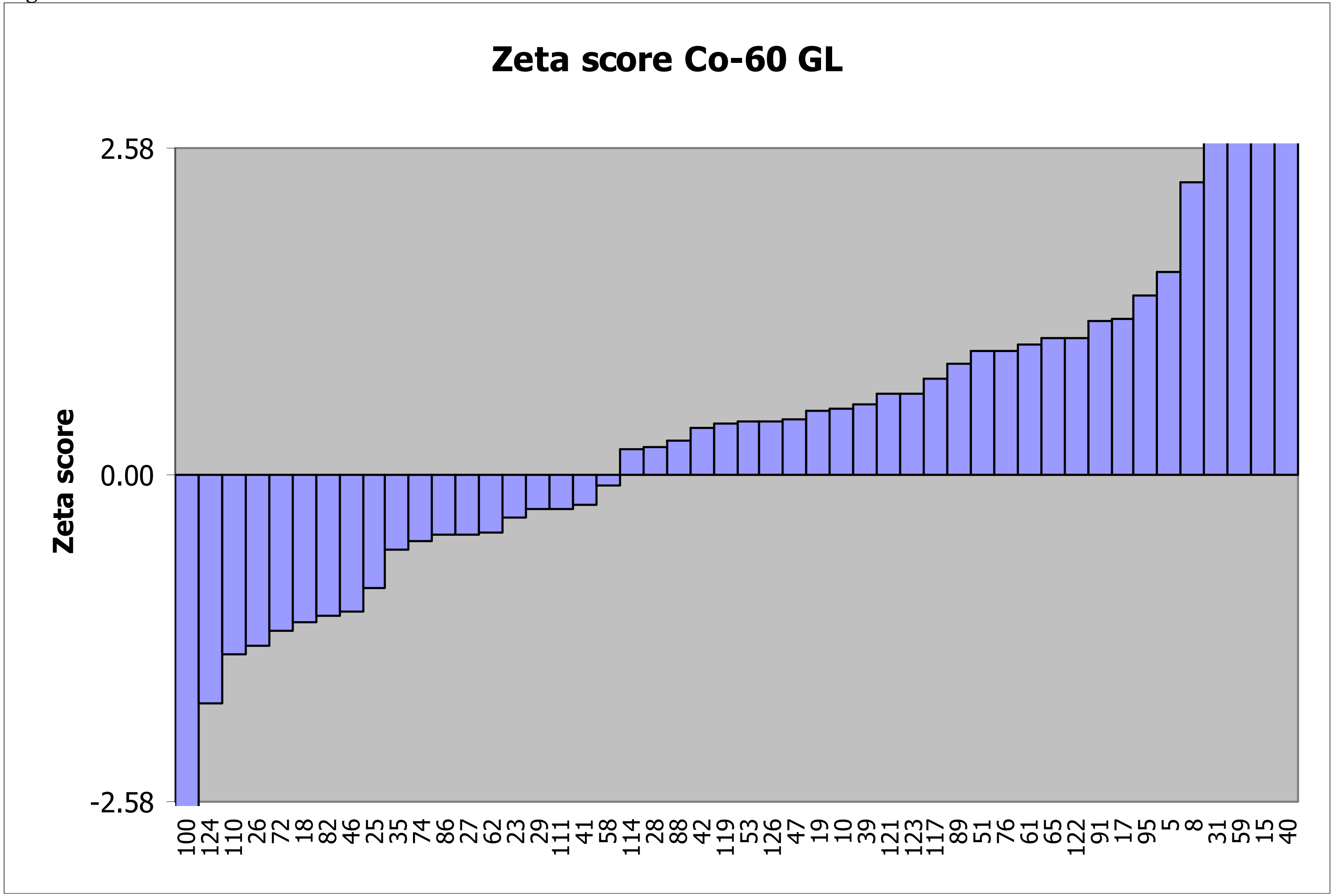


Figure 24C – Relative uncertainty Co-60 GL

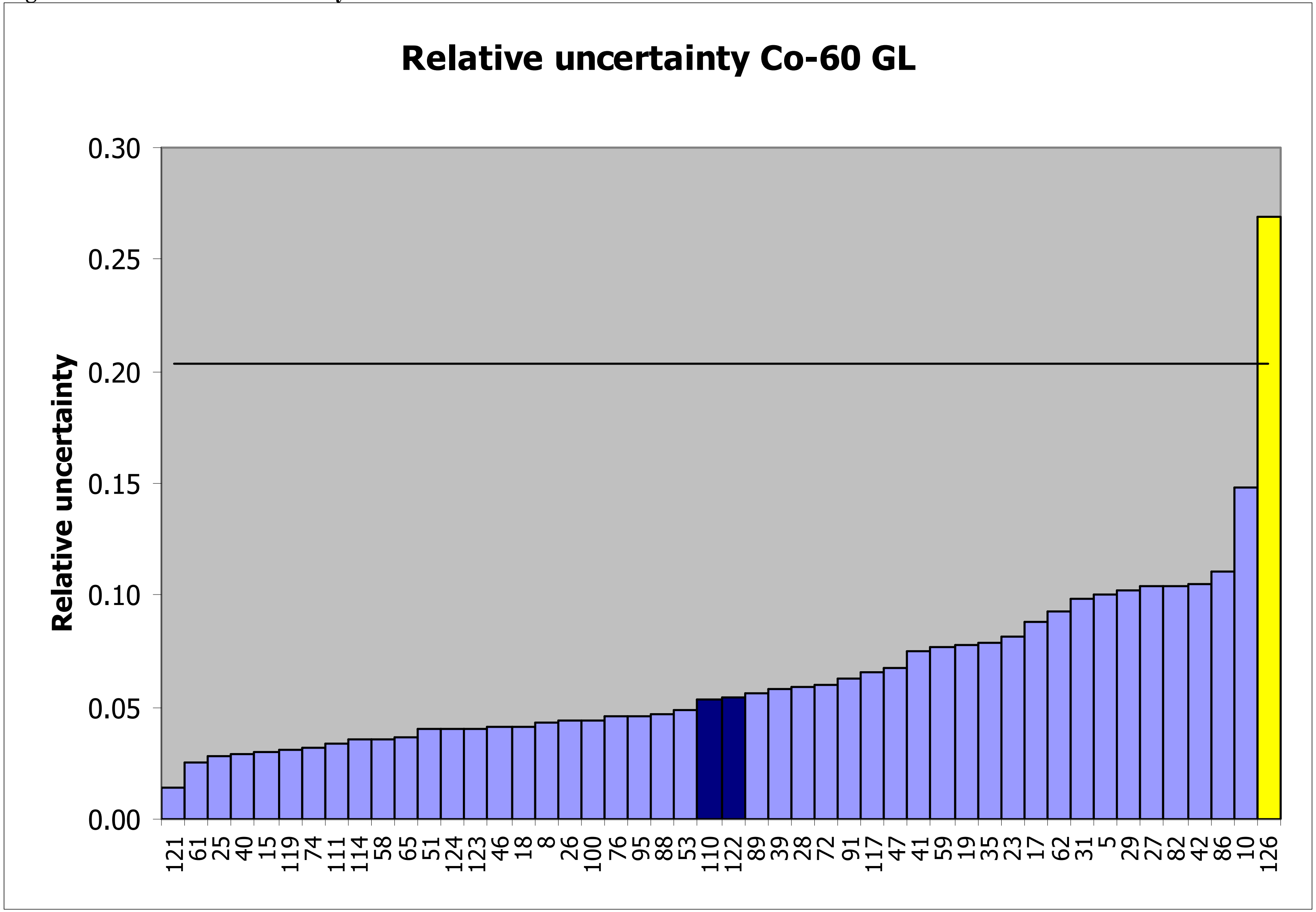


Figure 24D – Kiri plot Co-60 GL

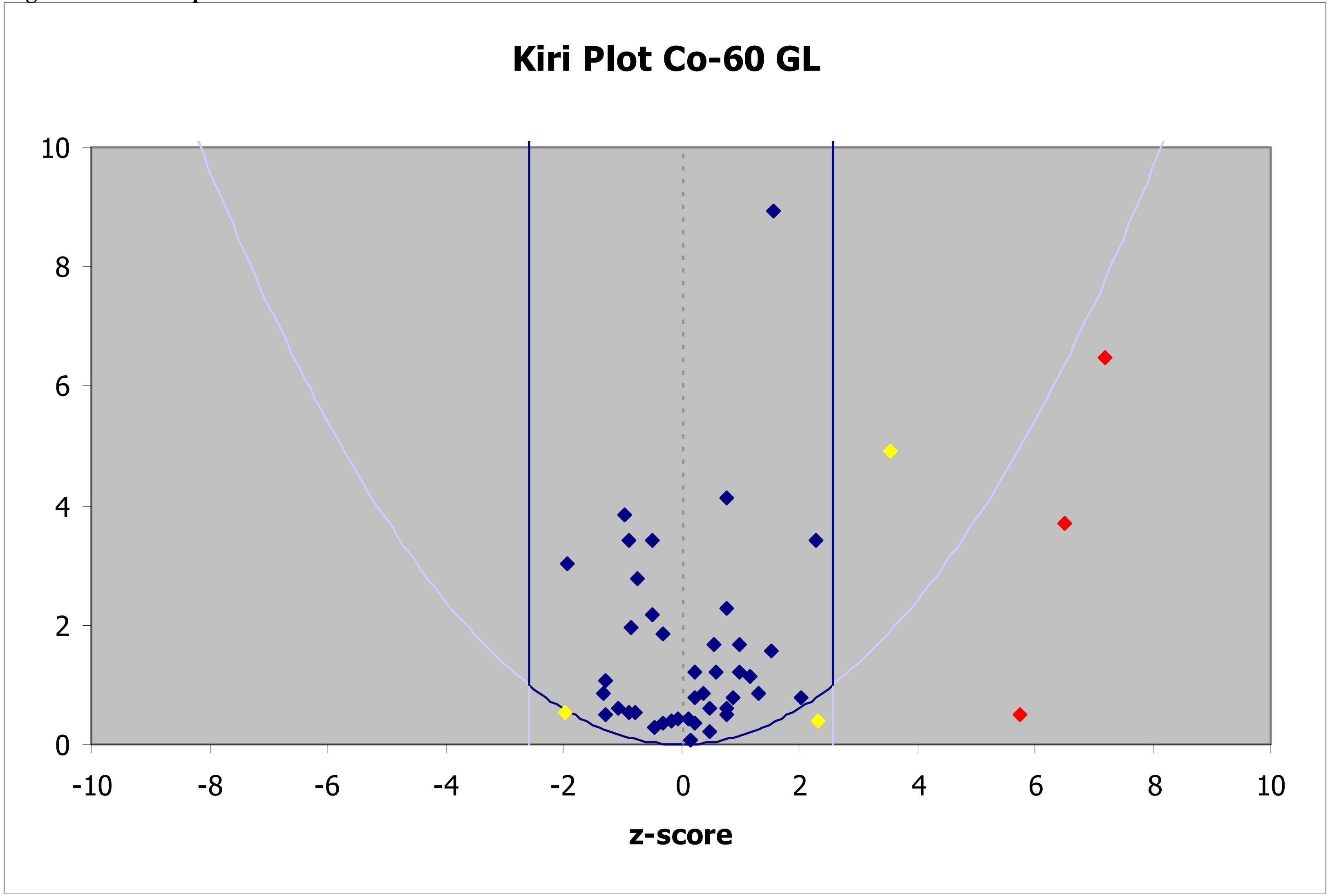


Figure 25A – Deviation Zn-65 GL

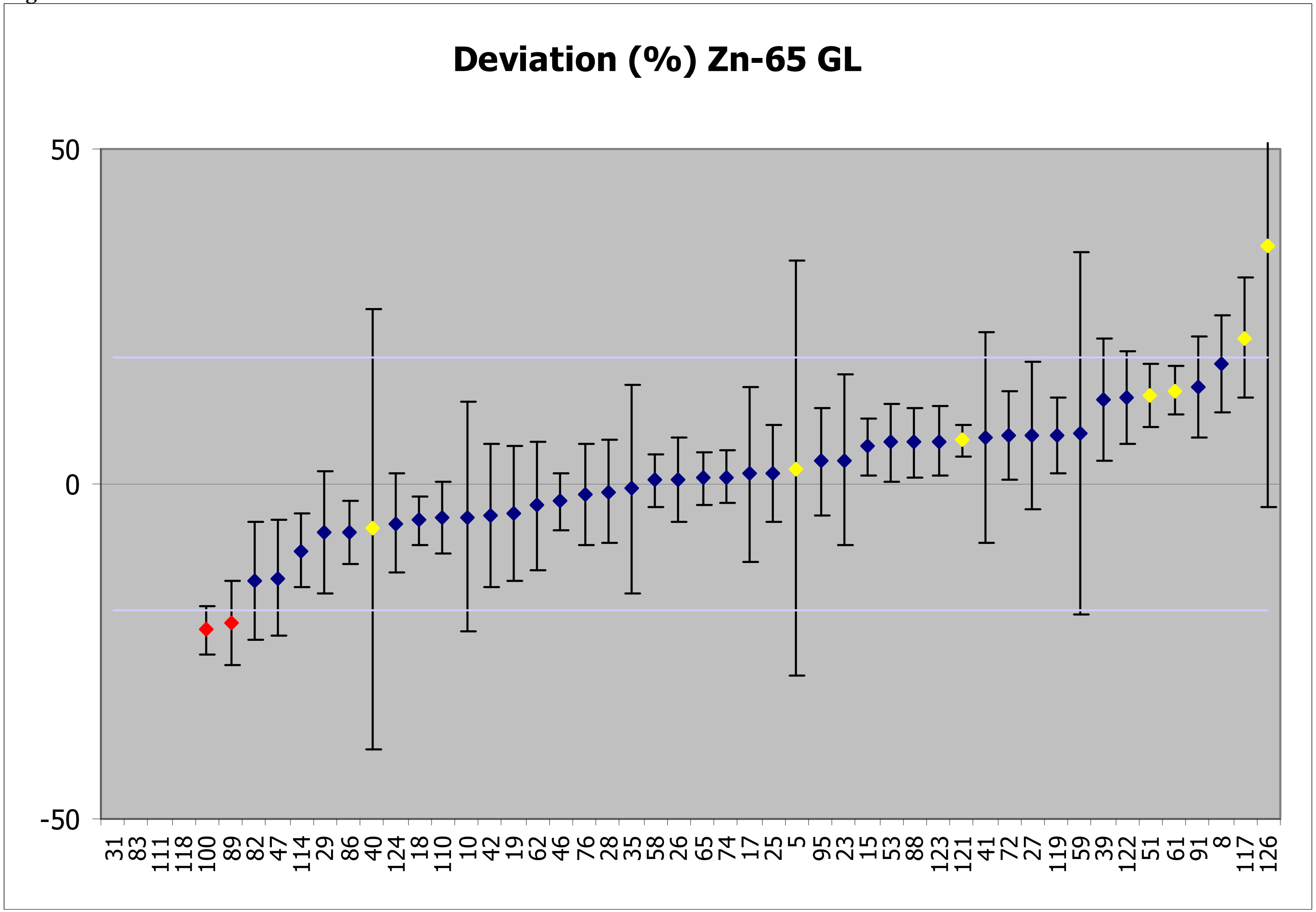


Figure 25B – Zeta score Zn-65 GL

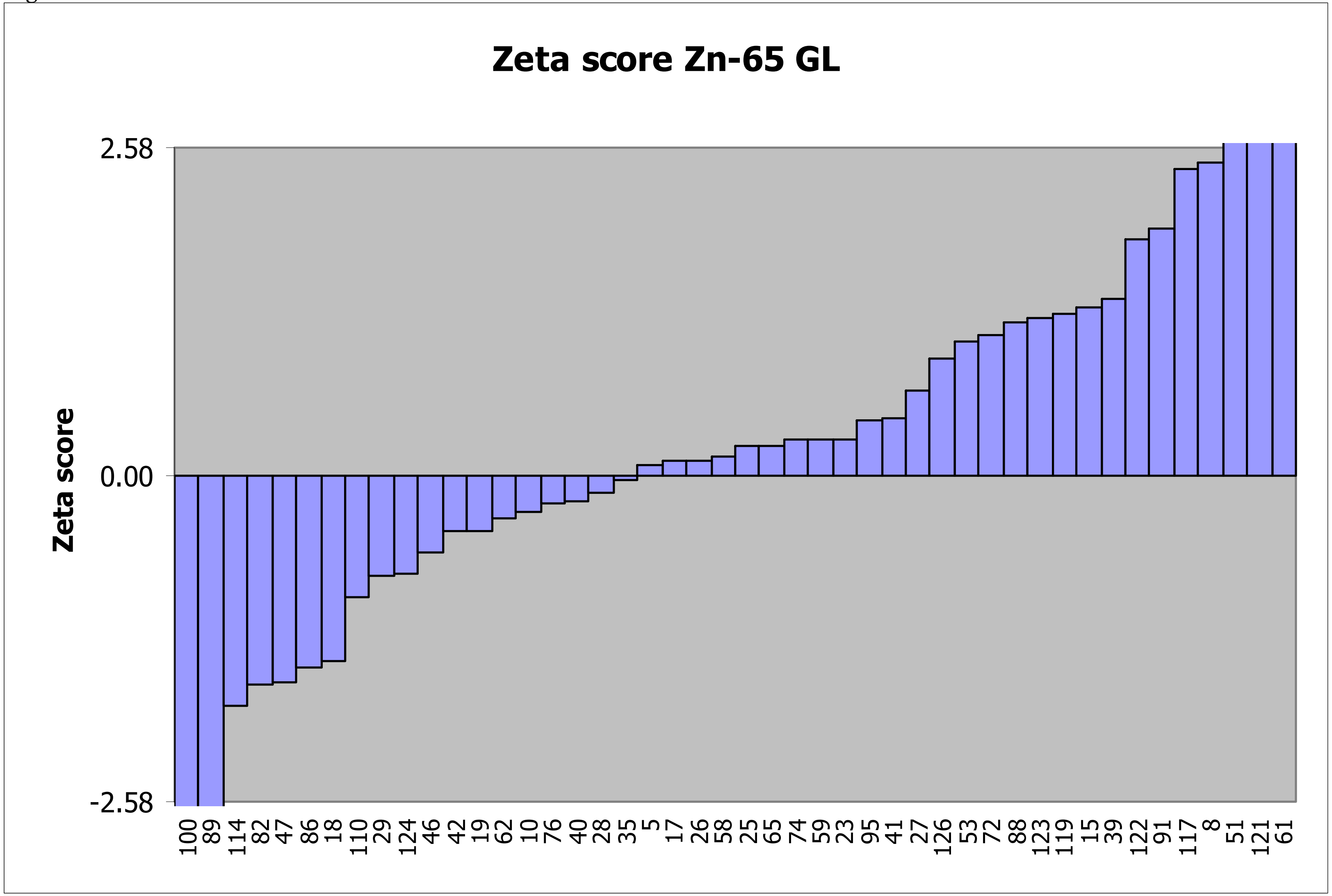


Figure 25C – Relative uncertainty Zn-65 GL

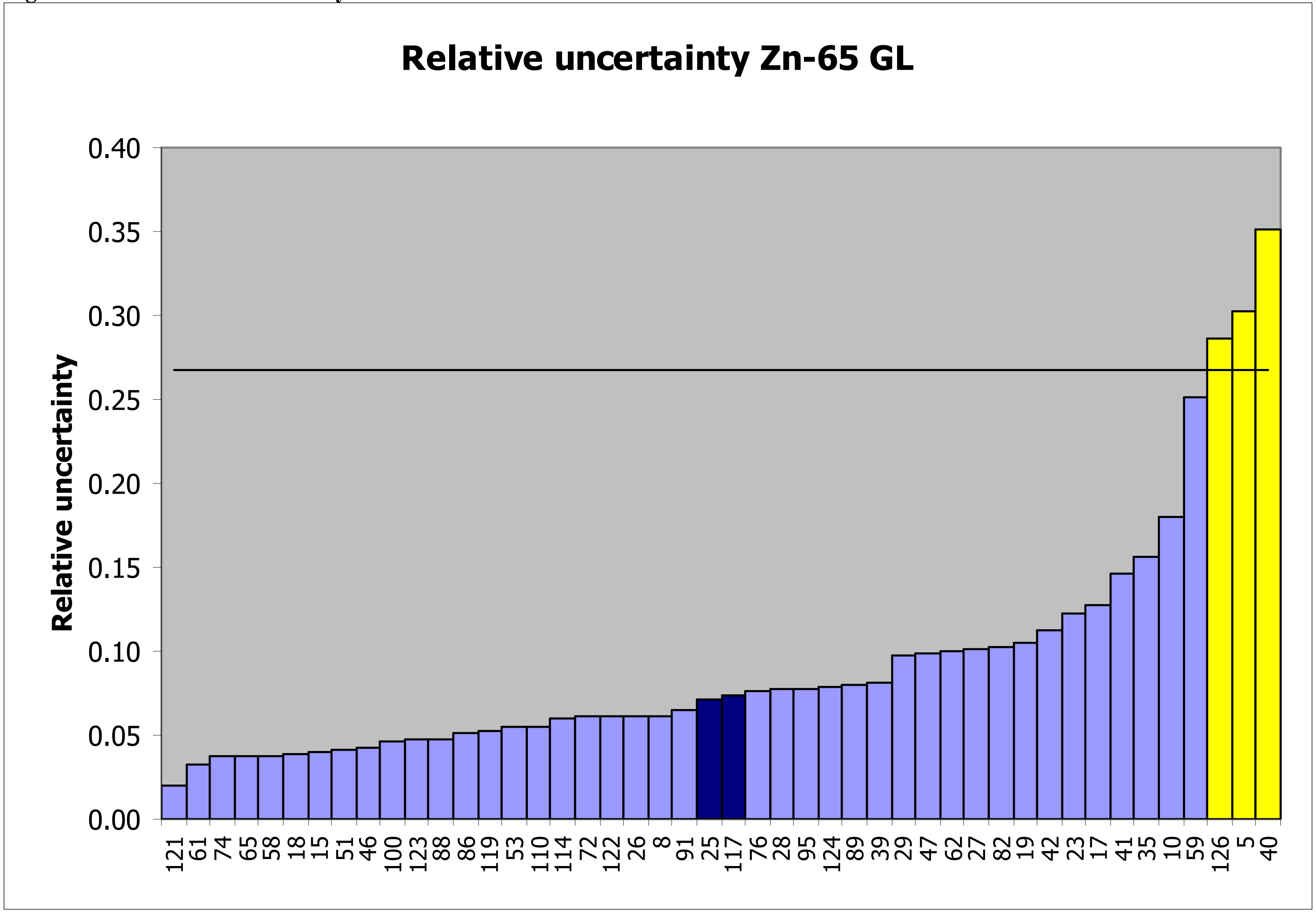


Figure 25D – Kiri plot Zn-65 GL

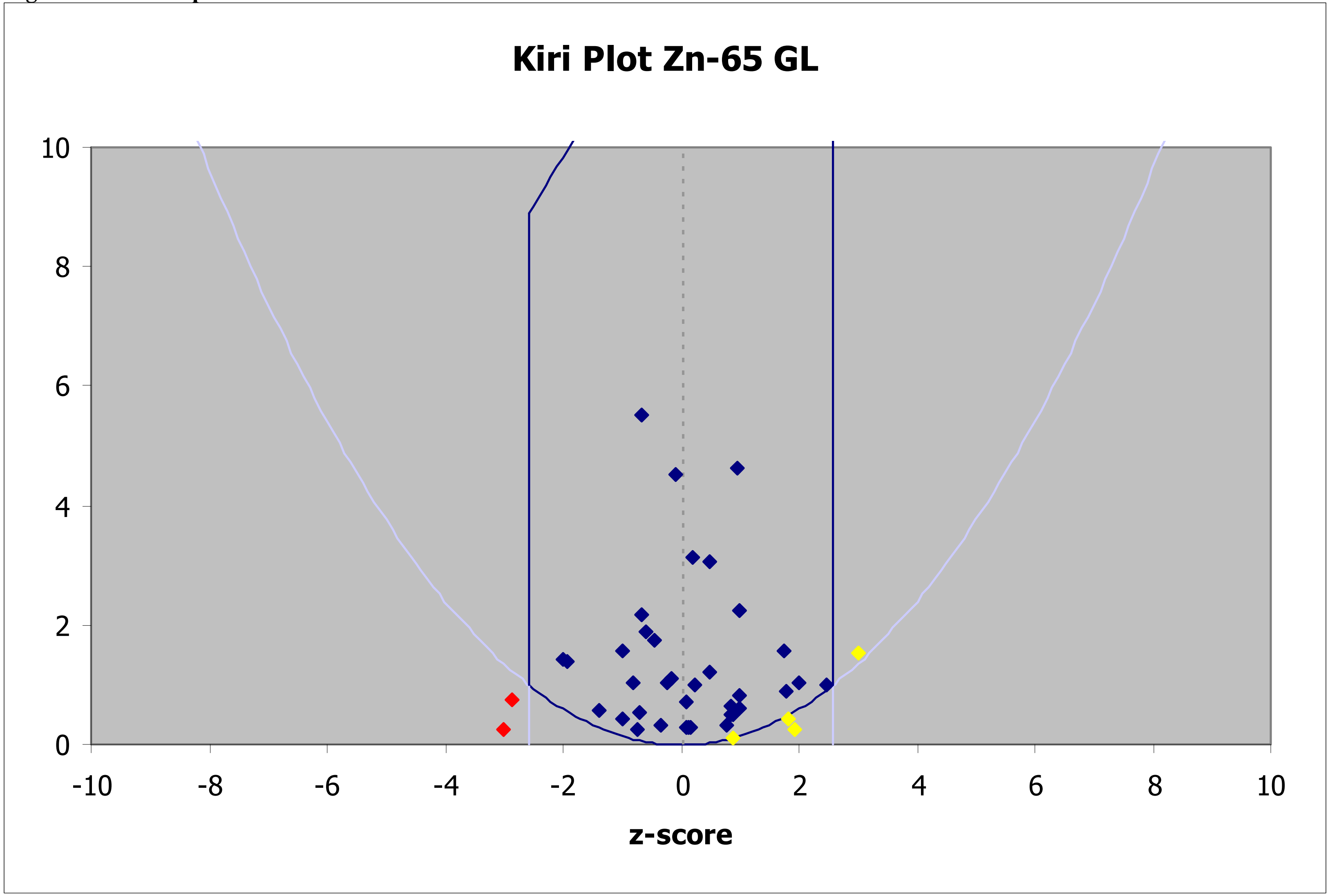


Figure 26A – Deviation Sr-85 GL

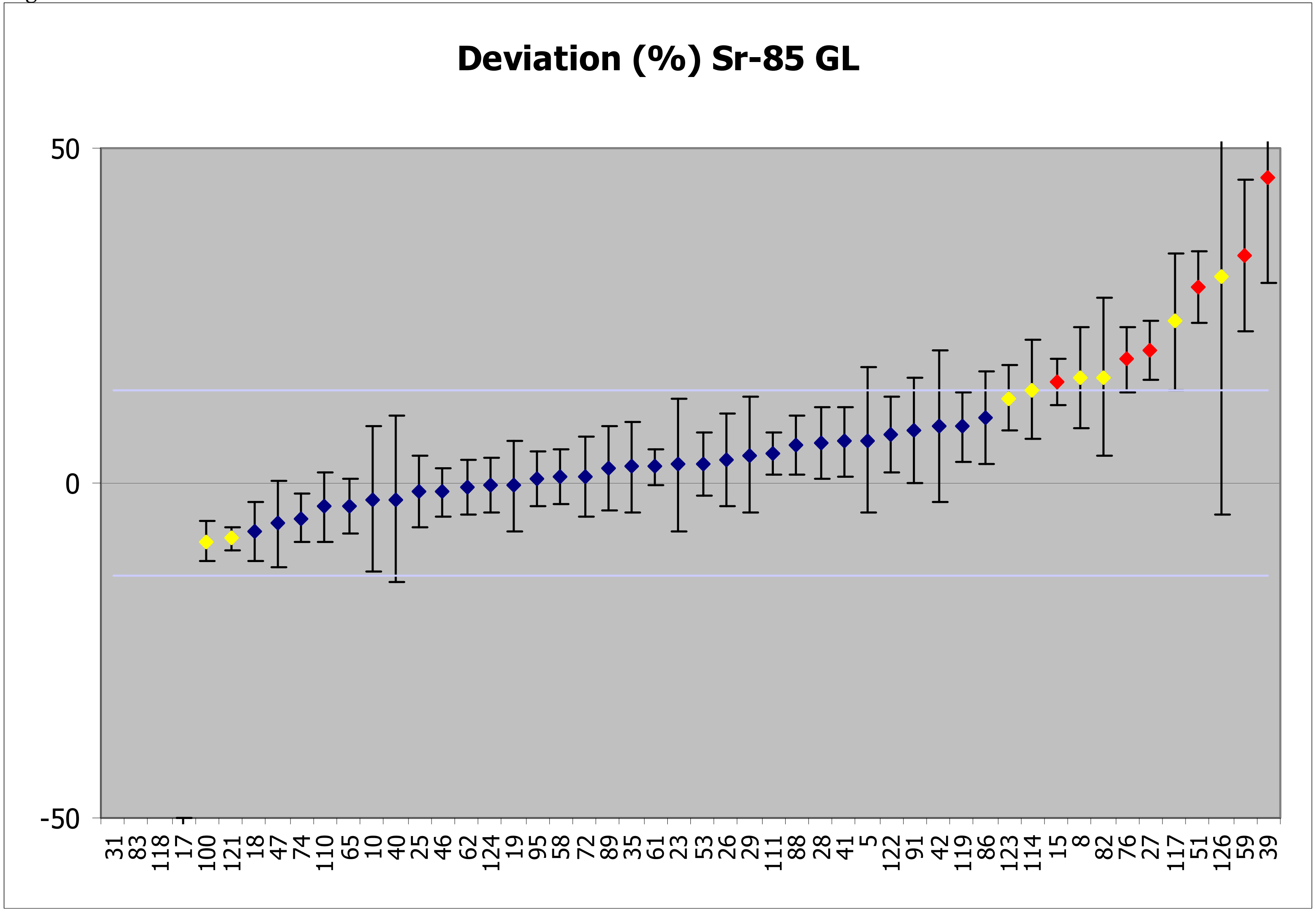


Figure 26B – Zeta score Sr-85 GL

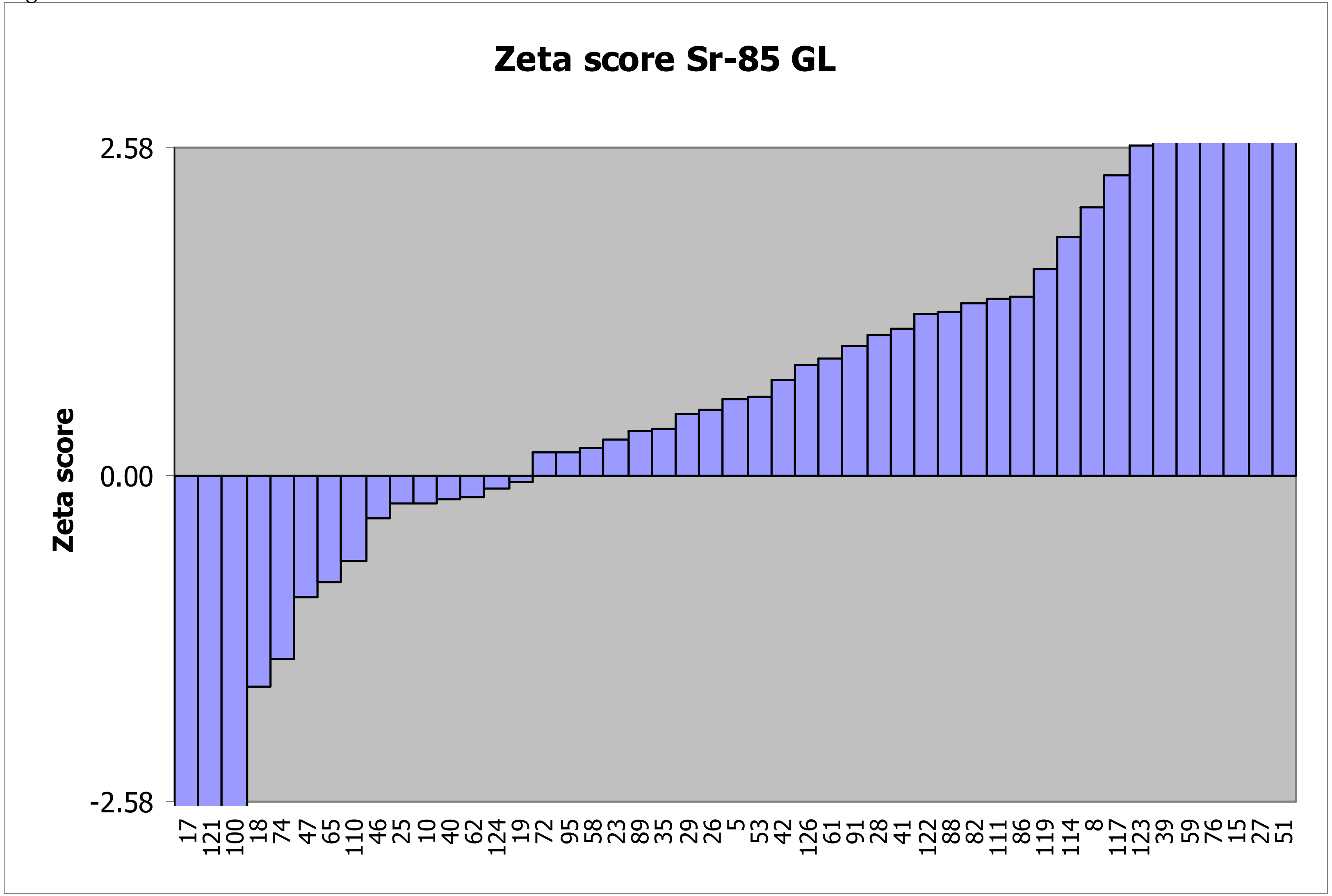


Figure 26C – Relative uncertainty Sr-85 GL

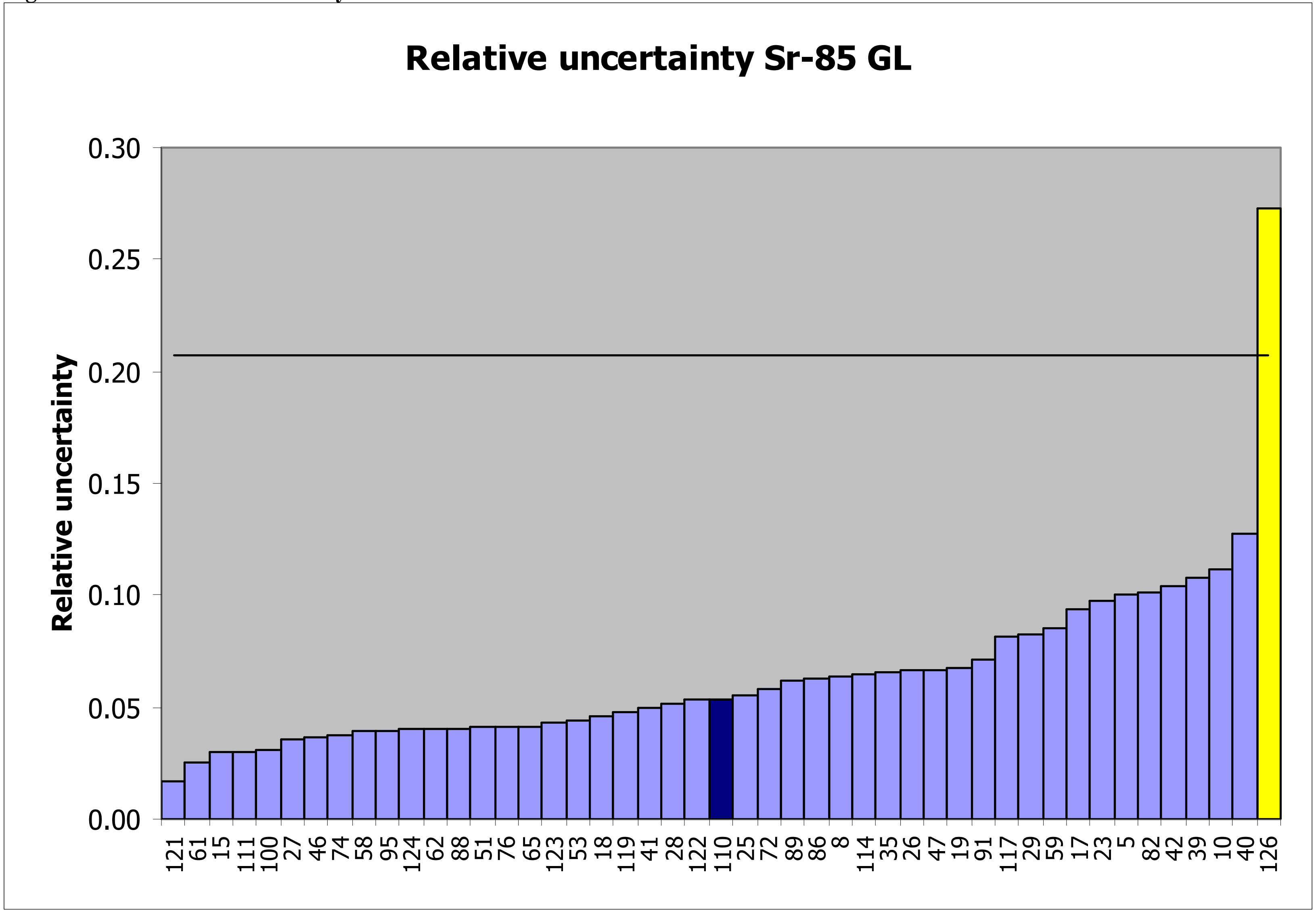


Figure 26D – Kiri plot Sr-85 GL

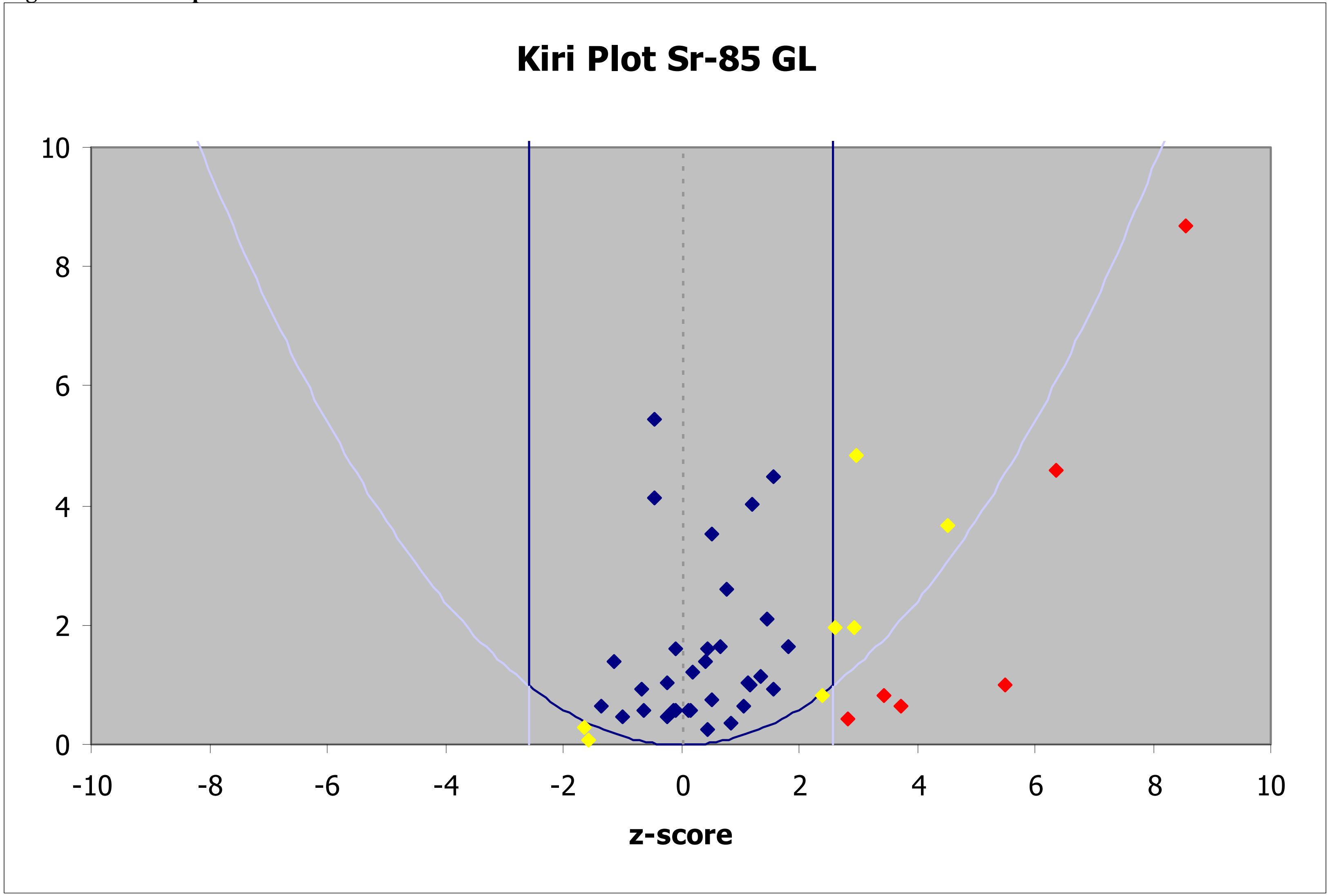


Figure 27A – Deviation Sb-125 GL

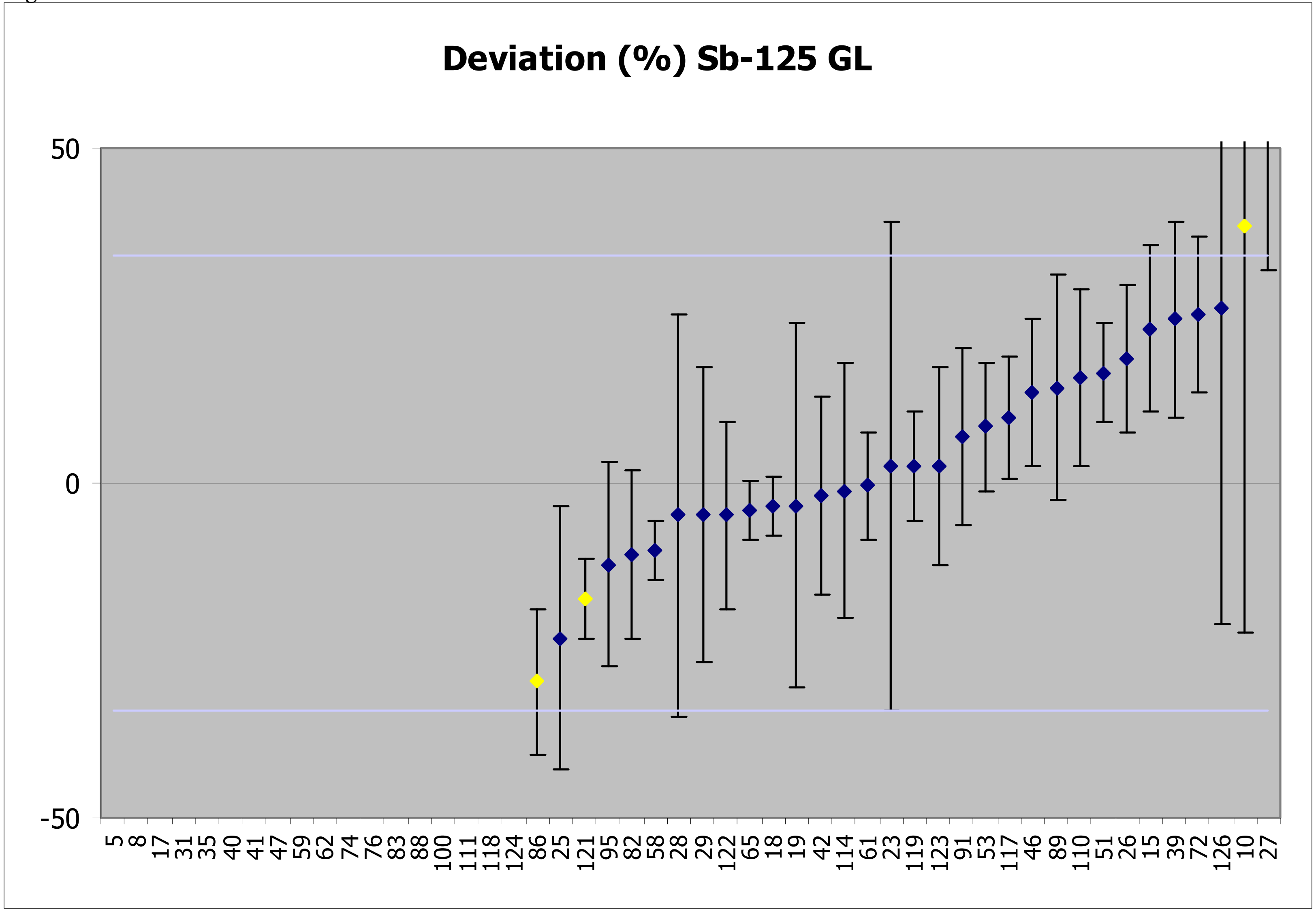


Figure 27B – Zeta score Sb-125 GL

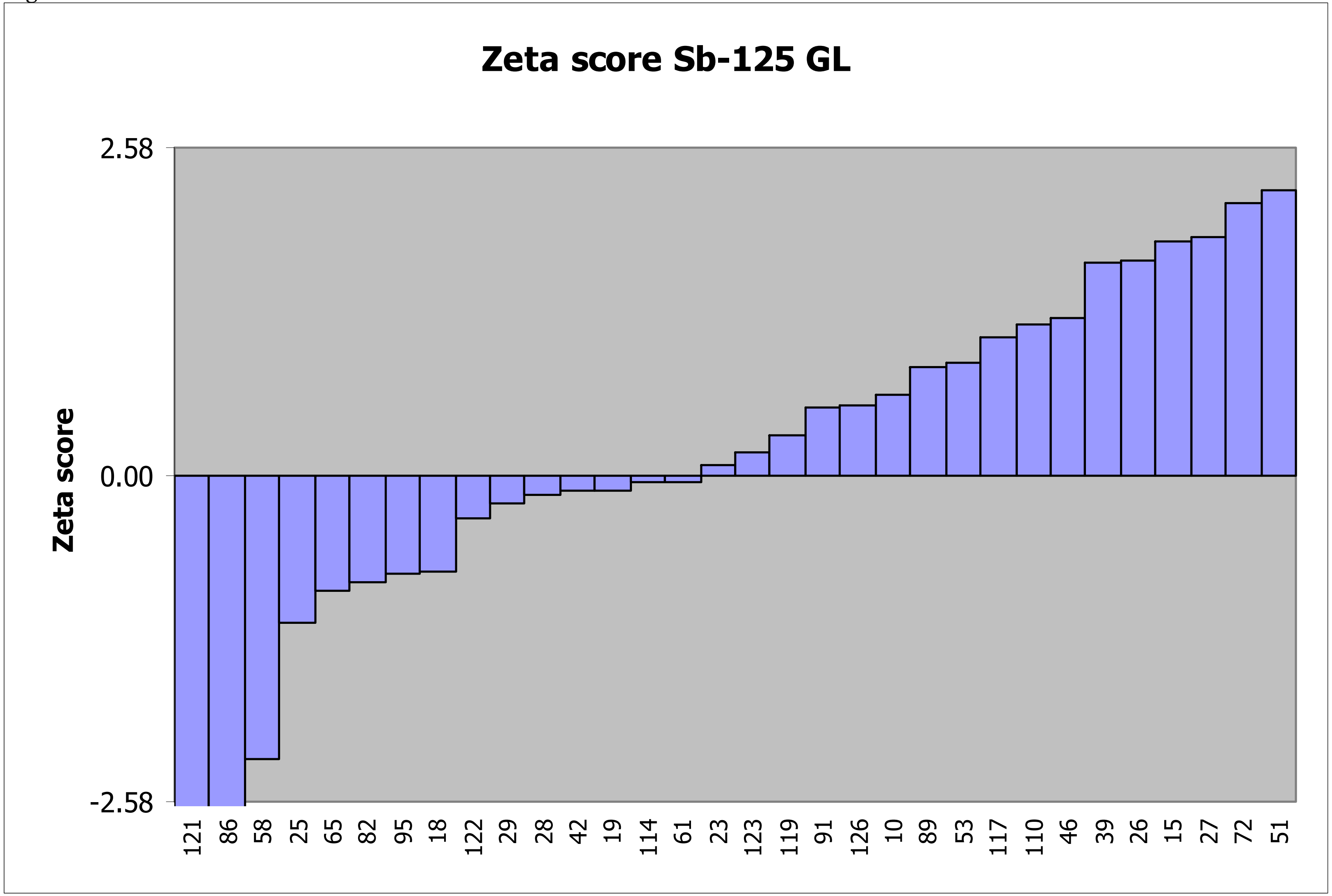


Figure 27C – Relative uncertainty Sb-125 GL

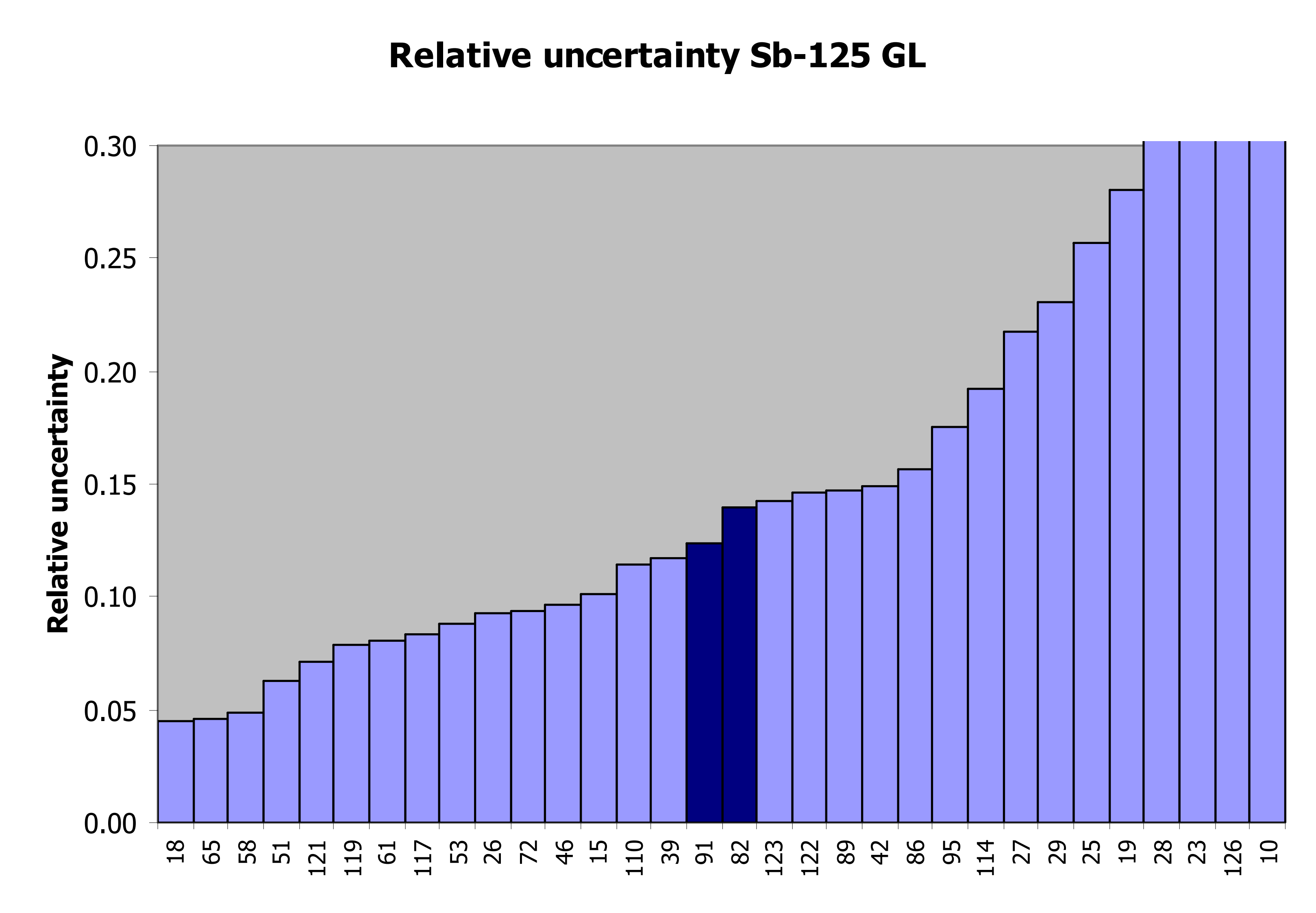


Figure 27D – Kiri plot Sb-125 GL

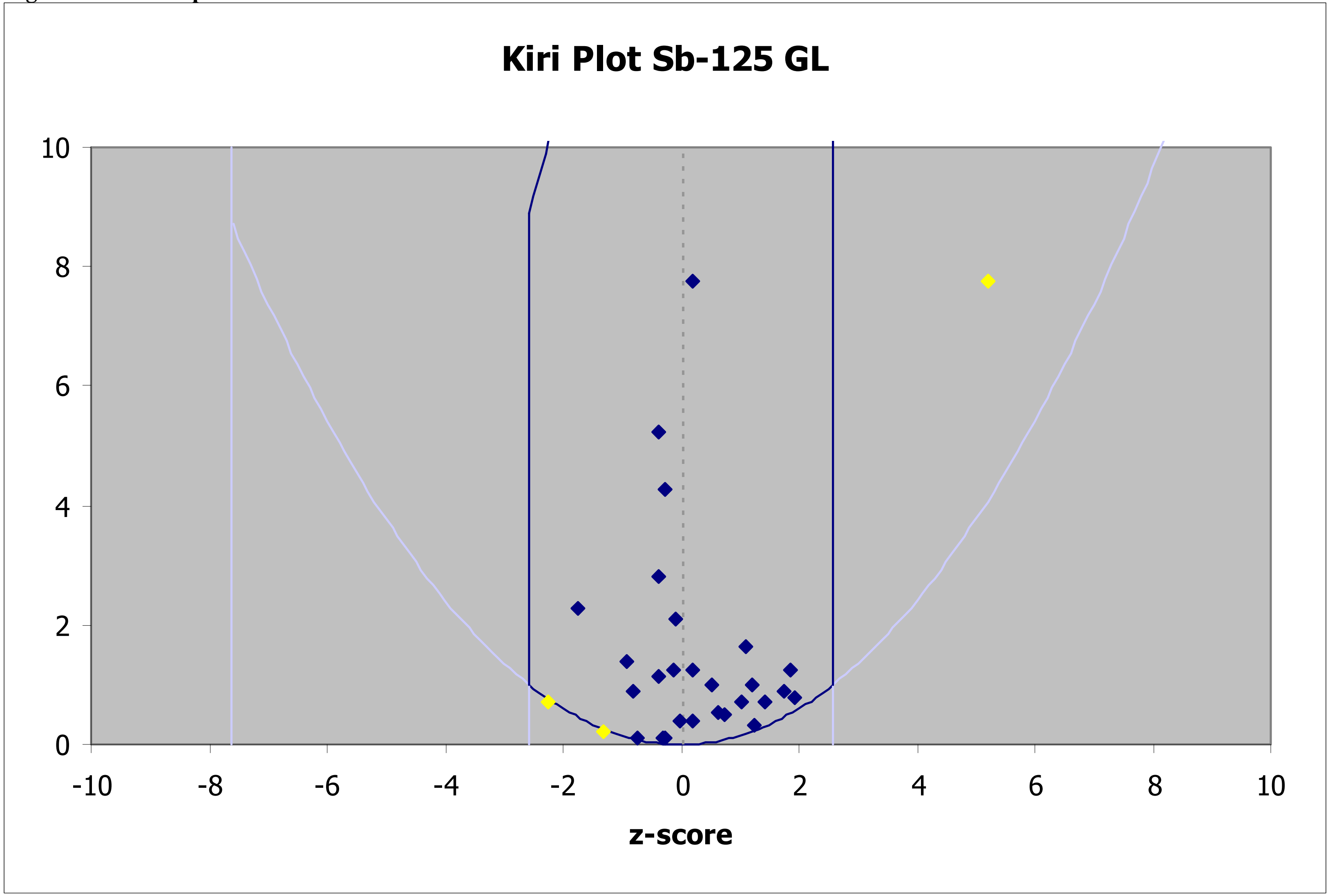


Figure 28A – Deviation Ba-133 GL

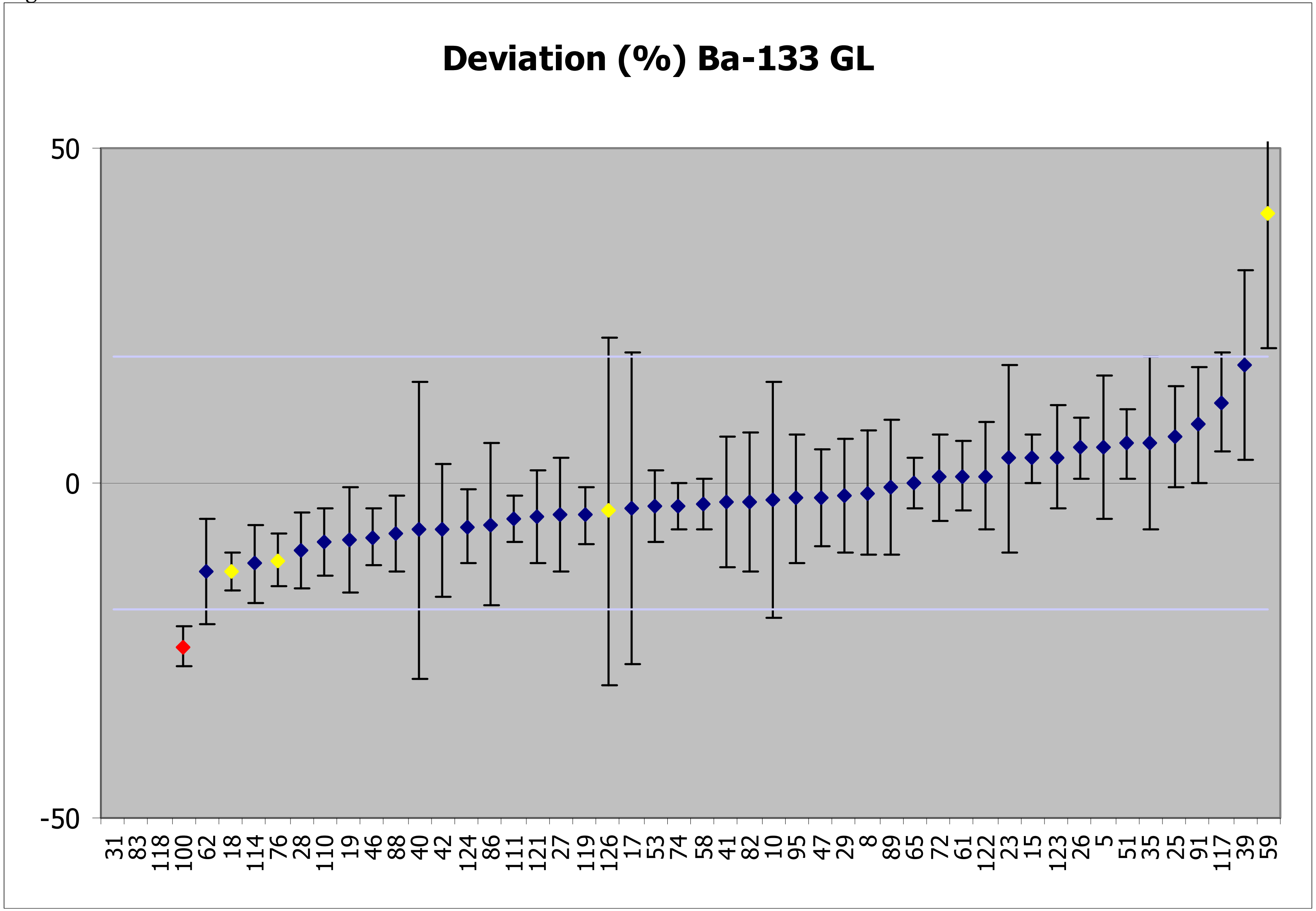


Figure 28B – Zeta score Ba-133 GL

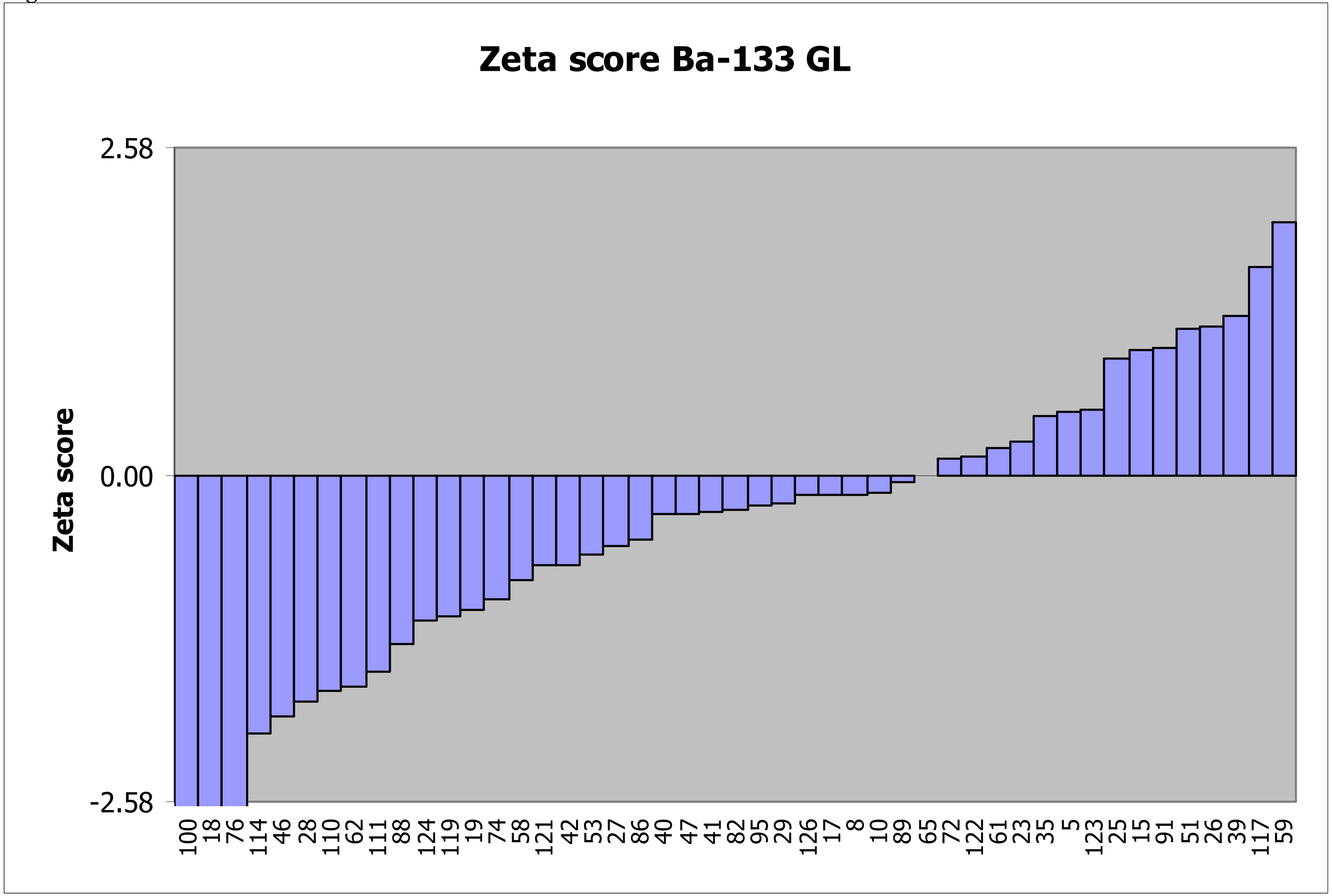


Figure 28C – Relative uncertainty Ba-133 GL

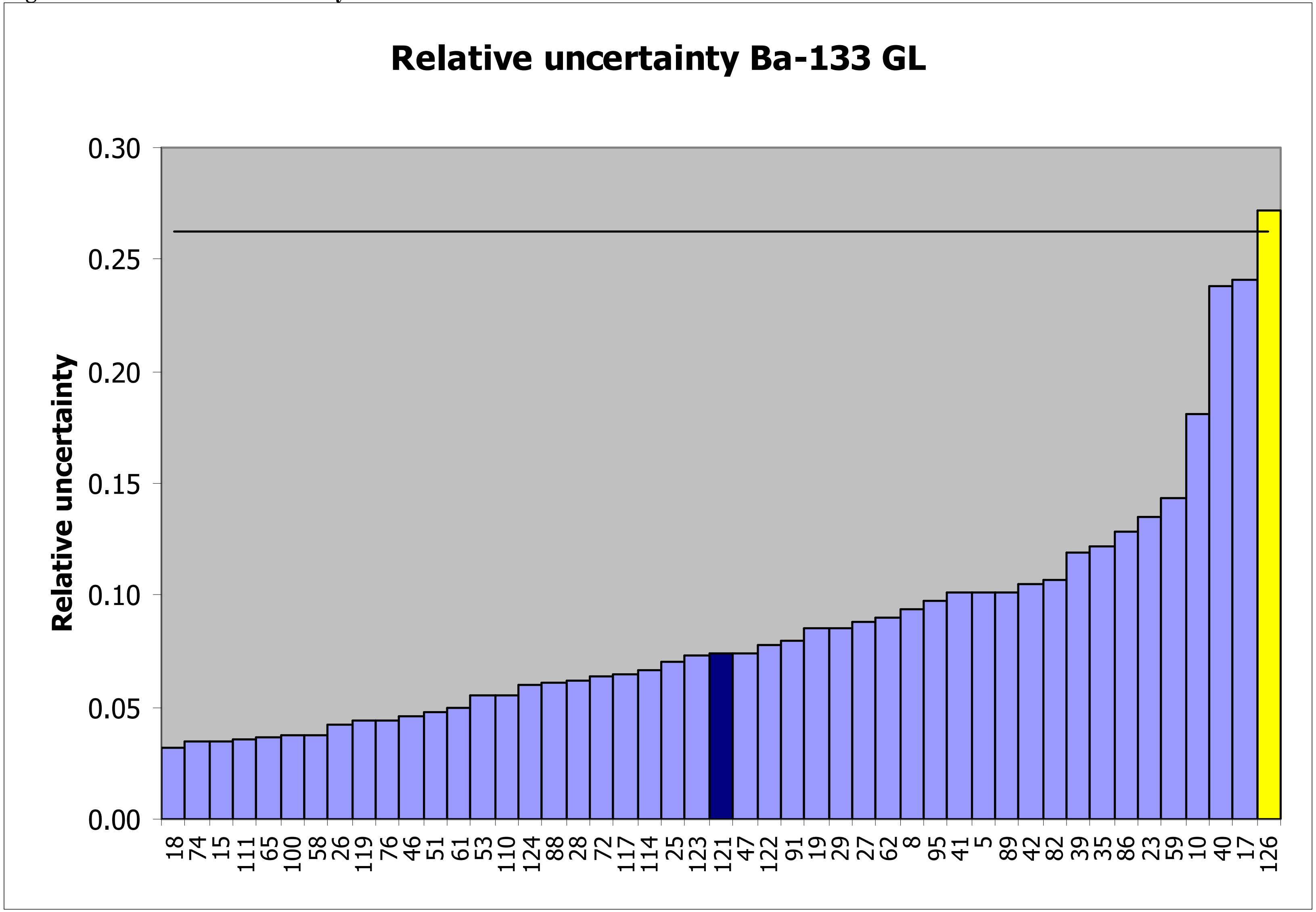


Figure 28D – Kiri plot Ba-133 GL

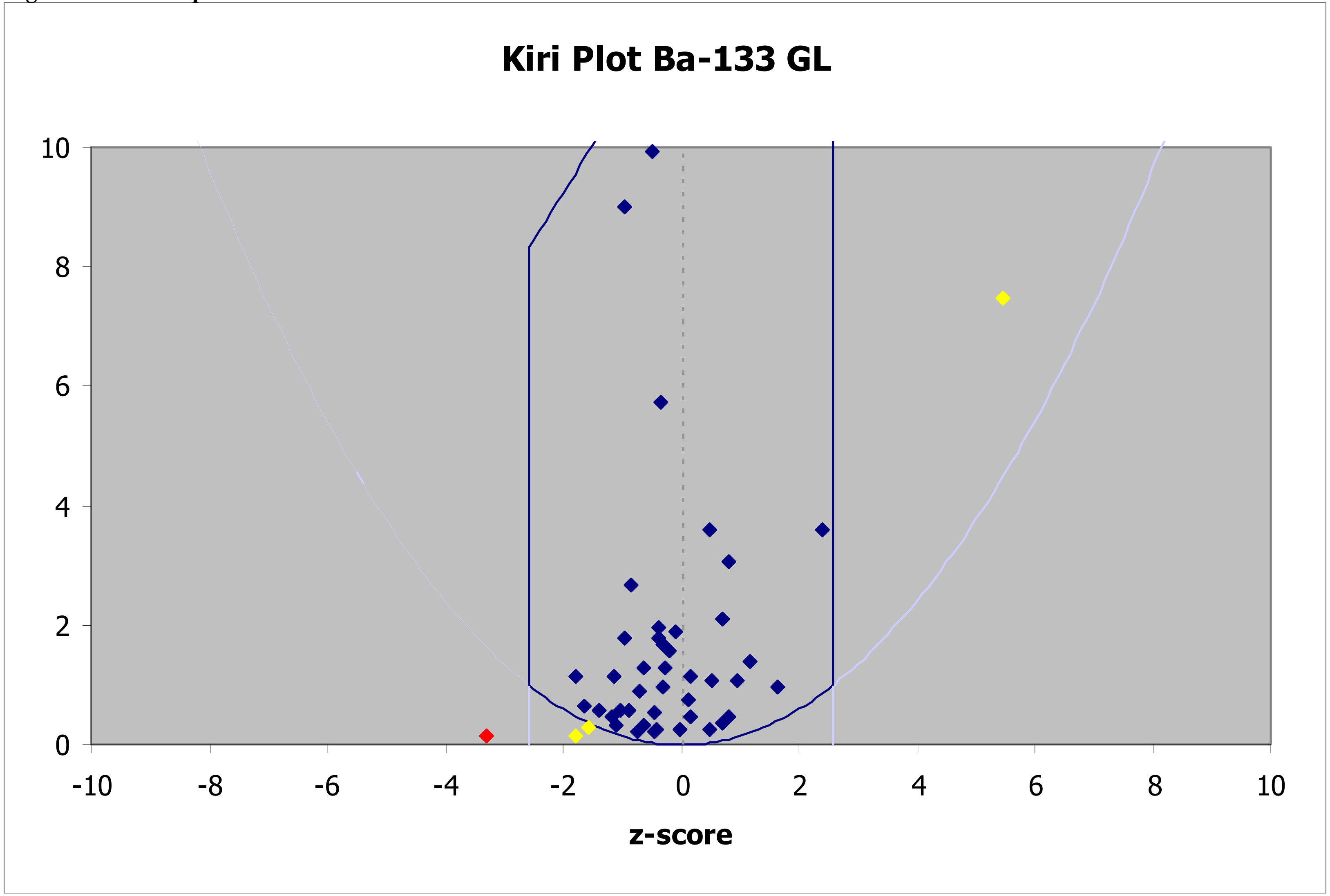


Figure 29A – Deviation Cs-134 GL

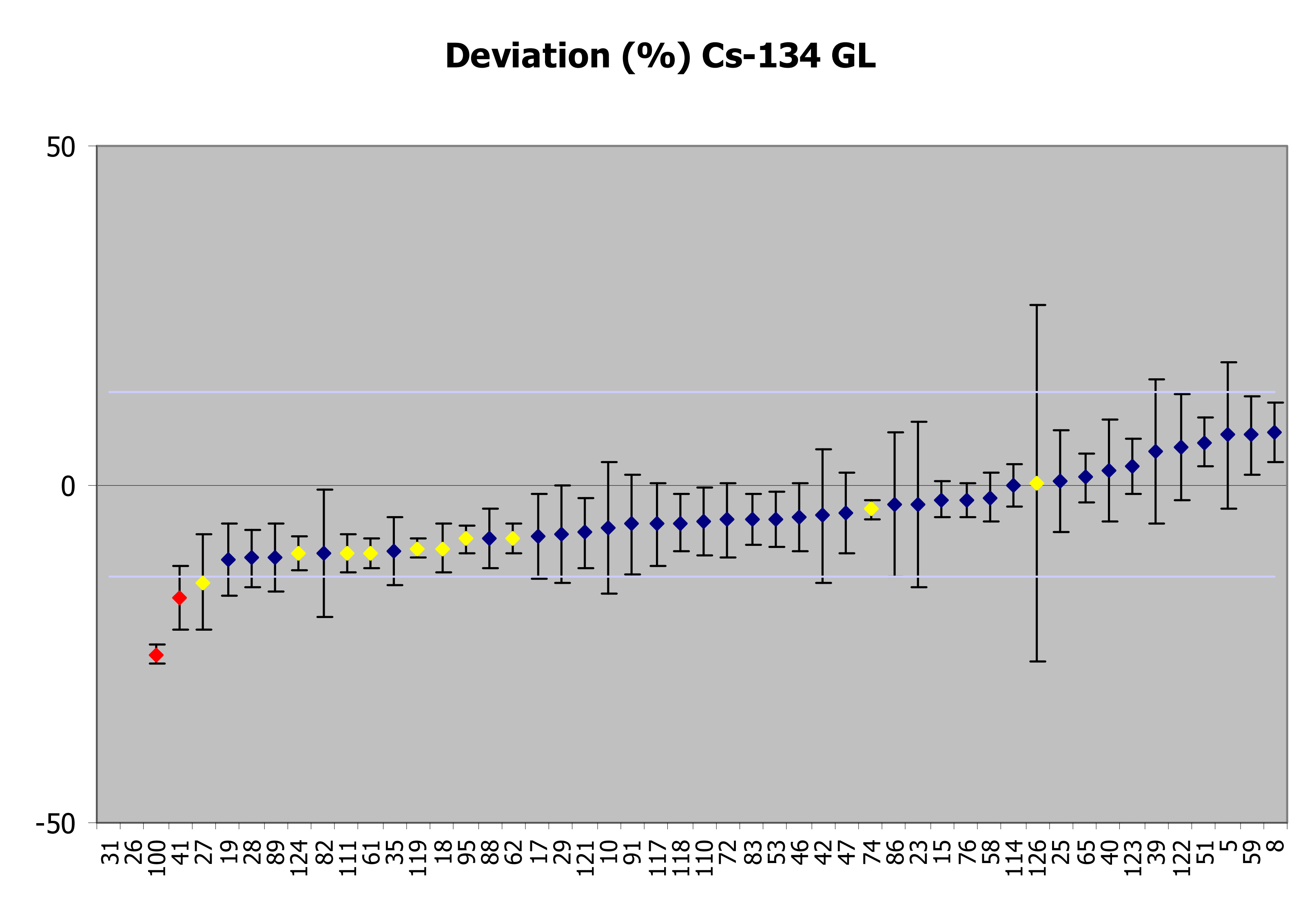


Figure 29B – Zeta score Cs-134 GL

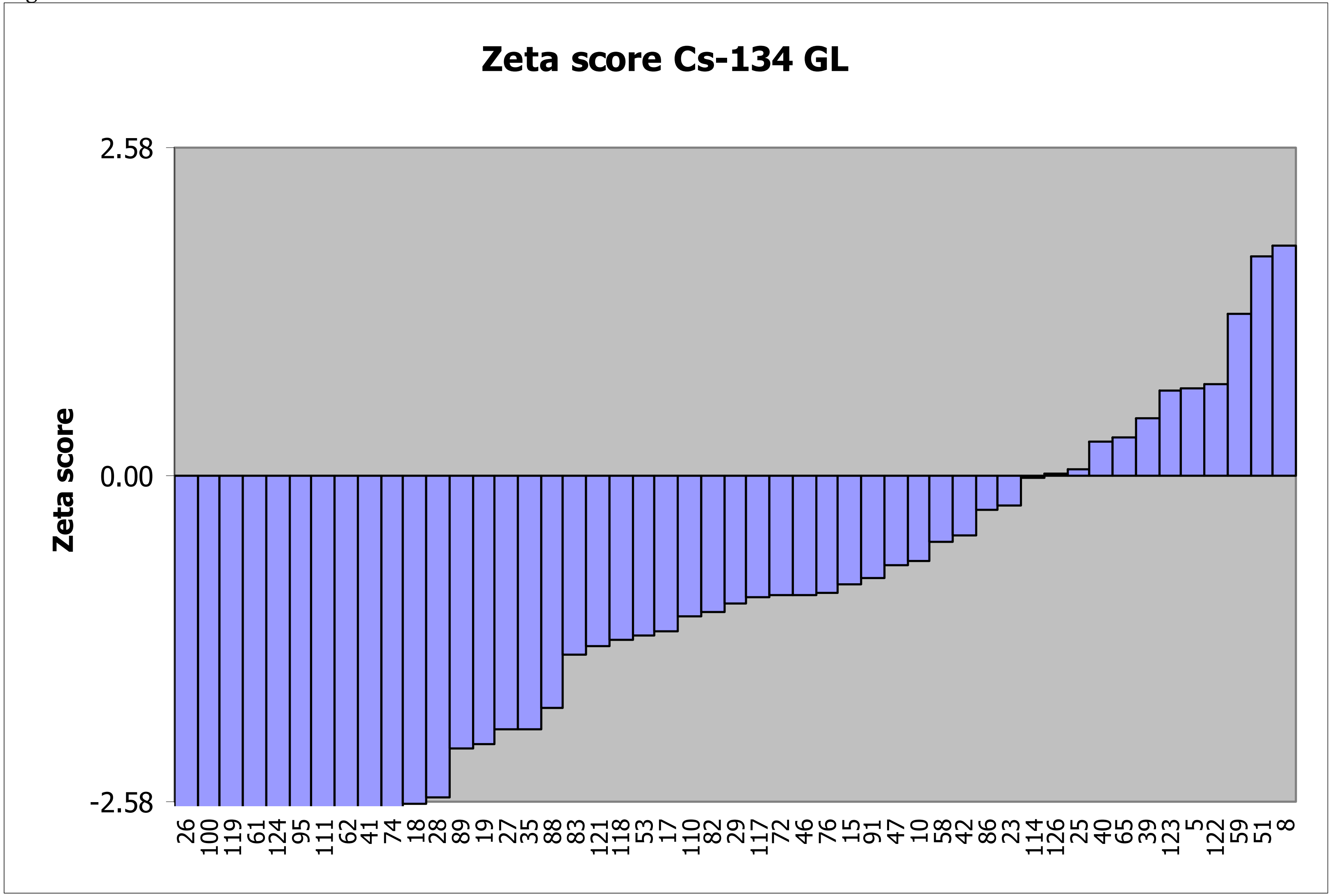


Figure 29C – Relative uncertainty Cs-134 GL

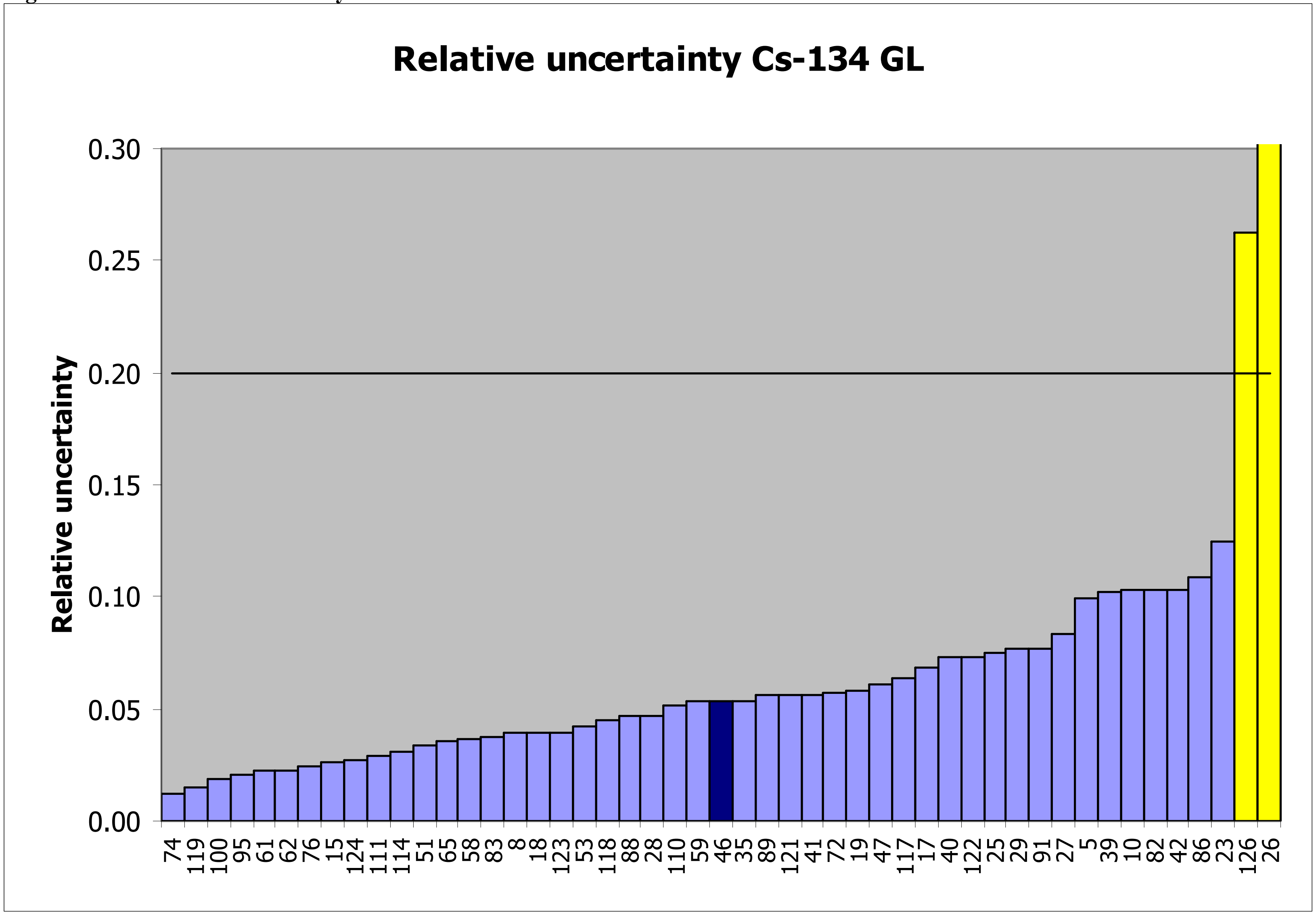


Figure 29D – Kiri plot Cs-134 GL

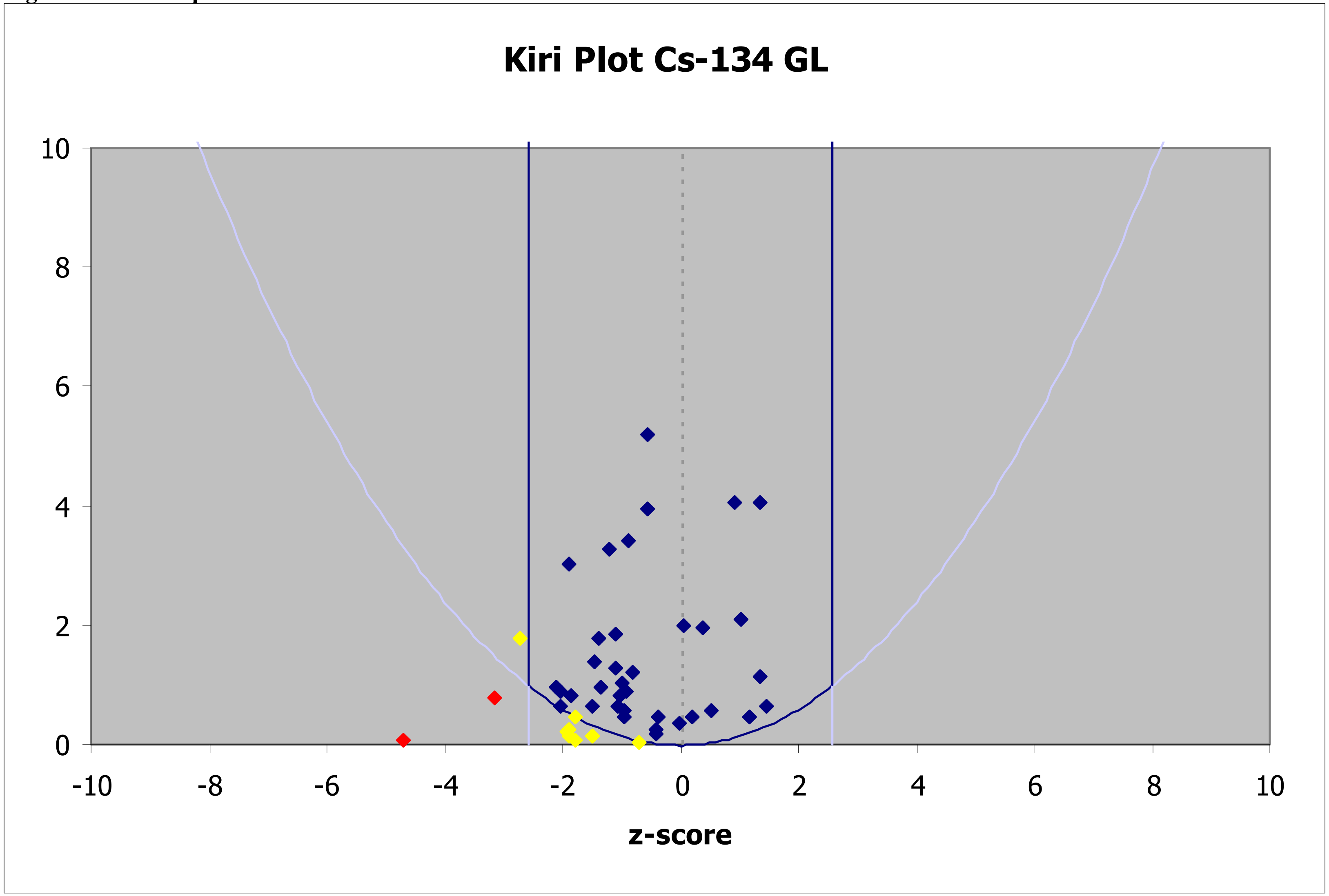


Figure 30A – Deviation Cs-137 GL

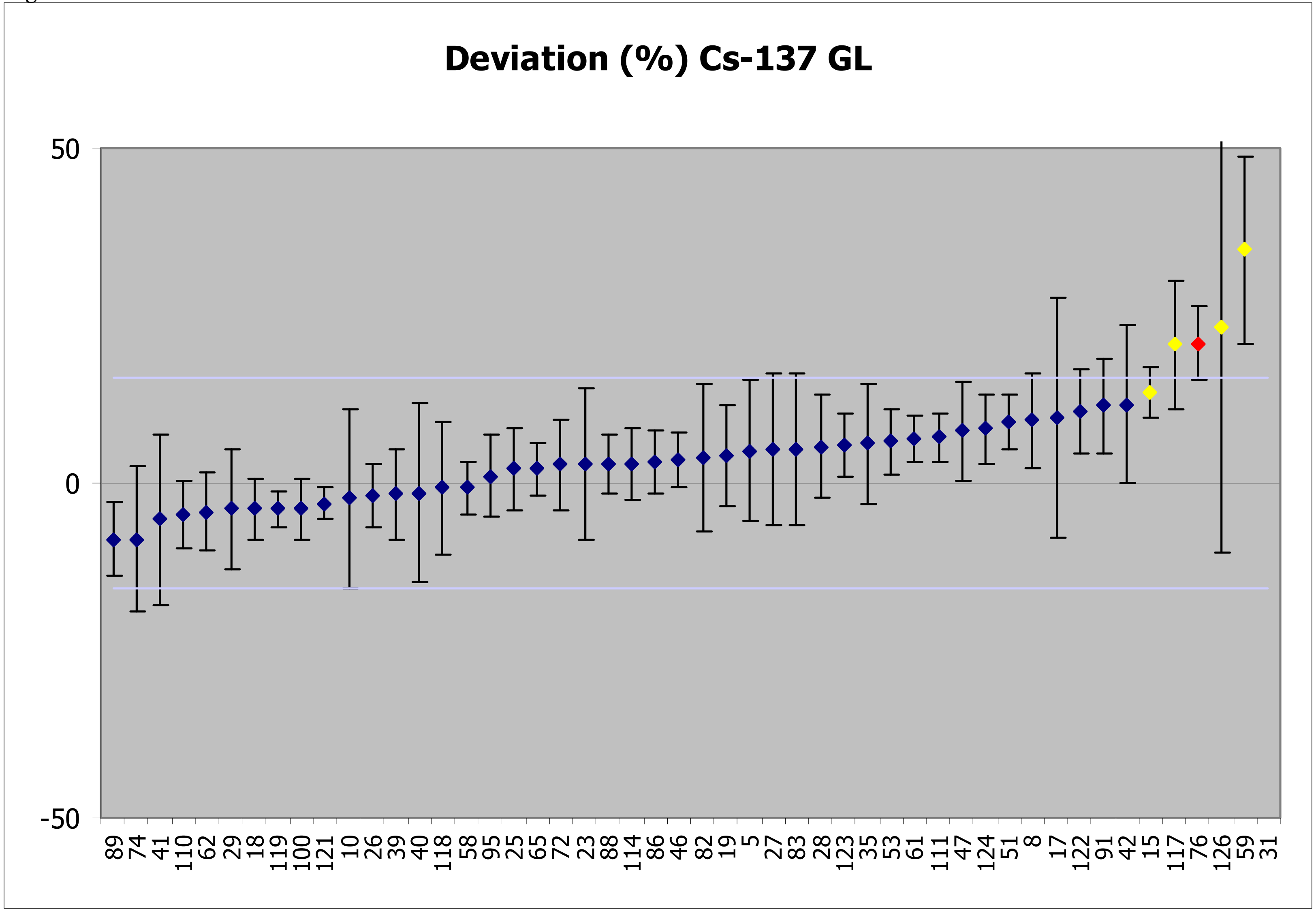


Figure 30B – Zeta score Cs-137 GL

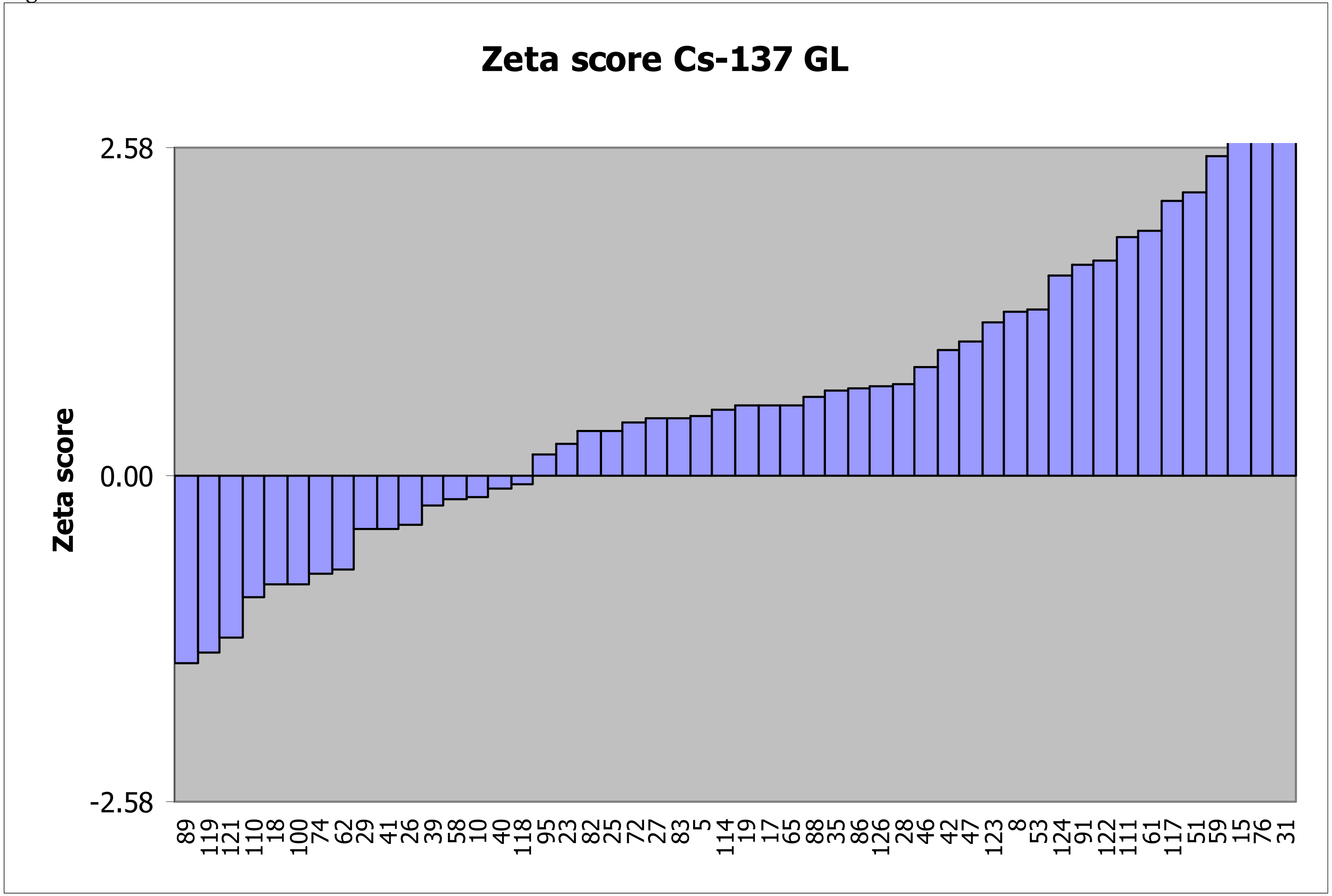


Figure 30C – Relative uncertainty Cs-137 GL

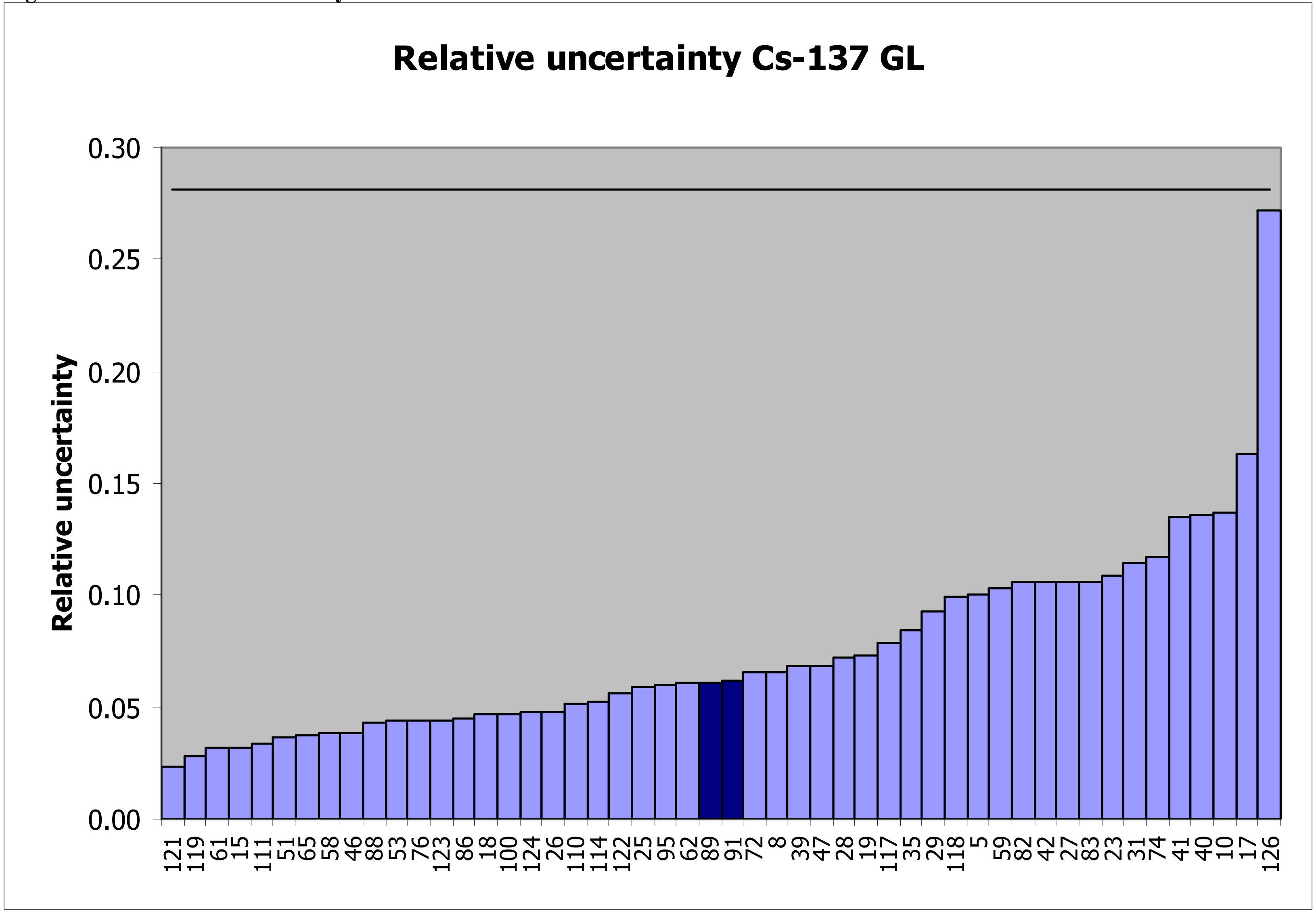


Figure 30D – Kiri plot Cs-137 GL

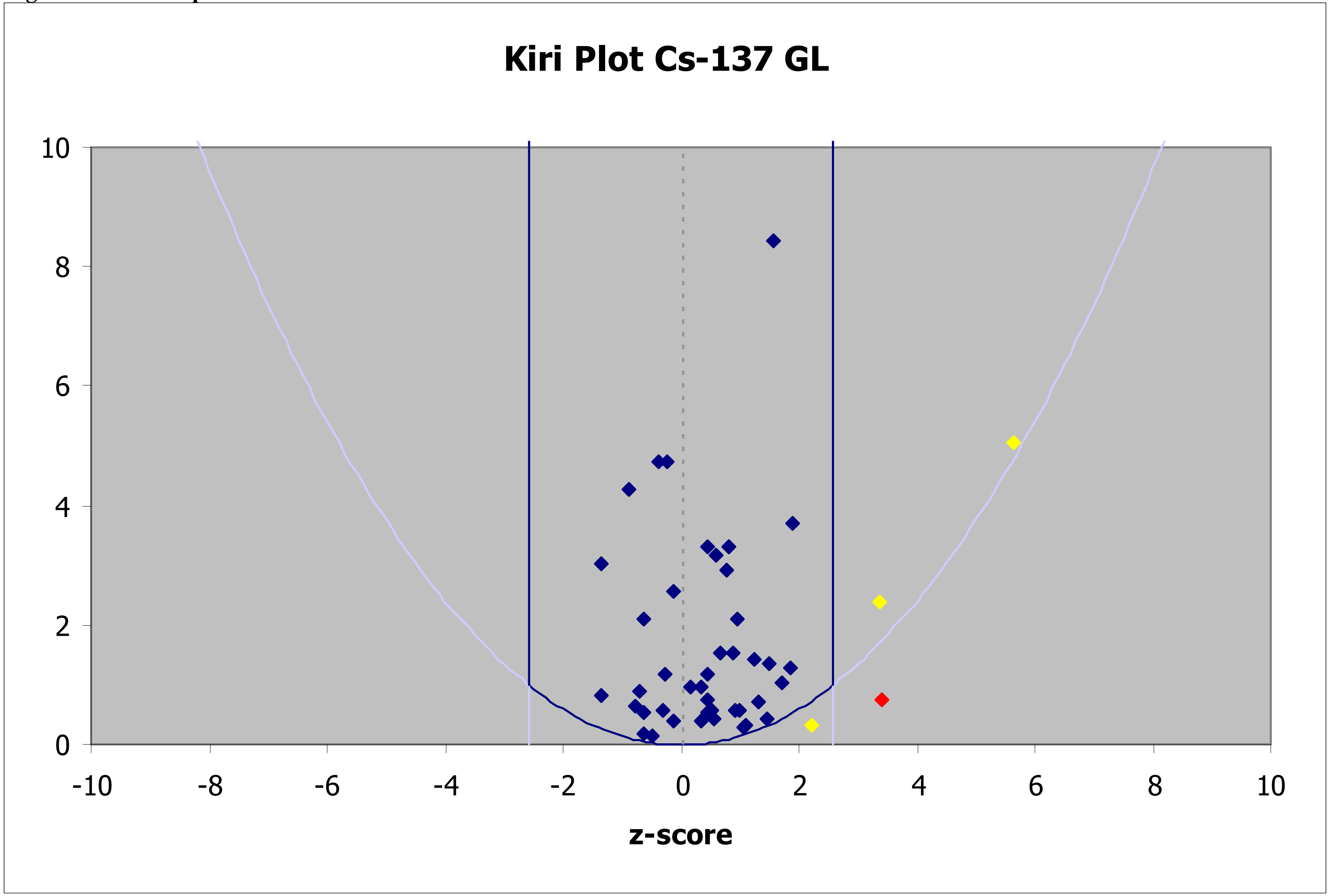


Figure 31A – Deviation Eu-152 GL

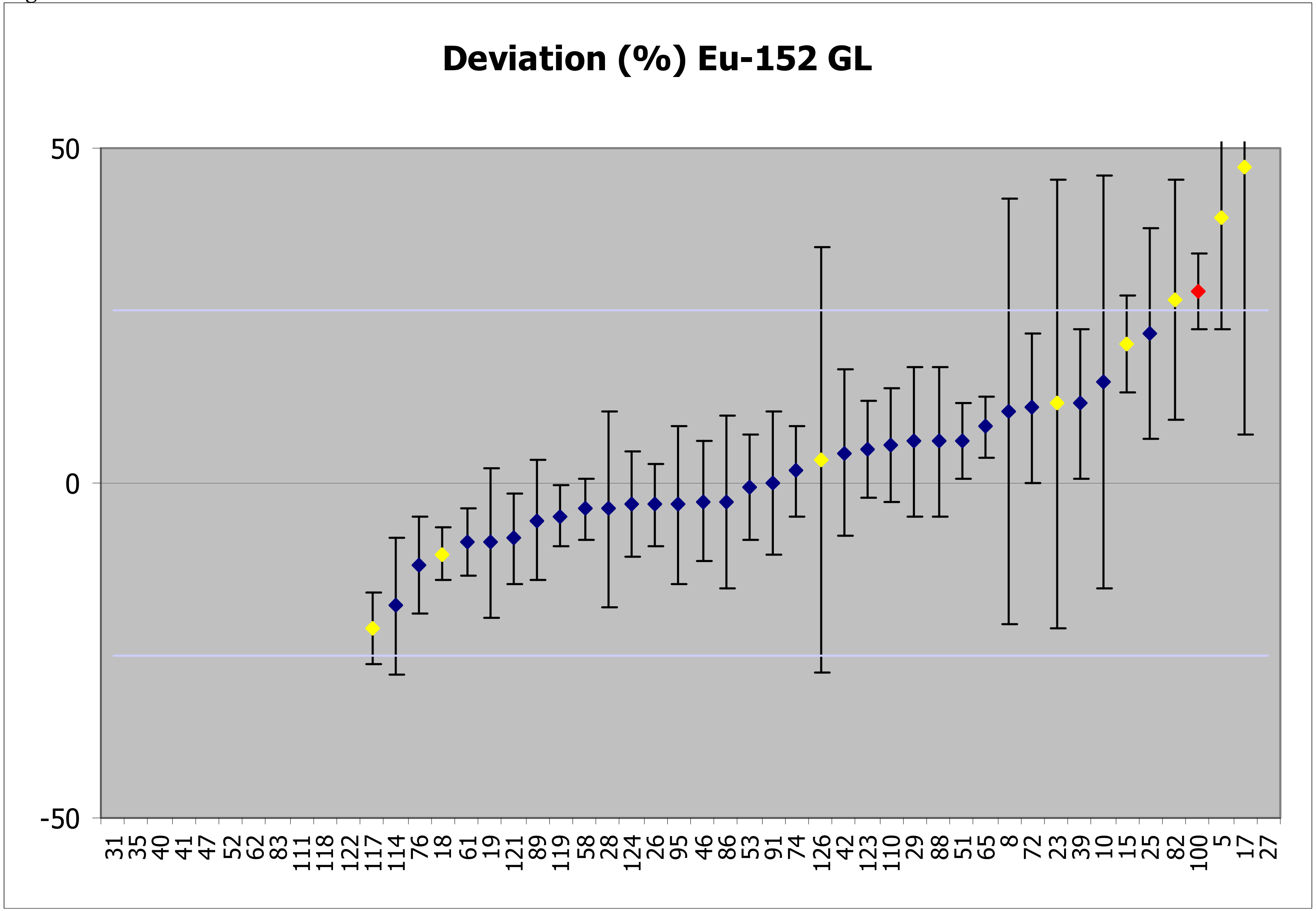


Figure 31B – Zeta score Eu-152 GL

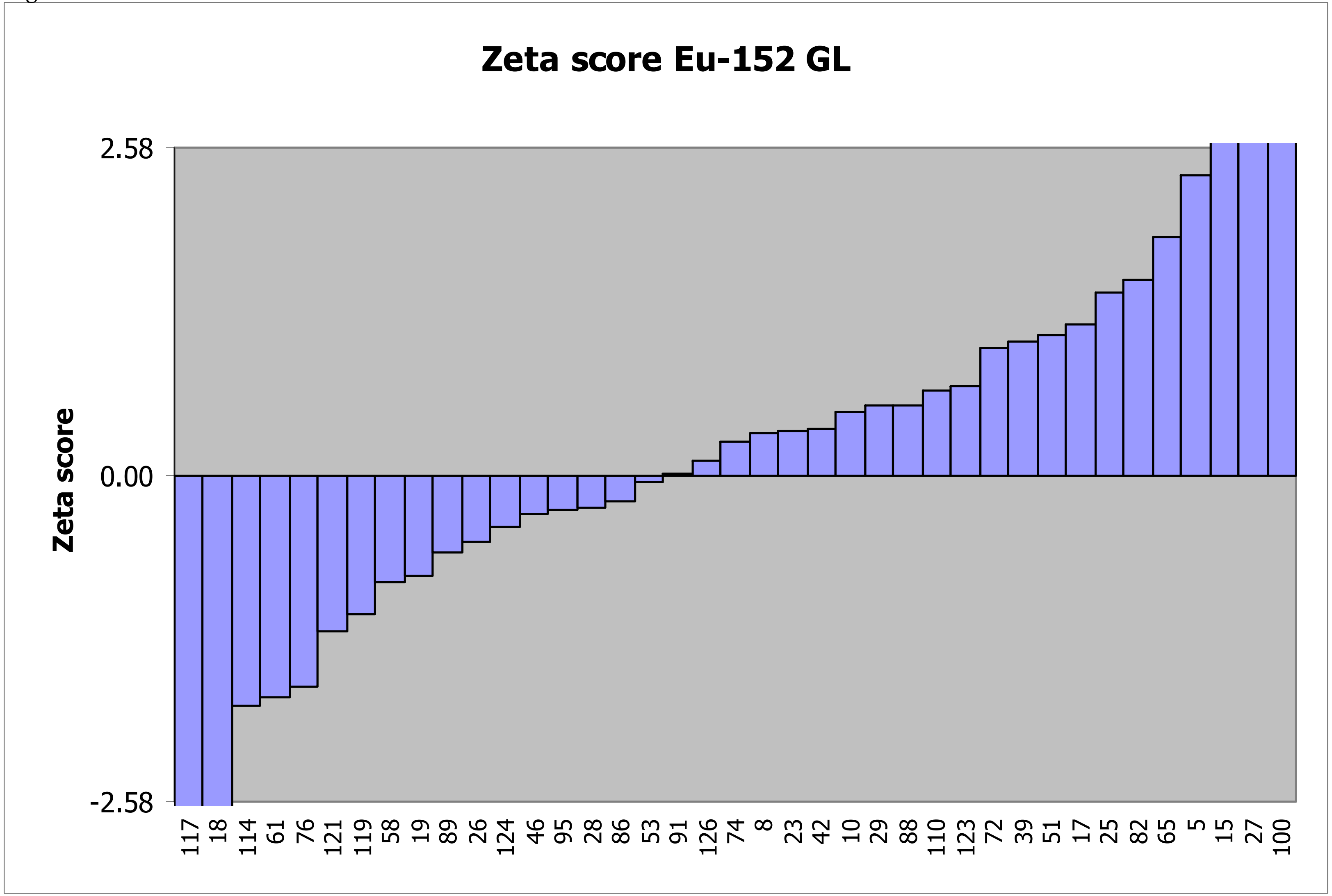


Figure 31C – Relative uncertainty Eu-152 GL

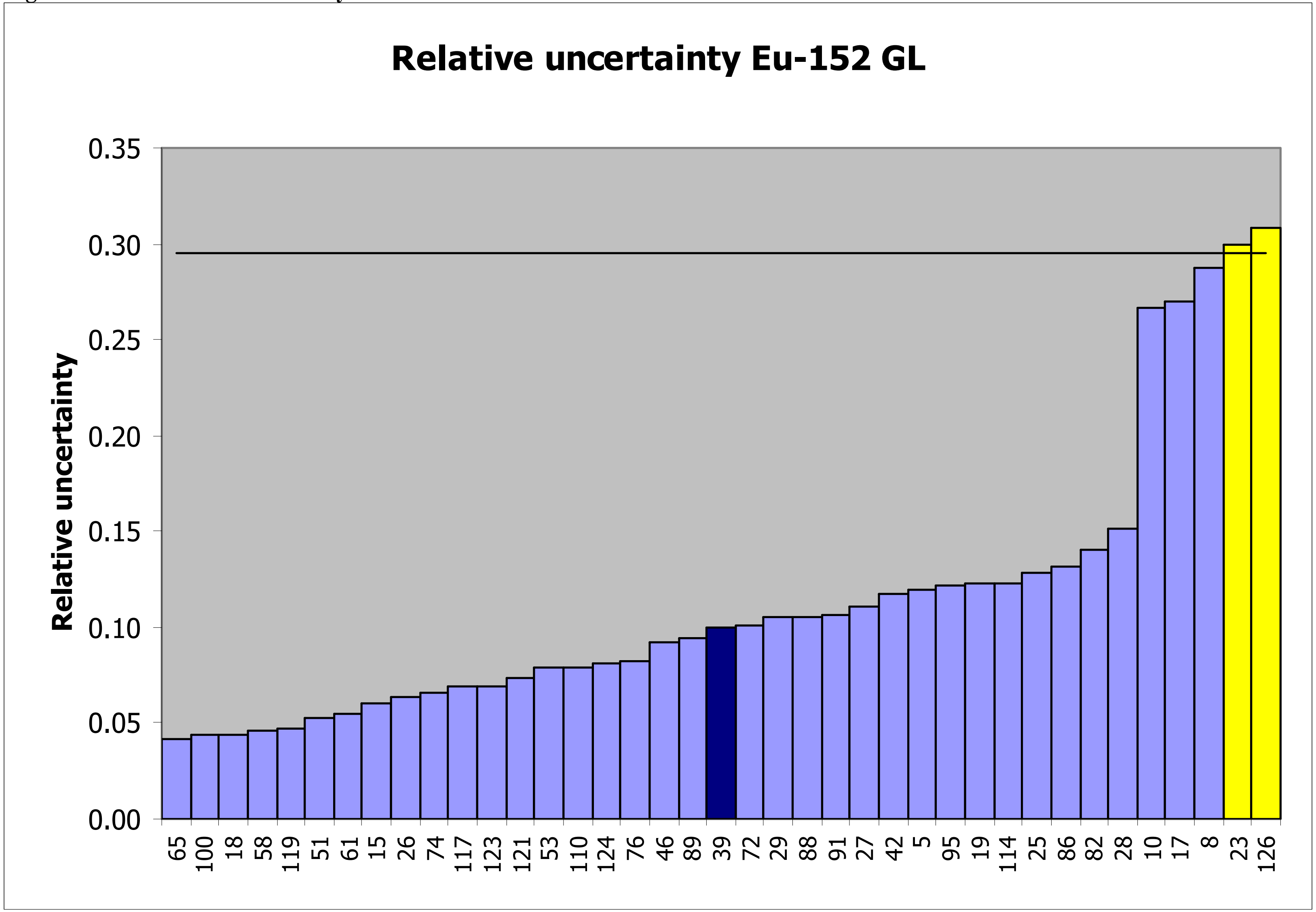


Figure 31D – Kiri plot Eu-152 GL

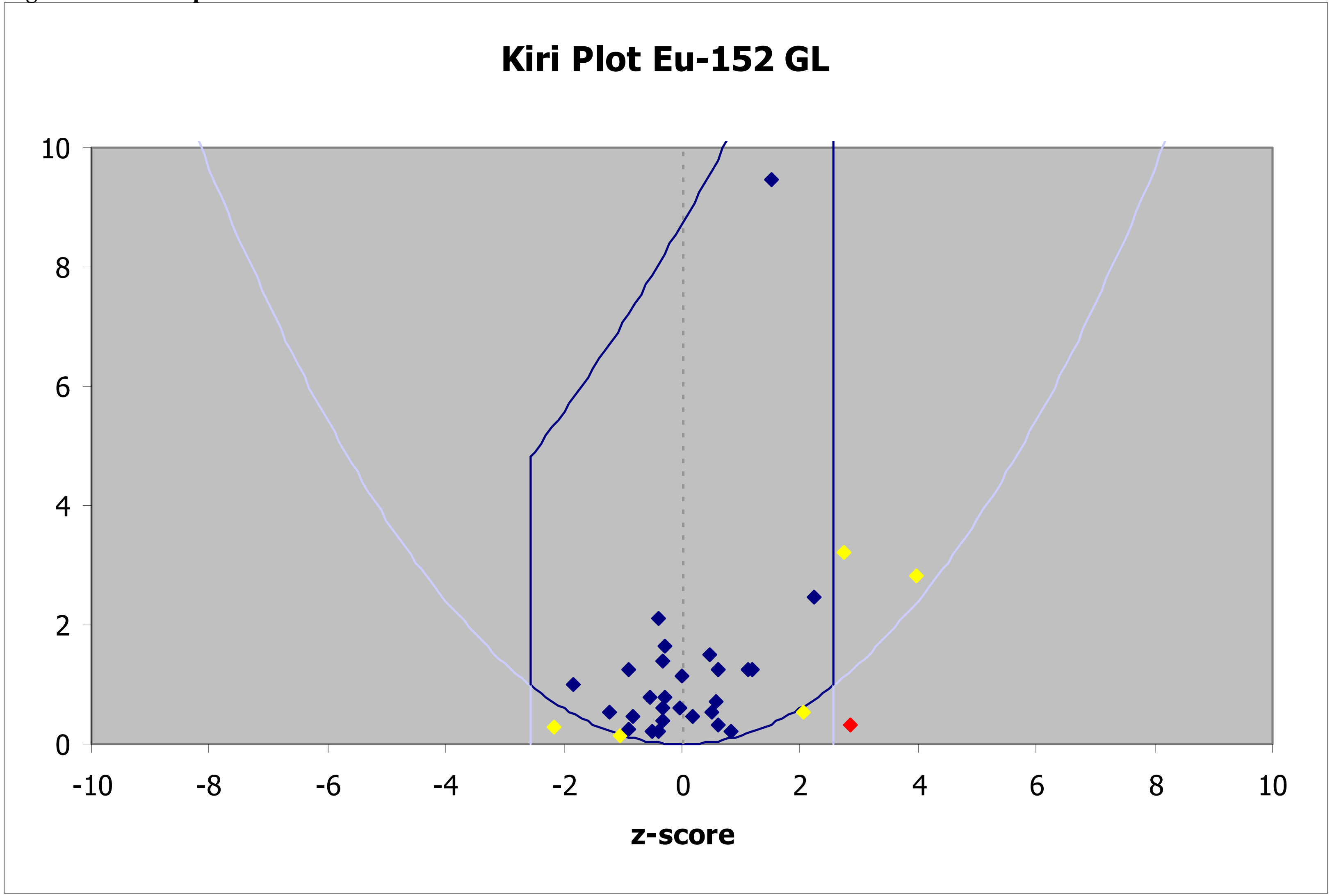


Figure 32A – Deviation Co-60 GH

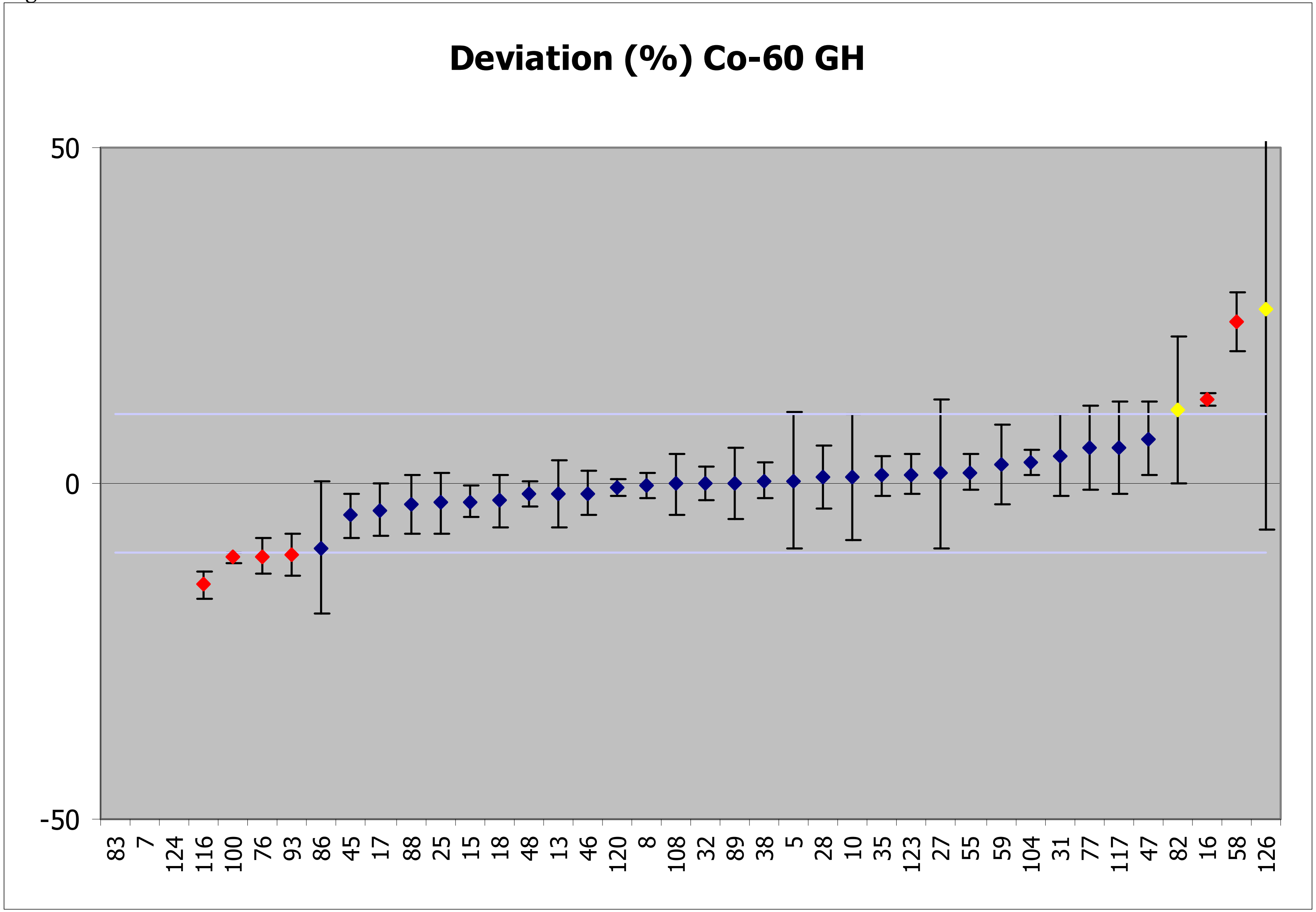


Figure 32B – Zeta score Co-60 GH

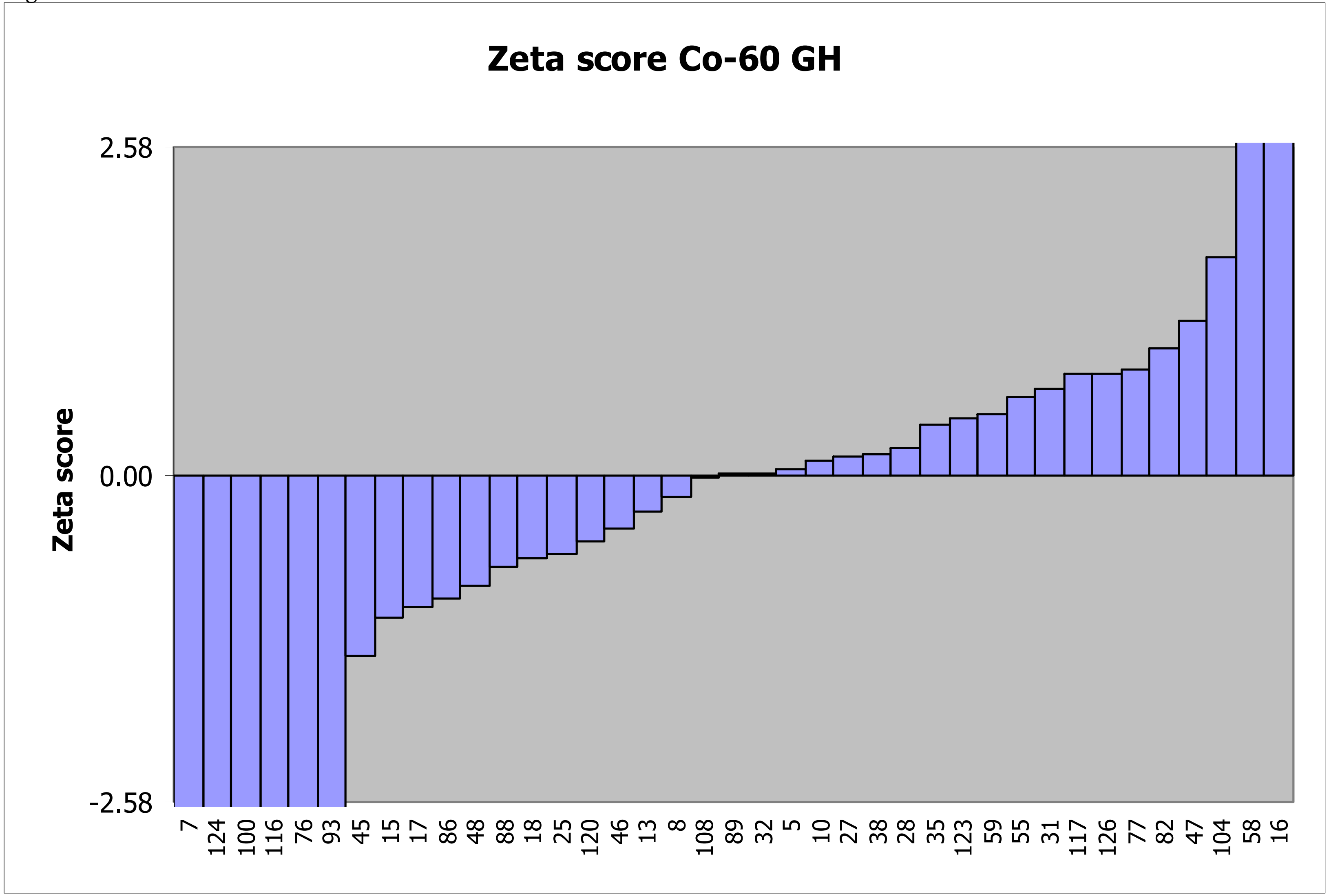


Figure 32C – Relative uncertainty Co-60 GH

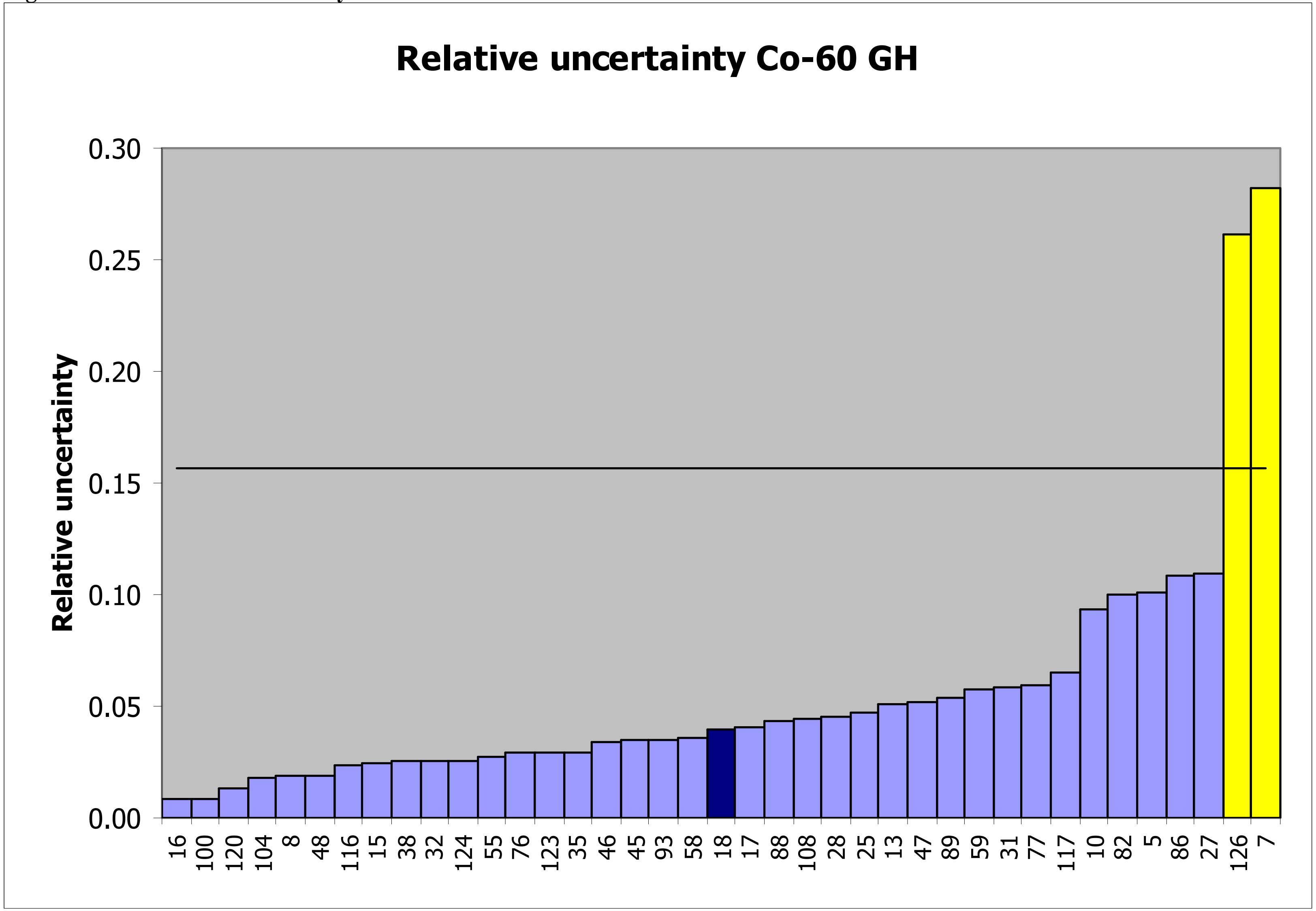


Figure 32D – Kiri plot Co-60 GH

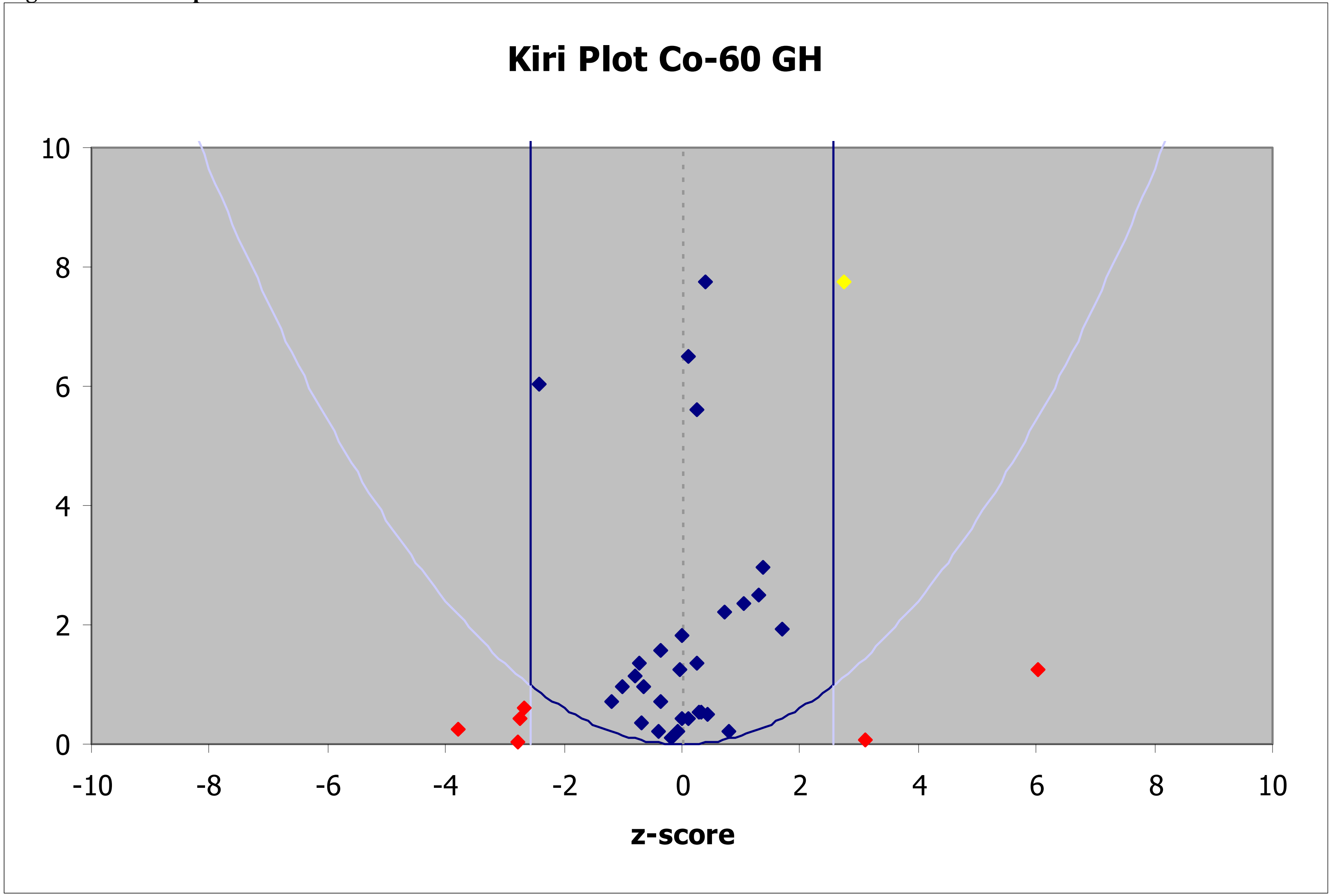


Figure 33A – Deviation Zn-65 GH

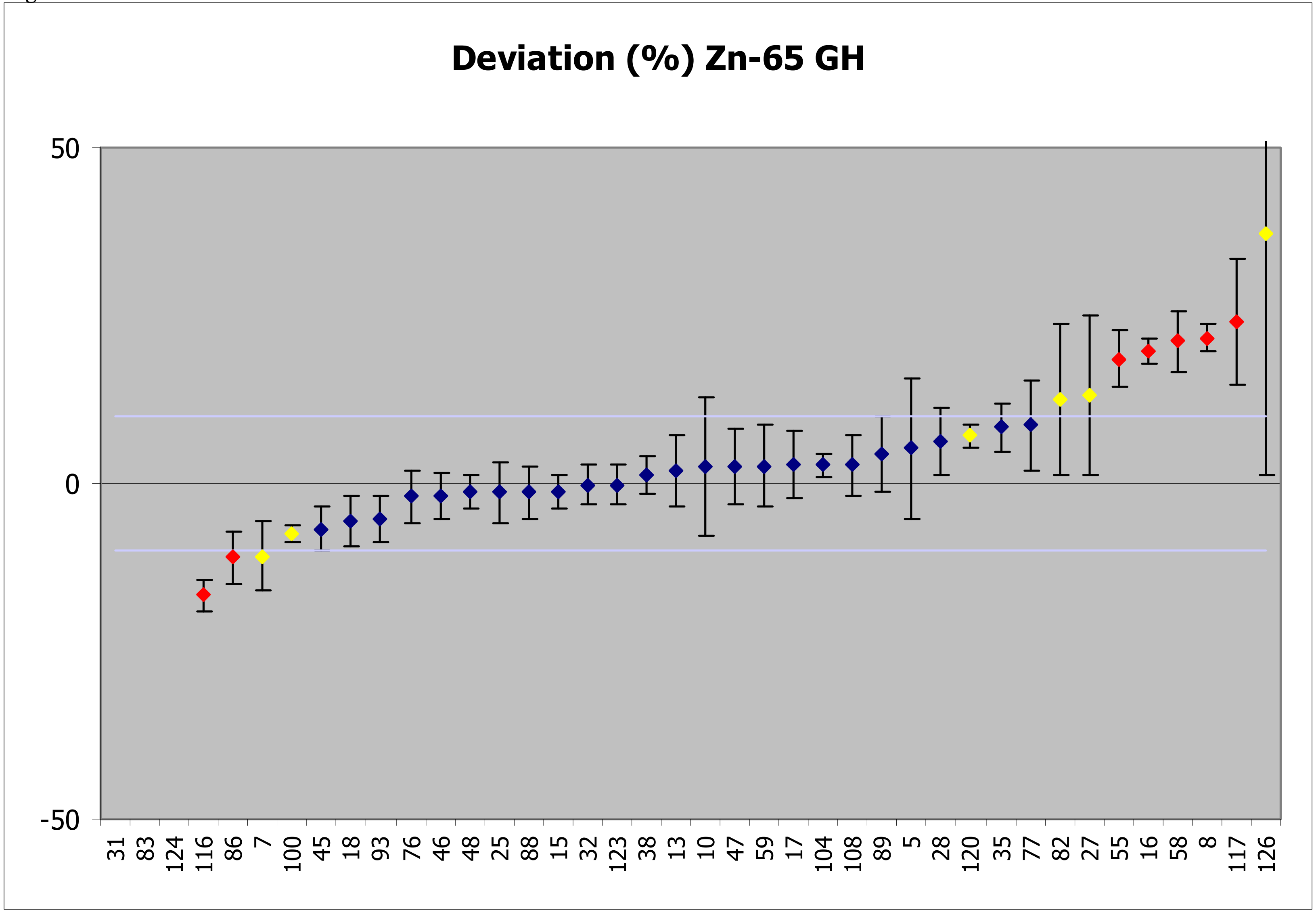


Figure 33B – Zeta score Zn-65 GH

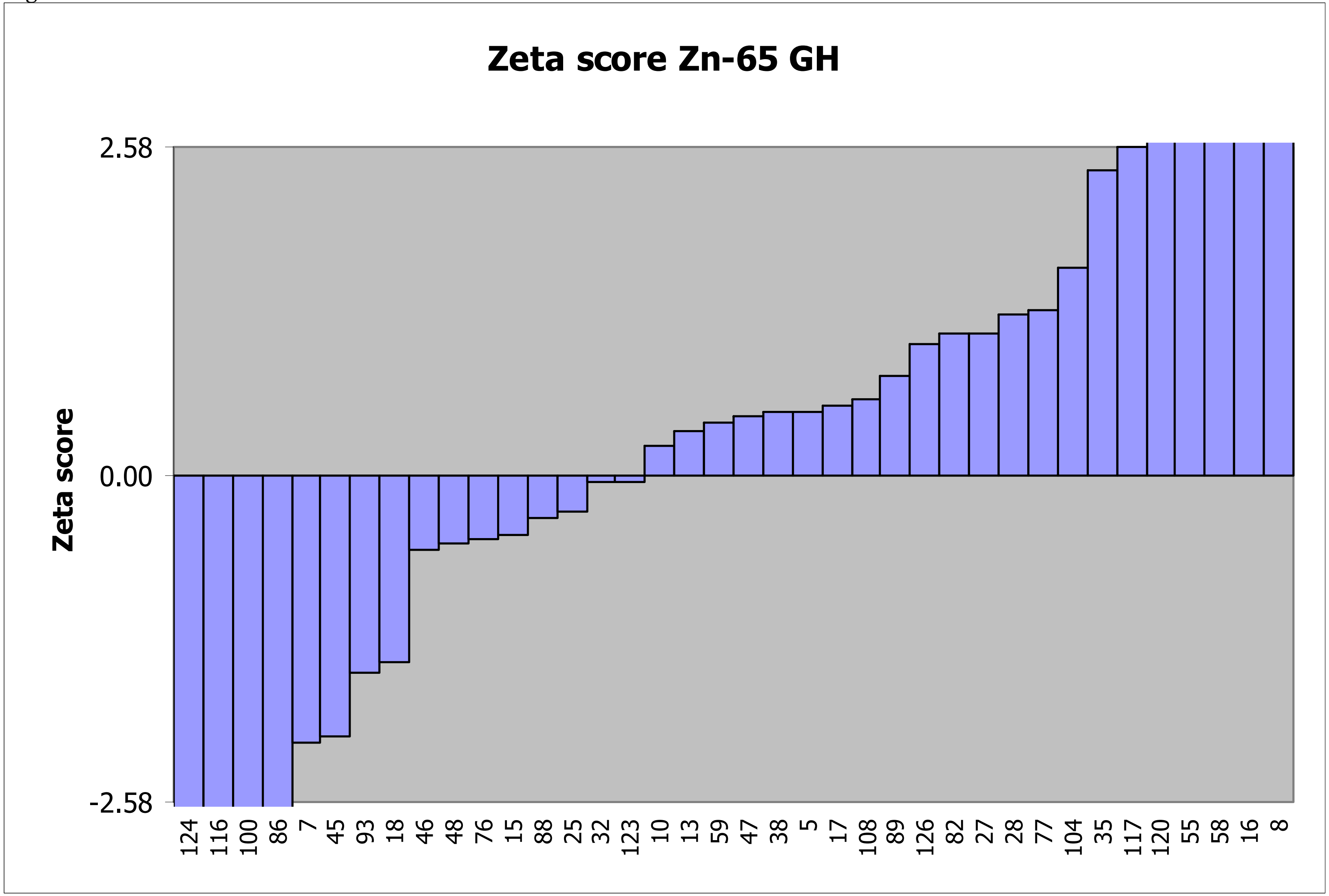


Figure 33C – Relative uncertainty Zn-65 GH

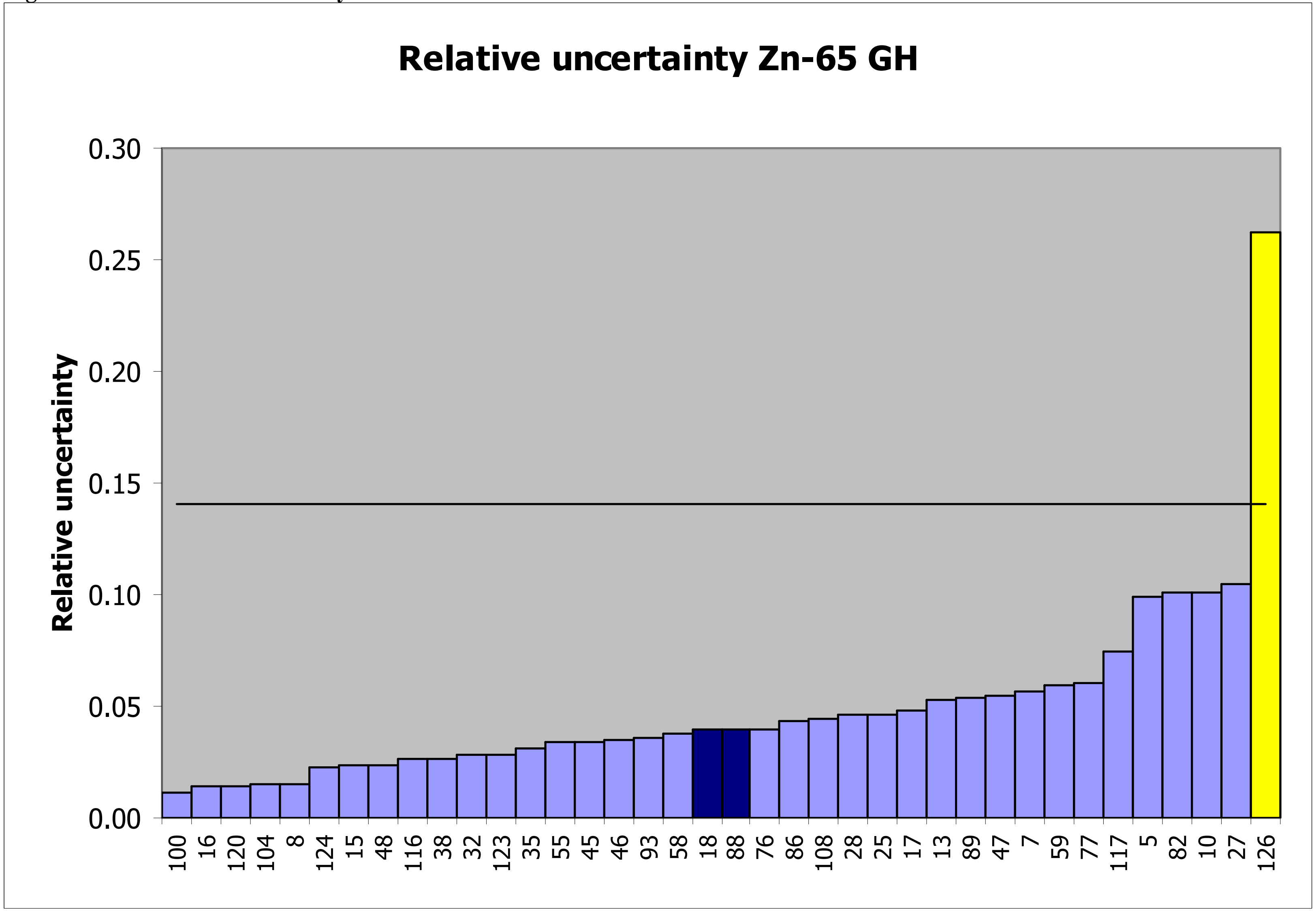


Figure 33D – Kiri plot Zn-65 GH

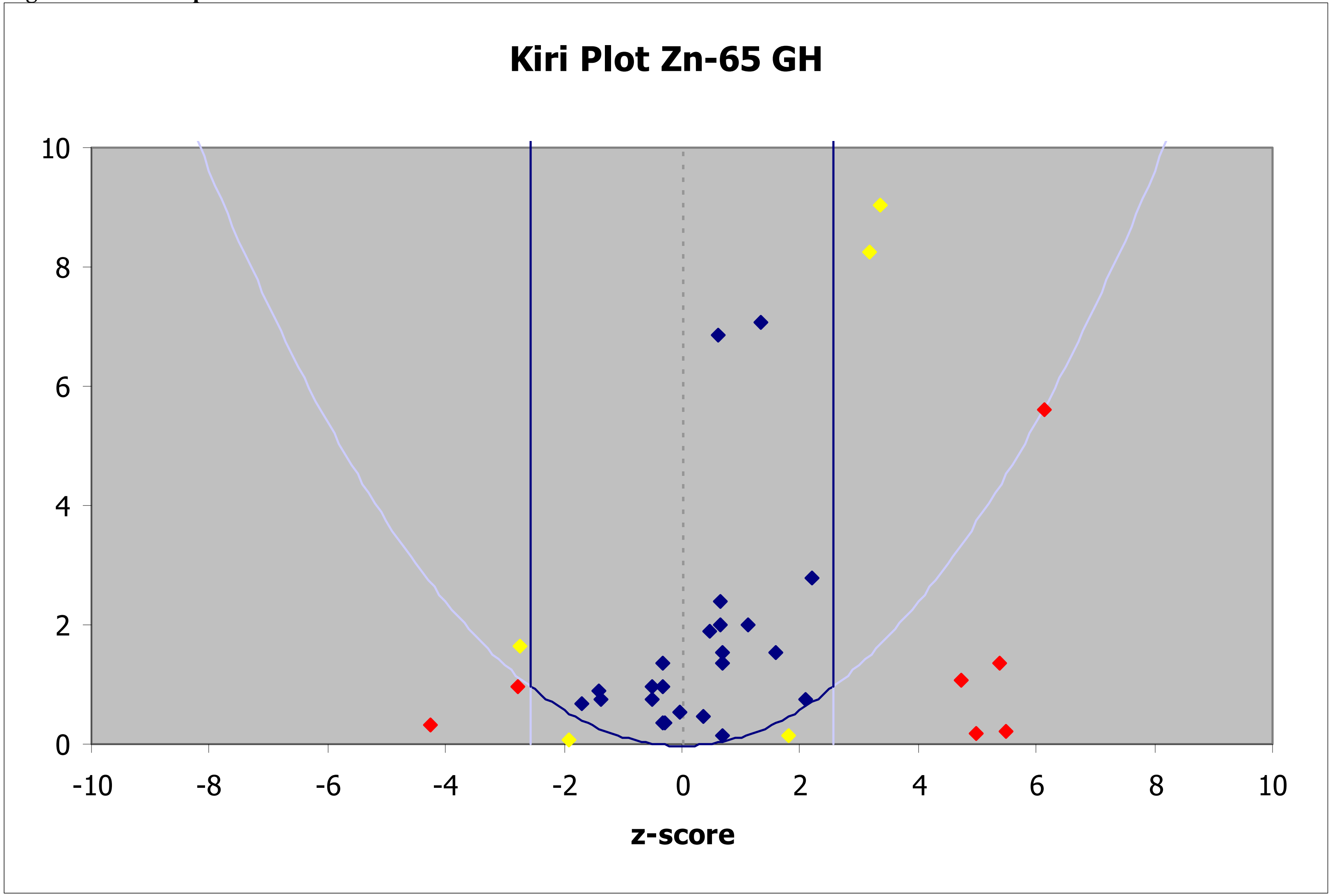


Figure 34A – Deviation Sr-85 GH

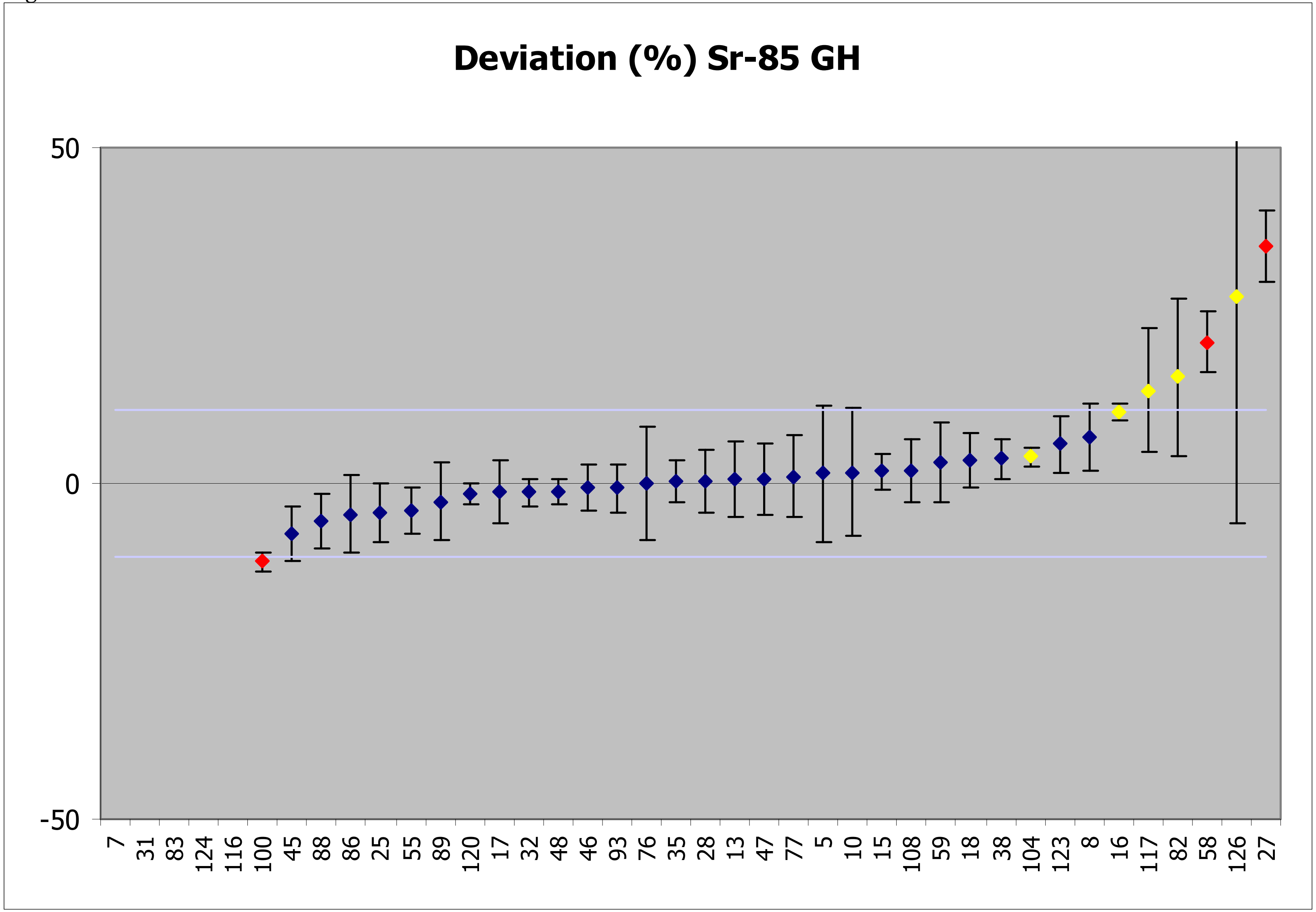


Figure 34B – Zeta score Sr-85 GH

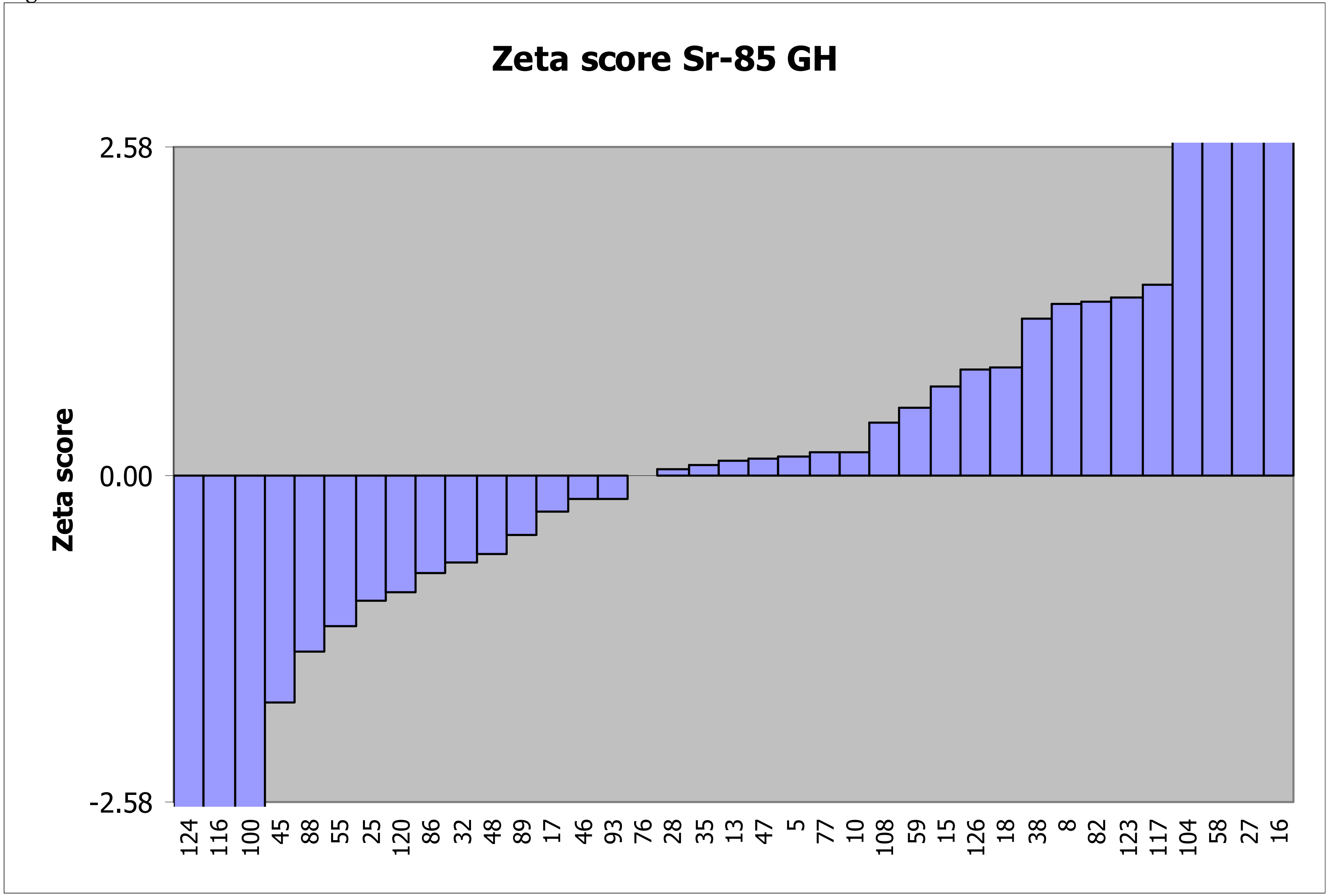


Figure 34C – Relative uncertainty Sr-85 GH

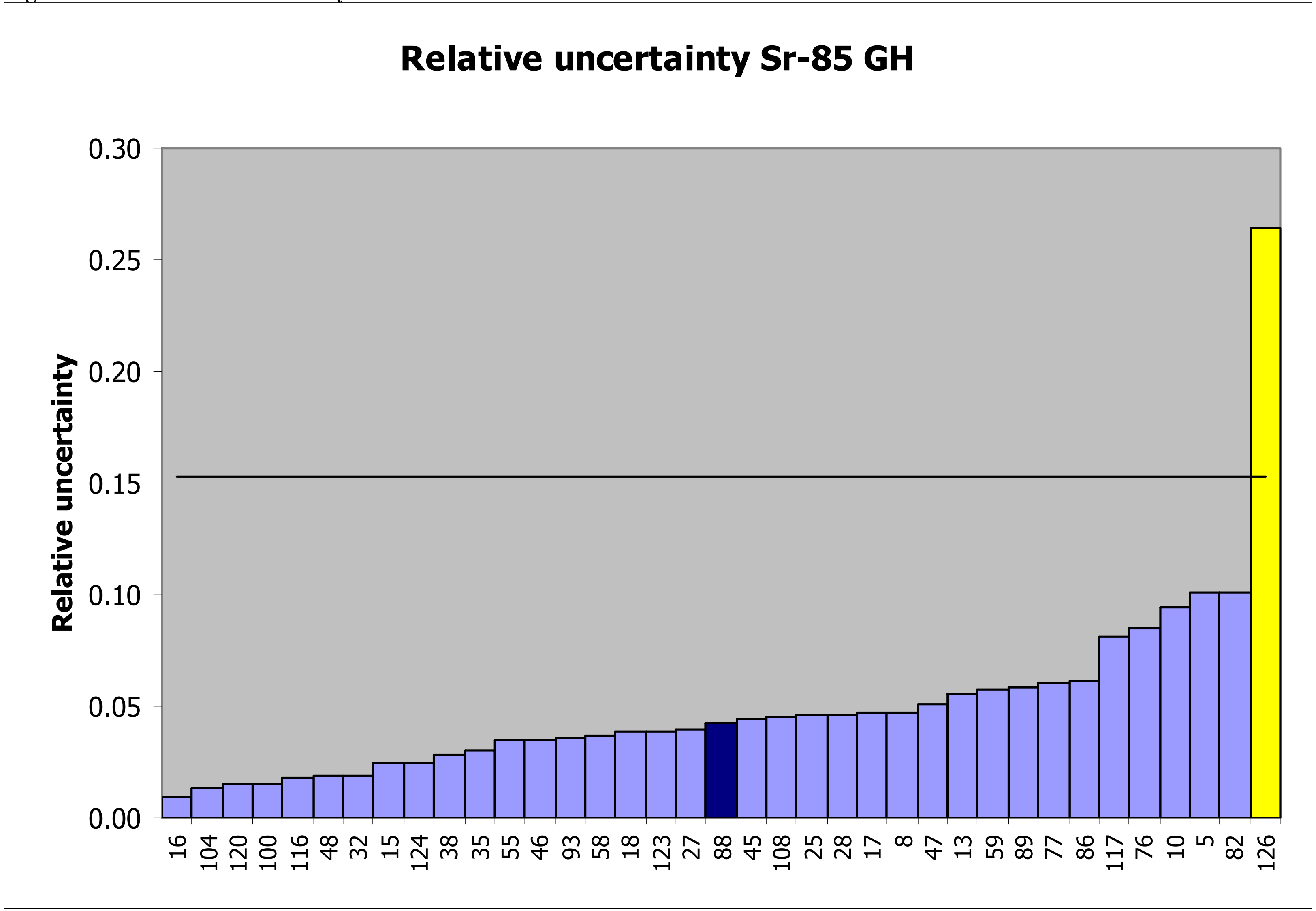


Figure 34D – Kiri plot Sr-85 GH

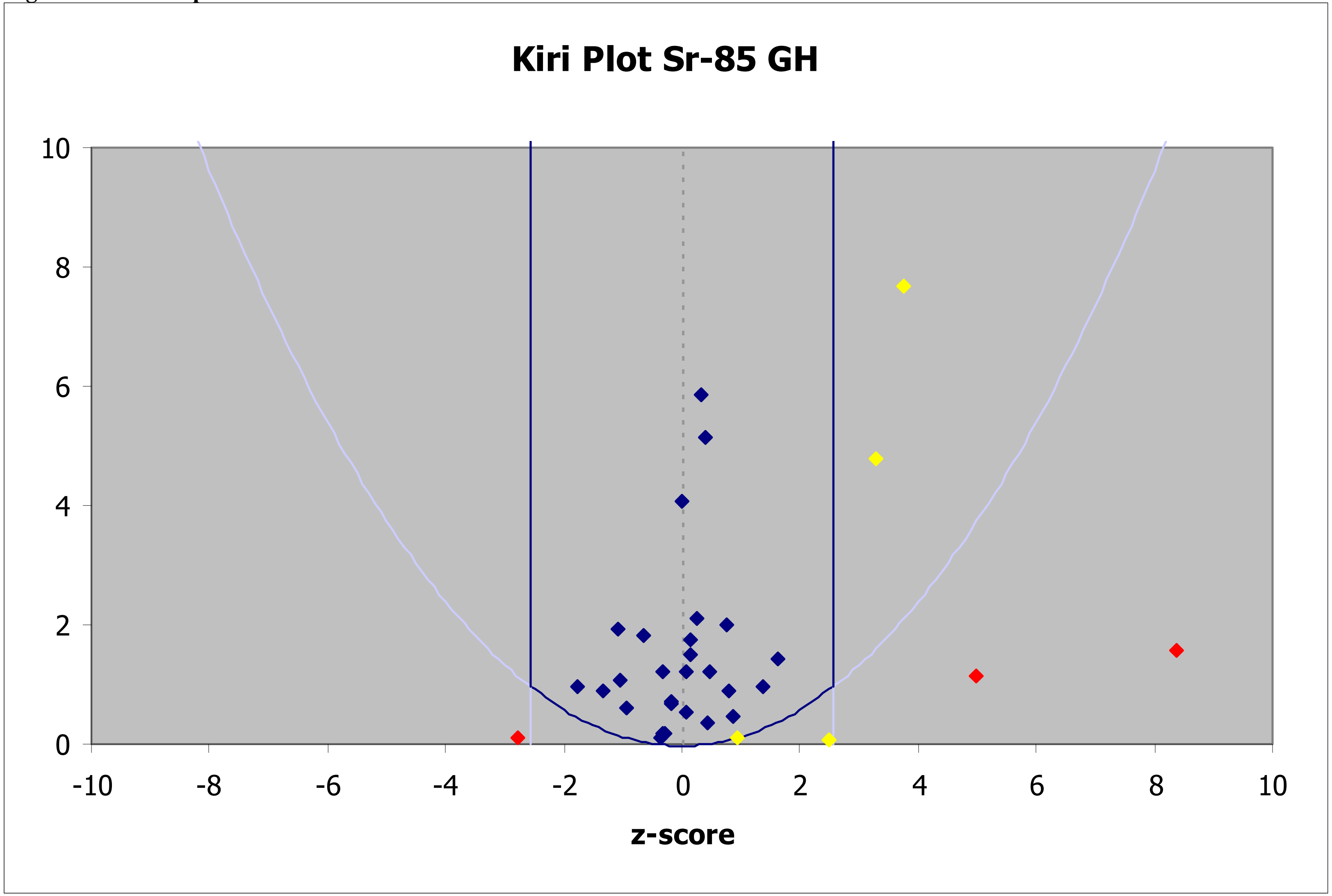


Figure 35A – Deviation Sb-125 GH

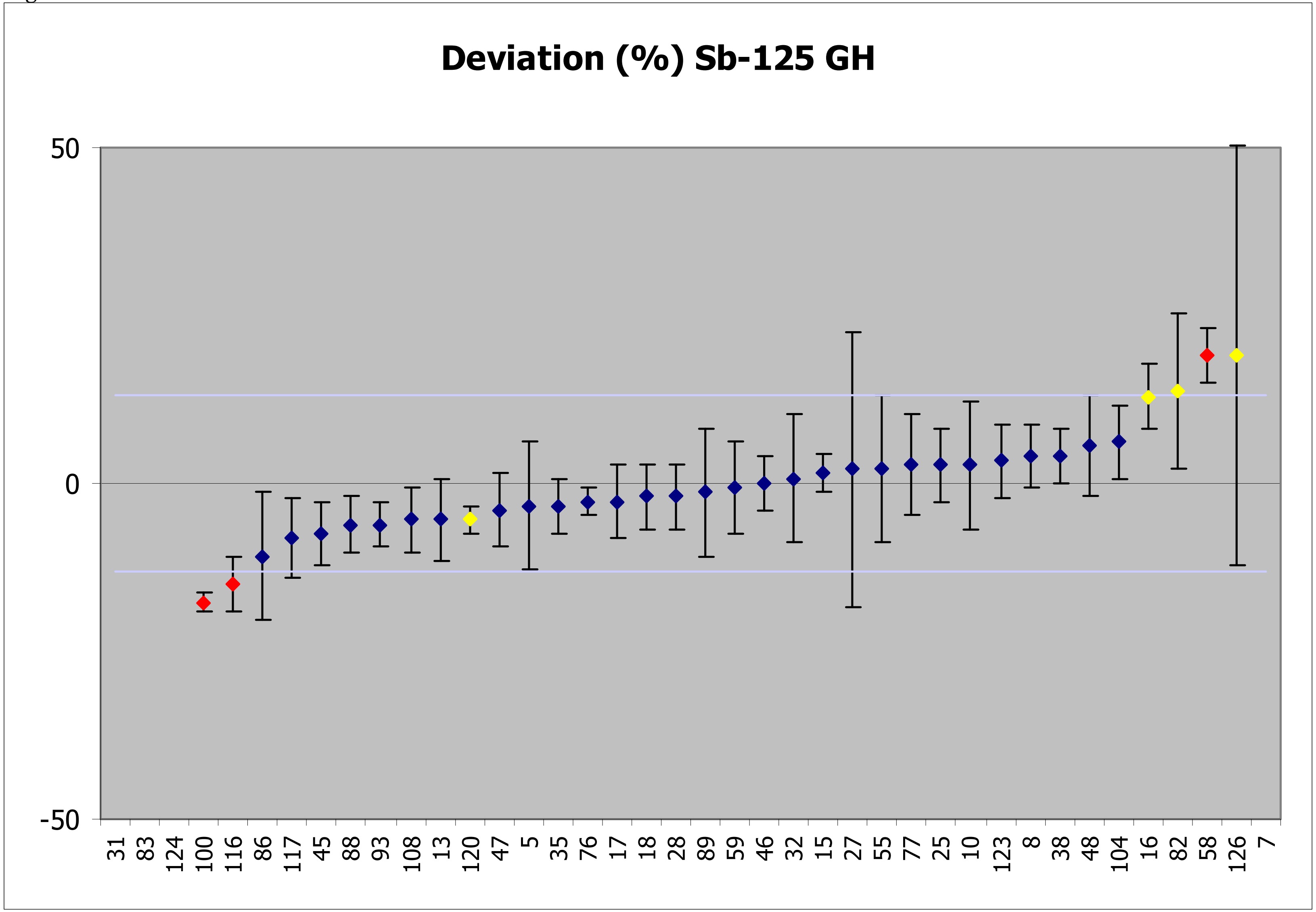


Figure 35B – Zeta score Sb-125 GH

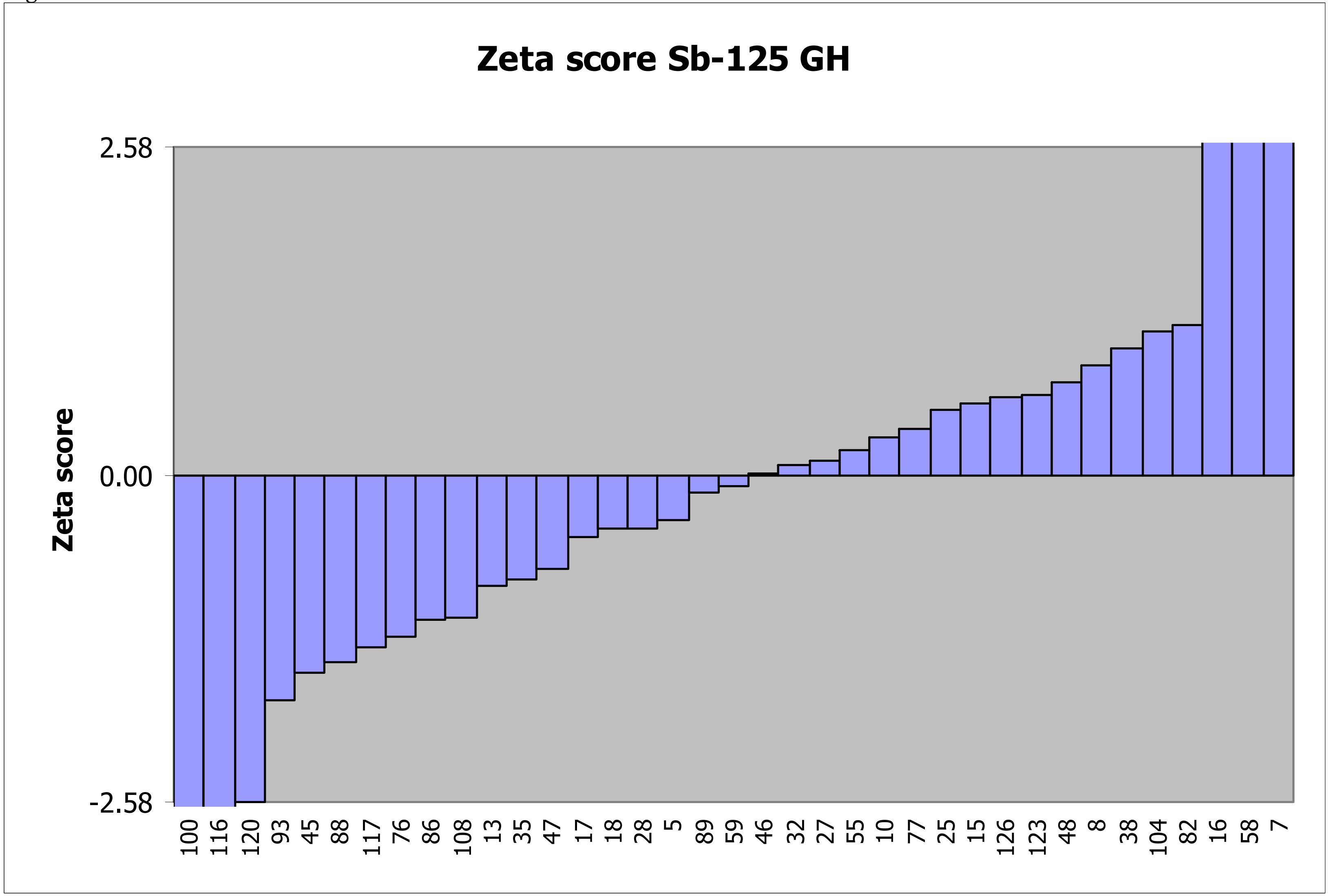


Figure 35C – Relative uncertainty Sb-125 GH

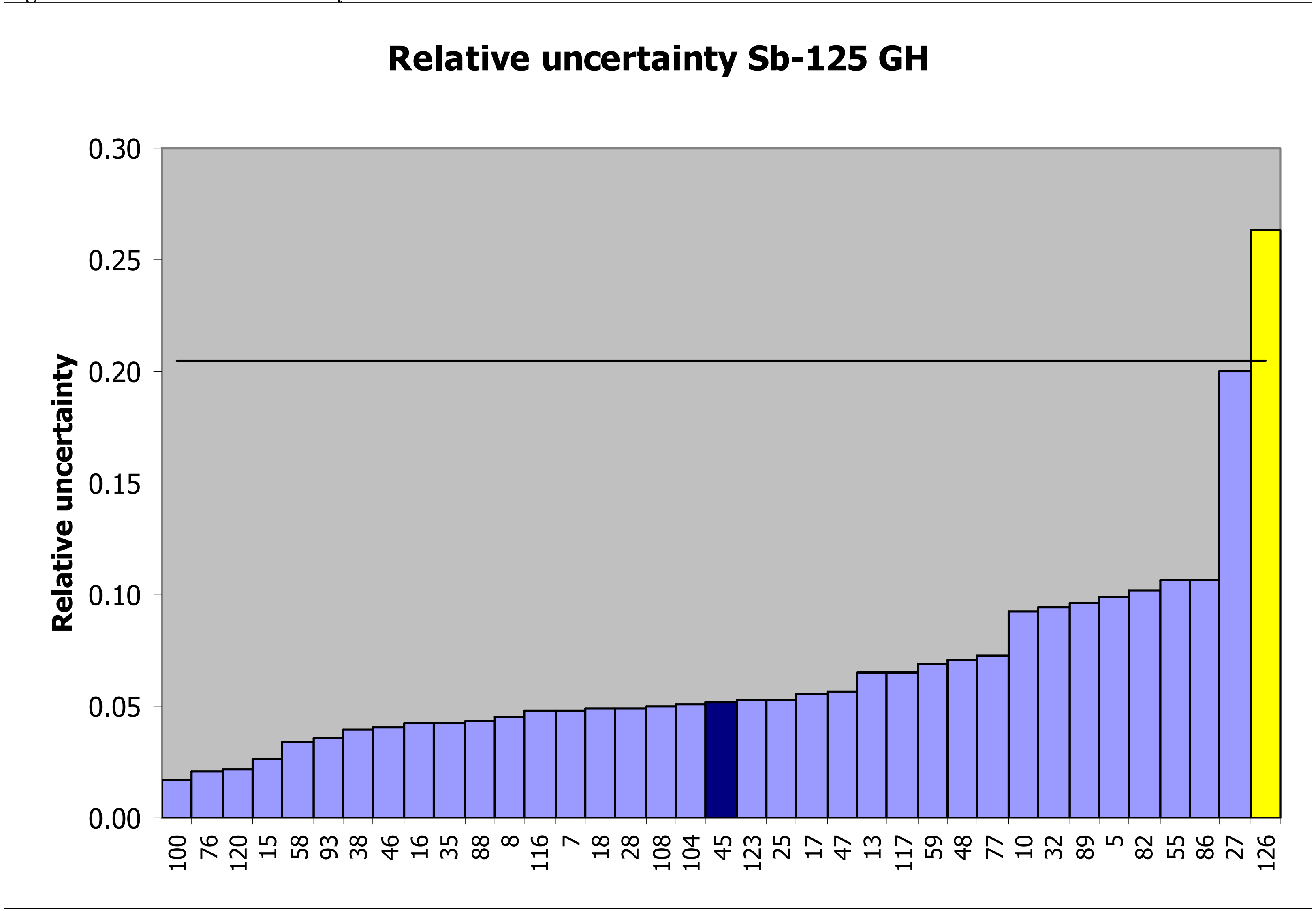


Figure 35D – Kiri plot Sb-125 GH

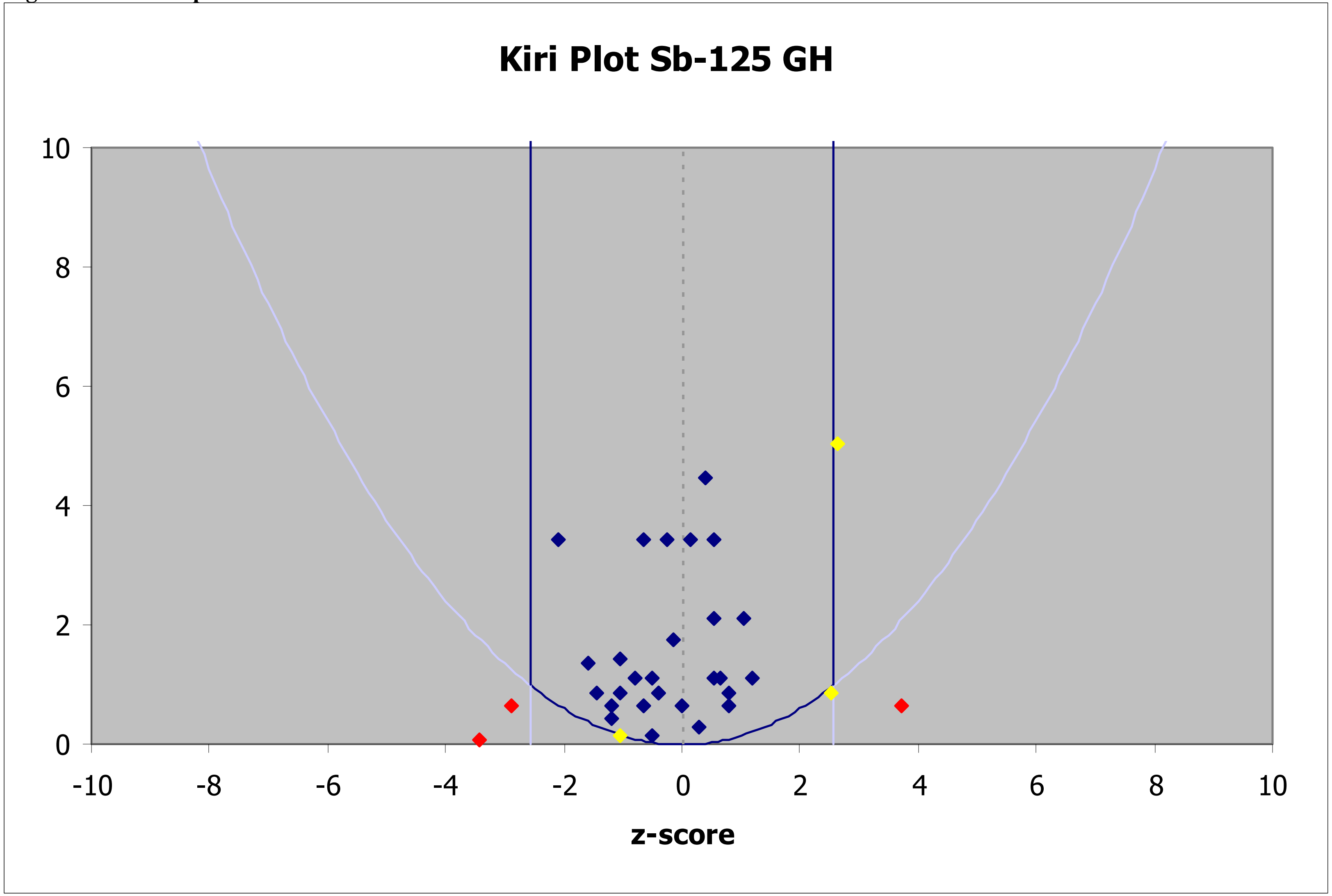


Figure 36A – Deviation Ba-133 GH

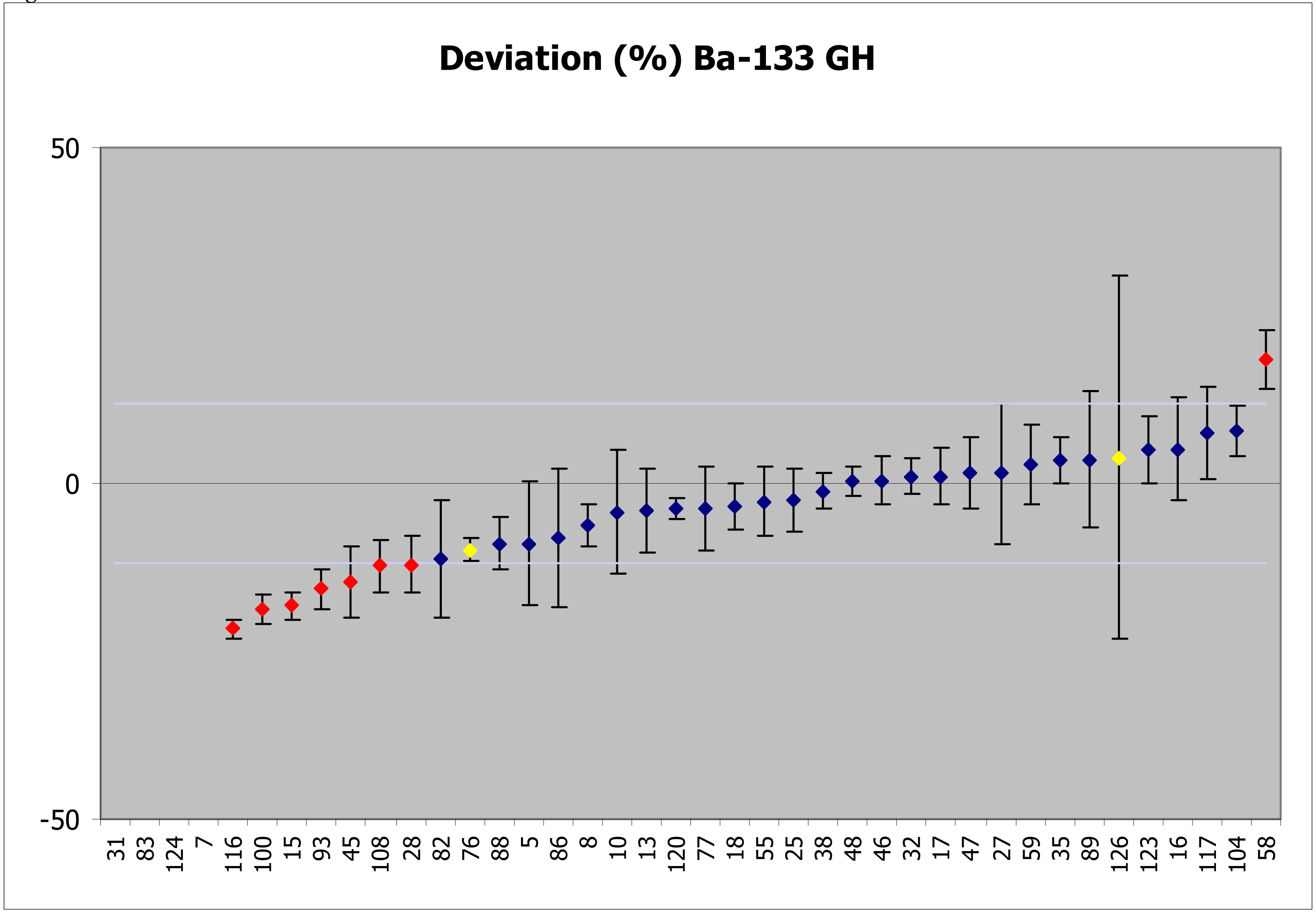


Figure 36B – Zeta score Ba-133 GH

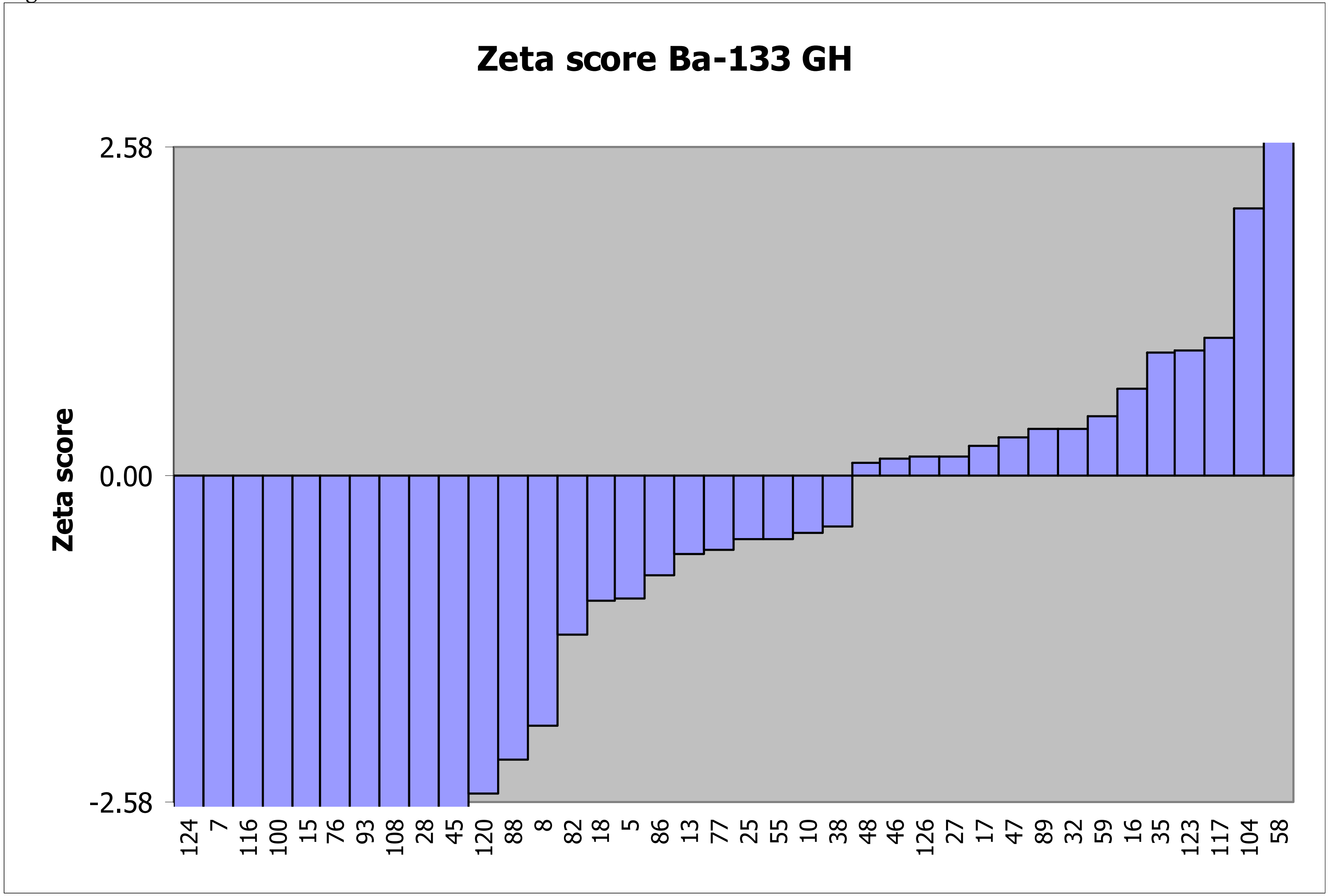


Figure 36C – Relative uncertainty Ba-133 GH

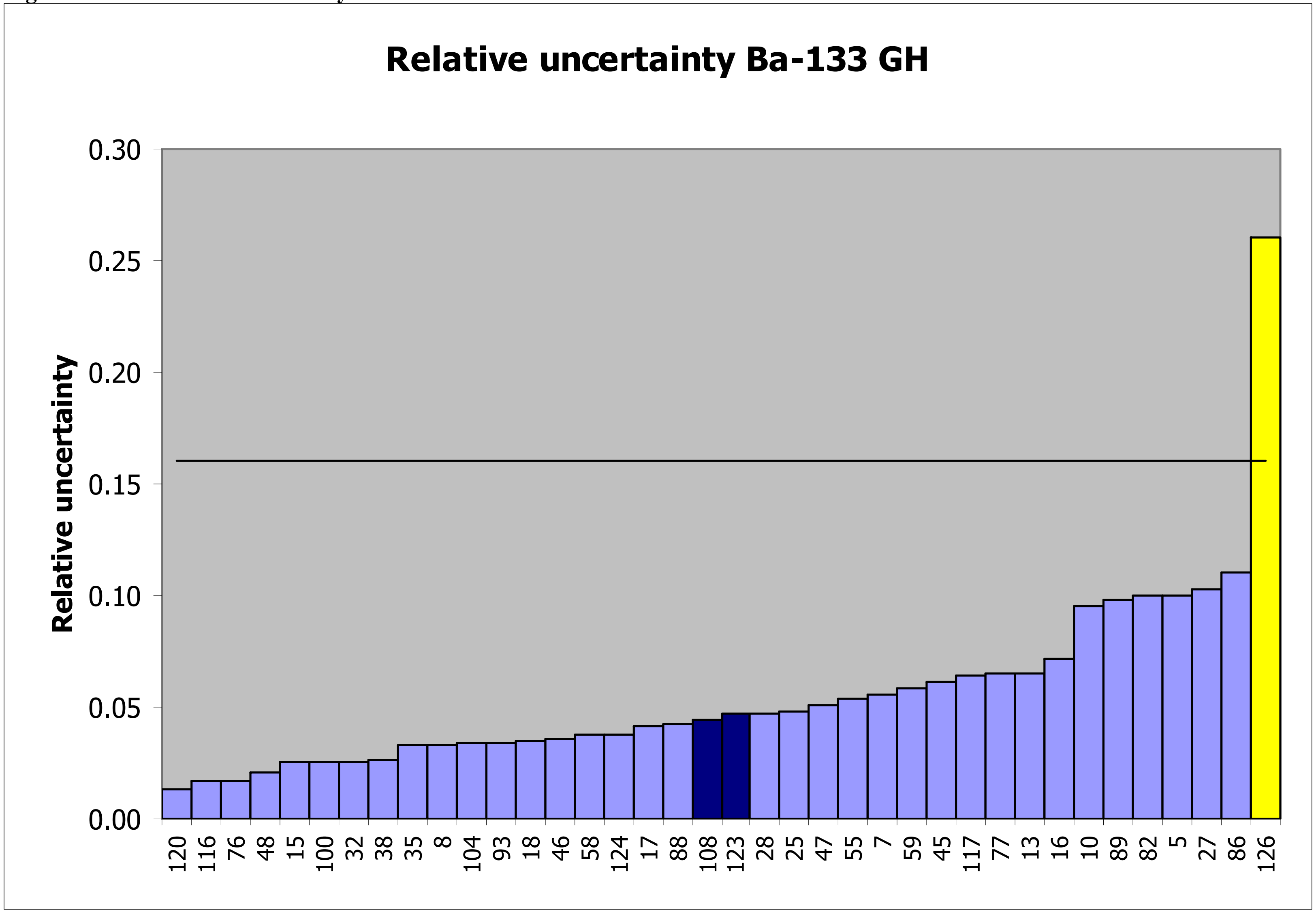


Figure 36D – Kiri plot Ba-133 GH

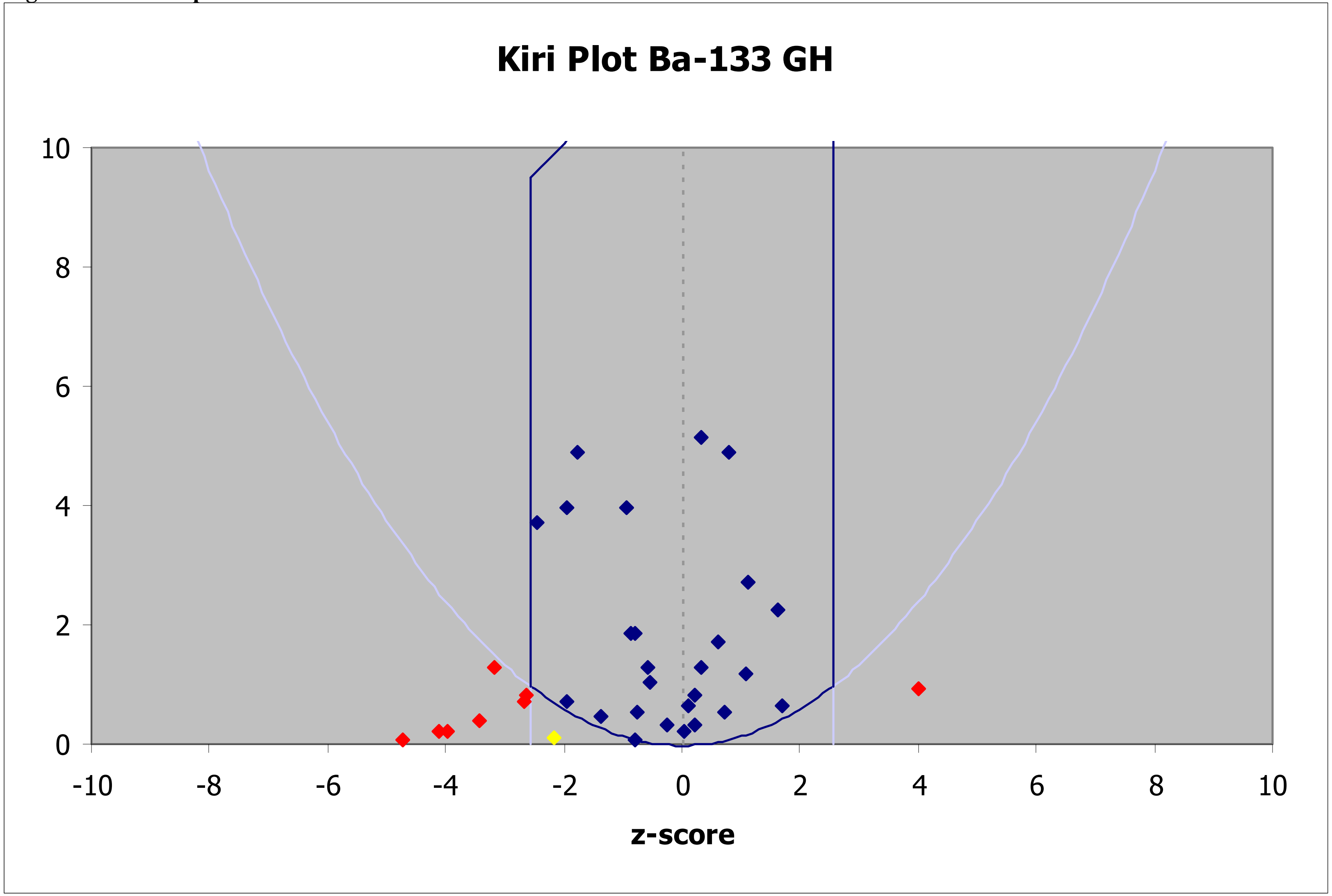


Figure 37A – Deviation Cs-134 GH

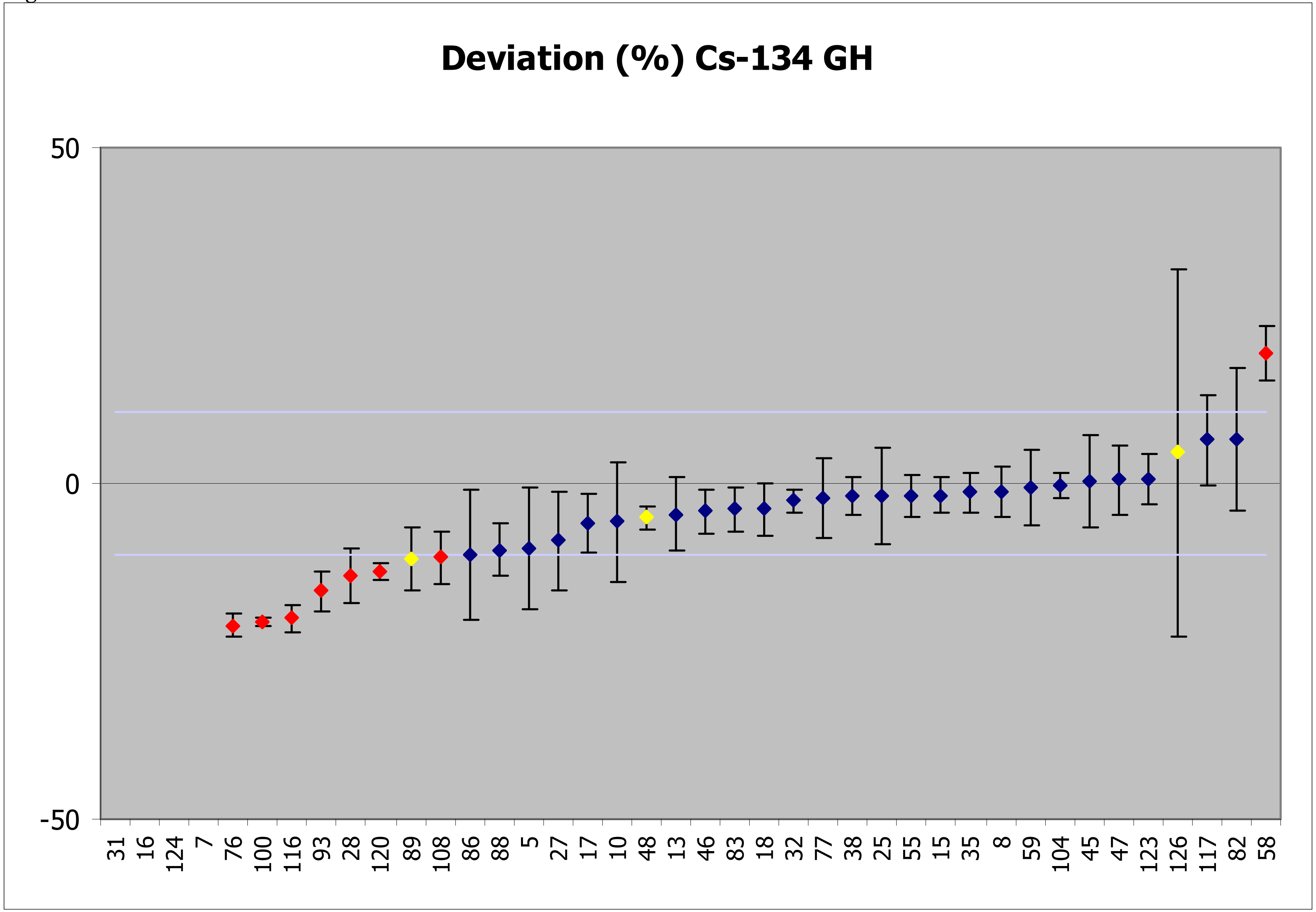


Figure 37B – Zeta score Cs-134 GH

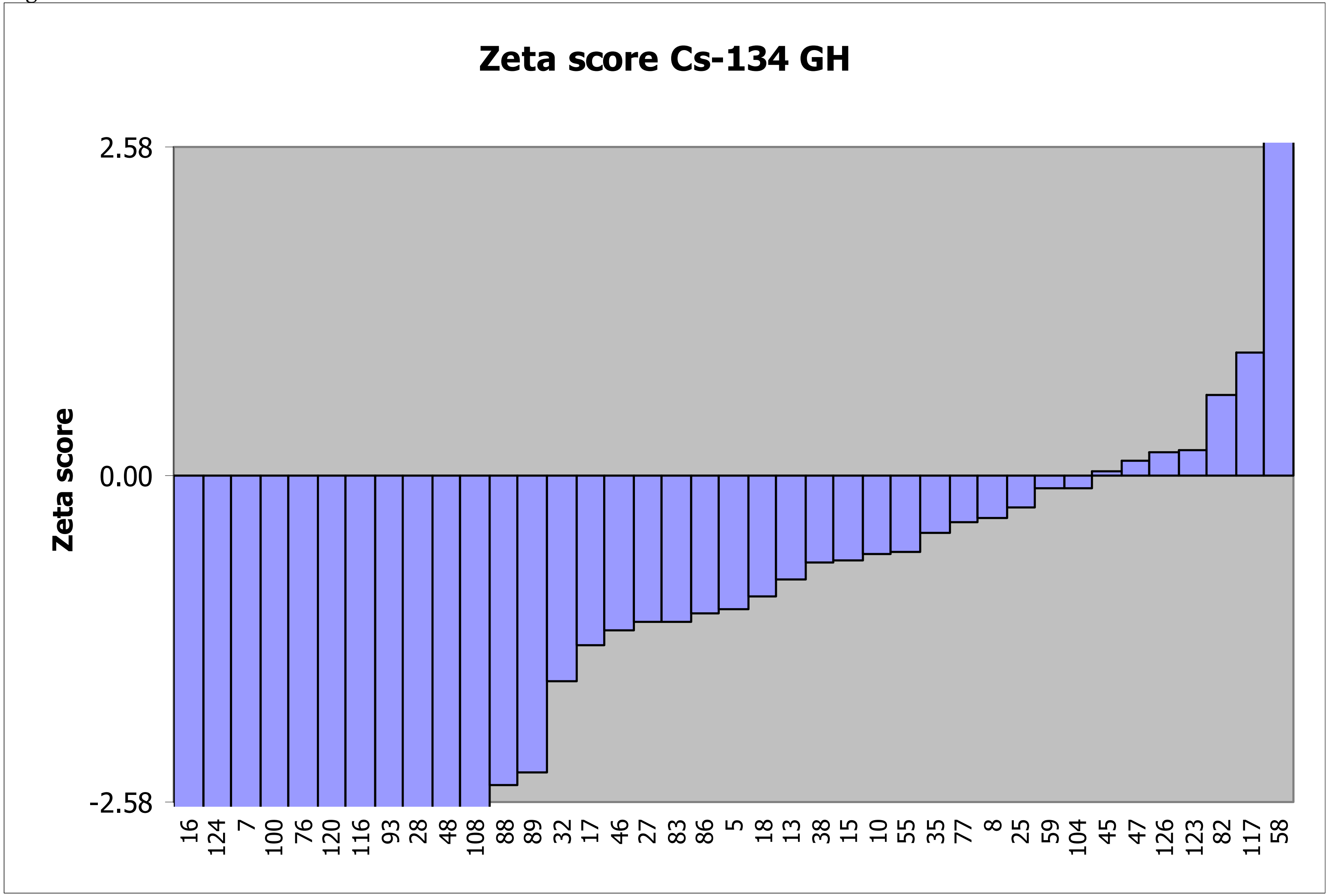


Figure 37C – Relative uncertainty Cs-134 GH

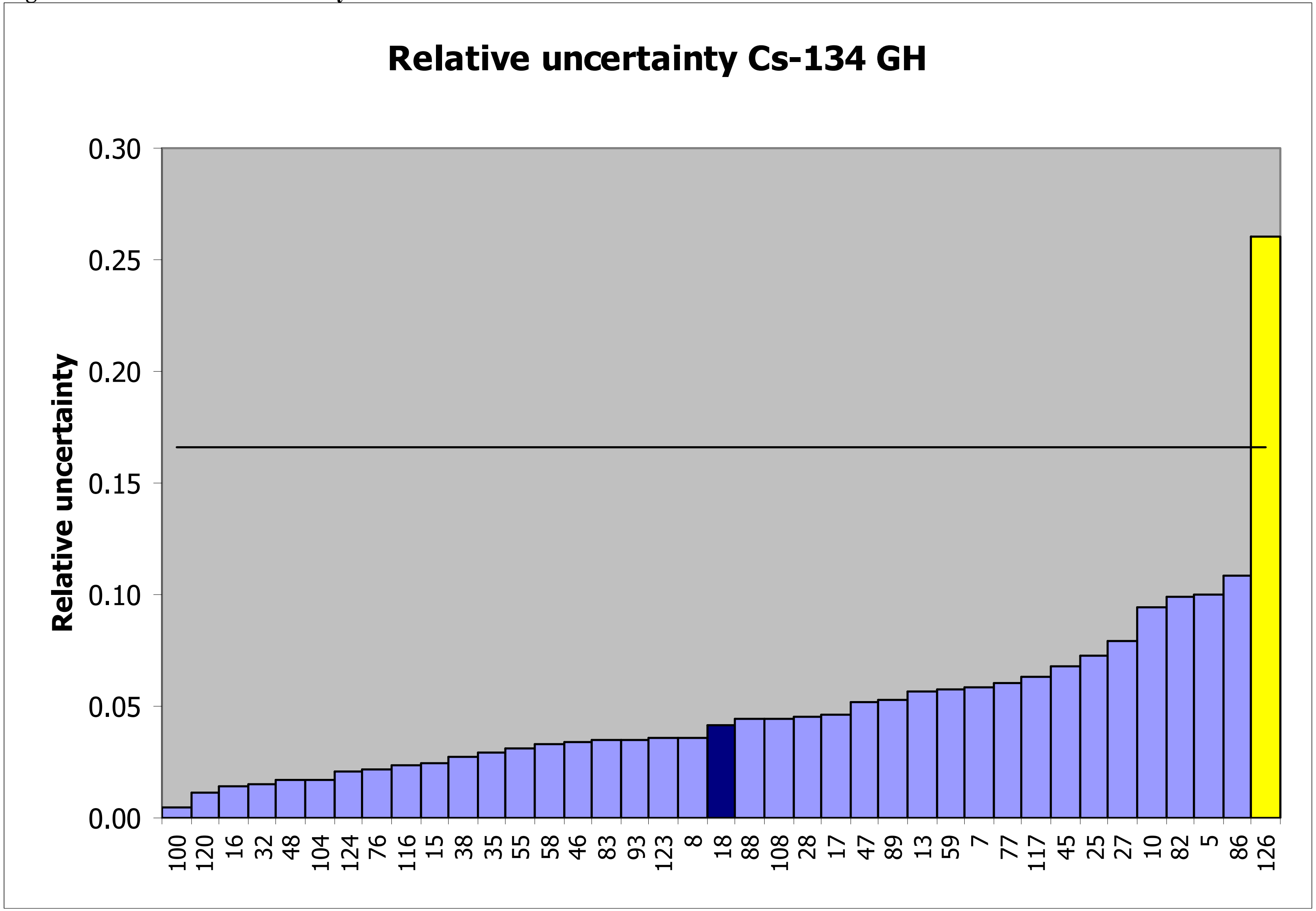


Figure 37D – Kiri plot Cs-134 GH

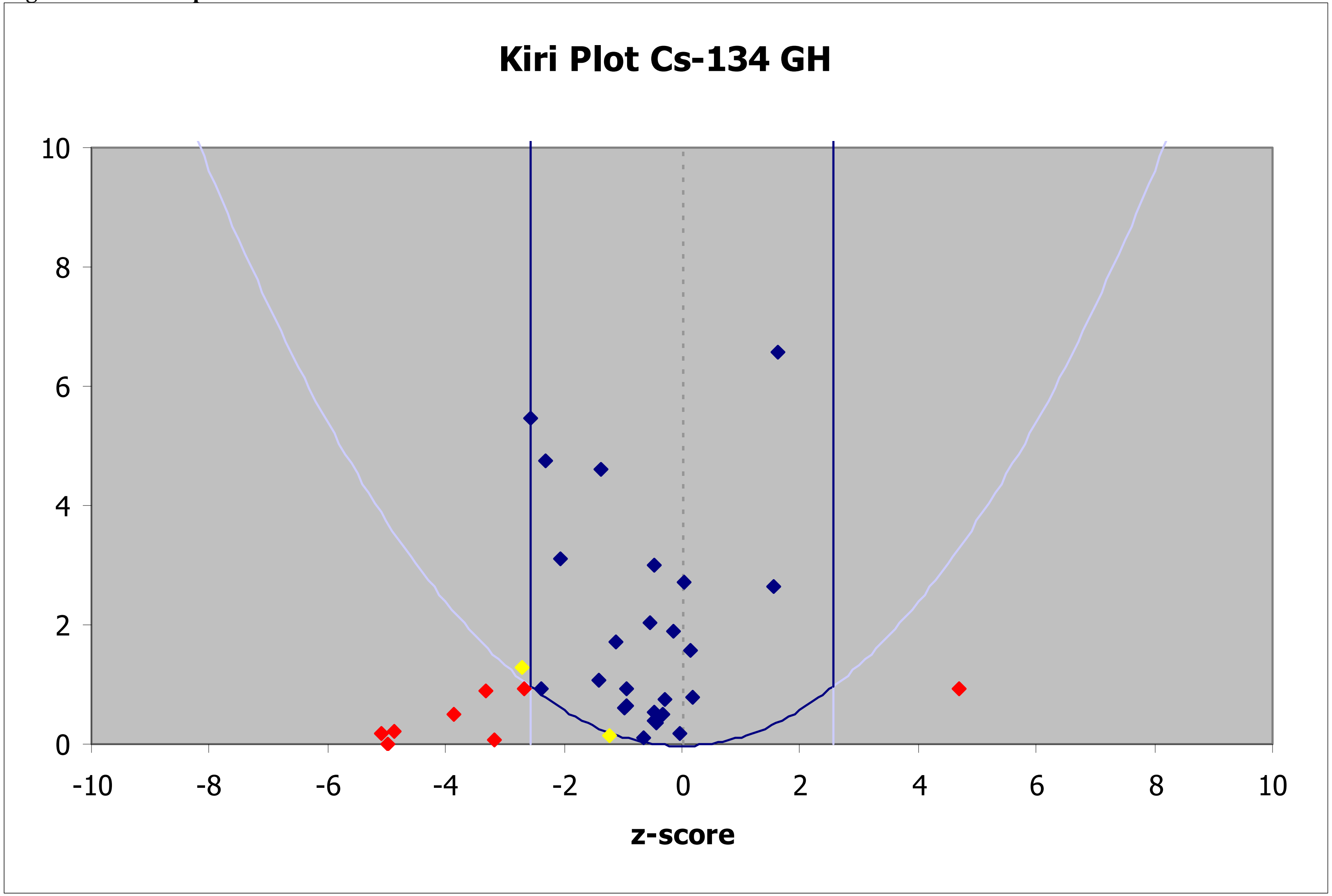


Figure 38A – Deviation Cs-137 GH

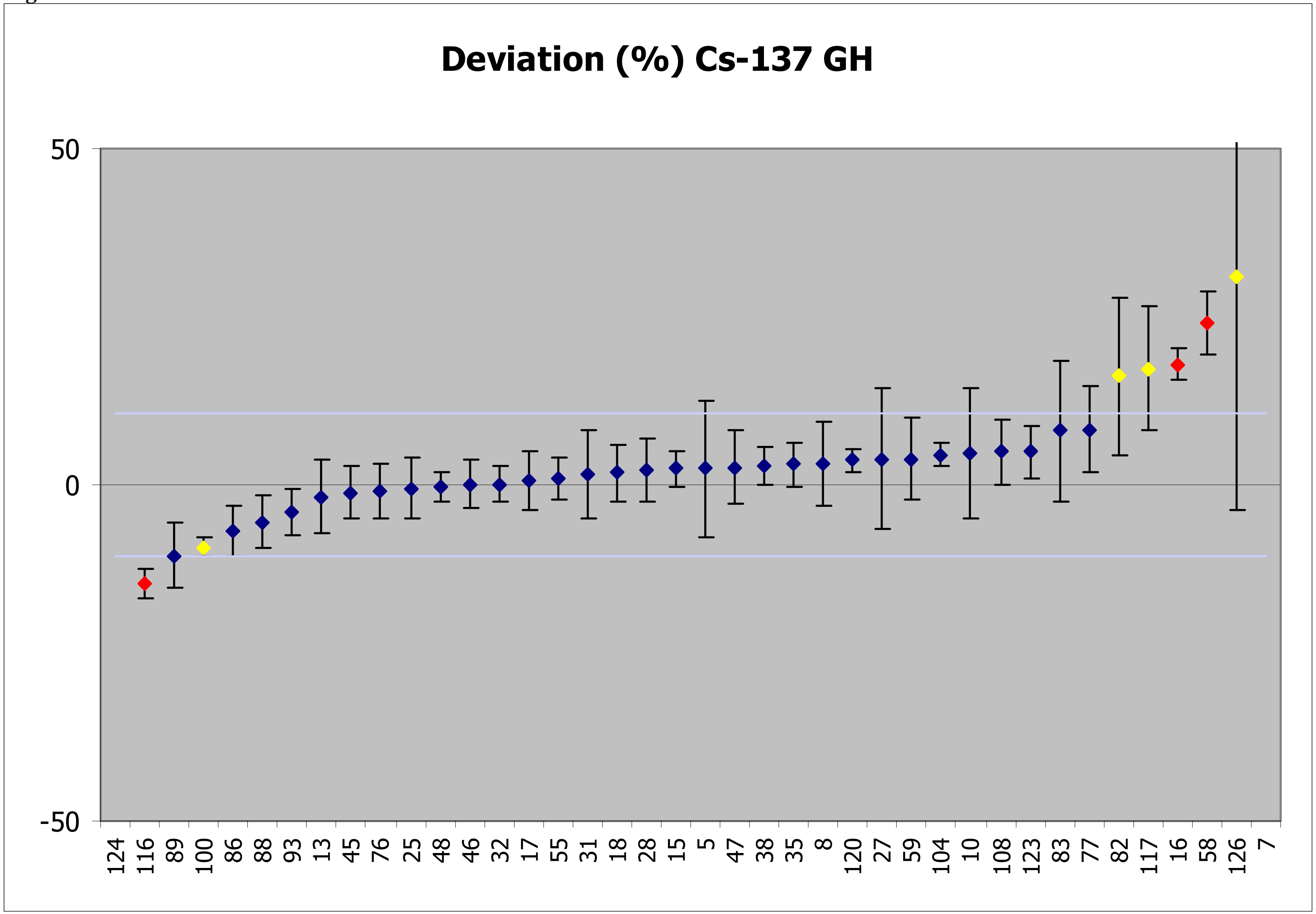


Figure 38B – Zeta score Cs-137 GH

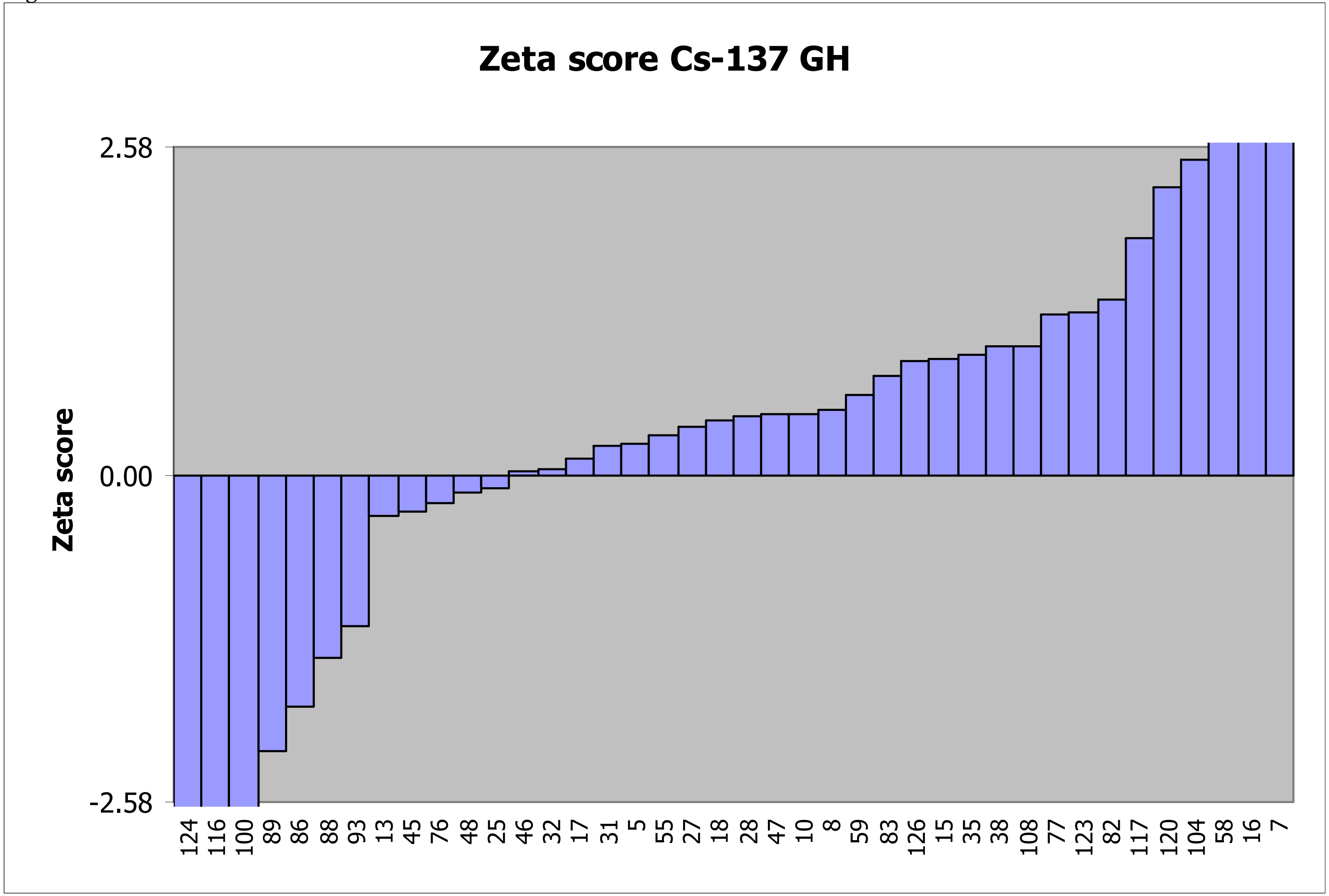


Figure 38C – Relative uncertainty Cs-137 GH

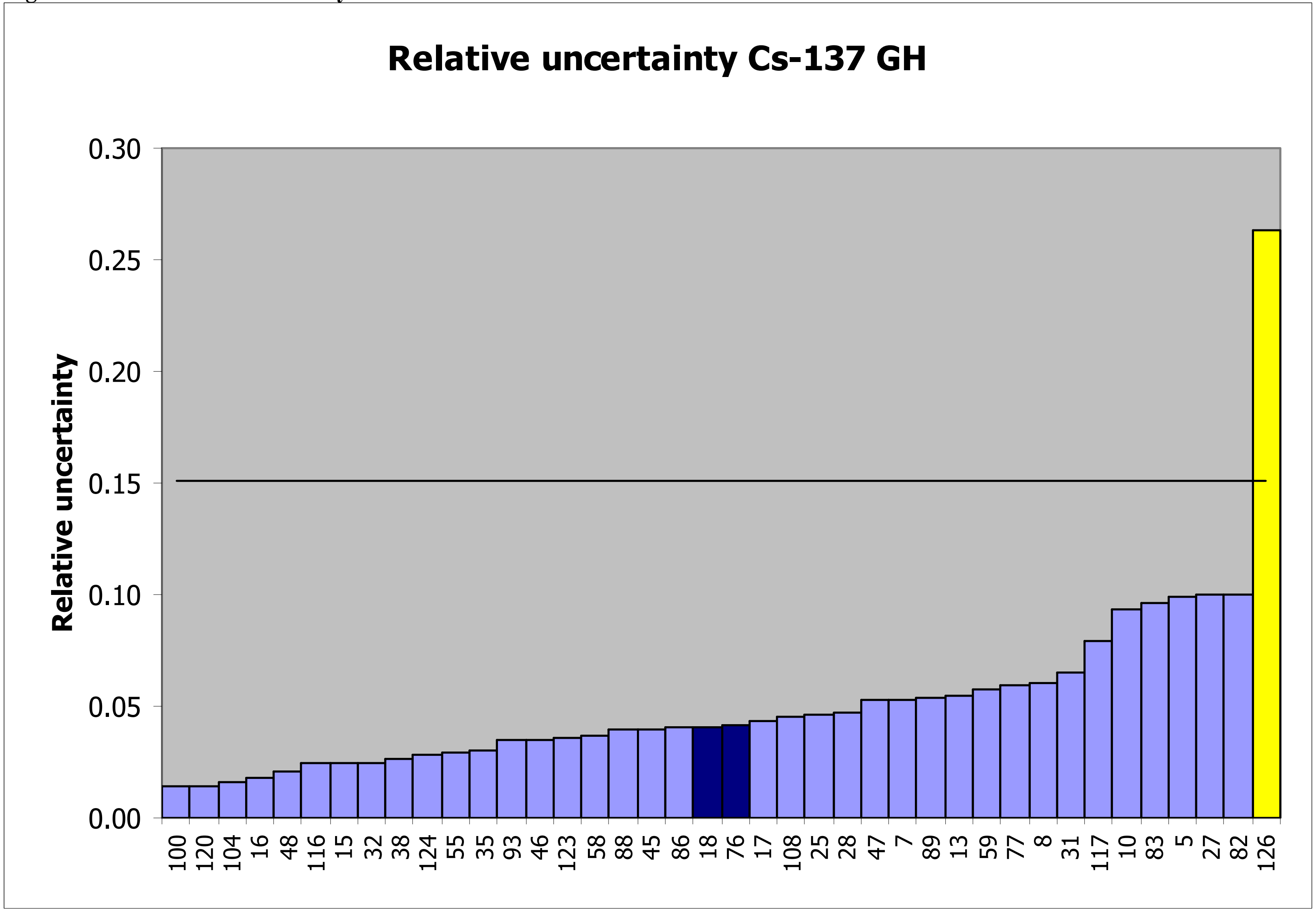


Figure 38D – Kiri plot Cs-137 GH

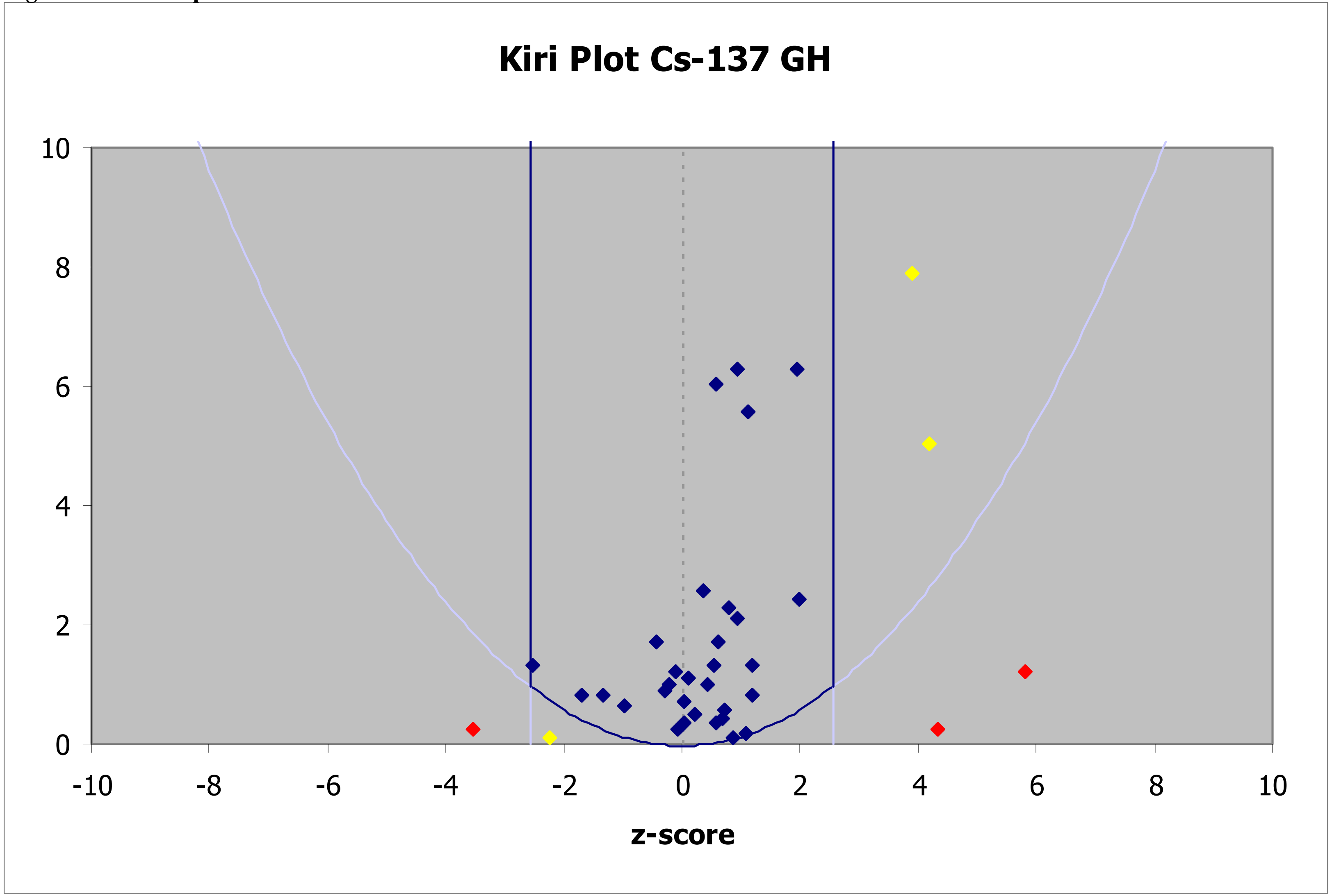


Figure 39A – Deviation Eu-152 GH

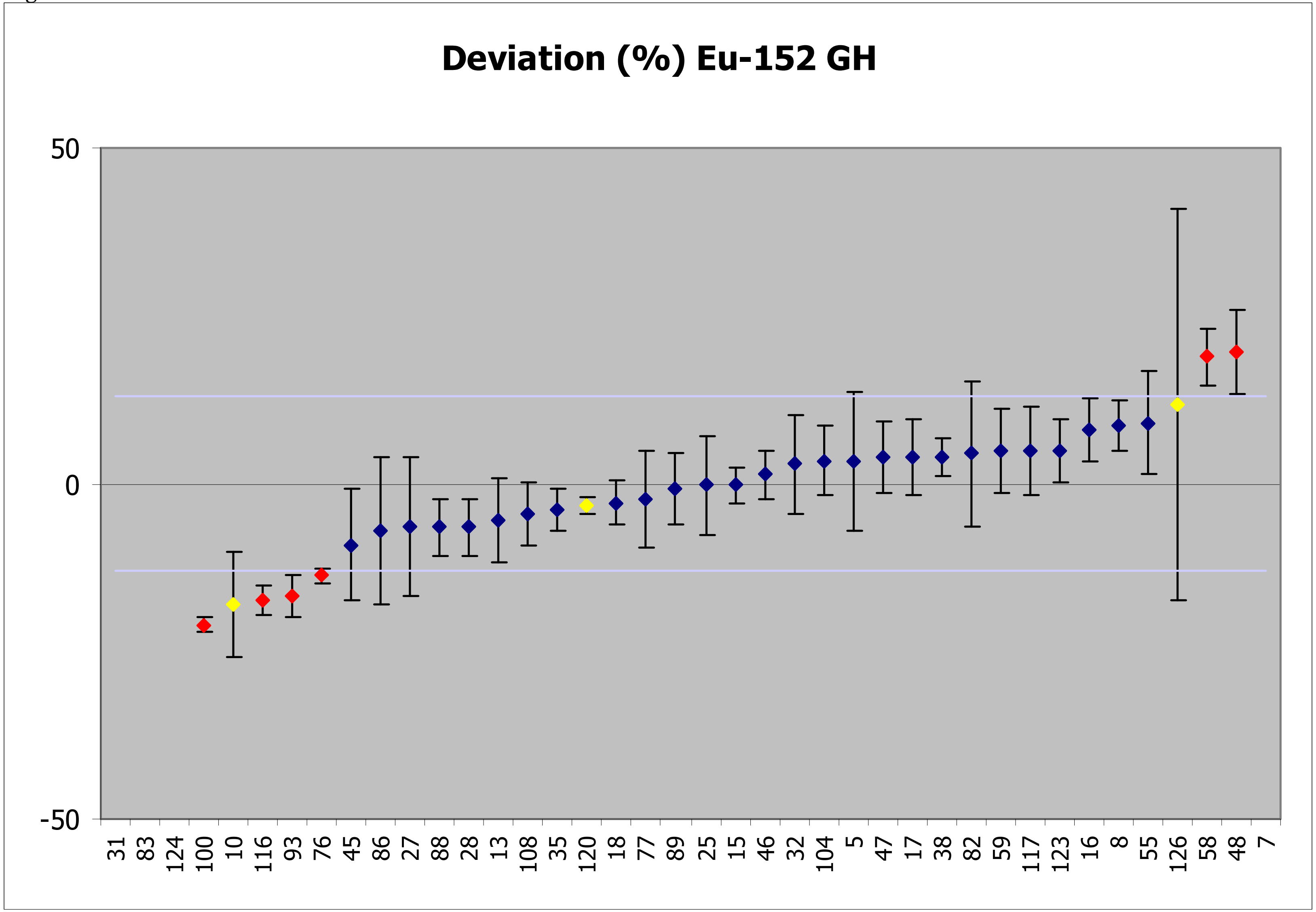


Figure 39B – Zeta score Eu-152 GH

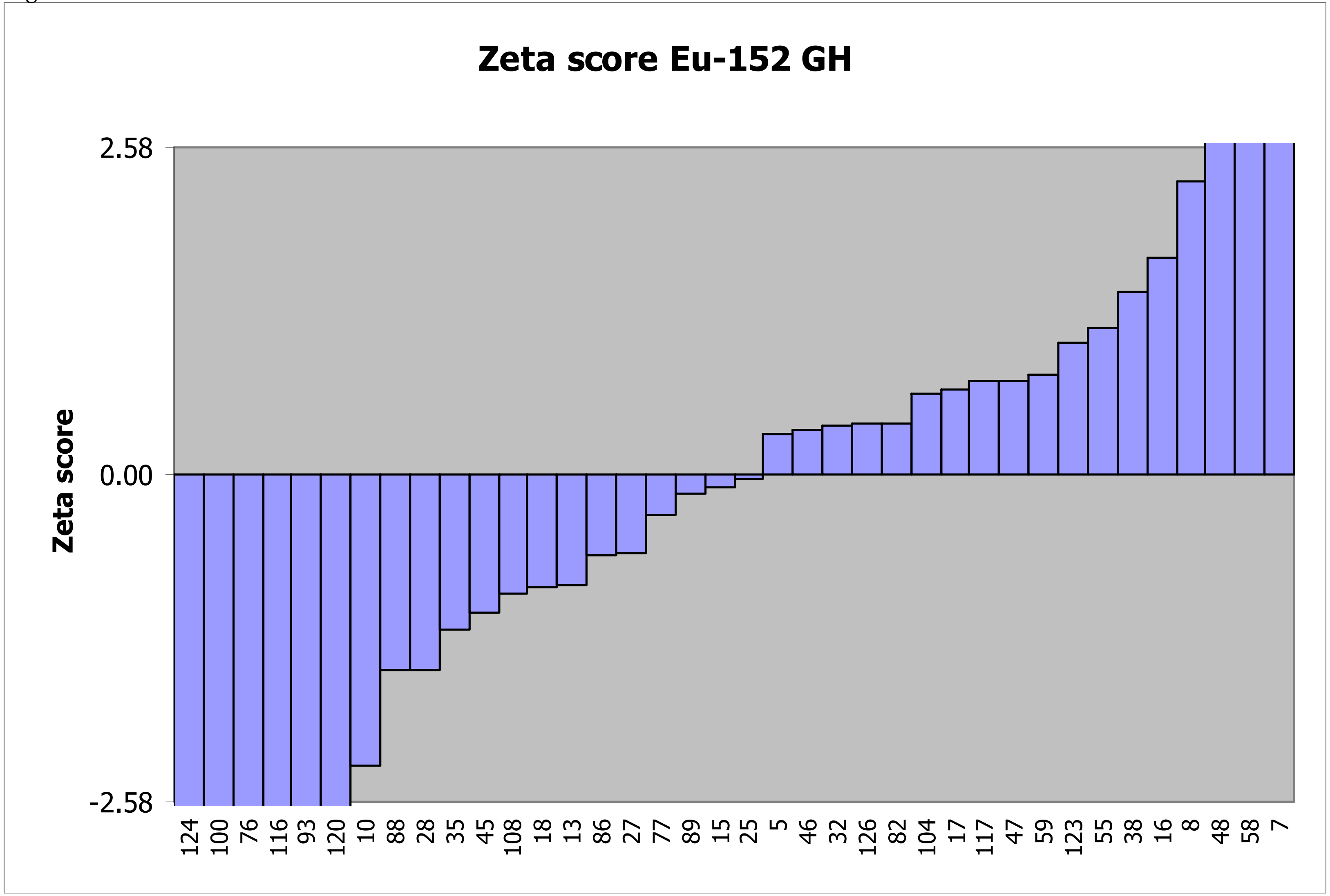


Figure 39C – Relative uncertainty Eu-152 GH

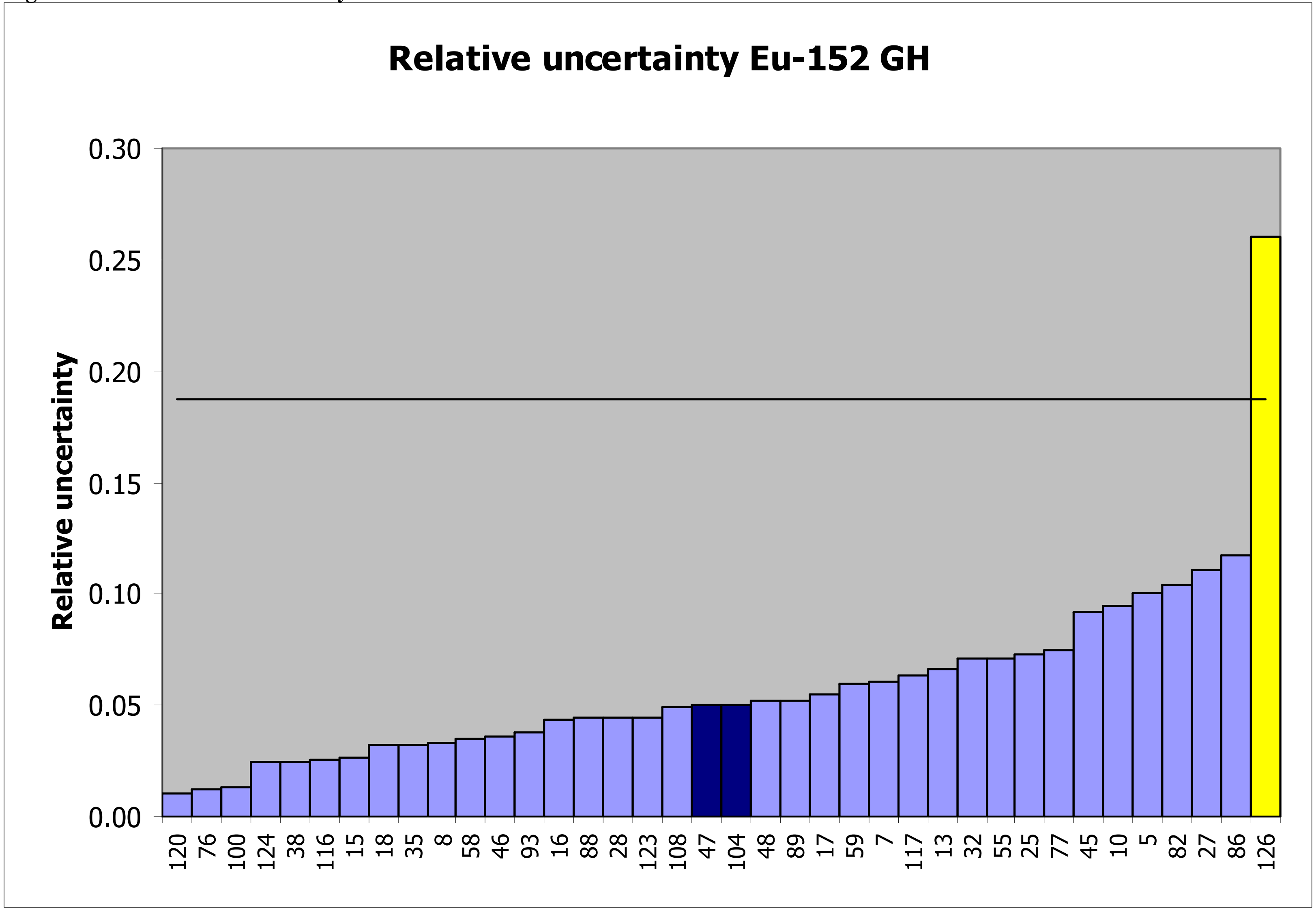


Figure 39D – Kiri plot Eu-152 GH

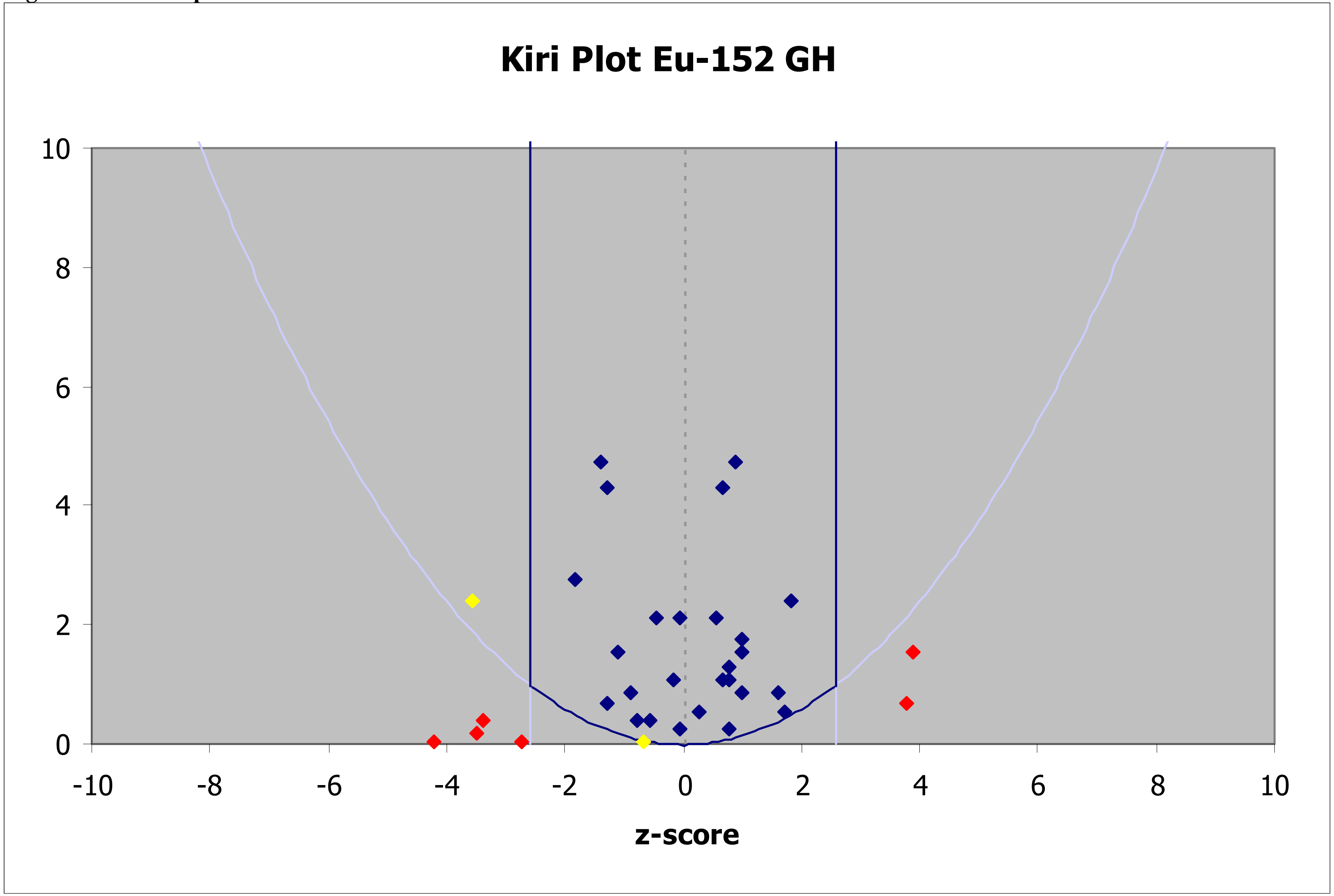


Figure 40A – Deviation Fe-55 S

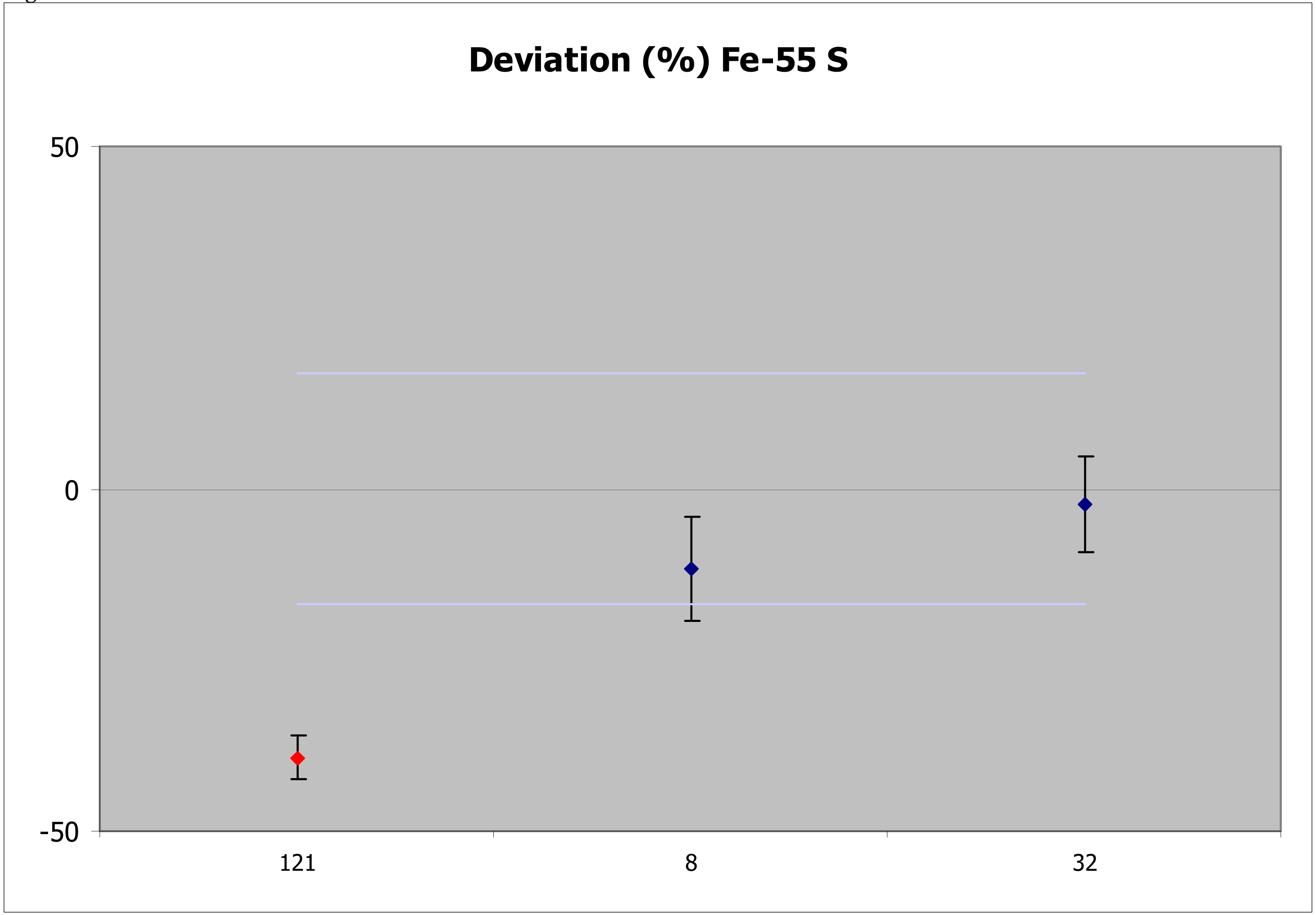


Figure 40B – Zeta score Fe-55 S

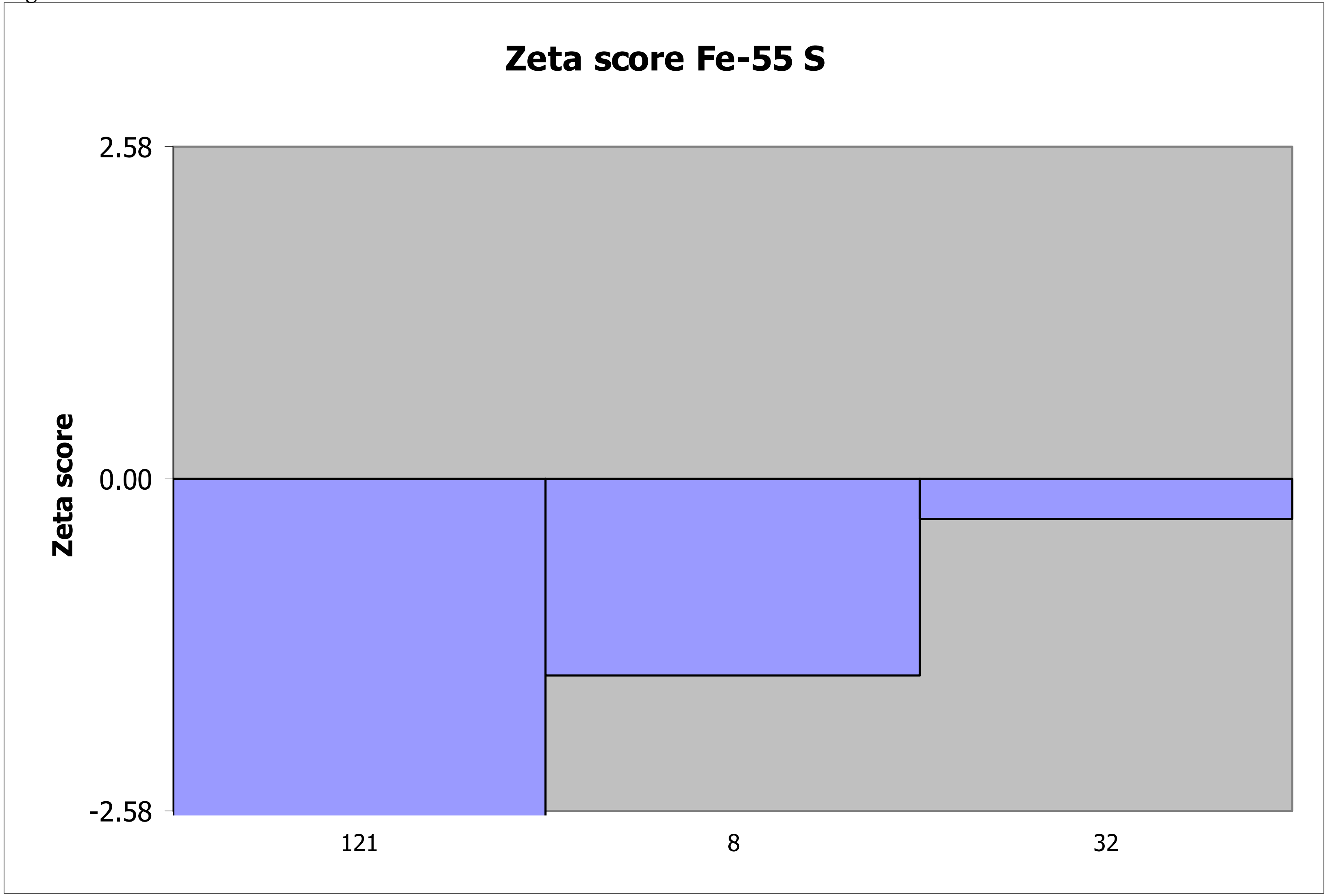


Figure 40C – Relative uncertainty Fe-55 S

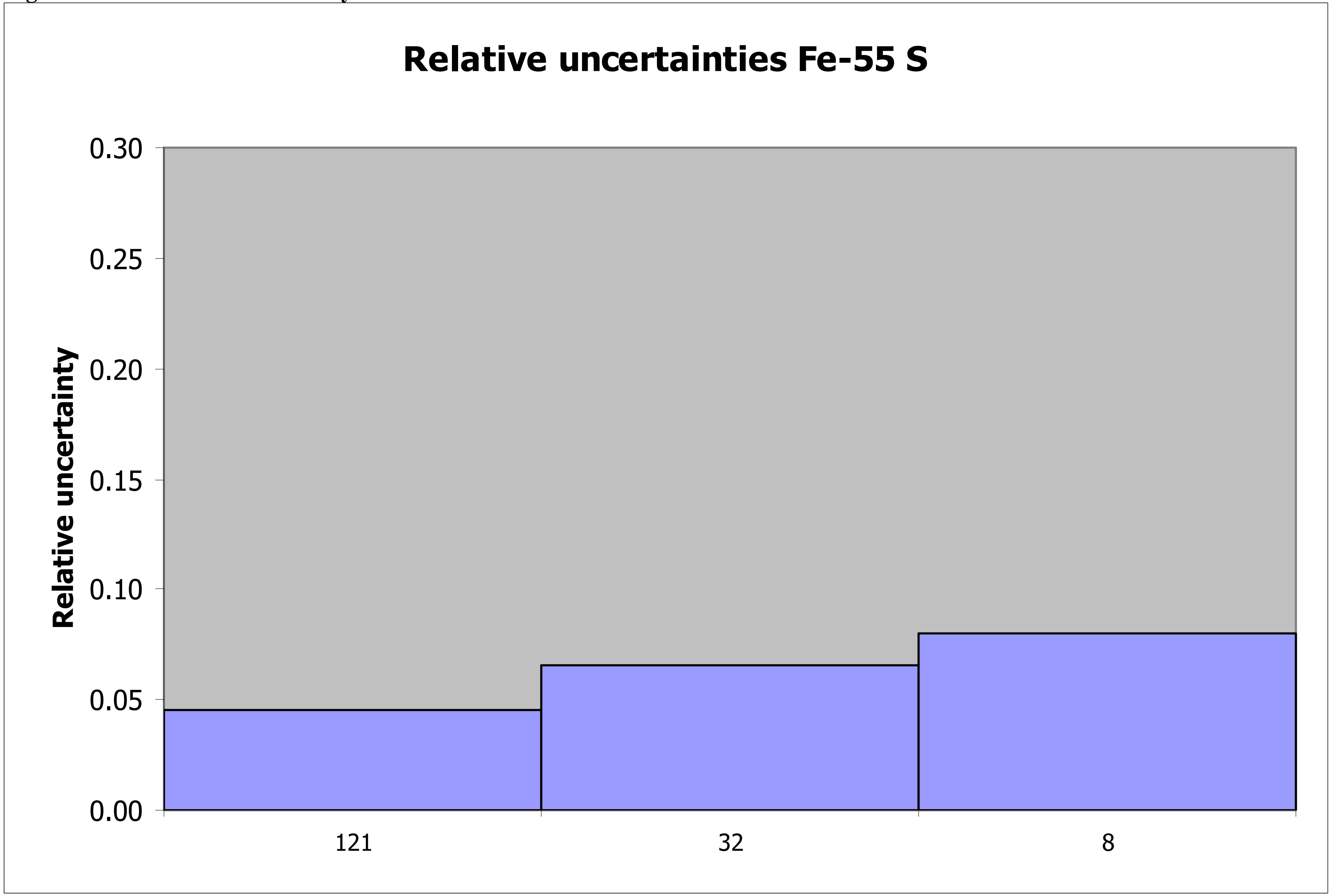


Figure 40D – Kiri plot Fe-55 S

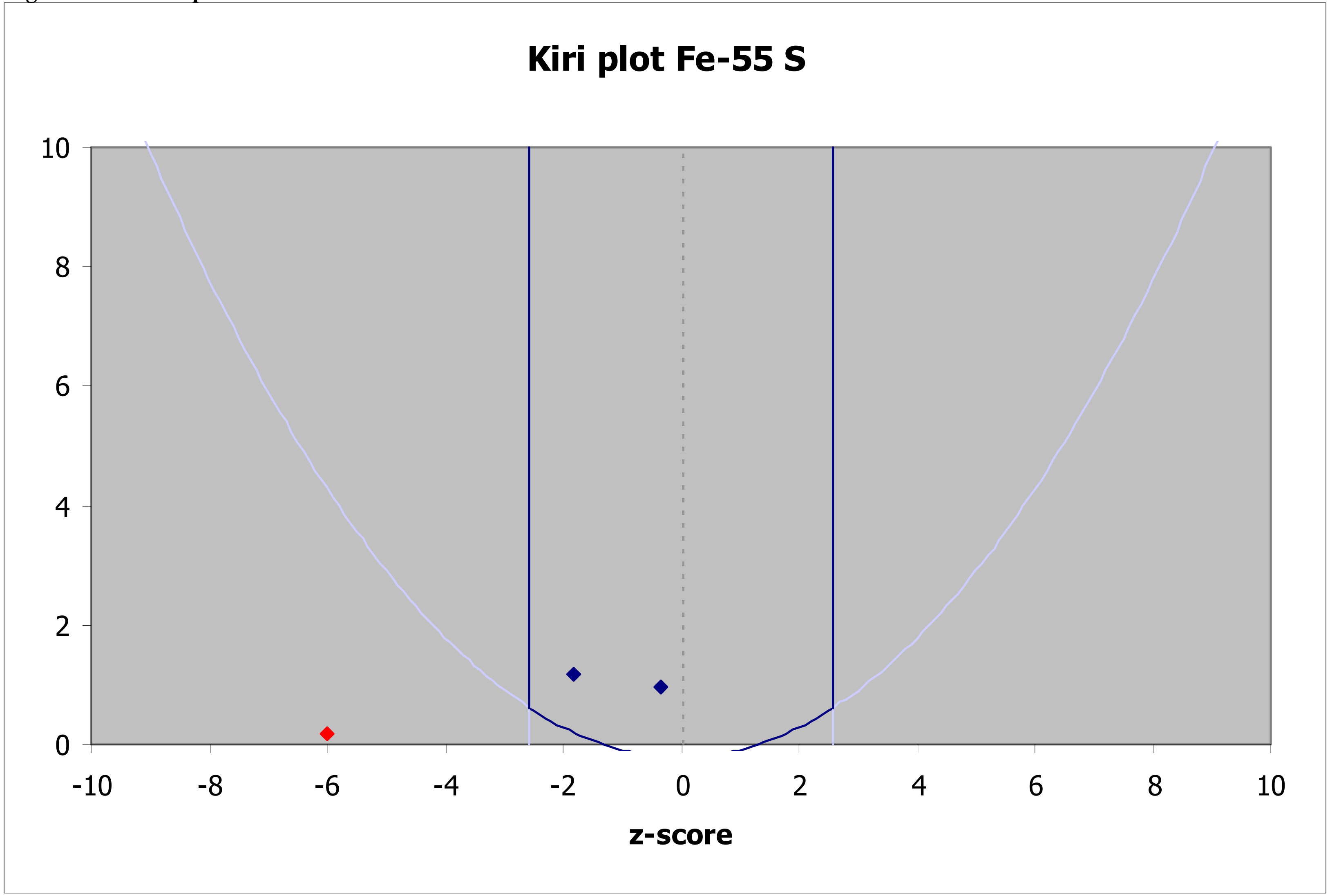


Figure 41A – Deviation Sr-90 S

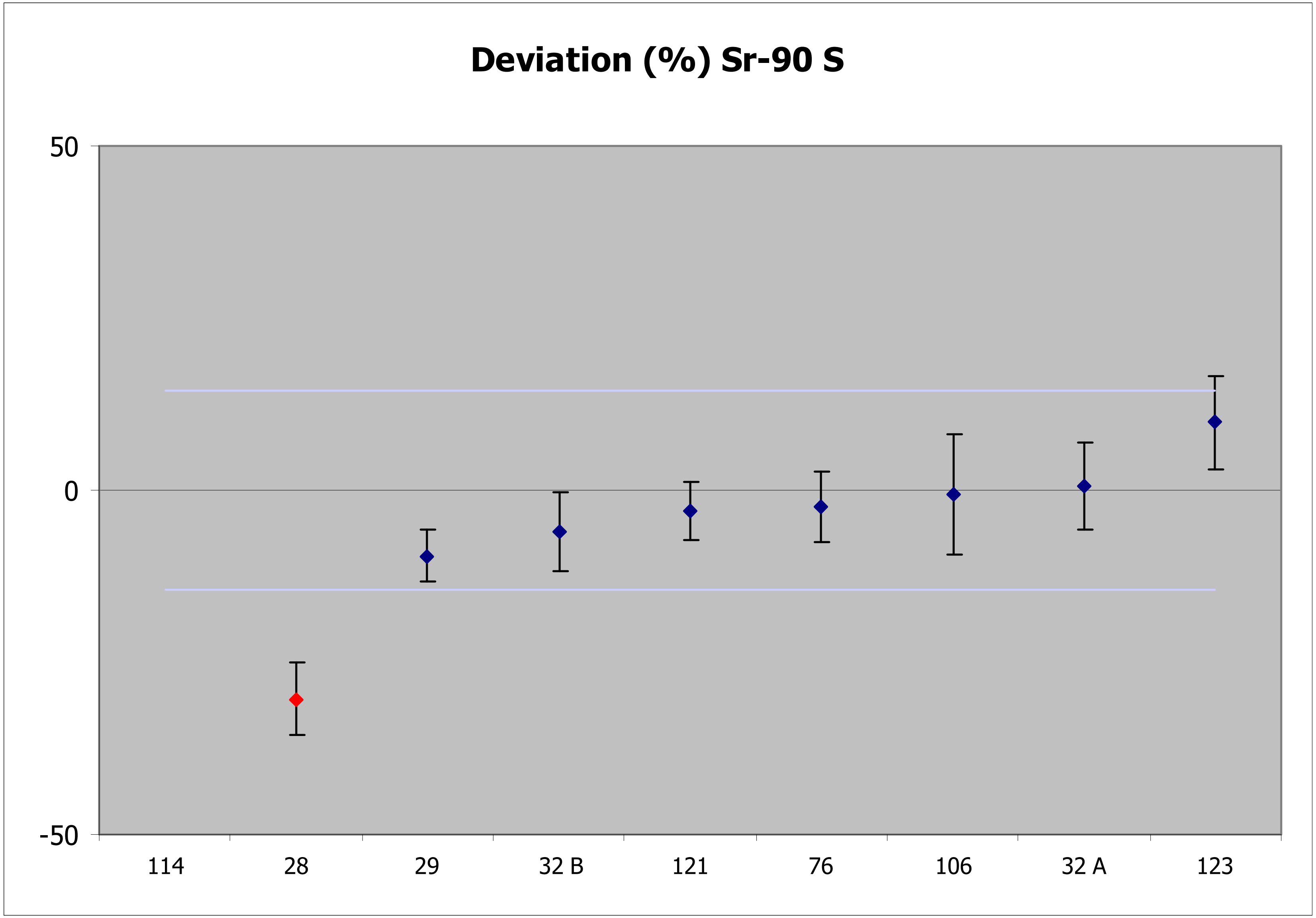


Figure 41B – Zeta score Sr-90 S

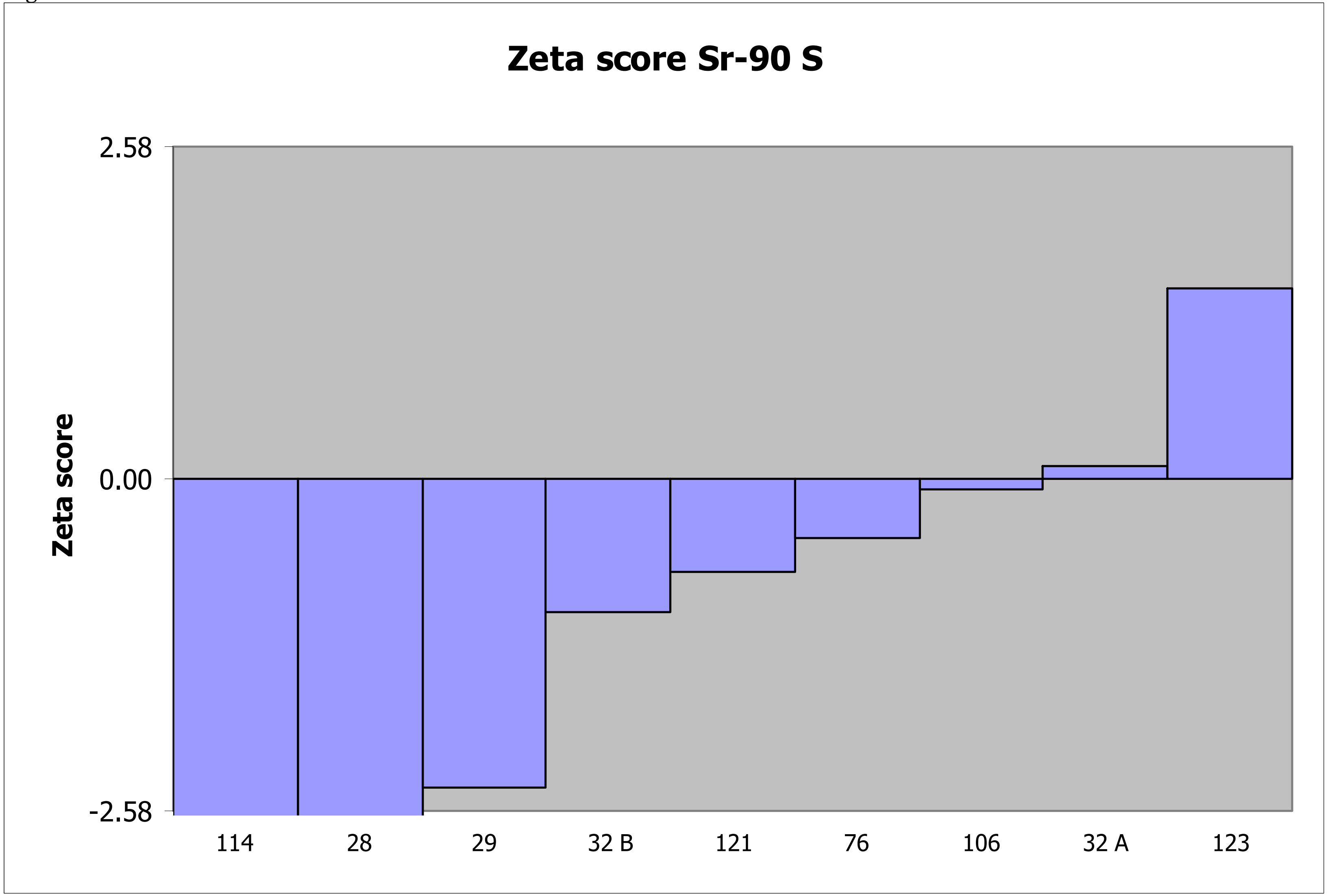


Figure 41C – Relative uncertainty Sr-90 S

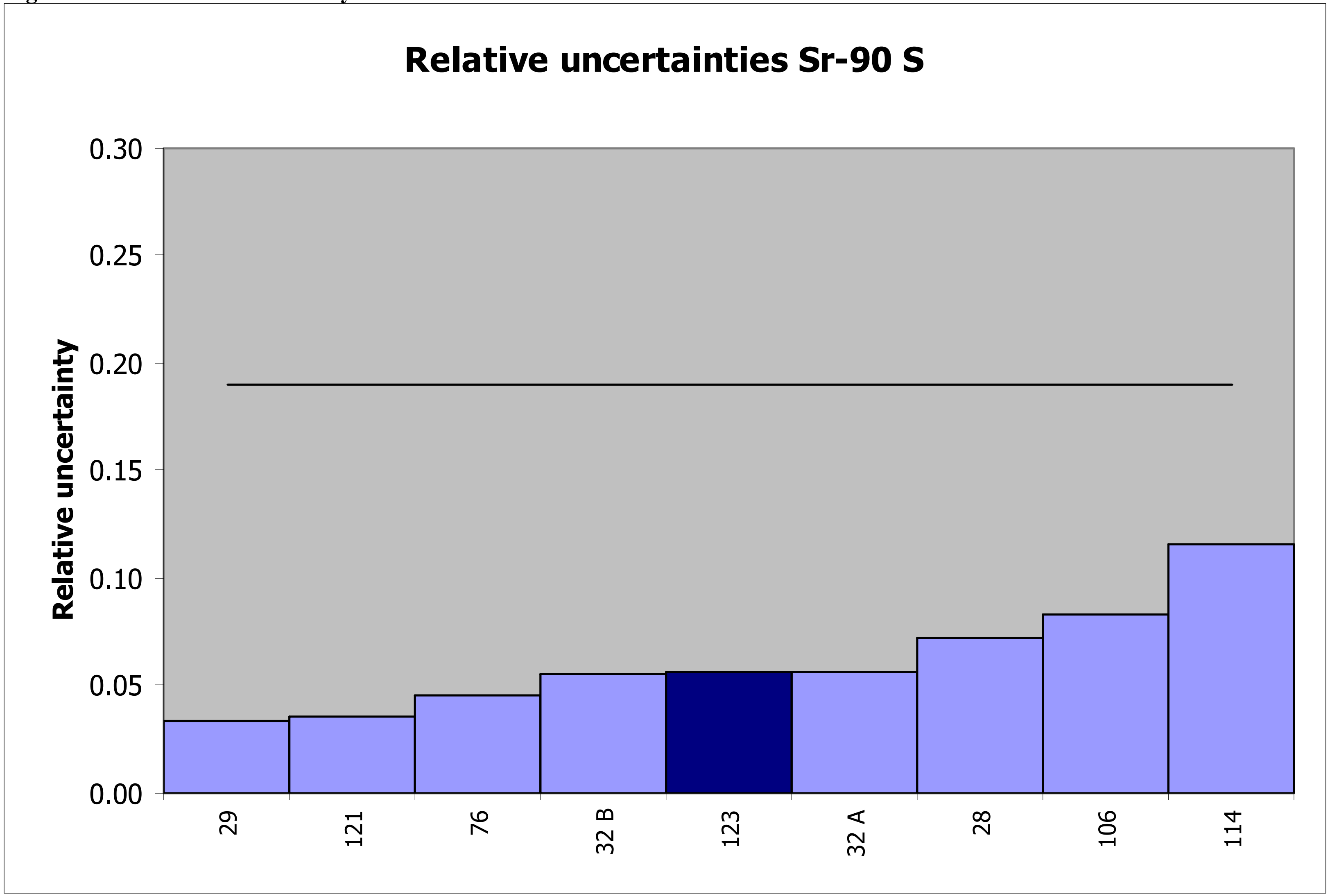


Figure 41D – Kiri plot Sr-90 S

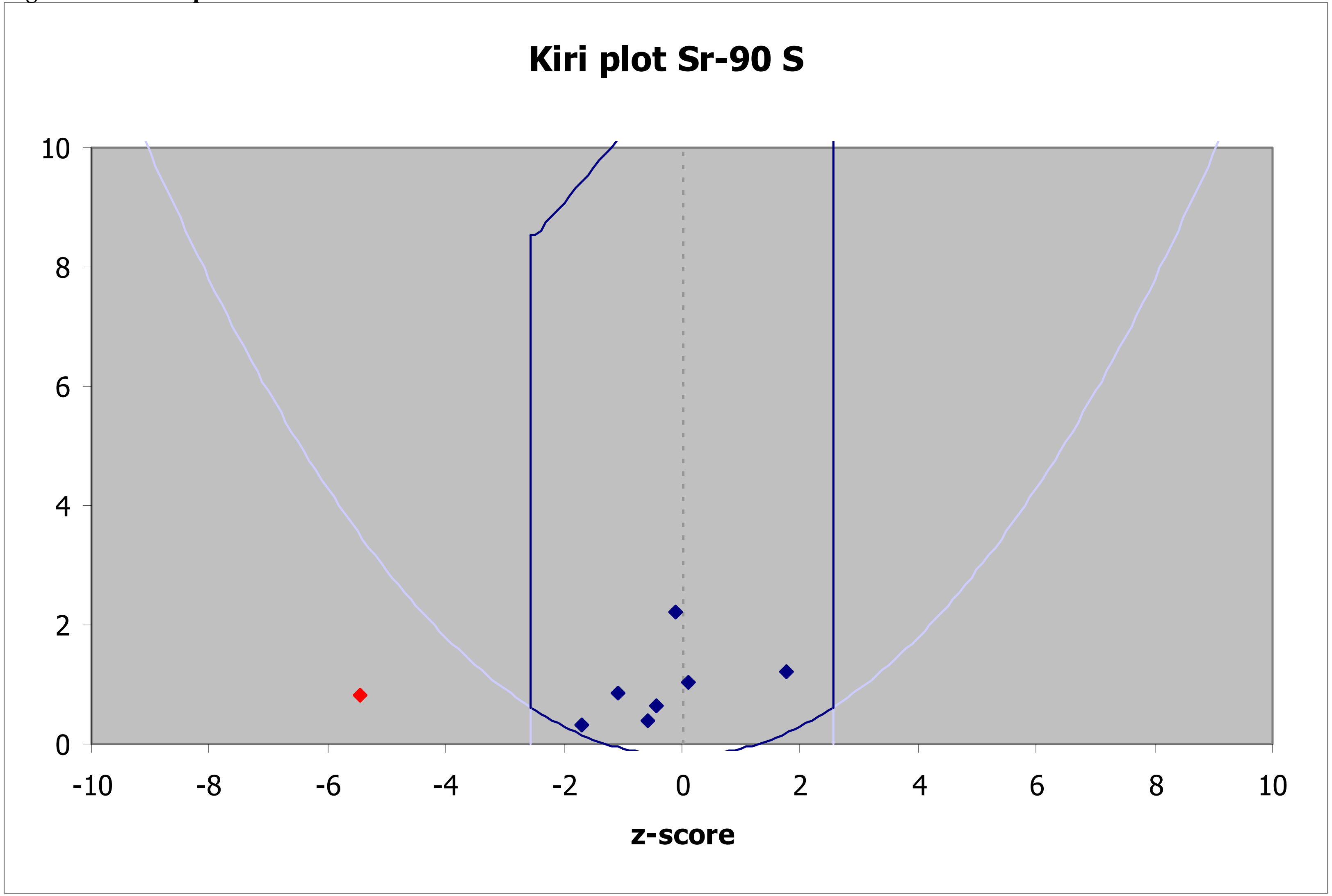


Figure 42A – Deviation Ba-133 S

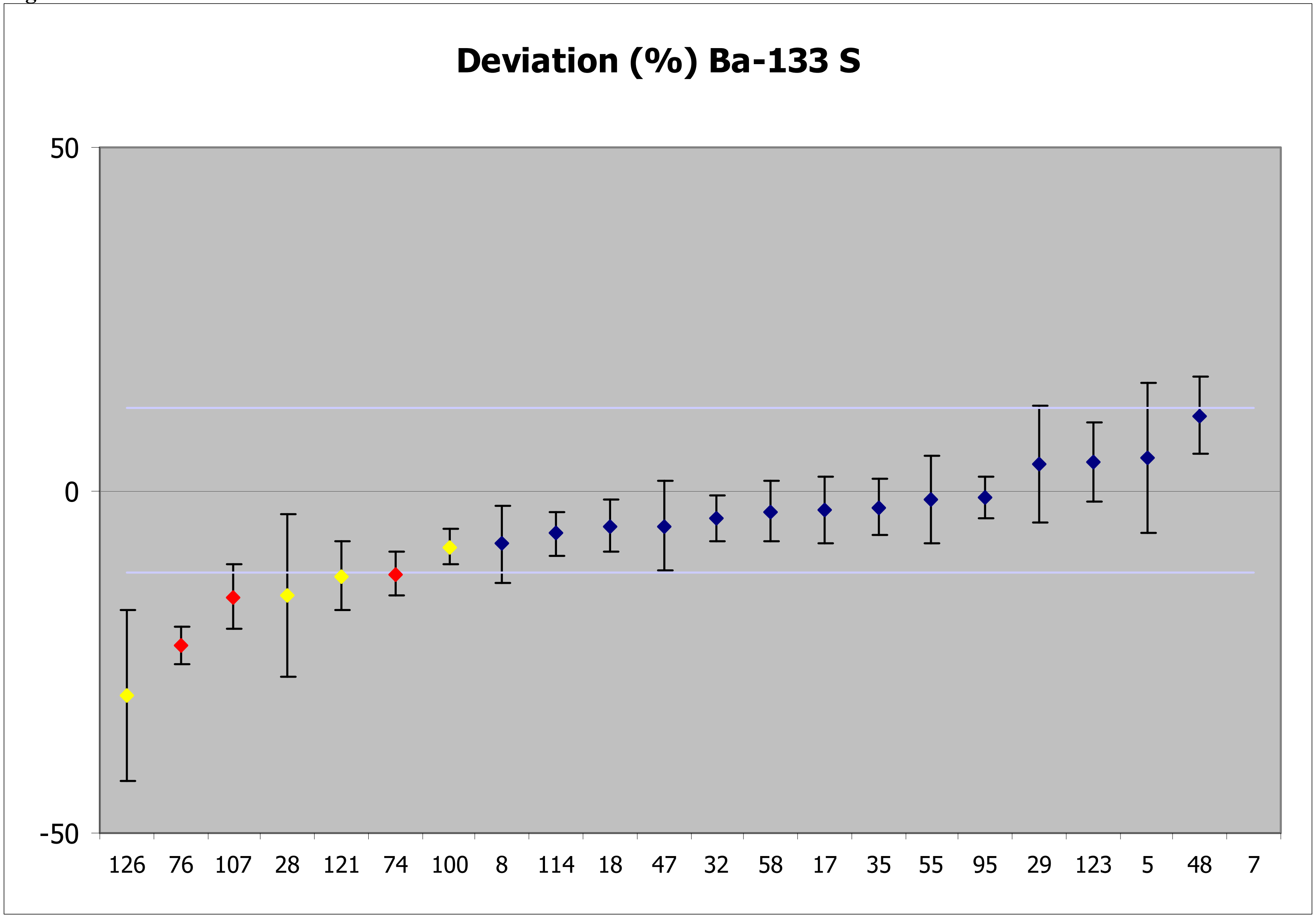


Figure 42B – Zeta score Ba-133 S

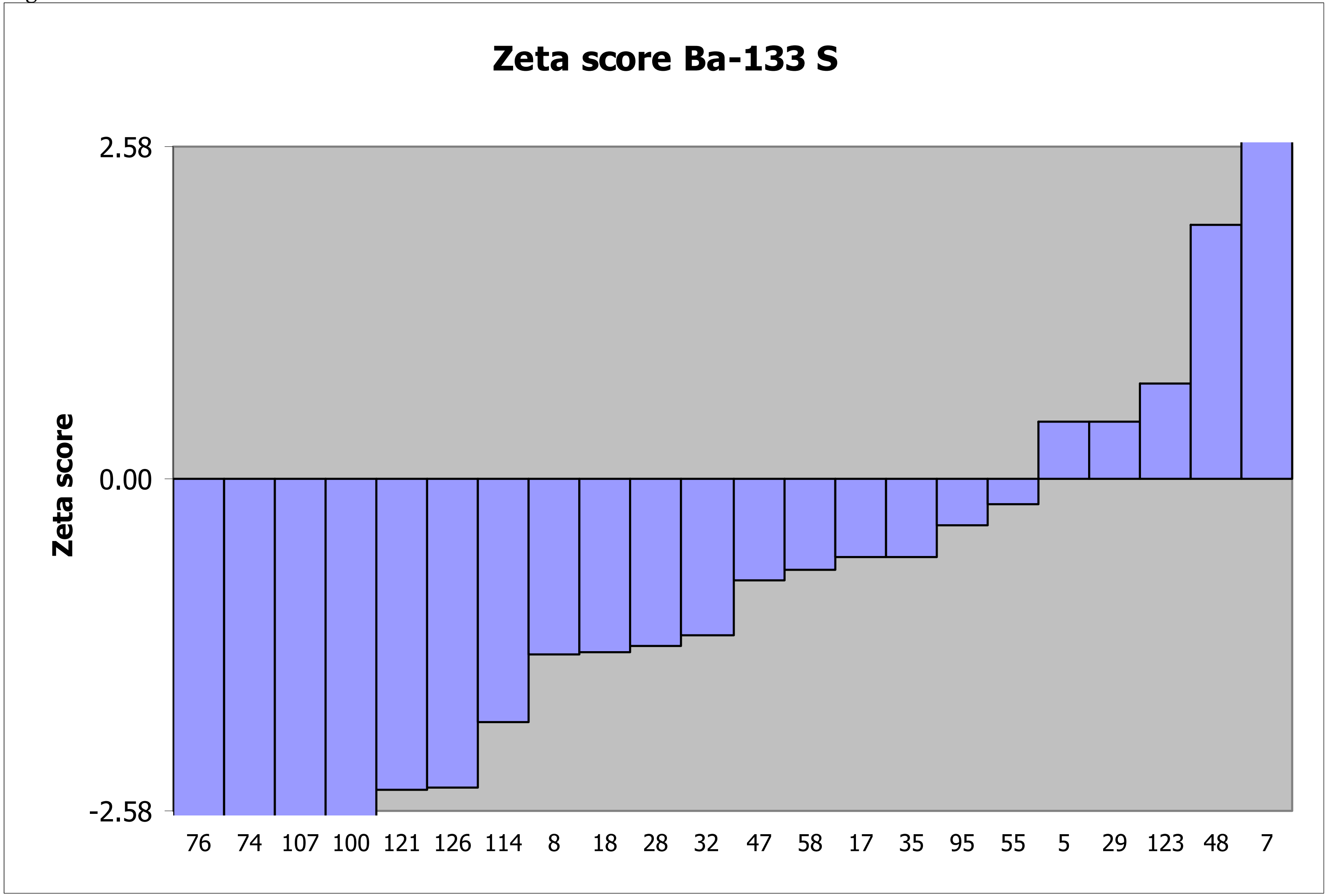


Figure 42C – Relative uncertainty Ba-133 S

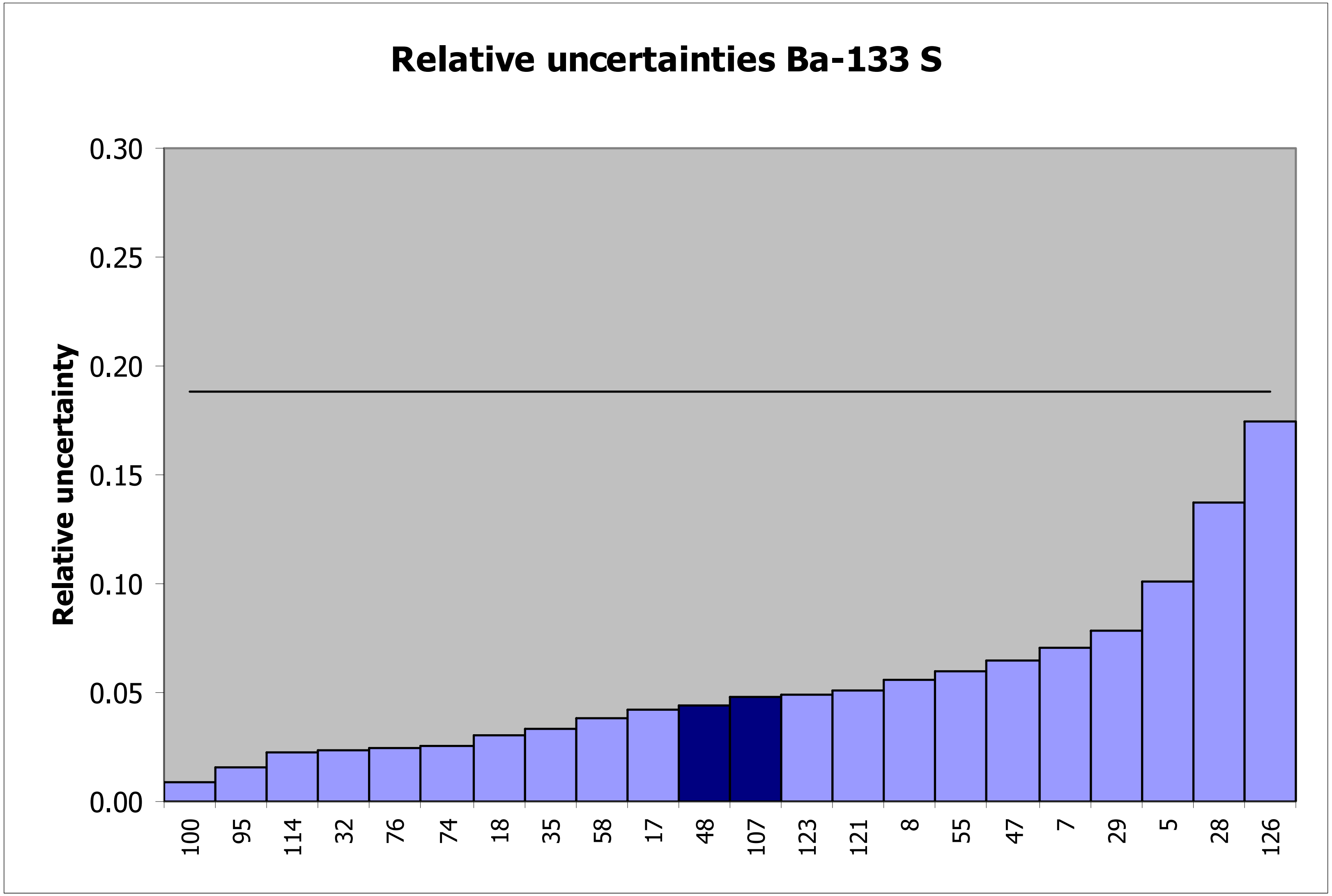


Figure 42D – Kiri plot Ba-133 S

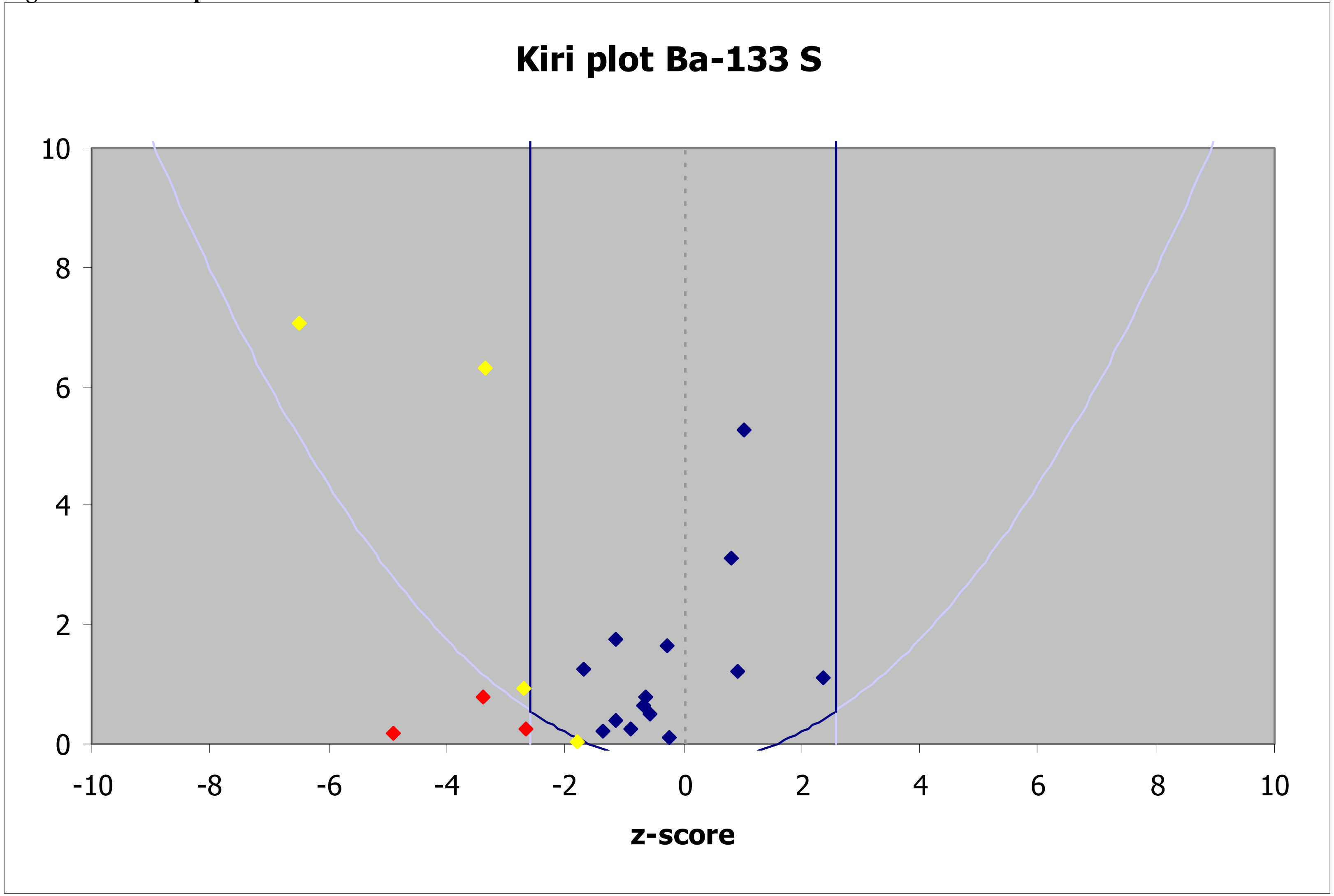


Figure 43A – Deviation Cs-134 S

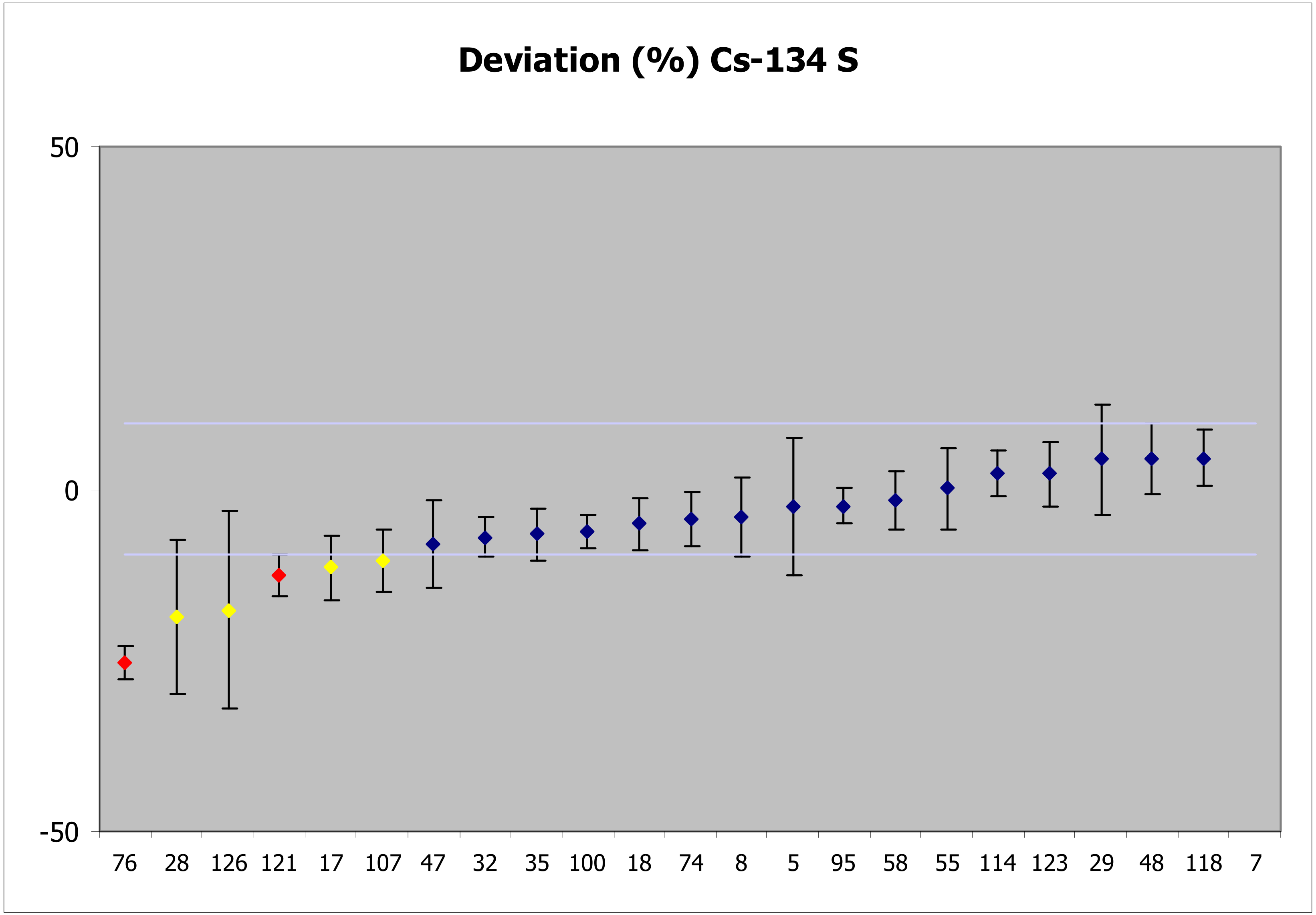


Figure 43B – zeta score Cs-134 S

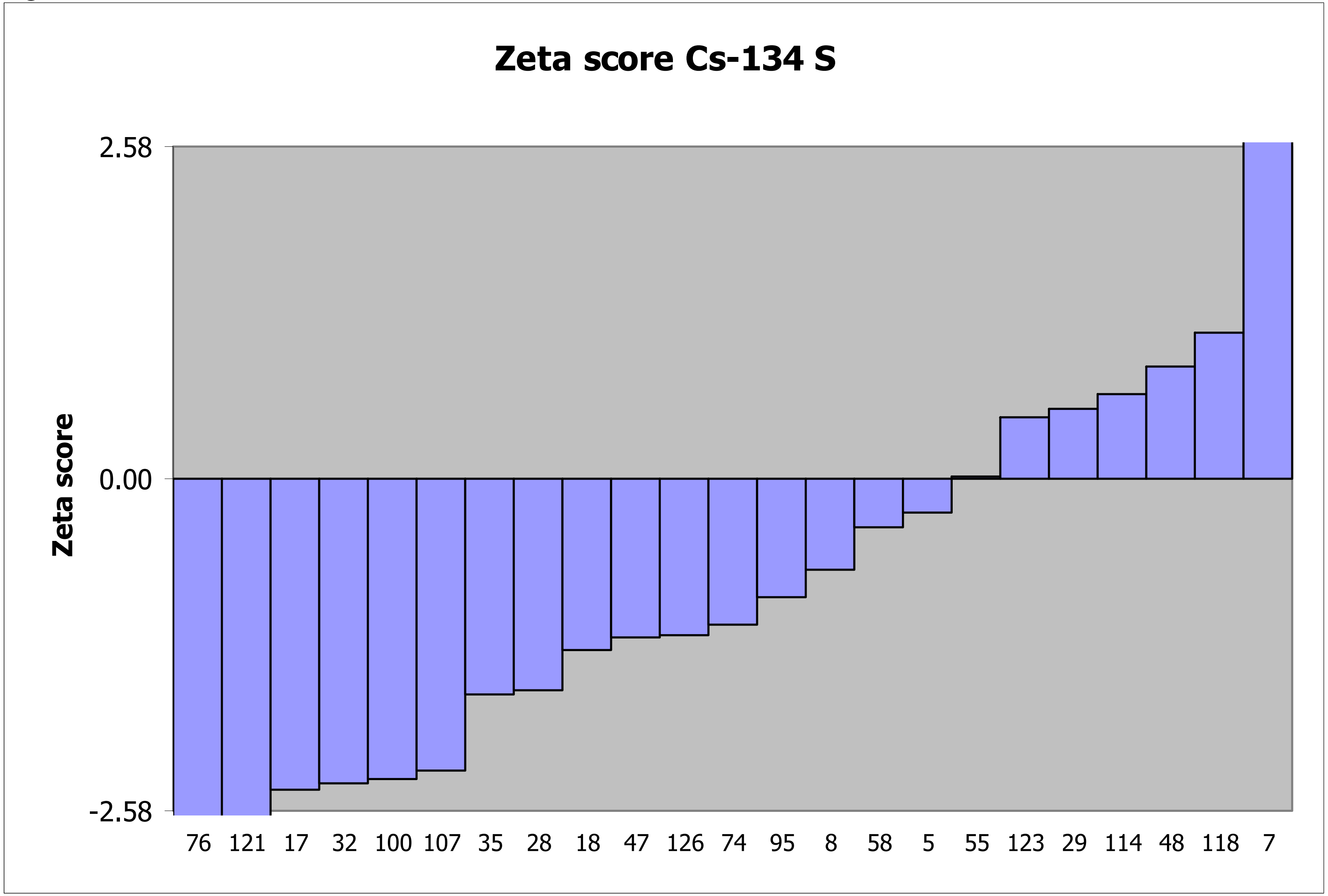


Figure 43C – Relative uncertainty Cs-134 S

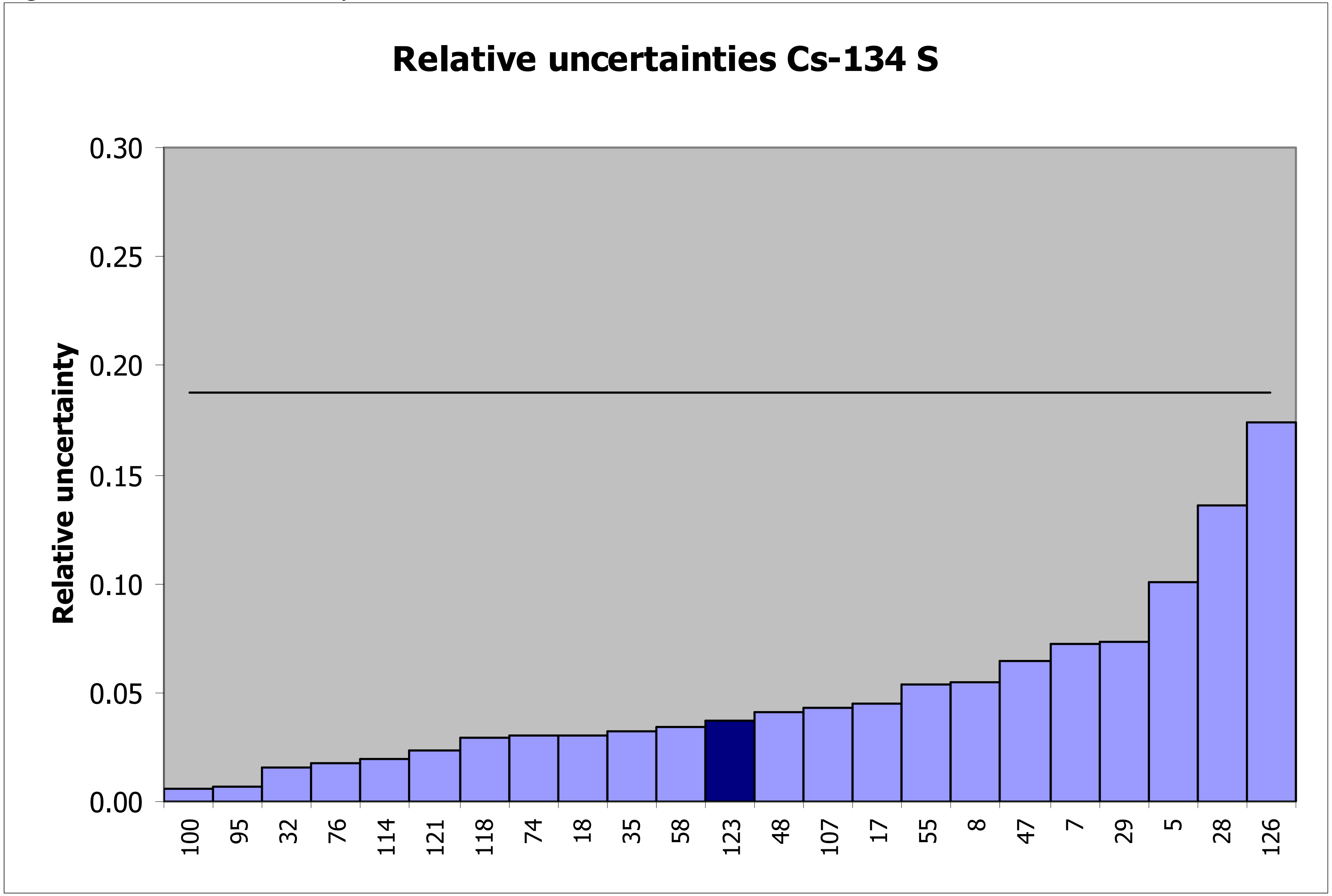


Figure 43D – Kiri plot Cs-134 S

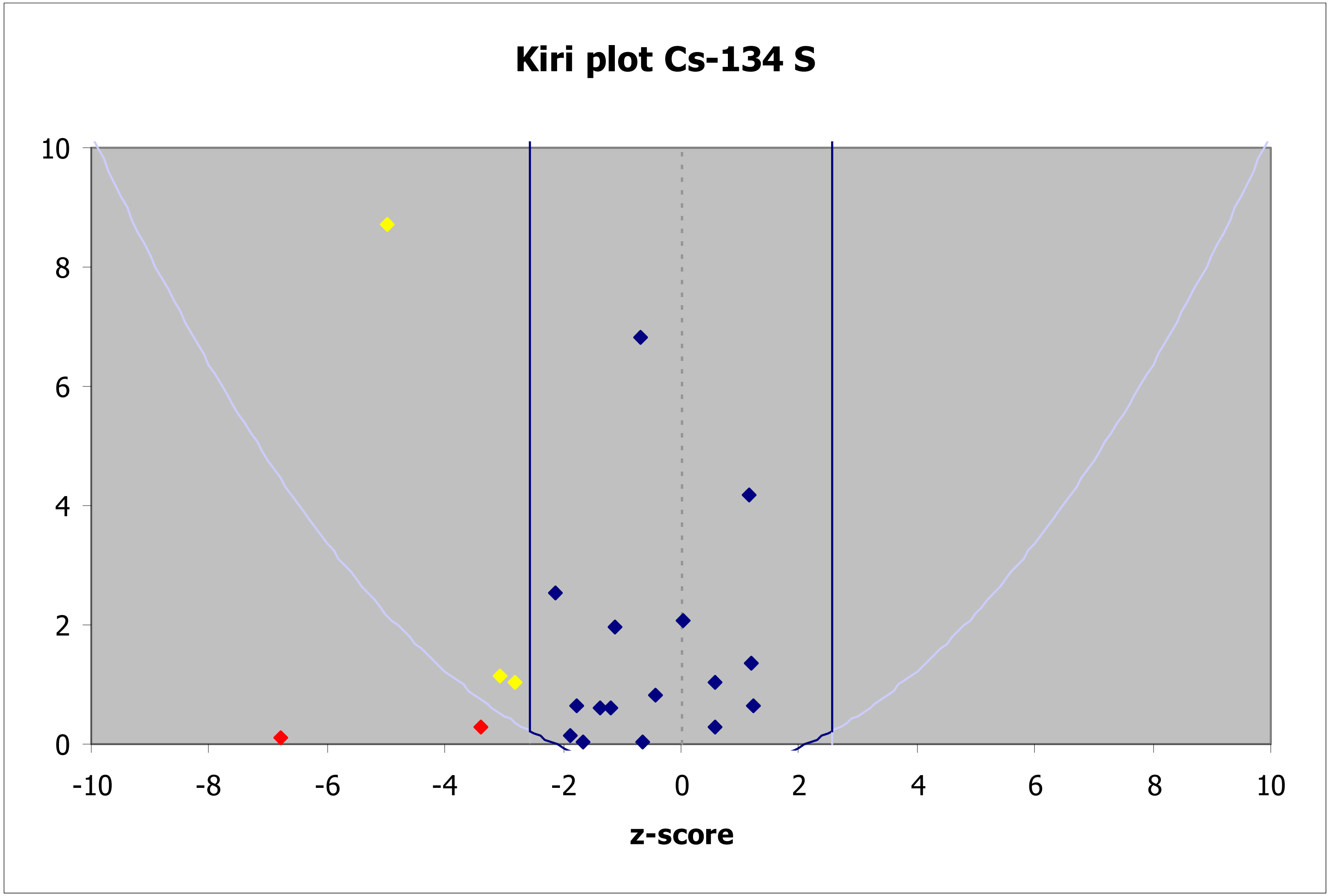


Figure 44A – Deviation Cs-137 S

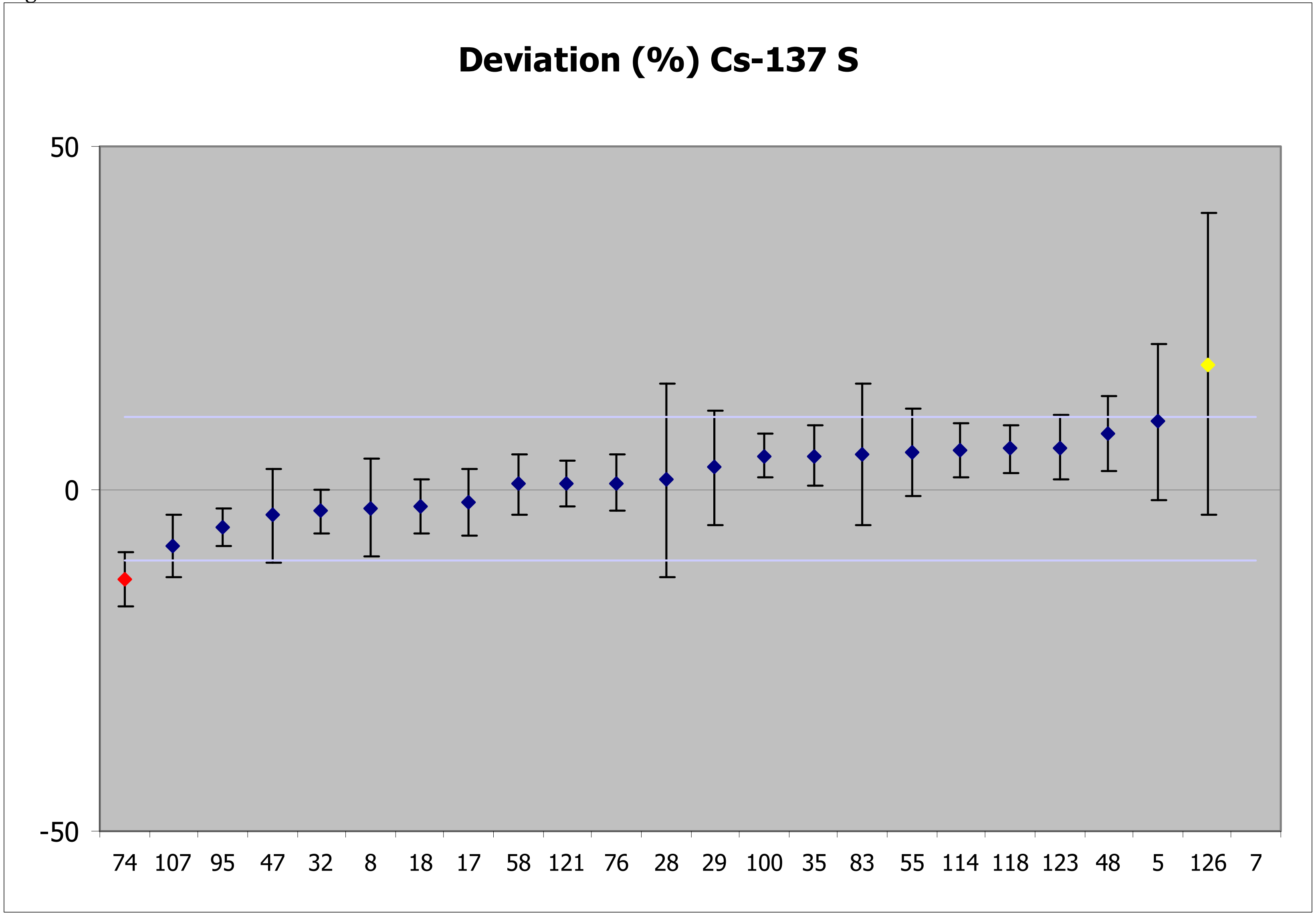


Figure 44B – Zeta score Cs-137 S

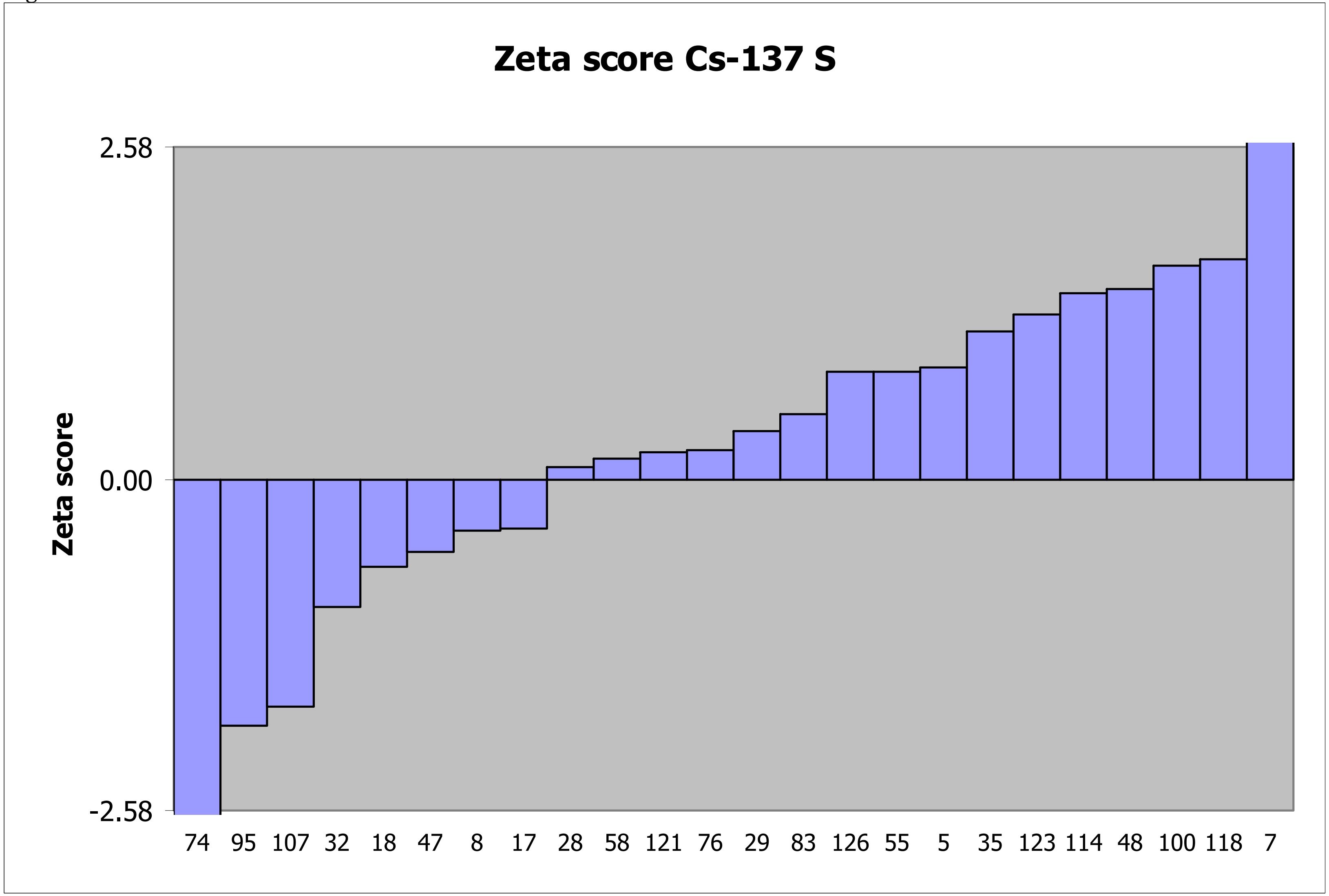


Figure 44C – Relative uncertainty Cs-137 S

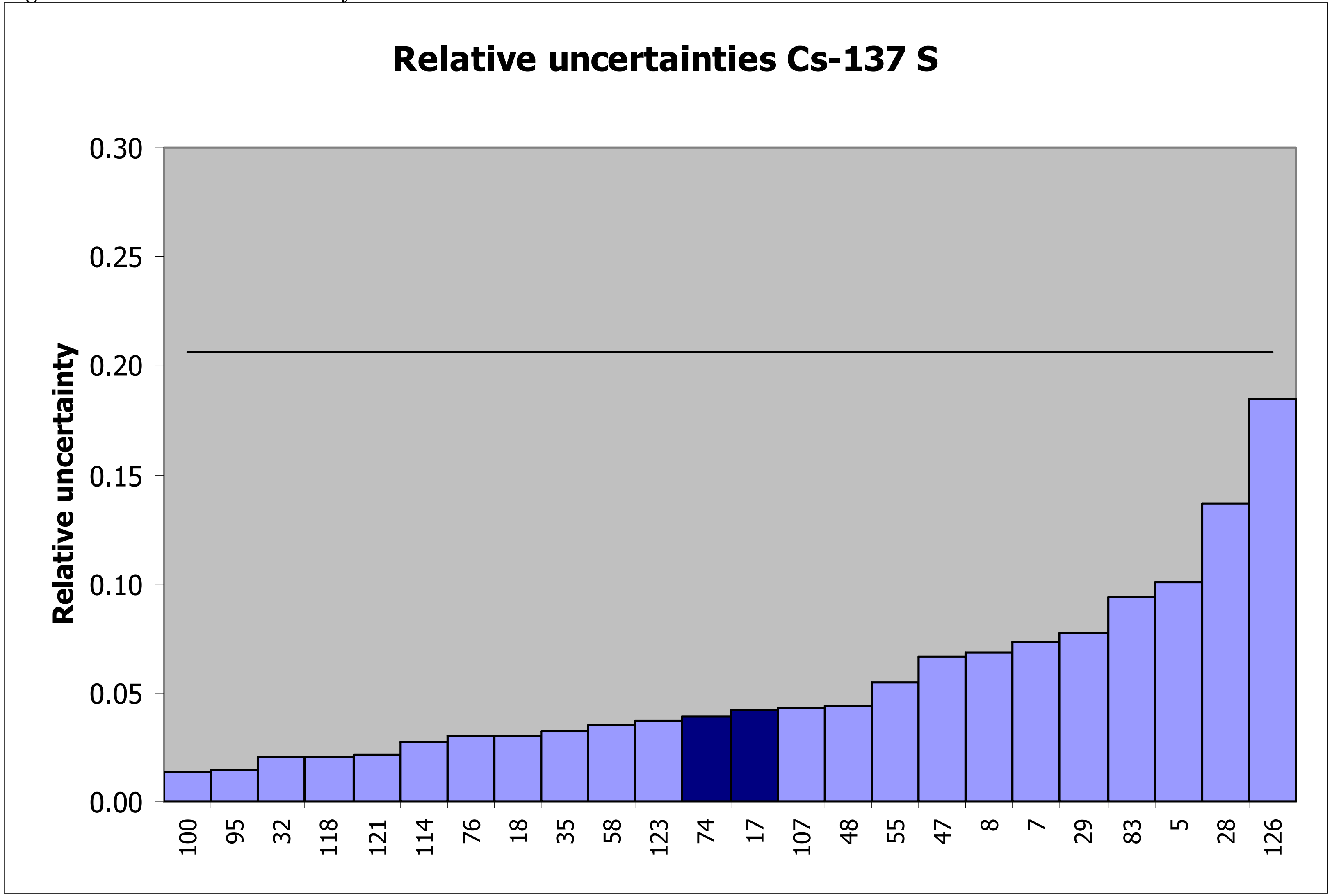


Figure 44D – Kiri plot Cs-137 S

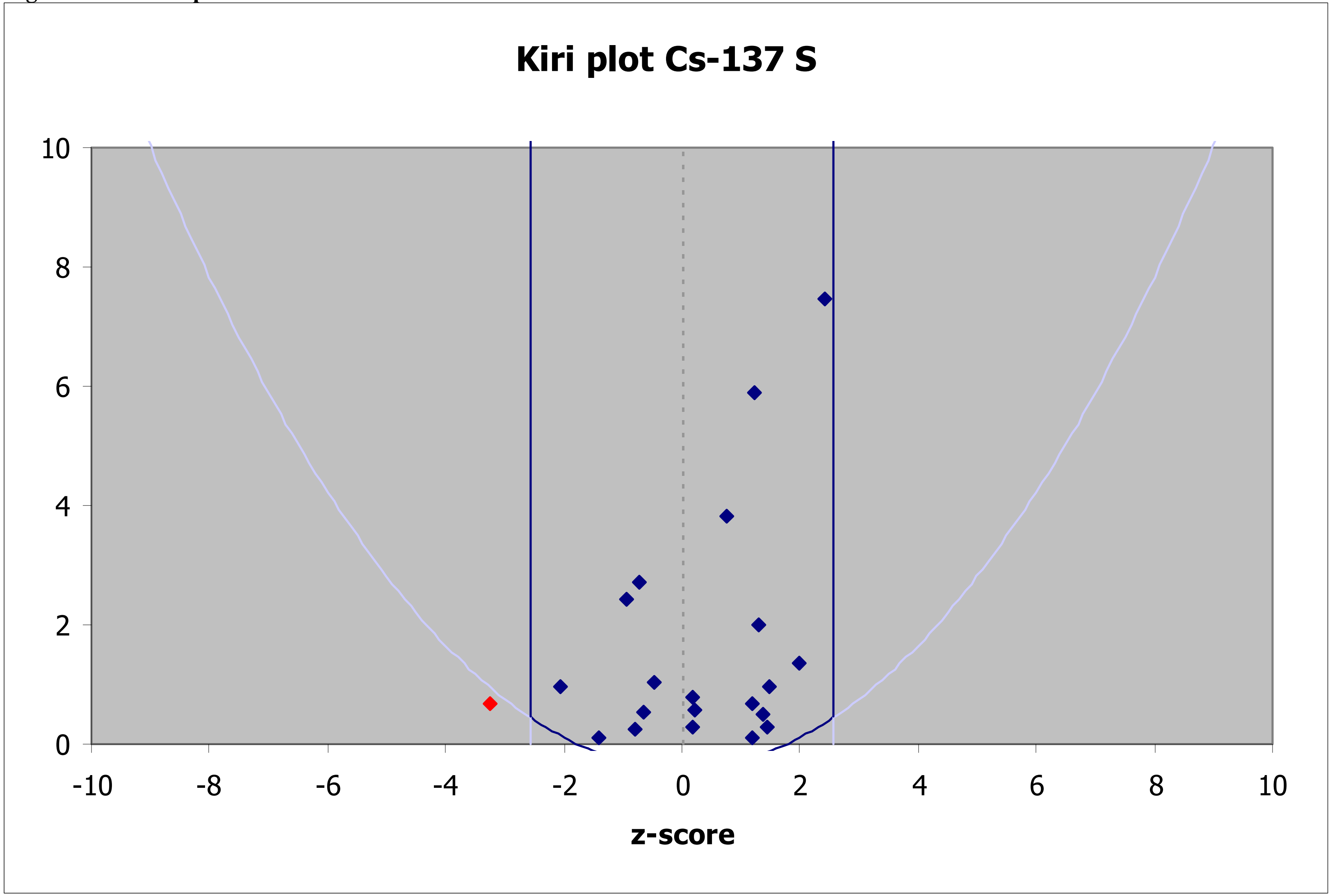


Figure 45A – Deviation Eu-152 S

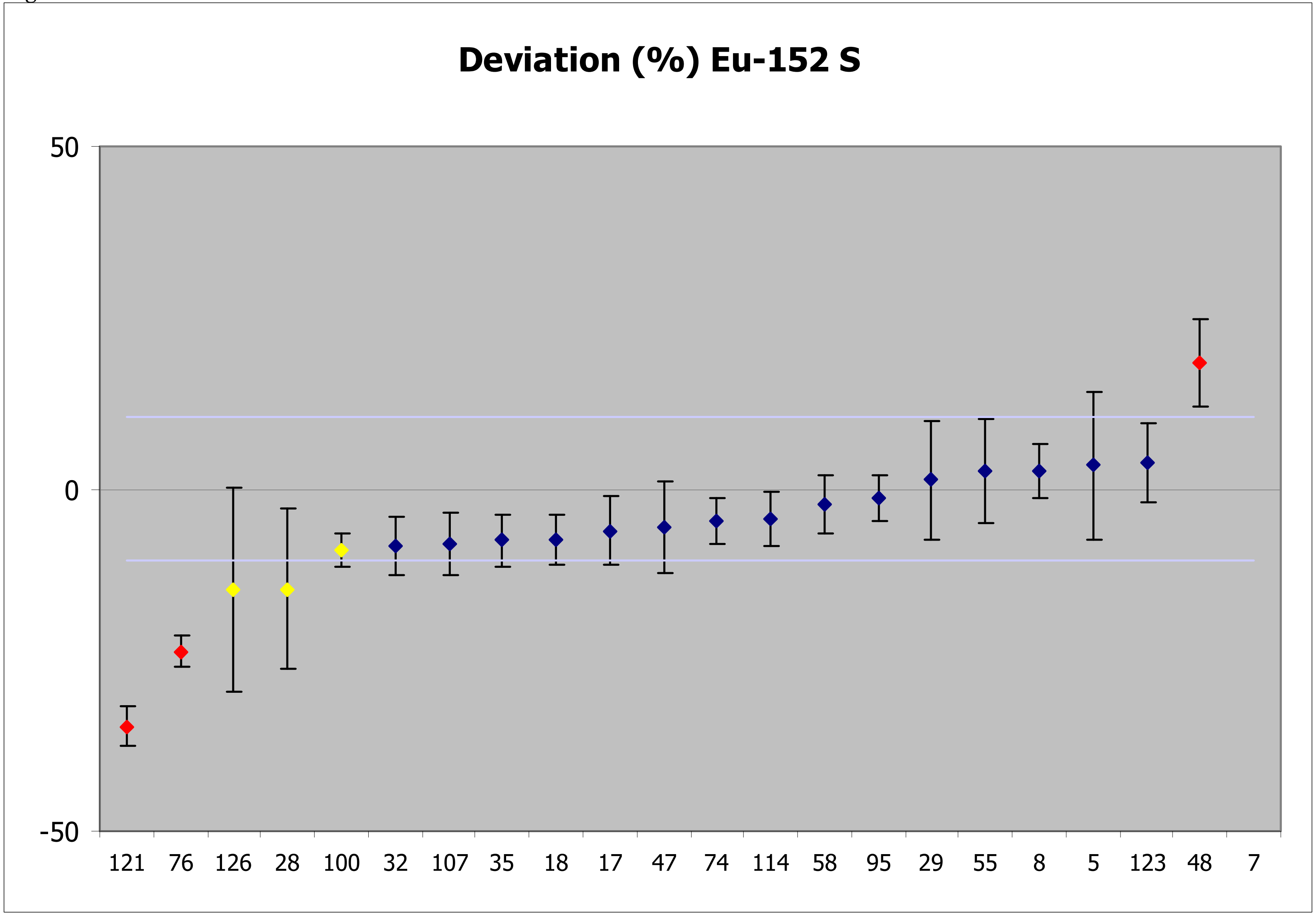


Figure 45B – Zeta score Eu-152 S

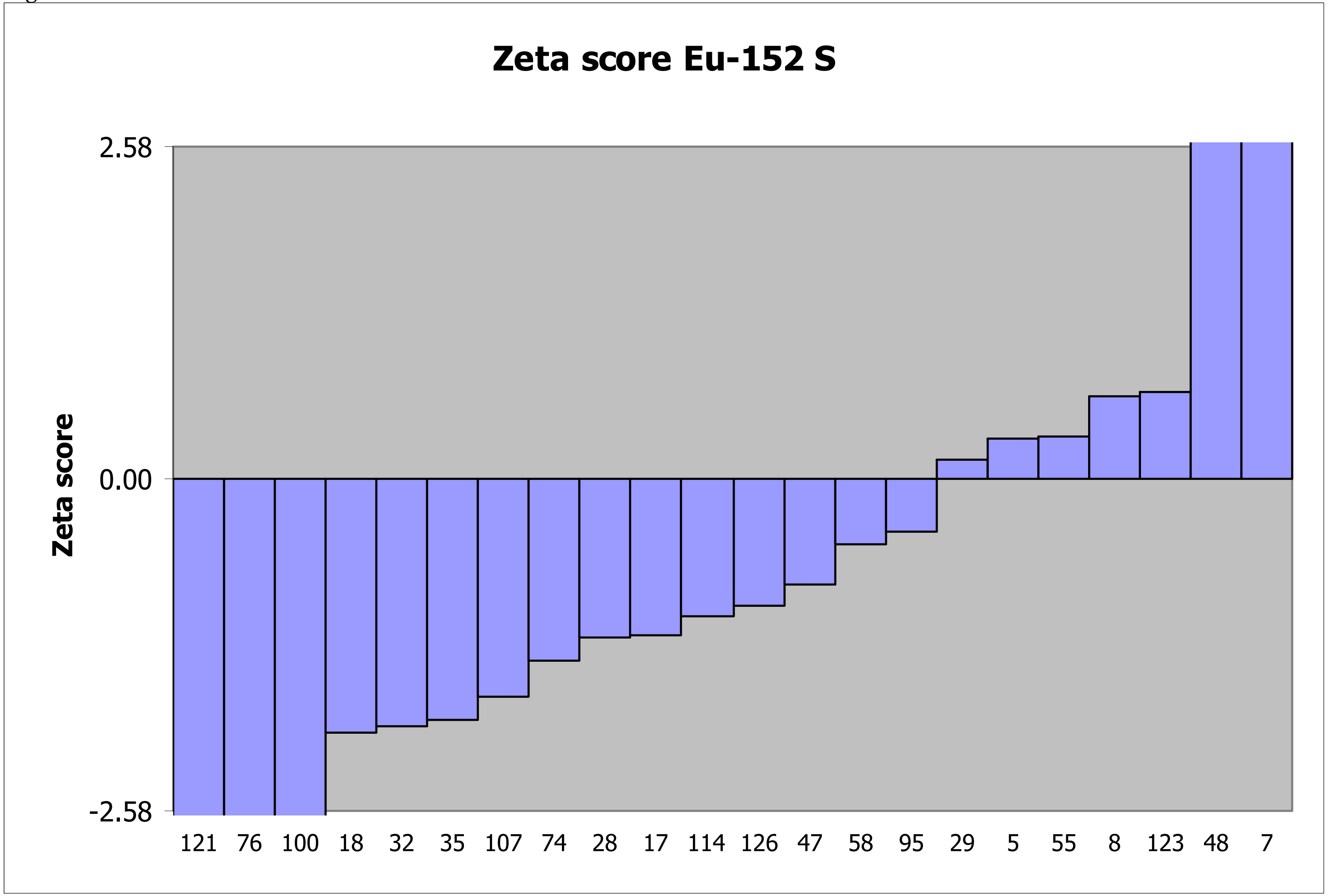


Figure 45C – Relative uncertainty Eu-152 S

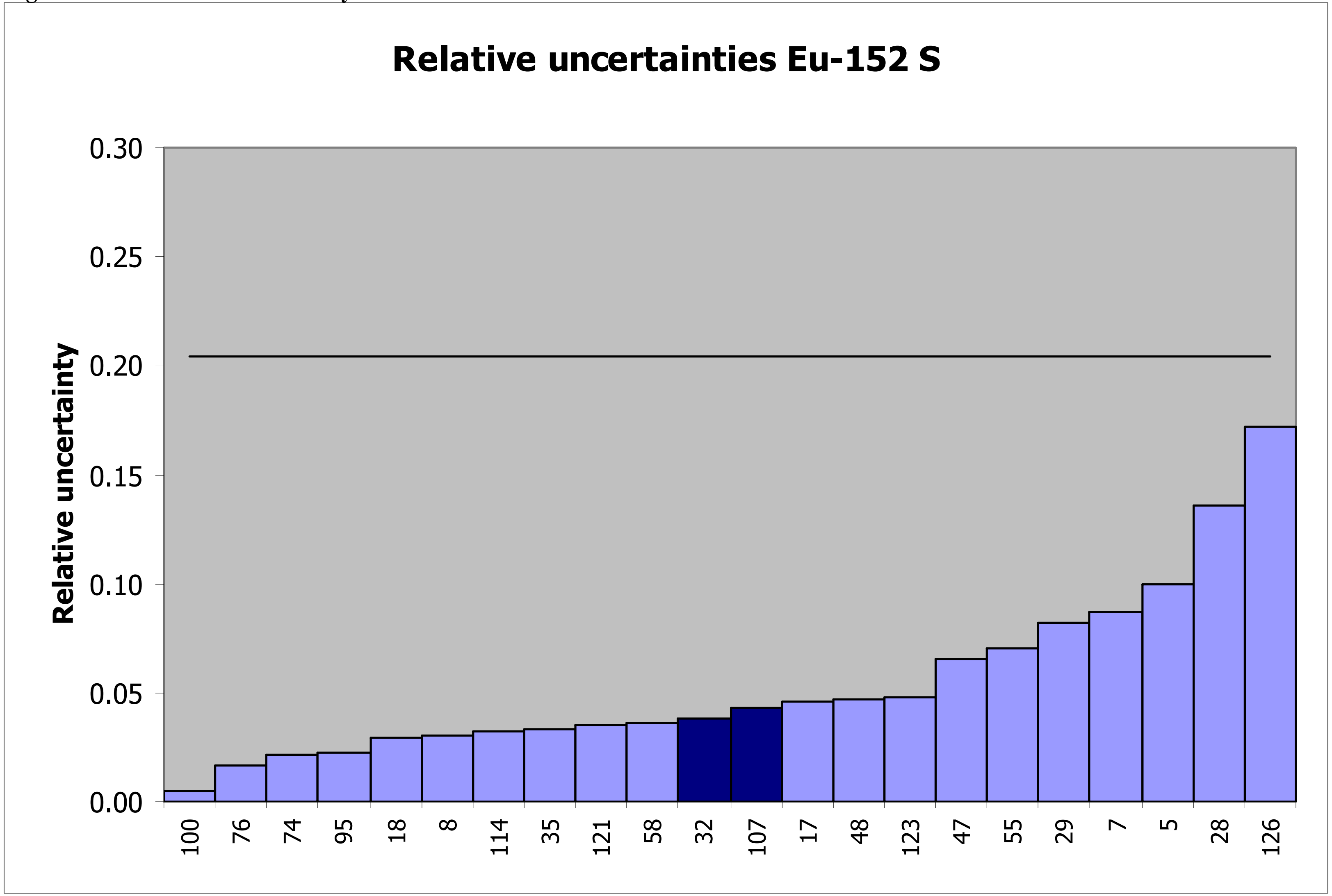


Figure 45D – Kiri plot Eu-152 S

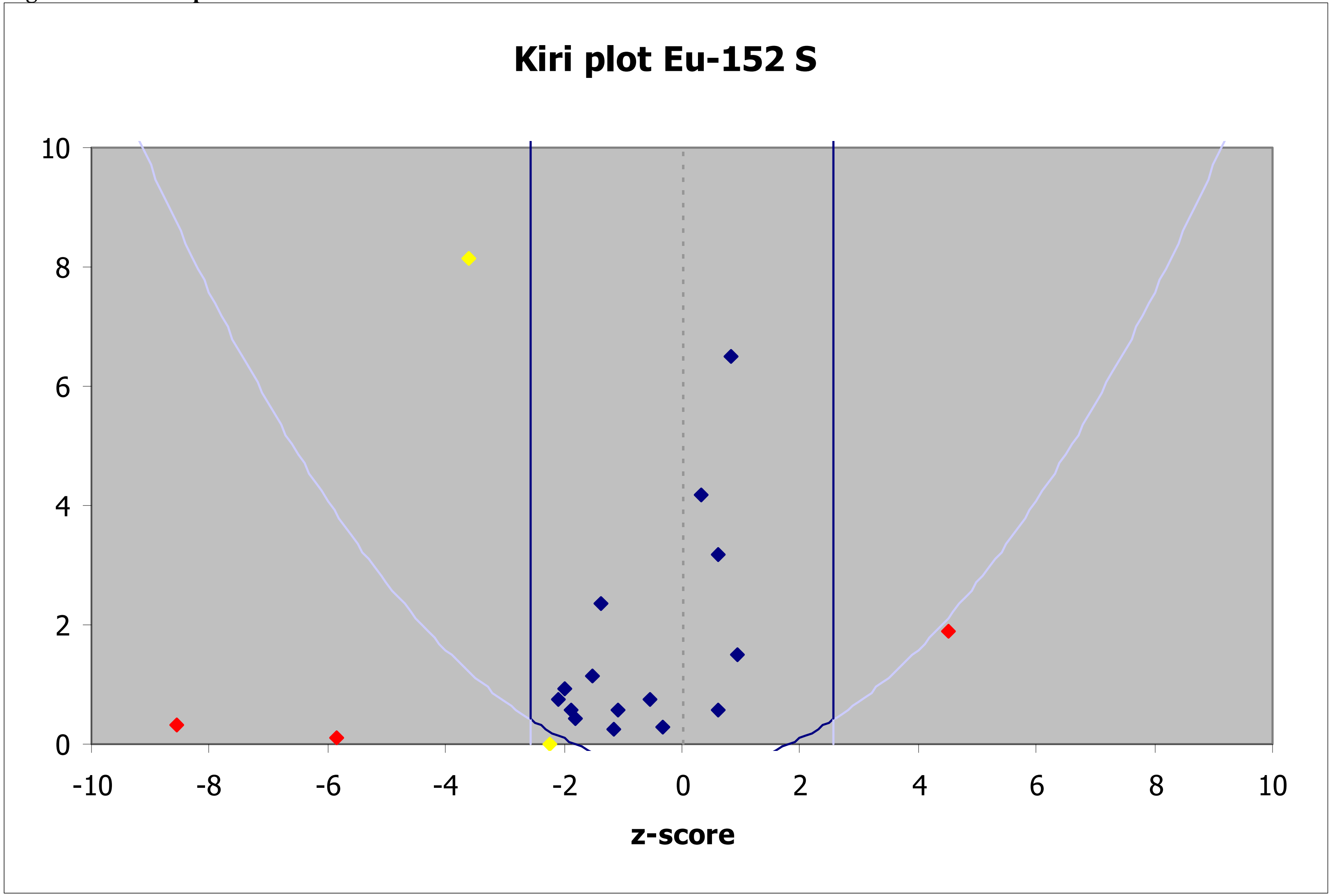


Figure 46A – Homogeneity test ^{133}Ba S

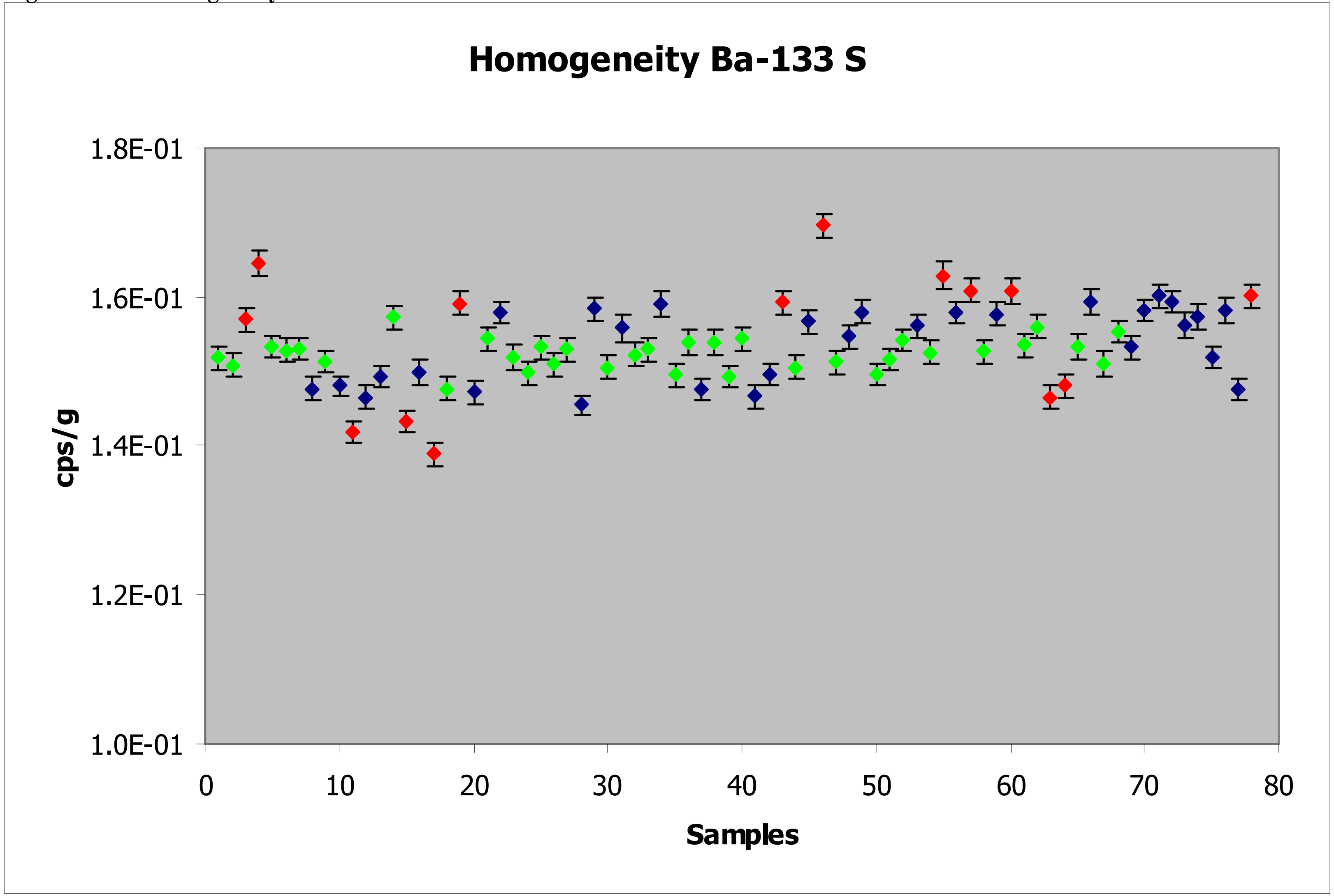


Figure 46B – Homogeneity test ^{134}Cs S

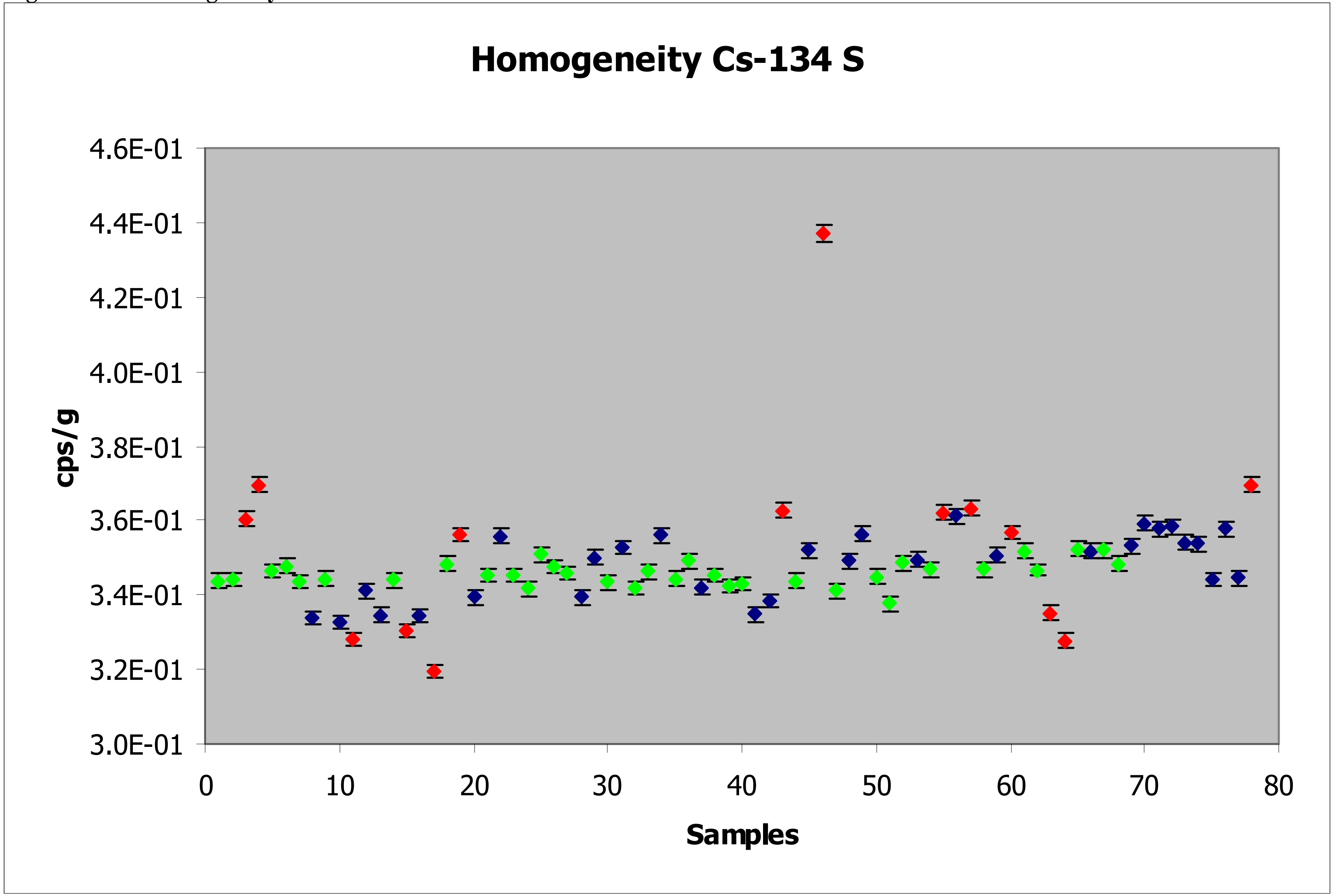


Figure 46C – Homogeneity test ^{137}Cs S

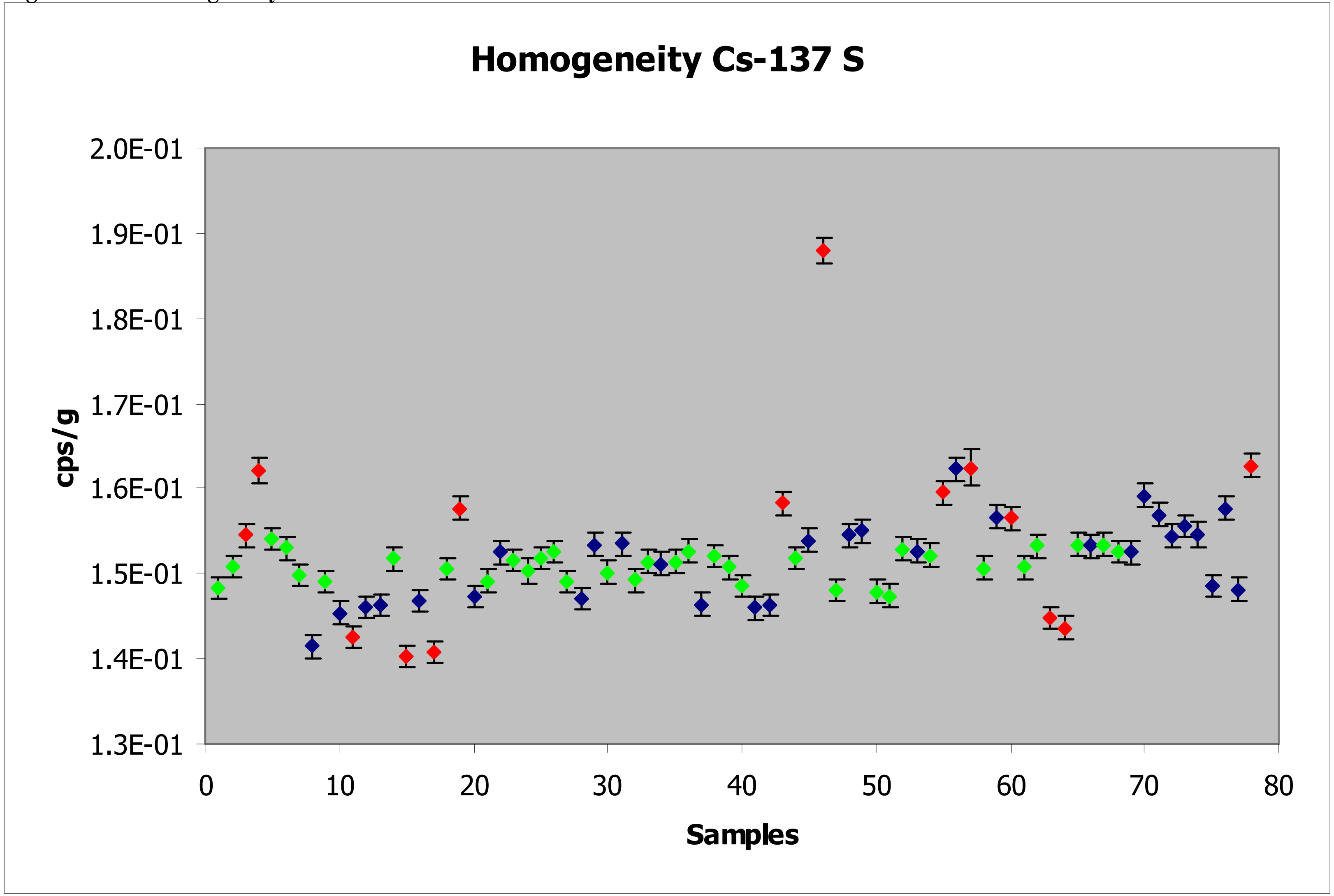


Figure 46D – Homogeneity test ^{152}Eu S

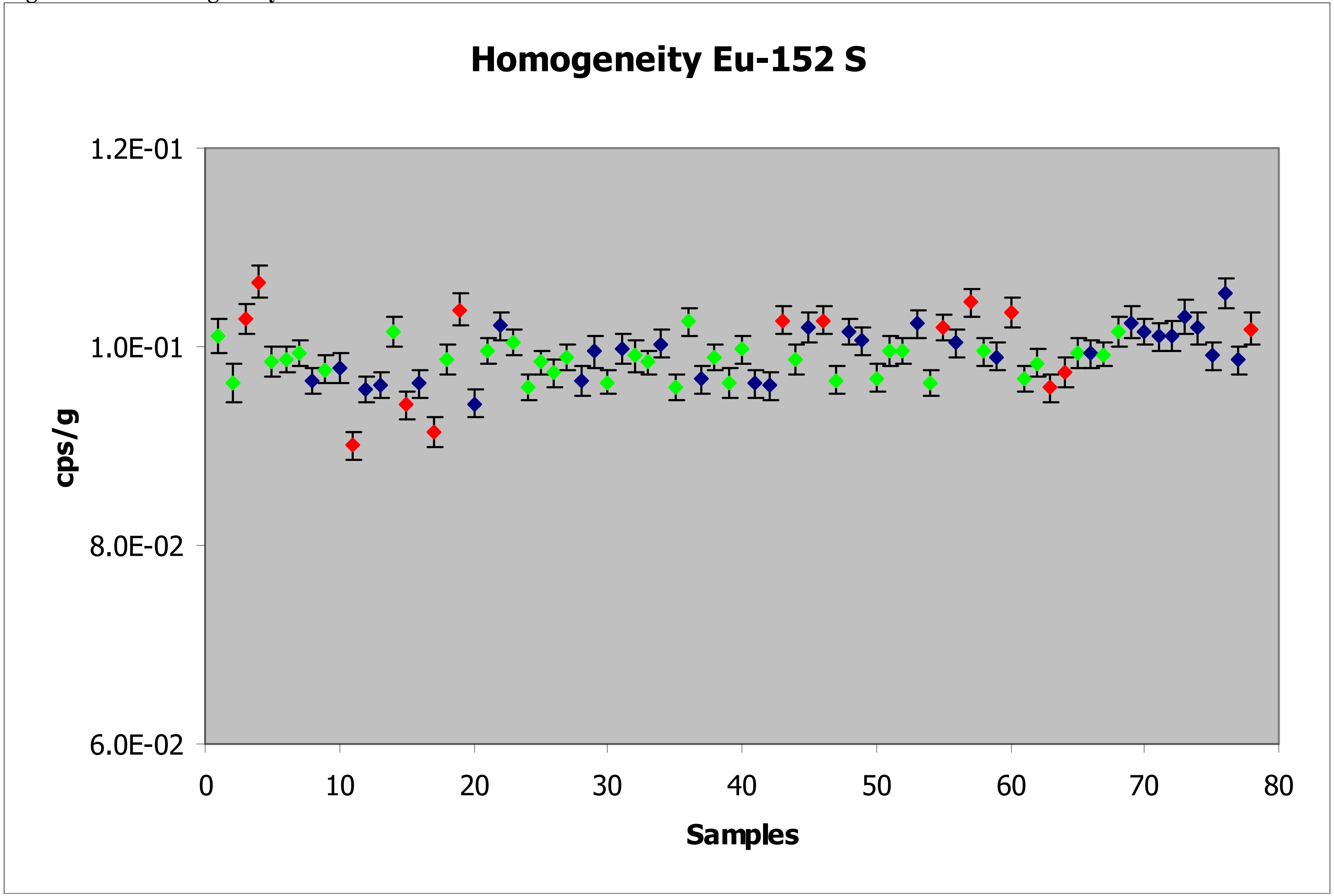


Figure 47 – Laboratory 1

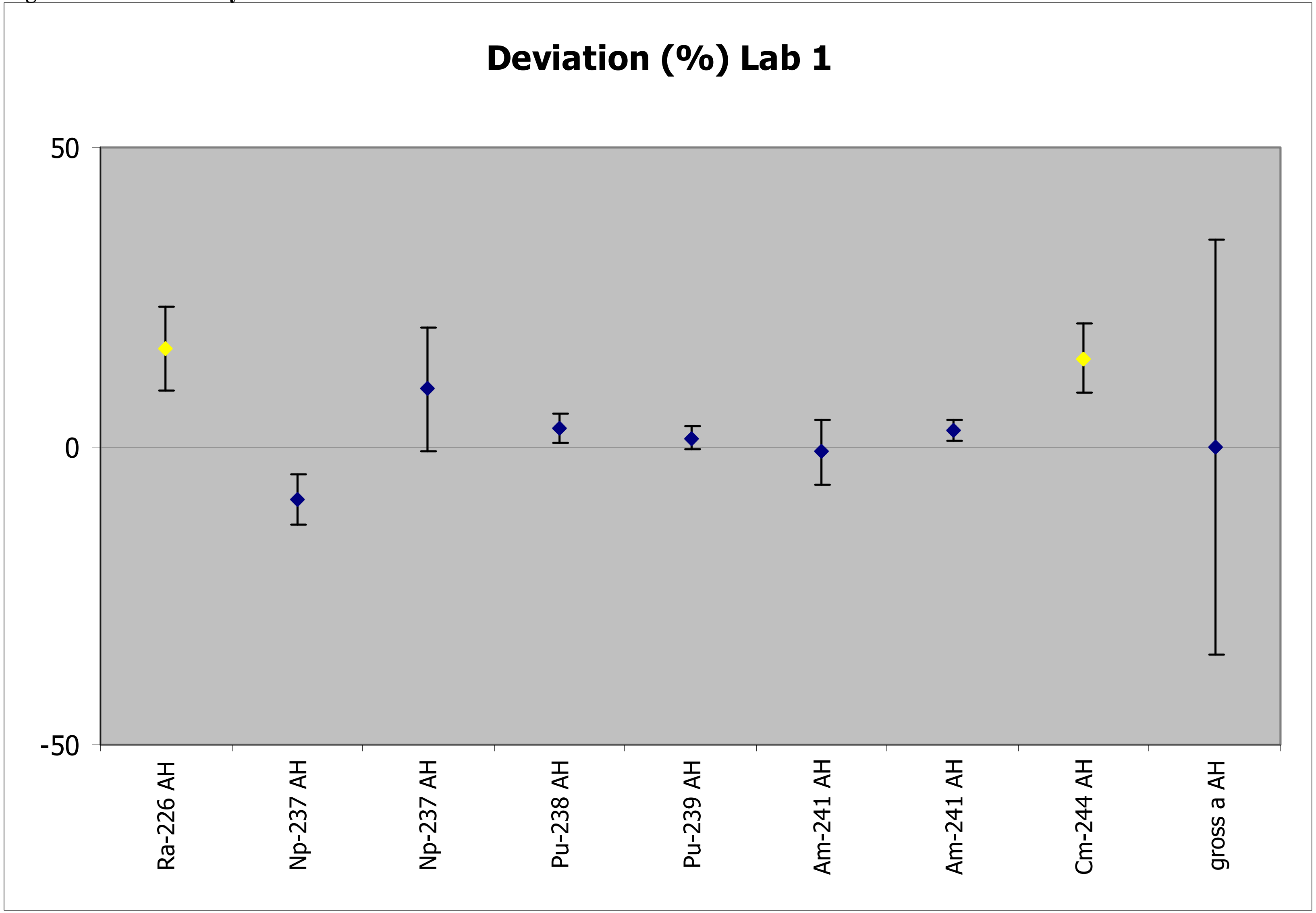


Figure 48 – Laboratory 4

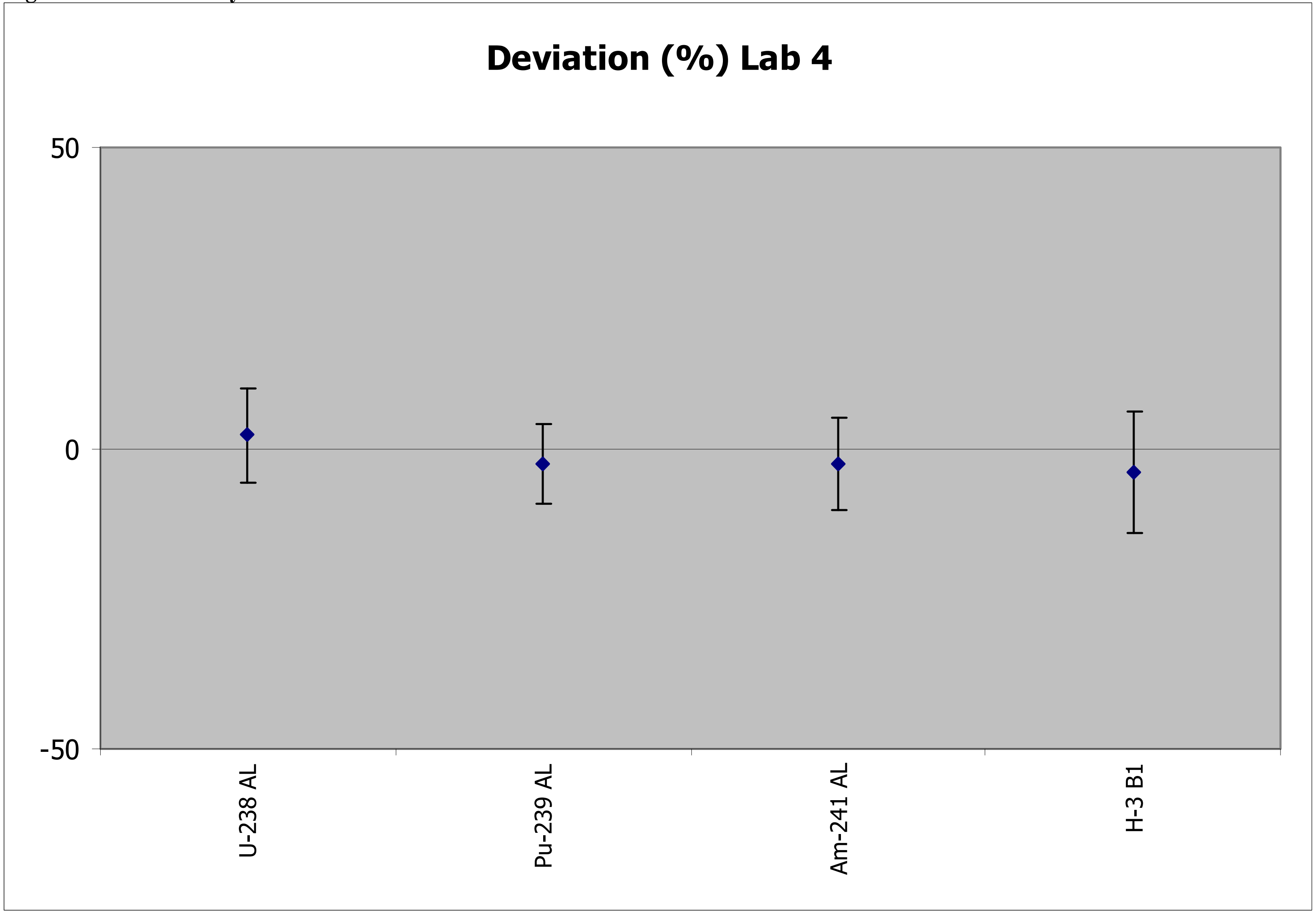


Figure 49 – Laboratory 5

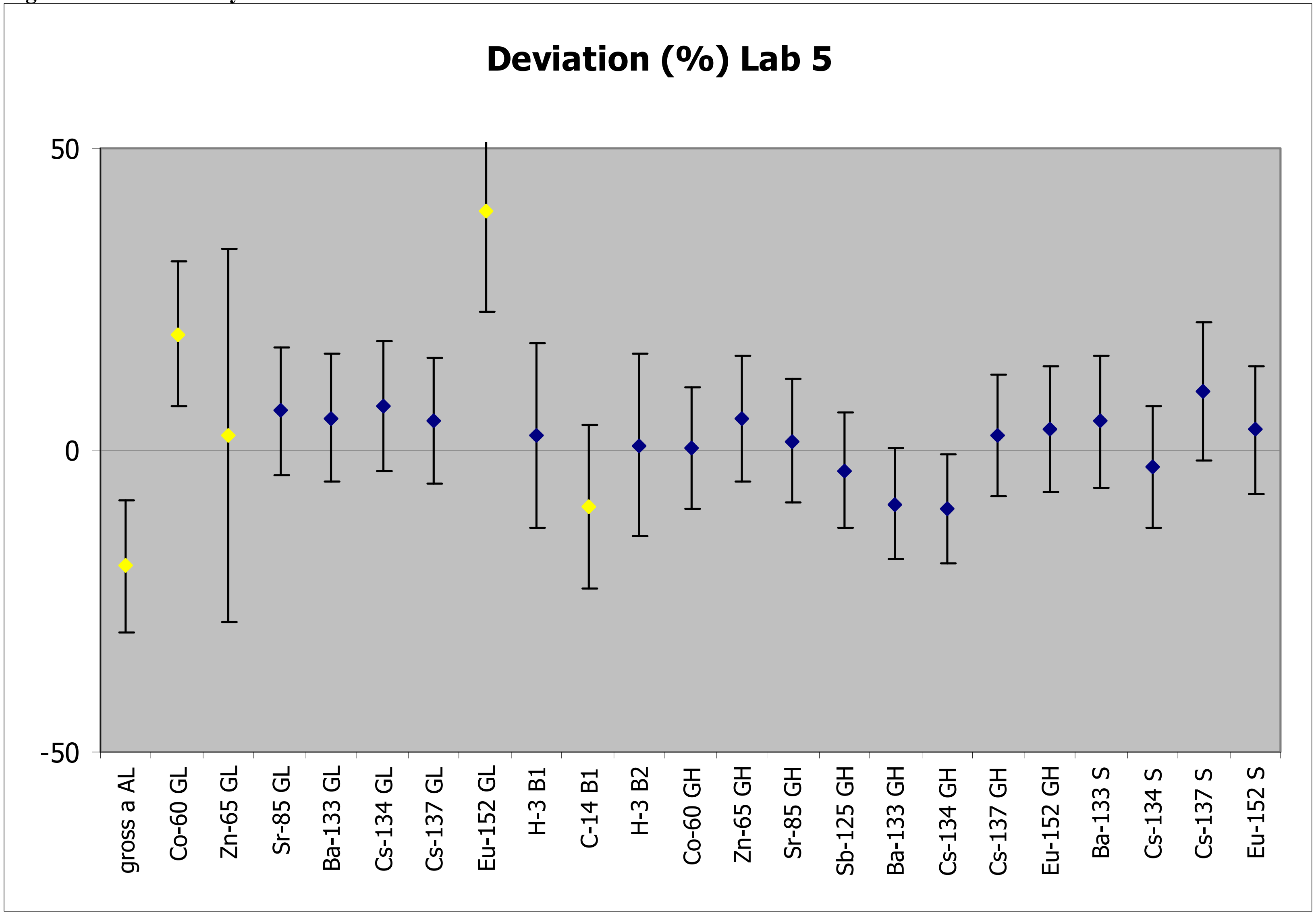


Figure 50 – Laboratory 7

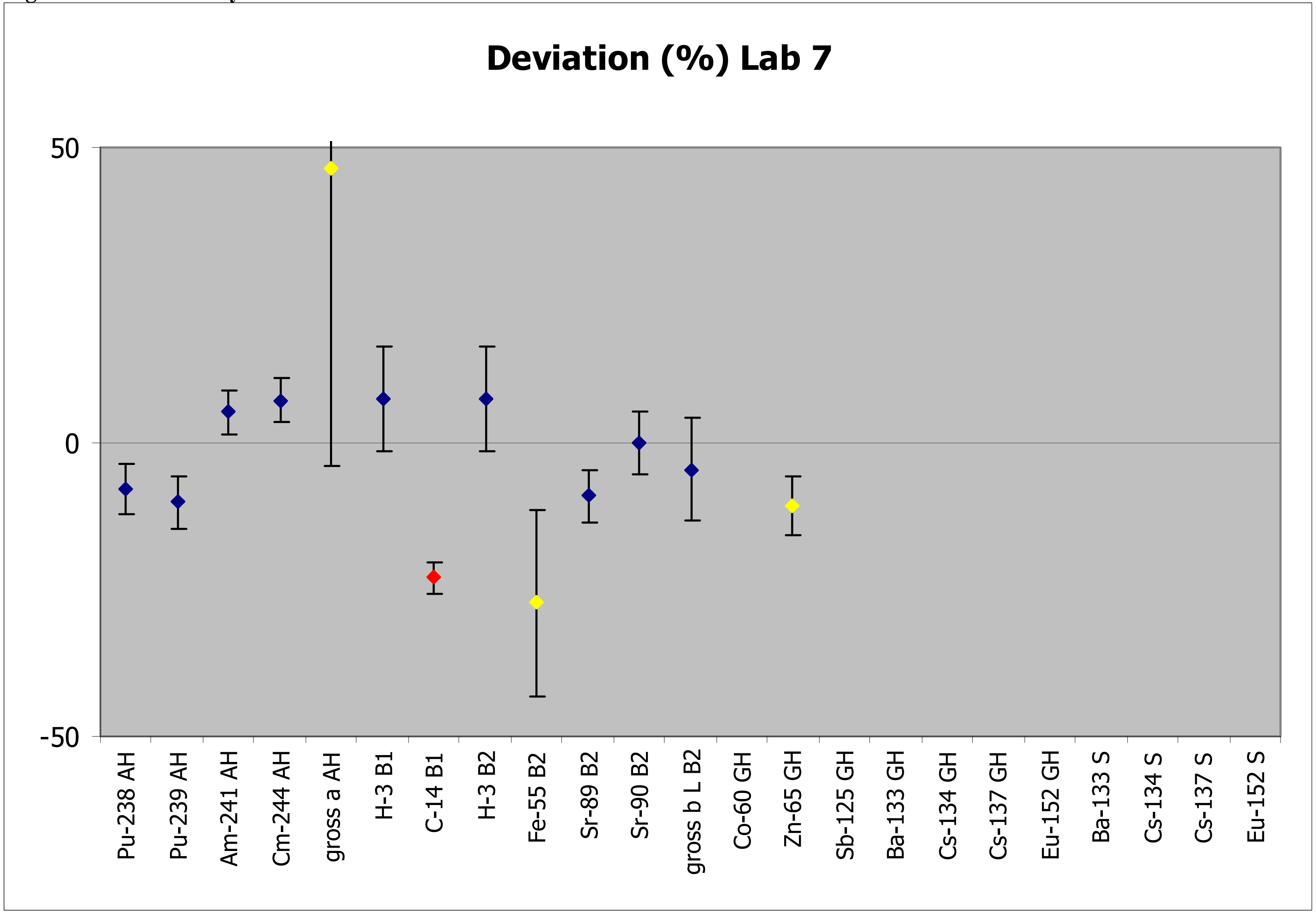


Figure 51 – Laboratory 8

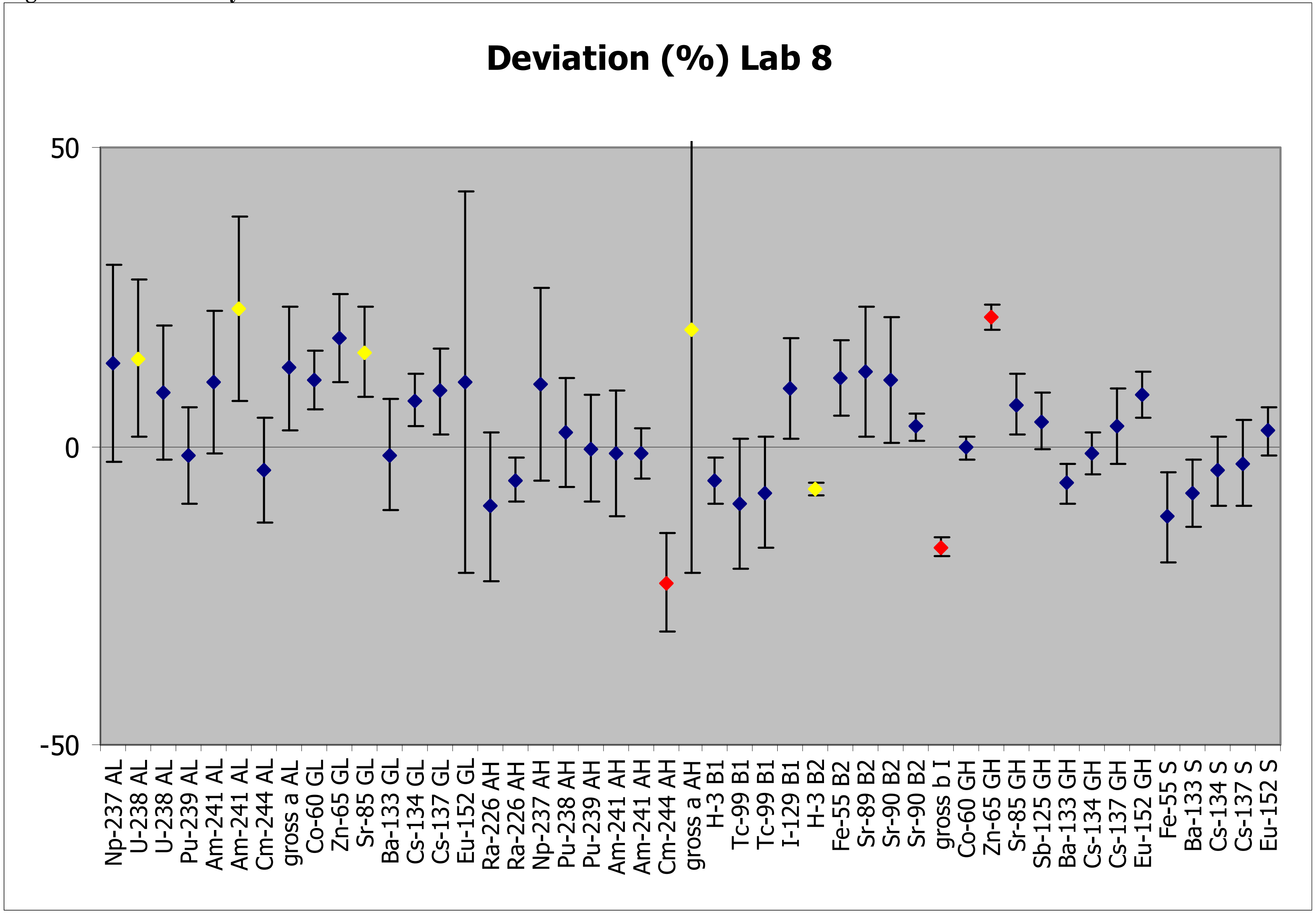


Figure 52 – Laboratory 10

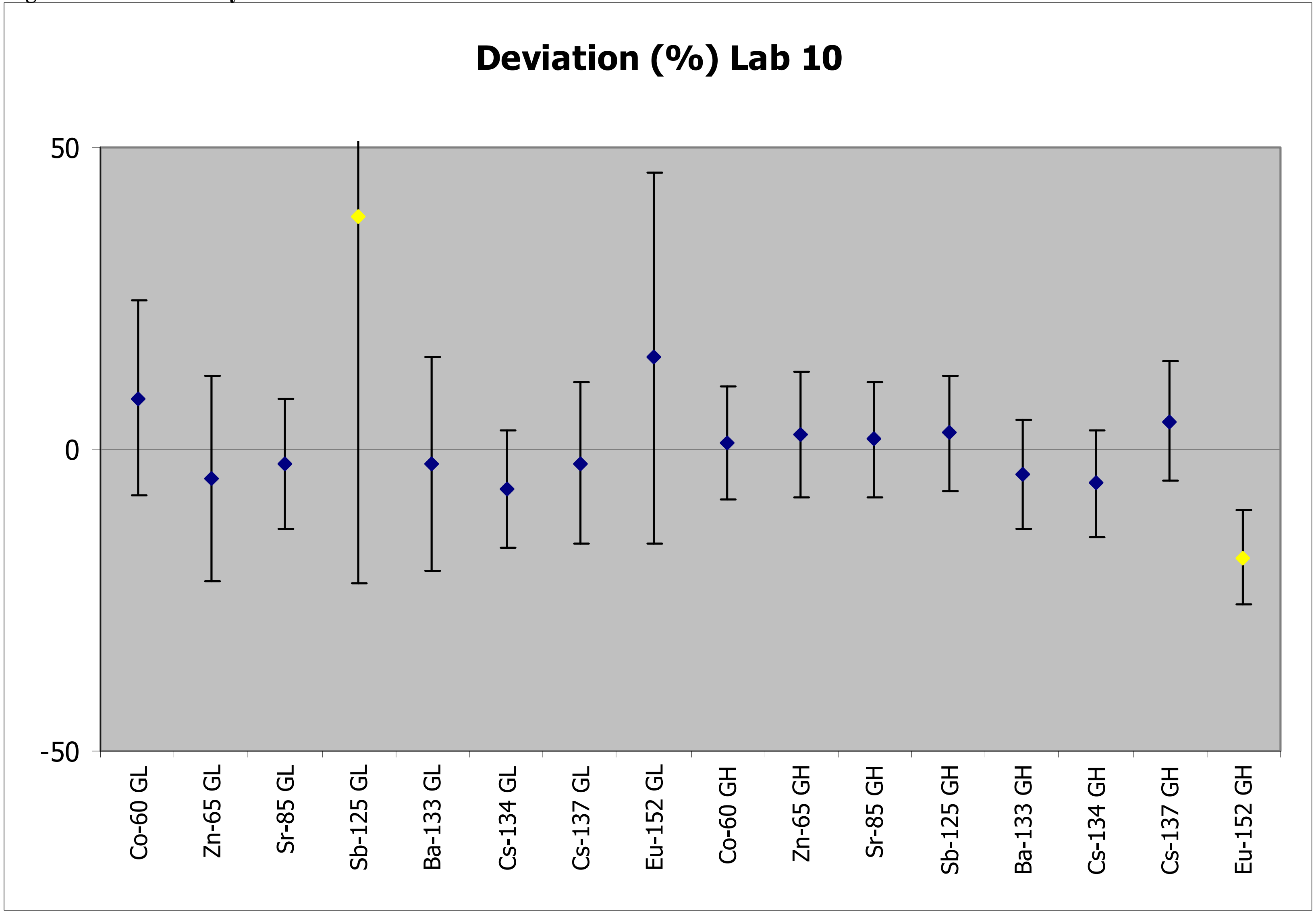


Figure 53 – Laboratory 13

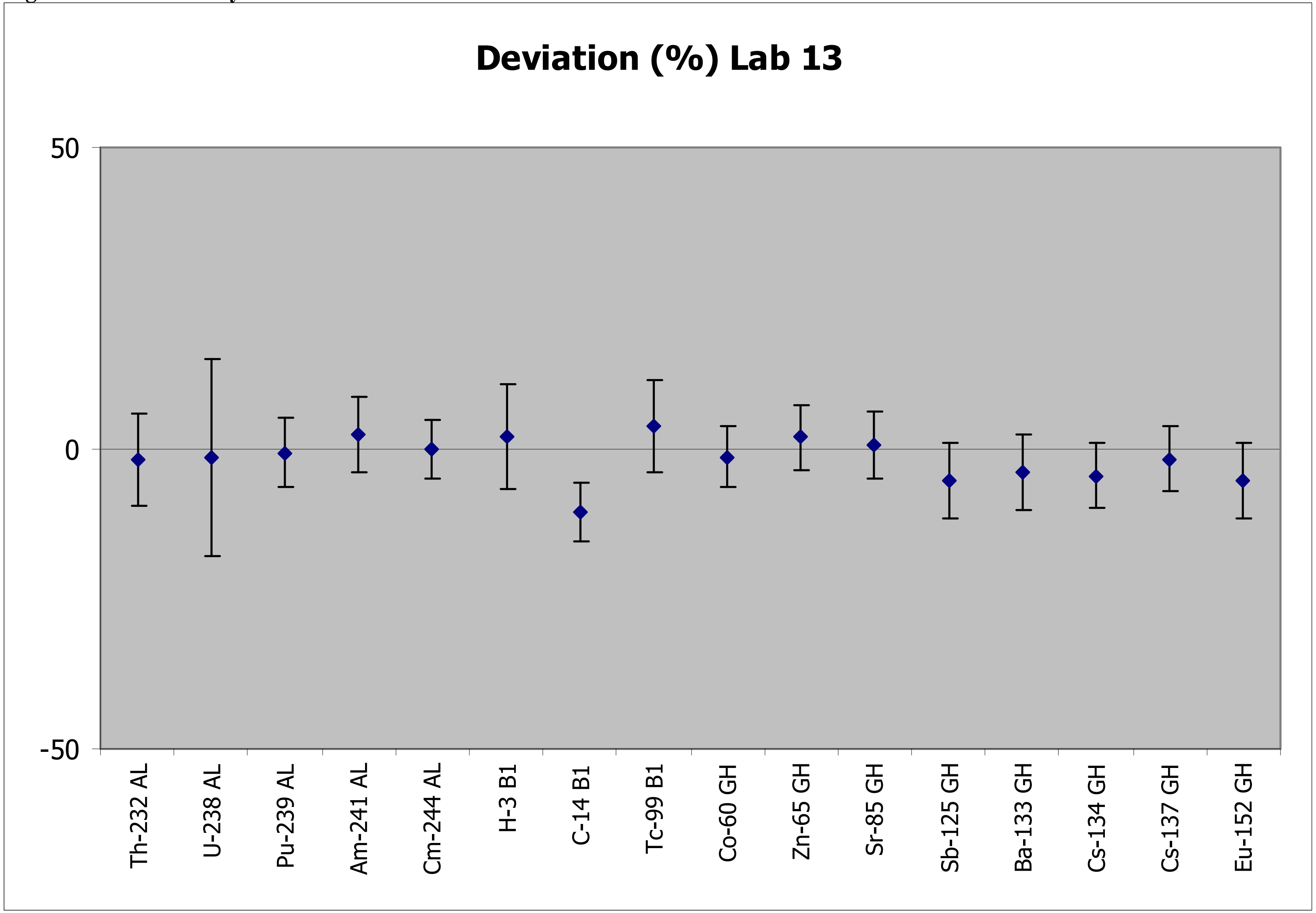


Figure 54 – Laboratory 15

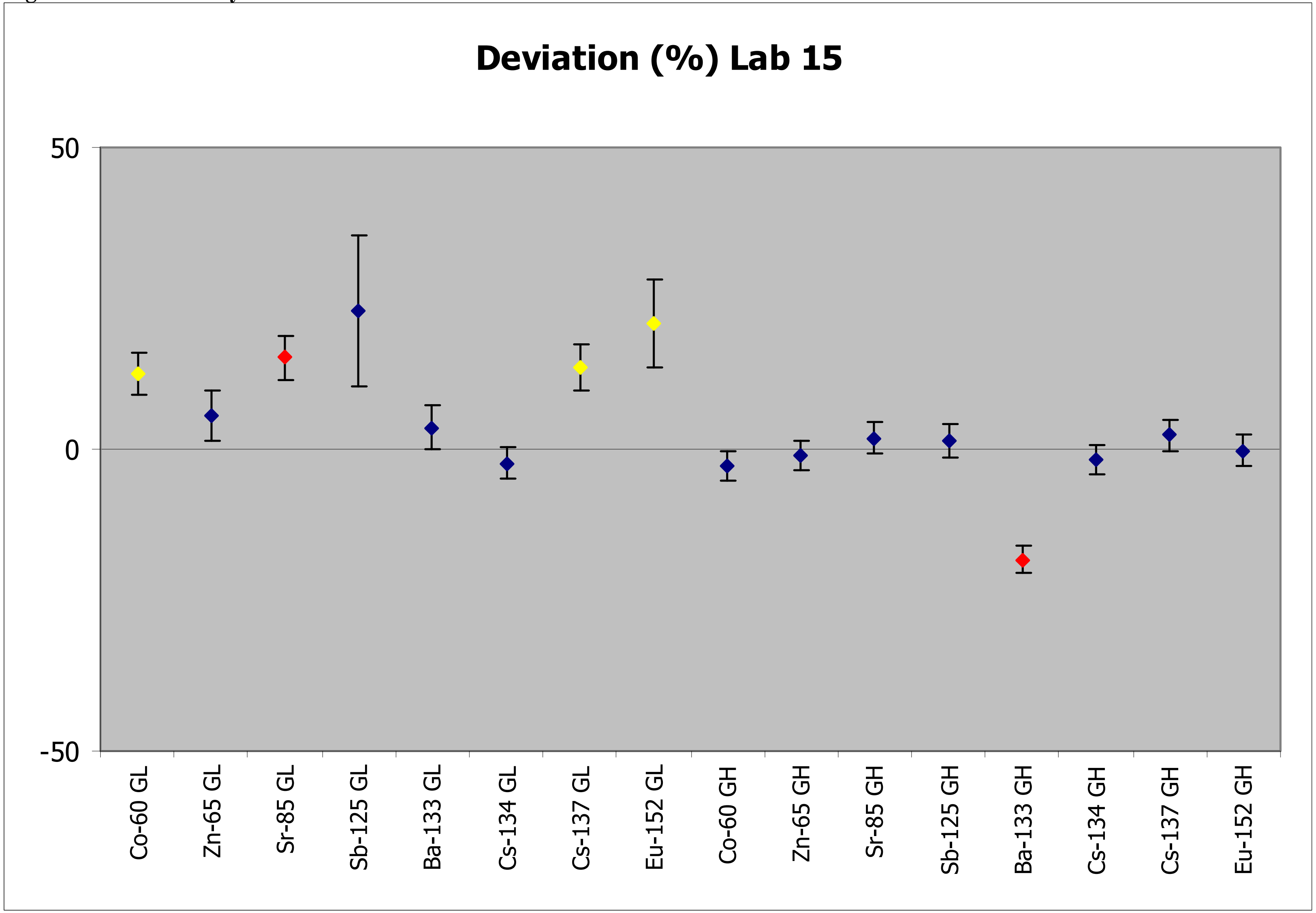


Figure 55 – Laboratory 16

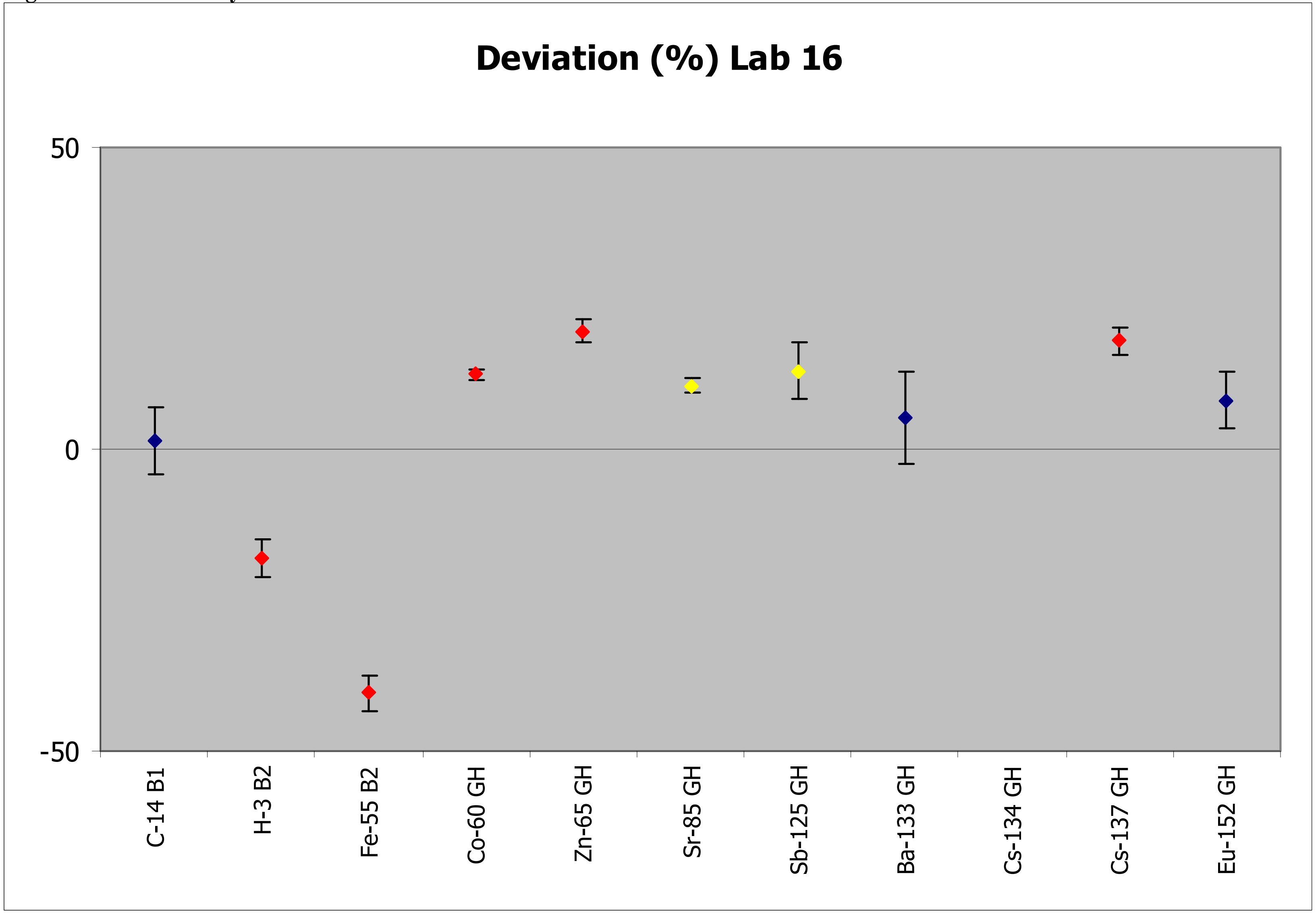


Figure 56 – Laboratory 17

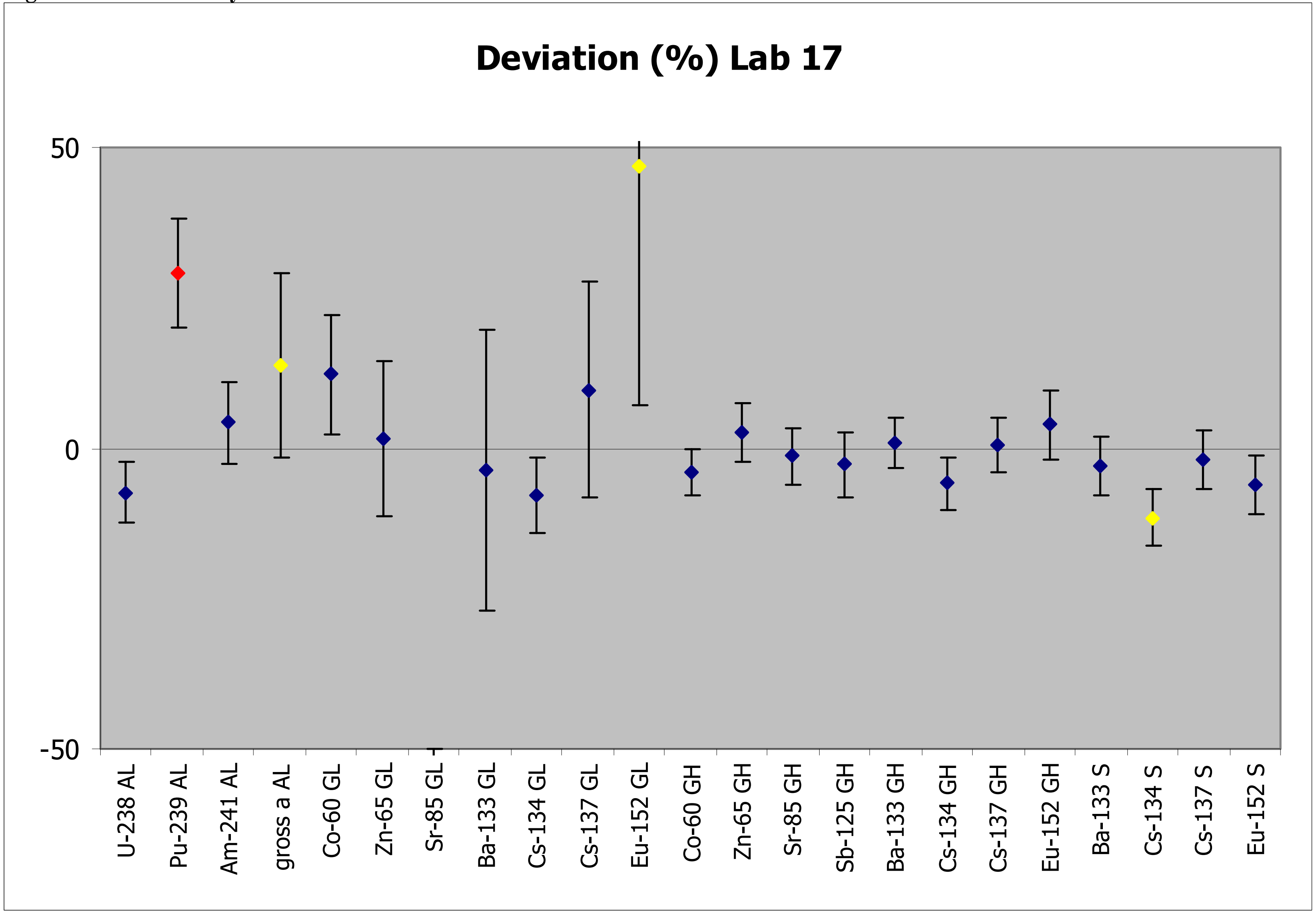


Figure 57 – Laboratory 18

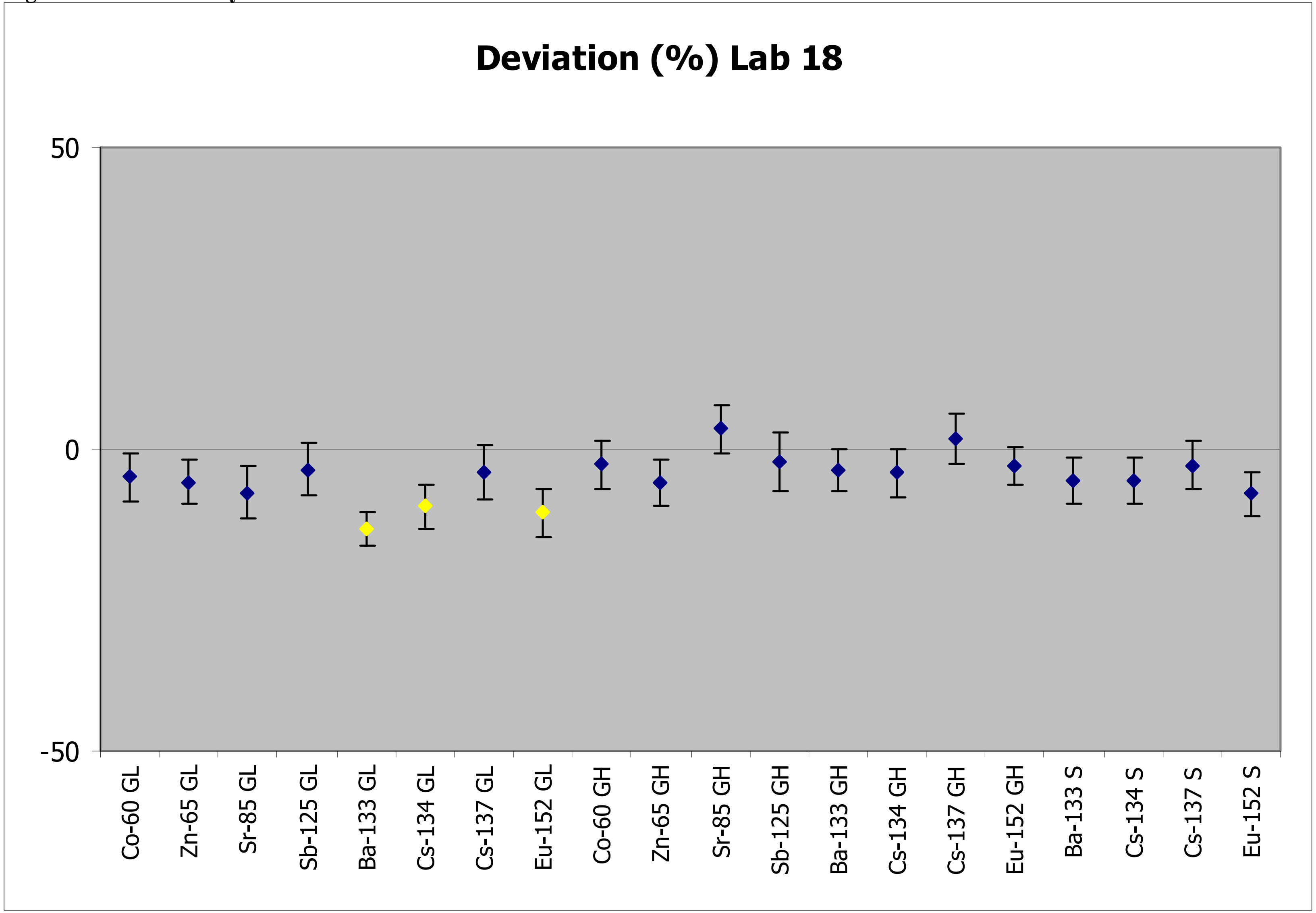


Figure 58 – Laboratory 19

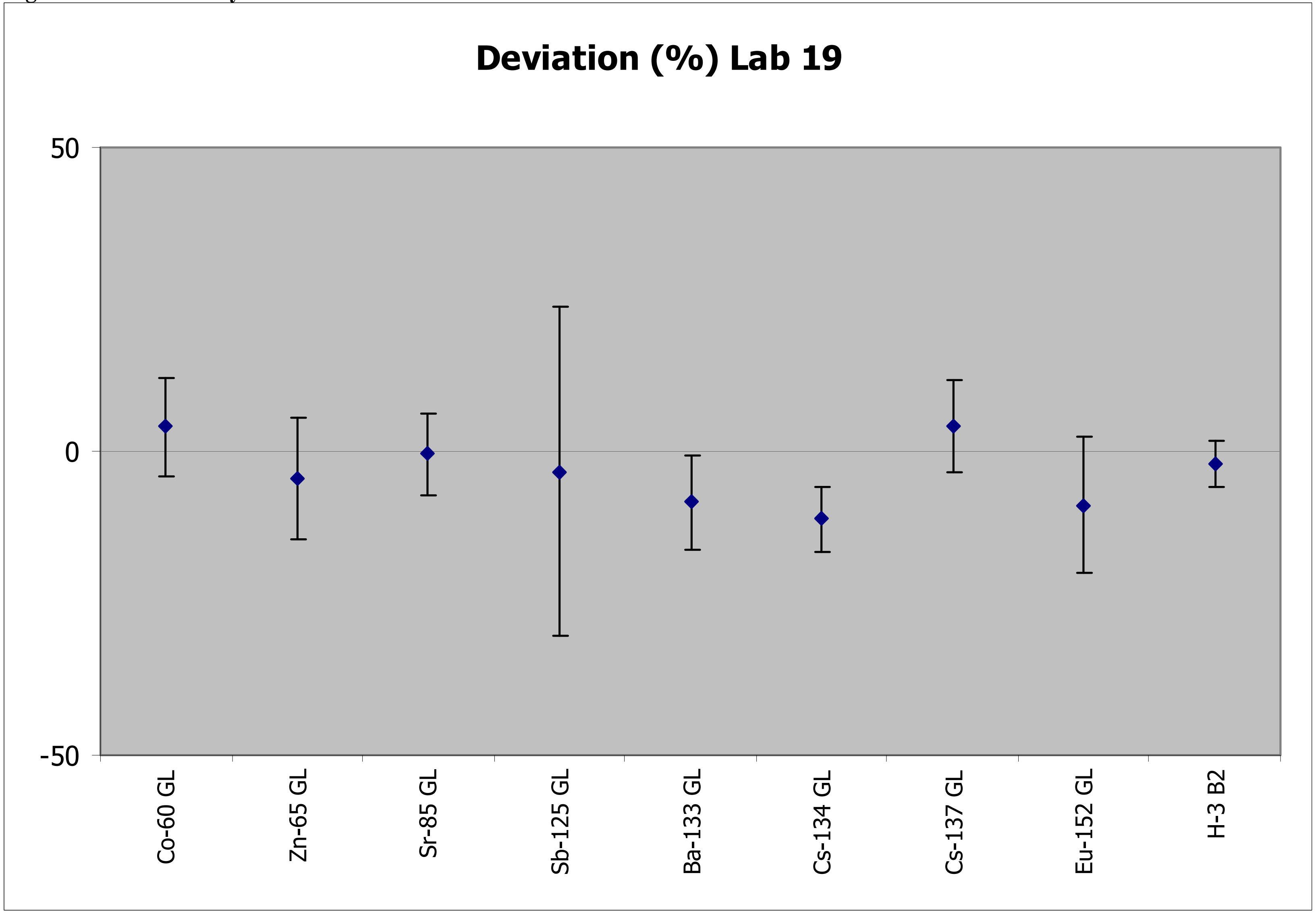


Figure 59 – Laboratory 23

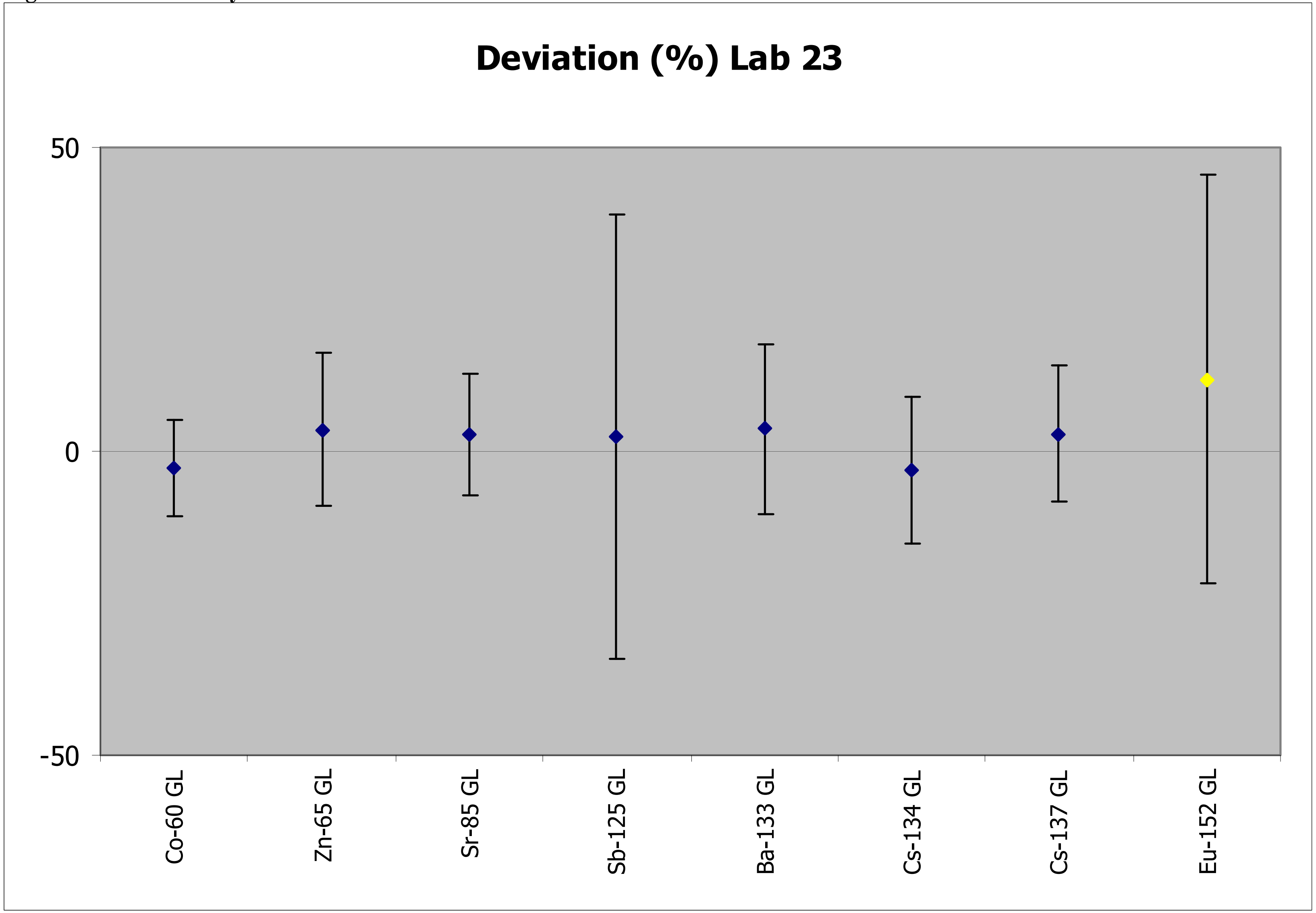


Figure 60 – Laboratory 25

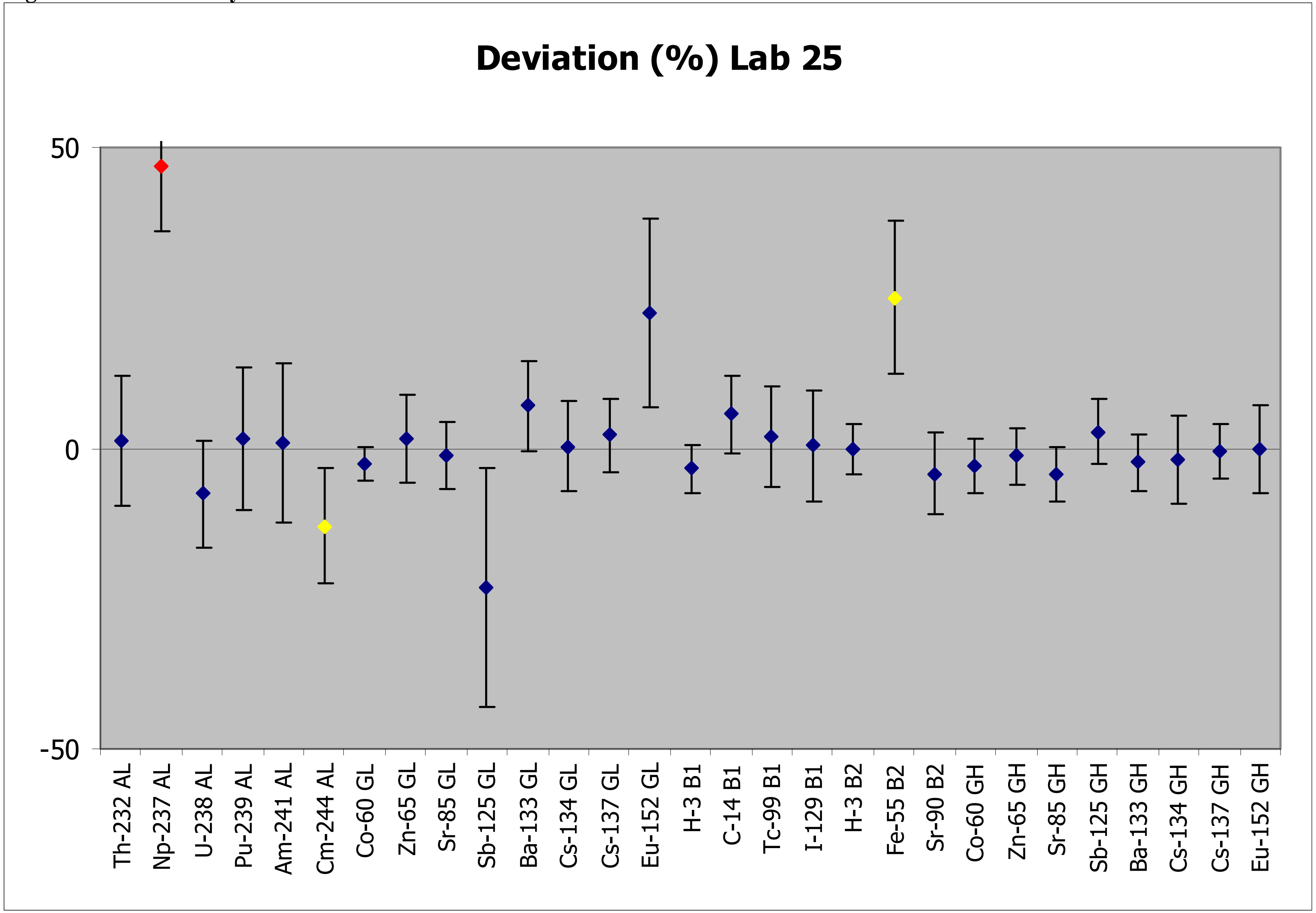


Figure 61 – Laboratory 26

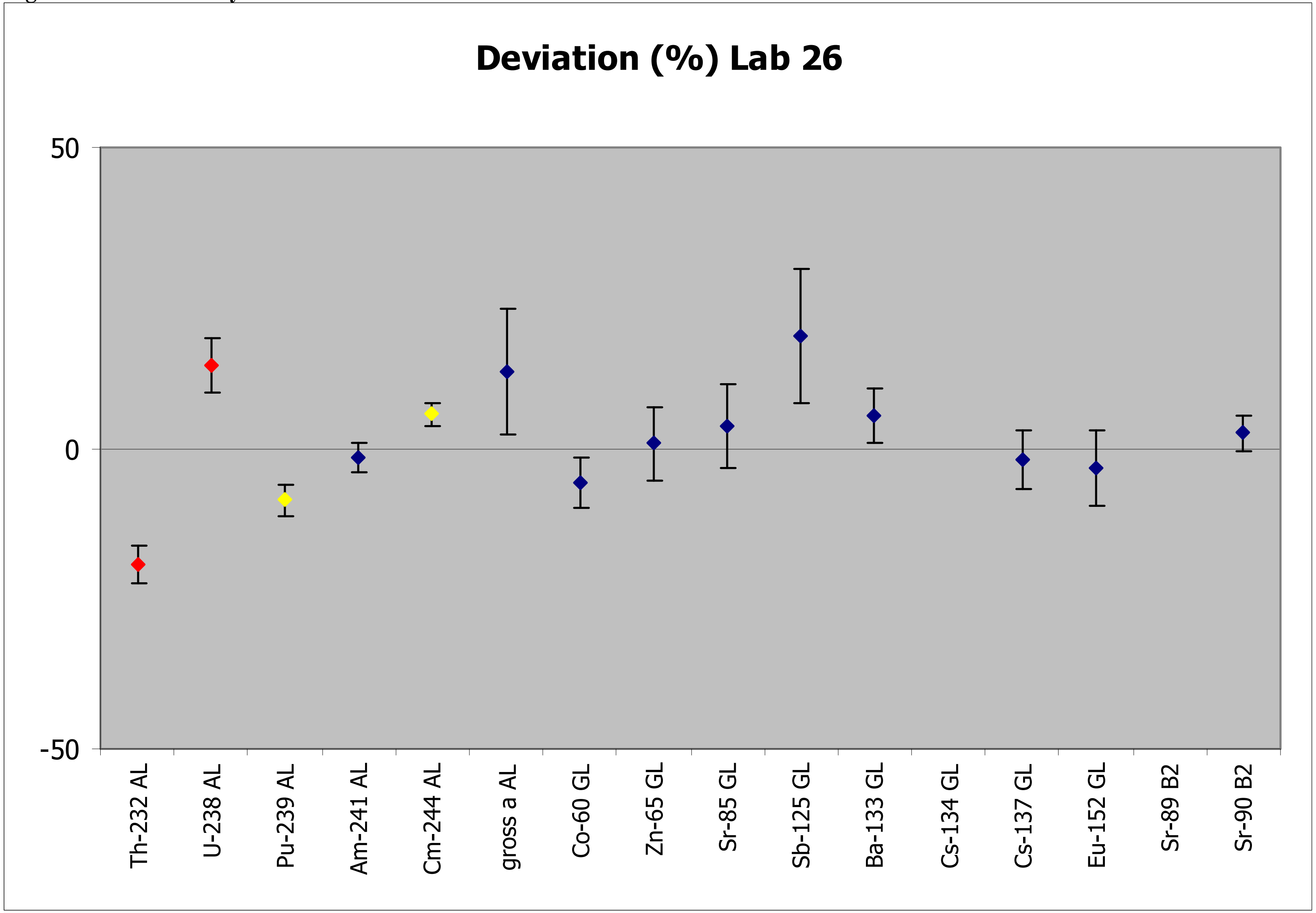


Figure 62 – Laboratory 27

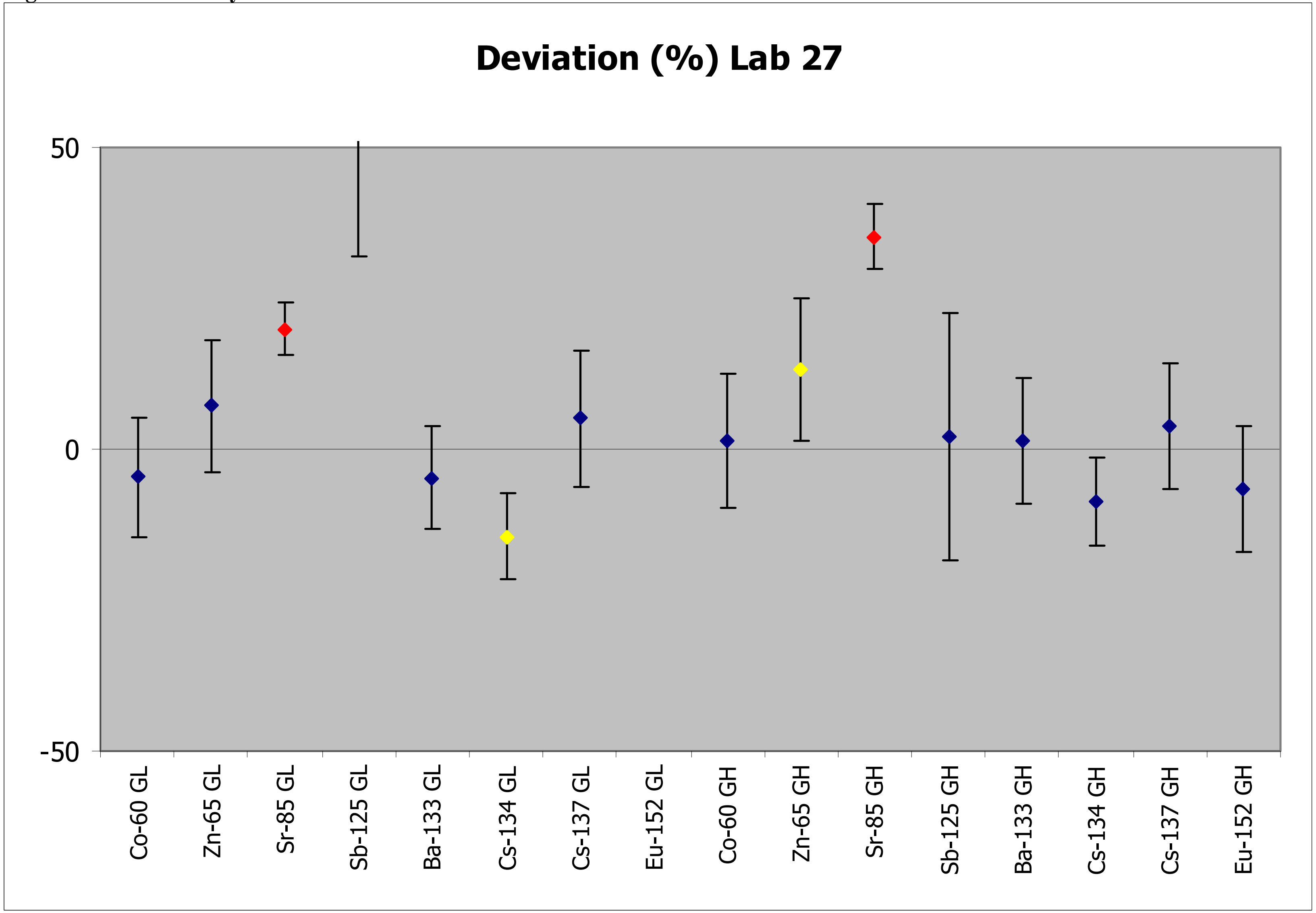


Figure 63 – Laboratory 28

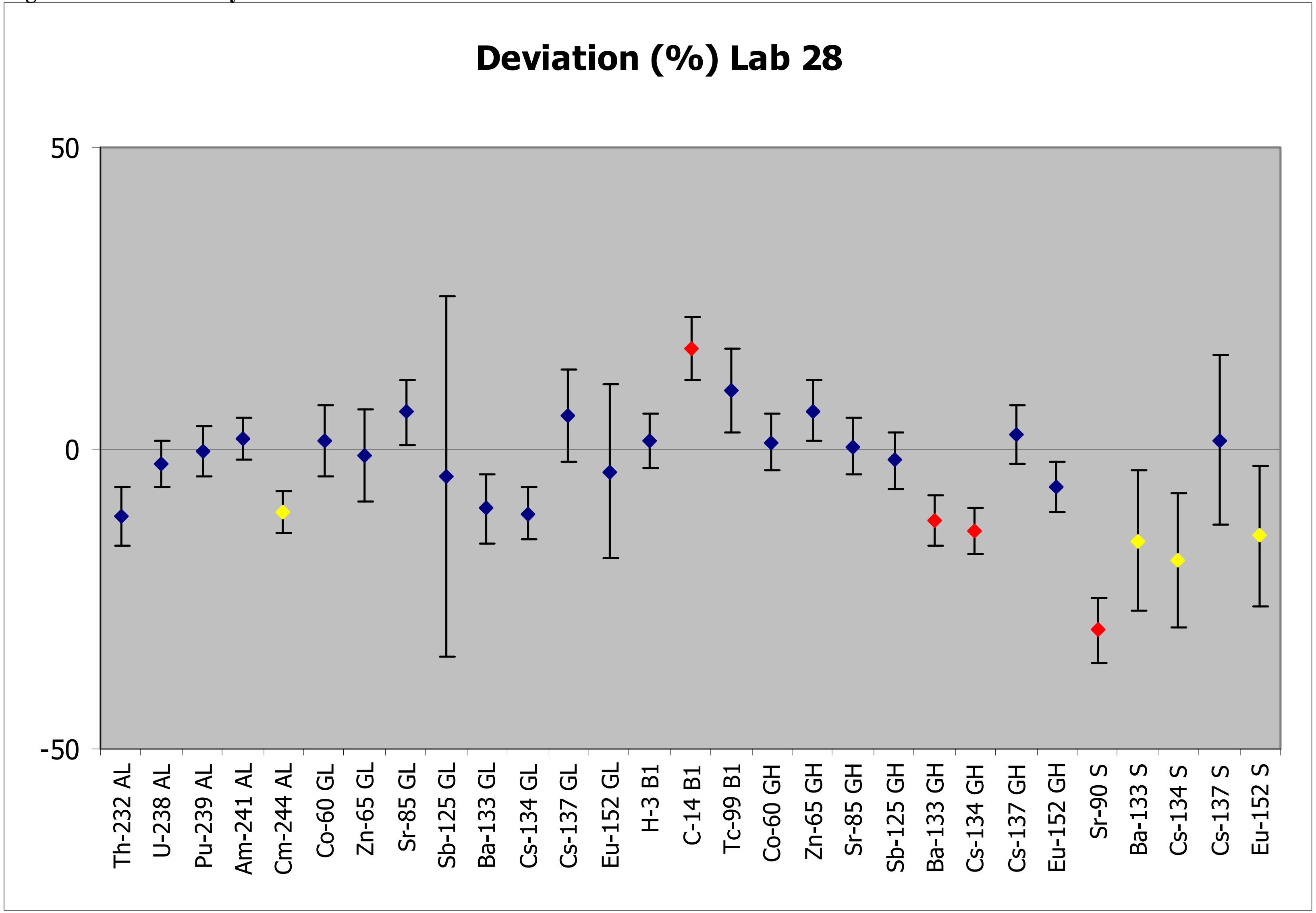


Figure 64 – Laboratory 29

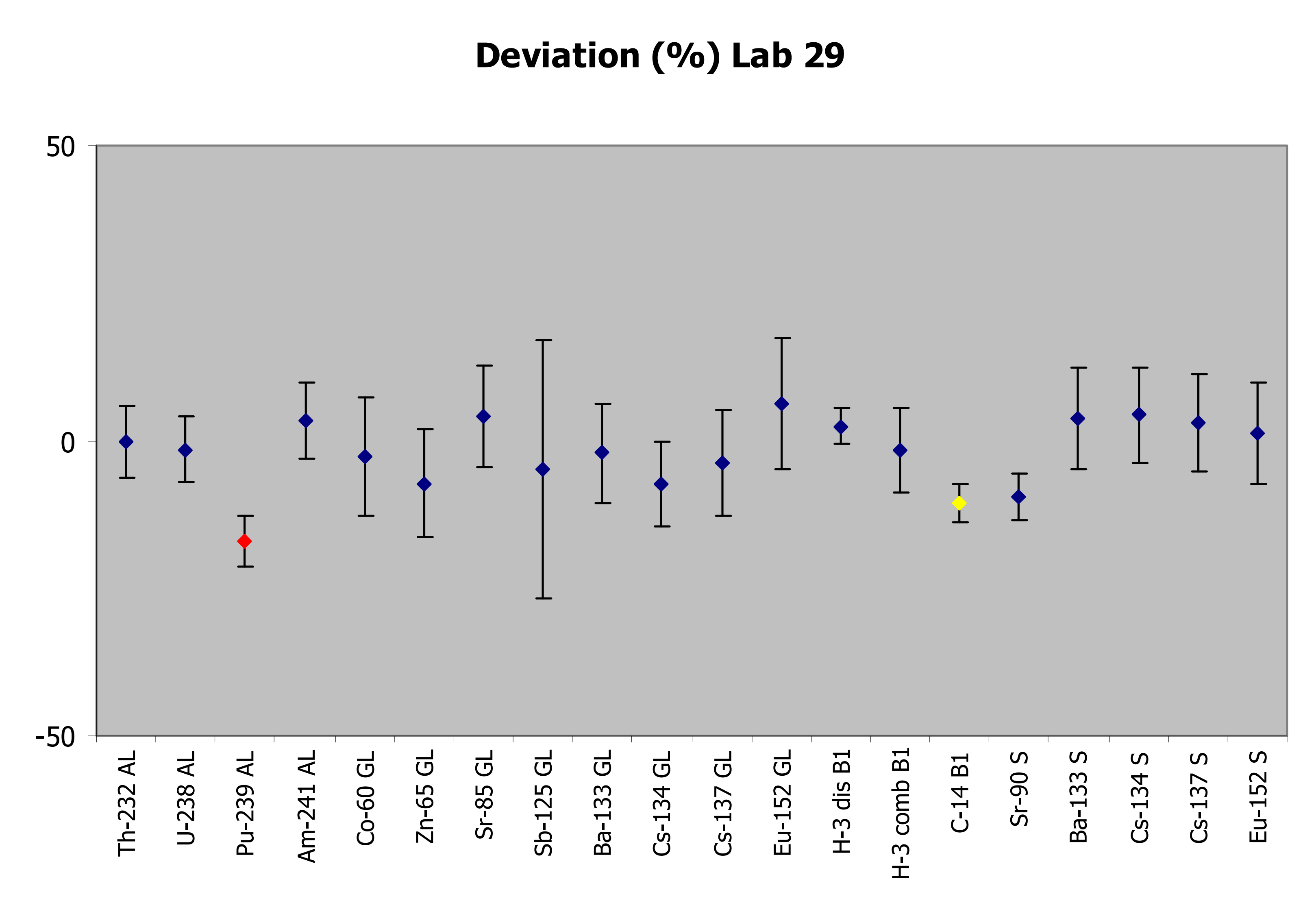


Figure 65 – Laboratory 31

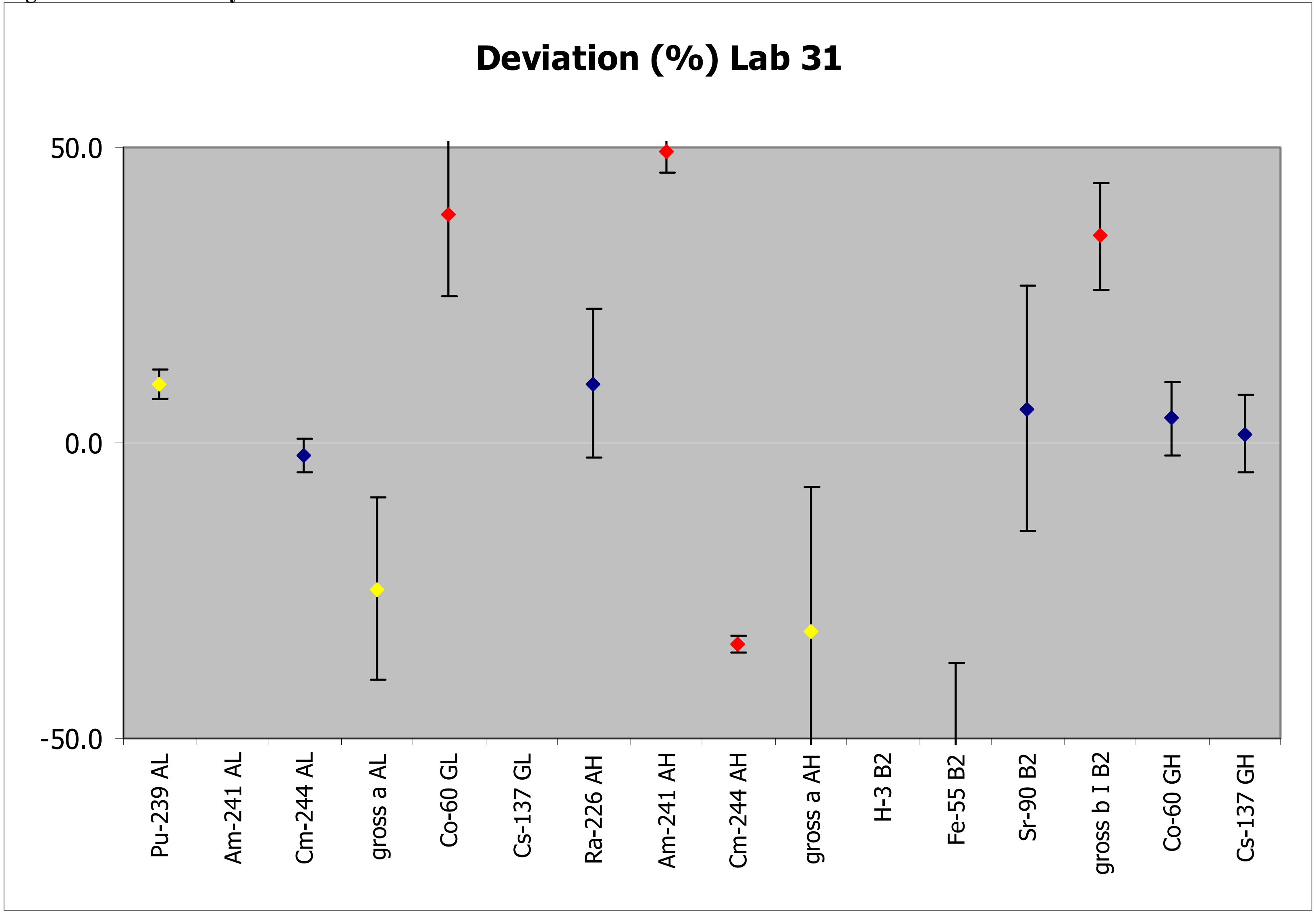


Figure 66 – Laboratory 32

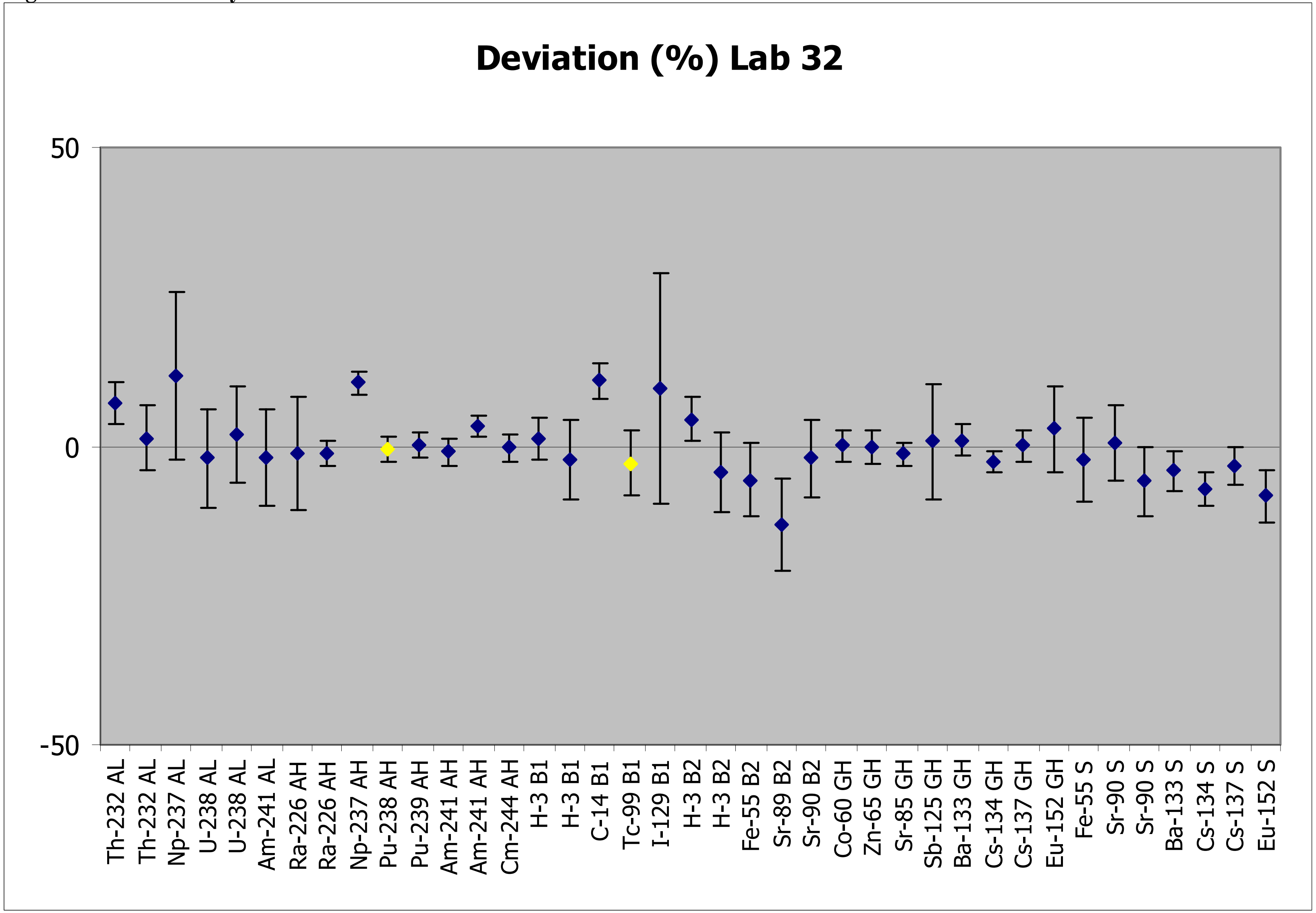


Figure 67 – Laboratory 35

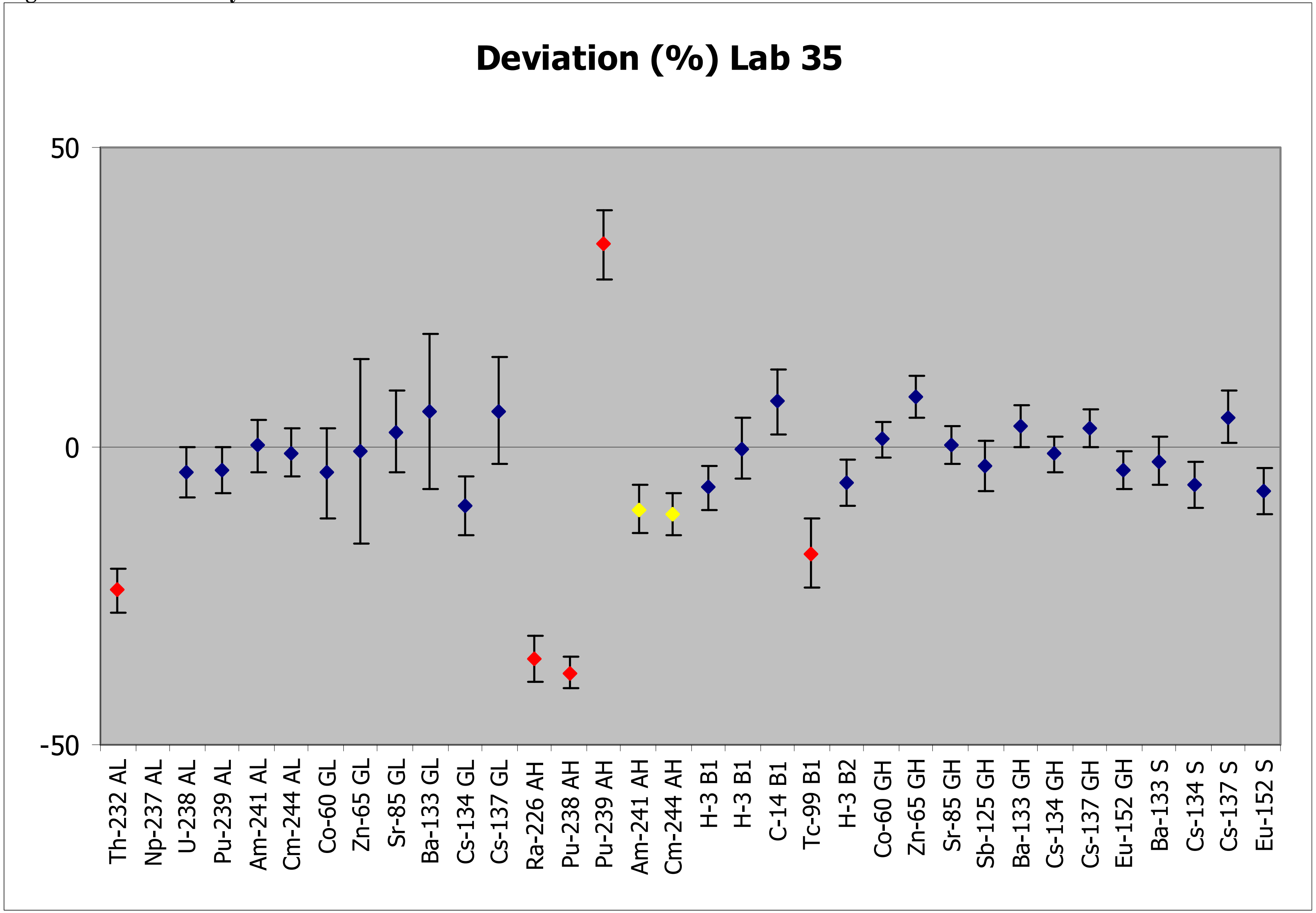


Figure 68 – Laboratory 38

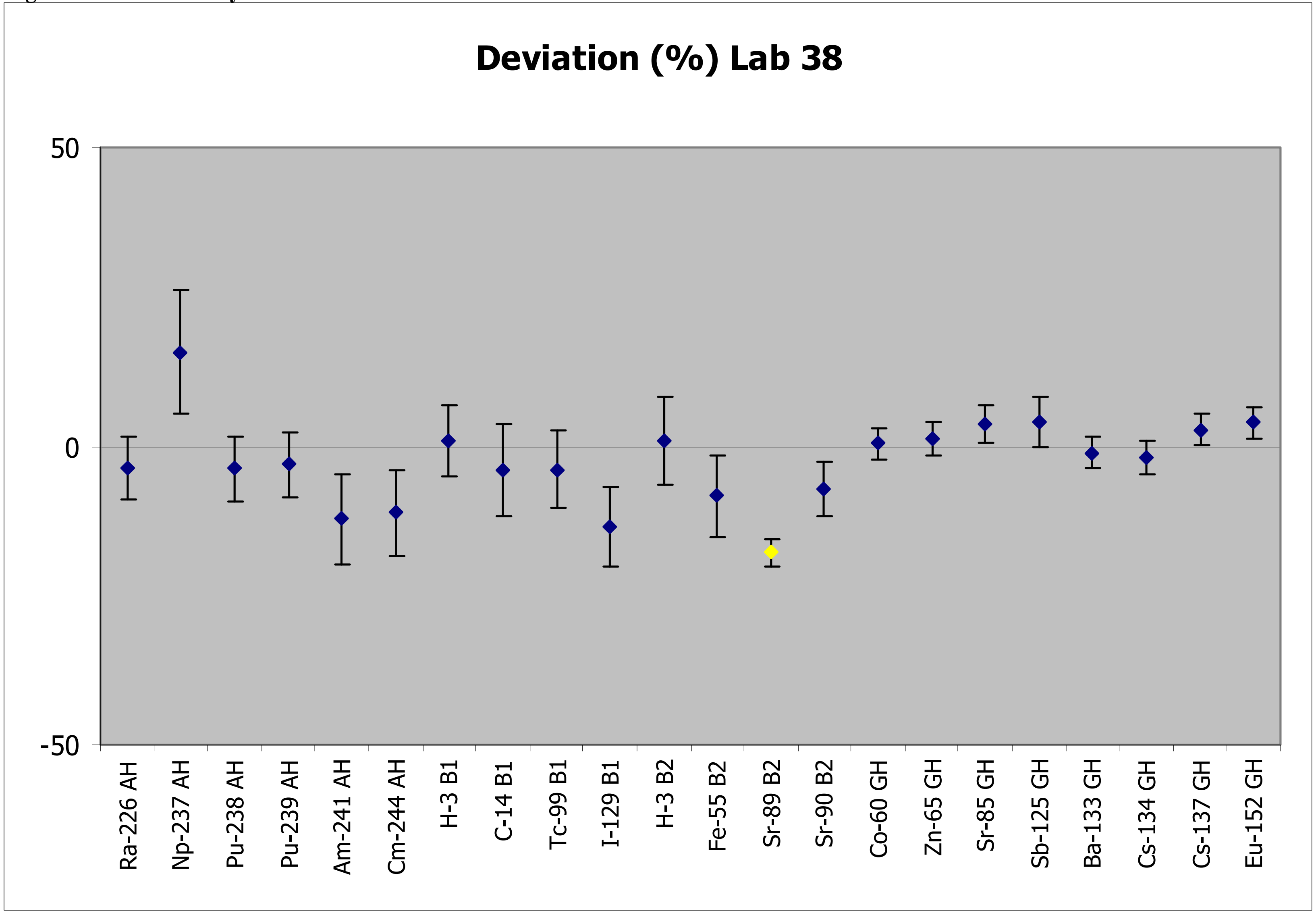


Figure 69 – Laboratory 39

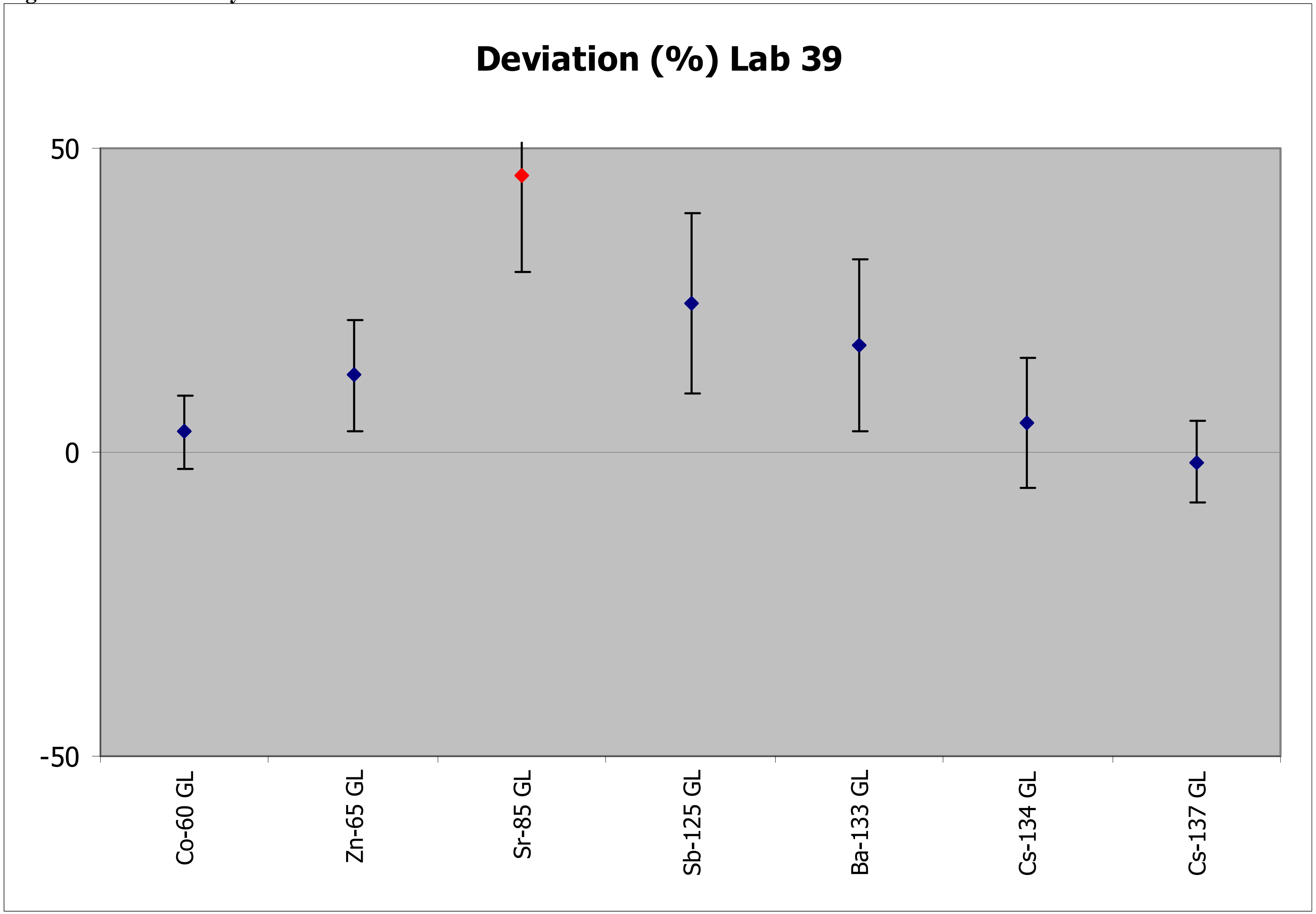


Figure 70 – Laboratory 40

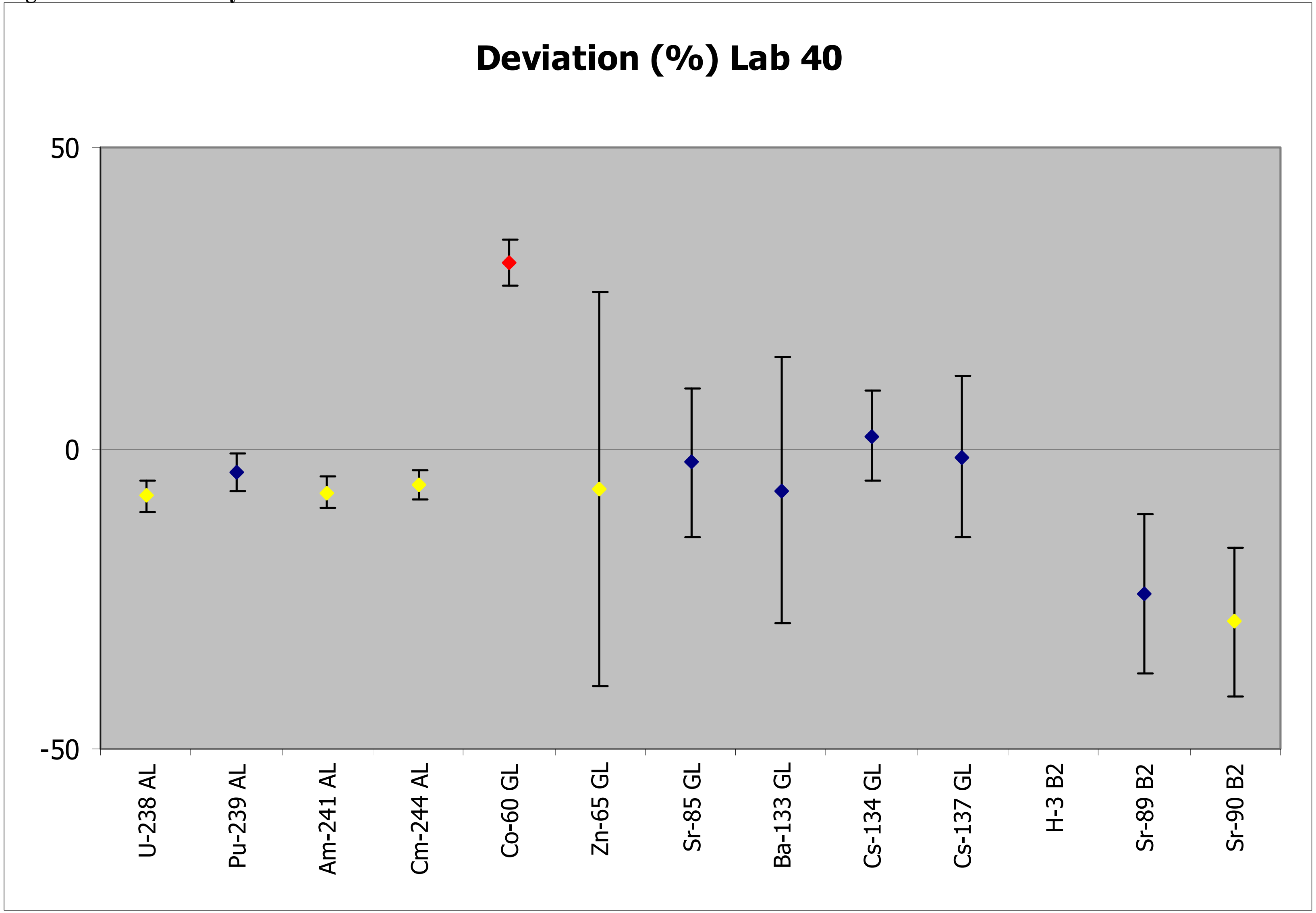


Figure 71 – Laboratory 41

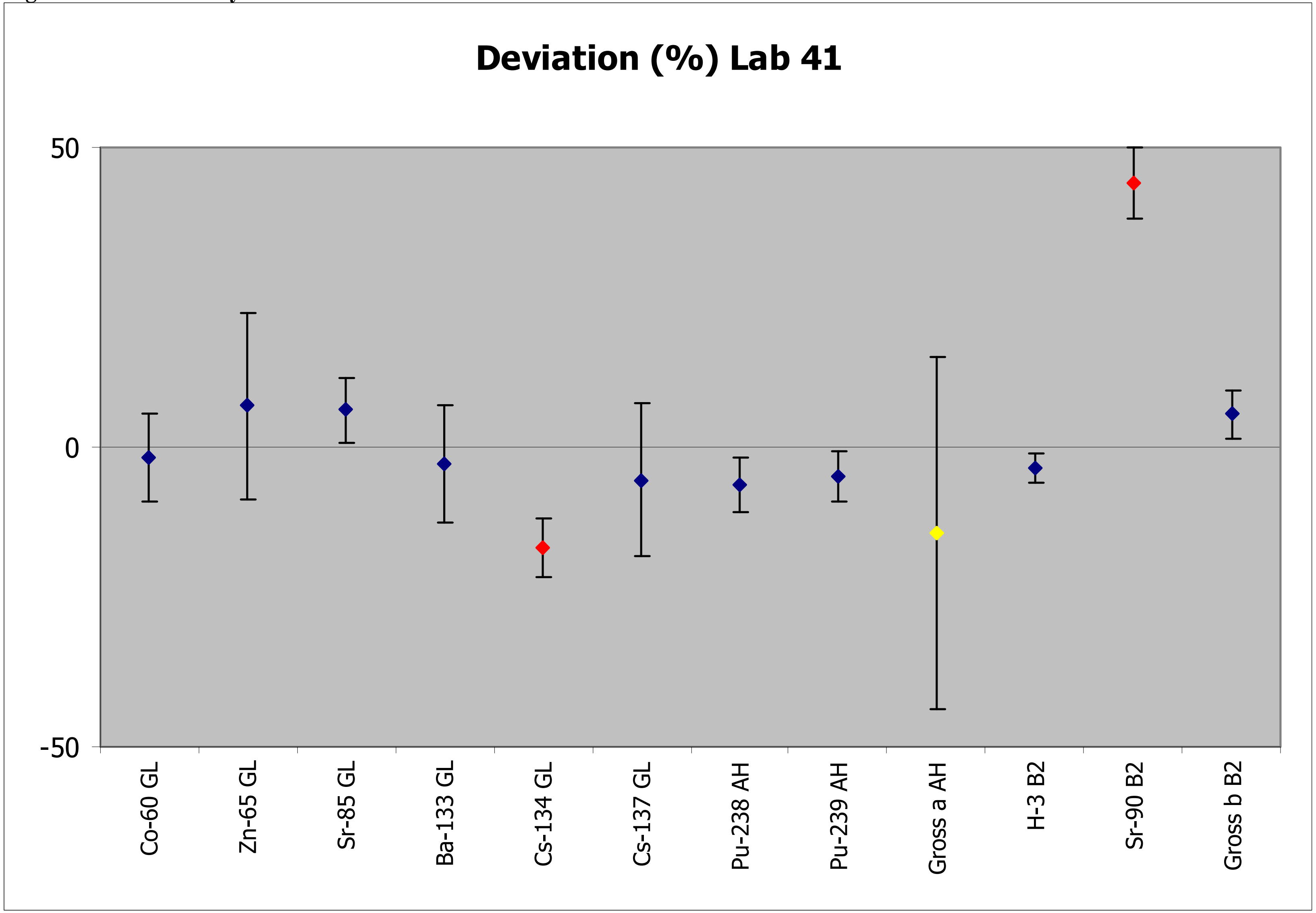


Figure 72 – Laboratory 42

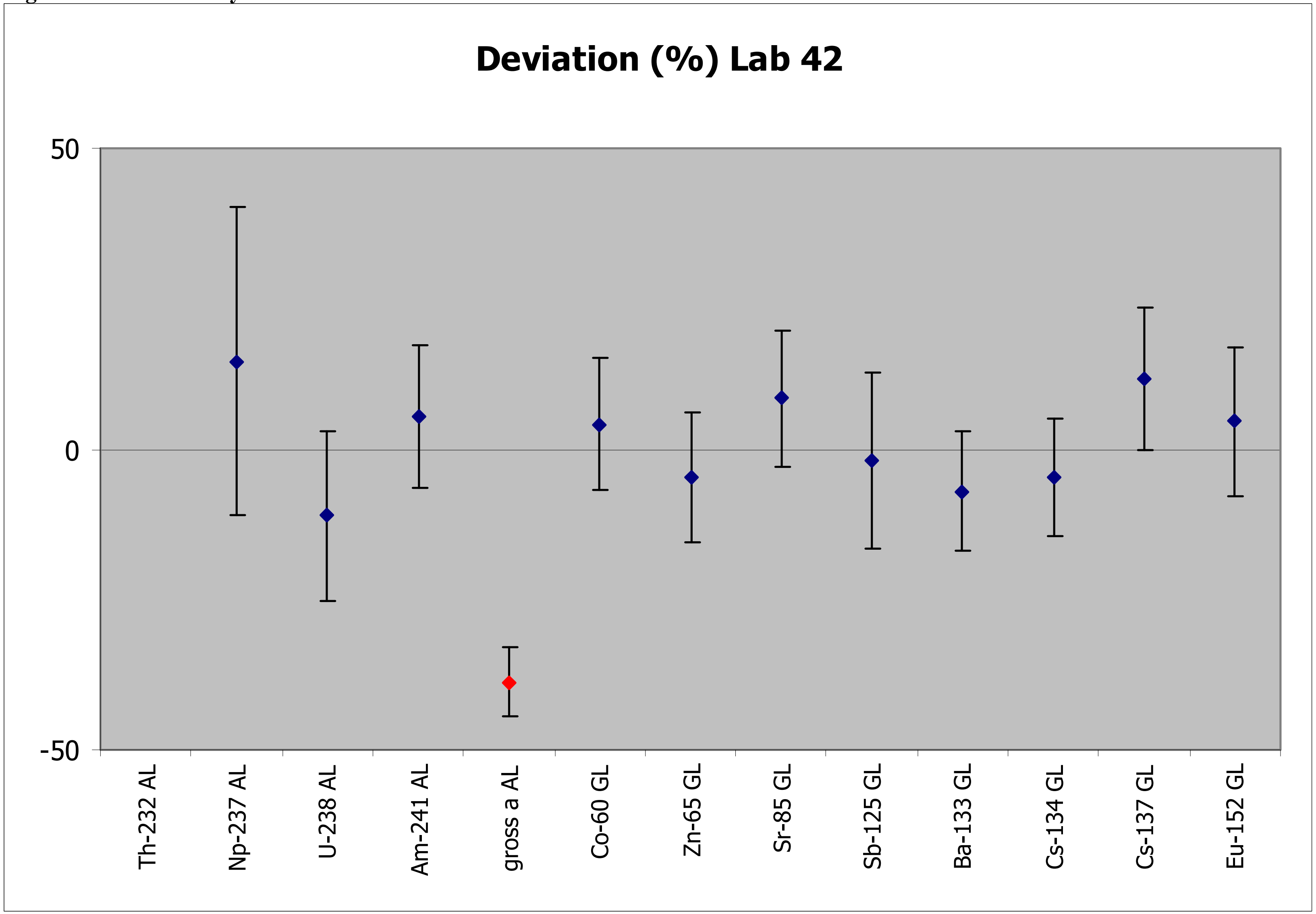


Figure 73 – Laboratory 45

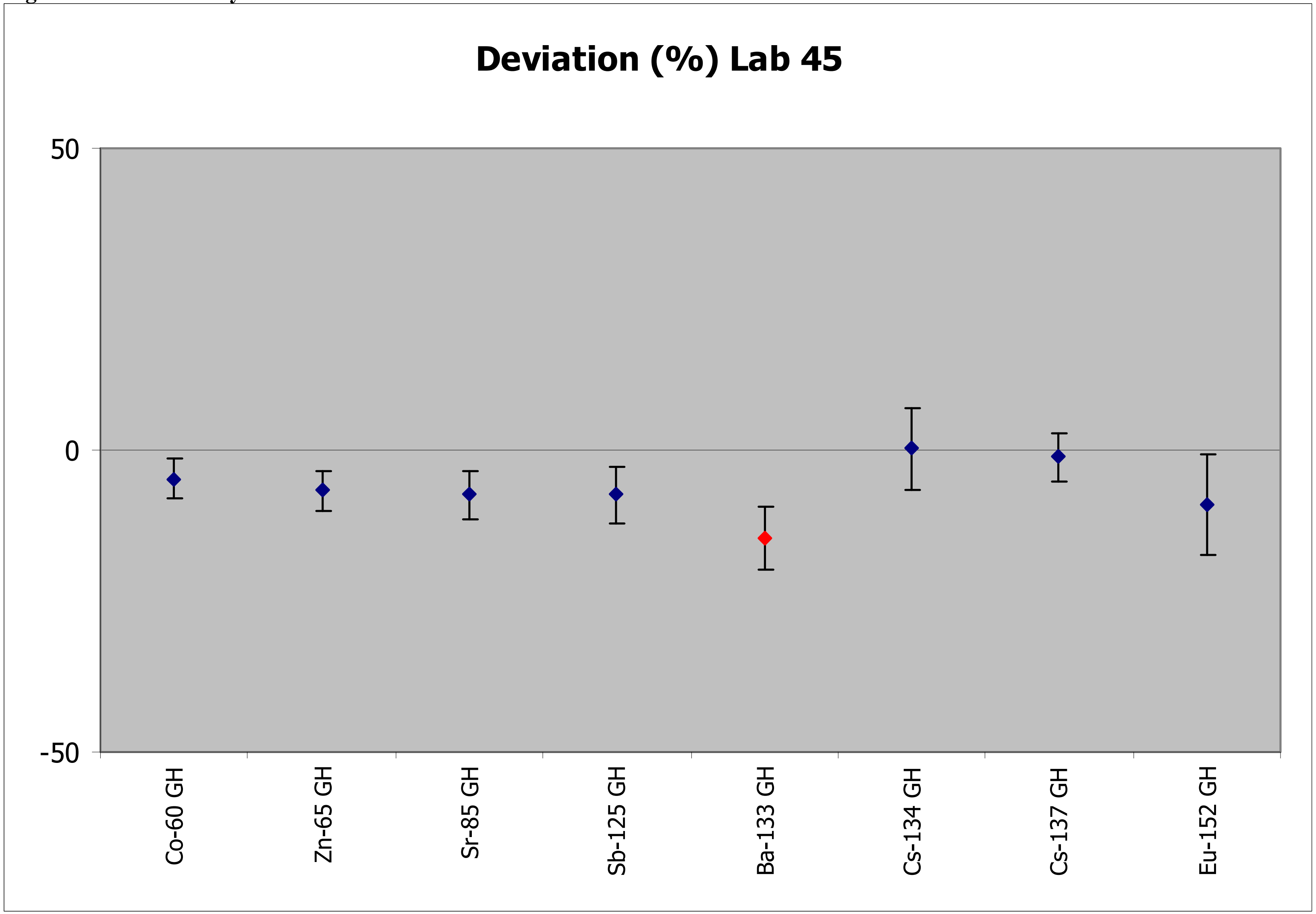


Figure 74 – Laboratory 46

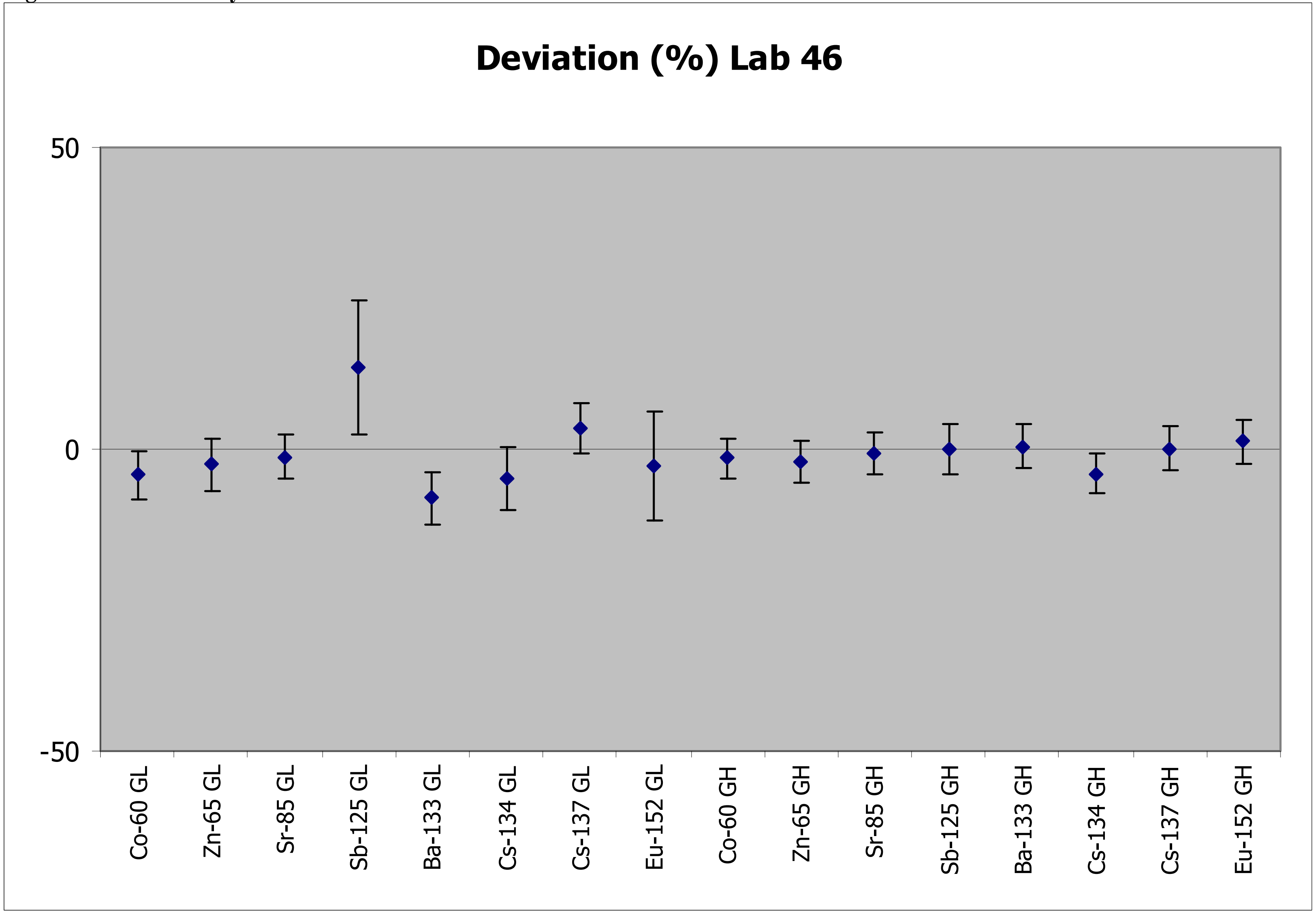


Figure 75 – Laboratory 47

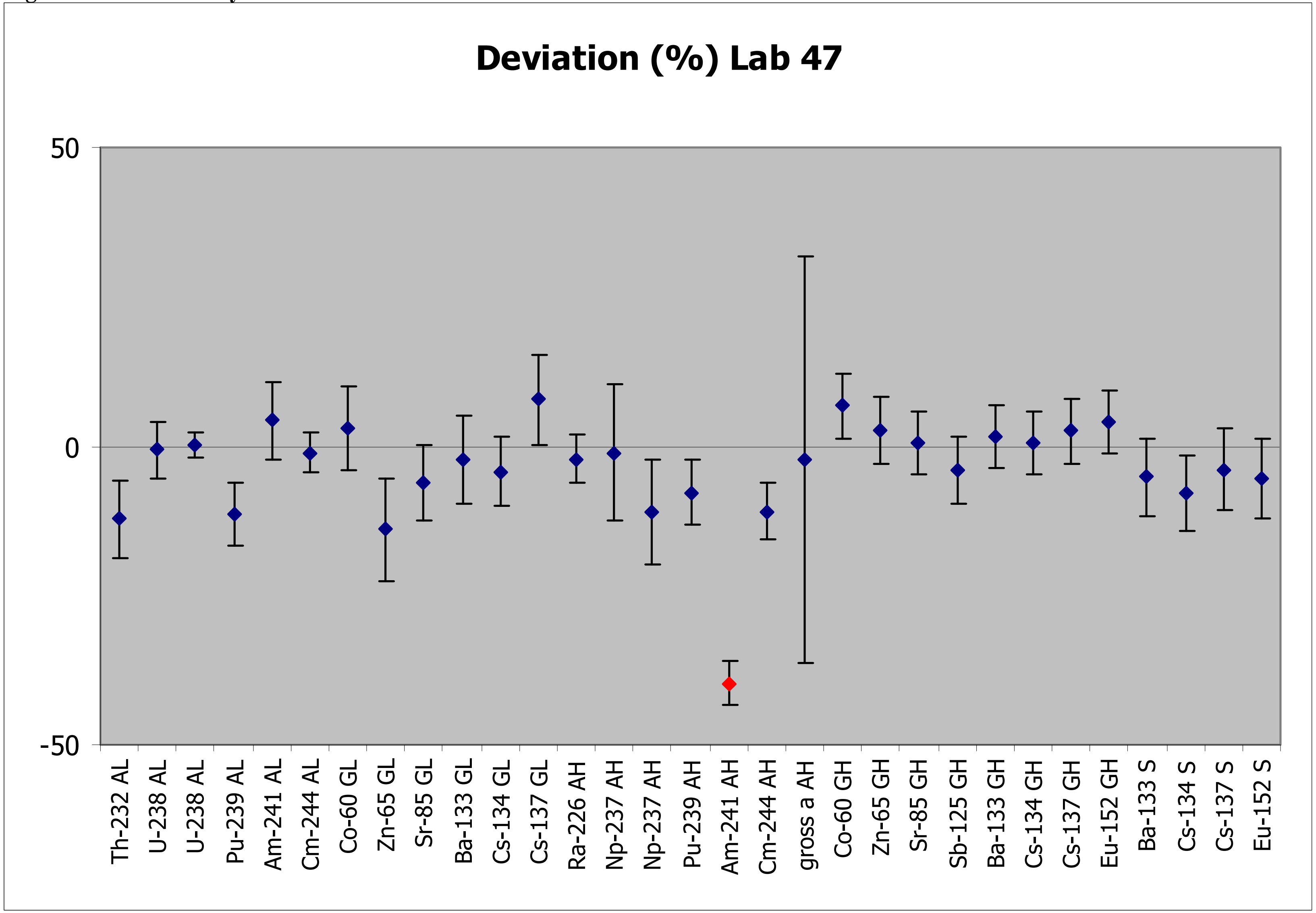


Figure 76 – Laboratory 48

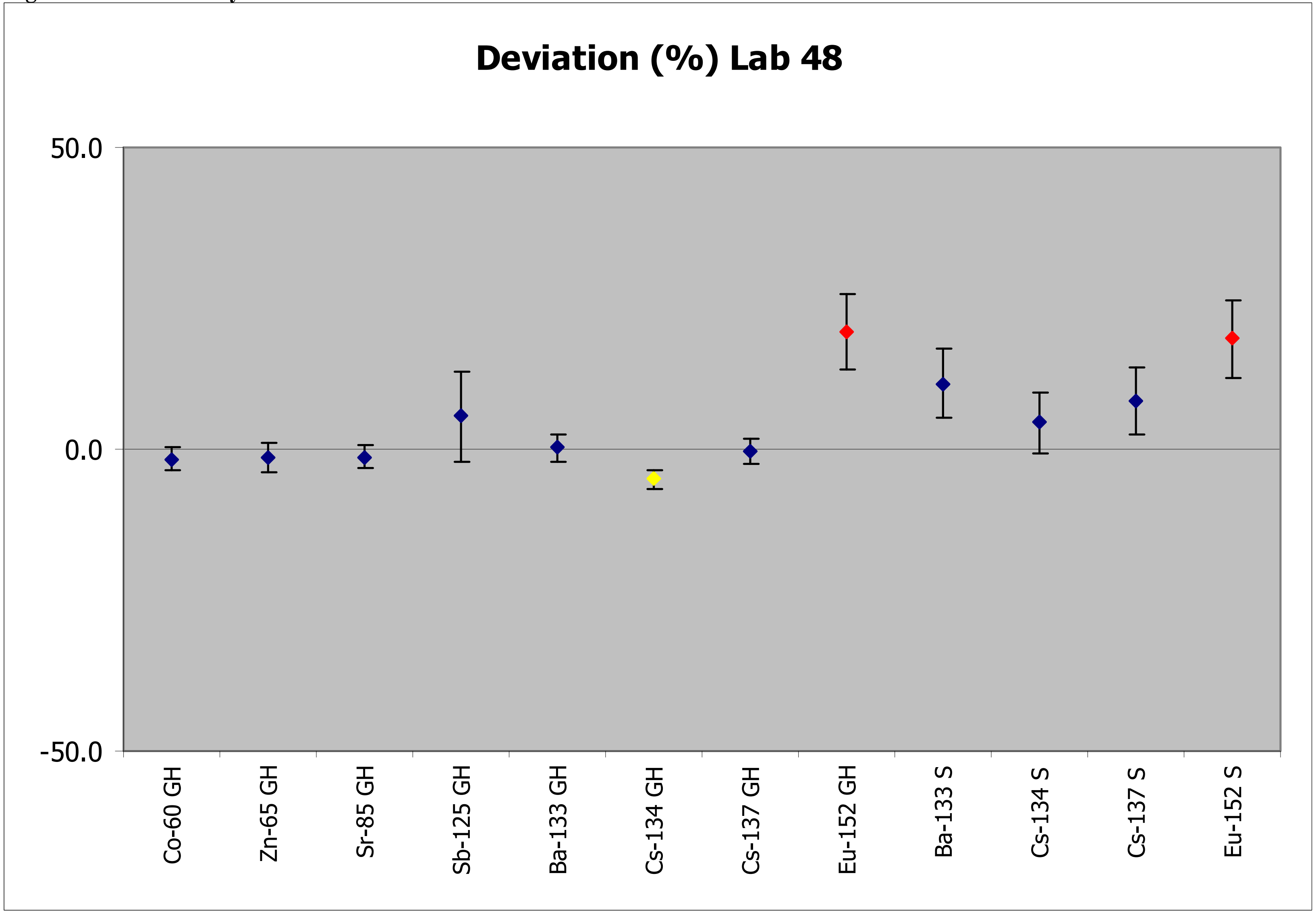


Figure 77 – Laboratory 51

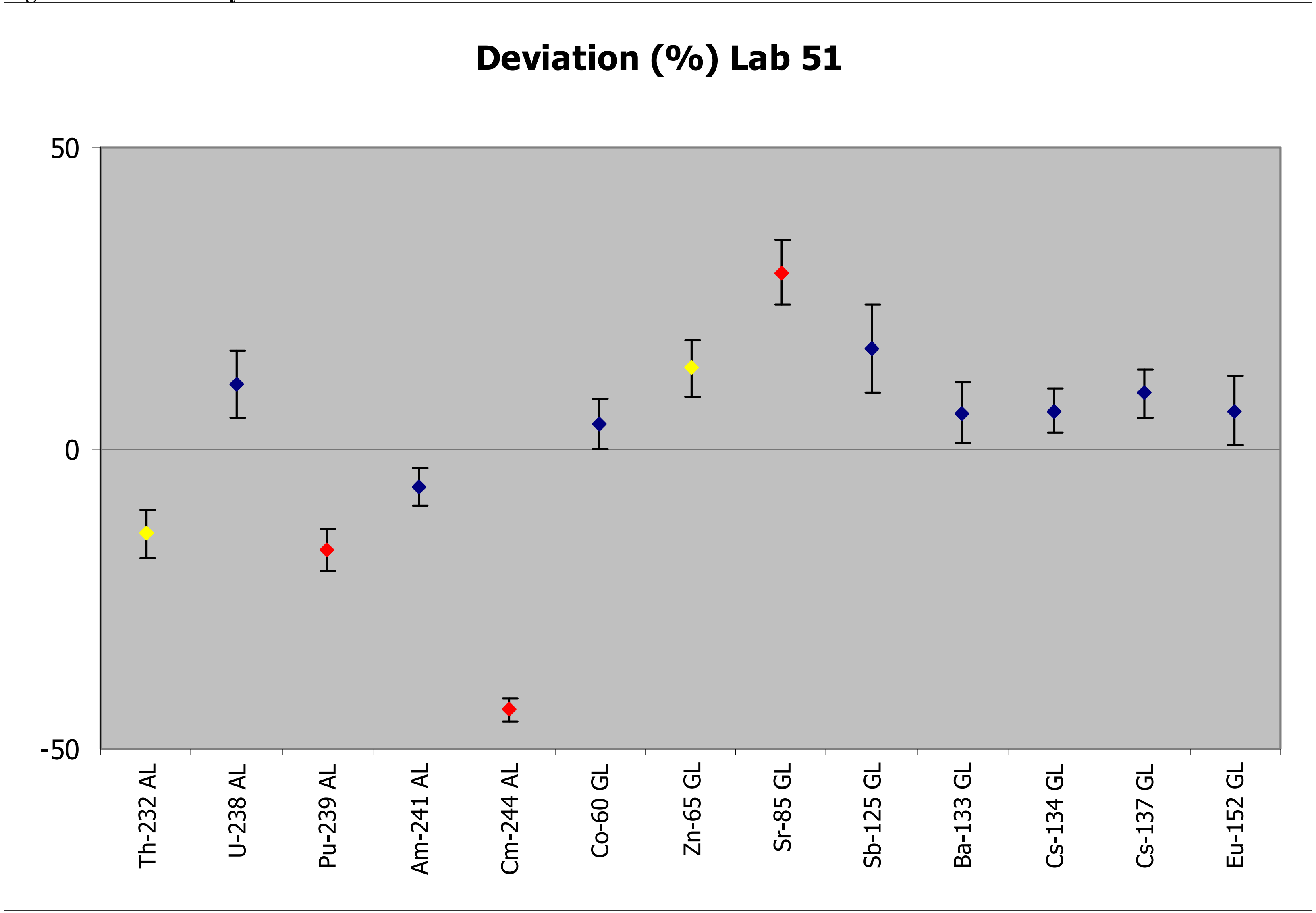


Figure 78 – Laboratory 53

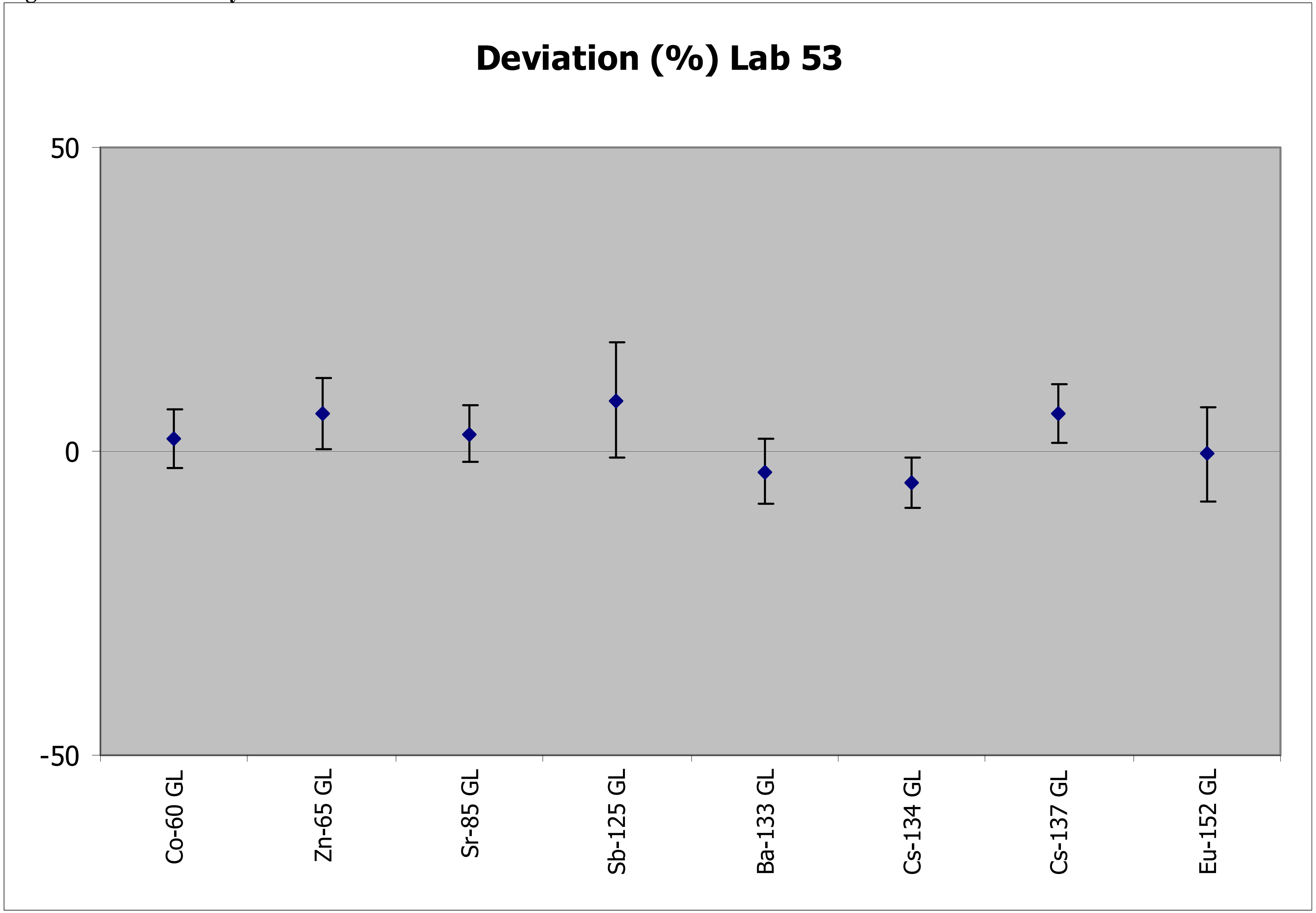


Figure 79 – Laboratory 55

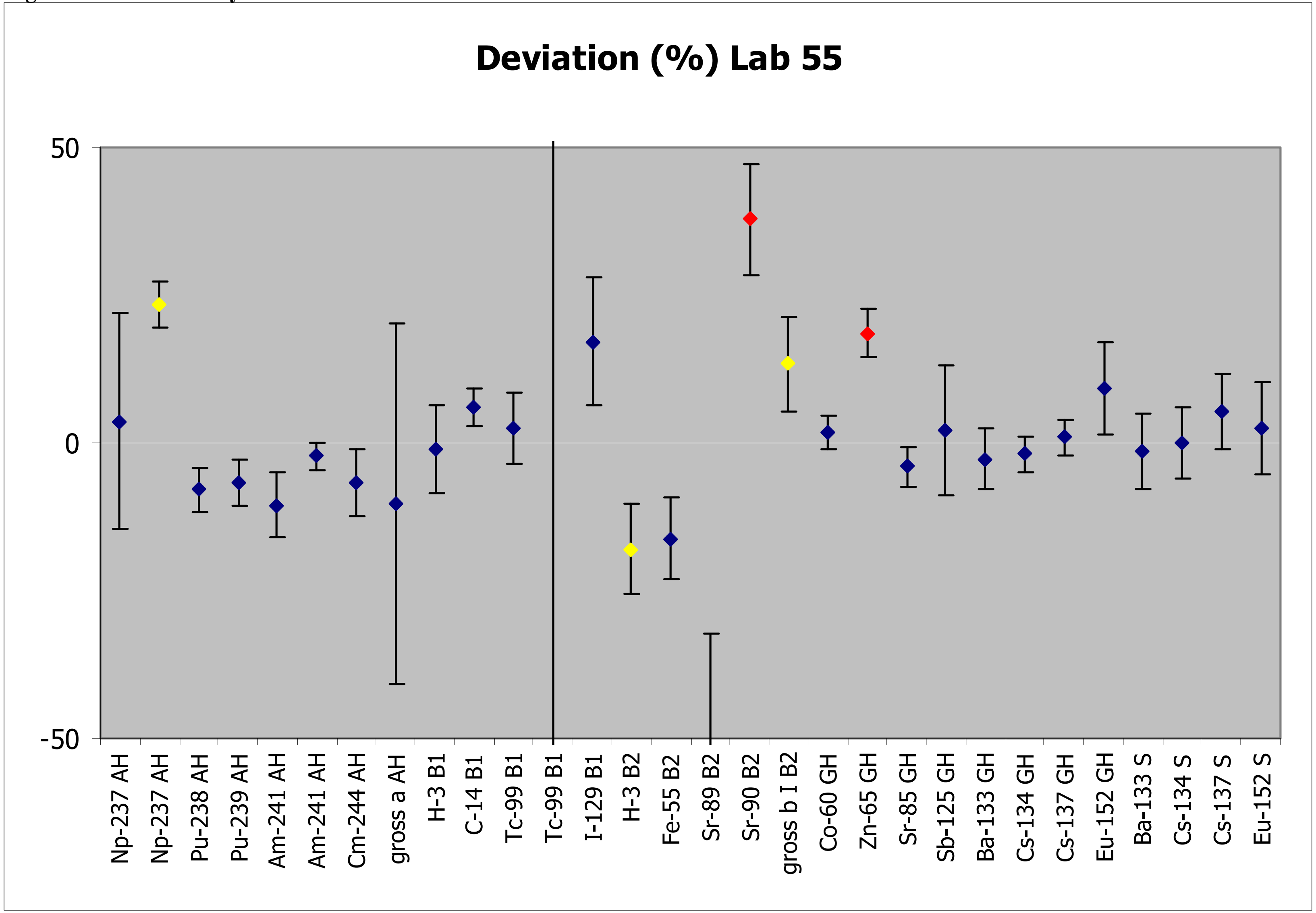


Figure 80 – Laboratory 58

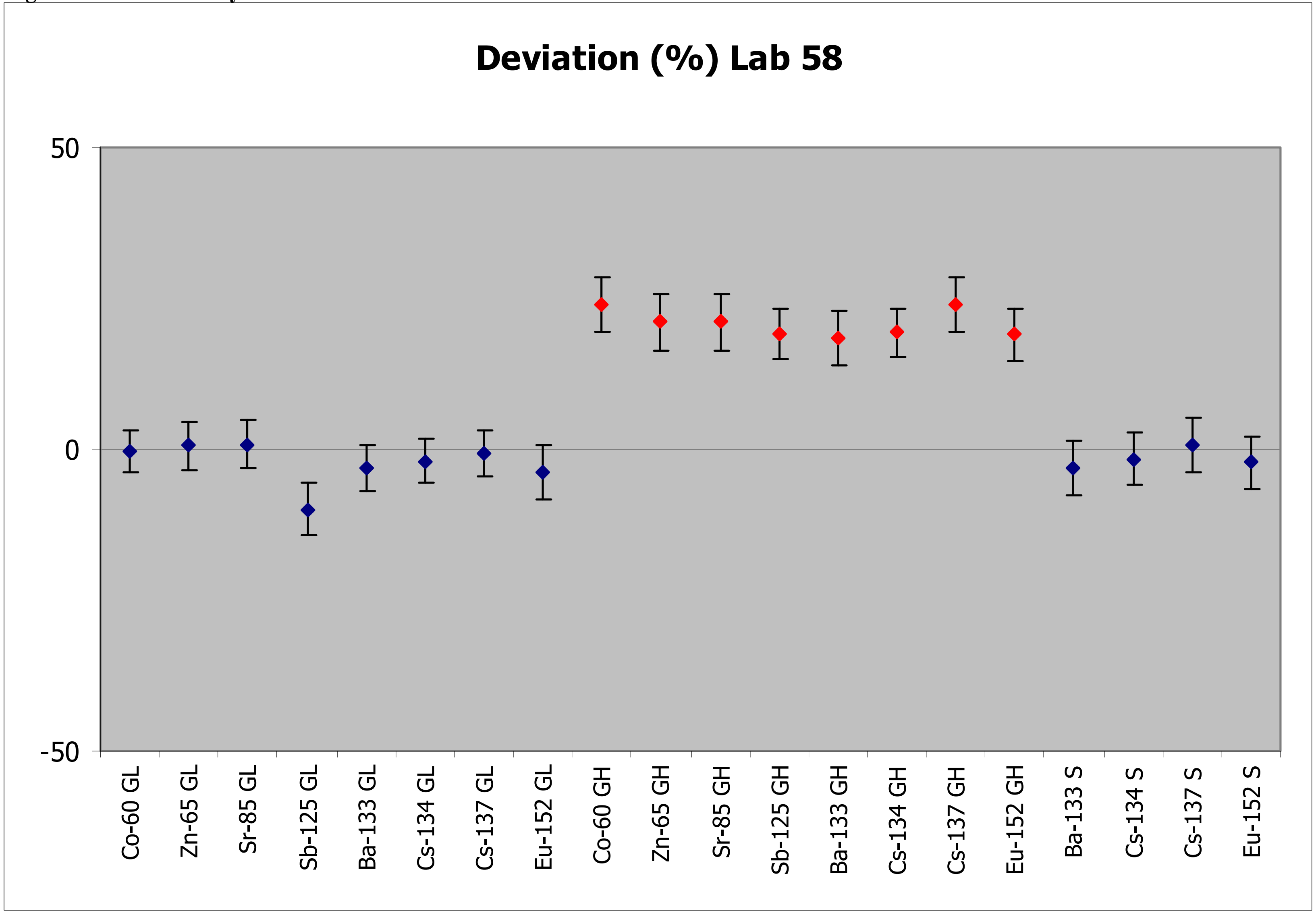


Figure 81 – Laboratory 59

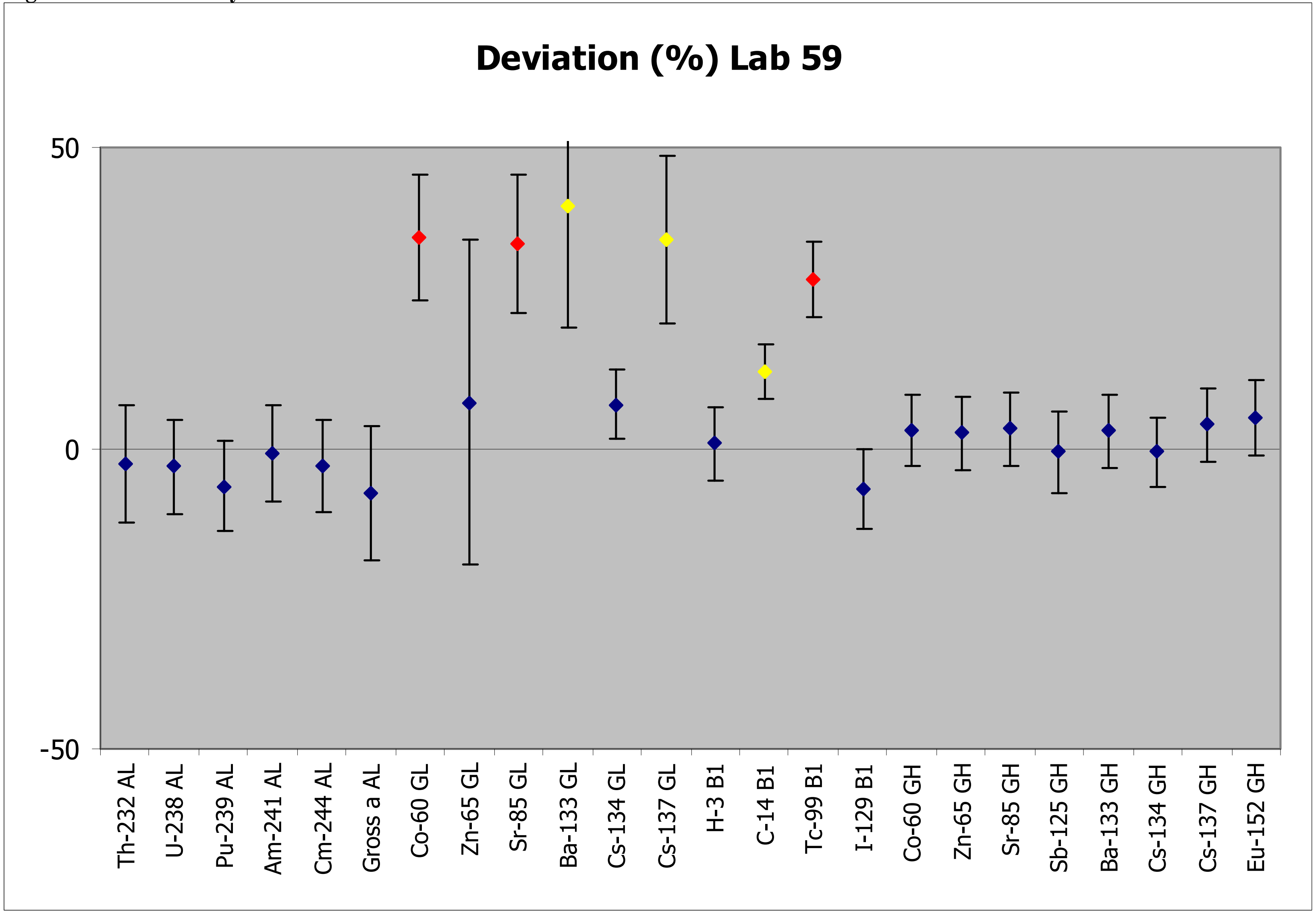


Figure 82 – Laboratory 61

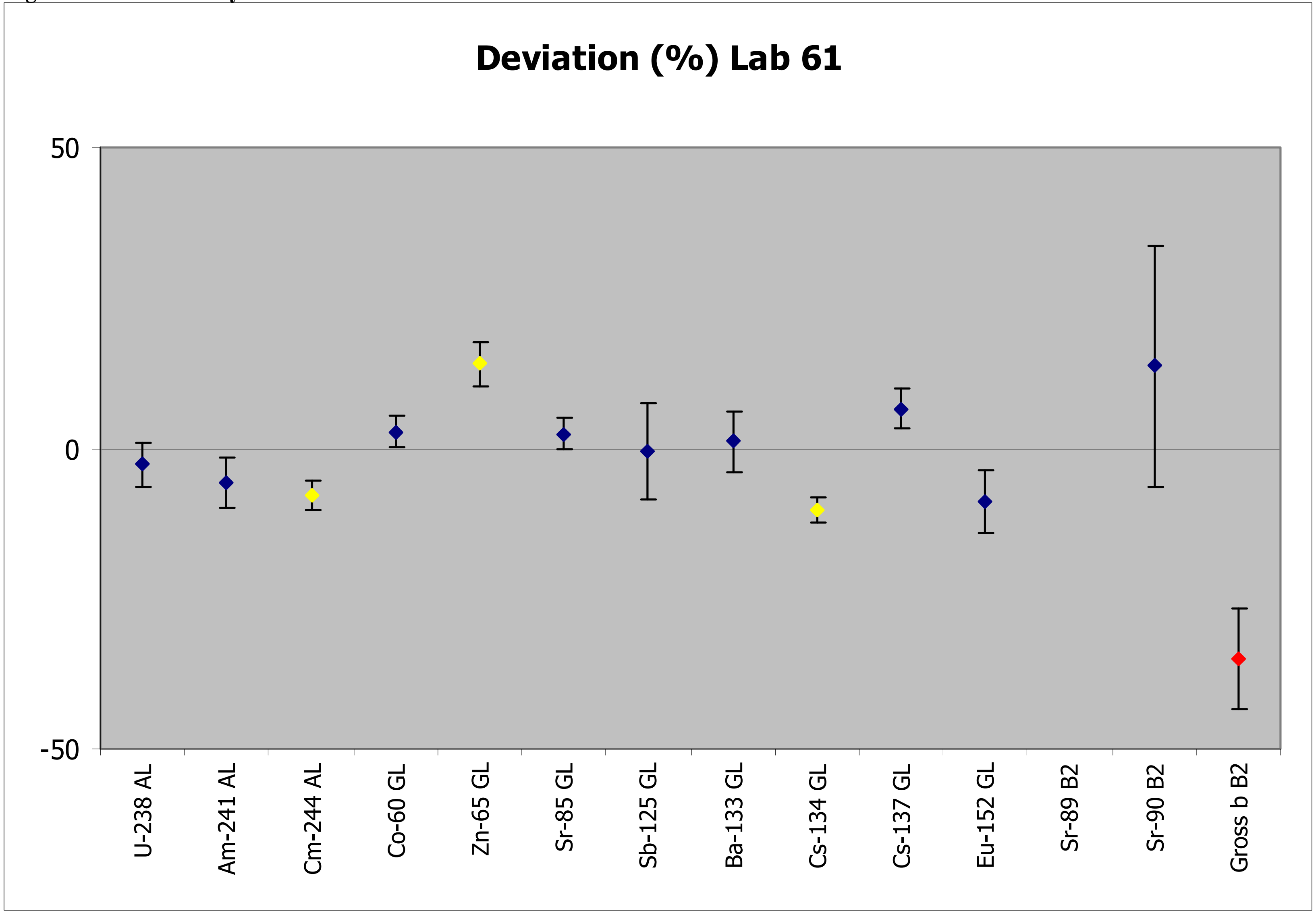


Figure 83 – Laboratory 62

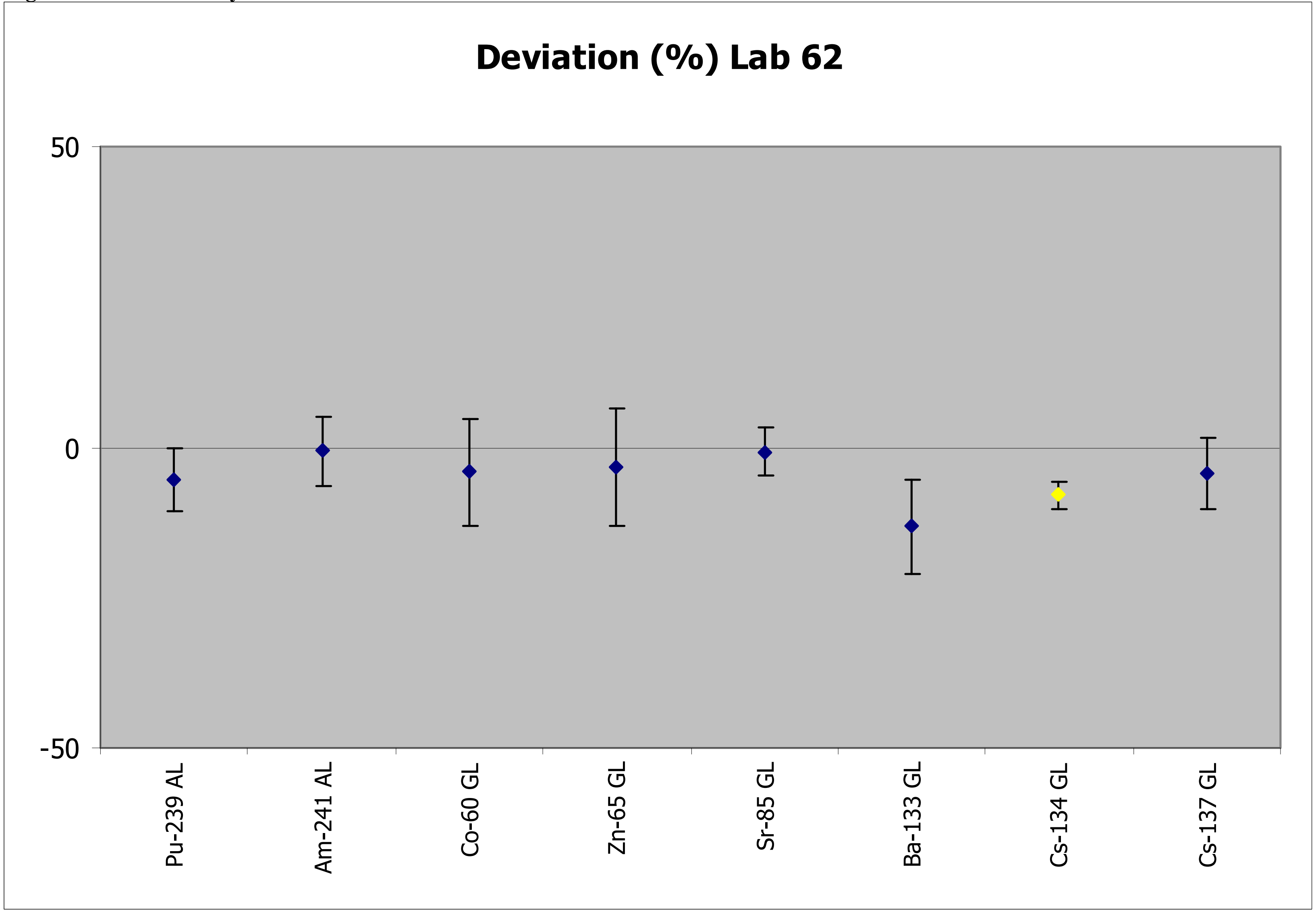


Figure 84 – Laboratory 65

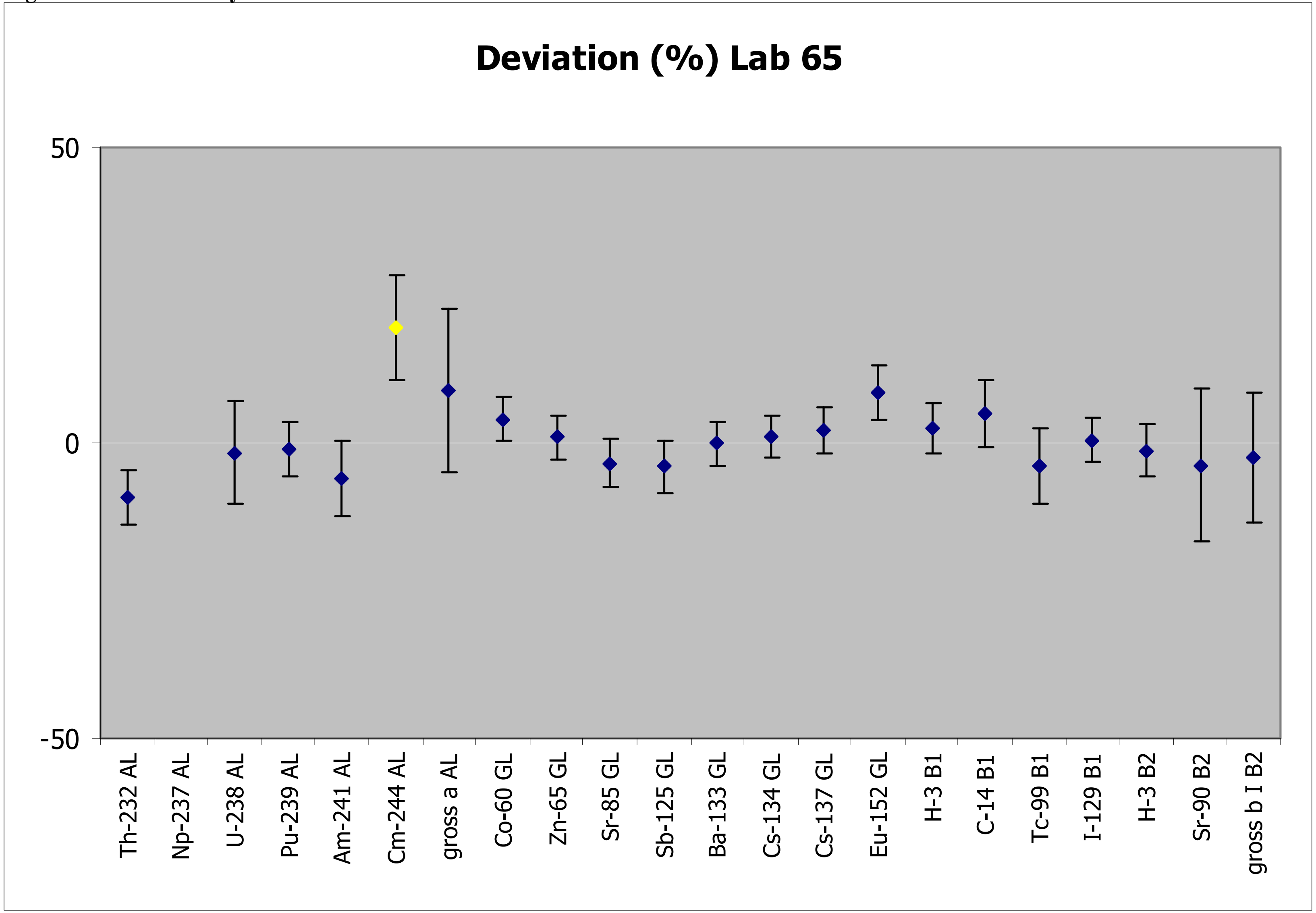


Figure 85 – Laboratory 72

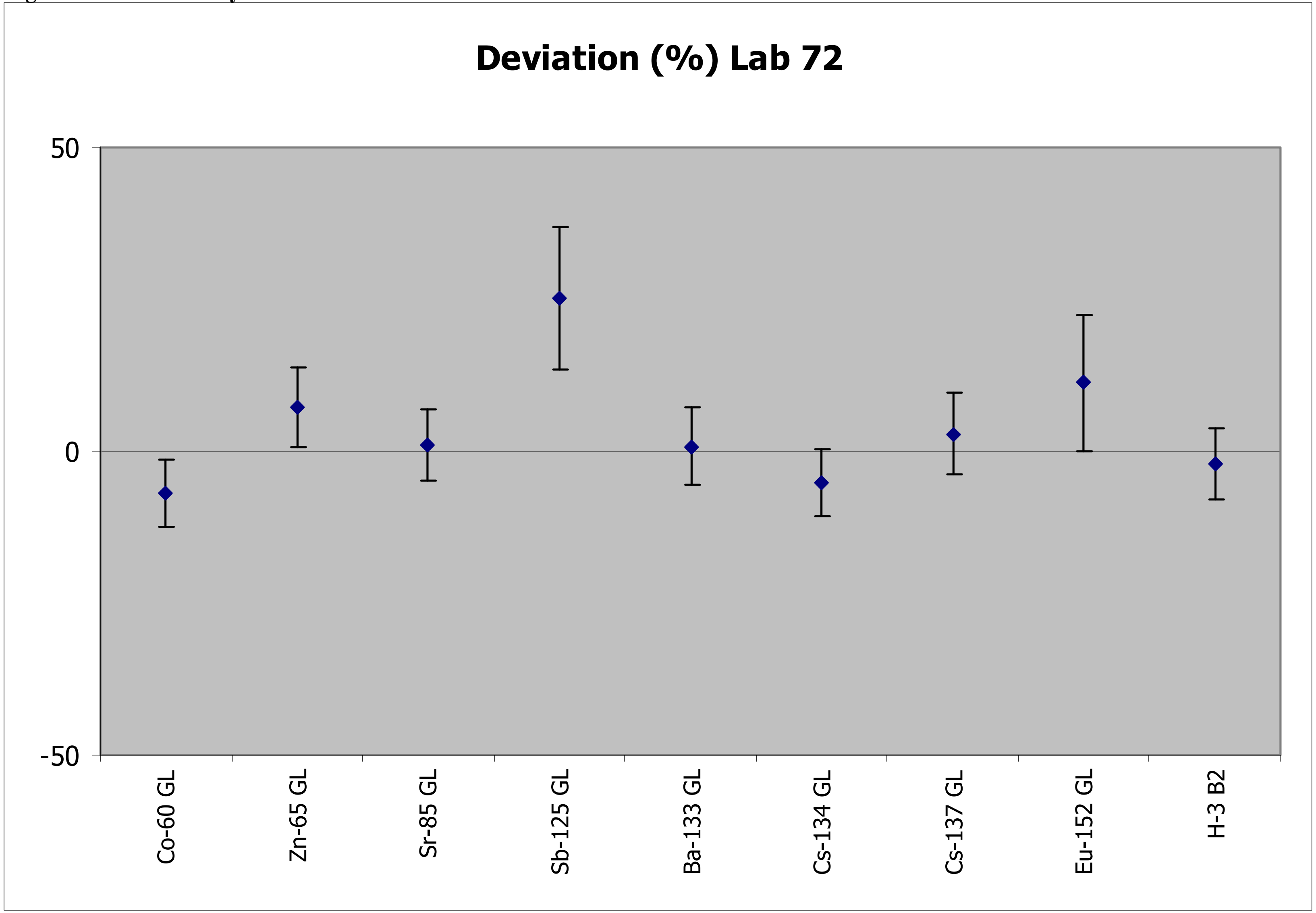


Figure 86 – Laboratory 74

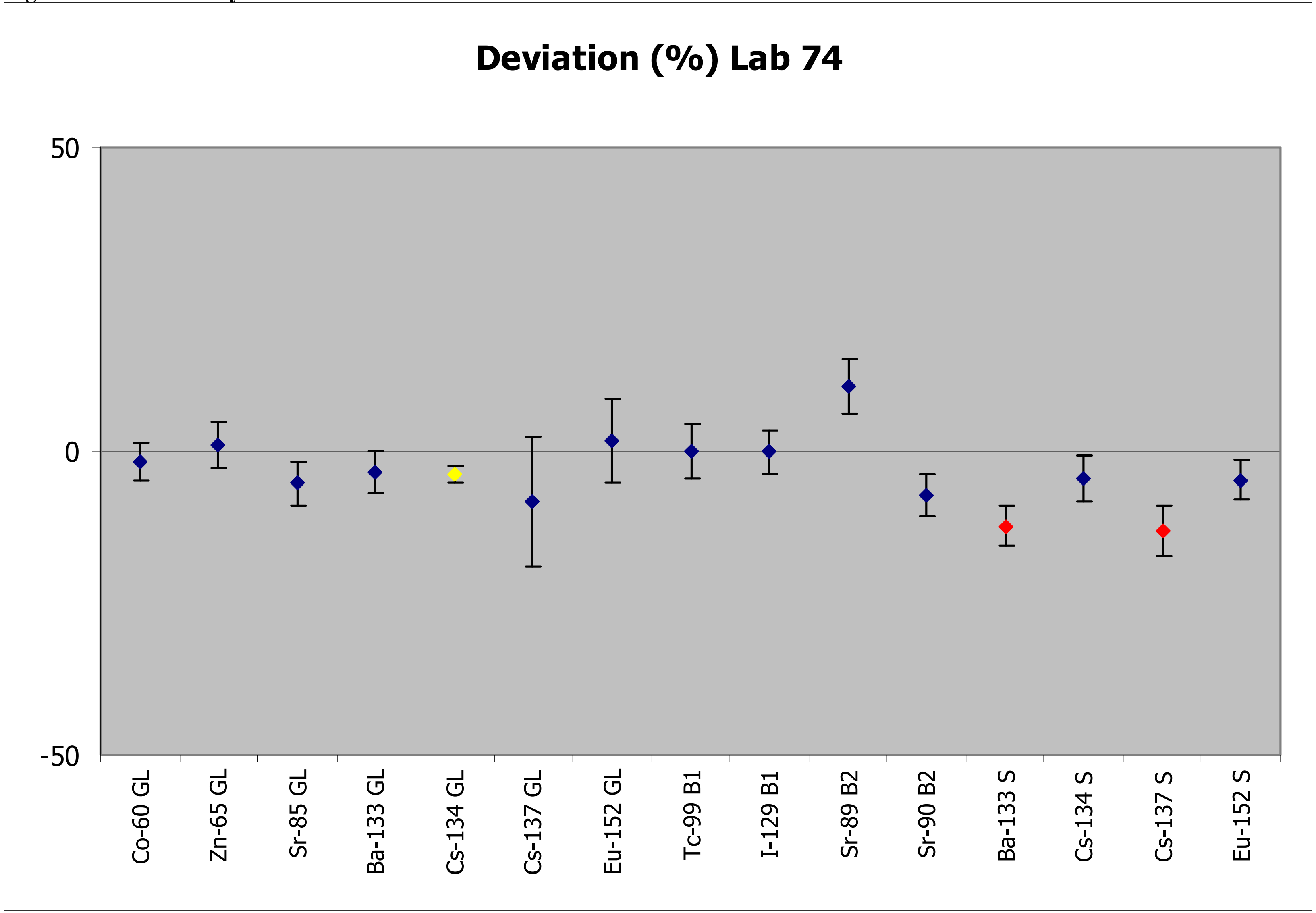


Figure 87 – Laboratory 76

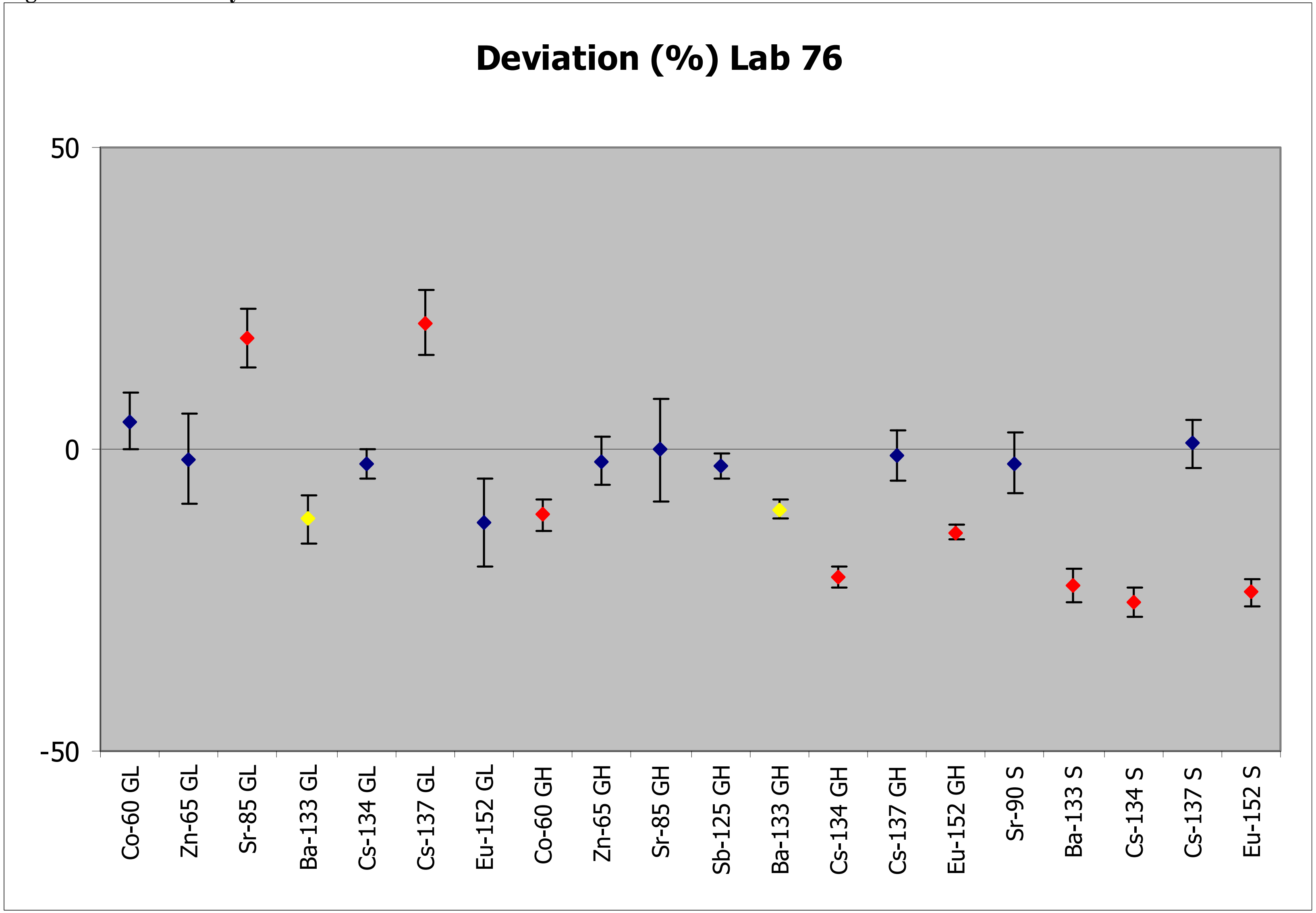


Figure 88 – Laboratory 77

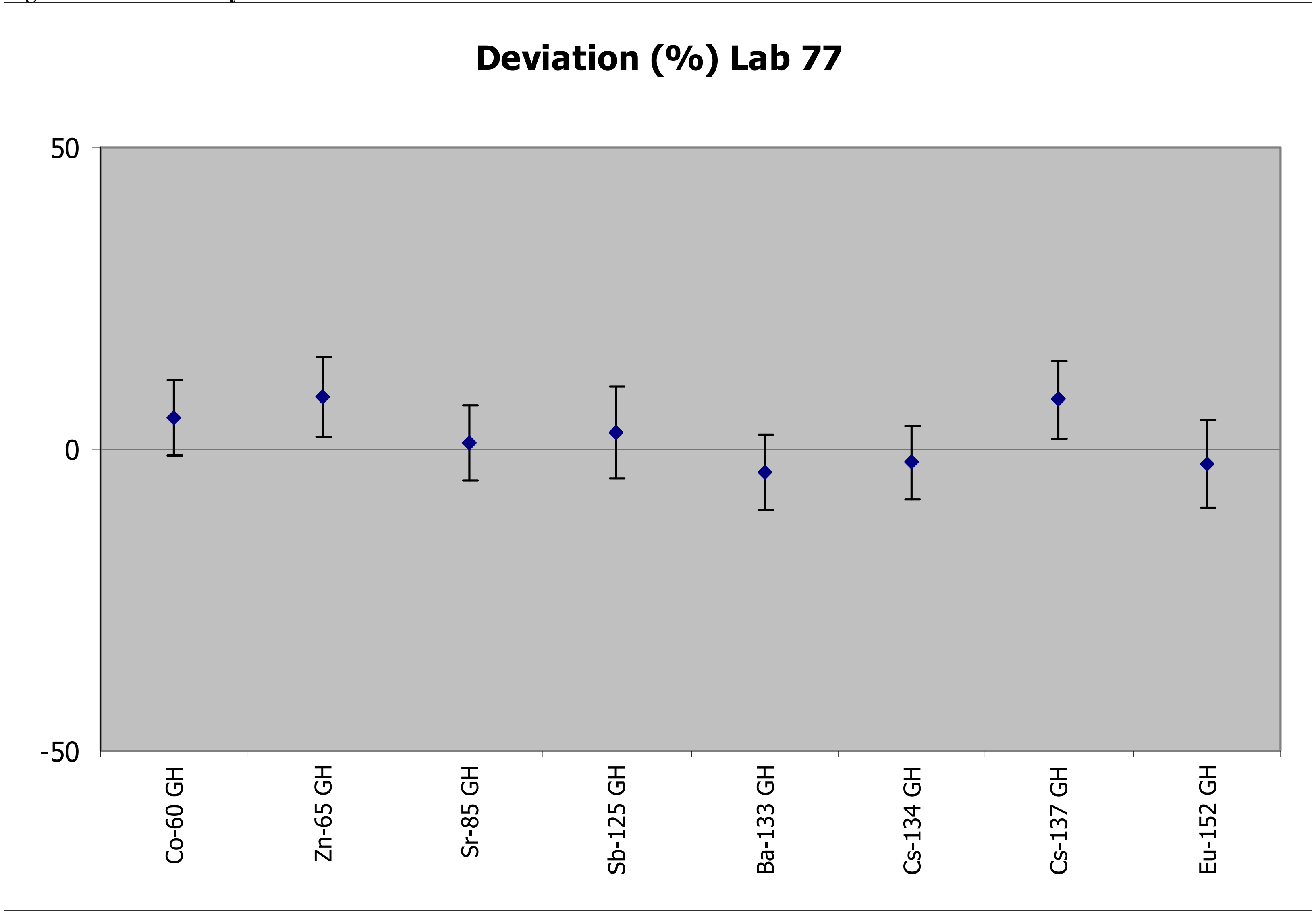


Figure 89 – Laboratory 78

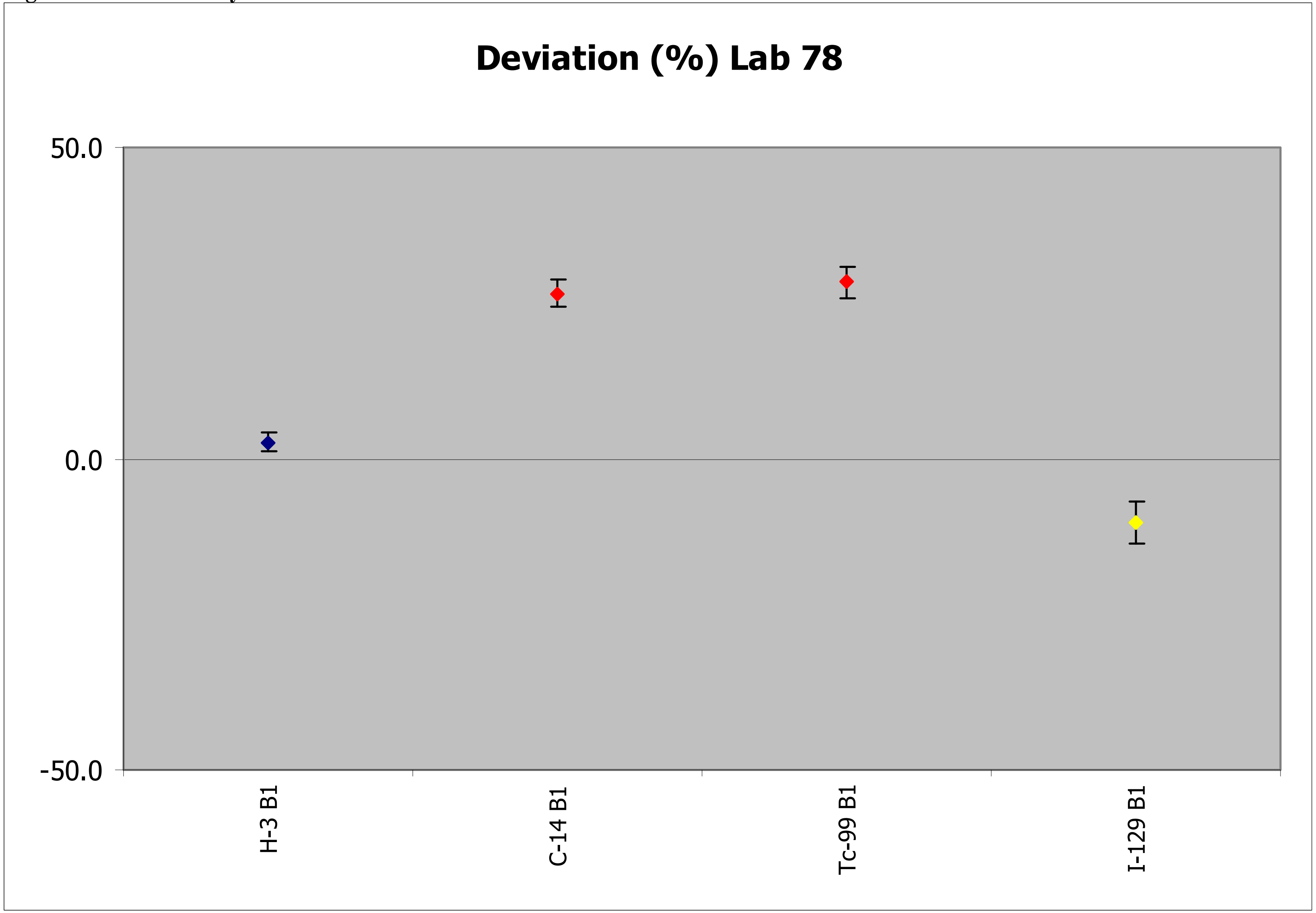


Figure 90 – Laboratory 82

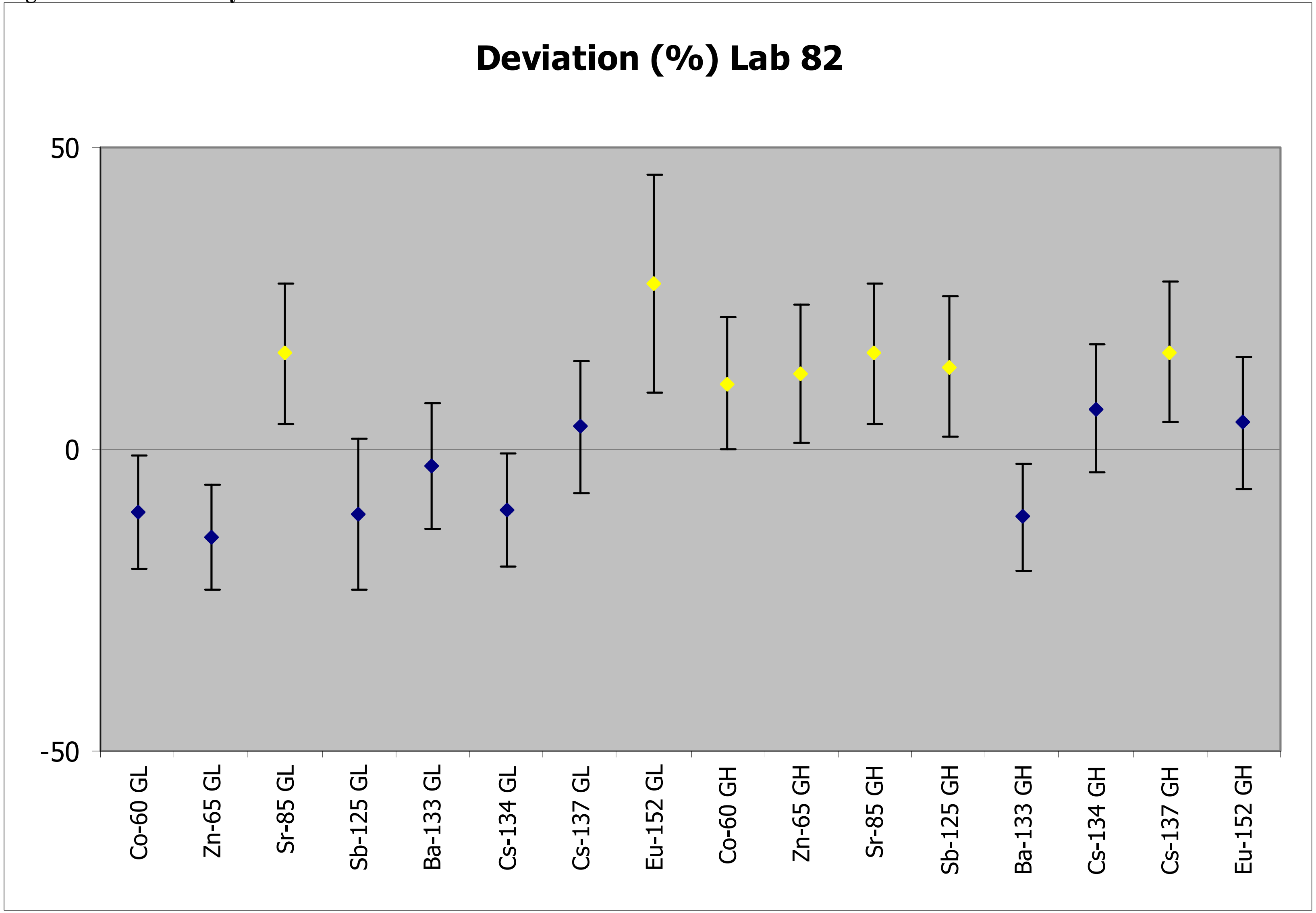


Figure 91 – Laboratory 83

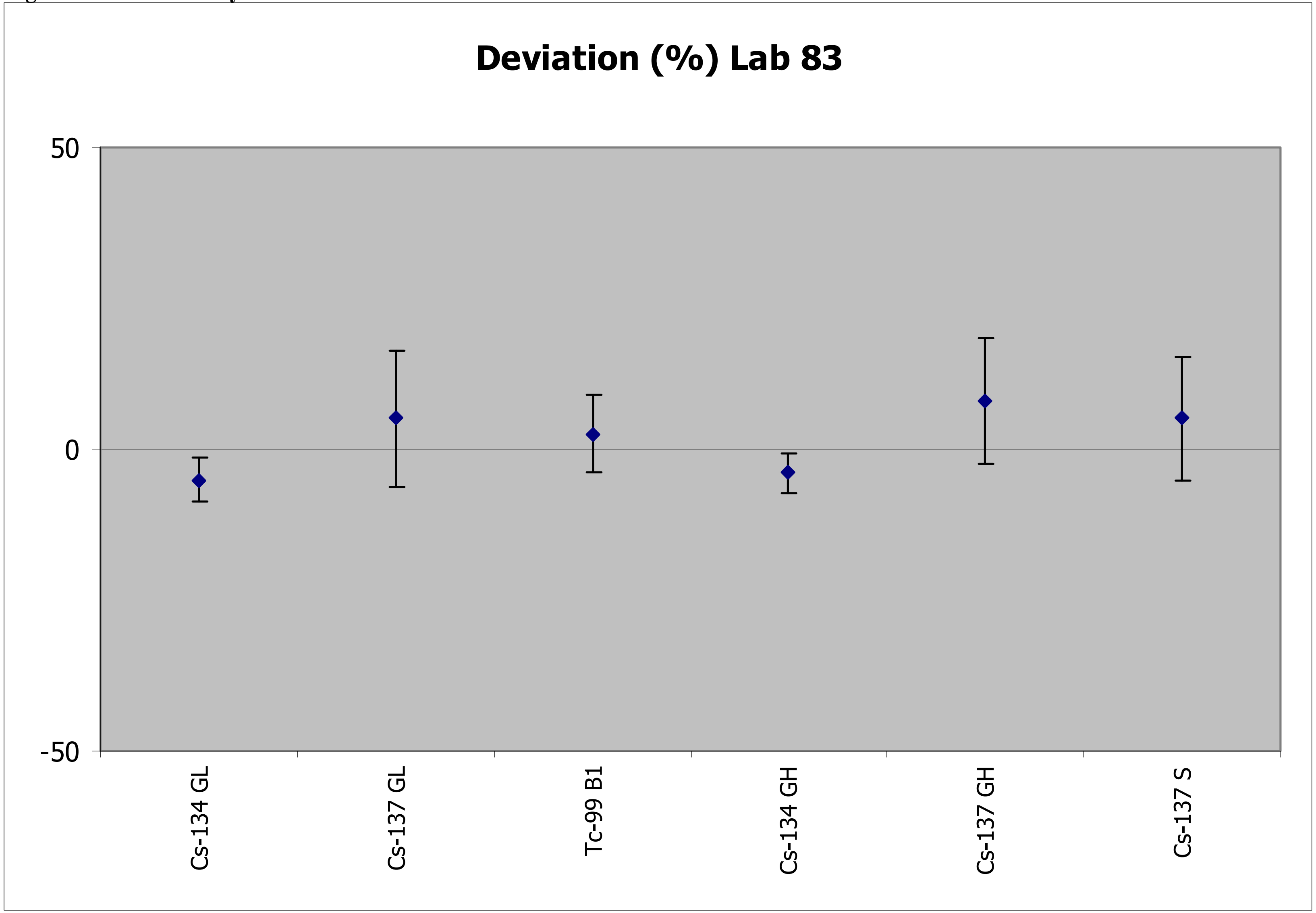


Figure 92 – Laboratory 86

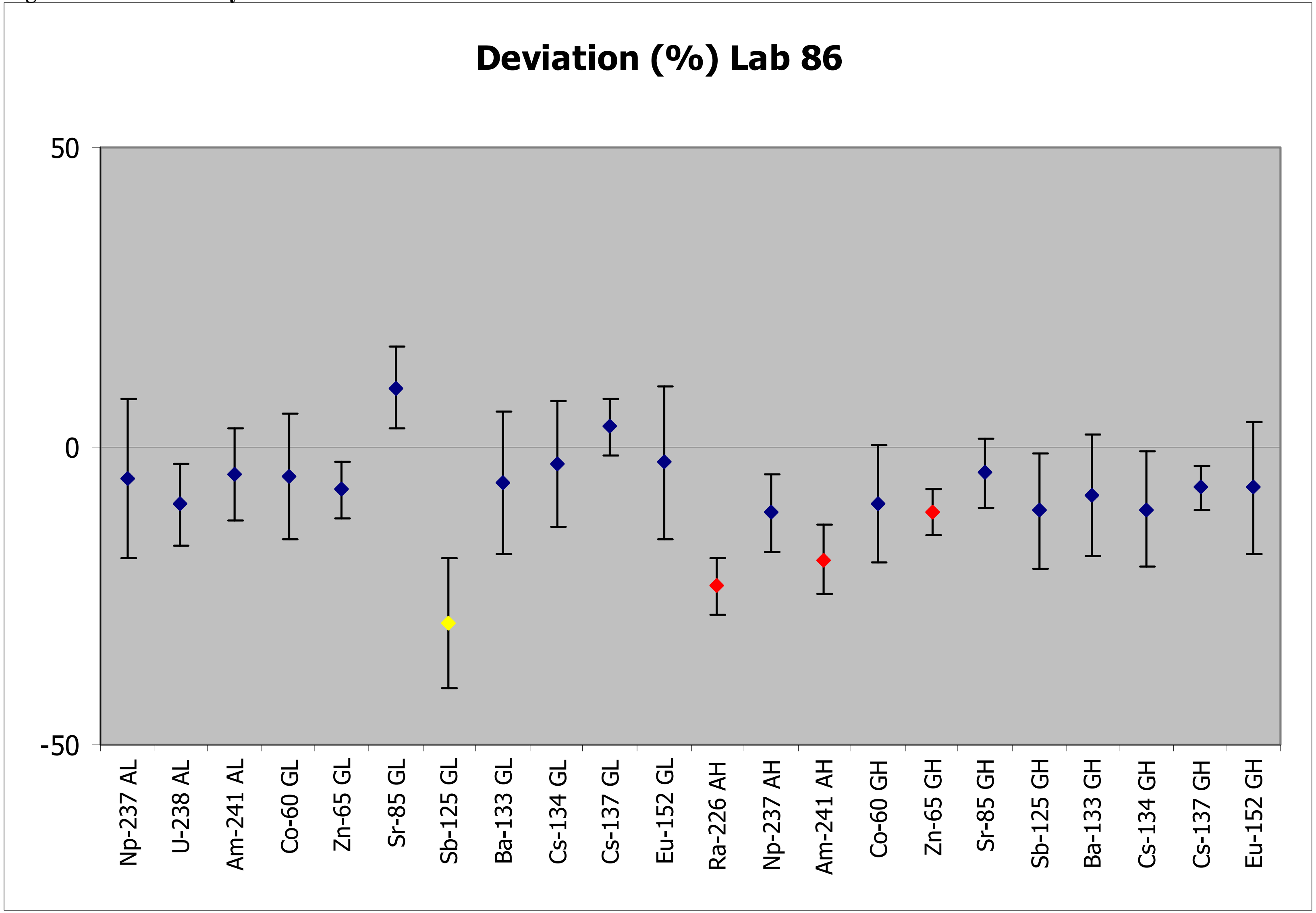


Figure 93 – Laboratory 88

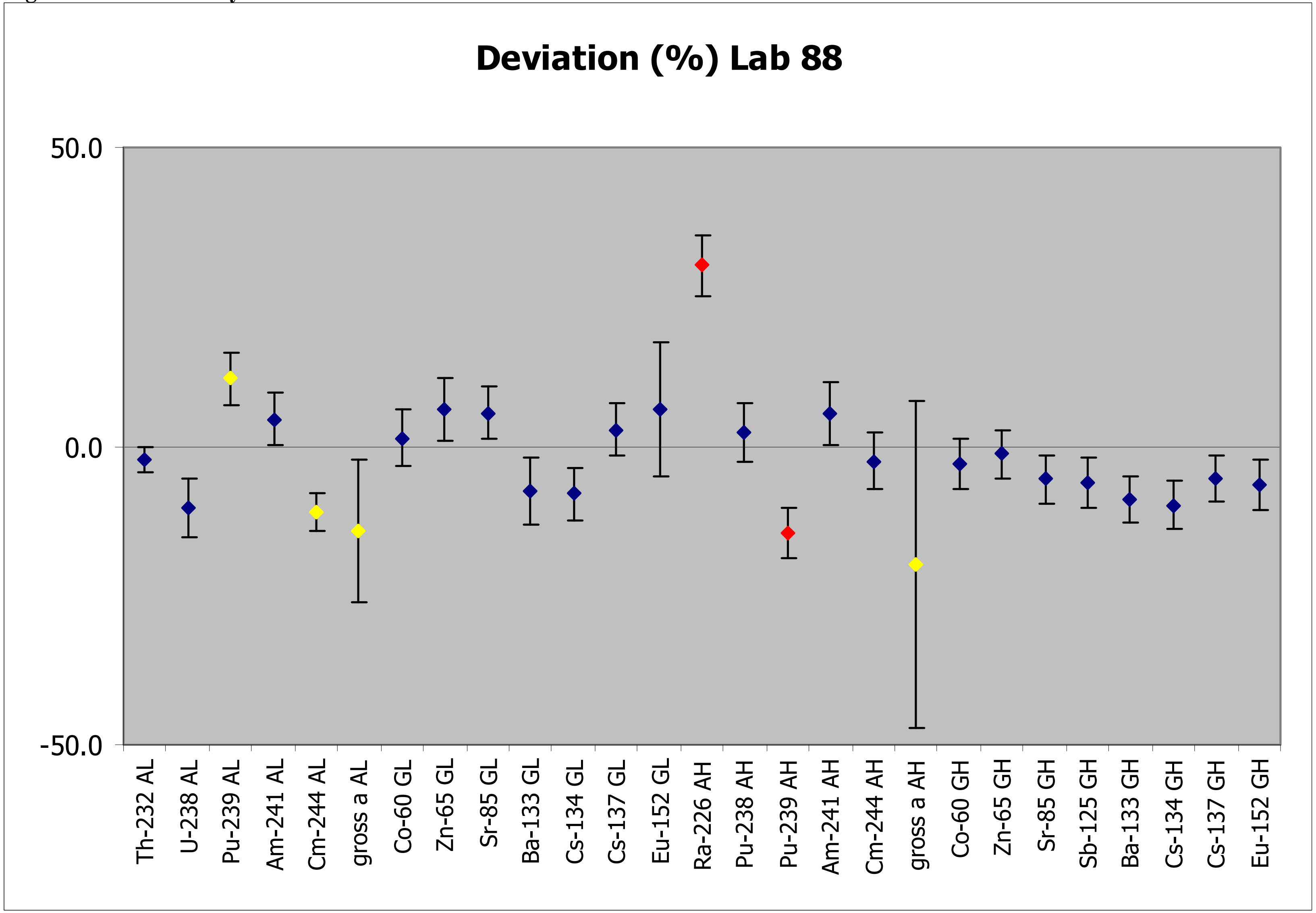


Figure 94 – Laboratory 89

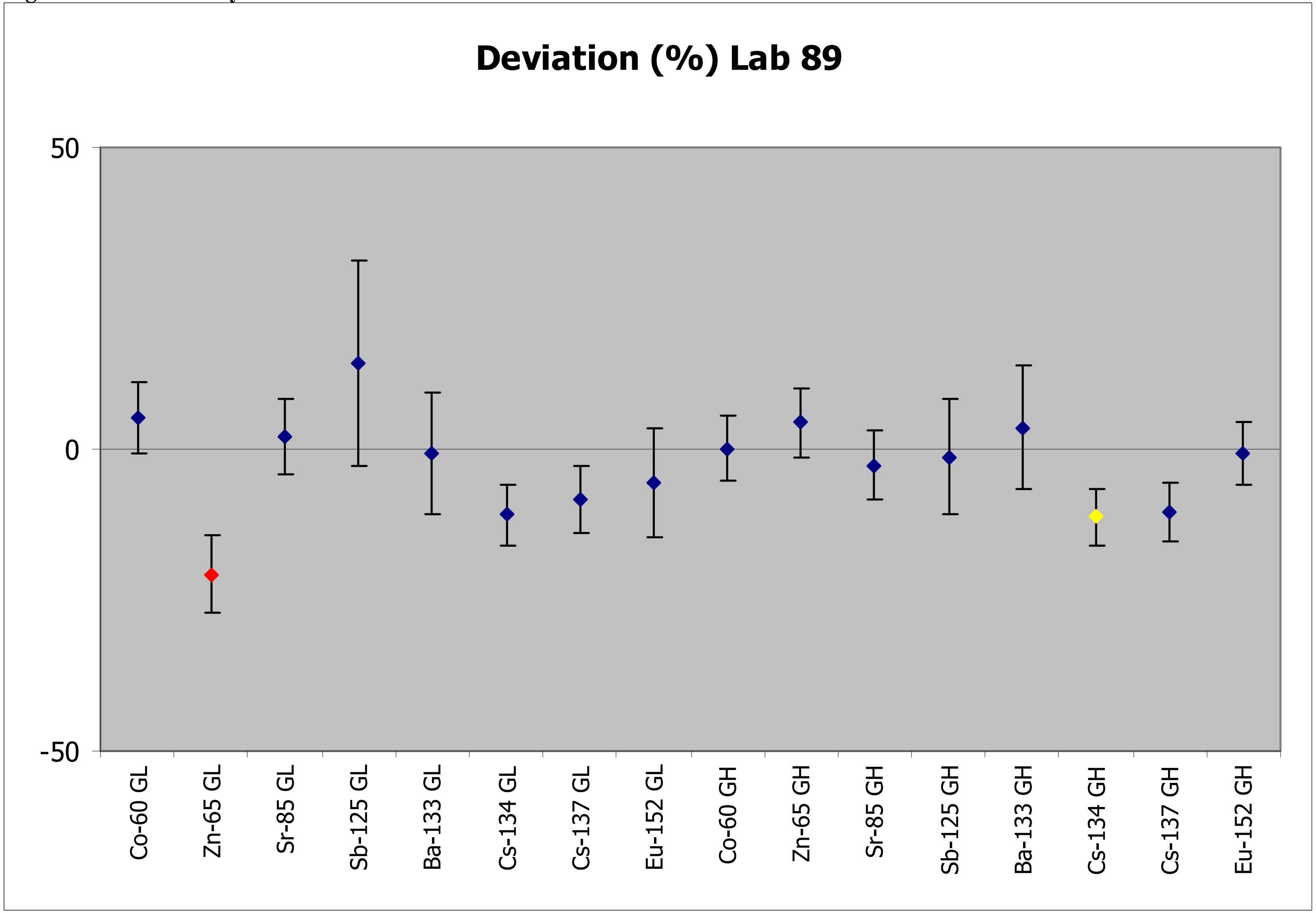


Figure 95 – Laboratory 90

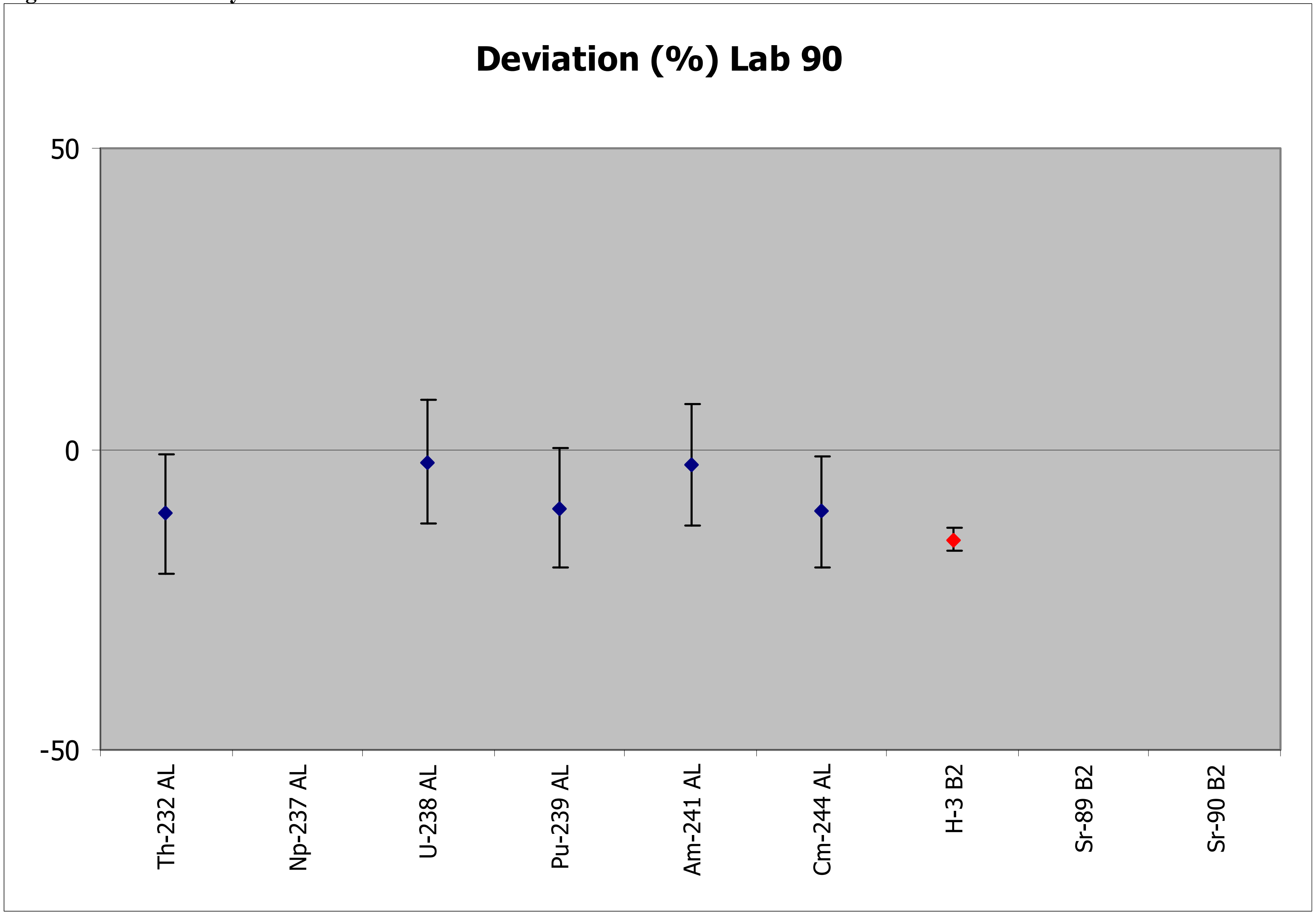


Figure 96 – Laboratory 91

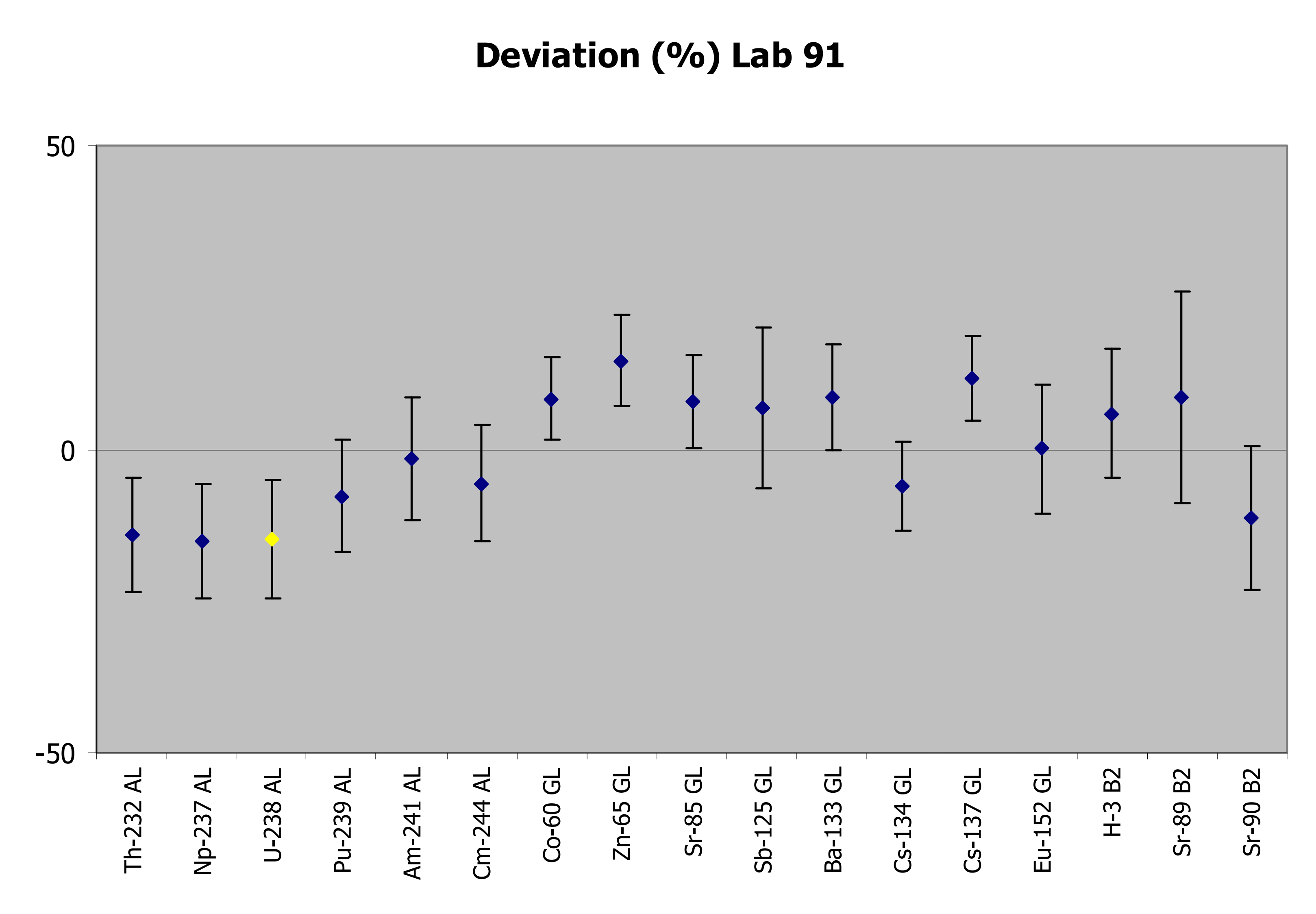


Figure 97 – Laboratory 93

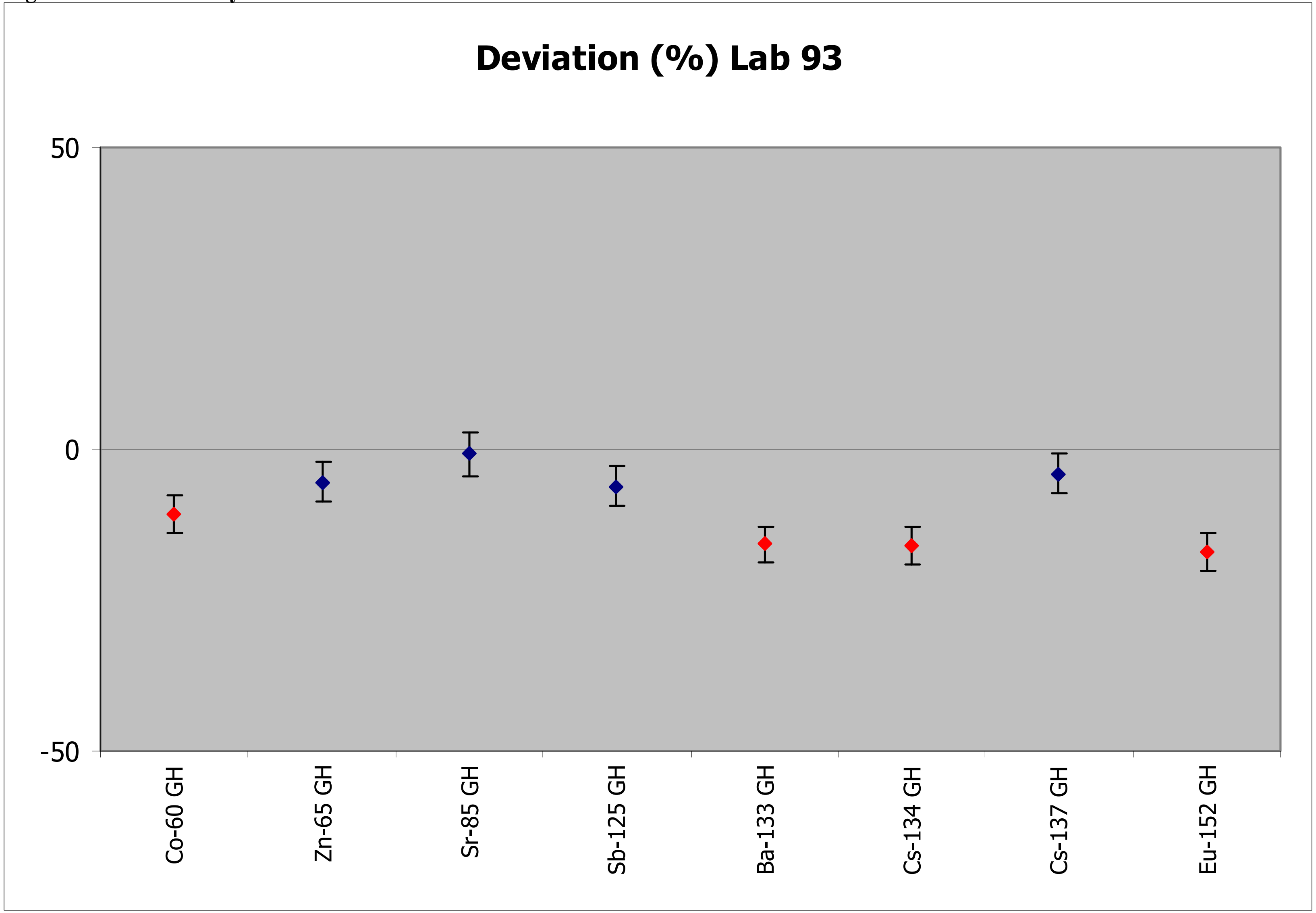


Figure 98 – Laboratory 95

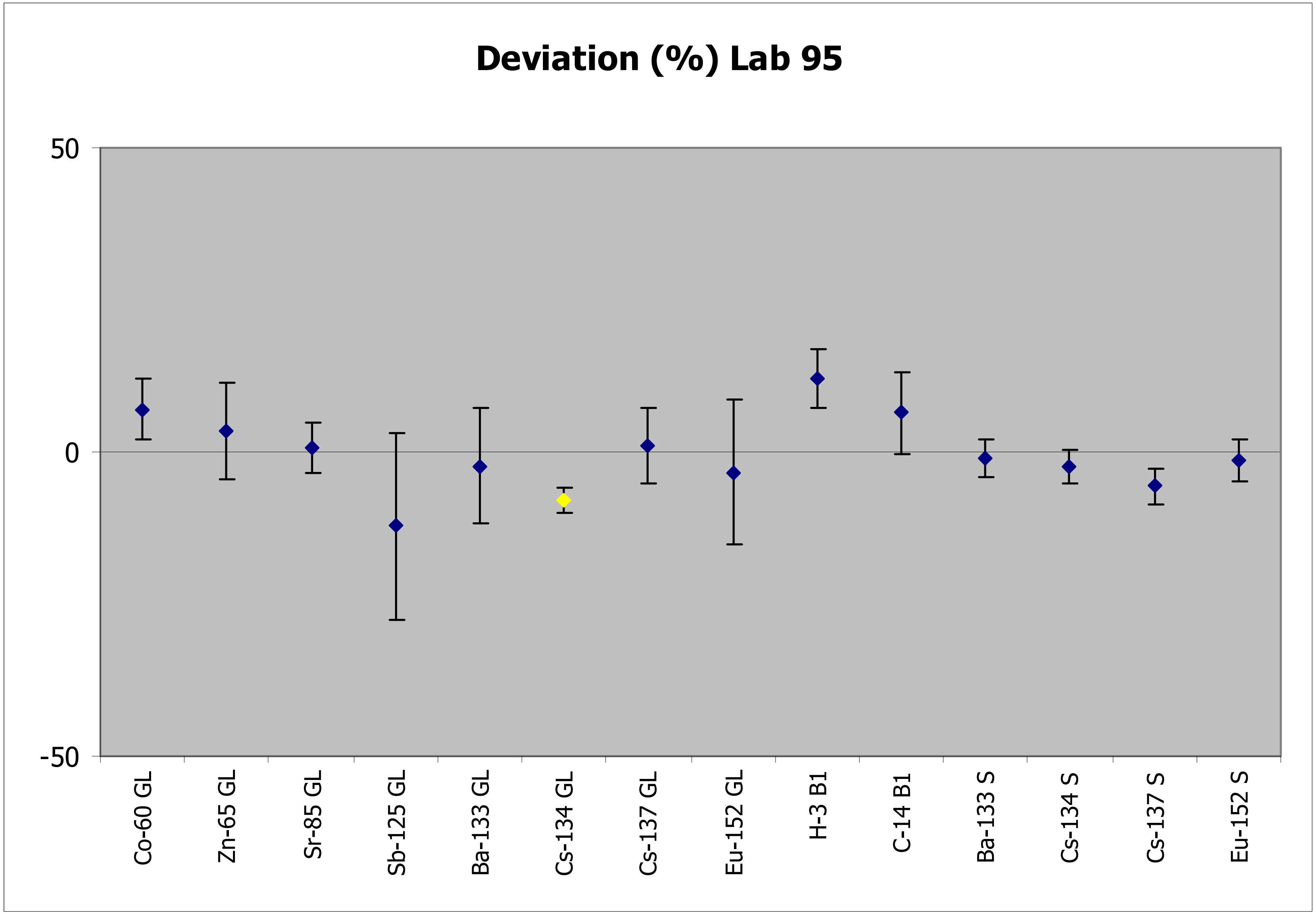


Figure 99 – Laboratory 100

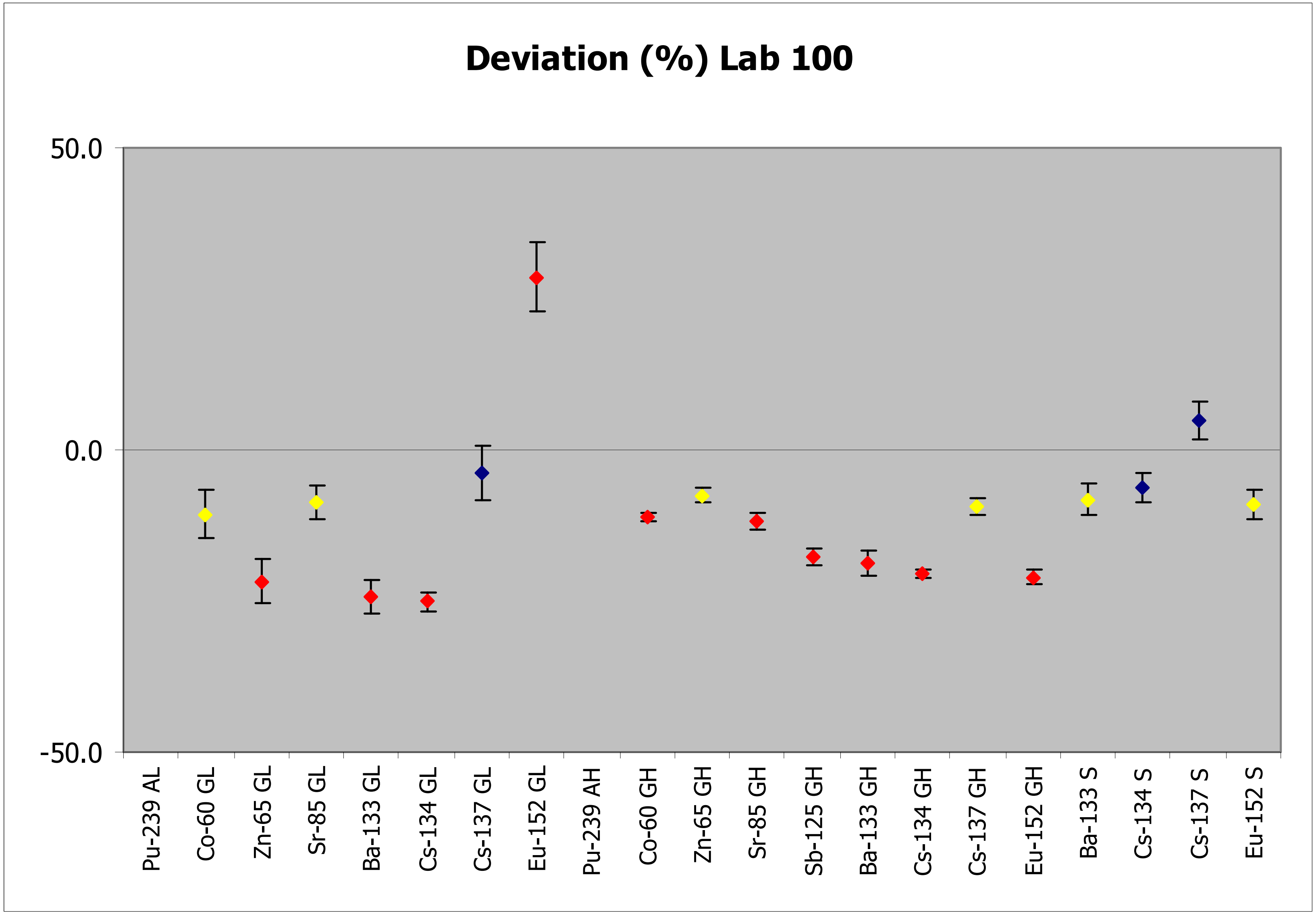


Figure 100 – Laboratory 104

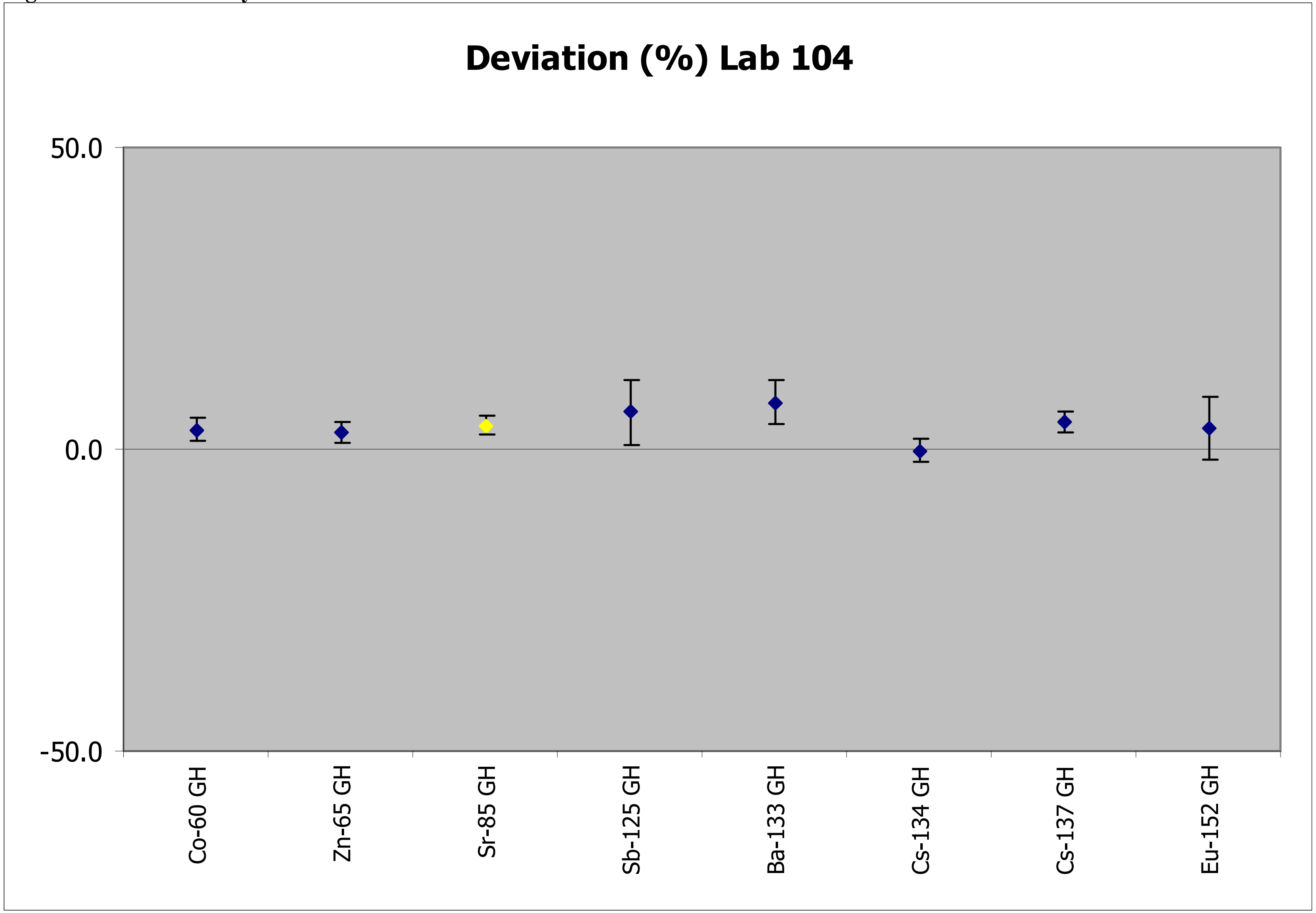


Figure 101 – Laboratory 106

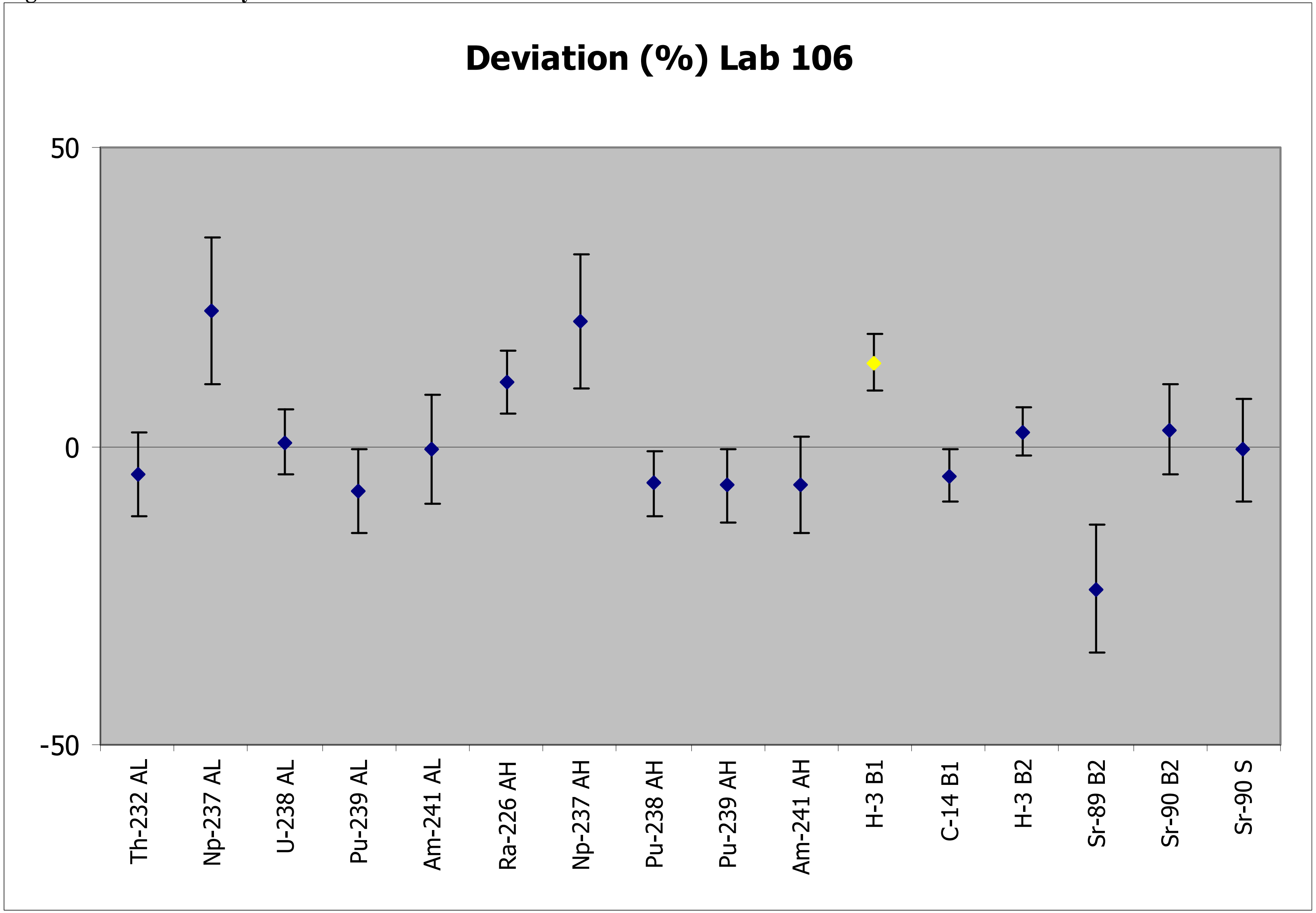


Figure 102 – Laboratory 107

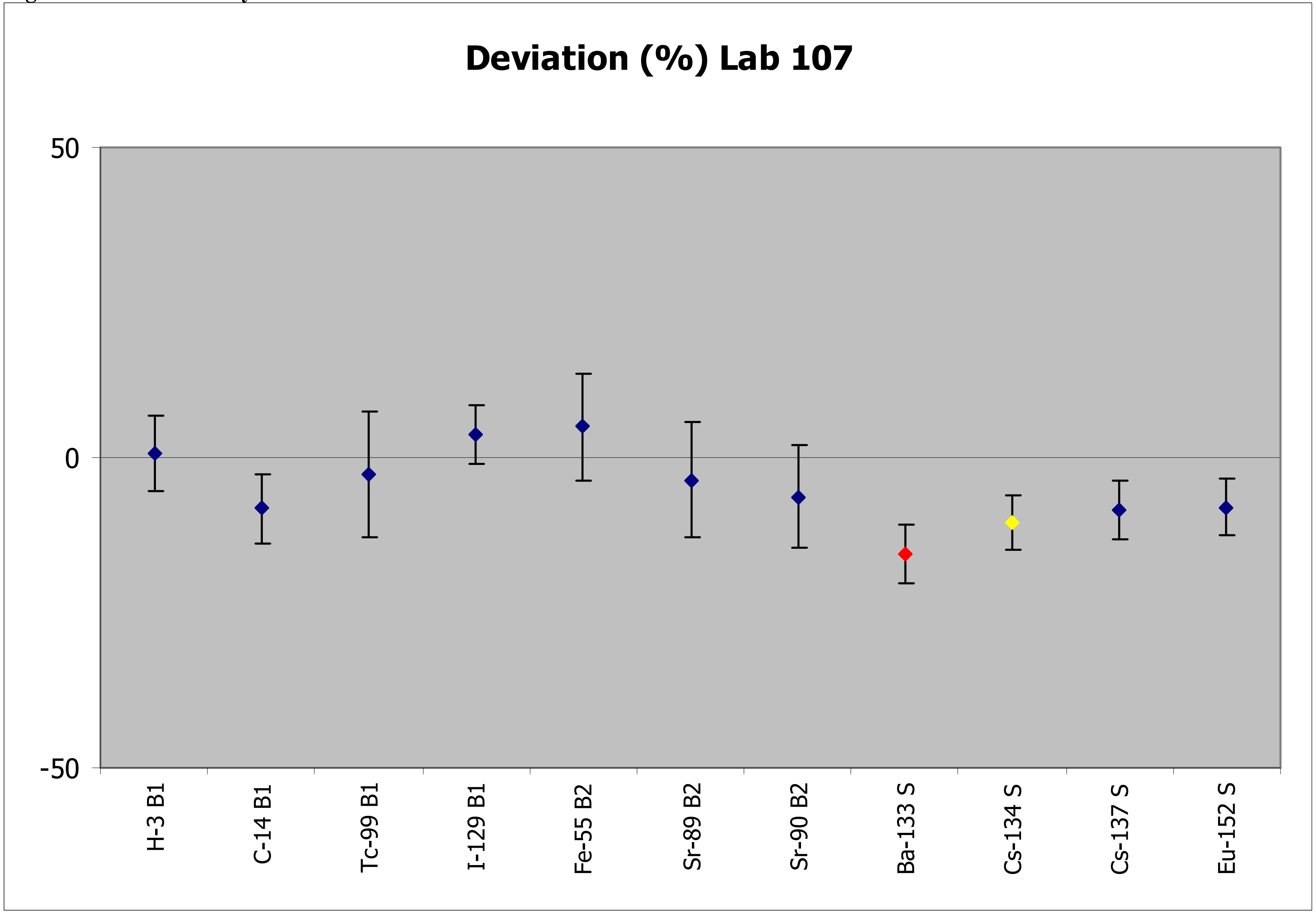


Figure 103 – Laboratory 108

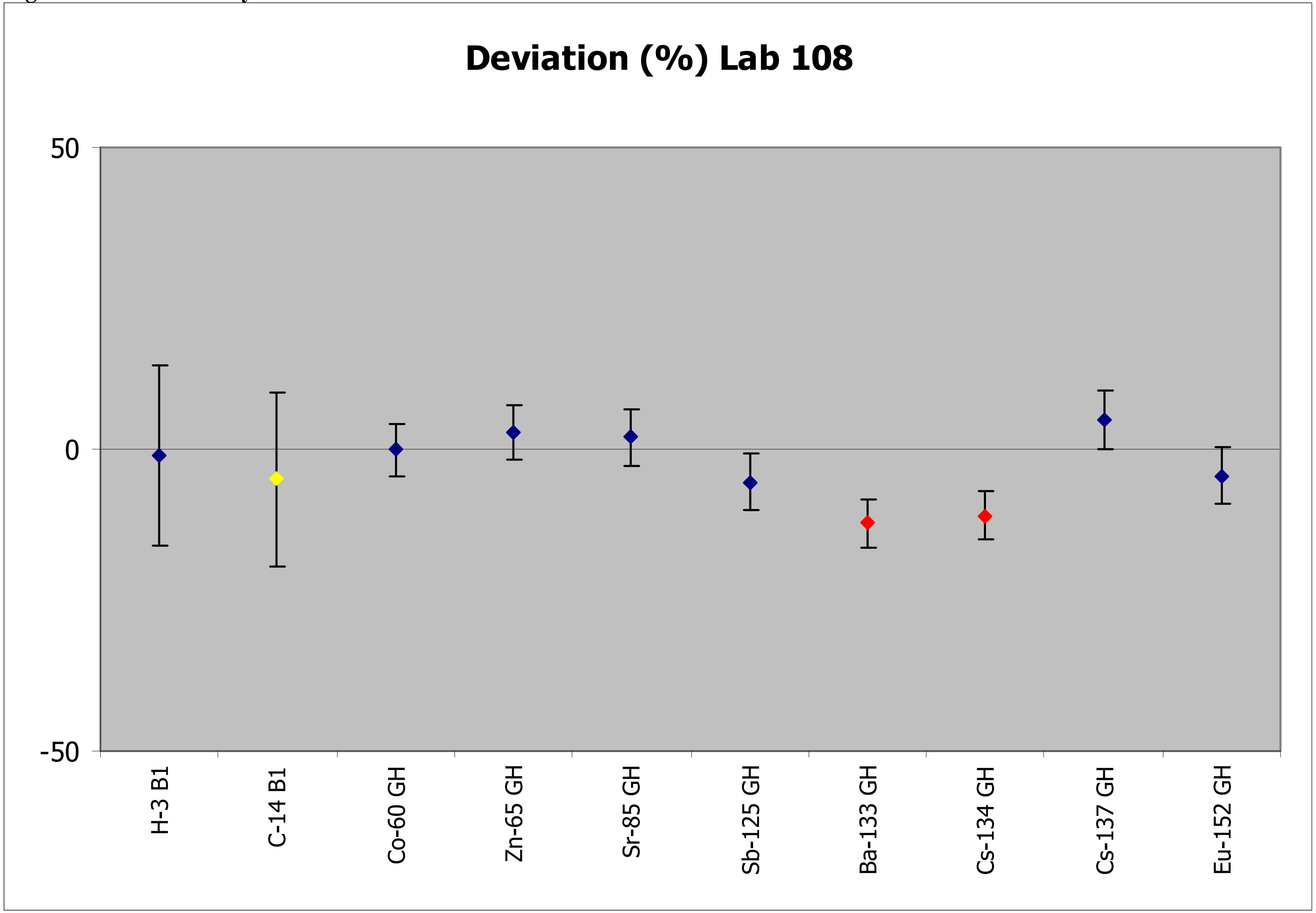


Figure 104 – Laboratory 110

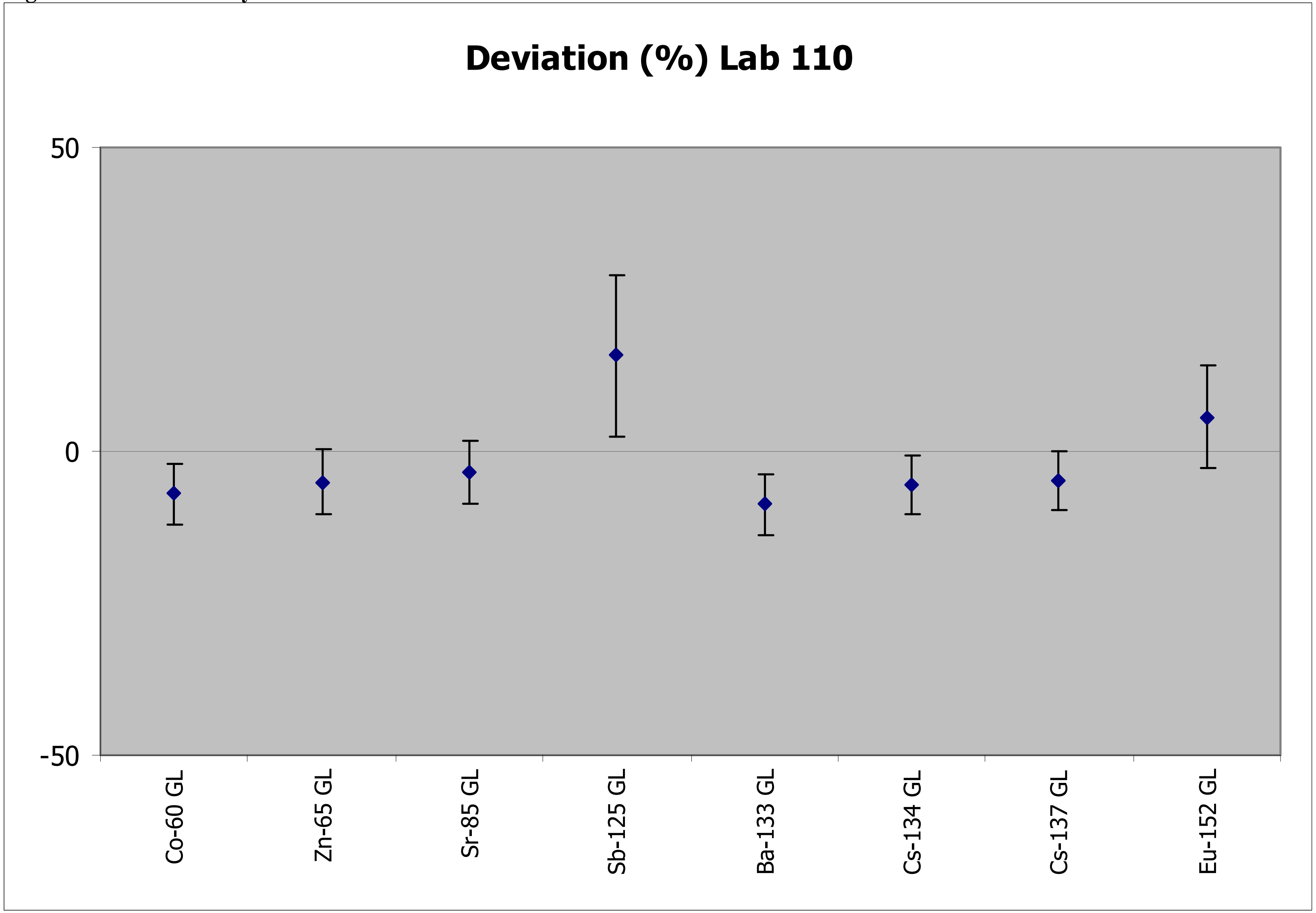


Figure 105 – Laboratory 111

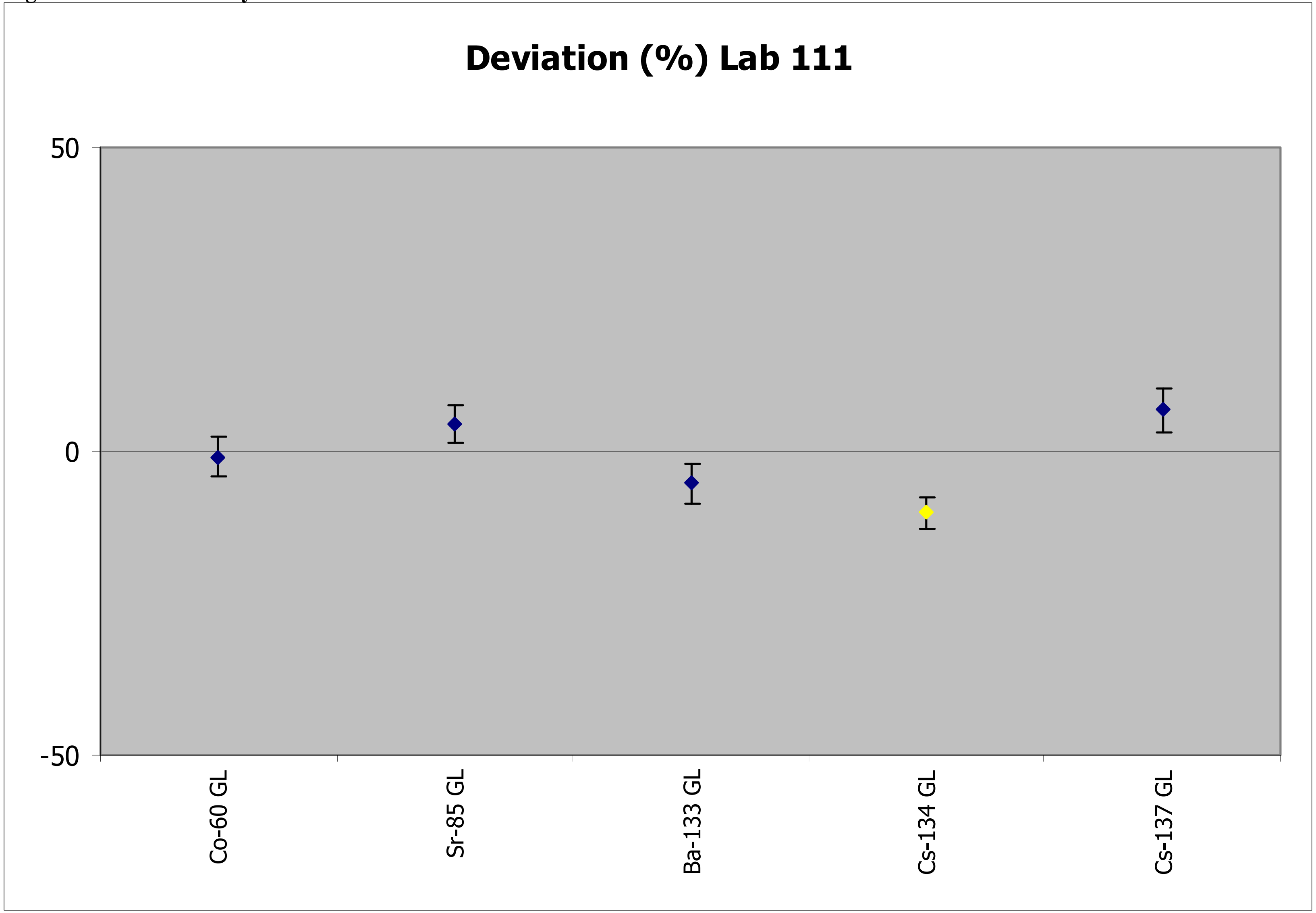


Figure 106 – Laboratory 113

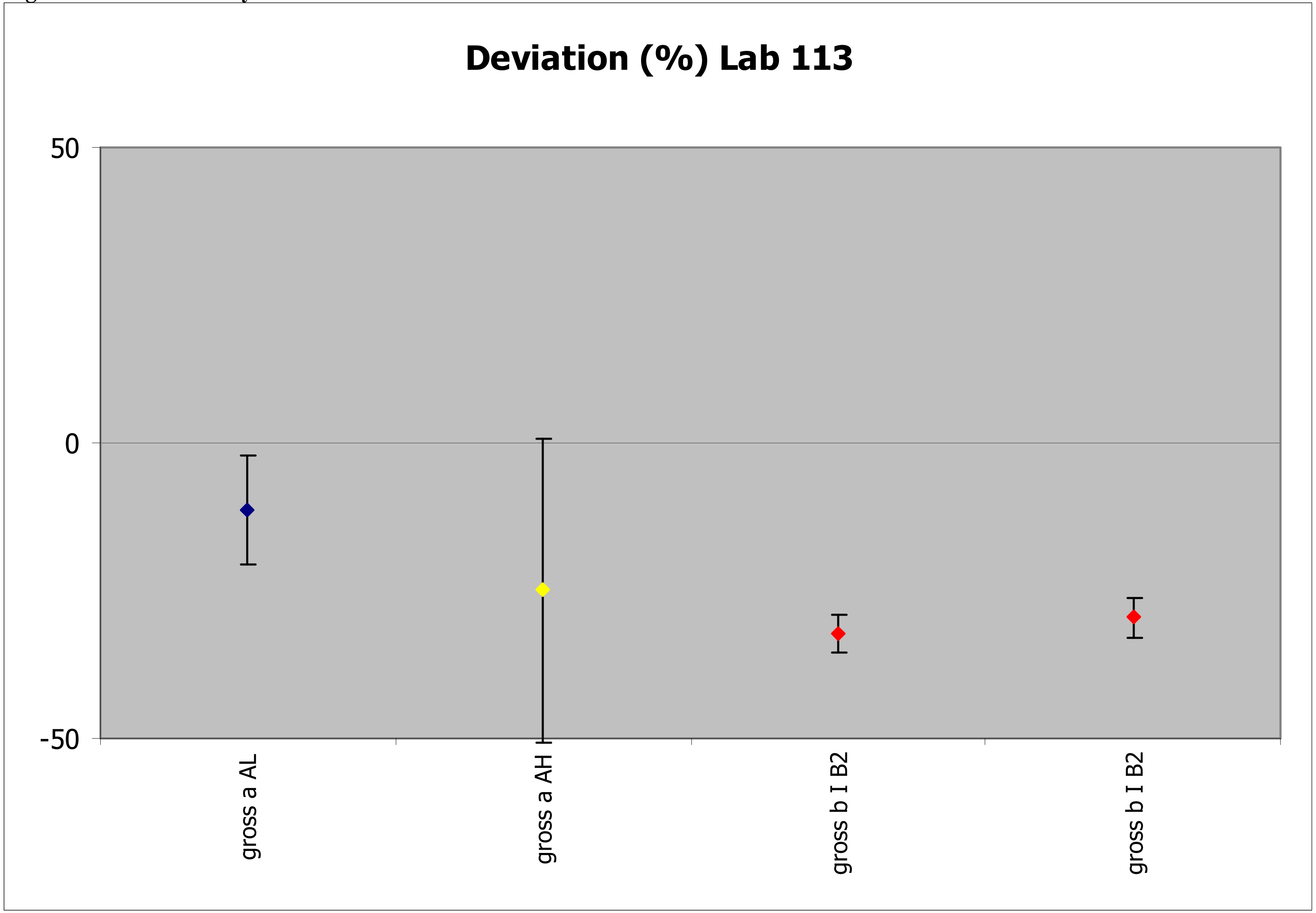


Figure 107 – Laboratory 114

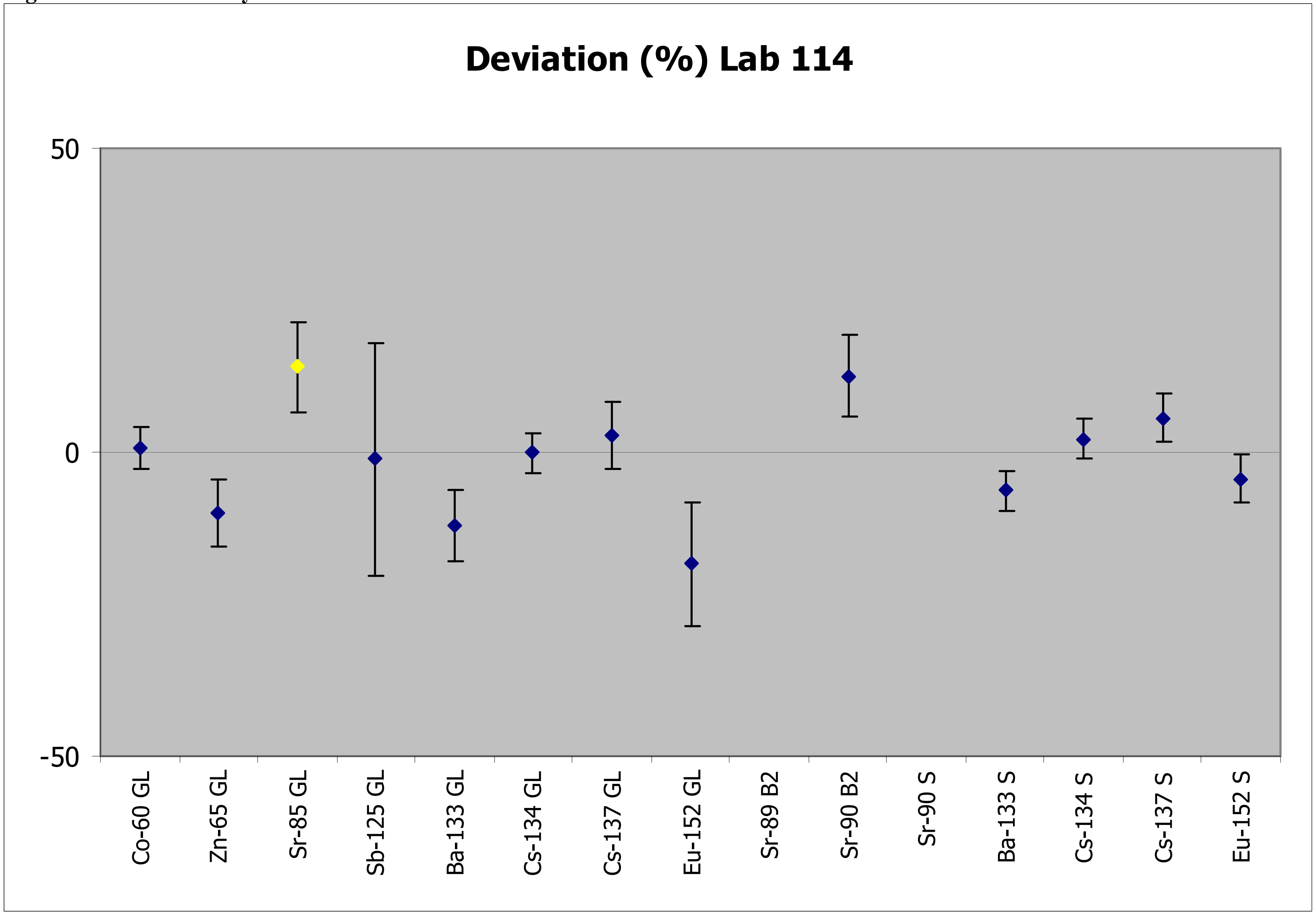


Figure 108 – Laboratory 115

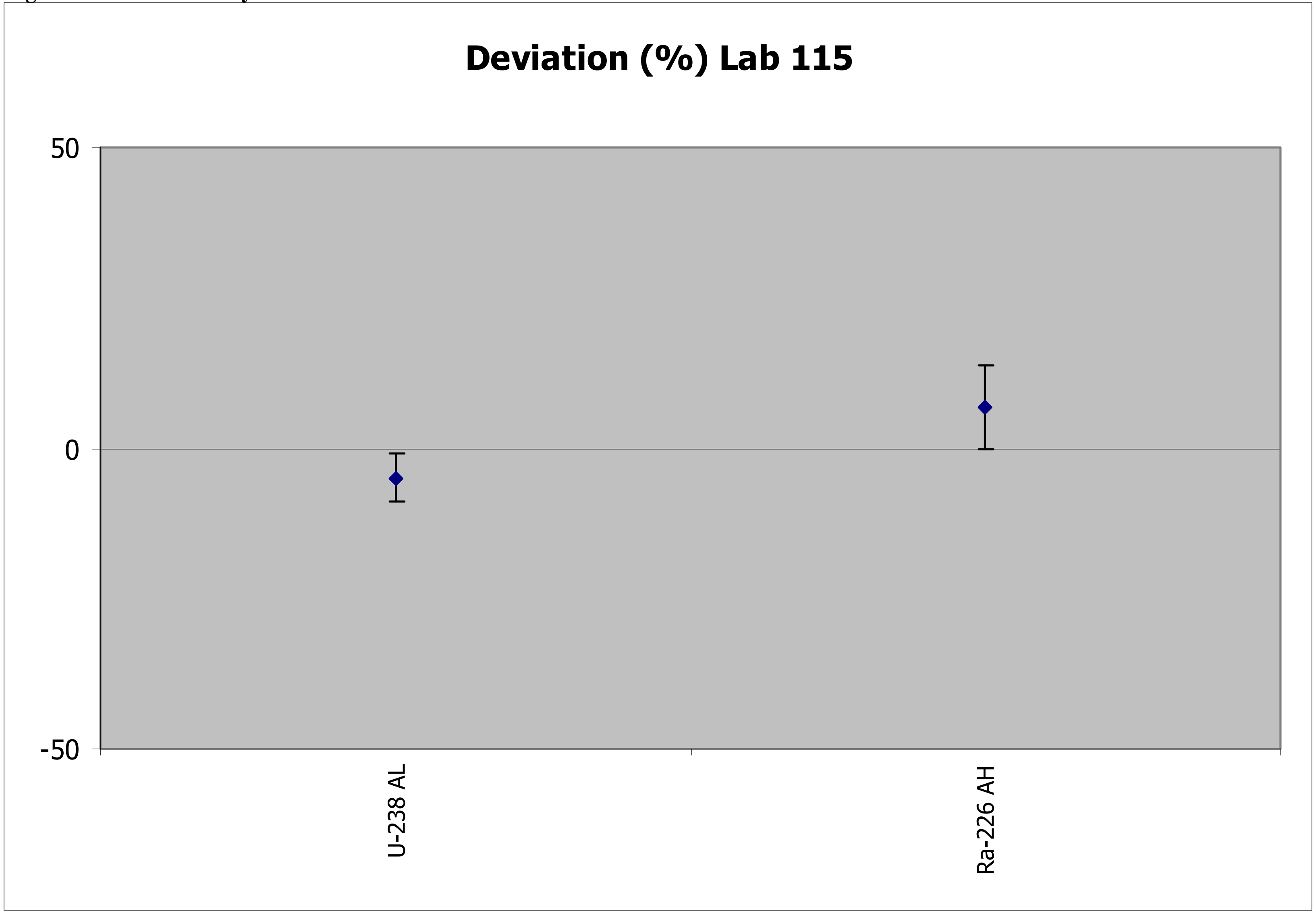


Figure 109 – Laboratory 116

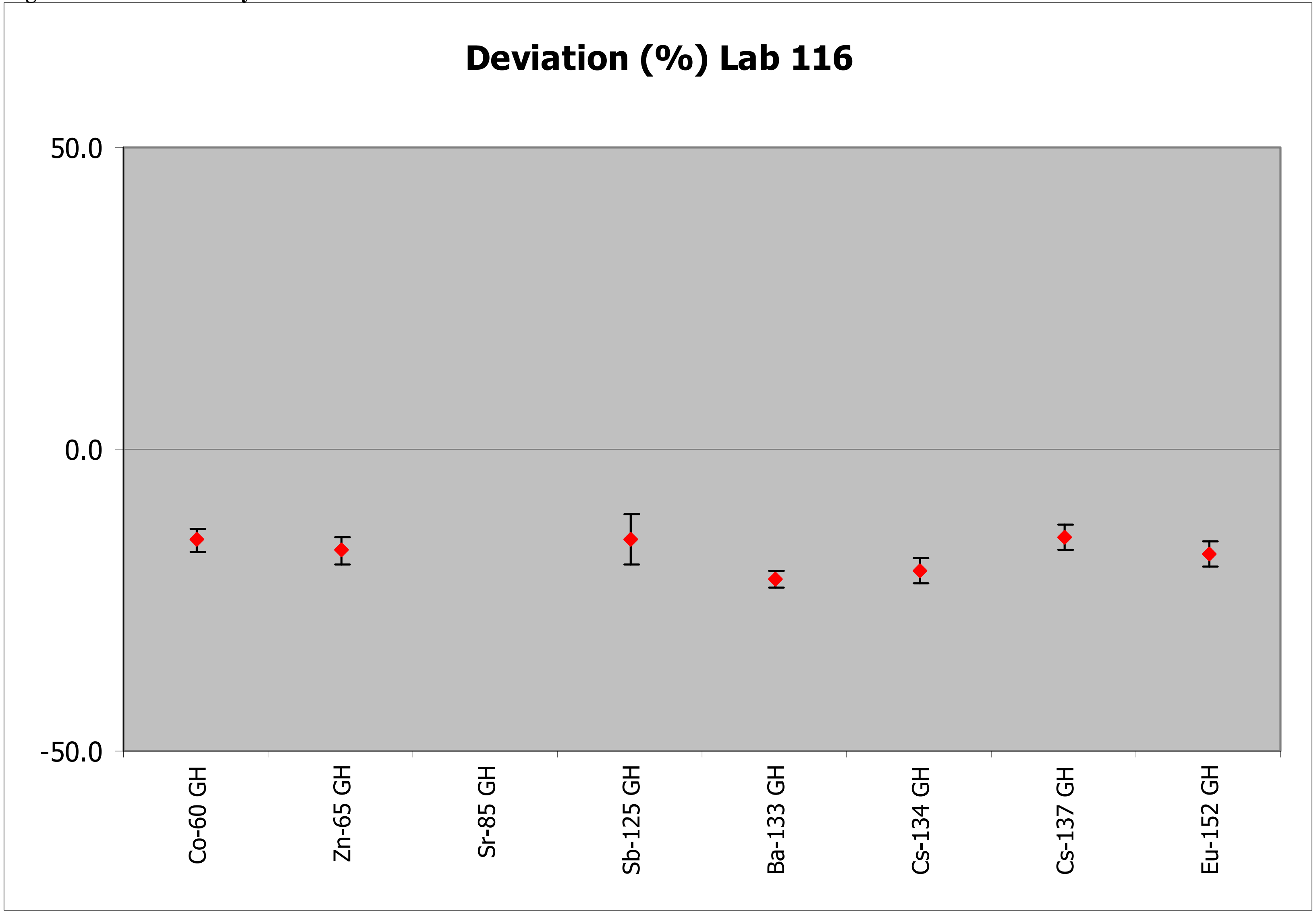


Figure 110 – Laboratory 117

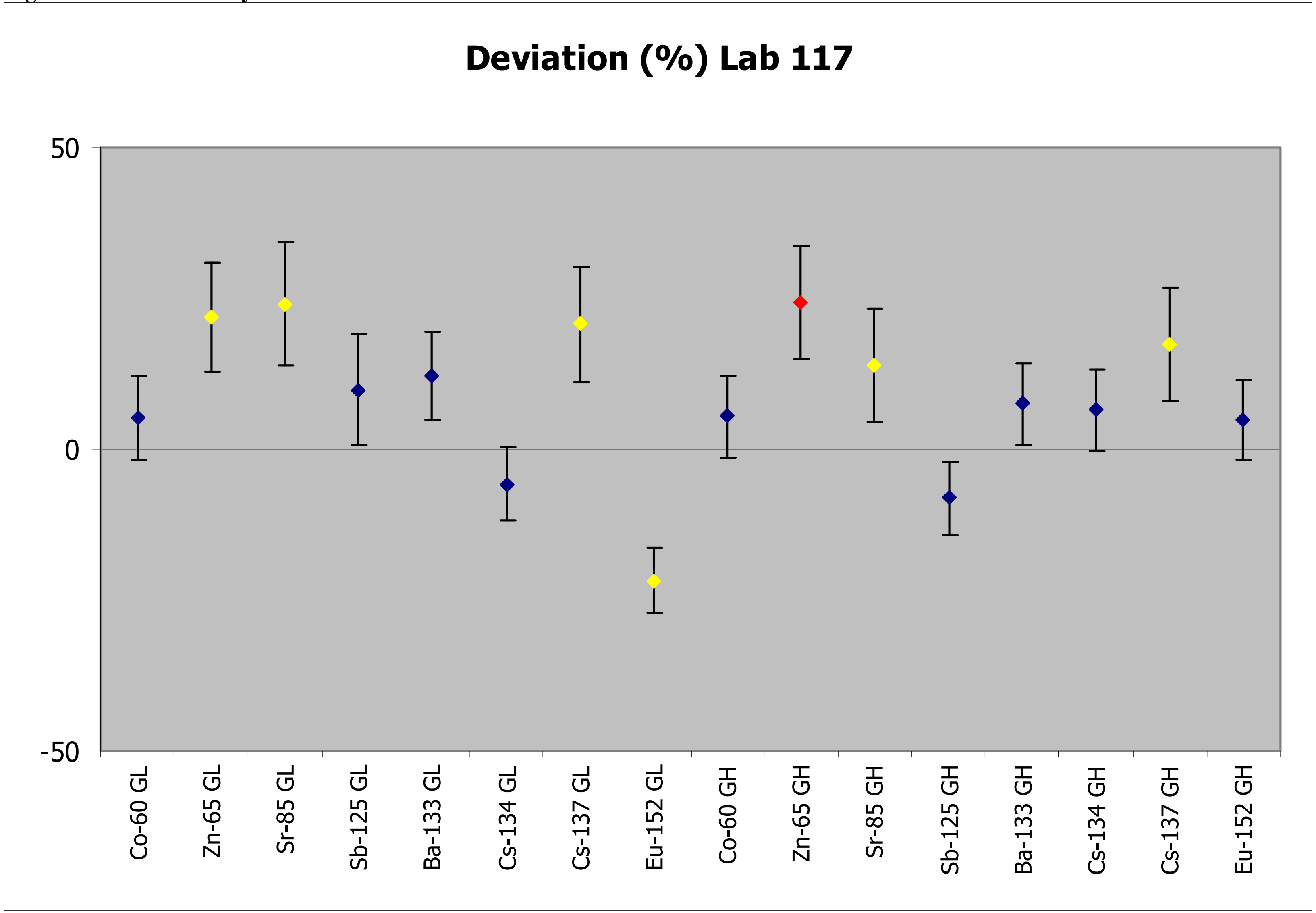


Figure 111 – Laboratory 118

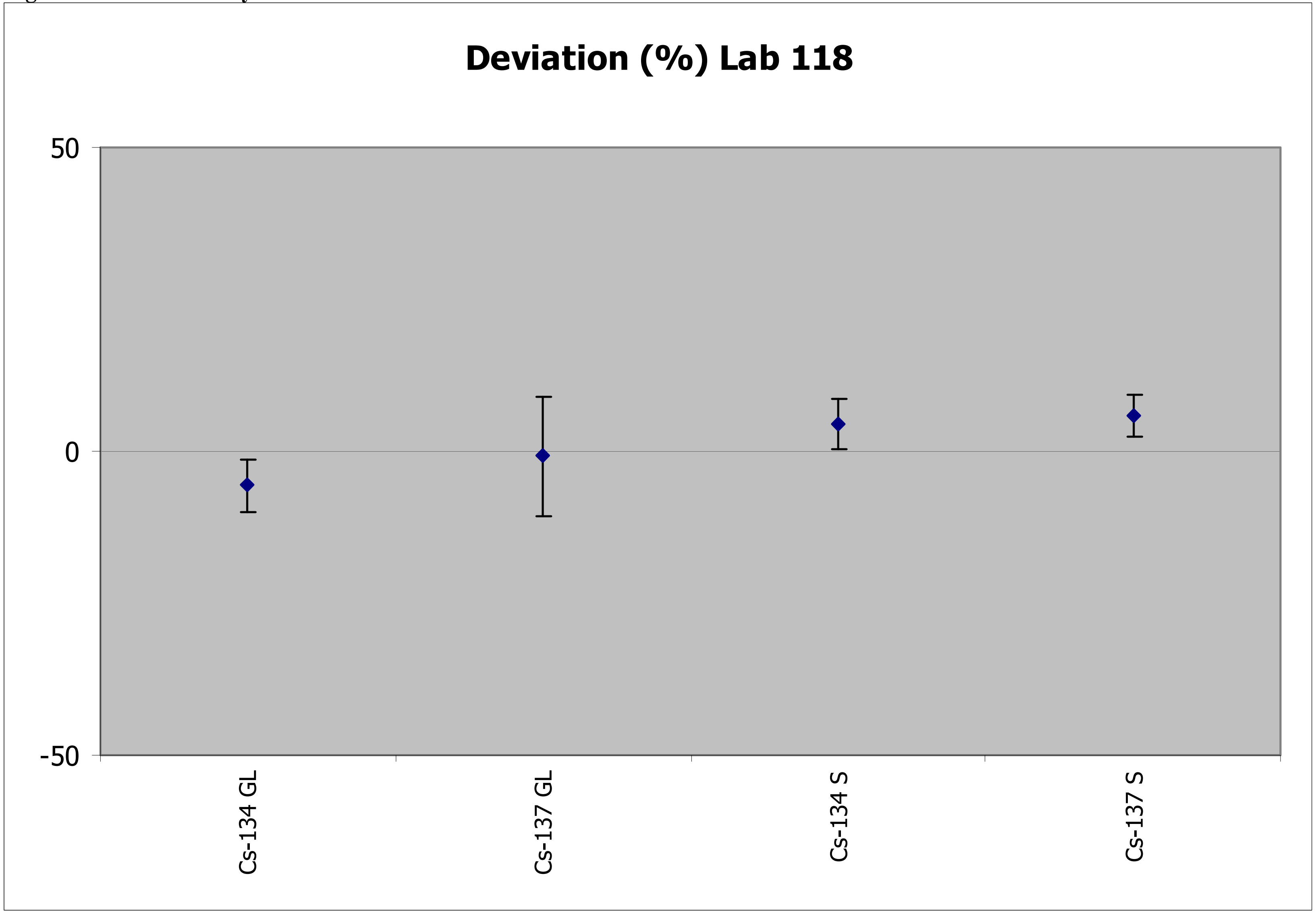


Figure 112 – Laboratory 119

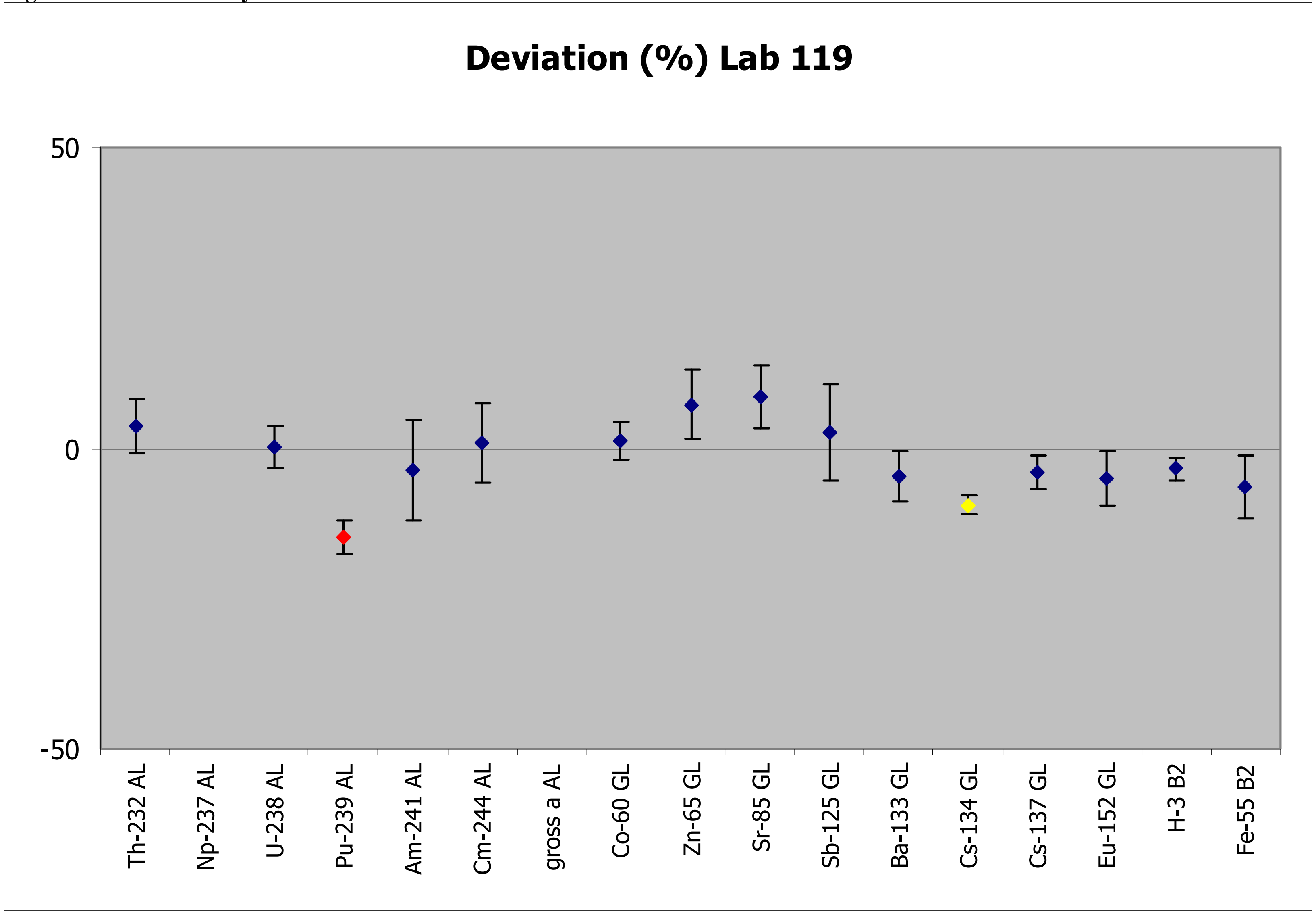


Figure 113 – Laboratory 120

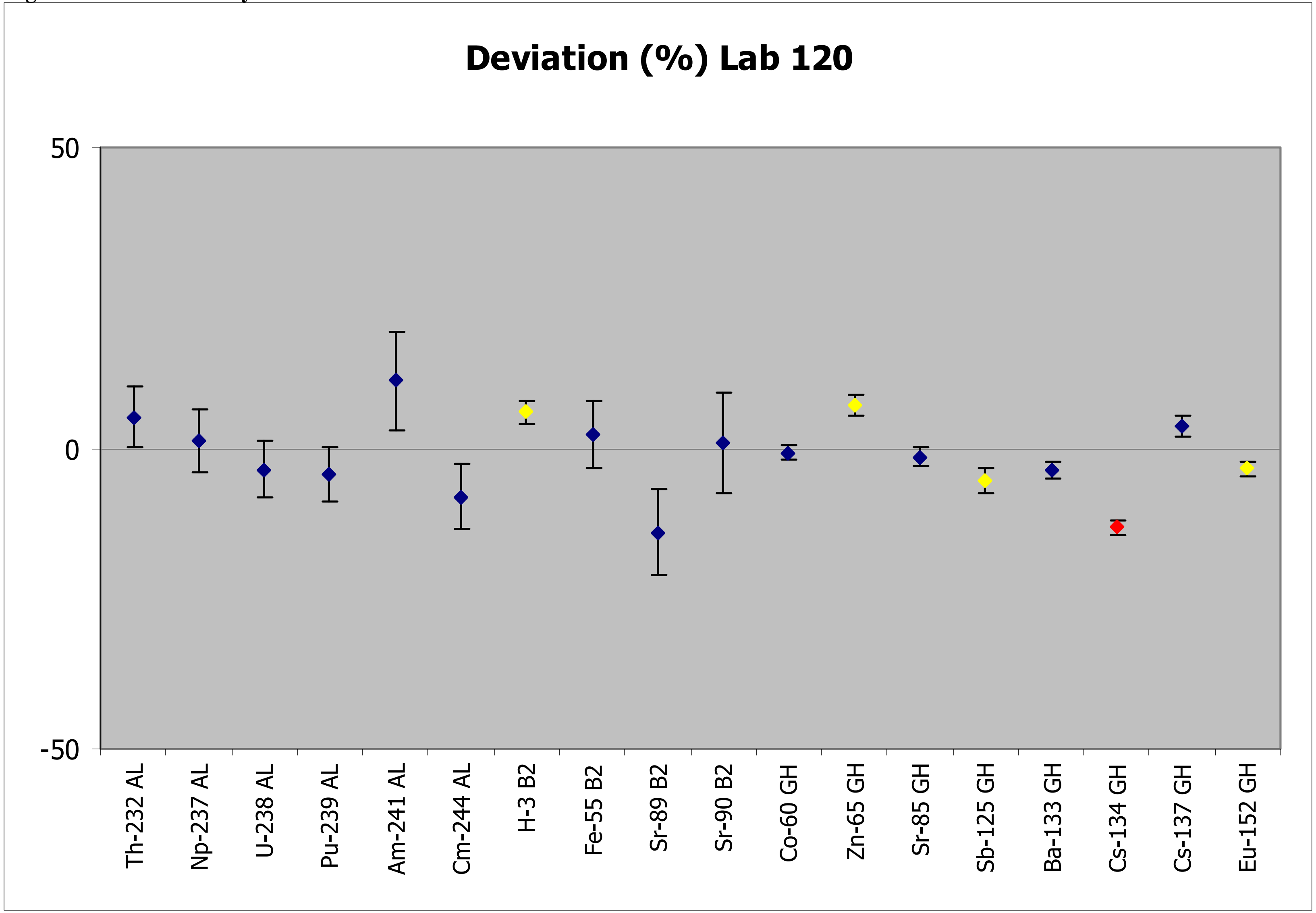


Figure 114 – Laboratory 121

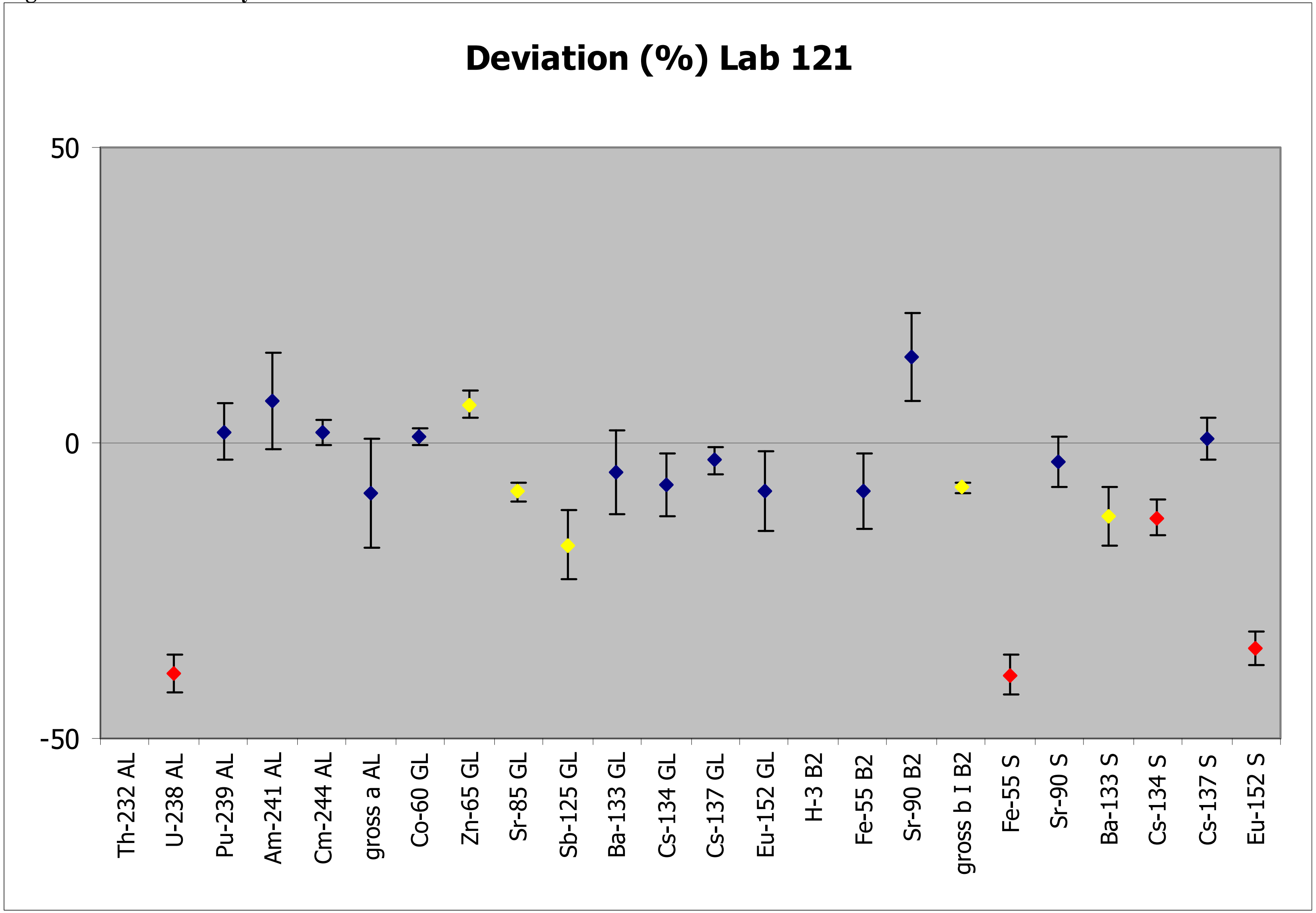


Figure 115 – Laboratory 122

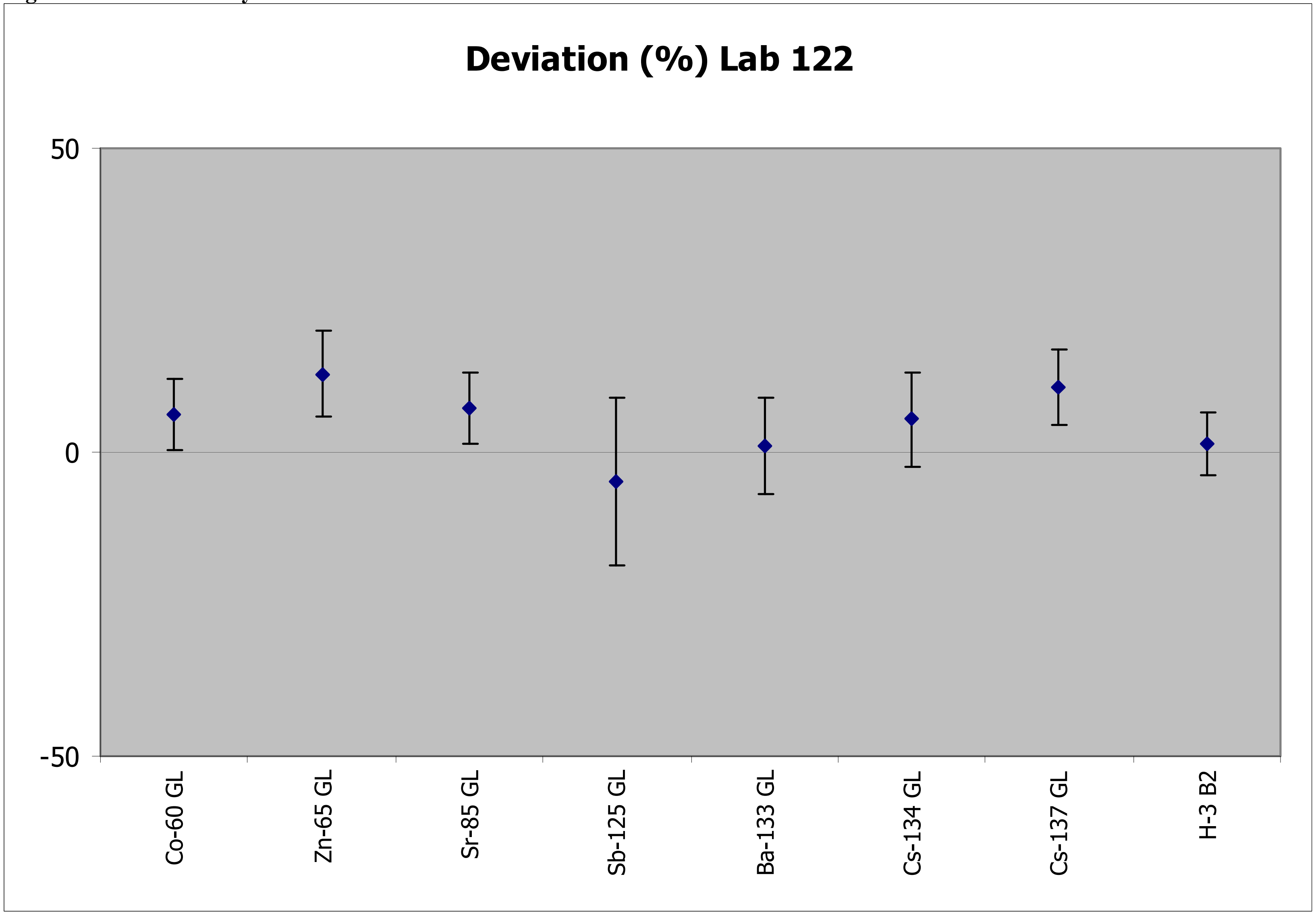


Figure 116 – Laboratory 123

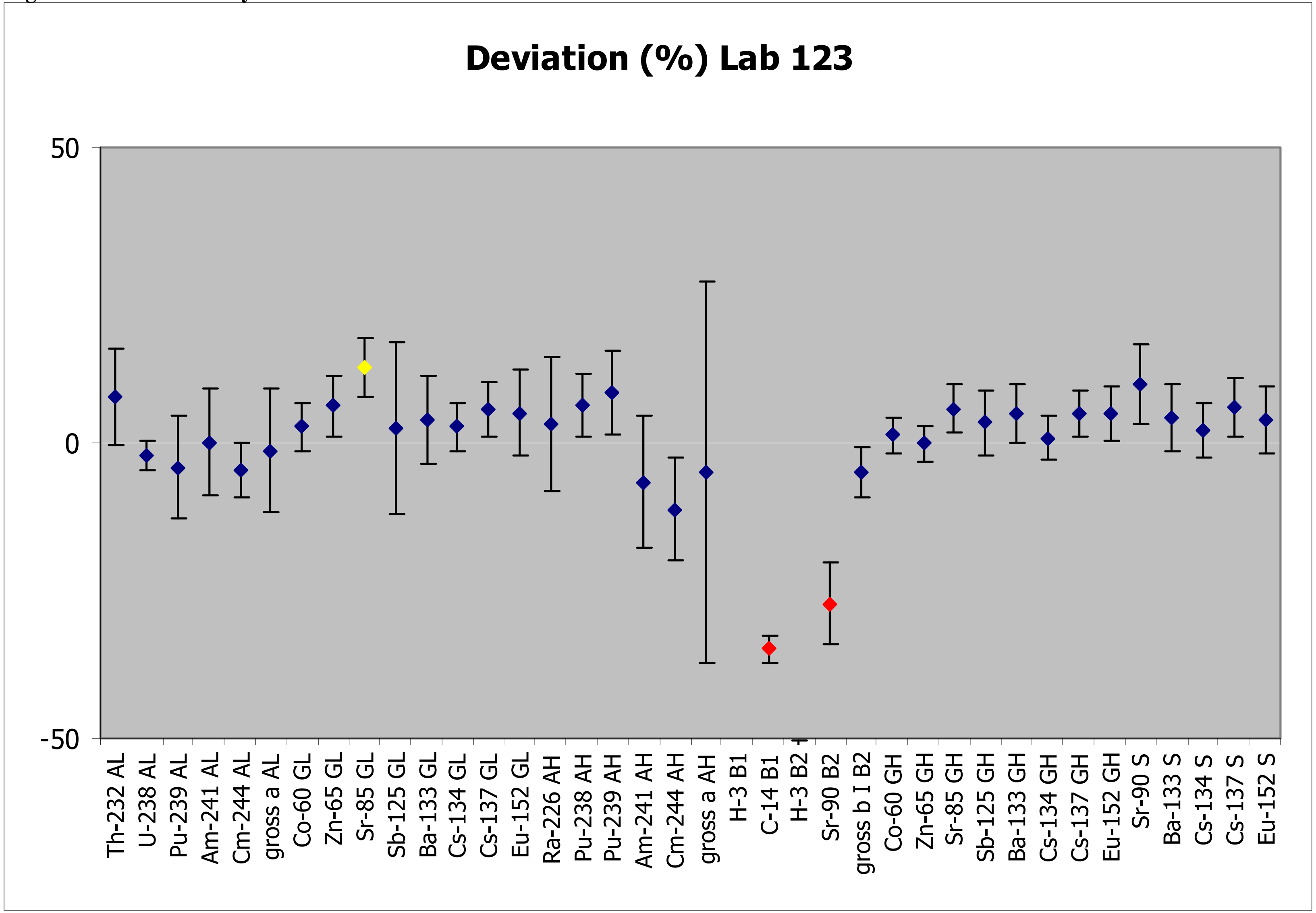


Figure 117 – Laboratory 124

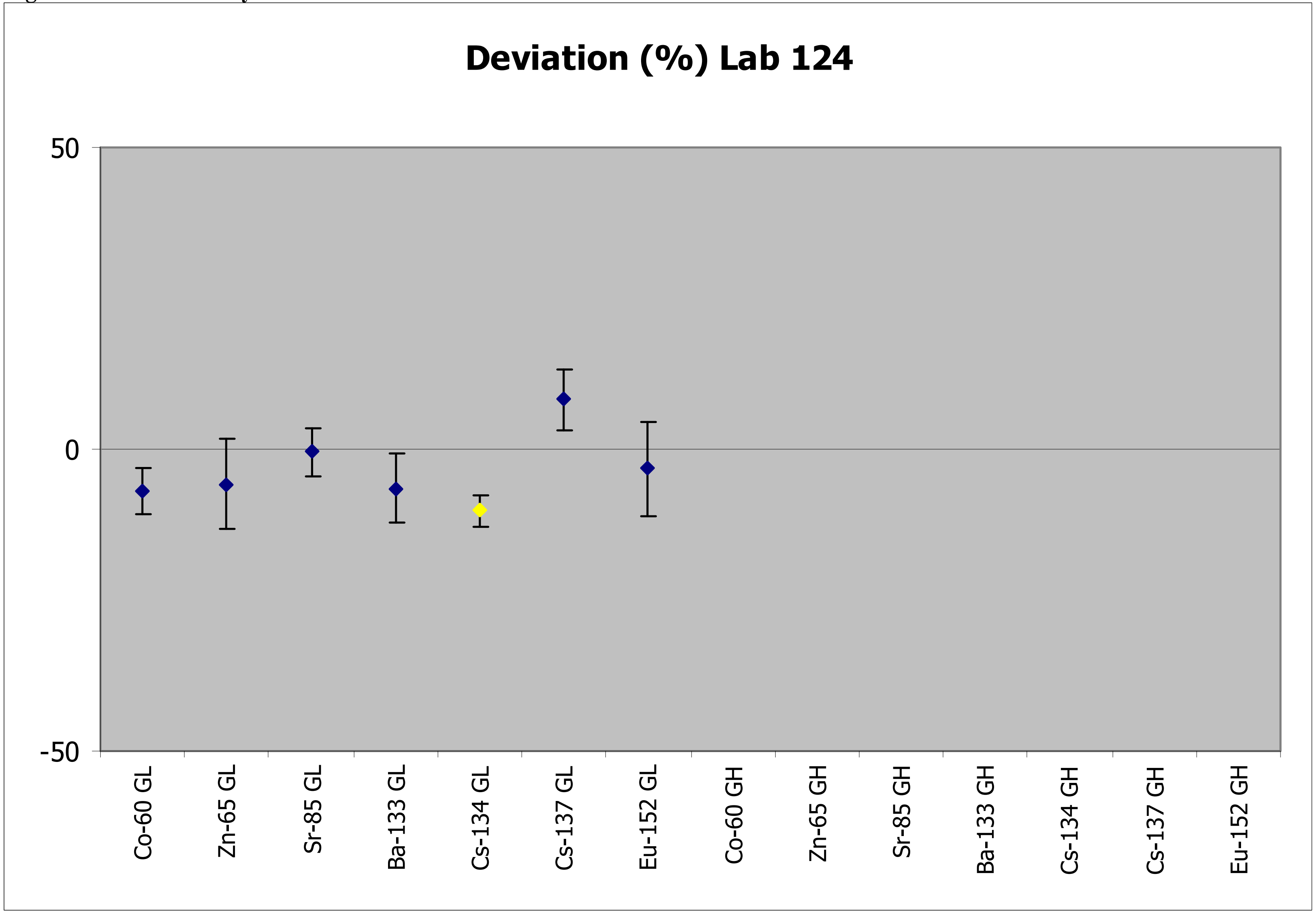


Figure 118 – Laboratory 126

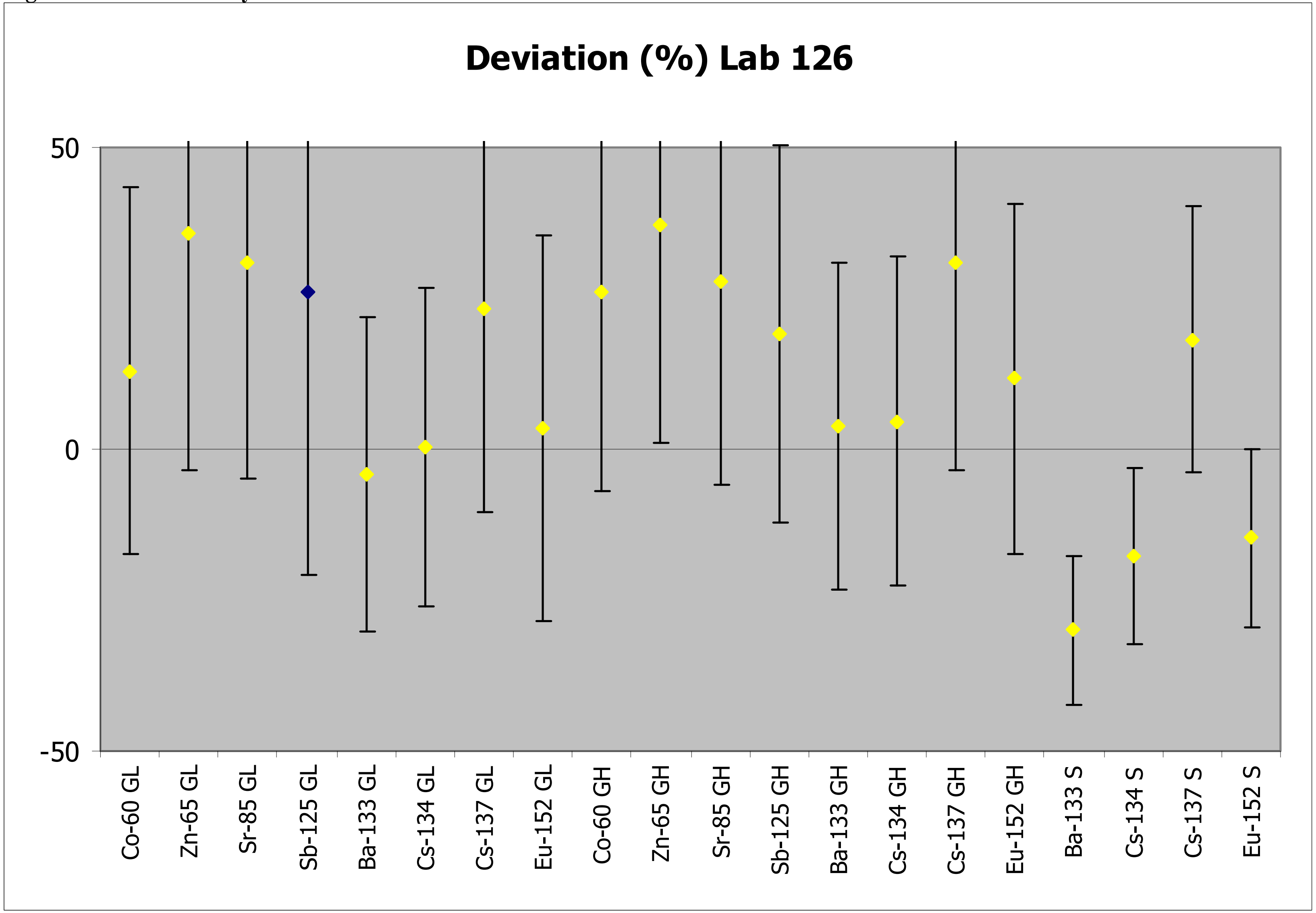


Figure 119 – Median relative uncertainties

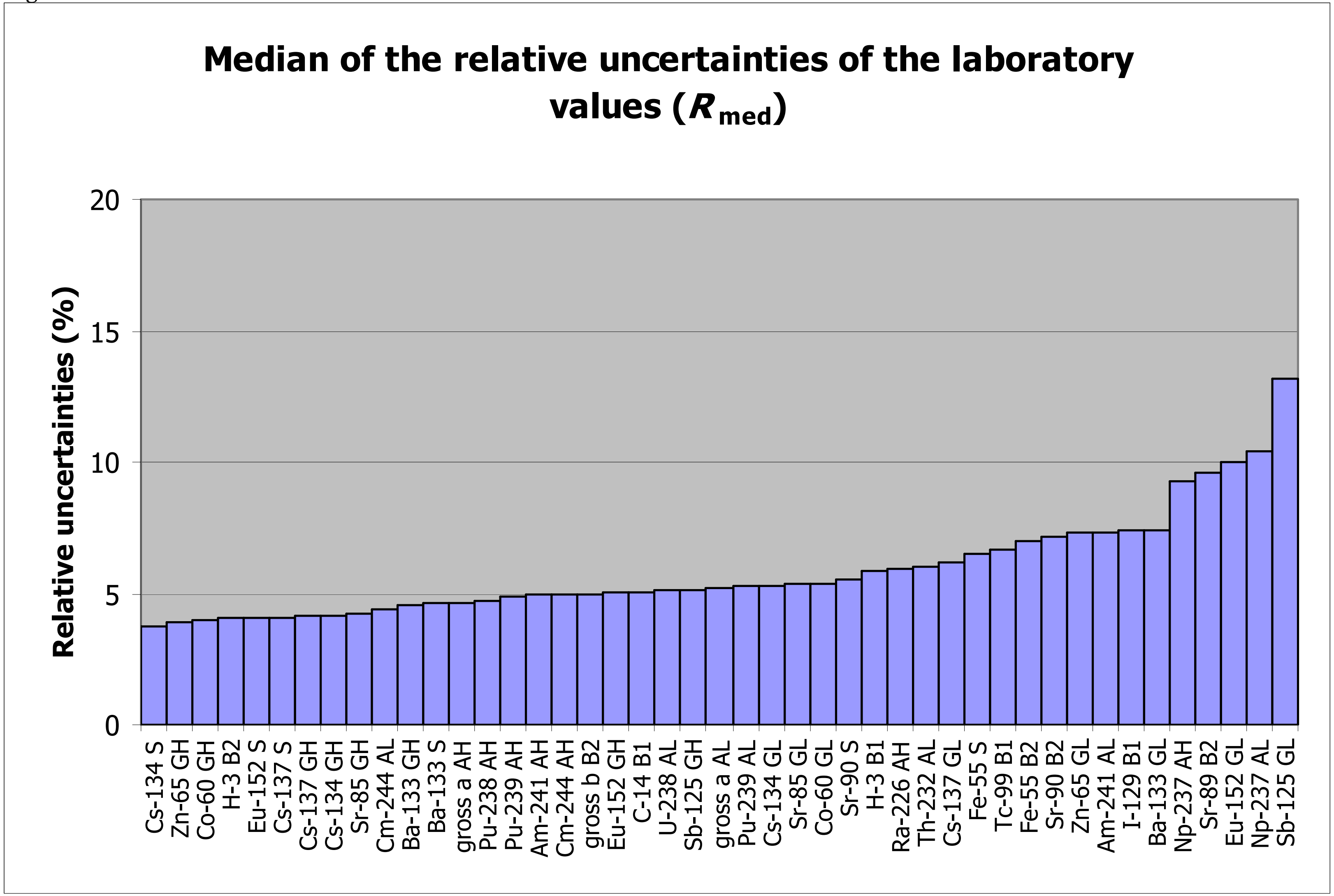


Figure 120 – Outlier limits relative uncertainties

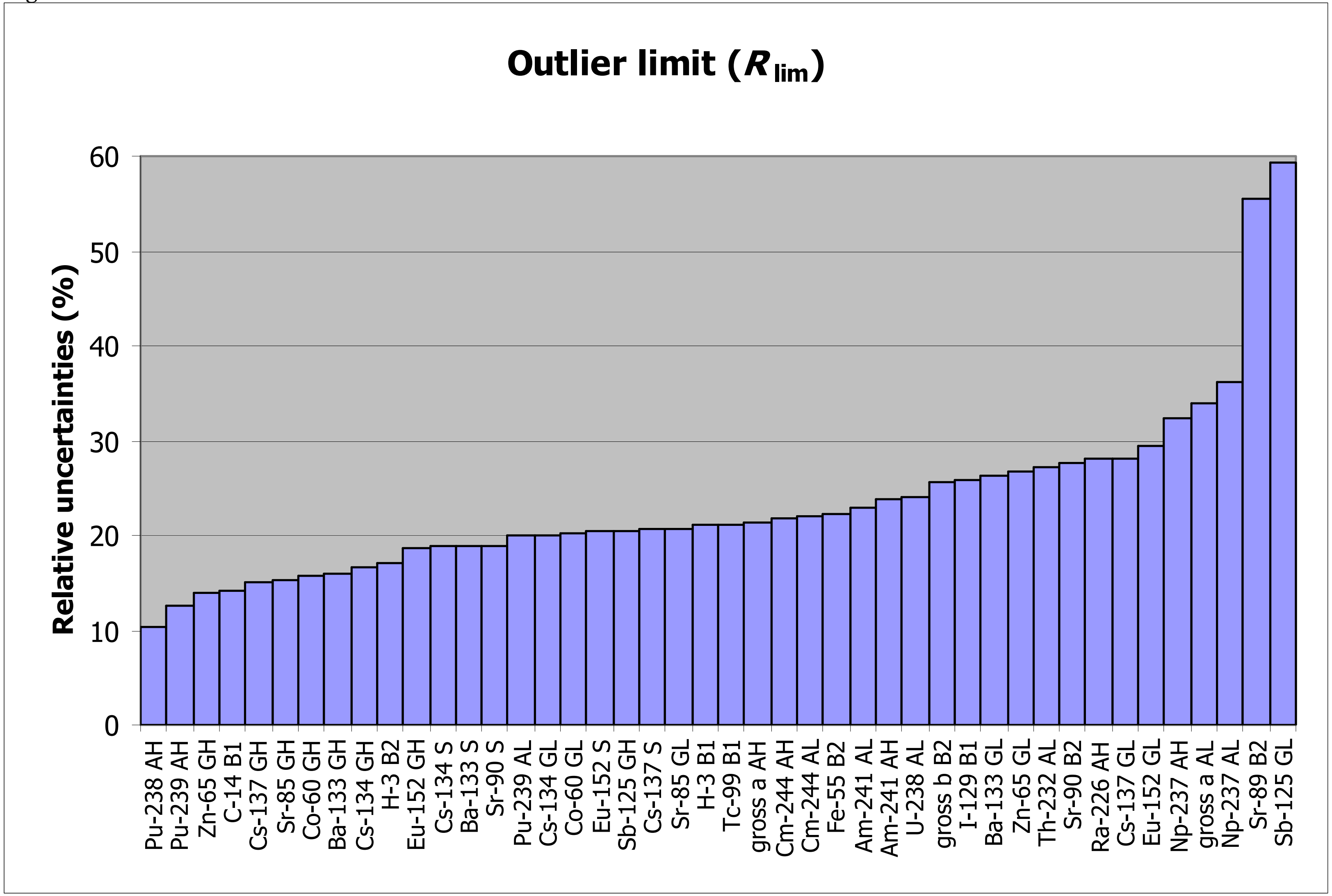


Figure 121A – Normalised ^{244}Cm / ^{241}Am ratios AL

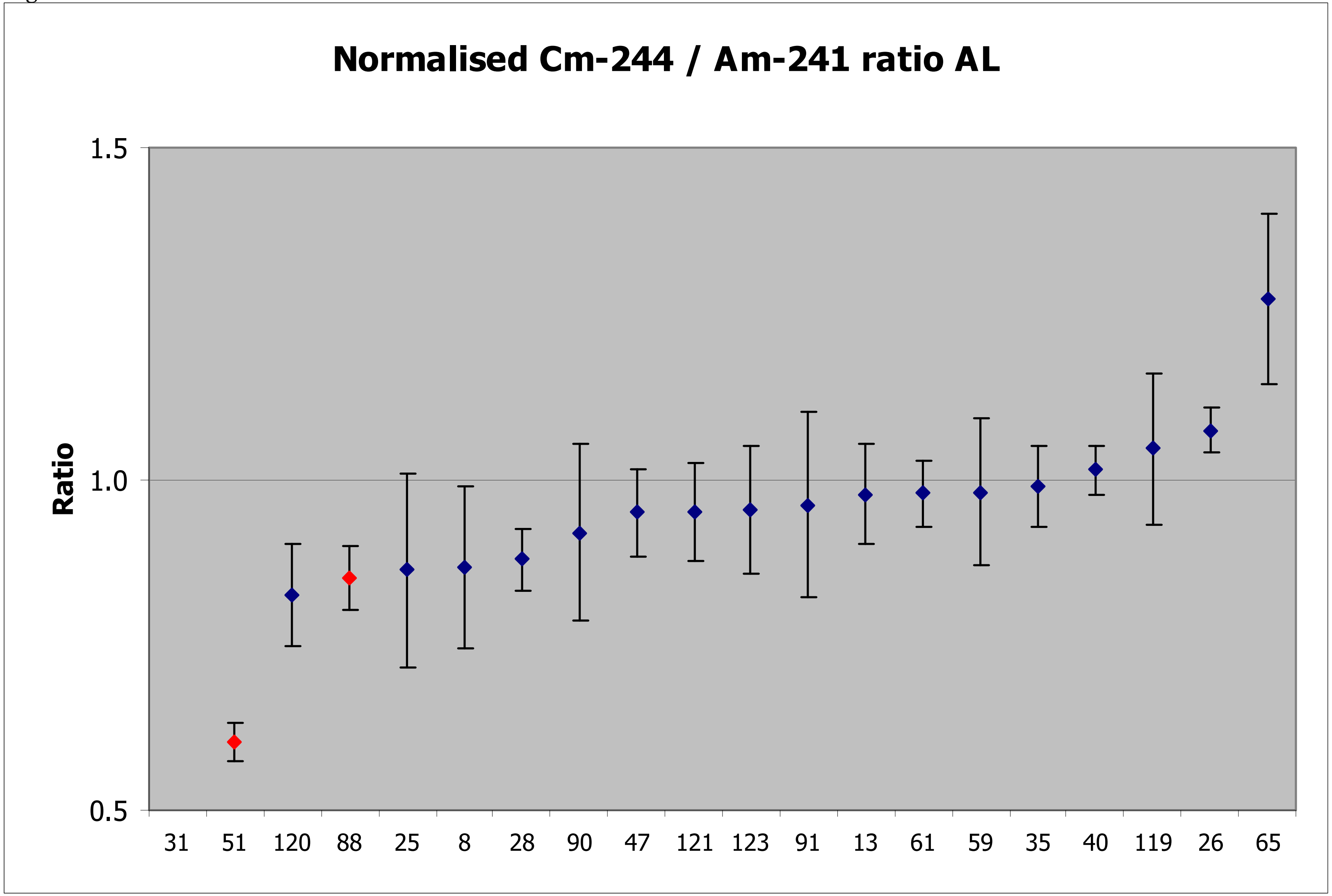
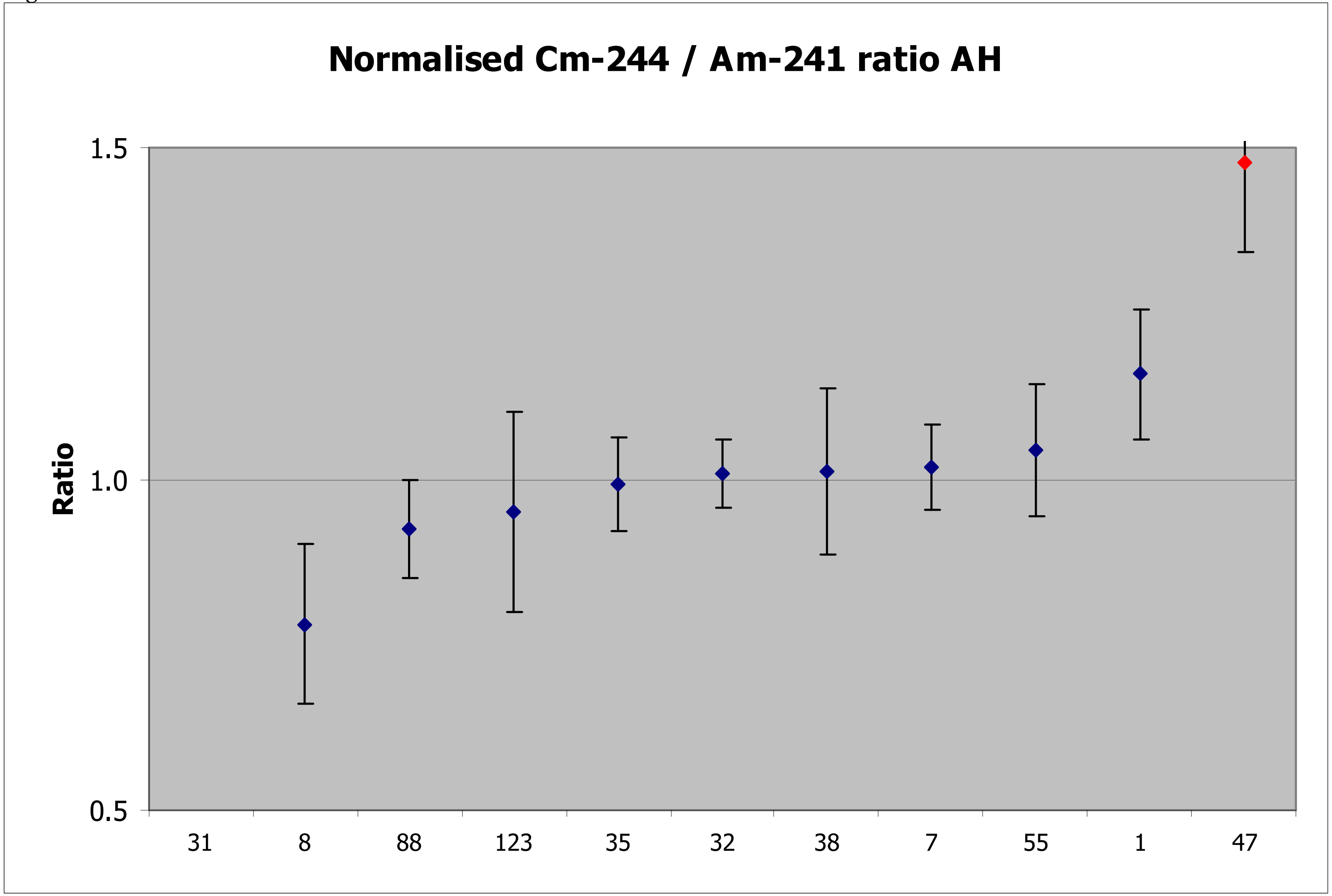


Figure 121B – Normalised ^{244}Cm / ^{241}Am ratios AH



Appendix A. Results sorted by nuclide

Table A1 – Th-232 AL **assigned result 5.01(5) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
35	3.80(18)	–6.50 D	–4.03 D	–24(4)
26	4.04(15)	–6.17 D	–3.23 D	–19(3)
91	4.3(5)	–1.50	–2.36	–14(10)
51	4.30(20)	–3.46 Q	–2.36	–14(4)
47	4.4(4)	–1.89	–2.03	–12(7)
28	4.44(24)	–2.33	–1.90	–11(5)
90	4.5(5)	–1.10	–1.80	–11(10)
65	4.55(23)	–1.96	–1.53	–9(5)
106	4.8(4)	–0.65	–0.77	–5(7)
59	4.9(5)	–0.27	–0.44	–3(10)
88	4.90(10)	–1.00	–0.37	–2.2(22)
13	4.9(4)	–0.24	–0.30	–2(8)
29	5.0(3)	–0.04	–0.04	0(6)
25	5.1(6)	0.11	0.20	1(11)
32 M	5.1(3)	0.25	0.23	1(6)
119	5.19(22)	0.80	0.60	4(5)
120	5.27(25)	1.02	0.86	5(5)
32 A	5.37(17)	2.03	1.19	7(4)
123	5.4(4)	0.97	1.29	8(8)
121	14.9(16)	6.18 D	32.89 D	20(4) $\times 10^1$
42	19(7) Q	2.14	45.81 Q	27(13) $\times 10^1$

Table A2 – Np-237 AL **assigned result 4.65(5) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
91	3.9(5)	–1.62	–1.47	–15(9)
86	4.4(6)	–0.40	–0.51	–5(13)
120	4.70(24)	0.21	0.11	1(6)
8	5.3(8)	0.84	1.32	14(16)
42	5.3(12)	0.57	1.40	$1(3) \times 10^1$
106	5.7(6)	1.84	2.17	23(12)
25	6.8(5)	4.41 D	4.48 D	47(11)
65	8.4(7)	5.60 D	7.76 D	81(15)
90	10.0(10)	5.12 D	11.00 D	115(22)
35	10.1(6)	9.65 D	11.19 D	117(12)
119	14(3)	3.11 D	19.92 D	$21(7) \times 10^1$

Table A3 – U-238 AL **assigned result 18.0(4) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
121	11.0(5)	–10.91 D	–7.67 D	–39(3)
91	15.3(17)	–1.52	–2.92 Q	–15(10)
42	16.0(25)	–0.79	–2.18	–11(14)
88	16.1(8)	–2.05	–2.05	–10(5)
86	16.2(12)	–1.40	–1.91	–10(7)
40	16.5(3)	–2.85 Q	–1.57	–8(3)
25	16.6(15)	–0.86	–1.49	–8(9)
17	16.7(9)	–1.41	–1.45	–7(5)
115	17.1(6)	–1.18	–0.97	–5(4)
35	17.2(7)	–1.04	–0.88	–4(5)
120	17.3(7)	–0.76	–0.69	–4(5)
59	17.4(14)	–0.39	–0.61	–3(8)
28	17.5(6)	–0.70	–0.52	–3(4)
61	17.5(6)	–0.72	–0.52	–3(4)
90	17.6(18)	–0.21	–0.42	–2(10)
123	17.60(20)	–0.83	–0.41	–2.1(25)
32 A	17.6(14)	–0.26	–0.41	–2(8)
65	17.7(15)	–0.19	–0.32	–2(9)
13	18(3)	–0.09	–0.30	–2(16)
29	17.7(9)	–0.28	–0.30	–2(6)
47 A	17.9(8)	–0.12	–0.12	–1(5)
119	18.0(5)	0.04	0.03	0(4)
47 M	18.01(3)	0.09	0.04	0.2(23)
106	18.1(9)	0.13	0.14	1(6)
32 M	18.3(14)	0.22	0.35	2(8)
4	18.4(14)	0.28	0.43	2(8)
8 M	19.6(20)	0.81	1.78	9(11)
51	19.9(9)	1.95	2.10	11(6)
26	20.5(7)	3.25 D	2.72 D	14(5)
8 A	20.6(23)	1.11	2.87 Q	15(13)

Table A4 – Pu-239/240 AL **assigned result 11.77(12) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
100	1.40(24)	–38.52 D	–16.65 D	–88.0(21)
29	9.7(5)	–3.86 D	–3.21 D	–17(5)
51	9.7(4)	–4.76 D	–3.21 D	–17(4)
119	9.9(3)	–5.26 D	–2.82 D	–15(3)
47	10.4(6)	–2.13	–2.14	–11(6)
90	10.5(11)	–1.00	–1.85	–10(10)
26	10.7(3)	–3.34 Q	–1.64	–9(3)
91	10.8(11)	–0.83	–1.46	–8(9)
106	10.8(8)	–1.09	–1.43	–8(7)
59	11.0(9)	–0.85	–1.19	–6(7)
62	11.1(6)	–1.00	–0.99	–5(5)
120	11.2(5)	–0.96	–0.83	–4(5)
123	11.2(10)	–0.48	–0.78	–4(9)
40	11.2(4)	–1.33	–0.77	–4(3)
35	11.2(5)	–1.02	–0.75	–4(4)
4	11.4(8)	–0.39	–0.49	–3(7)
32	11.42(25)	–0.95	–0.43	–2.3(24)
8	11.5(10)	–0.19	–0.30	–2(8)
65	11.6(5)	–0.21	–0.18	–1(5)
13	11.6(7)	–0.13	–0.13	–1(6)
28	11.6(5)	–0.13	–0.10	–1(4)
25	11.9(5)	0.14	0.32	2(12)
121	11.9(14)	0.41	0.37	2(5)
31	12.85(25)	4.23 Q	1.89	10.0(24)
88	13.0(5)	2.67 Q	2.13	11(5)
17	15.1(10)	3.25 D	5.50 D	29(9)

Table A5 – Am-241 AL **assigned result 3.099(6) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
40	2.87(8)	–2.93 Q	–1.01	–7.4(25)
51	2.90(10)	–1.99	–0.88	–6(4)
65	2.91(20)	–0.94	–0.84	–6(7)
61	2.92(13)	–1.39	–0.79	–6(4)
86	2.95(24)	–0.62	–0.66	–5(8)
119	3.0(3)	–0.42	–0.48	–4(8)
90	3.0(3)	–0.25	–0.35	–3(10)
4	3.02(24)	–0.33	–0.35	–3(8)
32	3.04(25)	–0.24	–0.26	–2(8)
91	3.0(3)	–0.17	–0.23	–2(10)
26	3.05(8)	–0.65	–0.23	–1.6(25)
59	3.07(25)	–0.12	–0.13	–1(8)
62	3.08(18)	–0.10	–0.08	–1(6)
106	3.1(3)	–0.07	–0.08	–1(9)
35	3.10(14)	0.01	0.00	0(5)
123	3.1(3)	0.00	0.00	0(9)
25	3.1(4)	0.08	0.14	1(13)
28	3.15(11)	0.46	0.23	2(4)
13	3.17(19)	0.37	0.32	2(6)
29	3.20(20)	0.51	0.45	3(7)
47	3.23(20)	0.66	0.58	4(7)
17	3.23(21)	0.62	0.58	4(7)
88	3.24(14)	1.01	0.63	5(5)
42	3.3(4)	0.45	0.74	5(12)
121	3.32(25)	0.88	0.98	7(8)
8 A	3.4(4)	0.90	1.47	11(12)
120	3.45(25)	1.39	1.54	11(8)
8 G	3.8(5)	1.49	3.15 Q	23(15)
31	18.4(5)	29.42 D	67.81 D	494(17)

Table A6 – Cm-244 AL **assigned result 15.41(5) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
51	8.7(3)	–22.06 D	–9.86 D	–43.5(20)
25	13.4(15)	–1.36	–2.92 Q	–13(10)
88	13.7(5)	–3.62 Q	–2.51	–11(3)
28	13.8(6)	–2.97 Q	–2.41	–11(4)
90	13.8(14)	–1.13	–2.35	–10(9)
120	14.2(8)	–1.52	–1.84	–8(6)
61	14.2(4)	–3.37	–1.78	–7.9(23)
40	14.5(4)	–2.63 Q	–1.40	–6.2(23)
91	14.5(15)	–0.58	–1.27	–6(10)
123	14.7(7)	–1.01	–1.04	–5(5)
8	14.8(14)	–0.45	–0.90	–4(9)
59	15.0(12)	–0.38	–0.66	–3(8)
31	15.1(5)	–0.72	–0.46	–2(3)
35	15.2(6)	–0.27	–0.25	–1(4)
47	15.2(5)	–0.33	–0.25	–1(4)
13	15.4(8)	–0.01	–0.01	0(5)
119	15.5(10)	0.13	0.19	1(7)
121	15.7(3)	0.86	0.40	1.8(20)
26	16.3(3)	2.92 Q	1.26	5.6(19)
65	18.4(14)	2.17	4.41 Q	19(9)

Table A7 – Gross alpha AL **assigned result 72(7) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
42	43.9(8)	–4.23 D	–7.44 D	–39(6)
31	54(10)	–1.48	–4.74 Q	–25(16)
5	58(6)	–1.57	–3.66 Q	–19(11)
88	61(7)	–1.12	–2.75 Q	–14(12)
113	64(4)	–1.12	–2.19	–11(9)
121	66(3)	–0.84	–1.63	–8(9)
59	66(5)	–0.63	–1.42	–7(11)
123	71(4)	–0.12	–0.24	–1(10)
65	78(7)	0.67	1.71	9(14)
26	80.8(18)	1.35	2.44	13(11)
8	81.1(9)	1.43	2.52	13(11)
17	82(8)	0.94	2.62 Q	14(15)
119	130(0)	8.96 D	15.64 D	82(17)

Table A8 – Ra-226 AH **assigned result 15.90(21) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
35	10.2(6)	–8.95 D	–6.05 D	–36(4)
86	12.2(8)	–4.86 D	–3.97 D	–23(5)
8 A	14.3(20)	–0.81	–1.70	–10(12)
8 G	15.0(6)	–1.54	–0.96	–6(4)
38	15.3(8)	–0.73	–0.64	–4(5)
47	15.5(6)	–0.56	–0.38	–2(4)
32 G	15.7(3)	–0.61	–0.22	–1.3(22)
32 A	15.7(15)	–0.13	–0.21	–1(10)
123	16.4(18)	0.28	0.53	3(11)
115	17.0(11)	0.99	1.17	7(7)
31	17.5(20)	0.80	1.70	10(13)
106	17.6(8)	2.06	1.81	11(5)
1	18.5(11)	2.32	2.77 Q	16(7)
88	20.7(8)	6.02 D	5.11 D	30(5)

Table A9 – Np-237 AH **assigned result 4.84(5) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
47 M	4.3(4)	–1.27	–1.19	–11(9)
86	4.3(3)	–1.71	–1.19	–11(7)
1 A	4.40(20)	–2.13	–0.97	–9(5)
47 A	4.8(6)	–0.10	–0.13	–1(11)
55 G	5.0(9)	0.20	0.38	4(18)
1 G	5.3(5)	0.92	1.02	10(10)
8	5.3(8)	0.65	1.11	10(16)
32	5.35(8)	5.48 Q	1.14	10.6(20)
38	5.6(5)	1.52	1.69	16(10)
106	5.9(6)	1.87	2.24	21(11)
55 M	5.97(18)	6.08 Q	2.51	23(4)

Table A10 – Pu-238 AH **assigned result 16.63(5) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
35	10.3(5)	–14.24 D	–8.06 D	–38(3)
7	15.3(7)	–1.89	–1.70	–8(5)
55	15.3(6)	–2.13	–1.70	–8(4)
106	15.6(9)	–1.14	–1.31	–6(6)
41	15.6(8)	–1.35	–1.31	–6(5)
38	16.0(9)	–0.70	–0.80	–4(6)
32	16.5(4)	–0.28	–0.12	–0.6(21)
88	17.0(8)	0.47	0.48	2(5)
8	17.0(15)	0.25	0.48	2(9)
1	17.1(4)	1.17	0.61	2.8(24)
123	17.7(9)	1.19	1.37	6(6)

Table A11 – Pu-239/240 AH **assigned result 11.31(5) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
100	1.19(5)	–147.30 D	–18.26 D	–89.4(5)
88	9.6(5)	–3.49 D	–2.99 D	–15(4)
7	10.1(5)	–2.28	–2.08	–10(5)
47	10.4(6)	–1.45	–1.61	–8(6)
106	10.5(7)	–1.06	–1.36	–7(6)
55	10.5(5)	–1.72	–1.36	–7(4)
41	10.7(5)	–1.19	–0.99	–5(4)
38	10.9(6)	–0.58	–0.63	–3(6)
8	11.2(10)	–0.05	–0.09	0(9)
32	11.27(24)	0.09	0.04	0.2(22)
1	11.40(20)	0.74	0.28	1.4(18)
123	12.2(8)	1.19	1.73	8(7)
35	15.0(7)	5.91 D	6.89 D	34(6)

Table A12 – Am-241 AH **assigned result 5.356(10) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
47	3.23(20)	–10.62 D	–8.00 D	–40(4)
86	4.3(3)	–3.28 D	–3.82 D	–19(6)
38	4.7(4)	–1.64	–2.47	–12(8)
35	4.79(21)	–2.69 Q	–2.13	–11(4)
55 A	4.8(3)	–1.91	–2.13	–11(6)
123	5.0(6)	–0.59	–1.34	–7(11)
106	5.0(5)	–0.79	–1.30	–6(8)
55 G	5.24(12)	–0.93	–0.44	–2.2(23)
8 G	5.29(23)	–0.29	–0.25	–1(5)
8 A	5.3(6)	–0.12	–0.25	–1(10)
32 A	5.30(13)	–0.43	–0.21	–1.1(24)
1 A	5.3(3)	–0.19	–0.21	–1(6)
1 G	5.50(10)	1.43	0.54	2.7(19)
32 G	5.54(9)	2.03	0.69	3.4(17)
7	5.63(20)	1.37	1.03	5(4)
88	5.6(3)	1.01	1.07	5(5)
31	8.00(20)	13.20 D	9.94 D	49(4)

Table A13 – Cm-244 AH **assigned result 6.980(22) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
31	4.60(10)	–23.26 D	–6.82 D	–34.1(14)
8	5.4(6)	–2.80 D	–4.58 D	–23(8)
35	6.19(25)	–3.15 Q	–2.26	–11(4)
38	6.2(5)	–1.56	–2.23	–11(7)
123	6.2(6)	–1.30	–2.23	–11(9)
47	6.2(4)	–2.23	–2.18	–11(5)
55	6.5(4)	–1.19	–1.35	–7(6)
88	6.8(4)	–0.54	–0.52	–3(5)
32	6.96(16)	–0.12	–0.06	–0.3(23)
7	7.5(3)	1.88	1.40	7(4)
1	8.0(4)	2.55	2.92 Q	15(6)

Table A14 – Gross alpha AH **assigned result 8(3) × 10^{1} Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
31	54(6)	–0.92	–6.89 Q	–32(24)
113	59(3)	–0.73	–5.41 Q	–2(3) × 10^{1}
88	63(3)	–0.58	–4.28 Q	–2(3) × 10^{1}
41	67(3)	–0.42	–3.09 Q	–1(3) × 10^{1}
55	70(3)	–0.30	–2.23	–1(3) × 10^{1}
123	74.6(19)	–0.15	–1.09	–1(4) × 10^{1}
47	77(6)	–0.07	–0.50	0(4) × 10^{1}
1	78(6)	0.00	–0.03	0(4) × 10^{1}
8	93.7(10)	0.57	4.19 Q	2(4) × 10^{1}
7	115(7)	1.33	10.06 Q	5(5) × 10^{1}

Table A15 – H-3 B1 **assigned result 1.688(12) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
123	0.140(20)	–66.60 D	–15.59 D	–91.7(12)
35 D	1.57(6)	–1.87	–1.19	–7(4)
8	1.59(6)	–1.54	–0.99	–6(4)
4	1.62(17)	–0.40	–0.69	–4(10)
25	1.63(7)	–0.84	–0.58	–3(4)
32 C	1.65(11)	–0.34	–0.38	–2(7)
29 C	1.66(12)	–0.23	–0.28	–2(7)
55	1.67(12)	–0.15	–0.18	–1(8)
108	1.67(25)	–0.07	–0.18	–1(15)
35 C	1.68(9)	–0.09	–0.08	0(5)
38	1.70(10)	0.12	0.12	1(6)
107	1.70(10)	0.12	0.12	1(6)
59	1.70(10)	0.12	0.12	1(6)
32 D	1.71(6)	0.35	0.21	1(4)
28	1.71(8)	0.29	0.22	1(5)
13	1.72(15)	0.22	0.33	2(9)
65	1.73(7)	0.59	0.42	2(5)
5	1.7(3)	0.16	0.42	2(15)
29 D	1.73(5)	0.82	0.42	2(3)
78	1.732(23)	1.67	0.44	2.6(16)
7	1.81(15)	0.81	1.23	7(9)
95	1.89(8)	2.57	2.06	12(5)
106	1.92(8)	3.03 Q	2.38	14(5)

Table A16 – C-14 B1 **assigned result 0.905(6) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
123	0.590(20)	–15.22 D	–6.92 D	–34.8(22)
7	0.696(23)	–8.86 D	–4.59 D	–23(3)
13	0.81(5)	–2.13	–2.11	–11(5)
29	0.81(3)	–3.13 Q	–2.09	–11(4)
5	0.82(12) Q	–0.69	–1.87	–9(14)
107	0.83(5)	–1.48	–1.63	–8(6)
106	0.86(4)	–1.12	–0.99	–5(5)
108	0.86(13) Q	–0.35	–0.99	–5(14)
38	0.87(7)	–0.50	–0.78	–4(8)
16	0.92(5)	0.25	0.28	1(6)
65	0.95(5)	0.89	0.98	5(6)
25	0.96(6)	0.87	1.11	6(7)
55	0.96(3)	1.94	1.22	6(4)
95	0.96(6)	0.97	1.28	6(7)
35	0.97(5)	1.37	1.48	7(6)
32	1.01(3)	3.75 Q	2.19	11(3)
59	1.02(4)	2.84 Q	2.51	13(5)
28	1.05(5)	3.14 D	3.26 D	16(5)
78	1.146(19)	12.12 D	5.28 D	26.6(22)

Table A17 – Tc-99 B1 **assigned result 0.1562(4) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
35	0.128(9)	–3.12 D	–2.70 D	–18(6)
8 P	0.141(17)	–0.90	–1.46	–10(11)
8 M	0.144(14)	–0.84	–1.17	–8(9)
65	0.150(10)	–0.62	–0.59	–4(7)
38	0.150(10)	–0.62	–0.59	–4(7)
32	0.152(8)	–0.54	–0.44	–3(6)
107	0.152(16)	–0.27	–0.40	–3(10)
74	0.156(7)	–0.02	–0.02	0(5)
25	0.159(13)	0.22	0.27	2(8)
55 L	0.160(10)	0.40	0.37	2(6)
83	0.160(10)	0.38	0.37	2(7)
13	0.162(12)	0.49	0.56	4(8)
28	0.171(11)	1.35	1.42	9(7)
59	0.200(10)	4.38 D	4.21 D	28(7)
78	0.200(4)	11.84 D	4.25 D	28.3(24)
55 M	0.6(6) Q	0.75	45.51 Q	3(4) × 10^{2}

Table A18 – I-129 B1 **assigned result 0.1504(9) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
38	0.130(10)	–2.03	–1.84	–14(7)
78	0.135(5)	–3.08 Q	–1.39	–10(4)
59	0.140(10)	–1.03	–0.94	–7(7)
74	0.150(6)	–0.03	–0.02	0(4)
25	0.151(14)	0.04	0.06	0(9)
65	0.151(6)	0.11	0.06	0(4)
107	0.156(7)	0.81	0.51	4(5)
8	0.165(13)	1.17	1.32	10(8)
32	0.17(3)	0.50	1.32	10(19)
55	0.176(16)	1.58	2.32	17(11)

Table A19 – H-3 B2 **assigned result 1.389(15) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
40	0.133(4)	–79.45 D	–22.35 D	–90.4(4)
31	0.630(20)	–30.18 D	–13.50 D	–54.6(15)
123	0.65(4)	–17.26 D	–13.15 D	–53(3)
16	1.14(4)	–5.86 D	–4.46 D	–18(3)
55	1.14(11)	–2.34	–4.43 Q	–18(8)
90	1.180(24)	–7.34 D	–3.71 D	–15.0(20)
8	1.290(5)	–6.14 Q	–1.76	–7.1(11)
35	1.31(5)	–1.57	–1.49	–6(4)
32 C	1.33(9)	–0.68	–1.10	–4(7)
41	1.34(4)	–1.35	–0.87	–4(3)
119	1.341(21)	–1.84	–0.85	–3.4(18)
72	1.36(8)	–0.35	–0.51	–2(6)
19	1.36(5)	–0.55	–0.51	–2(4)
65	1.37(6)	–0.30	–0.33	–1(5)
25	1.39(6)	–0.04	–0.05	0(5)
38	1.40(10)	0.11	0.20	1(7)
5	1.40(21)	0.05	0.20	1(15)
122	1.41(7)	0.30	0.38	2(5)
106	1.42(6)	0.58	0.58	2(4)
32 D	1.45(5)	1.19	1.09	4(4)
91	1.47(15)	0.54	1.43	6(11)
120	1.472(20)	3.31 Q	1.48	6.0(19)
7	1.49(12)	0.84	1.80	7(9)
121	3.04(16)	10.27 D	29.39 D	119(12)

Table A20 – Fe-55 B2 **assigned result 1.53(3) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
31	0.6(4)	–2.76 D	–8.35 D	–58(21)
16	0.91(4)	–12.44 D	–5.81 D	–40(3)
7	1.11(24)	–1.73	–3.93 Q	–27(16)
55	1.28(10)	–2.29	–2.33	–16(7)
38	1.40(10)	–1.22	–1.20	–8(7)
121	1.40(10)	–1.26	–1.18	–8(7)
119	1.43(8)	–1.22	–0.92	–6(5)
32	1.44(9)	–0.92	–0.81	–6(6)
120	1.56(8)	0.39	0.32	2(6)
107	1.60(13)	0.58	0.72	5(9)
8	1.70(9)	1.82	1.63	11(6)
25	1.91(19)	1.99	3.60 Q	25(13)

Table A21 – Sr-89 B2 **assigned result 0.463(4) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
26	0.0600(22)	–85.78 D	–9.07 D	–87.0(5)
90	0.089(19)	–19.21 D	–8.42 D	–81(4)
55	0.20(11) Q	–2.32	–5.92 Q	–57(24)
40	0.35(6)	–1.84	–2.54	–24(13)
106	0.35(5)	–2.20	–2.49	–24(11)
38	0.380(10)	–7.63 Q	–1.86	–17.8(23)
120	0.40(4)	–1.94	–1.45	–14(7)
32	0.40(4)	–1.67	–1.36	–13(8)
7	0.420(20)	–2.08	–0.96	–9(5)
107	0.45(5)	–0.39	–0.37	–4(9)
91	0.50(8)	0.49	0.89	9(17)
74	0.512(21)	2.31	1.11	11(5)
8	0.52(5)	1.15	1.29	12(11)
61	0.86(15)	2.65 D	8.95 D	$9(4) \times 10^1$
114	21(9)	2.28	460.44 Q	$44(19) \times 10^2$

Table A22 – Sr-90 B2 **assigned result 1.153(10) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
90	0.233(23)	–36.68 D	–11.14 D	–79.8(20)
40	0.82(14)	–2.33	–4.03 Q	–29(12)
123	0.84(8)	–3.88 D	–3.79 D	–27(7)
91	1.02(14)	–0.97	–1.59	–11(12)
38	1.07(5)	–1.63	–1.01	–7(5)
74	1.07(4)	–2.01	–1.01	–7(4)
107	1.08(10)	–0.76	–0.88	–6(8)
25	1.10(8)	–0.62	–0.59	–4(7)
65	1.11(15)	–0.29	–0.52	–4(13)
32	1.13(8)	–0.31	–0.28	–2(7)
7	1.15(6)	–0.05	–0.04	0(6)
120	1.16(10)	0.11	0.13	1(8)
26	1.18(4)	0.86	0.35	3(3)
106	1.18(9)	0.36	0.37	3(8)
8 P	1.190(24)	1.41	0.45	3.2(23)
31	1.22(24)	0.28	0.81	6(21)
8 L	1.28(12)	1.04	1.54	11(11)
114	1.30(8)	1.92	1.75	13(7)
61	1.31(23)	0.68	1.90	14(20)
121	1.32(9)	1.95	2.02	14(8)
55	1.59(11)	4.07 D	5.29 D	38(9)
41	1.66(7)	7.58 D	6.14 D	44(6)

Table A23 – Gross beta B2

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
61 L	3.7(5)	–4.23 D	–7.02 D	–35(8)
113 (WL) P	3.85(18)	–9.99 D	–6.45 D	–32(4)
113 (W) P	1.95(9)	–8.98 D	–5.91 D	–30(4)
8	2.30(4)	–10.73 D	–3.39 D	–16.9(15)
121 P	2.560(20)	–8.40 Q	–1.51	–7.5(9)
123 P	2.63(12)	–1.15	–1.00	–5(5)
7 L	5.4(5)	–0.53	–0.93	–5(9)
65 P	2.7(3)	–0.23	–0.50	–2(11)
41 P	2.92(11)	1.36	1.09	5(4)
55 Geiger	3.14(22)	1.68	2.68 Q	13(8)
31 P	3.74(25)	3.88 D	7.02 D	35(9)

Assigned results 2.769(15) Bq g^{-1} (ISO 9697:2008) and 5.68(4) Bq g^{-1} (LSC and window less gas-flow proportional counting)

Table A24 – Co-60 GL **assigned result 5.035(12) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
100	4.50(20)	–2.67 Q	–1.97	–11(4)
82	4.5(5)	–1.12	–1.94	–10(9)
110	4.68(25)	–1.42	–1.31	–7(5)
72	4.7(3)	–1.23	–1.27	–7(6)
124	4.69(19)	–1.81	–1.27	–7(4)
26	4.75(21)	–1.35	–1.05	–6(4)
86	4.8(6)	–0.48	–0.94	–5(11)
27	4.8(5)	–0.47	–0.87	–5(10)
18	4.80(20)	–1.17	–0.87	–5(4)
35	4.8(4)	–0.59	–0.83	–4(8)
46	4.82(20)	–1.07	–0.79	–4(4)
62	4.8(5)	–0.45	–0.76	–4(9)
23	4.9(4)	–0.34	–0.50	–3(8)
29	4.9(5)	–0.27	–0.50	–3(10)
25	4.91(14)	–0.89	–0.46	–2(3)
41	5.0(4)	–0.23	–0.31	–2(8)
74	4.95(16)	–0.53	–0.31	–2(4)
111	4.99(17)	–0.26	–0.17	–1(4)
58	5.02(18)	–0.08	–0.05	0(4)
114	5.07(18)	0.20	0.13	1(4)
121	5.08(7)	0.64	0.17	0.9(14)
88	5.10(24)	0.27	0.24	1(5)
119	5.10(16)	0.41	0.24	1(4)
28	5.1(3)	0.22	0.24	1(6)
53	5.14(25)	0.42	0.39	2(5)
61	5.17(13)	1.04	0.50	3(3)
123	5.17(21)	0.64	0.50	3(4)
47	5.2(4)	0.44	0.57	3(7)
39	5.2(3)	0.55	0.61	3(6)
42	5.2(6)	0.37	0.76	4(11)
51	5.24(21)	0.98	0.76	4(4)
65	5.24(19)	1.08	0.76	4(4)
19	5.2(4)	0.50	0.76	4(8)

continues

continued				
	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
76	5.27(24)	0.98	0.87	5(5)
117	5.3(4)	0.76	0.98	5(7)
89	5.3(3)	0.88	0.98	5(6)
122	5.4(3)	1.09	1.16	6(6)
95	5.39(25)	1.42	1.31	7(5)
91	5.5(4)	1.22	1.53	8(7)
10	5.5(8)	0.52	1.57	8(16)
8	5.59(24)	2.31	2.05	11(5)
17	5.7(5)	1.23	2.27	12(10)
15	5.66(17)	3.67 Q	2.31	12(4)
126	5.7(15) Q	0.43	2.42	1(3) × 10^{1}
5	6.0(6)	1.61	3.56 Q	19(12)
40	6.59(19)	8.17 D	5.74 D	31(4)
59	6.8(5)	3.39 D	6.52 D	35(10)
31	7.0(7)	2.82 D	7.18 D	39(14)

Table A25 – Zn-65 GL **assigned result 5.50(4) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
100	4.30(20)	–5.90 D	–3.00 D	–22(4)
89	4.4(4)	–3.24 D	–2.85 D	–21(7)
82	4.7(5)	–1.66	–2.00	–15(9)
47	4.7(5)	–1.64	–1.93	–14(9)
114	5.0(3)	–1.82	–1.38	–10(6)
29	5.1(5)	–0.80	–1.00	–7(9)
86	5.1(3)	–1.53	–1.00	–7(5)
40	5.1(18) Q	–0.21	–0.93	–1(4) × 10^{1}
124	5.2(4)	–0.78	–0.80	–6(8)
18	5.20(20)	–1.48	–0.75	–5(4)
110	5.2(3)	–0.96	–0.70	–5(6)
10	5.2(9)	–0.29	–0.68	–5(17)
42	5.2(6)	–0.44	–0.65	–5(11)
19	5.3(6)	–0.44	–0.60	–4(10)
62	5.3(6)	–0.34	–0.45	–3(10)
46	5.36(23)	–0.61	–0.35	–3(5)
76	5.4(4)	–0.22	–0.23	–2(8)
28	5.4(4)	–0.14	–0.15	–1(8)
35	5.5(9)	–0.05	–0.10	–1(15)
58	5.53(21)	0.14	0.07	1(4)
26	5.5(4)	0.11	0.10	1(6)
65	5.55(21)	0.23	0.12	1(4)
74	5.56(21)	0.28	0.15	1(4)
17	5.6(7)	0.11	0.20	1(13)
25	5.6(4)	0.22	0.22	2(7)
5	5.6(17) Q	0.08	0.32	0(3) × 10^{1}
95	5.7(5)	0.43	0.47	3(8)
23	5.7(7)	0.28	0.50	4(13)
15	5.81(23)	1.32	0.77	6(5)
53	5.8(4)	1.05	0.85	6(6)
88	5.8(3)	1.20	0.85	6(5)
123	5.9(3)	1.23	0.87	6(5)
121	5.86(12)	2.85 Q	0.90	6.5(23)

continues

continued				
	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
41	5.9(9)	0.44	0.95	7(16)
72	5.9(4)	1.10	1.00	7(7)
27	5.9(6)	0.66	1.00	7(11)
119	5.9(3)	1.28	1.00	7(6)
59	5.9(15)	0.28	1.05	$1(3) \times 10^1$
39	6.2(5)	1.39	1.75	13(9)
122	6.2(4)	1.86	1.77	13(7)
51	6.2(3)	2.77 Q	1.82	13(5)
61	6.27(20)	3.78 Q	1.92	14(4)
91	6.3(4)	1.94	2.00	15(8)
8	6.5(4)	2.46	2.47	18(7)
117	6.7(5)	2.41	2.99 Q	22(9)
126	7.5(21) Q	0.92	4.89 Q	$4(4) \times 10^1$

Table A26 – Sr-85 GL **assigned result 7.01(5) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
17	3.2(3)	–12.50 D	–10.18 D	–54(5)
100	6.40(20)	–2.96 Q	–1.63	–9(3)
121	6.43(11)	–4.82 Q	–1.55	–8.3(17)
18	6.5(3)	–1.68	–1.36	–7(5)
47	6.6(5)	–0.97	–1.15	–6(7)
74	6.64(25)	–1.45	–0.99	–5(4)
110	6.8(4)	–0.69	–0.67	–4(5)
65	6.8(3)	–0.84	–0.64	–3(4)
10	6.8(8)	–0.22	–0.45	–2(11)
40	6.8(9)	–0.19	–0.45	–2(12)
25	6.9(4)	–0.23	–0.24	–1(6)
46	6.92(25)	–0.35	–0.24	–1(4)
62	7.0(3)	–0.17	–0.13	–1(4)
124	7.0(3)	-0.10	–0.08	0(4)
19	7.0(5)	–0.06	–0.08	0(7)
95	7.1(3)	0.18	0.14	1(4)
58	7.1(3)	0.21	0.16	1(4)
72	7.1(4)	0.17	0.19	1(6)
89	7.2(5)	0.34	0.40	2(7)
35	7.2(5)	0.36	0.46	2(7)
61	7.18(18)	0.92	0.46	2(3)
23	7.2(7)	0.27	0.51	3(10)
53	7.2(4)	0.62	0.54	3(5)
26	7.3(5)	0.52	0.67	4(7)
29	7.3(6)	0.48	0.78	4(9)
111	7.32(22)	1.38	0.83	4(4)
88	7.4(3)	1.29	1.05	6(5)
28	7.4(4)	1.10	1.13	6(6)
41	7.4(4)	1.15	1.15	6(6)
5	7.5(8)	0.60	1.21	6(11)
122	7.5(4)	1.27	1.37	7(6)
91	7.6(6)	1.02	1.48	8(8)
42	7.6(8)	0.75	1.58	8(11)

continues

continued				
	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
119	7.6(4)	1.63	1.58	8(5)
86	7.7(5)	1.41	1.82	10(7)
123	7.9(4)	2.59 Q	2.39	13(5)
114	8.0(5)	1.88	2.63 Q	14(8)
15	8.07(24)	4.33 D	2.84 D	15(4)
8	8.1(5)	2.11	2.95 Q	16(8)
82	8.1(8)	1.35	2.98 Q	16(12)
76	8.3(4)	3.76 D	3.46 D	18(5)
27	8.4(3)	4.58 D	3.73 D	20(5)
117	8.7(7)	2.36	4.53 Q	24(10)
51	9.1(4)	5.50 D	5.49 D	29(6)
126	9.2(25) Q	0.86	5.79 Q	3(4) × 10^1
59	9.4(8)	2.97 D	6.38 D	34(11)
39	10.2(11)	2.90 D	8.55 D	46(16)

Table A27 – Sb-125 GL **assigned result 1.366(7) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
86	0.96(15)	–2.70 Q	–2.26	–30(11)
25	1.1(3)	–1.17	–1.76	–23(20)
121	1.13(8)	–2.94 Q	–1.31	–17(6)
95	1.20(21)	–0.79	–0.92	–12(15)
82	1.22(17)	–0.86	–0.81	–11(12)
58	1.23(6)	–2.25	–0.76	–10(5)
28	1.3(4)	–0.16	–0.37	0(3) × 10^{1}
29	1.3(3)	–0.22	–0.37	–5(22)
122	1.30(19)	–0.35	–0.37	–5(14)
65	1.31(6)	–0.92	–0.31	–4(5)
18	1.32(6)	–0.76	–0.25	–3(5)
19	1.3(4)	–0.12	–0.25	0(3) × 10^{1}
42	1.34(20)	–0.13	–0.14	–2(15)
114	1.4(3)	–0.06	–0.09	–1(19)
61	1.36(11)	–0.05	–0.03	0(8)
23	1.4(5)	0.07	0.19	0(4) × 10^{1}
119	1.40(11)	0.31	0.19	3(8)
123	1.40(20)	0.17	0.19	3(15)
91	1.46(18)	0.52	0.53	7(13)
53	1.48(13)	0.88	0.64	8(10)
117	1.50(12)	1.08	0.75	10(9)
46	1.55(15)	1.23	1.03	13(11)
89	1.56(23)	0.84	1.08	14(17)
110	1.58(18)	1.19	1.20	16(13)
51	1.59(10)	2.24	1.25	16(7)
26	1.62(15)	1.69	1.42	19(11)
15	1.68(17)	1.85	1.75	23(12)
39	1.70(20)	1.67	1.86	24(15)
72	1.71(16)	2.15	1.92	25(12)
126	1.7(7) Q	0.55	1.98	3(5) × 10^{1}
10	1.9(8)	0.63	2.92 Q	4(6) × 10^{1}
27	2.3(5)	1.87	5.21 Q	7(4) × 10^{1}

Table A28 – Ba-133 GL **assigned result 3.571(25) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
100	2.70(10)	–8.45 D	–3.31 D	–24(3)
62	3.1(3)	–1.67	–1.79	–13(8)
18	3.10(10)	–4.57 Q	–1.79	–13(3)
114	3.14(21)	–2.04	–1.64	–12(6)
76	3.16(14)	–2.89 Q	–1.56	–12(4)
28	3.21(20)	–1.79	–1.37	–10(6)
110	3.26(18)	–1.71	–1.18	–9(5)
19	3.3(3)	–1.07	–1.14	–8(8)
46	3.28(15)	–1.91	–1.10	–8(4)
88	3.30(20)	–1.34	–1.03	–8(6)
40	3.3(8)	–0.32	–0.95	–7(22)
42	3.3(4)	–0.71	–0.95	–7(10)
124	3.34(20)	–1.14	–0.88	–6(6)
86	3.4(5)	–0.51	–0.84	–6(12)
111	3.38(12)	–1.56	–0.72	–5(4)
121	3.39(25)	–0.72	–0.69	–5(7)
27	3.4(3)	–0.57	–0.65	–5(9)
119	3.40(15)	–1.12	–0.65	–5(5)
126	3.4(9)	–0.16	–0.57	$0(3) \times 10^{1}$
17	3.4(8)	–0.16	–0.50	–4(23)
53	3.45(19)	–0.63	–0.46	–3(6)
74	3.45(12)	–0.99	–0.46	–3(4)
58	3.46(13)	–0.84	–0.42	–3(4)
41	3.5(4)	–0.29	–0.38	–3(10)
82	3.5(4)	–0.27	–0.38	–3(10)
10	3.5(6)	–0.14	–0.34	–3(18)
95	3.5(4)	–0.24	–0.31	–2(10)
47	3.5(3)	–0.31	–0.31	–2(7)
29	3.5(3)	–0.23	–0.27	–2(9)
8	3.5(4)	–0.15	–0.19	–1(9)
89	3.6(4)	–0.06	–0.08	–1(10)
65	3.57(13)	–0.01	0.00	0(4)
72	3.60(23)	0.13	0.11	1(7)

continues

continued				
	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
61	3.61(18)	0.22	0.15	1(5)
122	3.6(3)	0.14	0.15	1(8)
23	3.7(5)	0.26	0.49	4(14)
15	3.70(13)	0.98	0.49	4(4)
123	3.7(3)	0.51	0.53	4(8)
26	3.76(16)	1.17	0.72	5(5)
5	3.8(4)	0.50	0.72	5(11)
51	3.78(18)	1.15	0.79	6(5)
35	3.8(5)	0.45	0.79	6(13)
25	3.8(3)	0.92	0.95	7(8)
91	3.9(3)	0.99	1.17	9(9)
117	4.0(3)	1.64	1.63	12(7)
39	4.2(5)	1.26	2.39	18(14)
59	5.0(7)	2.00	5.47 Q	40(20)

Table A29 – Cs-134 GL **assigned result 14.02(10) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
26	1.3(4)	–29.37 D	–16.99 D	–90(3)
100	10.50(20)	–15.74 D	–4.72 D	–25.1(15)
41	11.7(7)	–3.52 D	–3.15 D	–17(5)
27	12.0(10)	–2.01	–2.71 Q	–14(7)
19	12.5(7)	–2.12	–2.09	–11(5)
28	12.5(6)	–2.54	–2.04	–11(5)
89	12.5(7)	–2.15	–2.04	–11(5)
124	12.6(4)	–4.04 Q	–1.92	–10.2(25)
82	12.6(13)	–1.09	–1.91	–10(9)
111	12.6(4)	–3.71 Q	–1.91	–10(3)
61	12.6(3)	–4.78 Q	–1.91	–10.1(21)
35	12.6(7)	–2.01	–1.85	–10(5)
119	12.70(19)	–6.16 Q	–1.77	–9.4(15)
18	12.7(5)	–2.59 Q	–1.77	–9(4)
95	12.9(3)	–3.90 Q	–1.50	–8.0(20)
88	12.9(6)	–1.85	–1.50	–8(5)
62	12.9(3)	–3.66 Q	–1.50	–8.0(22)
17	12.9(9)	–1.23	–1.46	–8(7)
29	13.0(10)	–1.02	–1.37	–7(7)
121	13.0(7)	–1.36	–1.34	–7(5)
10	13.1(14)	–0.67	–1.22	–7(10)
91	13.2(10)	–0.81	–1.12	–6(7)
117	13.2(9)	–0.97	–1.10	–6(6)
118	13.2(6)	–1.30	–1.06	–6(5)
110	13.3(7)	–1.12	–1.04	–6(5)
72	13.3(8)	–0.96	–0.98	–5(6)
83	13.3(5)	–1.42	–0.97	–5(4)
53	13.3(6)	–1.27	–0.97	–5(4)
46	13.3(7)	–0.95	–0.91	–5(5)
42	13.4(14)	–0.47	–0.87	–5(10)
47	13.4(8)	–0.72	–0.79	–4(6)
74	13.50(16)	–2.77 Q	–0.70	–3.7(13)
86	13.6(15)	–0.28	–0.57	–3(11)

continues

continued				
	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
23	13.6(17)	–0.25	–0.57	–3(12)
15	13.7(4)	–0.86	–0.43	–2(3)
76	13.7(4)	–0.94	–0.43	–2.3(25)
58	13.8(5)	–0.53	–0.37	–2(4)
114	14.0(5)	–0.03	–0.02	0(4)
126	14(4) Q	0.01	0.05	$0(3) \times 10^1$
25	14.1(11)	0.04	0.06	0(8)
65	14.2(5)	0.29	0.20	1(4)
40	14.3(10)	0.27	0.37	2(8)
123	14.4(6)	0.67	0.52	3(4)
39	14.7(15)	0.45	0.91	5(11)
122	14.8(11)	0.71	1.03	5(8)
51	14.9(5)	1.72	1.18	6(4)
5	15.0(15)	0.68	1.36	7(11)
59	15.0(8)	1.26	1.36	7(6)
8	15.1(6)	1.80	1.44	8(5)

Table A30 – Cs-137 GL **assigned result 4.47(3) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
89	4.10(25)	–1.49	–1.36	–8(6)
74	4.1(5)	–0.78	–1.36	–8(11)
41	4.2(6)	–0.43	–0.89	–5(13)
110	4.26(22)	–0.97	–0.78	–5(5)
62	4.3(3)	–0.74	–0.71	–4(6)
29	4.3(4)	–0.44	–0.63	–4(9)
18	4.30(20)	–0.86	–0.63	–4(5)
119	4.30(12)	–1.41	–0.63	–4(3)
100	4.30(20)	–0.86	–0.63	–4(5)
121	4.34(10)	–1.29	–0.49	–3.0(23)
10	4.4(6)	–0.17	–0.38	–2(13)
26	4.39(21)	–0.40	–0.31	–2(5)
39	4.4(3)	–0.25	–0.27	–2(7)
40	4.4(6)	–0.11	–0.23	–1(13)
118	4.4(5)	–0.08	–0.13	–1(10)
58	4.44(17)	–0.20	–0.13	–1(4)
95	4.5(3)	0.17	0.17	1(6)
25	4.6(3)	0.35	0.35	2(6)
65	4.57(17)	0.55	0.35	2(4)
72	4.6(3)	0.42	0.46	3(7)
23	4.6(5)	0.25	0.46	3(11)
88	4.60(20)	0.62	0.46	3(5)
114	4.60(24)	0.52	0.46	3(6)
86	4.62(21)	0.69	0.53	3(5)
46	4.63(18)	0.85	0.56	3(4)
82	4.6(5)	0.34	0.60	4(11)
19	4.7(4)	0.54	0.67	4(8)
5	4.7(5)	0.46	0.78	5(11)
27	4.7(5)	0.45	0.82	5(11)
83	4.7(5)	0.45	0.82	5(11)
28	4.7(4)	0.72	0.89	5(8)
123	4.73(21)	1.20	0.93	6(5)
35	4.7(4)	0.66	0.96	6(9)

continues

continued				
	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
53	4.75(21)	1.30	1.00	6(5)
61	4.77(15)	1.93	1.07	7(4)
111	4.78(16)	1.87	1.11	7(4)
47	4.8(4)	1.04	1.25	8(8)
124	4.84(23)	1.57	1.33	8(5)
51	4.88(18)	2.22	1.47	9(4)
8	4.9(4)	1.29	1.51	9(7)
17	4.9(8)	0.54	1.58	10(18)
122	5.0(3)	1.69	1.73	11(7)
91	5.0(3)	1.65	1.87	12(7)
42	5.0(6)	0.99	1.91	12(12)
15	5.08(16)	3.72 Q	2.20	14(4)
117	5.4(5)	2.16	3.36 Q	21(10)
76	5.41(24)	3.87 D	3.40 D	21(6)
126	5.5(15)	0.69	3.76 Q	$2(4) \times 10^1$
59	6.0(6)	2.51	5.65 Q	35(14)
31	9.6(11)	4.66 D	18.61 D	115(25)

Table A31 – Eu-152 GL **assigned result 1.789(12) Bq kg^{-1}**

	Result (Bq kg^{-1})	Zeta score	*z*-score	Deviation (%)
117	1.40(10)	–3.99 Q	–2.17	–22(6)
114	1.46(18)	–1.82	–1.84	–18(10)
76	1.57(13)	–1.68	–1.22	–12(7)
18	1.60(7)	–2.66 Q	–1.06	–11(4)
61	1.63(9)	–1.75	–0.89	–9(5)
19	1.63(20)	–0.79	–0.89	–9(11)
121	1.64(12)	–1.23	–0.83	–8(7)
89	1.69(16)	–0.62	–0.55	–6(9)
119	1.70(8)	–1.10	–0.50	–5(5)
58	1.72(8)	–0.85	–0.39	–4(5)
28	1.7(3)	–0.26	–0.39	–4(15)
124	1.73(14)	–0.42	–0.33	–3(8)
26	1.73(11)	–0.53	–0.33	–3(6)
95	1.73(21)	–0.28	–0.33	–3(12)
46	1.74(16)	–0.30	–0.27	–3(9)
86	1.74(23)	–0.21	–0.27	–3(13)
53	1.78(14)	–0.06	–0.05	0(8)
91	1.79(19)	0.01	0.01	0(11)
74	1.82(12)	0.26	0.17	2(7)
126	1.9(6) Q	0.11	0.34	0(4) × 10^{1}
42	1.87(22)	0.37	0.45	5(12)
123	1.88(13)	0.70	0.51	5(7)
110	1.89(15)	0.67	0.56	6(9)
29	1.90(20)	0.55	0.62	6(11)
88	1.90(20)	0.55	0.62	6(11)
51	1.90(10)	1.10	0.62	6(6)
65	1.94(8)	1.87	0.84	8(5)
8	2.0(6)	0.34	1.07	1(4) × 10^{1}
72	1.99(20)	1.00	1.12	11(11)
23	2.0(6) Q	0.35	1.18	1(4) × 10^{1}
39	2.00(20)	1.05	1.18	12(11)
10	2.1(6)	0.49	1.52	2(3) × 10^{1}
15	2.16(13)	2.84 Q	2.07	21(7)

continues

continued				
	Result (Bq kg^{-1})	Zeta score	z-score	Deviation (%)
25	2.2(3)	1.43	2.24	22(16)
82	2.3(4)	1.53	2.74 Q	27(18)
100	2.30(10)	5.07 D	2.86 D	29(6)
5	2.5(3)	2.37	3.97 Q	40(17)
17	2.6(7)	1.18	4.70 Q	$5(4) \times 10^1$
27	3.6(4)	4.53 D	10.12 D	101(22)

Table A32 – Co-60 GH **assigned result 5.418(12) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
7	0.0071(20)	–445.45 D	–25.11 D	–99.87(4)
124	1.16(3)	–131.80 D	–19.76 D	–78.6(6)
116	4.6(11)	–7.39 D	–3.80 D	–15.1(20)
100	4.82(4)	–14.32 D	–2.77 D	–11.0(8)
76	4.83(14)	–4.18 D	–2.73 D	–11(3)
93	4.84(17)	–3.39 D	–2.68 D	–11(3)
86	4.9(6)	–0.98	–2.40	–10(10)
45	5.16(18)	–1.43	–1.20	–5(4)
17	5.2(21)	–1.04	–1.01	–4(4)
88	5.25(23)	–0.73	–0.78	–3(5)
25	5.26(25)	–0.63	–0.73	–3(5)
15	5.27(13)	–1.13	–0.69	–2.7(24)
18	5.28(21)	–0.66	–0.64	–3(4)
48	5.33(10)	–0.87	–0.41	–1.6(19)
13	5.3(3)	–0.29	–0.36	–1(5)
46	5.34(18)	–0.43	–0.36	–1(4)
120	5.38(7)	–0.53	–0.18	–0.7(13)
8	5.40(10)	–0.18	–0.08	–0.3(19)
108	5.41(24)	–0.03	–0.04	0(5)
32	5.42(14)	0.02	0.01	0(3)
89	5.4(3)	0.01	0.01	0(6)
38	5.44(14)	0.16	0.10	0(3)
5	5.4(6)	0.04	0.10	0(10)
28	5.47(25)	0.21	0.24	1(5)
10	5.5(5)	0.10	0.24	1(9)
35	5.48(16)	0.39	0.29	1(3)
123	5.49(16)	0.45	0.34	1(3)
27	5.5(6)	0.14	0.38	2(11)
55	5.51(15)	0.61	0.43	2(3)
59	5.6(4)	0.48	0.71	3(6)
104	5.59(10)	1.71	0.80	3.2(19)
31	5.6(4)	0.67	1.03	4(6)
77	5.7(4)	0.83	1.31	5(6)

continues

continued				
	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
117	5.7(4)	0.79	1.36	5(7)
47	5.8(3)	1.21	1.68	7(6)
82	6.0(6)	0.99	2.75 Q	11(11)
16	6.09(5)	13.07 D	3.12 D	12.4(10)
58	6.72(24)	5.42 D	6.04 D	24(5)
126	6.8(18) Q	0.79	6.51 Q	$3(4) \times 10^1$

Table A33 – Zn-65 GH **assigned result 5.92(4) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
124	1.32(3)	–90.95 D	–19.74 D	–77.7(6)
116	4.93(13)	–7.26 D	–4.25 D	–16.7(23)
86	5.27(23)	–2.78 D	–2.79 D	–11(4)
7	5.3(3)	–2.11	–2.74 Q	–11(5)
100	5.47(6)	–6.20 Q	–1.93	–7.6(12)
45	5.52(19)	–2.06	–1.71	–7(4)
18	5.59(22)	–1.47	–1.41	–6(4)
93	5.60(20)	–1.57	–1.37	–5(4)
76	5.80(23)	–0.51	–0.51	–2(4)
46	5.80(20)	–0.59	–0.51	–2(4)
48	5.84(14)	–0.55	–0.34	–1.3(25)
25	5.8(3)	–0.29	–0.34	–1(5)
88	5.84(23)	–0.34	–0.34	–1(4)
15	5.85(14)	–0.48	–0.30	–1.2(25)
32	5.91(17)	–0.06	–0.04	0(3)
123	5.91(17)	–0.06	–0.04	0(3)
38	6.00(16)	0.49	0.34	1(3)
13	6.0(4)	0.34	0.47	2(6)
10	6.1(6)	0.23	0.60	2(10)
47	6.1(4)	0.45	0.65	3(6)
59	6.1(4)	0.42	0.65	3(6)
17	6.1(3)	0.55	0.69	3(5)
104	6.08(9)	1.62	0.69	2.7(17)
108	6.1(3)	0.59	0.69	3(5)
89	6.2(4)	0.78	1.12	4(6)
5	6.2(6)	0.50	1.33	5(10)
28	6.3(3)	1.26	1.59	6(5)
120	6.34(9)	4.26 Q	1.80	7.1(17)
35	6.41(20)	2.40	2.10	8(4)
77	6.4(4)	1.30	2.19	9(7)
82	6.7(7)	1.10	3.18 Q	13(11)
27	6.7(7)	1.11	3.35 Q	13(12)
55	7.02(24)	4.52 D	4.72 D	19(4)

continues

continued				
	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
16	7.08(10)	10.75 D	4.98 D	19.6(19)
58	7.2(3)	4.58 D	5.37 D	21(5)
8	7.20(11)	10.92 D	5.49 D	21.6(20)
117	7.4(6)	2.59 D	6.14 D	24(9)
126	8.1(21) Q	1.03	9.44 Q	$4(4) \times 10^1$

Table A34 – Sr-85 GH **assigned result 7.54(5) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
124	1.60(4)	–91.11 D	–18.70 D	–78.8(6)
116	2.20(4)	–81.91 D	–16.81 D	–70.8(6)
100	6.66(10)	–7.85 D	–2.78 D	–11.7(15)
45	7.0(3)	–1.79	–1.77	–7(4)
88	7.1(3)	–1.39	–1.33	–6(4)
86	7.2(5)	–0.77	–1.08	–5(6)
25	7.2(4)	–1.00	–1.05	–4(5)
55	7.24(25)	–1.19	–0.95	–4(4)
89	7.3(5)	–0.47	–0.64	–3(6)
120	7.43(11)	–0.93	–0.35	–1.5(16)
17	7.4(4)	–0.29	–0.32	–1(5)
32	7.44(14)	–0.69	–0.32	–1.4(20)
48	7.45(14)	–0.62	–0.29	–1.2(20)
46	7.5(3)	–0.20	–0.17	–1(4)
93	7.5(3)	–0.19	–0.17	–1(4)
76	7.5(7)	0.00	–0.01	0(9)
35	7.56(23)	0.07	0.05	0(3)
28	7.6(4)	0.05	0.05	0(5)
13	7.6(4)	0.11	0.15	1(6)
47	7.6(4)	0.12	0.15	1(5)
77	7.6(5)	0.17	0.24	1(6)
5	7.7(8)	0.14	0.34	1(10)
10	7.7(7)	0.18	0.40	2(10)
15	7.68(19)	0.70	0.43	2(3)
108	7.7(4)	0.42	0.46	2(5)
59	7.8(5)	0.52	0.75	3(6)
18	7.8(3)	0.85	0.81	3(4)
38	7.82(22)	1.23	0.87	4(3)
104	7.84(10)	2.64 Q	0.94	3.9(15)
123	8.0(3)	1.39	1.38	6(4)
8	8.1(4)	1.35	1.63	7(5)
16	8.34(8)	8.38 Q	2.51	10.6(13)
117	8.6(7)	1.50	3.30 Q	14(9)

continues

continued				
	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
82	8.7(9)	1.36	3.77 Q	16(12)
58	9.1(4)	4.62 D	4.99 D	21(5)
126	9.6(25) Q	0.82	6.57 Q	$3(4) \times 10^1$
27	10.2(4)	6.59 D	8.36 D	35(6)

Table A35 – Sb-125 GH **assigned result 1.470(7) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
100	1.210(20)	–12.20 D	–3.43 D	–17.7(14)
116	1.25(6)	–3.63 D	–2.90 D	–15(4)
86	1.31(14)	–1.14	–2.11	–11(10)
117	1.35(9)	–1.36	–1.58	–8(6)
45	1.36(7)	–1.56	–1.45	–7(5)
88	1.38(6)	–1.48	–1.18	–6(4)
93	1.38(5)	–1.77	–1.18	–6(4)
108	1.39(7)	–1.13	–1.05	–5(5)
13	1.39(9)	–0.88	–1.05	–5(6)
120	1.39(3)	–2.58 Q	–1.05	–5.4(21)
47	1.41(8)	–0.74	–0.79	–4(6)
5	1.42(14)	–0.35	–0.66	–3(10)
35	1.42(6)	–0.82	–0.66	–3(4)
76	1.43(3)	–1.28	–0.52	–2.7(21)
17	1.43(8)	–0.49	–0.52	–3(6)
18	1.44(7)	–0.42	–0.39	–2(5)
28	1.44(7)	–0.42	–0.39	–2(5)
89	1.45(14)	–0.14	–0.26	–1(10)
59	1.46(10)	–0.10	–0.13	–1(7)
46	1.47(6)	0.01	0.01	0(4)
32	1.48(14)	0.07	0.14	1(10)
15	1.49(4)	0.55	0.30	2(3)
27	1.5(3)	0.10	0.40	2(20)
55	1.50(16)	0.19	0.40	2(11)
77	1.51(11)	0.37	0.53	3(8)
25	1.51(8)	0.50	0.53	3(6)
10	1.51(14)	0.29	0.53	3(10)
123	1.52(8)	0.63	0.67	3(6)
8	1.53(7)	0.86	0.80	4(5)
38	1.53(6)	1.00	0.80	4(4)
48	1.55(11)	0.73	1.06	5(8)
104	1.56(8)	1.13	1.20	6(6)
16	1.66(7)	2.71 Q	2.52	13(5)

continues

continued				
	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
82	1.67(17)	1.18	2.65 Q	14(12)
58	1.75(6)	4.64 D	3.71 D	19(4)
126	1.8(5) Q	0.61	3.71 Q	$2(3) \times 10^1$
7	6.2(3)	15.76 D	62.54 D	322(21)

Table A36 – Ba-133 GH **assigned result 3.84(3) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
124	0.80(3)	–76.28 D	–17.28 D	–79.2(8)
7	1.43(8)	–28.65 D	–13.70 D	–62.8(21)
116	3.01(5)	–14.74 D	–4.73 D	–21.7(14)
100	3.12(8)	–8.58 D	–4.10 D	–18.8(22)
15	3.14(8)	–8.34 D	–3.99 D	–18.3(22)
93	3.24(11)	–5.33 D	–3.42 D	–16(3)
45	3.28(20)	–2.79 D	–3.19 D	–15(5)
108	3.37(15)	–3.10 D	–2.68 D	–12(4)
28	3.38(16)	–2.85 D	–2.63 D	–12(5)
82	3.4(4)	–1.27	–2.46	–11(9)
76	3.46(6)	–5.84 Q	–2.17	–10.0(17)
88	3.50(15)	–2.25	–1.94	–9(4)
5	3.5(4)	–0.98	–1.94	–9(9)
86	3.5(4)	–0.80	–1.77	–8(10)
8	3.60(12)	–1.97	–1.38	–6(4)
10	3.7(4)	–0.46	–0.92	–4(9)
13	3.69(24)	–0.63	–0.87	–4(6)
120	3.70(5)	–2.52	–0.81	–3.7(15)
77	3.70(24)	–0.59	–0.81	–4(6)
18	3.71(13)	–1.00	–0.75	–3(4)
55	3.74(20)	–0.51	–0.58	–3(5)
25	3.75(18)	–0.51	–0.52	–2(5)
38	3.80(10)	–0.41	–0.24	–1(3)
48	3.85(8)	0.09	0.04	0.2(22)
46	3.86(14)	0.12	0.10	0(4)
32	3.88(10)	0.36	0.21	1(3)
17	3.88(16)	0.23	0.21	1(5)
47	3.90(20)	0.29	0.33	2(6)
27	3.9(4)	0.14	0.33	2(10)
59	3.95(23)	0.46	0.61	3(6)
35	3.97(13)	0.96	0.72	3(4)
89	4.0(4)	0.35	0.78	4(10)
126	4.0(10) Q	0.14	0.84	0(3) × 10^{1}
123	4.03(19)	0.98	1.07	5(5)
continues				

continued				
	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
16	4.0(3)	0.68	1.12	5(8)
117	4.1(3)	1.08	1.63	7(7)
104	4.14(14)	2.09	1.69	8(4)
58	4.55(17)	4.11 D	4.02 D	18(5)

Table A37 – Cs-134 GH **assigned result 15.09(11) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
16	1.45(20)	–125.40 D	–21.84 D	–90.4(15)
124	2.95(6)	–99.02 D	–19.44 D	–80.4(5)
7	3.44(20)	–51.37 D	–18.66 D	–77.2(13)
76	11.9(3)	–11.35 D	–5.11 D	–21.1(18)
100	11.98(6)	–25.36 D	–4.98 D	–20.6(7)
116	12.1(3)	–10.14 D	–4.87 D	–20.1(19)
93	12.7(5)	–5.32 D	–3.86 D	–16(3)
28	13.0(6)	–3.45 D	–3.31 D	–14(4)
120	13.10(15)	–10.80 D	–3.19 D	–13.2(12)
89	13.4(7)	–2.35	–2.71 Q	–11(5)
108	13.4(6)	–2.74 D	–2.67 D	–11(4)
86	13.5(15)	–1.09	–2.55	–11(10)
88	13.6(6)	–2.44	–2.39	–10(4)
5	13.6(14)	–1.06	–2.32	–10(9)
27	13.8(11)	–1.17	–2.07	–9(7)
17	14.2(7)	–1.35	–1.42	–6(5)
10	14.2(13)	–0.63	–1.36	–6(9)
48	14.33(24)	–2.89 Q	–1.22	–5.0(17)
13	14.4(8)	–0.83	–1.10	–5(6)
46	14.5(5)	–1.24	–0.99	–4(4)
83	14.5(5)	–1.15	–0.94	–4(4)
18	14.5(6)	–0.97	–0.94	–4(4)
32	14.69(22)	–1.63	–0.64	–2.6(16)
77	14.8(9)	–0.38	–0.54	–2(6)
38	14.8(4)	–0.70	–0.46	–2(3)
25	14.8(11)	–0.27	–0.46	–2(7)
55	14.8(5)	–0.61	–0.46	–2(3)
15	14.8(4)	–0.67	–0.42	–1.7(25)
35	14.9(5)	–0.46	–0.34	–1(3)
8	14.9(6)	–0.34	–0.30	–1(4)
59	15.0(9)	–0.11	–0.16	–1(6)
104	15.1(3)	–0.10	–0.05	–0.2(19)
45	15.1(10)	0.03	0.05	0(7)
47	15.2(8)	0.10	0.13	1(5)
123	15.2(6)	0.20	0.18	1(4)
126	16(4) Q	0.17	1.11	0(3) × 10^{1}
continues				

continued				
	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
117	16.1(10)	0.95	1.55	6(7)
82	16.1(16)	0.63	1.62	7(11)
58	18.0(6)	4.79 D	4.68 D	19(4)

Table A38 – Cs-137 GH **assigned result 4.81(4) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
124	1.06(3)	–84.29 D	–18.85 D	–78.0(7)
116	4.11(10)	–6.70 D	–3.54 D	–14.6(22)
89	4.31(23)	–2.17	–2.53	–10(5)
100	4.37(6)	–6.50 Q	–2.23	–9.2(14)
86	4.48(18)	–1.83	–1.68	–7(4)
88	4.55(18)	–1.45	–1.33	–6(4)
93	4.62(16)	–1.19	–0.98	–4(4)
13	4.7(3)	–0.32	–0.43	–2(6)
45	4.76(19)	–0.29	–0.28	–1(4)
76	4.77(20)	–0.22	–0.23	–1(5)
25	4.79(22)	–0.11	–0.13	–1(5)
48	4.80(10)	–0.14	–0.08	–0.3(22)
46	4.82(17)	0.03	0.03	0(4)
32	4.82(12)	0.04	0.03	0(3)
17	4.84(21)	0.12	0.13	1(5)
55	4.86(14)	0.31	0.23	1(3)
31	4.9(4)	0.23	0.38	2(7)
18	4.90(20)	0.42	0.43	2(5)
28	4.92(23)	0.45	0.53	2(5)
15	4.93(12)	0.91	0.57	2(3)
5	4.9(5)	0.23	0.58	2(10)
47	4.9(3)	0.48	0.63	3(6)
38	4.95(13)	1.01	0.68	3(3)
35	4.96(15)	0.94	0.73	3(4)
8	5.0(3)	0.51	0.78	3(6)
120	4.99(7)	2.26	0.88	3.6(16)
27	5.0(5)	0.37	0.93	4(10)
59	5.0(3)	0.63	0.93	4(6)
104	5.03(8)	2.49	1.08	4.5(18)
10	5.0(5)	0.48	1.13	5(10)
108	5.05(23)	1.01	1.18	5(5)
123	5.05(18)	1.28	1.18	5(4)
83	5.2(5)	0.77	1.93	8(10)

continues

continued				
	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
77	5.2(3)	1.27	1.98	8(7)
82	5.6(6)	1.38	3.89 Q	16(12)
117	5.7(5)	1.87	4.19 Q	17(9)
16	5.68(10)	8.22 D	4.34 D	18.0(22)
58	5.97(22)	5.19 D	5.80 D	24(5)
126	6.3(17) Q	0.89	7.45 Q	$3(4) \times 10^1$
7	13.2(7)	11.97 D	42.09 D	174(15)

Table A39 – Eu-152 GH **assigned result 1.925(13) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	z-score	Deviation (%)
124	0.410(10)	–91.13 D	–15.70 D	–78.7(6)
100	1.520(20)	–16.87 D	–4.20 D	–21.0(12)
10	1.58(15)	–2.29	–3.58 Q	–18(8)
116	1.59(4)	–7.95 D	–3.47 D	–17.4(22)
93	1.60(6)	–5.29 D	–3.37 D	–17(4)
76	1.660(20)	–11.04 D	–2.75 D	–13.8(12)
45	1.75(16)	–1.09	–1.81	–9(8)
86	1.79(21)	–0.64	–1.40	–7(11)
27	1.80(20)	–0.62	–1.30	–6(10)
88	1.80(8)	–1.54	–1.30	–6(5)
28	1.80(8)	–1.54	–1.30	–6(5)
13	1.82(12)	–0.87	–1.09	–5(6)
108	1.84(9)	–0.93	–0.88	–4(5)
35	1.85(6)	–1.22	–0.78	–4(4)
120	1.860(20)	–2.71 Q	–0.67	–3.4(12)
18	1.87(6)	–0.90	–0.57	–3(4)
77	1.88(14)	–0.32	–0.47	–2(7)
89	1.91(10)	–0.15	–0.16	–1(5)
25	1.92(14)	–0.04	–0.05	0(7)
15	1.92(5)	–0.10	–0.05	0(3)
46	1.95(7)	0.35	0.26	1(4)
32	1.98(14)	0.39	0.57	3(7)
104	1.99(10)	0.64	0.67	3(5)
5	1.99(20)	0.32	0.67	3(10)
47	2.00(10)	0.74	0.78	4(5)
17	2.00(11)	0.68	0.78	4(6)
38	2.00(5)	1.45	0.78	4(3)
82	2.01(21)	0.40	0.88	4(11)
59	2.02(12)	0.79	0.98	5(6)
117	2.02(13)	0.74	0.98	5(7)
123	2.02(9)	1.04	0.98	5(5)
16	2.08(9)	1.70	1.61	8(5)
8	2.09(7)	2.32	1.71	9(4)
55	2.10(15)	1.16	1.81	9(8)

continues

continued				
	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
126	2.2(6) Q	0.40	2.33	$1(3) \times 10^1$
58	2.29(8)	4.50 D	3.78 D	19(5)
48	2.30(12)	3.11 D	3.89 D	19(6)
7	4.9(3)	10.01 D	31.14 D	156(16)

Table A40 – Fe-55 S **assigned result 4.38(13) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
121	2.66(12)	–9.59 D	–6.00 D	–39(4)
8	3.9(3)	–1.53	–1.80	–12(8)
32	4.3(3)	–0.31	–0.34	–2(7)

Table A41 – Sr-90 S **assigned result 0.810(20) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
114	0.31(4)	–12.10 D	–11.09 D	–62(5)
28	0.57(4)	–5.36 D	–5.44 D	–30(6)
29	0.733(25)	–2.40	–1.71	–10(4)
32 B	0.76(4)	–1.03	–1.07	–6(6)
121	0.79(3)	–0.73	–0.56	–3(5)
76	0.79(4)	–0.47	–0.43	–2(5)
106	0.81(7)	–0.08	–0.12	–1(9)
32 A	0.82(5)	0.09	0.10	1(6)
123	0.89(5)	1.48	1.77	10(7)

Table A42 – Ba-133 S **assigned result 4.91(13) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
126	3.4(6)	–2.39	–6.49 Q	–30(12)
76	3.80(9)	–7.08 D	–4.92 D	–23(3)
107	4.15(20)	–3.23 D	–3.37 D	–16(5)
28	4.2(6)	–1.29	–3.33 Q	–15(12)
121	4.30(22)	–2.42	–2.71 Q	–13(5)
74	4.31(11)	–3.59 D	–2.67 D	–12(4)
100	4.51(4)	–3.03 Q	–1.79	–8.2(25)
8	4.53(25)	–1.36	–1.70	–8(6)
114	4.60(10)	–1.90	–1.37	–6(4)
18	4.66(14)	–1.35	–1.12	–5(4)
47	4.7(3)	–0.78	–1.12	–5(7)
32	4.71(11)	–1.22	–0.90	–4(4)
58	4.76(18)	–0.70	–0.68	–3(5)
17	4.77(20)	–0.61	–0.64	–3(5)
35	4.79(16)	–0.61	–0.55	–3(4)
55	4.9(3)	–0.20	–0.29	–1(7)
95	4.86(8)	–0.37	–0.24	–1(3)
29	5.1(4)	0.44	0.82	4(9)
123	5.12(25)	0.73	0.91	4(6)
5	5.2(5)	0.44	1.04	5(11)
48	5.45(24)	1.97	2.36	11(6)
7	9.2(7)	6.42 D	18.78 D	87(14)

Table A43 – Cs-134 S **assigned result 11.8(3) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
76	8.80(15)	–8.75 D	–6.79 D	–25.4(23)
28	9.6(13)	–1.64	–4.97 Q	–19(11)
126	9.7(17)	–1.22	–4.74 Q	–18(14)
121	10.29(24)	–3.85 D	–3.40 D	–13(3)
17	10.4(5)	–2.42	–3.09 Q	–12(5)
107	10.6(5)	–2.28	–2.81 Q	–11(5)
47	10.9(7)	–1.23	–2.13	–8(7)
32	10.96(17)	–2.37	–1.88	–7(3)
35	11.0(4)	–1.67	–1.77	–7(4)
100	11.06(6)	–2.34	–1.66	–6.2(25)
18	11.2(4)	–1.33	–1.38	–5(4)
74	11.3(4)	–1.13	–1.18	–4(4)
8	11.3(6)	–0.71	–1.11	–4(6)
5	11.5(12)	–0.26	–0.70	–3(10)
95	11.50(8)	–0.91	–0.66	–2(3)
58	11.6(4)	–0.37	–0.43	–2(5)
55	11.8(7)	0.02	0.03	0(6)
114	12.05(23)	0.66	0.58	2(4)
123	12.1(5)	0.48	0.59	2(5)
29	12.3(9)	0.54	1.16	4(8)
48	12.3(5)	0.88	1.18	4(5)
118	12.3(4)	1.13	1.21	5(4)
7	23.6(17)	6.84 D	26.83 D	100(15)

Table A44 – Cs-137 S **assigned result 5.05(13) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
74	4.38(17)	–3.10 D	–3.25 D	–13(4)
107	4.62(20)	–1.78	–2.07	–8(5)
95	4.76(7)	–1.91	–1.39	–6(3)
47	4.9(4)	–0.56	–0.95	–4(7)
32	4.88(10)	–1.00	–0.81	–3(4)
8	4.9(4)	–0.40	–0.71	–3(7)
18	4.91(15)	–0.68	–0.66	–3(4)
17	4.95(21)	–0.38	–0.46	–2(5)
58	5.08(18)	0.16	0.17	1(5)
121	5.08(11)	0.20	0.17	1(4)
76	5.09(15)	0.22	0.22	1(4)
28	5.1(7)	0.09	0.32	1(14)
29	5.2(4)	0.37	0.76	3(8)
100	5.29(7)	1.65	1.20	5(3)
35	5.29(17)	1.14	1.20	5(5)
83	5.3(5)	0.49	1.24	5(10)
55	5.3(3)	0.83	1.29	5(7)
114	5.33(14)	1.45	1.38	6(4)
118	5.34(11)	1.70	1.43	6(4)
123	5.35(20)	1.28	1.49	6(5)
48	5.45(24)	1.48	1.98	8(6)
5	5.5(6)	0.86	2.42	10(11)
126	6.0(11)	0.83	4.47 Q	18(22)
7	12.2(9)	7.87 D	34.91 D	142(19)

Table A45 – Eu-152 S **assigned result 4.84(13) Bq g^{-1}**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
121	3.16(11)	–10.05 D	–8.55 D	–35(3)
76	3.69(6)	–8.25 D	–5.85 D	–23.7(23)
126	4.1(7)	–0.99	–3.62 Q	–15(15)
28	4.1(6)	–1.23	–3.61 Q	–15(12)
100	4.400(20)	–3.44 Q	–2.23	–9.0(24)
32	4.43(17)	–1.93	–2.08	–8(5)
107	4.45(19)	–1.70	–1.97	–8(5)
35	4.47(15)	–1.88	–1.87	–8(4)
18	4.48(13)	–1.98	–1.82	–7(4)
17	4.54(21)	–1.21	–1.51	–6(5)
47	4.6(3)	–0.82	–1.36	–6(7)
74	4.61(10)	–1.42	–1.16	–5(4)
114	4.63(15)	–1.07	–1.07	–4(4)
58	4.73(17)	–0.51	–0.55	–2(5)
95	4.77(11)	–0.41	–0.34	–1(4)
29	4.9(4)	0.15	0.32	1(9)
55	5.0(4)	0.33	0.63	3(8)
8	4.96(15)	0.63	0.63	3(4)
5	5.0(5)	0.32	0.83	3(11)
123	5.02(24)	0.68	0.93	4(6)
48	5.7(3)	2.97 D	4.50 D	18(7)
7	10.3(9)	6.01 D	27.86 D	113(19)

Table A46 – Gross beta S **no assigned result**

	Result (Bq g^{-1})	Zeta score	*z*-score	Deviation (%)
95	11.92(19)	–	–	–
113	13.5(6)	–	–	–
121	16.97(18)	–	–	–
123	21.8(11)	–	–	–

Appendix B. Results sorted by laboratory

Table B1 – Laboratory 1

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq g^{-1})	(Bq g^{-1})			
^{226}Ra AH	18.5(11)	15.90(21)	2.32	2.77 Q	16(7)
^{237}Np AH	4.40(20)	4.84(5)	–2.13	–0.97	–9(5)
^{237}Np AH	5.3(5)	4.84(5)	0.92	1.02	10(10)
^{238}Pu AH	17.1(4)	16.63(5)	1.17	0.61	2.8(24)
^{239}Pu AH	11.40(20)	11.25(5)	0.74	0.28	1.4(18)
^{241}Am AH	5.3(3)	5.356(10)	–0.19	–0.21	–1(6)
^{241}Am AH	5.50(10)	5.356(10)	1.43	0.54	2.7(19)
^{244}Cm AH	8.0(4)	6.980(22)	2.55	2.92 Q	15(6)
Gross a AH	78(6)	$8(3) \times 10^1$	0.00	–0.03	$0(4) \times 10^1$

Table B2 – Laboratory 4

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{238}U AL	18.4(14)	18.0(4)	0.28	0.43	2(8)
^{239}Pu AL	11.4(8)	11.68(12)	–0.39	–0.49	–3(7)
^{241}Am AL	3.02(24)	3.099(6)	–0.33	–0.35	–3(8)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B1	1.62(17)	1.688(12)	–0.40	–0.69	–4(10)

Table B3 – Laboratory 5

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
Gross a AL	58(6)	72(7)	–1.57	–3.66 Q	–19(11)
^{60}Co GL	6.0(6)	5.035(12)	1.61	3.56 Q	19(12)
^{65}Zn GL	5.6(17) Q	5.50(4)	0.08	0.32	$0(3) \times 10^{1}$
^{85}Sr GL	7.5(8)	7.01(5)	0.60	1.21	6(11)
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	3.8(4)	3.571(25)	0.50	0.72	5(11)
^{134}Cs GL	15.0(15)	14.02(10)	0.68	1.36	7(11)
^{137}Cs GL	4.7(5)	4.47(3)	0.46	0.78	5(11)
^{152}Eu GL	2.5(3)	1.789(12)	2.37	3.97 Q	40(17)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B1	1.7(3)	1.688(12)	0.16	0.42	2(15)
^{14}C B1	0.82(12) Q	0.905(6)	–0.69	–1.87	–9(14)
^{3}H B2	1.40(21)	1.389(15)	0.05	0.20	1(15)
^{60}Co GH	5.4(6)	5.418(12)	0.04	0.10	0(10)
^{65}Zn GH	6.2(6)	5.92(4)	0.50	1.33	5(10)
^{85}Sr GH	7.7(8)	7.54(5)	0.14	0.34	1(10)
^{125}Sb GH	1.42(14)	1.470(7)	–0.35	–0.66	–3(10)
^{133}Ba GH	3.5(4)	3.84(3)	–0.98	–1.94	–9(9)
^{134}Cs GH	13.6(14)	15.09(11)	–1.06	–2.32	–10(9)
^{137}Cs GH	4.9(5)	4.81(4)	0.23	0.58	2(10)
^{152}Eu GH	1.99(20)	1.925(13)	0.32	0.67	3(10)
^{133}Ba S	5.2(5)	4.91(13)	0.44	1.04	5(11)
^{134}Cs S	11.5(12)	11.8(3)	–0.26	–0.70	–3(10)
^{137}Cs S	5.5(6)	5.05(13)	0.86	2.42	10(11)
^{152}Eu S	5.0(5)	4.84(13)	0.32	0.83	3(11)

Table B4 – Laboratory 7

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq g^{-1})	(Bq g^{-1})			
^{238}Pu AH	15.3(7)	16.63(5)	–1.89	–1.70	–8(5)
^{239}Pu AH	10.1(5)	11.25(5)	–2.28	–2.08	–10(5)
^{241}Am AH	5.63(20)	5.356(10)	1.37	1.03	5(4)
^{244}Cm AH	7.5(3)	6.980(22)	1.88	1.40	7(4)
Gross a AH	115(7)	8(3) × 10^{1}	1.33	10.06 Q	5(5) × 10^{1}
^{3}H B1	1.81(15)	1.688(12)	0.81	1.23	7(9)
^{14}C B1	0.696(23)	0.905(6)	–8.86 D	–4.59 D	–23(3)
^{3}H B2	1.49(12)	1.389(15)	0.84	1.80	7(9)
^{55}Fe B2	1.11(24)	1.53(3)	–1.73	–3.93 Q	–27(16)
^{89}Sr B2	0.420(20)	0.463(4)	–2.08	–0.96	–9(5)
^{90}Sr B2	1.15(6)	1.153(10)	–0.05	–0.04	0(6)
Gross b L B2	5.4(5)	5.68(4)	–0.53	–0.93	–5(9)
^{60}Co GH	0.0071(20)	5.418(12)	–445.45 D	–25.11 D	–99.87(4)
^{65}Zn GH	5.3(3)	5.92(4)	–2.11	–2.74 Q	–11(5)
^{85}Sr GH	–	7.54(5)	–	–	–
^{125}Sb GH	6.2(3)	1.470(7)	15.76 D	62.54 D	322(21)
^{133}Ba GH	1.43(8)	3.84(3)	–28.65 D	–13.70 D	–62.8(21)
^{134}Cs GH	3.44(20)	15.09(11)	–51.37 D	–18.66 D	–77.2(13)
^{137}Cs GH	13.2(7)	4.81(4)	11.97 D	42.09 D	174(15)
^{152}Eu GH	4.9(3)	1.925(13)	10.01 D	31.14 D	156(16)
^{133}Ba S	9.2(7)	4.91(13)	6.42 D	18.78 D	87(14)
^{134}Cs S	23.6(17)	11.8(3)	6.84 D	26.83 D	100(15)
^{137}Cs S	12.2(9)	5.05(13)	7.87 D	34.91 D	142(19)
^{152}Eu S	10.3(9)	4.84(13)	6.01 D	27.86 D	113(19)

Table B5 – Laboratory 8

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{237}Np AL	5.3(8)	4.65(5)	0.84	1.32	14(16)
^{238}U AL	20.6(23)	18.0(4)	1.11	2.87 Q	15(13)
^{238}U AL	19.6(20)	18.0(4)	0.81	1.78	9(11)
^{239}Pu AL	11.5(10)	11.68(12)	–0.19	–0.30	–2(8)
^{241}Am AL	3.4(4)	3.099(6)	0.90	1.47	11(12)
^{241}Am AL	3.8(5)	3.099(6)	1.49	3.15 Q	23(15)
^{244}Cm AL	14.8(14)	15.41(5)	–0.45	–0.90	–4(9)
Gross a AL	81.1(9)	72(7)	1.43	2.52	13(10)
^{60}Co GL	5.59(24)	5.035(12)	2.31	2.05	11(5)
^{65}Zn GL	6.5(4)	5.50(4)	2.46	2.47	18(7)
^{85}Sr GL	8.1(5)	7.01(5)	2.11	2.95 Q	16(8)
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	3.5(4)	3.571(25)	–0.15	–0.19	–1(9)
^{134}Cs GL	15.1(6)	14.02(10)	1.80	1.44	8(5)
^{137}Cs GL	4.9(4)	4.47(3)	1.29	1.51	9(7)
^{152}Eu GL	2.0(6)	1.789(12)	0.34	1.07	$1(4) \times 10^1$
	(Bq g^{-1})	(Bq g^{-1})			
^{226}Ra AH	14.3(20)	15.90(21)	–0.81	–1.70	–10(12)
^{226}Ra AH	15.0(6)	15.90(21)	–1.54	–0.96	–6(4)
^{237}Np AH	5.3(8)	4.84(5)	0.65	1.11	10(16)
^{238}Pu AH	17.0(15)	16.63(5)	0.25	0.48	2(9)
^{239}Pu AH	11.2(10)	11.25(5)	–0.05	–0.09	0(9)
^{241}Am AH	5.3(6)	5.356(10)	–0.12	–0.25	–1(10)
^{241}Am AH	5.29(23)	5.356(10)	–0.29	–0.25	–1(5)
^{244}Cm AH	5.4(6)	6.980(22)	–2.80	–4.58	–23(8)
Gross a AH	93.7(10)	$8(3) \times 10^1$	0.57	4.19	$2(4) \times 10^1$
^{3}H B1	1.59(6)	1.688(12)	–1.54	–0.99	–6(4)
^{99}Tc B1	0.141(17)	0.1562(4)	–0.90	–1.46	–10(11)
^{99}Tc B1	0.144(14)	0.1562(4)	–0.84	–1.17	–8(9)
^{129}I B1	0.165(13)	0.1504(9)	1.17	1.32	10(8)
^{3}H B2	1.290(5)	1.389(15)	–6.14 Q	–1.76	–7.1(11)

continues

continued					
	Result	Assigned result	Zeta score	z-score	Deviation (%)
^{55}Fe B2	1.70(9)	1.53(3)	1.82	1.63	11(6)
^{89}Sr B2	0.52(5)	0.463(4)	1.15	1.29	12(11)
^{90}Sr B2	1.28(12)	1.153(10)	1.04	1.54	11(11)
^{90}Sr B2	1.190(24)	1.153(10)	1.41	0.45	3.2(23)
Gross b I B2	2.30(4)	2.769(15)	–10.73 D	–3.39 D	–16.9(15)
^{60}Co GH	5.40(10)	5.418(12)	–0.18	–0.08	–0.3(19)
^{65}Zn GH	7.20(11)	5.92(4)	10.92 D	5.49 D	21.6(20)
^{85}Sr GH	8.1(4)	7.54(5)	1.35	1.63	7(5)
^{125}Sb GH	1.53(7)	1.470(7)	0.86	0.80	4(5)
^{133}Ba GH	3.60(12)	3.84(3)	–1.97	–1.38	–6(4)
^{134}Cs GH	14.9(6)	15.09(11)	–0.34	–0.30	–1(4)
^{137}Cs GH	5.0(3)	4.81(4)	0.51	0.78	3(6)
^{152}Eu GH	2.09(7)	1.925(13)	2.32	1.71	9(4)
^{55}Fe S	3.9(3)	4.38(13)	–1.53	–1.80	–12(8)
^{133}Ba S	4.53(25)	4.91(13)	–1.36	–1.70	–8(6)
^{134}Cs S	11.3(6)	11.8(3)	–0.71	–1.11	–4(6)
^{137}Cs S	4.9(4)	5.05(13)	–0.40	–0.71	–3(7)
^{152}Eu S	4.96(15)	4.84(13)	0.63	0.63	3(4)

Table B6 – Laboratory 10

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	5.5(8)	5.035(12)	0.52	1.57	8(16)
^{65}Zn GL	5.2(9)	5.50(4)	–0.29	–0.68	–5(17)
^{85}Sr GL	6.8(8)	7.01(5)	–0.22	–0.45	–2(11)
^{125}Sb GL	1.9(8)	1.366(7)	0.63	2.92 Q	$4(6) \times 10^1$
^{133}Ba GL	3.5(6)	3.571(25)	–0.14	–0.34	–3(18)
^{134}Cs GL	13.1(14)	14.02(10)	–0.67	–1.22	–7(10)
^{137}Cs GL	4.4(6)	4.47(3)	–0.17	–0.38	–2(13)
^{152}Eu GL	2.1(6)	1.789(12)	0.49	1.52	$2(3) \times 10^1$
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	5.5(5)	5.418(12)	0.10	0.24	1(9)
^{65}Zn GH	6.1(6)	5.92(4)	0.23	0.60	2(10)
^{85}Sr GH	7.7(7)	7.54(5)	0.18	0.40	2(10)
^{125}Sb GH	1.51(14)	1.470(7)	0.29	0.53	3(10)
^{133}Ba GH	3.7(4)	3.84(3)	–0.46	–0.92	–4(9)
^{134}Cs GH	14.2(13)	15.09(11)	–0.63	–1.36	–6(9)
^{137}Cs GH	5.0(5)	4.81(4)	0.48	1.13	5(10)
^{152}Eu GH	1.58(15)	1.925(13)	–2.29	–3.58 Q	–18(8)

Table B7 – Laboratory 13

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	4.9(4)	5.01(5)	–0.24	–0.30	–2(8)
^{238}U AL	18(3)	18.0(4)	–0.09	–0.30	–2(16)
^{239}Pu AL	11.6(7)	11.68(12)	–0.13	–0.13	–1(6)
^{241}Am AL	3.17(19)	3.099(6)	0.37	0.32	2(6)
^{244}Cm AL	15.4(8)	15.41(5)	–0.01	–0.01	0(5)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B1	1.72(15)	1.688(12)	0.22	0.33	2(9)
^{14}C B1	0.81(5)	0.905(6)	–2.13	–2.11	–11(5)
^{99}Tc B1	0.162(12)	0.1562(4)	0.49	0.56	4(8)
^{60}Co GH	5.3(3)	5.418(12)	–0.29	–0.36	–1(5)
^{65}Zn GH	6.0(4)	5.92(4)	0.34	0.47	2(6)
^{85}Sr GH	7.6(4)	7.54(5)	0.11	0.15	1(6)
^{125}Sb GH	1.39(9)	1.470(7)	–0.88	–1.05	–5(6)
^{133}Ba GH	3.69(24)	3.84(3)	–0.63	–0.87	–4(6)
^{134}Cs GH	14.4(8)	15.09(11)	–0.83	–1.10	–5(6)
^{137}Cs GH	4.7(3)	4.81(4)	–0.32	–0.43	–2(6)
^{152}Eu GH	1.82(12)	1.925(13)	–0.87	–1.09	–5(6)

Table B8 – Laboratory 15

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	5.66(17)	5.035(12)	3.67 Q	2.31	12(4)
^{65}Zn GL	5.81(23)	5.50(4)	1.32	0.77	6(5)
^{85}Sr GL	8.07(24)	7.01(5)	4.33 D	2.84 D	15(4)
^{125}Sb GL	1.68(17)	1.366(7)	1.85	1.75	23(12)
^{133}Ba GL	3.70(13)	3.571(25)	0.98	0.49	4(4)
^{134}Cs GL	13.7(4)	14.02(10)	–0.86	–0.43	–2(3)
^{137}Cs GL	5.08(16)	4.47(3)	3.72 Q	2.20	14(4)
^{152}Eu GL	2.16(13)	1.789(12)	2.84 Q	2.07	21(7)
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	5.27(13)	5.418(12)	–1.13	–0.69	–2.7(24)
^{65}Zn GH	5.85(14)	5.92(4)	–0.48	–0.30	–1.2(25)
^{85}Sr GH	7.68(19)	7.54(5)	0.70	0.43	2(3)
^{125}Sb GH	1.49(4)	1.470(7)	0.55	0.30	2(3)
^{133}Ba GH	3.14(8)	3.84(3)	–8.34 D	–3.99 D	–18.3(22)
^{134}Cs GH	14.8(4)	15.09(11)	–0.67	–0.42	–1.7(25)
^{137}Cs GH	4.93(12)	4.81(4)	0.91	0.57	2(3)
^{152}Eu GH	1.92(5)	1.925(13)	–0.10	–0.05	0(3)

Table B9 – Laboratory 16

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq g^{-1})	(Bq g^{-1})			
^{14}C B1	0.918(5)	0.905(6)	0.25	0.28	1(6)
^{3}H B2	1.14(4)	1.389(15)	–5.86 D	–4.46 D	–18(3)
^{55}Fe B2	0.91(4)	1.53(3)	–12.44 D	–5.81 D	–40(3)
^{60}Co GH	6.09(5)	5.418(12)	13.07 D	3.12 D	12.4(10)
^{65}Zn GH	7.08(10)	5.92(4)	10.75 D	4.98 D	19.6(19)
^{85}Sr GH	8.34(8)	7.54(5)	8.38 Q	2.51	10.6(13)
^{125}Sb GH	1.66(7)	1.470(7)	2.71 Q	2.52	13(5)
^{133}Ba GH	4.0(3)	3.84(3)	0.68	1.12	5(8)
^{134}Cs GH	1.45(2)	15.09(11)	–125.40 D	–21.84 D	–90.39(15)
^{137}Cs GH	5.68(10)	4.81(4)	8.22 D	4.34 D	18.0(22)
^{152}Eu GH	2.08(9)	1.925(13)	1.70	1.61	8(5)

Table B10 – Laboratory 17

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{238}U AL	16.7(9)	18.0(4)	–1.41	–1.45	–7(5)
^{239}Pu AL	15.1(10)	11.68(12)	3.25 D	5.50 D	29(9)
^{241}Am AL	3.23(21)	3.099(6)	0.62	0.58	4(7)
Gross a AL	82(8)	72(7)	0.94	2.62 Q	14(15)
^{60}Co GL	5.7(5)	5.035(12)	1.23	2.27	12(10)
^{65}Zn GL	5.6(7)	5.50(4)	0.11	0.20	1(13)
^{85}Sr GL	3.2(3)	7.01(5)	–12.50 D	–10.18 D	–54(5)
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	3.4(8)	3.571(25)	–0.16	–0.50	–4(23)
^{134}Cs GL	12.9(9)	14.02(10)	–1.23	–1.46	–8(7)
^{137}Cs GL	4.9(8)	4.47(3)	0.54	1.58	10(18)
^{152}Eu GL	2.6(7)	1.789(12)	1.18	4.70 Q	$5(4) \times 10^1$
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	5.20(21)	5.418(12)	–1.04	–1.01	–4(4)
^{65}Zn GH	6.1(3)	5.92(4)	0.55	0.69	3(5)
^{85}Sr GH	7.4(4)	7.54(5)	–0.29	–0.32	–1(5)
^{125}Sb GH	1.43(8)	1.470(7)	–0.49	–0.52	–3(6)
^{133}Ba GH	3.88(16)	3.84(3)	0.23	0.21	1(5)
^{134}Cs GH	14.2(7)	15.09(11)	–1.35	–1.42	–6(5)
^{137}Cs GH	4.84(21)	4.81(4)	0.12	0.13	1(5)
^{152}Eu GH	2.00(11)	1.925(13)	0.68	0.78	4(6)
^{133}Ba S	4.77(20)	4.91(13)	–0.61	–0.64	–3(5)
^{134}Cs S	10.4(5)	11.8(3)	–2.42	–3.09 Q	–12(5)
^{137}Cs S	4.95(21)	5.05(13)	–0.38	–0.46	–2(5)
^{152}Eu S	4.54(21)	4.84(13)	–1.21	–1.51	–6(5)

Table B11 – Laboratory 18

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	4.8(2)	5.035(12)	–1.17	–0.87	–5(4)
^{65}Zn GL	5.2(2)	5.50(4)	–1.48	–0.75	–5(4)
^{85}Sr GL	6.5(3)	7.01(5)	–1.68	–1.36	–7(5)
^{125}Sb GL	1.32(6)	1.366(7)	–0.76	–0.25	–3(5)
^{133}Ba GL	3.1(1)	3.571(25)	–4.57 Q	–1.79	–13(3)
^{134}Cs GL	12.7(5)	14.02(10)	–2.59 Q	–1.77	–9(4)
^{137}Cs GL	4.3(2)	4.47(3)	–0.86	–0.63	–4(5)
^{152}Eu GL	1.60(7)	1.789(12)	–2.66 Q	–1.06	–11(4)
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	5.28(21)	5.418(12)	–0.66	–0.64	–3(4)
^{65}Zn GH	5.59(22)	5.92(4)	–1.47	–1.41	–6(4)
^{85}Sr GH	7.8(3)	7.54(5)	0.85	0.81	3(4)
^{125}Sb GH	1.44(7)	1.470(7)	–0.42	–0.39	–2(5)
^{133}Ba GH	3.71(13)	3.84(3)	–1.00	–0.75	–3(4)
^{134}Cs GH	14.5(6)	15.09(11)	–0.97	–0.94	–4(4)
^{137}Cs GH	4.9(2)	4.81(4)	0.42	0.43	2(5)
^{152}Eu GH	1.87(6)	1.925(13)	–0.90	–0.57	–3(4)
^{133}Ba S	4.66(14)	4.91(13)	–1.35	–1.12	–5(4)
^{134}Cs S	11.2(4)	11.8(3)	–1.33	–1.38	–5(4)
^{137}Cs S	4.91(15)	5.05(13)	–0.68	–0.66	–3(4)
^{152}Eu S	4.48(13)	4.84(13)	–1.98	–1.82	–7(4)

Table B12 – Laboratory 19

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	5.2(4)	5.035(12)	0.50	0.76	4(8)
^{65}Zn GL	5.3(6)	5.50(4)	–0.44	–0.60	–4(10)
^{85}Sr GL	7.0(5)	7.01(5)	–0.06	–0.08	0(7)
^{125}Sb GL	1.3(4)	1.366(7)	–0.12	–0.25	0(3) × 10^{1}
^{133}Ba GL	3.3(3)	3.571(25)	–1.07	–1.14	–8(8)
^{134}Cs GL	12.5(7)	14.02(10)	–2.12	–2.09	–11(5)
^{137}Cs GL	4.7(4)	4.47(3)	0.54	0.67	4(8)
^{152}Eu GL	1.63(20)	1.789(12)	–0.79	–0.89	–9(11)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B2	1.36(5)	1.389(15)	–0.55	–0.51	–2(4)

Table B13 – Laboratory 23

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	4.9(4)	5.035(12)	–0.34	–0.50	–3(8)
^{65}Zn GL	5.7(7)	5.50(4)	0.28	0.50	4(13)
^{85}Sr GL	7.2(7)	7.01(5)	0.27	0.51	3(10)
^{125}Sb GL	1.4(5)	1.366(7)	0.07	0.19	0(4) × 10^{1}
^{133}Ba GL	3.7(5)	3.571(25)	0.26	0.49	4(14)
^{134}Cs GL	13.6(17)	14.02(10)	–0.25	–0.57	–3(12)
^{137}Cs GL	4.6(5)	4.47(3)	0.25	0.46	3(11)
^{152}Eu GL	2.0(6) Q	1.789(12)	0.35	1.18	1(4) × 10^{1}

Table B14 – Laboratory 25

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	5.1(6)	5.01(5)	0.11	0.20	1(11)
^{237}Np AL	6.8(5)	4.65(5)	4.41 D	4.48 D	47(11)
^{238}U AL	16.6(15)	18.0(4)	–0.86	–1.49	–8(9)
^{239}Pu AL	11.9(14)	11.68(12)	0.14	0.32	2(12)
^{241}Am AL	3.1(4)	3.099(6)	0.08	0.14	1(13)
^{244}Cm AL	13.4(15)	15.41(5)	–1.36	–2.92 Q	–13(10)
^{60}Co GL	4.91(14)	5.035(12)	–0.89	–0.46	–2(3)
^{65}Zn GL	5.6(4)	5.50(4)	0.22	0.22	2(7)
^{85}Sr GL	6.9(4)	7.01(5)	–0.23	–0.24	–1(6)
^{125}Sb GL	1.1(3)	1.366(7)	–1.17	–1.76	–23(20)
^{133}Ba GL	3.8(3)	3.571(25)	0.92	0.95	7(8)
^{134}Cs GL	14.1(11)	14.02(10)	0.04	0.06	0(8)
^{137}Cs GL	4.6(3)	4.47(3)	0.35	0.35	2(6)
^{152}Eu GL	2.2(3)	1.789(12)	1.43	2.24	22(16)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B1	1.63(7)	1.688(12)	–0.84	–0.58	–3(4)
^{14}C B1	0.96(6)	0.905(6)	0.87	1.11	6(7)
^{99}Tc B1	0.159(13)	0.1562(4)	0.22	0.27	2(8)
^{129}I B1	0.151(14)	0.1504(9)	0.04	0.06	0(9)
^{3}H B2	1.39(6)	1.389(15)	–0.04	–0.05	0(5)
^{55}Fe B2	1.91(19)	1.53(3)	1.99	3.60 Q	25(13)
^{90}Sr B2	1.10(8)	1.153(10)	–0.62	–0.59	–4(7)
^{60}Co GH	5.26(25)	5.418(12)	–0.63	–0.73	–3(5)
^{65}Zn GH	5.8(3)	5.92(4)	–0.29	–0.34	–1(5)
^{85}Sr GH	7.2(4)	7.54(5)	–1.00	–1.05	–4(5)
^{125}Sb GH	1.51(8)	1.470(7)	0.50	0.53	3(6)
^{133}Ba GH	3.75(18)	3.84(3)	–0.51	–0.52	–2(5)
^{134}Cs GH	14.8(11)	15.09(11)	–0.27	–0.46	–2(7)
^{137}Cs GH	4.79(22)	4.81(4)	–0.11	–0.13	–1(5)
^{152}Eu GH	1.92(14)	1.925(13)	–0.04	–0.05	0(7)

Table B15 – Laboratory 26

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	4.04(15)	5.01(5)	–6.17 D	–3.23 D	–19(3)
^{238}U AL	20.5(7)	18.0(4)	3.25 D	2.72 D	14(5)
^{239}Pu AL	10.7(3)	11.68(12)	–3.34 Q	–1.64	–9(3)
^{241}Am AL	3.05(8)	3.099(6)	–0.65	–0.23	–1.6(25)
^{244}Cm AL	16.3(3)	15.41(5)	2.92 Q	1.26	5.6(19)
Gross a AL	80.8(18)	72(7)	1.35	2.44	13(11)
^{60}Co GL	4.75(21)	5.035(12)	–1.35	–1.05	–6(4)
^{65}Zn GL	5.5(4)	5.50(4)	0.11	0.10	1(6)
^{85}Sr GL	7.3(5)	7.01(5)	0.52	0.67	4(7)
^{125}Sb GL	1.62(15)	1.366(7)	1.69	1.42	19(11)
^{133}Ba GL	3.76(16)	3.571(25)	1.17	0.72	5(5)
^{134}Cs GL	1.3(4)	14.02(10)	–29.37 D	–16.99 D	–90(3)
^{137}Cs GL	4.39(21)	4.47(3)	–0.40	–0.31	–2(5)
^{152}Eu GL	1.73(11)	1.789(12)	–0.53	–0.33	–3(6)
	(Bq g^{-1})	(Bq g^{-1})			
^{89}Sr B2	0.0600(22)	0.463(4)	–85.78 D	–9.07 D	–87.0(5)
^{90}Sr B2	1.18(4)	1.153(10)	0.86	0.35	3(3)

Table B16 – Laboratory 27

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	4.8(5)	5.035(12)	–0.47	–0.87	–5(10)
^{65}Zn GL	5.9(6)	5.50(4)	0.66	1.00	7(11)
^{85}Sr GL	8.4(3)	7.01(5)	4.58 D	3.73 D	20(5)
^{125}Sb GL	2.3(5)	1.366(7)	1.87	5.21 Q	$7(4) \times 10^1$
^{133}Ba GL	3.4(3)	3.571(25)	–0.57	–0.65	–5(9)
^{134}Cs GL	12.0(10)	14.02(10)	–2.01	–2.71 Q	–14(7)
^{137}Cs GL	4.7(5)	4.47(3)	0.45	0.82	5(11)
^{152}Eu GL	3.6(4)	1.789(12)	4.53 D	10.12 D	101(22)
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	5.5(6)	5.418(12)	0.14	0.38	2(11)
^{65}Zn GH	6.7(7)	5.92(4)	1.11	3.35 Q	13(12)
^{85}Sr GH	10.2(4)	7.54(5)	6.59 D	8.36 D	35(6)
^{125}Sb GH	1.5(3)	1.470(7)	0.10	0.40	2(20)
^{133}Ba GH	3.9(4)	3.84(3)	0.14	0.33	2(10)
^{134}Cs GH	13.8(11)	15.09(11)	–1.17	–2.07	–9(7)
^{137}Cs GH	5.0(5)	4.81(4)	0.37	0.93	4(10)
^{152}Eu GH	1.8(2)	1.925(13)	–0.62	–1.30	–6(10)

Table B17 – Laboratory 28

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	4.44(24)	5.01(5)	–2.33	–1.90	–11(5)
^{238}U AL	17.5(6)	18.0(4)	–0.70	–0.52	–3(4)
^{239}Pu AL	11.6(5)	11.68(12)	–0.13	–0.10	–1(4)
^{241}Am AL	3.15(11)	3.099(6)	0.46	0.23	2(4)
^{244}Cm AL	13.8(6)	15.41(5)	–2.97 Q	–2.41	–11(4)
^{60}Co GL	5.1(3)	5.035(12)	0.22	0.24	1(6)
^{65}Zn GL	5.4(4)	5.50(4)	–0.14	–0.15	–1(8)
^{85}Sr GL	7.4(4)	7.01(5)	1.10	1.13	6(6)
^{125}Sb GL	1.3(4)	1.366(7)	–0.16	–0.37	0(3) × 10^{1}
^{133}Ba GL	3.21(20)	3.571(25)	–1.79	–1.37	–10(6)
^{134}Cs GL	12.5(6)	14.02(10)	–2.54	–2.04	–11(5)
^{137}Cs GL	4.7(4)	4.47(3)	0.72	0.89	5(8)
^{152}Eu GL	1.7(3)	1.789(12)	–0.26	–0.39	–4(15)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B1	1.71(8)	1.688(12)	0.29	0.22	1(5)
^{14}C B1	1.05(5)	0.905(6)	3.14 D	3.26 D	16(5)
^{99}Tc B1	0.171(11)	0.1562(4)	1.35	1.42	9(7)
^{60}Co GH	5.47(25)	5.418(12)	0.21	0.24	1(5)
^{65}Zn GH	6.3(3)	5.92(4)	1.26	1.59	6(5)
^{85}Sr GH	7.6(4)	7.54(5)	0.05	0.05	0(5)
^{125}Sb GH	1.44(7)	1.470(7)	–0.42	–0.39	–2(5)
^{133}Ba GH	3.38(16)	3.84(3)	–2.85 D	–2.63 D	–12(5)
^{134}Cs GH	13.0(6)	15.09(11)	–3.45 D	–3.31 D	–14(4)
^{137}Cs GH	4.92(23)	4.81(4)	0.45	0.53	2(5)
^{152}Eu GH	1.80(8)	1.925(13)	–1.54	–1.30	–6(5)
^{90}Sr S	0.57(4)	0.810(20)	–5.36 D	–5.44 D	–30(6)
^{133}Ba S	4.2(6)	4.91(13)	–1.29	–3.33 Q	–15(12)
^{134}Cs S	9.6(13)	11.8(3)	–1.64	–4.97 Q	–19(11)
^{137}Cs S	5.1(7)	5.05(13)	0.09	0.32	1(14)
^{152}Eu S	4.1(6)	4.84(13)	–1.23	–3.61 Q	–15(12)

Table B18 – Laboratory 29

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	5.0(3)	5.01(5)	–0.04	–0.04	0(6)
^{238}U AL	17.7(9)	18.0(4)	–0.28	–0.30	–2(6)
^{239}Pu AL	9.7(5)	11.68(12)	–3.86 D	–3.21 D	–17(5)
^{241}Am AL	3.20(20)	3.099(6)	0.51	0.45	3(7)
^{60}Co GL	4.9(5)	5.035(12)	–0.27	–0.50	–3(10)
^{65}Zn GL	5.1(5)	5.50(4)	–0.80	–1.00	–7(9)
^{85}Sr GL	7.3(6)	7.01(5)	0.48	0.78	4(9)
^{125}Sb GL	1.3(3)	1.366(7)	–0.22	–0.37	–5(22)
^{133}Ba GL	3.5(3)	3.571(25)	–0.23	–0.27	–2(9)
^{134}Cs GL	13(1)	14.02(10)	–1.02	–1.37	–7(7)
^{137}Cs GL	4.3(4)	4.47(3)	–0.44	–0.63	–4(9)
^{152}Eu GL	1.9(2)	1.789(12)	0.55	0.62	6(11)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B1 dis	1.73(5)	1.688(12)	0.82	0.42	2(3)
^{3}H B1 comb	1.66(12)	1.688(12)	–0.23	–0.28	–2(7)
^{14}C B1	0.81(3)	0.905(6)	–3.13 Q	–2.09	–11(4)
^{90}Sr S	0.733(25)	0.810(20)	–2.40	–1.71	–10(4)
^{133}Ba S	5.1(4)	4.91(13)	0.44	0.82	4(9)
^{134}Cs S	12.3(9)	11.8(3)	0.54	1.16	4(8)
^{137}Cs S	5.2(4)	5.05(13)	0.37	0.76	3(8)
^{152}Eu S	4.9(4)	4.84(13)	0.15	0.32	1(9)

Table B19 – Laboratory 31

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{239}Pu AL	12.85(25)	11.68(12)	4.23 Q	1.89	10.0(24)
^{241}Am AL	18.4(5)	3.099(6)	29.42 D	67.81 D	494(17)
^{244}Cm AL	15.1(5)	15.41(5)	–0.72	–0.46	–2(3)
Gross a AL	54(10)	72(7)	–1.48	–4.74 Q	–25(16)
^{60}Co GL	7.0(7)	5.035(12)	2.82 D	7.18 D	39(14)
^{65}Zn GL	–	5.50(4)	–	–	–
^{85}Sr GL	–	7.01(5)	–	–	–
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	–	3.571(25)	–	–	–
^{134}Cs GL	–	14.02(10)	–	–	–
^{137}Cs GL	9.6(11)	4.47(3)	4.66 D	18.61 D	115(25)
^{152}Eu GL	–	1.789(12)	–	–	–
	(Bq g^{-1})	(Bq g^{-1})			
^{226}Ra AH	17.5(20)	15.90(21)	0.80	1.70	10(13)
^{241}Am AH	8.00(20)	5.356(10)	13.20 D	9.94 D	49(4)
^{244}Cm AH	4.60(10)	6.980(22)	–23.26 D	–6.82 D	–34.1(14)
Gross a AH	54(6)	8(3) × 10^{1}	–0.92	–6.89 Q	–32(24)
^{3}H B2	0.630(20)	1.389(15)	–30.18 D	–13.50 D	–54.6(15)
^{55}Fe B2	0.6(4)	1.53(3)	–2.76 D	–8.35 D	–58(21)
^{90}Sr B2	1.22(24)	1.153(10)	0.28	0.81	6(21)
Gross b I B2	3.74(25)	2.769(15)	3.88 D	7.02 D	35(9)
^{60}Co GH	5.6(4)	5.418(12)	0.67	1.03	4(6)
^{65}Zn GH	–	5.92(4)	–	–	–
^{85}Sr GH	–	7.54(5)	–	–	–
^{125}Sb GH	–	1.470(7)	–	–	–
^{133}Ba GH	–	3.84(3)	–	–	–
^{134}Cs GH	–	15.09(11)	–	–	–
^{137}Cs GH	4.9(4)	4.81(4)	0.23	0.38	2(7)
^{152}Eu GH	–	1.925(13)	–	–	–

Table B20 – Laboratory 32

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	5.37(17)	5.01(5)	2.03	1.19	7(4)
^{232}Th AL	5.1(3)	5.01(5)	0.25	0.23	1(6)
^{237}Np AL	5.2(7)	4.65(5)	0.85	1.14	12(14)
^{238}U A AL	17.6(14)	18.0(4)	–0.26	–0.41	–2(8)
^{238}U M AL	18.3(14)	18.0(4)	0.22	0.35	2(8)
^{241}Am AL	3.04(25)	3.099(6)	–0.24	–0.26	–2(8)
	(Bq g^{-1})	(Bq g^{-1})			
^{226}Ra AH	15.7(15)	15.90(21)	–0.13	–0.21	–1(10)
^{226}Ra AH	15.7(3)	15.90(21)	–0.61	–0.22	–1.3(22)
^{237}Np AH	5.35(8)	4.84(5)	5.48 Q	1.14	10.6(20)
^{238}Pu AH	16.5(4)	16.63(5)	–0.28	–0.12	–0.6(21)
^{239}Pu AH	11.27(24)	11.25(5)	0.09	0.04	0.2(22)
^{241}Am AH	5.30(13)	5.356(10)	–0.43	–0.21	–1.1(24)
^{241}Am AH	5.54(9)	5.356(10)	2.03	0.69	3.4(17)
^{244}Cm AH	6.96(16)	6.980(22)	–0.12	–0.06	–0.3(23)
^{3}H B1	1.71(6)	1.688(12)	0.35	0.21	1(4)
^{3}H B1	1.65(11)	1.688(12)	–0.34	–0.38	–2(7)
^{14}C B1	1.01(3)	0.905(6)	3.75 Q	2.19	11(3)
^{99}Tc B1	0.152(8)	0.1562(4)	–0.54	–0.44	–3(6)
^{129}I B1	0.17(3)	0.1504(9)	0.50	1.32	10(19)
^{3}H B2	1.45(5)	1.389(15)	1.19	1.09	4(4)
^{3}H B2	1.33(9)	1.389(15)	–0.68	–1.10	–4(7)
^{55}Fe B2	1.44(9)	1.53(3)	–0.92	–0.81	–6(6)
^{89}Sr B2	0.40(4)	0.463(4)	–1.67	–1.36	–13(8)
^{90}Sr B2	1.13(8)	1.153(10)	–0.31	–0.28	–2(7)
^{60}Co GH	5.42(14)	5.418(12)	0.02	0.01	0(3)
^{65}Zn GH	5.91(17)	5.92(4)	–0.06	–0.04	0(3)
^{85}Sr GH	7.44(14)	7.54(5)	–0.69	–0.32	–1.4(20)
^{125}Sb GH	1.48(14)	1.470(7)	0.07	0.14	1(10)
^{133}Ba GH	3.88(10)	3.84(3)	0.36	0.21	1(3)
^{134}Cs GH	14.69(22)	15.09(11)	–1.63	–0.64	–2.6(16)

continues

continued

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
^{137}Cs GH	4.82(12)	4.81(4)	0.04	0.03	0(3)
^{152}Eu GH	1.98(14)	1.925(13)	0.39	0.57	3(7)
^{55}Fe S	4.3(3)	4.38(13)	–0.31	–0.34	–2(7)
^{90}Sr S	0.82(5)	0.810(20)	0.09	0.10	1(6)
^{90}Sr S	0.76(4)	0.810(20)	–1.03	–1.07	–6(6)
^{133}Ba S	4.71(11)	4.91(13)	–1.22	–0.90	–4(4)
^{134}Cs S	10.96(17)	11.8(3)	–2.37	–1.88	–7(3)
^{137}Cs S	4.88(10)	5.05(13)	–1.00	–0.81	–3(4)
^{152}Eu S	4.43(17)	4.84(13)	–1.93	–2.08	–8(5)

Table B21 – Laboratory 35

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	3.80(18)	5.01(5)	–6.50 D	–4.03 D	–24(4)
^{237}Np AL	10.1(6)	4.65(5)	9.65 D	11.19 D	117(12)
^{238}U AL	17.2(7)	18.0(4)	–1.04	–0.88	–4(5)
^{239}Pu AL	11.2(5)	11.68(12)	–1.02	–0.75	–4(4)
^{241}Am AL	3.10(14)	3.099(6)	0.01	0.00	0(5)
^{244}Cm AL	15.2(6)	15.41(5)	–0.27	–0.25	–1(4)
^{60}Co GL	4.8(4)	5.035(12)	–0.59	–0.83	–4(8)
^{65}Zn GL	5.5(9)	5.50(4)	–0.05	–0.10	–1(15)
^{85}Sr GL	7.2(5)	7.01(5)	0.36	0.46	2(7)
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	3.8(5)	3.571(25)	0.45	0.79	6(13)
^{134}Cs GL	12.6(7)	14.02(10)	–2.01	–1.85	–10(5)
^{137}Cs GL	4.7(4)	4.47(3)	0.66	0.96	6(9)
^{152}Eu GL	–	1.789(12)	–	–	–
	(Bq g^{-1})	(Bq g^{-1})			
^{226}Ra AH	10.2(6)	15.90(21)	–8.95 D	–6.05 D	–36(4)
^{238}Pu AH	10.3(5)	16.63(5)	–14.24 D	–8.06 D	–38(3)
^{239}Pu AH	15.0(7)	11.25(5)	5.91 D	6.89 D	34(6)
^{241}Am AH	4.79(21)	5.356(10)	–2.69 Q	–2.13	–11(4)
^{244}Cm AH	6.19(25)	6.980(22)	–3.15 Q	–2.26	–11(4)
^{3}H B1	1.57(6)	1.688(12)	–1.87	–1.19	–7(4)
^{3}H B1	1.68(9)	1.688(12)	–0.09	–0.08	0(5)
^{14}C B1	0.97(5)	0.905(6)	1.37	1.48	7(6)
^{99}Tc B1	0.128(9)	0.1562(4)	–3.12 D	–2.70 D	–18(6)
^{3}H B2	1.31(5)	1.389(15)	–1.57	–1.49	–6(4)
^{60}Co GH	5.48(16)	5.418(12)	0.39	0.29	1(3)
^{65}Zn GH	6.41(20)	5.92(4)	2.40	2.10	8(4)
^{85}Sr GH	7.56(23)	7.54(5)	0.07	0.05	0(3)
^{125}Sb GH	1.42(6)	1.470(7)	–0.82	–0.66	–3(4)
^{133}Ba GH	3.97(13)	3.84(3)	0.96	0.72	3(4)
^{134}Cs GH	14.9(5)	15.09(11)	–0.46	–0.34	–1(3)

continues

continued

	Result	Assigned result	Zeta score	z-score	Deviation (%)
^{137}Cs GH	4.96(15)	4.81(4)	0.94	0.73	3(4)
^{152}Eu GH	1.85(6)	1.925(13)	–1.22	–0.78	–4(4)
^{133}Ba S	4.79(16)	4.91(13)	–0.61	–0.55	–3(4)
^{134}Cs S	11.0(4)	11.8(3)	–1.67	–1.77	–7(4)
^{137}Cs S	5.29(17)	5.05(13)	1.14	1.20	5(6)
^{152}Eu S	4.47(15)	4.84(13)	–1.88	–1.87	–8(4)

Table B22 – Laboratory 38

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq g^{-1})	(Bq g^{-1})			
^{226}Ra AH	15.3(8)	15.90(21)	–0.73	–0.64	–4(5)
^{237}Np AH	5.6(5)	4.84(5)	1.52	1.69	16(10)
^{238}Pu AH	16.0(9)	16.63(5)	–0.70	–0.80	–4(6)
^{239}Pu AH	10.9(6)	11.25(5)	–0.58	–0.63	–3(6)
^{241}Am AH	4.7(4)	5.356(10)	–1.64	–2.47	–12(8)
^{244}Cm AH	6.2(5)	6.980(22)	–1.56	–2.23	–11(7)
^{3}H B1	1.70(10)	1.688(12)	0.12	0.12	1(6)
^{14}C B1	0.87(7)	0.905(6)	–0.50	–0.78	–4(8)
^{99}Tc B1	0.150(10)	0.1562(4)	–0.62	–0.59	–4(7)
^{129}I B1	0.130(10)	0.1504(9)	–2.03	–1.84	–14(7)
^{3}H B2	1.40(10)	1.389(15)	0.11	0.20	1(7)
^{55}Fe B2	1.40(10)	1.53(3)	–1.22	–1.20	–8(7)
^{89}Sr B2	0.380(10)	0.463(4)	–7.63 Q	–1.86	–17.8(23)
^{90}Sr B2	1.07(5)	1.153(10)	–1.63	–1.01	–7(5)
^{60}Co GH	5.44(14)	5.418(12)	0.16	0.10	0(3)
^{65}Zn GH	6.00(16)	5.92(4)	0.49	0.34	1(3)
^{85}Sr GH	7.82(22)	7.54(5)	1.23	0.87	4(3)
^{125}Sb GH	1.53(6)	1.470(7)	1.00	0.80	4(4)
^{133}Ba GH	3.80(10)	3.84(3)	–0.41	–0.24	–1(3)
^{134}Cs GH	14.8(4)	15.09(11)	–0.70	–0.46	–2(3)
^{137}Cs GH	4.95(13)	4.81(4)	1.01	0.68	3(3)
^{152}Eu GH	2.00(5)	1.925(13)	1.45	0.78	4(3)

Table B23 – Laboratory 39

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	5.2(3)	5.035(12)	0.55	0.61	3(6)
^{65}Zn GL	6.2(5)	5.50(4)	1.39	1.75	13(9)
^{85}Sr GL	10.2(11)	7.01(5)	2.90 D	8.55 D	46(16)
^{125}Sb GL	1.7(2)	1.366(7)	1.67	1.86	24(15)
^{133}Ba GL	4.2(5)	3.571(25)	1.26	2.39	18(14)
^{134}Cs GL	14.7(15)	14.02(10)	0.45	0.91	5(11)
^{137}Cs GL	4.4(3)	4.47(3)	–0.25	–0.27	–2(7)
^{152}Eu GL	2.0(2)	1.789(12)	1.05	1.18	12(11)

Table B24 – Laboratory 40

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{238}U AL	16.5(3)	18.0(4)	–2.85 Q	–1.57	–8(3)
^{239}Pu AL	11.2(4)	11.68(12)	–1.33	–0.77	–4(3)
^{241}Am AL	2.87(8)	3.099(6)	–2.93 Q	–1.01	–7.4(25)
^{244}Cm AL	14.5(4)	15.41(5)	–2.63 Q	–1.40	–6.2(23)
^{60}Co GL	6.59(19)	5.035(12)	8.17 D	5.74 D	31(4)
^{65}Zn GL	5.13(18) Q	5.50(4)	–0.21	–0.93	$-1(4) \times 10^{1}$
^{85}Sr GL	6.8(9)	7.01(5)	–0.19	–0.45	–2(12)
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	3.3(8)	3.571(25)	–0.32	–0.95	–7(22)
^{134}Cs GL	14.3(10)	14.02(10)	0.27	0.37	2(7)
^{137}Cs GL	4.4(6)	4.47(3)	–0.11	–0.23	–1(13)
^{152}Eu GL	–	1.789(12)	–	–	–
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B2	0.133(5)	1.389(15)	–79.45 D	–22.35 D	–90.4(4)
^{89}Sr B2	0.35(6)	0.463(4)	–1.84	–2.54	–24(13)
^{90}Sr B2	0.82(14)	1.153(10)	–2.33	–4.03 Q	–29(12)

Table B25 – Laboratory 41

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	5.0(4)	5.035(12)	–0.23	–0.31	–2(8)
^{65}Zn GL	5.9(9)	5.50(4)	0.44	0.95	7(16)
^{85}Sr GL	7.4(4)	7.01(5)	1.15	1.15	6(6)
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	3.5(4)	3.571(25)	–0.29	–0.38	–3(10)
^{134}Cs GL	11.7(7)	14.02(10)	–3.52 D	–3.15 D	–17(5)
^{137}Cs GL	4.2(6)	4.47(3)	–0.43	–0.89	–5(13)
^{152}Eu GL	–	1.789(12)	–	–	–
	(Bq g^{-1})	(Bq g^{-1})			
238Pu AH	15.6(8)	16.63(5)	–1.35	–1.31	–6(5)
^{239}Pu AH	10.7(5)	11.25(5)	–1.19	–0.99	–5(4)
Gross a AH	67(3)	8(3) × 10^{1}	–0.42	–3.09 Q	–1(3) × 10^{1}
^{3}H B2	1.34(4)	1.389(15)	–1.35	–0.87	–4(3)
^{90}Sr B2	1.66(7)	1.153(10)	7.58 D	6.14 D	44(6)
Gross b B2	2.92(11)	2.769(15)	1.36	1.09	5(4)

Table B26 – Laboratory 42

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	19(7) Q	5.01(5)	2.14	45.81 Q	27(13) × 10^{1}
^{237}Np AL	5.3(12)	4.65(5)	0.57	1.40	1(3) × 10^{1}
^{238}U AL	16.0(25)	18.0(4)	–0.79	–2.18	–11(14)
^{241}Am AL	3.3(4)	3.099(6)	0.45	0.74	5(12)
Gross a AL	43.9(8)	72(7)	–4.23 D	–7.44 D	–39(6)
^{60}Co GL	5.2(6)	5.035(12)	0.37	0.76	4(11)
^{65}Zn GL	5.2(6)	5.50(4)	–0.44	–0.65	–5(11)
^{85}Sr GL	7.6(8)	7.01(5)	0.75	1.58	8(11)
^{125}Sb GL	1.34(20)	1.366(7)	–0.13	–0.14	–2(15)
^{133}Ba GL	3.3(4)	3.571(25)	–0.71	–0.95	–7(10)
^{134}Cs GL	13.4(14)	14.02(10)	–0.47	–0.87	–5(10)
^{137}Cs GL	5.0(6)	4.47(3)	0.99	1.91	12(12)
^{152}Eu GL	1.87(22)	1.789(12)	0.37	0.45	5(12)

Table B27 – Laboratory 45

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	5.16(18)	5.418(12)	–1.43	–1.20	–5(4)
^{65}Zn GH	5.52(19)	5.92(4)	–2.06	–1.71	–7(4)
^{85}Sr GH	7.0(3)	7.54(5)	–1.79	–1.77	–7(4)
^{125}Sb GH	1.36(7)	1.470(7)	–1.56	–1.45	–7(5)
^{133}Ba GH	3.28(20)	3.84(3)	–2.79 D	–3.19 D	–15(5)
^{134}Cs GH	15.1(10)	15.09(11)	0.03	0.05	0(7)
^{137}Cs GH	4.76(19)	4.81(4)	–0.29	–0.28	–1(4)
^{152}Eu GH	1.75(16)	1.925(13)	–1.09	–1.81	–9(8)

Table B28 – Laboratory 46

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	4.82(20)	5.035(12)	–1.07	–0.79	–4(4)
^{65}Zn GL	5.36(23)	5.50(4)	–0.61	–0.35	–3(5)
^{85}Sr GL	6.92(25)	7.01(5)	–0.35	–0.24	–1(4)
^{125}Sb GL	1.55(15)	1.366(7)	1.23	1.03	13(11)
^{133}Ba GL	3.28(15)	3.571(25)	–1.91	–1.10	–8(5)
^{134}Cs GL	13.3(7)	14.02(10)	–0.95	–0.91	–5(5)
^{137}Cs GL	4.63(18)	4.47(3)	0.85	0.56	3(4)
^{152}Eu GL	1.74(16)	1.789(12)	–0.30	–0.27	–3(9)
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	5.34(18)	5.418(12)	–0.43	–0.36	–1(4)
^{65}Zn GH	5.80(20)	5.92(4)	–0.59	–0.51	–2(4)
^{85}Sr GH	7.5(3)	7.54(5)	–0.20	–0.17	–1(4)
^{125}Sb GH	1.47(6)	1.470(7)	0.01	0.01	0(4)
^{133}Ba GH	3.86(14)	3.84(3)	0.12	0.10	0(4)
^{134}Cs GH	14.5(5)	15.09(11)	–1.24	–0.99	–4(4)
^{137}Cs GH	4.82(17)	4.81(4)	0.03	0.03	0(4)
^{152}Eu GH	1.95(7)	1.925(13)	0.35	0.26	1(4)

Table B29 – Laboratory 47

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	4.4(4)	5.01(5)	–1.89	–2.03	–12(7)
^{238}U AL	17.9(8)	18.0(4)	–0.12	–0.12	–1(5)
^{238}U AL	18.01(3)	18.0(4)	0.09	0.04	0.2(23)
^{239}Pu AL	10.4(6)	11.68(12)	–2.13	–2.14	–11(6)
^{241}Am AL	3.23(20)	3.099(6)	0.66	0.58	4(7)
^{244}Cm AL	15.2(5)	15.41(5)	–0.33	–0.25	–1(4)
^{60}Co GL	5.2(4)	5.035(12)	0.44	0.57	3(7)
^{65}Zn GL	4.7(5)	5.50(4)	–1.64	–1.93	–14(9)
^{85}Sr GL	6.6(5)	7.01(5)	–0.97	–1.15	–6(7)
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	3.5(3)	3.571(25)	–0.31	–0.31	–2(7)
^{134}Cs GL	13.4(8)	14.02(10)	–0.72	–0.79	–4(6)
^{137}Cs GL	4.8(4)	4.47(3)	1.04	1.25	8(8)
^{152}Eu GL	–	1.789(12)	–	–	–
	(Bq g^{-1})	(Bq g^{-1})			
^{226}Ra AH	15.5(6)	15.90(21)	–0.56	–0.38	–2(4)
^{237}Np AH	4.8(6)	4.84(5)	–0.10	–0.13	–1(11)
^{237}Np AH	4.3(4)	4.84(5)	–1.27	–1.19	–11(9)
^{239}Pu AH	10.4(6)	11.25(5)	–1.45	–1.61	–8(6)
^{241}Am AH	3.23(20)	5.356(10)	–10.62	–8.00	–40(4)
^{244}Cm AH	6.2(4)	6.980(22)	–2.23	–2.18	–11(5)
Gross a AH	77(6)	$8(3) \times 10^1$	–0.07	–0.50	$0(4) \times 10^1$
^{60}Co GH	5.8(3)	5.418(12)	1.21	1.68	7(6)
^{65}Zn GH	6.1(4)	5.92(4)	0.45	0.65	3(6)
^{85}Sr GH	7.6(4)	7.54(5)	0.12	0.15	1(5)
^{125}Sb GH	1.41(8)	1.470(7)	–0.74	–0.79	–4(6)
^{133}Ba GH	3.90(20)	3.84(3)	0.29	0.33	2(6)
^{134}Cs GH	15.2(8)	15.09(11)	0.10	0.13	1(5)
^{137}Cs GH	4.9(3)	4.81(4)	0.48	0.63	3(6)
^{152}Eu GH	2.00(10)	1.925(13)	0.74	0.78	4(5)
^{133}Ba S	4.7(3)	4.91(13)	–0.78	–1.12	–5(7)

continues

continued					
	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
^{134}Cs S	10.9(7)	11.8(3)	–1.23	–2.13	–8(7)
^{137}Cs S	4.9(4)	5.05(13)	–0.56	–0.95	–4(7)
^{152}Eu S	4.6(3)	4.84(13)	–0.82	–1.36	–6(7)

Table B30 – Laboratory 48

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	5.33(10)	5.418(12)	–0.87	–0.41	–1.6(19)
^{65}Zn GH	5.84(14)	5.92(4)	–0.55	–0.34	–1.3(25)
^{85}Sr GH	7.45(14)	7.54(5)	–0.62	–0.29	–1.2(20)
^{125}Sb GH	1.55(11)	1.470(7)	0.73	1.06	5(8)
^{133}Ba GH	3.85(8)	3.84(3)	0.09	0.04	0.2(22)
^{134}Cs GH	14.33(24)	15.09(11)	–2.89 Q	–1.22	–5.0(17)
^{137}Cs GH	4.80(10)	4.81(4)	–0.14	–0.08	–0.3(22)
^{152}Eu GH	2.30(12)	1.925(13)	3.11 D	3.89 D	19(6)
^{133}Ba S	5.45(24)	4.91(13)	1.97	2.36	11(6)
^{134}Cs S	12.3(5)	11.8(3)	0.88	1.18	4(5)
^{137}Cs S	5.45(24)	5.05(13)	1.48	1.98	8(6)
^{152}Eu S	5.7(3)	4.84(13)	2.97 D	4.50 D	18(7)

Table B31 – Laboratory 51

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	4.30(20)	5.01(5)	–3.46 Q	–2.36	–14(4)
^{238}U AL	19.9(9)	18.0(4)	1.95	2.10	11(6)
^{239}Pu AL	9.7(4)	11.68(12)	–4.76 D	–3.21 D	–17(4)
^{241}Am AL	2.90(10)	3.099(6)	–1.99	–0.88	–6(4)
^{244}Cm AL	8.7(3)	15.41(5)	–22.06 D	–9.86 D	–43.5(20)
^{60}Co GL	5.24(21)	5.035(12)	0.98	0.76	4(4)
^{65}Zn GL	6.2(3)	5.50(4)	2.77 Q	1.82	13(5)
^{85}Sr GL	9.1(4)	7.01(5)	5.50 D	5.49 D	29(6)
^{125}Sb GL	1.59(10)	1.366(7)	2.24	1.25	16(7)
^{133}Ba GL	3.78(18)	3.571(25)	1.15	0.79	6(5)
^{134}Cs GL	14.9(5)	14.02(10)	1.72	1.18	6(4)
^{137}Cs GL	4.88(18)	4.47(3)	2.22	1.47	9(4)
^{152}Eu GL	1.90(10)	1.789(12)	1.10	0.62	6(6)

Table B32 – Laboratory 53

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	5.14(25)	5.035(12)	0.42	0.39	2(5)
^{65}Zn GL	5.8(3)	5.50(4)	1.05	0.85	6(6)
^{85}Sr GL	7.2(4)	7.01(5)	0.62	0.54	3(5)
^{125}Sb GL	1.48(13)	1.366(7)	0.88	0.64	8(10)
^{133}Ba GL	3.45(19)	3.571(25)	–0.63	–0.46	–3(6)
^{134}Cs GL	13.3(6)	14.02(10)	–1.27	–0.97	–5(4)
^{137}Cs GL	4.75(21)	4.47(3)	1.30	1.00	6(5)
^{152}Eu GL	1.78(14)	1.789(12)	–0.06	–0.05	0(8)

Table B33 – Laboratory 55

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq g^{-1})	(Bq g^{-1})			
^{237}Np G AH	5.0(9)	4.84(5)	0.20	0.38	4(18)
^{237}Np M AH	5.97(18)	4.84(5)	6.08 Q	2.51	23(4)
^{238}Pu AH	15.3(6)	16.63(5)	–2.13	–1.70	–8(4)
^{239}Pu AH	10.5(5)	11.25(5)	–1.72	–1.36	–7(4)
^{241}Am AH	4.8(3)	5.356(10)	–1.91	–2.13	–11(6)
^{241}Am AH	5.24(12)	5.356(10)	–0.93	–0.44	–2.2(23)
^{244}Cm AH	6.5(4)	6.980(22)	–1.19	–1.35	–7(6)
Gross a AH	70(3)	8(3) × 10^{1}	–0.30	–2.23	–1(3) × 10^{1}
^{3}H B1	1.67(12)	1.688(12)	–0.15	–0.18	–1(8)
^{14}C B1	0.96(3)	0.905(6)	1.94	1.22	6(4)
^{99}Tc L B1	0.160(10)	0.1562(4)	0.40	0.37	2(6)
^{99}Tc M B1	0.6(6) Q	0.1562(4)	0.75	45.51 Q	3(4) × 10^{2}
^{129}I B1	0.176(16)	0.1504(9)	1.58	2.32	17(11)
^{3}H B2	1.14(11)	1.389(15)	–2.34	–4.43 Q	–18(8)
^{55}Fe B2	1.28(10)	1.53(3)	–2.29	–2.33	–16(7)
^{89}Sr B2	0.20(11) Q	0.463(4)	–2.32	–5.92 Q	–57(24)
^{90}Sr B2	1.59(11)	1.153(10)	4.07 D	5.29 D	38(9)
Gross b B2 I	3.14(22)	2.769(15)	1.68	2.68 Q	13(8)
^{60}Co GH	5.51(15)	5.418(12)	0.61	0.43	2(3)
^{65}Zn GH	7.02(24)	5.92(4)	4.52 D	4.72 D	19(4)
^{85}Sr GH	7.24(25)	7.54(5)	–1.19	–0.95	–4(4)
^{125}Sb GH	1.50(16)	1.470(7)	0.19	0.40	2(11)
^{133}Ba GH	3.74(20)	3.84(3)	–0.51	–0.58	–3(5)
^{134}Cs GH	14.8(5)	15.09(11)	–0.61	–0.46	–2(3)
^{137}Cs GH	4.86(14)	4.81(4)	0.31	0.23	1(3)
^{152}Eu GH	2.10(15)	1.925(13)	1.16	1.81	9(8)
^{133}Ba S	4.9(3)	4.91(13)	–0.20	–0.29	–1(7)
^{134}Cs S	11.8(7)	11.8(3)	0.02	0.03	0(6)
^{137}Cs S	5.3(3)	5.05(13)	0.83	1.29	5(7)
^{152}Eu S	5.0(4)	4.84(13)	0.33	0.63	3(8)

Table B34 – Laboratory 58

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	5.02(18)	5.035(12)	–0.08	–0.05	0(4)
^{65}Zn GL	5.53(21)	5.50(4)	0.14	0.07	1(4)
^{85}Sr GL	7.1(3)	7.01(5)	0.21	0.16	1(4)
^{125}Sb GL	1.23(6)	1.366(7)	–2.25	–0.76	–10(5)
^{133}Ba GL	3.46(13)	3.571(25)	–0.84	–0.42	–3(4)
^{134}Cs GL	13.8(5)	14.02(10)	–0.53	–0.37	–2(4)
^{137}Cs GL	4.44(17)	4.47(3)	–0.20	–0.13	–1(4)
^{152}Eu GL	1.72(8)	1.789(12)	–0.85	–0.39	–4(5)
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	6.72(24)	5.418(12)	5.42 D	6.04 D	24(5)
^{65}Zn GH	7.2(3)	5.92(4)	4.58 D	5.37 D	21(5)
^{85}Sr GH	9.1(4)	7.54(5)	4.62 D	4.99 D	21(5)
^{125}Sb GH	1.75(6)	1.470(7)	4.64 D	3.71 D	19(4)
^{133}Ba GH	4.55(17)	3.84(3)	4.11 D	4.02 D	18(5)
^{134}Cs GH	18.0(6)	15.09(11)	4.79 D	4.68 D	19(4)
^{137}Cs GH	5.97(22)	4.81(4)	5.19 D	5.80 D	24(5)
^{152}Eu GH	2.29(8)	1.925(13)	4.50 D	3.78 D	19(5)
^{133}Ba S	4.76(18)	4.91(13)	–0.70	–0.68	–3(5)
^{134}Cs S	11.6(4)	11.8(3)	–0.37	–0.43	–2(5)
^{137}Cs S	5.08(18)	5.05(13)	0.16	0.17	1(5)
^{152}Eu S	4.73(17)	4.84(13)	–0.51	–0.55	–2(5)

Table B35 – Laboratory 59

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	4.9(5)	5.01(5)	–0.27	–0.44	–3(10)
^{238}U AL	17.4(14)	18.0(4)	–0.39	–0.61	–3(8)
^{239}Pu AL	11.0(9)	11.68(12)	–0.85	–1.19	–6(7)
^{241}Am AL	3.07(25)	3.099(6)	–0.12	–0.13	–1(8)
^{244}Cm AL	15.0(12)	15.41(5)	–0.38	–0.66	–3(8)
Gross a AL	66(5)	72(7)	–0.63	–1.42	–7(11)
^{60}Co GL	6.8(5)	5.035(12)	3.39 D	6.52 D	35(10)
^{65}Zn GL	5.9(15)	5.50(4)	0.28	1.05	$1(3) \times 10^1$
^{85}Sr GL	9.4(8)	7.01(5)	2.97 D	6.38 D	34(11)
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	5.0(7)	3.571(25)	2.00	5.47 Q	40(20)
^{134}Cs GL	15.0(8)	14.02(10)	1.26	1.36	7(6)
^{137}Cs GL	6.0(6)	4.47(3)	2.51	5.65 Q	35(14)
^{152}Eu GL	–	1.789(12)	–	–	–
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B1	1.7(1)	1.688(12)	0.12	0.12	1(6)
^{14}C B1	1.02(4)	0.905(6)	2.84 Q	2.51	13(5)
^{99}Tc B1	0.20(1)	0.1562(4)	4.38 D	4.21 D	28(7)
^{129}I B1	0.14(1)	0.1504(9)	–1.03	–0.94	–7(7)
^{60}Co GH	5.6(4)	5.418(12)	0.48	0.71	3(6)
^{65}Zn GH	6.1(4)	5.92(4)	0.42	0.65	3(6)
^{85}Sr GH	7.8(5)	7.54(5)	0.52	0.75	3(6)
^{125}Sb GH	1.46(10)	1.470(7)	–0.10	–0.13	–1(7)
^{133}Ba GH	3.95(23)	3.84(3)	0.46	0.61	3(6)
^{134}Cs GH	15.0(9)	15.09(11)	–0.11	–0.16	–1(6)
^{137}Cs GH	5.0(3)	4.81(4)	0.63	0.93	4(6)
^{152}Eu GH	2.02(12)	1.925(13)	0.79	0.98	5(6)

Table B36 – Laboratory 61

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{238}U AL	17.5(6)	18.0(4)	–0.72	–0.52	–3(4)
^{241}Am AL	2.92(13)	3.099(6)	–1.39	–0.79	–6(4)
^{244}Cm AL	14.2(4)	15.41(5)	–3.37 Q	–1.78	–7.9(23)
^{60}Co GL	5.17(13)	5.035(12)	1.04	0.50	3(3)
^{65}Zn GL	6.27(20)	5.50(4)	3.78 Q	1.92	14(4)
^{85}Sr GL	7.18(18)	7.01(5)	0.92	0.46	2(3)
^{125}Sb GL	1.36(11)	1.366(7)	–0.05	–0.03	0(8)
^{133}Ba GL	3.61(18)	3.571(25)	0.22	0.15	1(5)
^{134}Cs GL	12.6(3)	14.02(10)	–4.78 Q	–1.91	–10.1(21)
^{137}Cs GL	4.77(15)	4.47(3)	1.93	1.07	7(4)
^{152}Eu GL	1.63(9)	1.789(12)	–1.75	–0.89	–9(5)
^{40}K GL	6.4(6)	–	–	–	–
	(Bq g^{-1})	(Bq g^{-1})			
^{89}Sr B2	0.86(15)	0.463(4)	2.65 D	8.95 D	$9(4) \times 10^1$
^{90}Sr B2	1.31(23)	1.153(10)	0.68	1.90	14(4)
Gross b B2	3.7(5)	5.68(4)	–4.23 D	–7.02 D	–35(8)

Table B37 – Laboratory 62

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{239}Pu AL	11.1(6)	11.68(12)	–1.00	–0.99	–5(5)
^{241}Am AL	3.08(18)	3.099(6)	–0.10	–0.08	–1(6)
^{60}Co GL	4.8(5)	5.035(12)	–0.45	–0.76	–4(9)
^{65}Zn GL	5.3(6)	5.50(4)	–0.34	–0.45	–3(10)
^{85}Sr GL	7.0(3)	7.01(5)	–0.17	–0.13	–1(4)
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	3.1(3)	3.571(25)	–1.67	–1.79	–13(8)
^{134}Cs GL	12.9(3)	14.02(10)	–3.66 Q	–1.50	–8.0(22)
^{137}Cs GL	4.3(3)	4.47(3)	–0.74	–0.71	–4(6)
^{152}Eu GL	–	1.789(12)	–	–	–

Table B38 – Laboratory 65

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	4.55(23)	5.01(5)	–1.96	–1.53	–9(5)
^{237}Np AL	8.4(7)	4.65(5)	5.60 D	7.76 D	81(15)
^{238}U AL	17.7(15)	18.0(4)	–0.19	–0.32	–2(9)
^{239}Pu AL	11.6(5)	11.68(12)	–0.21	–0.18	–1(5)
^{241}Am AL	2.91(20)	3.099(6)	–0.94	–0.84	–6(7)
^{244}Cm AL	18.4(14)	15.41(5)	2.17	4.41 Q	19(9)
Gross a AL	78(7)	72(7)	0.67	1.71	9(14)
^{60}Co GL	5.24(19)	5.035(12)	1.08	0.76	4(4)
^{65}Zn GL	5.55(21)	5.50(4)	0.23	0.12	1(4)
^{85}Sr GL	6.8(3)	7.01(5)	–0.84	–0.64	–3(4)
^{125}Sb GL	1.31(6)	1.366(7)	–0.92	–0.31	–4(5)
^{133}Ba GL	3.57(13)	3.571(25)	–0.01	0.00	0(4)
^{134}Cs GL	14.2(5)	14.02(10)	0.29	0.20	1(4)
^{137}Cs GL	4.57(17)	4.47(3)	0.55	0.35	2(4)
^{152}Eu GL	1.94(8)	1.789(12)	1.87	0.84	8(5)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B1	1.73(7)	1.688(12)	0.59	0.42	2(5)
^{14}C B1	0.95(5)	0.905(6)	0.89	0.98	5(6)
^{99}Tc B1	0.150(10)	0.1562(4)	–0.62	–0.59	–4(7)
^{129}I B1	0.151(6)	0.1504(9)	0.11	0.06	0(4)
^{3}H B2	1.37(6)	1.389(15)	–0.30	–0.33	–1(5)
^{90}Sr B2	1.11(15)	1.153(10)	–0.29	–0.52	–4(13)
Gross b I B2	2.7(3)	2.769(15)	–0.23	–0.50	–2(11)

Table B39 – Laboratory 72

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	4.7(3)	5.035(12)	–1.23	–1.27	–7(6)
^{65}Zn GL	5.9(4)	5.50(4)	1.10	1.00	7(7)
^{85}Sr GL	7.1(4)	7.01(5)	0.17	0.19	1(6)
^{125}Sb GL	1.71(16)	1.366(7)	2.15	1.92	25(12)
^{133}Ba GL	3.60(23)	3.571(25)	0.13	0.11	1(7)
^{134}Cs GL	13.3(8)	14.02(10)	–0.96	–0.98	–5(6)
^{137}Cs GL	4.6(3)	4.47(3)	0.42	0.46	3(7)
^{152}Eu GL	1.99(20)	1.789(12)	1.00	1.12	11(11)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B2	1.36(8)	1.389(15)	–0.35	–0.51	–2(6)

Table B40 – Laboratory 74

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	4.95(16)	5.035(12)	–0.53	–0.31	–2(4)
^{65}Zn GL	5.56(21)	5.50(4)	0.28	0.15	1(4)
^{85}Sr GL	6.64(25)	7.01(5)	–1.45	–0.99	–5(4)
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	3.45(12)	3.571(25)	–0.99	–0.46	–3(4)
^{134}Cs GL	13.50(16)	14.02(10)	–2.77 Q	–0.70	–3.7(13)
^{137}Cs GL	4.1(5)	4.47(3)	–0.78	–1.36	–8(11)
^{152}Eu GL	1.82(12)	1.789(12)	0.26	0.17	2(7)
	(Bq g^{-1})	(Bq g^{-1})			
^{99}Tc B1	0.156(7)	0.1562(4)	–0.02	–0.02	0(5)
^{129}I B1	0.150(6)	0.1504(9)	–0.03	–0.02	0(4)
^{89}Sr B2	0.512(21)	0.463(4)	2.31	1.11	11(5)
^{90}Sr B2	1.07(4)	1.153(10)	–2.01	–1.01	–7(4)
^{133}Ba S	4.31(11)	4.91(13)	–3.59 D	–2.67 D	–12(4)
^{134}Cs S	11.3(4)	11.8(3)	–1.13	–1.18	–4(4)
^{137}Cs S	4.38(17)	5.05(13)	–3.10 D	–3.25 D	–13(4)
^{152}Eu S	4.61(10)	4.84(13)	–1.42	–1.16	–5(4)

Table B41 – Laboratory 76

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	5.27(24)	5.035(12)	0.98	0.87	5(5)
^{65}Zn GL	5.4(4)	5.50(4)	–0.22	–0.23	–2(8)
^{85}Sr GL	8.3(4)	7.01(5)	3.76 D	3.46 D	18(5)
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	3.16(14)	3.571(25)	–2.89 Q	–1.56	–12(4)
^{134}Cs GL	13.7(4)	14.02(10)	–0.94	–0.43	–2.3(25)
^{137}Cs GL	5.41(24)	4.47(3)	3.87 D	3.40 D	21(6)
^{152}Eu GL	1.57(13)	1.789(12)	–1.68	–1.22	–12(7)
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	4.83(14)	5.418(12)	–4.18 D	–2.73 D	–11(3)
^{65}Zn GH	5.80(23)	5.92(4)	–0.51	–0.51	–2(4)
^{85}Sr GH	7.5(7)	7.54(5)	0.00	–0.01	0(9)
^{125}Sb GH	1.43(3)	1.470(7)	–1.28	–0.52	–2.7(21)
^{133}Ba GH	3.46(6)	3.84(3)	–5.84 Q	–2.17	–10.0(17)
^{134}Cs GH	11.9(3)	15.09(11)	–11.35 D	–5.11 D	–21.1(18)
^{137}Cs GH	4.77(20)	4.81(4)	–0.22	–0.23	–1(5)
^{152}Eu GH	1.660(20)	1.925(13)	–11.04 D	–2.75 D	–13.8(12)
^{90}Sr S	0.79(4)	0.810(20)	–0.47	–0.43	–2(5)
^{133}Ba S	3.80(9)	4.91(13)	–7.08 D	–4.92 D	–23(3)
^{134}Cs S	8.80(15)	11.8(3)	–8.75 D	–6.79 D	–25.4(23)
^{137}Cs S	5.09(15)	5.05(13)	0.22	0.22	1(4)
^{152}Eu S	3.69(6)	4.84(13)	–8.25 D	–5.85 D	–23.7(23)

Table B42 – Laboratory 77

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	5.7(4)	5.418(12)	0.83	1.31	5(6)
^{65}Zn GH	6.4(4)	5.92(4)	1.30	2.19	9(7)
^{85}Sr GH	7.6(5)	7.54(5)	0.17	0.24	1(6)
^{125}Sb GH	1.51(11)	1.470(7)	0.37	0.53	3(8)
^{133}Ba GH	3.70(24)	3.84(3)	–0.59	–0.81	–4(6)
^{134}Cs GH	14.8(9)	15.09(11)	–0.38	–0.54	–2(6)
^{137}Cs GH	5.2(3)	4.81(4)	1.27	1.98	8(7)
^{152}Eu GH	1.88(14)	1.925(13)	–0.32	–0.47	–2(7)

Table B43 – Laboratory 78

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B1	1.732(23)	1.688(12)	1.67	0.44	2.6(16)
^{14}C B1	1.146(19)	0.905(6)	12.12 D	5.28 D	26.6(22)
^{99}Tc B1	0.200(4)	0.1562(4)	11.84 D	4.25 D	28.3(24)
^{129}I B1	0.135(5)	0.1504(9)	–3.08 Q	–1.39	–10(4)

Table B44 – Laboratory 82

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	4.5(5)	5.035(12)	–1.12	–1.94	–10(9)
^{65}Zn GL	4.7(5)	5.50(4)	–1.66	–2.00	–15(9)
^{85}Sr GL	8.1(8)	7.01(5)	1.35	2.98 Q	16(12)
^{125}Sb GL	1.22(17)	1.366(7)	–0.86	–0.81	–11(12)
^{133}Ba GL	3.5(4)	3.571(25)	–0.27	–0.38	–3(10)
^{134}Cs GL	12.6(13)	14.02(10)	–1.09	–1.91	–10(9)
^{137}Cs GL	4.6(5)	4.47(3)	0.34	0.60	4(11)
^{152}Eu GL	2.3(4)	1.789(12)	1.53	2.74 Q	27(18)
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	6.0(6)	5.418(12)	0.99	2.75 Q	11(11)
^{65}Zn GH	6.7(7)	5.92(4)	1.10	3.18 Q	13(11)
^{85}Sr GH	8.7(9)	7.54(5)	1.36	3.77 Q	16(12)
^{125}Sb GH	1.67(17)	1.470(7)	1.18	2.65 Q	14(12)
^{133}Ba GH	3.4(4)	3.84(3)	–1.27	–2.46	–11(9)
^{134}Cs GH	16.1(16)	15.09(11)	0.63	1.62	7(11)
^{137}Cs GH	5.6(6)	4.81(4)	1.38	3.89 Q	16(12)
^{152}Eu GH	2.01(21)	1.925(13)	0.40	0.88	4(11)

Table B45 – Laboratory 83

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	–	5.035(12)	–	–	–
^{65}Zn GL	–	5.50(4)	–	–	–
^{85}Sr GL	–	7.01(5)	–	–	–
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	–	3.571(25)	–	–	–
^{134}Cs GL	13.3(5)	14.02(10)	–1.42	–0.97	–5(4)
^{137}Cs GL	4.7(5)	4.47(3)	0.45	0.82	5(11)
^{152}Eu GL	–	1.789(12)	–	–	–
	(Bq g^{-1})	(Bq g^{-1})			
^{99}Tc B1	0.160(10)	0.1562(4)	0.38	0.37	2(7)
^{60}Co GH	–	5.418(12)	–	–	–
^{65}Zn GH	–	5.92(4)	–	–	–
^{85}Sr GH	–	7.54(5)	–	–	–
^{125}Sb GH	–	1.470(7)	–	–	–
^{133}Ba GH	–	3.84(3)	–	–	–
^{134}Cs GH	14.5(5)	15.09(11)	–1.15	–0.94	–4(4)
^{137}Cs GH	5.2(5)	4.81(4)	0.77	1.93	8(10)
^{152}Eu GH	–	1.925(13)	–	–	–
^{137}Cs S	5.3(5)	5.05(13)	0.49	1.24	5(10)

Table B46 – Laboratory 86

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{237}Np AL	4.4(6)	4.65(5)	–0.40	–0.51	–5(13)
^{238}U AL	16.2(12)	18.0(4)	–1.40	–1.91	–10(7)
^{241}Am AL	2.95(24)	3.099(6)	–0.62	–0.66	–5(8)
^{60}Co GL	4.8(6)	5.035(12)	–0.48	–0.94	–5(11)
^{65}Zn GL	5.1(3)	5.50(4)	–1.53	–1.00	–7(5)
^{85}Sr GL	7.7(5)	7.01(5)	1.41	1.82	10(7)
^{125}Sb GL	0.96(15)	1.366(7)	–2.70 Q	–2.26	–30(11)
^{133}Ba GL	3.4(5)	3.571(25)	–0.51	–0.84	–6(12)
^{134}Cs GL	13.6(15)	14.02(10)	–0.28	–0.57	–3(11)
^{137}Cs GL	4.62(21)	4.47(3)	0.69	0.53	3(5)
^{152}Eu GL	1.74(23)	1.789(12)	–0.21	–0.27	–3(13)
	(Bq g^{-1})	(Bq g^{-1})			
^{226}Ra AH	12.2(8)	15.90(21)	–4.86 D	–3.97 D	–23(5)
^{237}Np AH	4.3(3)	4.84(5)	–1.71	–1.19	–11(7)
^{241}Am AH	4.3(3)	5.356(10)	–3.28 D	–3.82 D	–19(6)
^{60}Co GH	4.9(6)	5.418(12)	–0.98	–2.40	–10(10)
^{65}Zn GH	5.27(23)	5.92(4)	–2.78 D	–2.79 D	–11(4)
^{85}Sr GH	7.2(5)	7.54(5)	–0.77	–1.08	–5(6)
^{125}Sb GH	1.31(14)	1.470(7)	–1.14	–2.11	–11(10)
^{133}Ba GH	3.5(4)	3.84(3)	–0.80	–1.77	–8(10)
^{134}Cs GH	13.5(15)	15.09(11)	–1.09	–2.55	–11(10)
^{137}Cs GH	4.48(18)	4.81(4)	–1.83	–1.68	–7(4)
^{152}Eu GH	1.79(21)	1.925(13)	–0.64	–1.40	–7(11)

Table B47 – Laboratory 88

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	4.90(10)	5.01(5)	–1.00	–0.37	–2.2(22)
^{238}U AL	16.1(8)	18.0(4)	–2.05	–2.05	–10(5)
^{239}Pu AL	13.0(5)	11.68(12)	2.67 Q	2.13	11(5)
^{241}Am AL	3.24(14)	3.099(6)	1.01	0.63	5(5)
^{244}Cm AL	13.7(5)	15.41(5)	–3.62 Q	–2.51	–11(3)
Gross a AL	61(7)	72(7)	–1.12	–2.75 Q	–14(12)
^{60}Co GL	5.10(24)	5.035(12)	0.27	0.24	1(5)
^{65}Zn GL	5.8(3)	5.50(4)	1.20	0.85	6(5)
^{85}Sr GL	7.4(3)	7.01(5)	1.29	1.05	6(5)
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	3.30(20)	3.571(25)	–1.34	–1.03	–8(6)
^{134}Cs GL	12.9(6)	14.02(10)	–1.85	–1.50	–8(5)
^{137}Cs GL	4.60(20)	4.47(3)	0.62	0.46	3(5)
^{152}Eu GL	1.90(20)	1.789(12)	0.55	0.62	6(11)
	(Bq g^{-1})	(Bq g^{-1})			
^{226}Ra AH	20.7(8)	15.90(21)	6.02 D	5.11 D	30(5)
^{238}Pu AH	17.0(8)	16.63(5)	0.47	0.48	2(5)
^{239}Pu AH	9.6(5)	11.25(5)	–3.49 D	–2.99 D	–15(4)
^{241}Am AH	5.6(3)	5.356(10)	1.01	1.07	5(5)
^{244}Cm AH	6.8(4)	6.980(22)	–0.54	–0.52	–3(5)
Gross a AH	63(3)	$8(3) \times 10^1$	–0.58	–4.28 Q	$-2(3) \times 10^1$
^{60}Co GH	5.25(23)	5.418(12)	–0.73	–0.78	–3(5)
^{65}Zn GH	5.84(23)	5.92(4)	–0.34	–0.34	–1(4)
^{85}Sr GH	7.1(3)	7.54(5)	–1.39	–1.33	–6(4)
^{125}Sb GH	1.38(6)	1.470(7)	–1.48	–1.18	–6(4)
^{133}Ba GH	3.50(15)	3.84(3)	–2.25	–1.94	–9(4)
^{134}Cs GH	13.6(6)	15.09(11)	–2.44	–2.39	–10(4)
^{137}Cs GH	4.55(18)	4.81(4)	–1.45	–1.33	–6(4)
^{152}Eu GH	1.80(8)	1.925(13)	–1.54	–1.30	–6(5)

Table B48 – Laboratory 89

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	5.3(3)	5.035(12)	0.88	0.98	5(6)
^{65}Zn GL	4.4(4)	5.50(4)	–3.24 D	–2.85 D	–21(7)
^{85}Sr GL	7.2(5)	7.01(5)	0.34	0.40	2(7)
^{125}Sb GL	1.56(23)	1.366(7)	0.84	1.08	14(17)
^{133}Ba GL	3.6(4)	3.571(25)	–0.06	–0.08	–1(10)
^{134}Cs GL	12.5(7)	14.02(10)	–2.15	–2.04	–11(5)
^{137}Cs GL	4.10(25)	4.47(3)	–1.49	–1.36	–8(6)
^{152}Eu GL	1.69(16)	1.789(12)	–0.62	–0.55	–6(9)
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	5.4(3)	5.418(12)	0.01	0.01	0(6)
^{65}Zn GH	6.2(4)	5.92(4)	0.78	1.12	4(6)
^{85}Sr GH	7.3(5)	7.54(5)	–0.47	–0.64	–3(6)
^{125}Sb GH	1.45(14)	1.470(7)	–0.14	–0.26	–1(10)
^{133}Ba GH	4.0(4)	3.84(3)	0.35	0.78	4(10)
^{134}Cs GH	13.4(7)	15.09(11)	–2.35	–2.71 Q	–11(5)
^{137}Cs GH	4.31(23)	4.81(4)	–2.17	–2.53	–10(5)
^{152}Eu GH	1.91(10)	1.925(13)	–0.15	–0.16	–1(5)

Table B49 – Laboratory 90

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	4.5(5)	5.01(5)	–1.10	–1.80	–11(10)
^{237}Np AL	10.0(10)	4.65(5)	5.12 D	11.00 D	115(22)
^{238}U AL	17.6(18)	18.0(4)	–0.21	–0.42	–2(10)
^{239}Pu AL	10.5(11)	11.68()	–1.00	–1.85	–10(10)
^{241}Am AL	3.0(3)	3.099(6)	–0.25	–0.35	–3(10)
^{244}Cm AL	13.8(14)	15.41(5)	–1.13	–2.35	–10(9)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B2	1.180(24)	1.389(15)	–7.34 D	–3.71 D	–15.0(20)
^{89}Sr B2	0.089(19)	0.463(4)	–19.21 D	–8.42 D	–81(4)
^{90}Sr B2	0.233(23)	1.153(10)	–36.68 D	–11.14 D	–79.8(20)

Table B50 – Laboratory 91

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	4.3(5)	5.01(5)	–1.50	–2.36	–14(10)
^{237}Np AL	3.9(5)	4.65(5)	–1.62	–1.47	–15(9)
^{238}U AL	15.3(17)	18.0(4)	–1.52	–2.92 Q	–15(10)
^{239}Pu AL	10.8(11)	11.68(12)	–0.83	–1.46	–8(9)
^{241}Am AL	3.0(3)	3.099(6)	–0.17	–0.23	–2(10)
^{244}Cm AL	14.5(15)	15.41(5)	–0.58	–1.27	–6(10)
^{60}Co GL	5.5(4)	5.035(12)	1.22	1.53	8(7)
^{65}Zn GL	6.3(4)	5.50(4)	1.94	2.00	15(8)
^{85}Sr GL	7.6(6)	7.01(5)	1.02	1.48	8(8)
^{125}Sb GL	1.46(18)	1.366(7)	0.52	0.53	7(13)
^{133}Ba GL	3.9(3)	3.571(25)	0.99	1.17	9(9)
^{134}Cs GL	13.2(10)	14.02(10)	–0.81	–1.12	–6(7)
^{137}Cs GL	5.0(3)	4.47(3)	1.65	1.87	12(7)
^{152}Eu GL	1.79(19)	1.789(12)	0.01	0.01	0(11)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B2	1.47(15)	1.389(15)	0.54	1.43	6(11)
^{89}Sr B2	0.50(8)	0.463(4)	0.49	0.89	9(17)
^{90}Sr B2	1.02(14)	1.153(10)	–0.97	–1.59	–11(12)

Table B51 – Laboratory 93

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	4.84(17)	5.418(12)	–3.39 D	–2.68 D	–11(3)
^{65}Zn GH	5.60(20)	5.92(4)	–1.57	–1.37	–5(4)
^{85}Sr GH	7.5(3)	7.54(5)	–0.19	–0.17	–1(4)
^{125}Sb GH	1.38(5)	1.470(7)	–1.77	–1.18	–6(4)
^{133}Ba GH	3.24(11)	3.84(3)	–5.33 D	–3.42 D	–16(3)
^{134}Cs GH	12.7(5)	15.09(11)	–5.32 D	–3.86 D	–16(3)
^{137}Cs GH	4.62(16)	4.81(4)	–1.19	–0.98	–4(4)
^{152}Eu GH	1.60(6)	1.925(13)	–5.29 D	–3.37 D	–17(4)

Table B52 – Laboratory 95

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	5.39(25)	5.035(12)	1.42	1.31	7(5)
^{65}Zn GL	5.7(5)	5.50(4)	0.43	0.47	3(8)
^{85}Sr GL	7.1(3)	7.01(5)	0.18	0.14	1(4)
^{125}Sb GL	1.20(21)	1.366(7)	–0.79	–0.92	–12(15)
^{133}Ba GL	3.5(4)	3.571(25)	–0.24	–0.31	–2(10)
^{134}Cs GL	12.9(3)	14.02(10)	–3.90 Q	–1.50	–8.0(20)
^{137}Cs GL	4.5(3)	4.47(3)	0.17	0.17	1(6)
^{152}Eu GL	1.73(21)	1.789(12)	–0.28	–0.33	–3(12)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B1	1.89(8)	1.688(12)	2.57	2.06	12(5)
^{14}C B1	0.96(6)	0.905(6)	0.97	1.28	6(7)
^{133}Ba S	4.91(13)	4.91(13)	–0.37	–0.24	–1(3)
^{134}Cs S	11.8(3)	11.8(3)	–0.91	–0.66	–2(3)
^{137}Cs S	5.05(13)	5.05(13)	–1.91	–1.39	–6(3)
^{152}Eu S	4.84(13)	4.84(13)	–0.41	–0.34	–1(4)
Gross b S	11.92(19)	–	–	–	–

Table B53 – Laboratory 100

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{239}Pu AL	1.40(24)	11.68(12)	–38.52 D	–16.65 D	–88.0(21)
^{60}Co GL	4.50(20)	5.035(12)	–2.67 Q	–1.97	–11(4)
^{65}Zn GL	4.30(20)	5.50(4)	–5.90 D	–3.00 D	–22(4)
^{85}Sr GL	6.40(20)	7.01(5)	–2.96 Q	–1.63	–9(3)
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	2.70(10)	3.571(25)	–8.45 D	–3.31 D	–24(3)
^{134}Cs GL	10.50(20)	14.02(10)	–15.74 D	–4.72 D	–25.1(15)
^{137}Cs GL	4.30(20)	4.47(3)	–0.86	–0.63	–4(5)
^{152}Eu GL	2.30(10)	1.789(12)	5.07 D	2.86 D	29(6)
	(Bq g^{-1})	(Bq g^{-1})			
^{239}Pu AH	1.19(5)	11.25(5)	–147.30 D	–18.26 D	–89.4(5)
^{60}Co GH	4.82(4)	5.418(12)	–14.32 D	–2.77 D	–11.0(8)
^{65}Zn GH	5.47(6)	5.92(4)	–6.20 Q	–1.93	–7.6(12)
^{85}Sr GH	6.66(10)	7.54(5)	–7.85 D	–2.78 D	–11.7(15)
^{125}Sb GH	1.210(20)	1.470(7)	–12.20 D	–3.43 D	–17.7(14)
^{133}Ba GH	3.12(8)	3.84(3)	–8.58 D	–4.10 D	–18.8(22)
^{134}Cs GH	11.98(6)	15.09(11)	–25.36 D	–4.98 D	–20.6(7)
^{137}Cs GH	4.37(6)	4.81(4)	–6.50 Q	–2.23	–9.2(14)
^{152}Eu GH	1.520(20)	1.925(13)	–16.87 D	–4.20 D	–21.0(12)
^{133}Ba S	4.51(4)	4.91(13)	–3.03 Q	–1.79	–8.2(25)
^{134}Cs S	11.06(6)	11.8(3)	–2.34	–1.66	–6.2(25)
^{137}Cs S	5.29(7)	5.05(13)	1.65	1.20	5(3)
^{152}Eu S	4.400(20)	4.84(13)	–3.44 Q	–2.23	–9.0(24)

Table B54 – Laboratory 104

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	5.59(10)	5.418(12)	1.71	0.80	3.2(19)
^{65}Zn GH	6.08(9)	5.92(4)	1.62	0.69	2.7(17)
^{85}Sr GH	7.84(10)	7.54(5)	2.64 Q	0.94	3.9(15)
^{125}Sb GH	1.56(8)	1.470(7)	1.13	1.20	6(6)
^{133}Ba GH	4.14(14)	3.84(3)	2.09	1.69	8(4)
^{134}Cs GH	15.1(3)	15.09(11)	–0.10	–0.05	–0.2(19)
^{137}Cs GH	5.03(8)	4.81(4)	2.49	1.08	4.5(18)
^{152}Eu GH	1.99(10)	1.925(13)	0.64	0.67	3(5)

Table B55 – Laboratory 106

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	4.8(4)	5.01(5)	–0.65	–0.77	–5(7)
^{237}Np AL	5.7(6)	4.65(5)	1.84	2.17	23(12)
^{238}U AL	18.1(9)	18.0(4)	0.13	0.14	1(6)
^{239}Pu AL	10.8(8)	11.68(12)	–1.09	–1.43	–8(7)
^{241}Am AL	3.1(3)	3.099(6)	–0.07	–0.08	–1(9)
	(Bq g^{-1})	(Bq g^{-1})			
^{226}Ra AH	17.6(8)	15.90(21)	2.06	1.81	11(5)
^{237}Np AH	5.9(6)	4.84(5)	1.87	2.24	21(11)
^{238}Pu AH	15.6(9)	16.63(5)	–1.14	–1.31	–6(6)
^{239}Pu AH	10.5(7)	11.25(5)	–1.06	–1.36	–7(6)
^{241}Am AH	5.0(5)	5.356(10)	–0.79	–1.30	–6(8)
^{3}H B1	1.92(8)	1.688(12)	3.03 Q	2.38	14(5)
^{14}C B1	0.86(4)	0.905(6)	–1.12	–0.99	–5(5)
^{3}H B2	1.42(6)	1.389(15)	0.58	0.58	2(4)
^{89}Sr B2	0.35(5)	0.463(4)	–2.20	–2.49	–24(11)
^{90}Sr B2	1.18(9)	1.153(10)	0.36	0.37	3(8)
^{90}Sr S	0.81(7)	0.810(20)	–0.08	–0.12	–1(9)

Table B56 – Laboratory 107

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B1	1.70(10)	1.688(12)	0.12	0.12	1(6)
^{14}C B1	0.83(5)	0.905(6)	–1.48	–1.63	–8(6)
^{99}Tc B1	0.152(16)	0.1562(4)	–0.27	–0.40	–3(10)
^{129}I B1	0.156(7)	0.1504(9)	0.81	0.51	4(5)
^{55}Fe B2	1.60(13)	1.53(3)	0.58	0.72	5(9)
^{89}Sr B2	0.45(5)	0.463(4)	–0.39	–0.37	–4(9)
^{90}Sr B2	1.08(10)	1.153(10)	–0.76	–0.88	–6(8)
^{133}Ba S	4.15(20)	4.91(13)	–3.23 D	–3.37 D	–16(5)
^{134}Cs S	10.6(5)	11.8(3)	–2.28	–2.81 Q	–11(5)
^{137}Cs S	4.62(20)	5.05(13)	–1.78	–2.07	–8(5)
^{152}Eu S	4.45(19)	4.84(13)	–1.70	–1.97	–8(5)

Table B57 – Laboratory 108

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B1	1.67(25)	1.688(12)	–0.07	–0.18	–1(15)
^{14}C B1	0.86(13) Q	0.905(6)	–0.35	–1.03	–5(14)
^{60}Co GH	5.41(24)	5.418(12)	–0.03	–0.04	0(5)
^{65}Zn GH	6.1(3)	5.92(4)	0.59	0.69	3(5)
^{85}Sr GH	7.7(4)	7.54(5)	0.42	0.46	2(5)
^{125}Sb GH	1.39(7)	1.470(7)	–1.13	–1.05	–5(5)
^{133}Ba GH	3.37(15)	3.84(3)	–3.10 D	–2.68 D	–12(4)
^{134}Cs GH	13.4(6)	15.09(11)	–2.74 D	–2.67 D	–11(4)
^{137}Cs GH	5.05(23)	4.81(4)	1.01	1.18	5(5)
^{152}Eu GH	1.84(9)	1.925(13)	–0.93	–0.88	–4(5)

Table B58 – Laboratory 110

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	4.68(25)	5.035(12)	–1.42	–1.31	–7(5)
^{65}Zn GL	5.2(3)	5.50(4)	–0.96	–0.70	–5(6)
^{85}Sr GL	6.8(4)	7.01(5)	–0.69	–0.67	–4(5)
^{125}Sb GL	1.58(18)	1.366(7)	1.19	1.20	16(13)
^{133}Ba GL	3.26(18)	3.571(25)	–1.71	–1.18	–9(5)
^{134}Cs GL	13.3(7)	14.02(10)	–1.12	–1.04	–6(5)
^{137}Cs GL	4.26(22)	4.47(3)	–0.97	–0.78	–5(5)
^{152}Eu GL	1.89(15)	1.789(12)	0.67	0.56	6(9)

Table B59 – Laboratory 111

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	4.99(17)	5.035(12)	–0.26	–0.17	–1(4)
^{65}Zn GL	–	5.50(4)	–	–	–
^{85}Sr GL	7.32(22)	7.01(5)	1.38	0.83	4(4)
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	3.38(12)	3.571(25)	–1.56	–0.72	–5(4)
^{134}Cs GL	12.6(4)	14.02(10)	–3.71 Q	–1.91	–10(3)
^{137}Cs GL	4.78(16)	4.47(3)	1.87	1.11	7(4)
^{152}Eu GL	–	1.789(12)	–	–	–
^{125}I GL	10.8(9)	–	–	–	–

Table B60 – Laboratory 113

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
Gross a AL	64(4)	72(7)	–1.12	–2.19	–11(9)
	(Bq g^{-1})	(Bq g^{-1})			
Gross a AH	59(3)	8(3) × 10^{1}	–0.73	–5.41 Q	–2(3) × 10^{1}
Gross b WL B2	3.85(18)	5.68(4)	–9.99 D	–6.45 D	–32(4)
Gross b W B2	1.95(9)	2.769(15)	–8.98 D	–5.91 D	–30(4)
Gross b S	13.5(6)	–	–	–	–

Table B61 – Laboratory 114

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	5.07(18)	5.035(12)	0.20	0.13	1(4)
^{65}Zn GL	5.0(3)	5.50(4)	–1.82	–1.38	–10(6)
^{85}Sr GL	8.0(5)	7.01(5)	1.88	2.63 Q	14(8)
^{125}Sb GL	1.4(3)	1.366(7)	–0.06	–0.09	–1(19)
^{133}Ba GL	3.14(21)	3.571(25)	–2.04	–1.64	–12(6)
^{134}Cs GL	14.0(5)	14.02(10)	–0.03	–0.02	0(4)
^{137}Cs GL	4.60(24)	4.47(3)	0.52	0.46	3(6)
^{152}Eu GL	1.46(18)	1.789(12)	–1.82	–1.84	–18(10)
	(Bq g^{-1})	(Bq g^{-1})			
^{89}Sr B2	21(9)	0.463(4)	2.28	460.44 Q	44(19) × 10^{2}
^{90}Sr B2	1.30(8)	1.153(10)	1.92	1.75	13(7)
^{90}Sr S	0.31(4)	0.810(20)	–12.10 D	–11.09 D	–62(5)
^{133}Ba S	4.60(10)	4.91(13)	–1.90	–1.37	–6(4)
^{134}Cs S	12.05(23)	11.8(3)	0.66	0.58	2(4)
^{137}Cs S	5.33(14)	5.05(13)	1.45	1.38	6(4)
^{152}Eu S	4.63(15)	4.84(13)	–1.07	–1.07	–4(4)

Table B62 – Laboratory 115

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{238}U AL	17.1(6)	18.0(4)	–1.18	–0.97	–5(4)
	(Bq g^{-1})	(Bq g^{-1})			
^{226}Ra AH	17.0(11)	15.90(21)	0.99	1.17	7(7)

Table B63 – Laboratory 116

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	4.60(11)	5.418(12)	–7.39 D	–3.80 D	–15.1(20)
^{65}Zn GH	4.93(13)	5.92(4)	–7.26 D	–4.25 D	–16.7(23)
^{85}Sr GH	2.20(4)	7.54(5)	–81.91 D	–16.81 D	–70.8(6)
^{125}Sb GH	1.25(6)	1.470(7)	–3.63 D	–2.90 D	–15(4)
^{133}Ba GH	3.01(5)	3.84(3)	–14.74 D	–4.73 D	–21.7(14)
^{134}Cs GH	12.1(3)	15.09(11)	–10.14 D	–4.87 D	–20.1(19)
^{137}Cs GH	4.11(10)	4.81(4)	–6.70 D	–3.54 D	–14.6(22)
^{152}Eu GH	1.59(4)	1.925(13)	–7.95 D	–3.47 D	–17.4(22)

Table B64 – Laboratory 117

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	5.3(4)	5.035(12)	0.76	0.98	5(7)
^{65}Zn GL	6.7(5)	5.50(4)	2.41	2.99 Q	22(9)
^{85}Sr GL	8.7(7)	7.01(5)	2.36	4.53 Q	24(10)
^{125}Sb GL	1.50(12)	1.366(7)	1.08	0.75	10(9)
^{133}Ba GL	4.0(3)	3.571(25)	1.64	1.63	12(7)
^{134}Cs GL	13.2(9)	14.02(10)	–0.97	–1.10	–6(6)
^{137}Cs GL	5.4(5)	4.47(3)	2.16	3.36 Q	21(10)
^{152}Eu GL	1.40(10)	1.789(12)	–3.99 Q	–2.17	–22(6)
^{40}K GL	4.2(4)	–	–	–	–
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	5.7(4)	5.418(12)	0.79	1.36	5(7)
^{65}Zn GH	7.4(6)	5.92(4)	2.59 D	6.14 D	24(9)
^{85}Sr GH	8.6(7)	7.54(5)	1.50	3.30 Q	14(9)
^{125}Sb GH	1.35(9)	1.470(7)	–1.36	–1.58	–8(6)
^{133}Ba GH	4.1(3)	3.84(3)	1.08	1.63	7(7)
^{134}Cs GH	16.1(10)	15.09(11)	0.95	1.55	6(7)
^{137}Cs GH	5.7(5)	4.81(4)	1.87	4.19 Q	17(9)
^{152}Eu GH	2.02(13)	1.925(13)	0.74	0.98	5(7)

Table B65 – Laboratory 118

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	–	5.035(12)	–	–	–
^{65}Zn GL	–	5.50(4)	–	–	–
^{85}Sr GL	–	7.01(5)	–	–	–
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	–	3.571(25)	–	–	–
^{134}Cs GL	13.2(6)	14.02(10)	–1.30	–1.06	–6(5)
^{137}Cs GL	4.4(5)	4.47(3)	–0.08	–0.13	–1(10)
^{152}Eu GL	–	1.789(12)	–	–	–
	(Bq g^{-1})	(Bq g^{-1})			
^{134}Cs S	12.3(4)	11.8(3)	1.13	1.21	5(4)
^{137}Cs S	5.34(11)	5.05(13)	1.70	1.43	6(4)

Table B66 – Laboratory 119

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	5.19(22)	5.01(5)	0.80	0.60	4(5)
^{237}Np AL	14(3)	4.65(5)	3.11 D	19.92 D	21(7) × 10^{1}
^{238}U AL	18.0(5)	18.0(4)	0.04	0.03	0(4)
^{239}Pu AL	9.9(3)	11.68(12)	–5.26 D	–2.82 D	–15(3)
^{241}Am AL	3.0(3)	3.099(6)	–0.42	–0.48	–4(8)
^{244}Cm AL	15.5(10)	15.41(5)	0.13	0.19	1(7)
Gross a AL	130(0)	72(7)	8.96 D	15.64 D	82(17)
^{60}Co GL	5.10(16)	5.035(12)	0.41	0.24	1(4)
^{65}Zn GL	5.9(3)	5.50(4)	1.28	1.00	7(6)
^{85}Sr GL	7.6(4)	7.01(5)	1.63	1.58	8(5)
^{125}Sb GL	1.40(11)	1.366(7)	0.31	0.19	3(8)
^{133}Ba GL	3.40(15)	3.571(25)	–1.12	–0.65	–5(5)
^{134}Cs GL	12.70(19)	14.02(10)	–6.16 Q	–1.77	–9.4(15)
^{137}Cs GL	4.30(12)	4.47(3)	–1.41	–0.63	–4(3)
^{152}Eu GL	1.70(8)	1.789(12)	–1.10	–0.50	–5(5)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B2	1.341(21)	1.389(15)	–1.84	–0.85	–3.4(18)
^{55}Fe B2	1.43(8)	1.53(3)	–1.22	–0.92	–6(5)

Table B67 – Laboratory 120

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	5.27(25)	5.01(5)	1.02	0.86	5(5)
^{237}Np AL	4.70(24)	4.65(5)	0.21	0.11	1(6)
^{238}U AL	17.3(7)	18.0(4)	–0.76	–0.69	–4(5)
^{239}Pu AL	11.2(5)	11.68(12)	–0.96	–0.83	–4(5)
^{241}Am AL	3.45(25)	3.099(6)	1.39	1.54	11(8)
^{244}Cm AL	14.2(8)	15.41(5)	–1.52	–1.84	–8(6)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B2	1.472(20)	1.389(15)	3.31 Q	1.48	6.0(19)
^{55}Fe B2	1.56(8)	1.53(3)	0.39	0.32	2(6)
^{89}Sr B2	0.40(4)	0.463(4)	–1.94	–1.45	–14(7)
^{90}Sr B2	1.16(10)	1.153(10)	0.11	0.13	1(8)
^{60}Co GH	5.38(7)	5.418(12)	–0.53	–0.18	–0.7(13)
^{65}Zn GH	6.34(9)	5.92(4)	4.26 Q	1.80	7.1(17)
^{85}Sr GH	7.43(11)	7.54(5)	–0.93	–0.35	–1.5(16)
^{125}Sb GH	1.39(3)	1.470(7)	–2.58 Q	–1.05	–5.4(21)
^{133}Ba GH	3.70(5)	3.84(3)	–2.52	–0.81	–3.7(15)
^{134}Cs GH	13.10(15)	15.09(11)	–10.80 D	–3.19 D	–13.2(12)
^{137}Cs GH	4.99(7)	4.81(4)	2.26	0.88	3.6(16)
^{152}Eu GH	1.86(2)	1.925(13)	–2.71 Q	–0.67	–3.4(12)

Table B68 – Laboratory 121

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	14.9(16)	5.01(5)	6.18 D	32.89 D	20(4) × 10^{1}
^{238}U AL	11.0(5)	18.0(4)	–10.91 D	–7.66 D	–39(3)
^{239}Pu AL	11.9(6)	11.68(12)	0.41	0.37	2(5)
^{241}Am AL	3.32(25)	3.099(6)	0.88	0.98	7(8)
^{244}Cm AL	15.7(3)	15.41(5)	0.86	0.40	1.8(20)
Gross a AL	66(3)	72(7)	–0.84	–1.63	–8(9)
^{60}Co GL	5.08(7)	5.035(12)	0.64	0.17	0.9(14)
^{65}Zn GL	5.86(12)	5.50(4)	2.85 Q	0.90	6.5(23)
^{85}Sr GL	6.43(11)	7.01(5)	–4.82 Q	–1.55	–8.3(17)
^{125}Sb GL	1.13(8)	1.366(7)	–2.94 Q	–1.31	–17(6)
^{133}Ba GL	3.39(25)	3.571(25)	–0.72	–0.69	–5(7)
^{134}Cs GL	13.0(7)	14.02(10)	–1.36	–1.34	–7(5)
^{137}Cs GL	4.34(10)	4.47(3)	–1.29	–0.49	–3.0(23)
^{152}Eu GL	1.64(12)	1.789(12)	–1.23	–0.83	–8(7)
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B2	3.04(16)	1.389(15)	10.27 D	29.39 D	119(12)
^{55}Fe B2	1.40(10)	1.53(3)	–1.26	–1.18	–8(7)
^{90}Sr B2	1.32(9)	1.153(10)	1.95	2.02	14(8)
Gross b I B2	2.560(20)	2.769(15)	–8.40 Q	–1.51	–7.5(9)
^{55}Fe S	2.66(12)	4.38(13)	–9.59 D	–6.00 D	–39(4)
^{90}Sr S	0.79(3)	0.810(20)	–0.73	–0.56	–3(5)
^{133}Ba S	4.30(22)	4.91(13)	–2.42	–2.71 Q	–13(5)
^{134}Cs S	10.29(24)	11.8(3)	–3.85 D	–3.40 D	–13(3)
^{137}Cs S	5.08(11)	5.05(13)	0.20	0.17	1(4)
^{152}Eu S	3.16(11)	4.84(13)	–10.05 D	–8.55 D	–35(3)
Gross b S	16.97(18)	–	–	–	–

Table B69 – Laboratory 122

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	5.4(3)	5.035(12)	1.09	1.16	6(6)
^{65}Zn GL	6.2(4)	5.50(4)	1.86	1.77	13(7)
^{85}Sr GL	7.5(4)	7.01(5)	1.27	1.37	7(6)
^{125}Sb GL	1.30(19)	1.366(7)	–0.35	–0.37	–5(14)
^{133}Ba GL	3.6(3)	3.571(25)	0.14	0.15	1(8)
^{134}Cs GL	14.8(11)	14.02(10)	0.71	1.03	5(8)
^{137}Cs GL	5.0(3)	4.47(3)	1.69	1.73	11(7)
^{152}Eu GL	–	1.789(12)	–	–	–
	(Bq g^{-1})	(Bq g^{-1})			
^{3}H B2	1.41(7)	1.389(15)	0.30	0.38	2(5)

Table B70 – Laboratory 123

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{232}Th AL	5.4(4)	5.01(5)	0.97	1.29	8(8)
^{238}U AL	17.60(20)	18.0(4)	–0.83	–0.41	–2.1(25)
^{239}Pu AL	11.2(10)	11.68(12)	–0.48	–0.78	–4(9)
^{241}Am AL	3.1(3)	3.099(6)	0.00	0.00	0(9)
^{244}Cm AL	14.7(7)	15.41(5)	–1.01	–1.04	–5(5)
Gross a AL	71(4)	72(7)	–0.12	–0.24	–1(10)
^{60}Co GL	5.17(21)	5.035(12)	0.64	0.50	3(4)
^{65}Zn GL	5.9(3)	5.50(4)	1.23	0.87	6(5)
^{85}Sr GL	7.9(4)	7.01(5)	2.59 Q	2.39	13(5)
^{125}Sb GL	1.40(20)	1.366(7)	0.17	0.19	3(15)
^{133}Ba GL	3.7(3)	3.571(25)	0.51	0.53	4(8)
^{134}Cs GL	14.4(6)	14.02(10)	0.67	0.52	3(4)
^{137}Cs GL	4.73(21)	4.47(3)	1.20	0.93	6(5)
^{152}Eu GL	1.88(13)	1.789(12)	0.70	0.51	5(7)
	(Bq g^{-1})	(Bq g^{-1})			
^{226}Ra AH	16.4(18)	15.90(21)	0.28	0.53	3(11)
^{238}Pu AH	17.7(9)	16.63(5)	1.19	1.37	6(6)
^{239}Pu AH	12.2(8)	11.25(5)	1.19	1.73	8(7)
^{241}Am AH	5.0(6)	5.356(10)	–0.59	–1.34	–7(11)
^{244}Cm AH	6.2(6)	6.980(22)	–1.30	–2.23	–11(9)
Gross a AH	74.6(19)	$8(3) \times 10^1$	–0.15	–1.09	$-1(4) \times 10^1$
^{3}H B1	0.140(20)	1.688(12)	–66.60 D	–15.59 D	–91.7(12)
^{14}C B1	0.590(20)	0.905(6)	–15.22 D	–6.92 D	–34.8(22)
^{3}H B2	0.65(4)	1.389(15)	–17.26 D	–13.15 D	–53(3)
^{90}Sr B2	0.84(8)	1.153(10)	–3.88 D	–3.79 D	–27(7)
Gross b I B2	2.63(12)	2.769(15)	–1.15	–1.00	–5(5)
^{60}Co GH	5.49(16)	5.418(12)	0.45	0.34	1(3)
^{65}Zn GH	5.91(17)	5.92(4)	–0.06	–0.04	0(3)
^{85}Sr GH	8.0(3)	7.54(5)	1.39	1.38	6(4)
^{125}Sb GH	1.52(8)	1.470(7)	0.63	0.67	3(6)
^{133}Ba GH	4.03(19)	3.84(3)	0.98	1.07	5(5)

continues

continued

	Result	Assigned result	Zeta score	z-score	Deviation (%)
^{134}Cs GH	15.2(6)	15.09(11)	0.20	0.18	1(4)
^{137}Cs GH	5.05(18)	4.81(4)	1.28	1.18	5(4)
^{152}Eu GH	2.02(9)	1.925(13)	1.04	0.98	5(5)
^{90}Sr S	0.89(5)	0.810(20)	1.48	1.77	10(7)
^{133}Ba S	5.12(25)	4.91(13)	0.73	0.91	4(6)
^{134}Cs S	12.1(5)	11.8(3)	0.48	0.59	2(5)
^{137}Cs S	5.35(20)	5.05(13)	1.28	1.49	6(5)
^{152}Eu S	5.02(24)	4.84(13)	0.68	0.93	4(6)
Gross b S	21.8(11)	–	–	–	–

Table B71 – Laboratory 124

	Result	Assigned result	Zeta score	z-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	4.69(19)	5.035(12)	–1.81	–1.27	–7(4)
^{65}Zn GL	5.2(4)	5.50(4)	–0.78	–0.80	–6(8)
^{85}Sr GL	7.0(3)	7.01(5)	–0.10	–0.08	0(4)
^{125}Sb GL	–	1.366(7)	–	–	–
^{133}Ba GL	3.34(20)	3.571(25)	–1.14	–0.88	–6(6)
^{134}Cs GL	12.6(4)	14.02(10)	–4.04 Q	–1.92	–10.2(25)
^{137}Cs GL	4.84(23)	4.47(3)	1.57	1.33	8(5)
^{152}Eu GL	1.73(14)	1.789(12)	–0.42	–0.33	–3(8)
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	1.16(3)	5.418(12)	–131.80 D	–19.76 D	–78.6(6)
^{65}Zn GH	1.32(3)	5.92(4)	–90.95 D	–19.74 D	–77.7(6)
^{85}Sr GH	1.60(4)	7.54(5)	–91.11 D	–18.70 D	–78.8(6)
^{125}Sb GH	–	1.470(7)	–	–	–
^{133}Ba GH	0.80(3)	3.84(3)	–76.28 D	–17.28 D	–79.2(8)
^{134}Cs GH	2.95(6)	15.09(11)	–99.02 D	–19.44 D	–80.4(5)
^{137}Cs GH	1.06(3)	4.81(4)	–84.29 D	–18.85 D	–78.0(7)
^{152}Eu GH	0.41(1)	1.925(13)	–91.13 D	–15.70 D	–78.7(6)

Table B72 – Laboratory 126

	Result	Assigned result	Zeta score	*z*-score	Deviation (%)
	(Bq kg^{-1})	(Bq kg^{-1})			
^{60}Co GL	5.7(15) Q	5.035(12)	0.43	2.42	$1(3) \times 10^1$
^{65}Zn GL	7.5(21) Q	5.50(4)	0.92	4.89 Q	$4(4) \times 10^1$
^{85}Sr GL	9.2(25) Q	7.01(5)	0.86	5.79 Q	$3(4) \times 10^1$
^{125}Sb GL	1.7(7)	1.366(7)	0.55	1.98	$3(5) \times 10^1$
^{133}Ba GL	3.4(9) Q	3.571(25)	–0.16	–0.57	$0(3) \times 10^1$
^{134}Cs GL	14(4) Q	14.02(10)	0.01	0.05	$0(3) \times 10^1$
^{137}Cs GL	5.5(15)	4.47(3)	0.69	3.76 Q	$2(4) \times 10^1$
^{152}Eu GL	1.9(6) Q	1.789(12)	0.11	0.34	$0(4) \times 10^1$
	(Bq g^{-1})	(Bq g^{-1})			
^{60}Co GH	6.8(18) Q	5.418(12)	0.79	6.51 Q	$3(4) \times 10^1$
^{65}Zn GH	8.1(21) Q	5.92(4)	1.03	9.44 Q	$4(4) \times 10^1$
^{85}Sr GH	9.6(25) Q	7.54(5)	0.82	6.57 Q	$3(4) \times 10^1$
^{125}Sb GH	1.8(5) Q	1.470(7)	0.61	3.71 Q	$2(3) \times 10^1$
^{133}Ba GH	4.0(10) Q	3.84(3)	0.14	0.84	$0(3) \times 10^1$
^{134}Cs GH	16(4) Q	15.09(11)	0.17	1.11	$0(3) \times 10^1$
^{137}Cs GH	6.3(17) Q	4.81(4)	0.89	7.45 Q	$3(4) \times 10^1$
^{152}Eu GH	2.2(6) Q	1.925(13)	0.40	2.33	$1(3) \times 10^1$
^{133}Ba S	3.4(6)	4.91(13)	–2.39	–6.49 Q	–30(12)
^{134}Cs S	9.7(17)	11.8(3)	–1.22	–4.74 Q	–18(14)
^{137}Cs S	6.0(11)	5.05(13)	0.83	4.47 Q	18(22)
^{152}Eu S	4.1(7)	4.84(13)	–0.99	–3.62 Q	–15(15)

Appendix C. Source preparation

C1 AL samples

A mixed radionuclide solution (B09419) was prepared by mixing standardised solutions of the individual nuclides (Table C1). The chemical form of the AL samples was 2.3 M HNO_3.

Table C1 – Starting material B09419

Nuclide	Source identifier	Activity conc. (Bq g^{-1})	Gravimetric Dilution Factor AL GDF1	B09419 Act. conc. (Bq g^{-1})
^{232}Th	E4527	10.72(10)	38.5041(13)	0.278(3)
^{237}Np	A05946	9.95(10)	38.531(3)	0.258(3)
^{238}U	A00279	101.5(23)	101.665(25)	0.998(22)
^{239}Pu	E4307	49.6(5)	76.415(16)	0.649(7)
^{240}Pu*	E4307	0.22	76.415(16)	0.0029
^{241}Pu*	E4307	0.26	76.415(16)	0.0034
^{241}Am	A06229	9.972(19)	57.935(15)	0.1721(4)
^{244}Cm	E4370	32.67(11)	38.171(3)	0.856(3)
^{240}Pu*	E4370	0.074	38.171(3)	0.0019

The B09419 solution was diluted one to produce the AL sample in B09420 (Table C2). All dilutions were validated using liquid scintillation counting (see Appendix D). In total, 21.21 kg of AL sample was produced.

Table C2 – Preparation of solution for AL source B09420

Nuclide	Gravimetric Dilution Factor AL GDF2	B09420 Act. conc. (Bq kg^{-1})
^{232}Th	55.541(15)	5.01(5)
^{237}Np	55.541(15)	4.65(5)
^{238}U	55.541(15)	18.0(4)
^{239}Pu	55.541(15)	11.68(12)
^{240}Pu*	55.541(15)	0.086
^{241}Pu*	55.541(15)	0.061
^{241}Am	55.541(15)	3.099(6)
^{244}Cm	55.541(15)	15.41(5)
Gross alpha	–	72(7)

The gross alpha activity concentration was calculated by combining of the activity concentrations of all the nuclides listed above (except ^{241}Pu) plus contributions from the progeny of ^{232}Th. 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 ^{220}Rn, ^{216}Po and ^{212}Bi/^{212}Po activity concentrations.

C2 AH samples

A mixed radionuclide solution (B09217) was prepared by mixing standardised solutions of the individual nuclides (Table C3). The chemical form of the AH samples was 2.3 M HNO_3.

Table C3 – Starting material B09217

Nuclide	Source identifier	Activity conc. (kBq g^{-1})	Gravimetric Dilution Factor AH GDF1	B09217 Act. conc. (kBq g^{-1})
^{226}Ra	A07239	5.25(7)	11.0230(9)	0.477(6)
^{237}Np	A08215	9.11(9)	62.816(16)	0.1450(15)
^{238}Pu	A08216	17.12(5)	34.343(3)	0.4984(15)
^{239}Pu	A08217	19.88(9)	58.972(14)	0.3372(15)
^{240}Pu*	A08217	0.087	58.972(14)	0.0015
^{241}Pu*	A08217	0.10	58.972(14)	0.0018
^{241}Am	A08218	9.990(18)	62.217(15)	0.1606(3)
^{244}Cm	A08219	13.07(4)	62.478(16)	0.2092(7)
^{240}Pu*	A08219	0.030	62.478(16)	0.00047

The B09217 solution was diluted once to produce the AH sample in B09365 (Table C4). The dilution was validated using liquid scintillation counting (see Appendix D). In total, 0.45 kg of AH sample was produced.

Table C4 – Preparation of solution for AH source B09365

Nuclide	Gravimetric Dilution Factor AH GDF2	B09365 Act. conc. (Bq g^{-1})
^{226}Ra	29.979(9)	15.90(21)
^{237}Np	29.979(9)	4.84(5)
^{238}Pu	29.979(9)	16.63(5)
^{239}Pu	29.979(9)	11.25(5)
^{240}Pu*	29.979(9)	0.065
^{241}Pu*	29.979(9)	0.059
^{241}Am	29.979(9)	5.356(10)
^{244}Cm	29.979(9)	6.980(22)
Gross alpha	–	$8(3) \times 10^1$

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 35% of the ^{226}Ra activity concentration, which based on the time elapsed since the last purification of the ^{226}Ra starting material) and ^{222}Rn, ^{218}Po and ^{214}Po contributions (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 gross alpha activity concentration uncertainty is dominated by the uncertainty of the ^{222}Rn, ^{218}Po, ^{214}Po and ^{210}Po activity concentrations.

C3 B1 samples

A mixed radionuclide solution (B09464) was prepared by mixing standardised solutions of the individual nuclides (Table C5). The chemical form of the B1 samples was 0.01 M NaOH containing 0.010 mg g^{-1} C (as carbonate) and 0.050 mg g^{-1} I.

Table C5 – Starting material B09464

Nuclide	Source identifier	Activity conc. (kBq g^{-1})	Gravimetric Dilution Factor GDF1	B09464 Act. conc. (Bq g^{-1})
^{3}H	A08874	4.60(4)	67.713(18)	68.0(5)
^{14}C	A06307	1.898(11)	52.037(4)	36.47(22)
^{99}Tc	A09427, A09428 and A09429	0.10351(25)	16.4521(10)	6.292(15)
^{129}I	A09282, A09287 and A09288	0.0963(6)	15.8963(16)	6.06(4)

The solution in B09464 was diluted once to produce the B1 sample in B09465 (Table C6). The dilutions were validated using liquid scintillation counting (see Appendix D). In total, 20.01 kg of B1 sample was produced.

Table C6 – Preparation of solution for B1 source B09465

Nuclide	Gravimetric Dilution Factor B1 GDF2	B09465 Act. conc. (Bq g^{-1})
^{3}H	40.274(14)	1.688(12)
^{14}C	40.287(8)	0.905(6)
^{99}Tc	40.287(8)	0.1562(4)
^{129}I	40.287(8)	0.1504(9)

C4 B2 samples

A mixed radionuclide solution (B09461) was prepared by mixing standardised solutions of the individual nuclides (Table C7). The chemical form of the B2 samples was 0.13 M HCl (containing 0.010 mg g^{-1} Fe and 0.010 mg g^{-1} Sr).

Table C7 – Starting material B09461

Nuclide	Source identifier	Activity conc. (kBq g^{-1})	Gravimetric Dilution Factor B2 GDF1	B09461 Act. conc. (kBq g^{-1})
^{3}H	A08002	4.60(4)	2.71706(19)	1.694(12)
^{55}Fe	A09466	198(4)	106.65(4)	1.86(4)
^{89}Sr	A08939	5.165(15)	9.1684(6)	0.5633(17)
^{90}Sr	A09467	37.82(7)	26.933(9)	1.404(3)

The B09461 solution was diluted twice to produce the B2 sample in B09546 (Table C8). All dilutions were validated using liquid scintillation counting (see Appendix D). In total, 23.00 kg of B2 sample was produced.

Table C8 – Preparation of solution for B2 source B09546

Nuclide	Gravimetric Dilution Factor B2 GDF2	Gravimetric Dilution Factor B2 GDF3	B09546 Act. conc. (Bq g^{-1})
^{3}H	34.60(17)	35.26(24)*	1.389(15)
^{55}Fe	34.56(17)	35.24(24)**	1.53(3)
^{89}Sr	34.56(17)	35.24(24)**	0.463(4)
^{90}Sr	34.56(17)	35.24(24)**	1.153(10)
Gross beta ISO 9697	–	–	2.769(15)
Gross beta LSC	–	–	5.68(4)

* inflated from 35.260(13)
** inflated from 35.242(11)

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.

C5 GL and GH samples

A mixed radionuclide solution (B09606) was prepared by mixing and diluting standardised solutions of the individual nuclides (Table C9). The chemical form of the GL and GH samples was 1.9 M HCl containing 0.029 mg g^{-1} Ba, 0.031 mg g^{-1} Co, 0.051 mg g^{-1} Cs, 0.031 mg g^{-1} Nd, 0.030 mg g^{-1} Sb, 0.028 mg g^{-1} Sr and 0.039 mg g^{-1} Zn. The dilutions were validated using gamma-ray spectrometry (see Appendix D).

Table C9 – Starting material B09606

Nuclide	Source identifier	Activity conc. (kBq g^{-1})	Gravimetric Dilution Factor GDF1	B09606 Act. conc. (kBq g^{-1})
^{60}Co	A09474	254.4(6)	35.611(11)	7.144(15)
^{65}Zn	A09475	275.0(19)	35.2351(25)	7.81(6)
^{85}Sr	A09555	74.8(5)	7.5166(7)	9.95(7)
^{125}Sb	A09130	35.70(17)	18.421(3)	1.938(10)
^{133}Ba	A09478	46.1(3)	9.0894(4)	5.07(4)
^{134}Cs	A09476	225.1(16)	11.3137(15)	19.90(14)
^{137}Cs	A09477	225.6(15)	35.529(13)	6.35(5)
^{152}Eu	A09460	46.5(4)	18.3311(16)	2.538(17)

The solution in B09606 was diluted twice to produce the GH sample in B09608 (Table C10). Part of the solution in B09608 was diluted twice to produce the GL sample in B09614 (Table C10). The dilutions were validated using gamma-ray spectrometry (see Appendix D). In total, 7.57 kg of GH sample and 28.17 kg of GL sample were produced.

Table C10 – Preparation of solutions for GH source B09608 and GL source B09614

Nuclide	Gravimetric Dilution Factor GH GDF2	Gravimetric Dilution Factor GH GDF3	B09608 Act. conc. (Bq g^{-1})	Gravimetric Dilution Factor GL GDF4	Gravimetric Dilution Factor GL GDF5	B09614 Act. conc. (Bq kg^{-1})
^{60}Co	34.927(18)	37.754(12)	5.418(12)	33.319(19)	32.30(4)	5.035(12)
^{65}Zn	34.927(18)	37.754(12)	5.92(4)	33.319(19)	32.30(4)	5.50(4)
^{85}Sr	34.927(18)	37.754(12)	7.54(5)	33.319(19)	32.30(4)	7.01(5)
^{125}Sb	34.927(18)	37.754(12)	1.470(7)	33.319(19)	32.30(4)	1.366(7)
^{133}Ba	34.927(18)	37.754(12)	3.84(3)	33.319(19)	32.30(4)	3.571(25)
^{134}Cs	34.927(18)	37.754(12)	15.09(11)	33.319(19)	32.30(4)	14.02(10)
^{137}Cs	34.927(18)	37.754(12)	4.81(4)	33.319(19)	32.30(4)	4.47(3)
^{152}Eu	34.927(18)	37.754(12)	1.925(13)	33.319(19)	32.30(4)	1.789(12)

C6 S samples

A mixed radionuclide solution (B09203) was prepared by mixing standardised solutions of the individual nuclides (Table C11). The chemical form was 0.10 M HCl containing 0.058 mg g^{-1} Eu, 0.050 mg g^{-1} Fe, 0.045 mg g^{-1} Na and 0.057 mg g^{-1} Sr.

Table C11 – Starting material B09203

Nuclide	Source identifier	Activity conc. (kBq g^{-1})	Gravimetric Dilution Factor GDF1	B09203 Act. conc. (kBq g^{-1})
^{55}Fe	A08229	198(4)	48.50(5)	4.09(7)
^{90}Sr	A07398	37.82(7)	49.95(5)	0.7573(16)
^{133}Ba	A07494	46.1(3)	10.026(4)	4.59(3)
^{134}Cs	A08231	225.1(16)	20.432(9)	11.02(8)
^{137}Cs	A09303	225.6(15)	47.844(20)	4.71(4)
^{152}Eu	A09461	46.5(4)	10.293(11)	4.52(3)

The solid samples (SiO_2) were synthesized by hydrolysing a liquid mixture of tetraethyl orthosilicate (TEOS), ethanol and a mixed radionuclide solution (B09203 containing ^{55}Fe, ^{90}Sr, ^{133}Ba, ^{134}Cs, ^{137}Cs and ^{152}Eu in 0.1 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, 78 samples (50 g each) were prepared (see Table C12 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 C12 – Preparation of S samples

Nuclide	Activity conc. (Bq g^{-1})
^{55}Fe	4.38(13)
^{90}Sr	0.810(20)
^{133}Ba	4.91(13)
^{134}Cs	11.8(3)
^{137}Cs	5.05(13)
^{152}Eu	4.84(13)

All samples were tested with gamma spectrometry for homogeneity (see Table C13 and Figures 46 A-D).

Table C13 – Homogeneity tests (samples despatched)

Nuclide	u_{bb} (%)	u_{meas} (%)	u_{int} (%)	u_{hom} (%)	u_{N*} (%)	u_{stab} (%)	u_N (%)
^{133}Ba	1.34	1.61*	1.03	0	0.71	2.5	2.6
^{134}Cs	0.95	1.41*	0.55	0	0.68	2.5	2.6
^{137}Cs	1.19	1.73*	0.89	0	0.69	2.5	2.6
^{152}Eu	1.73	2.42*	1.42	0	0.68	2.5	2.6

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

Appendix D. Dilution checks

Table D1 – Dilution checks AL and AH samples

	AL	AH
GDF2 vs. RDF2	55.541(15) vs. 54.9(5)	29.979(9) vs. 29.9(7)
zeta score DF2	**1.51**	**0.08**

Table D2 – Dilution checks B1 and B2 samples

	B1	B2
GDF2 vs. RDF2	40.287(8) vs. 40.4(4)	34.56(17) vs. 34.68(8)
zeta score DF2	**–0.22**	**–0.66**
GDF2 vs. RDF2 (^3H)	40.274(14) vs. 40.4(4)	34.60(17) vs. 34.68(8)
zeta score DF2 (^3H)	**–0.26**	**–0.43**
GDF3 vs. RDF3	–	35.242(11)* vs. 34.68(17)
zeta score DF3	**–**	**3.34**
GDF3 vs. RDF3 (^3H)	–	35.260(13)** vs. 34.68(17)
zeta score DF3 (^3H)	**–**	**3.45**

* inflated to 35.24(24)
** inflated to 35.26(24)

Table D3 – Dilution checks GL and GH samples

	GL	GH
GDF1 vs. RDF1 ^{60}Co	–	35.611(11) vs. 35.7(3)
zeta score DF1 ^{60}Co	**–**	**–0.49**
GDF1 vs. RDF1 ^{65}Zn	–	35.2351(25) vs. 35.1(7)
zeta score DF1 ^{65}Zn	**–**	**0.20**
GDF1 vs. RDF1 ^{85}Sr	–	7.5166(7) vs. 7.43(19)
zeta score DF1 ^{85}Sr	**–**	**0.44**
GDF1 vs. RDF1 ^{125}Sb	–	18.421(3) vs. 19.2(4)
zeta score DF1 ^{125}Sb	**–**	**–2.26**
GDF1 vs. RDF1 ^{133}Ba	–	9.0894(4) vs. 9.17(11)
zeta score DF1 ^{133}Ba	**–**	**–0.78**
GDF1 vs. RDF1 ^{134}Cs	–	11.3137(15) vs. 11.62(17)
zeta score DF1 ^{134}Cs	**–**	**–1.86**
GDF1 vs. RDF1 ^{137}Cs	–	35.529(13) vs. 35.5(4)
zeta score DF1 ^{137}Cs	**–**	**0.14**
GDF1 vs. RDF1 ^{152}Eu	–	18.3311(16) vs. 18.31(21)
zeta score DF1 ^{152}Eu	**–**	**0.10**
GDF2 vs. RDF2	–	34.927(18) vs. 34.92(6)
zeta score DF2	**–**	**0.18**
GDF3 vs. RDF3	–	37.754(12) vs. 37.8(3)
zeta score DF3	**–**	**–0.12**
GDF4 vs. RDF4	33.319(19) vs. 34(6)	–
zeta score DF4	**–0.05**	**–**
GDF5s vs. RDF5s	32.30(4) vs. 28(6) to 36(5)	–
zeta scores DF5s	**–0.82 < zeta < 0.81**	**–**

Appendix E. Sample details

Lab code	AL	AH	B1	B2	GL	GH	S	Date results received
1		x						8 December 2009
4	x		x					1 December 2009
5	x		x	x	x	x	x	17 December 2009
7		x	x	x		x	x	14 December 2009
8	x	x	x	x	x	x	x	27 November 2009
10					x	x		1 December 2009
13	x		x			x		30 November 2009
15					x	x		1 December 2009
16			x	x		x		1 December 2009
17	x				x	x	x	30 November 2009
18					x	x	x	8 December 2009
19				x	x			30 November 2009
23					x			6 November 2009
25	x		x	x	x	x		1 December 2009
26	x			x	x			30 November 2009
27					x	x		19 November 2009
28	x		x		x	x	x	30 November 2009
29	x		x		x		x	30 November 2009
31	x	x		x	x	x		8 January 2010
32	x	x	x	x		x	x	24 December 2009
35	x	x	x	x	x	x	x	1 December 2009
38		x	x	x		x		14 December 2009
39					x			26 November 2009
40	x			x	x			24 November 2009
41		x		x	x			26 November 2009
42	x				x			24 November 2009
45						x		13 November 2009
46					x	x		26 November 2009
47	x	x			x	x	x	27 November 2009
48						x	x	30 November 2009
51	x				x			27 November 2009
53					x			13 November 2009
55		x	x	x		x	x	26 November 2009
58					x	x	x	27 November 2009
59	x		x		x	x		2 December 2009
61	x			x	x			30 November 2009
62	x				x			26 November 2009
65	x		x	x	x			11 December 2009
72				x	x			23 November 2009
74			x	x	x		x	15 December 2009
76					x	x	x	14 December 2009
77						x		1 December 2009
78			x					1 December 2009
82					x	x		1 December 2009
83			x		x	x	x	1 December 2009
86	x	x			x	x		1 December 2009
88	x	x			x	x		27 November 2009
89					x	x		20 November 2009

continues

continued								
Lab code	AL	AH	B1	B2	GL	GH	S	Date results received
90	x			x				30 November 2009
91	x			x	x			2 December 2009
93						x		21 December 2009
95			x		x		x	20 November 2009
100	x	x			x	x	x	10 December 2009
104						x		30 November 2009
106	x	x	x	x			x	30 November 2009
107			x	x			x	27 November 2009
108			x			x		26 November 2009
110					x			2 December 2009
111					x			1 December 2009
113	x	x		x			x	9 December 2009
114				x	x		x	30 November 2009
115	x	x						19 November 2009
116						x		8 January 2010
117					x	x		2 December 2009
118					x		x	25 November 2009
119	x			x	x			30 November 2009
120	x			x		x		30 November 2009
121	x			x	x		x	1 December 2009
122				x	x			30 November 2009
123	x	x	x	x	x	x	x	9 December 2009
124					x	x		30 November 2009
126					x	x	x	18 December 2009
Total	32	17	23	29	50	40	26	(217)

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

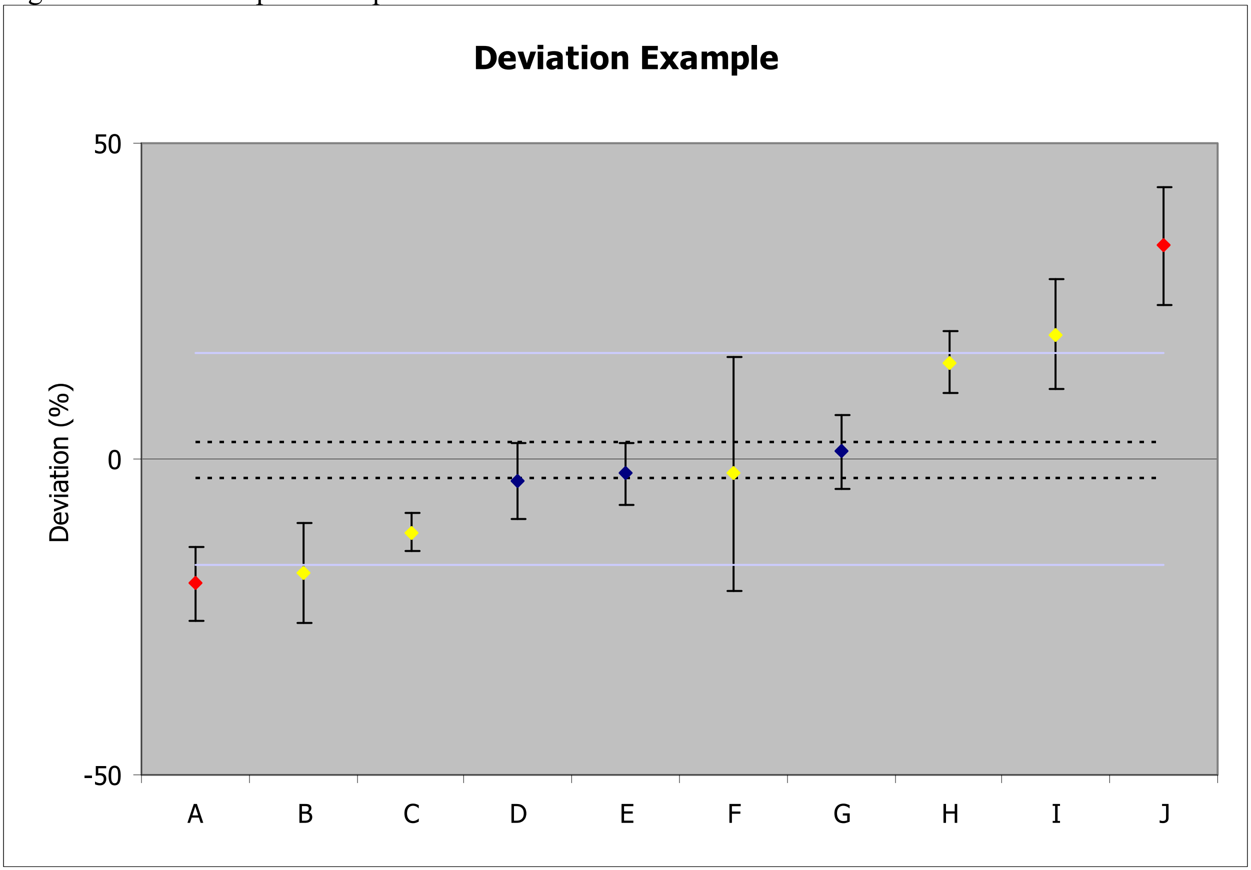
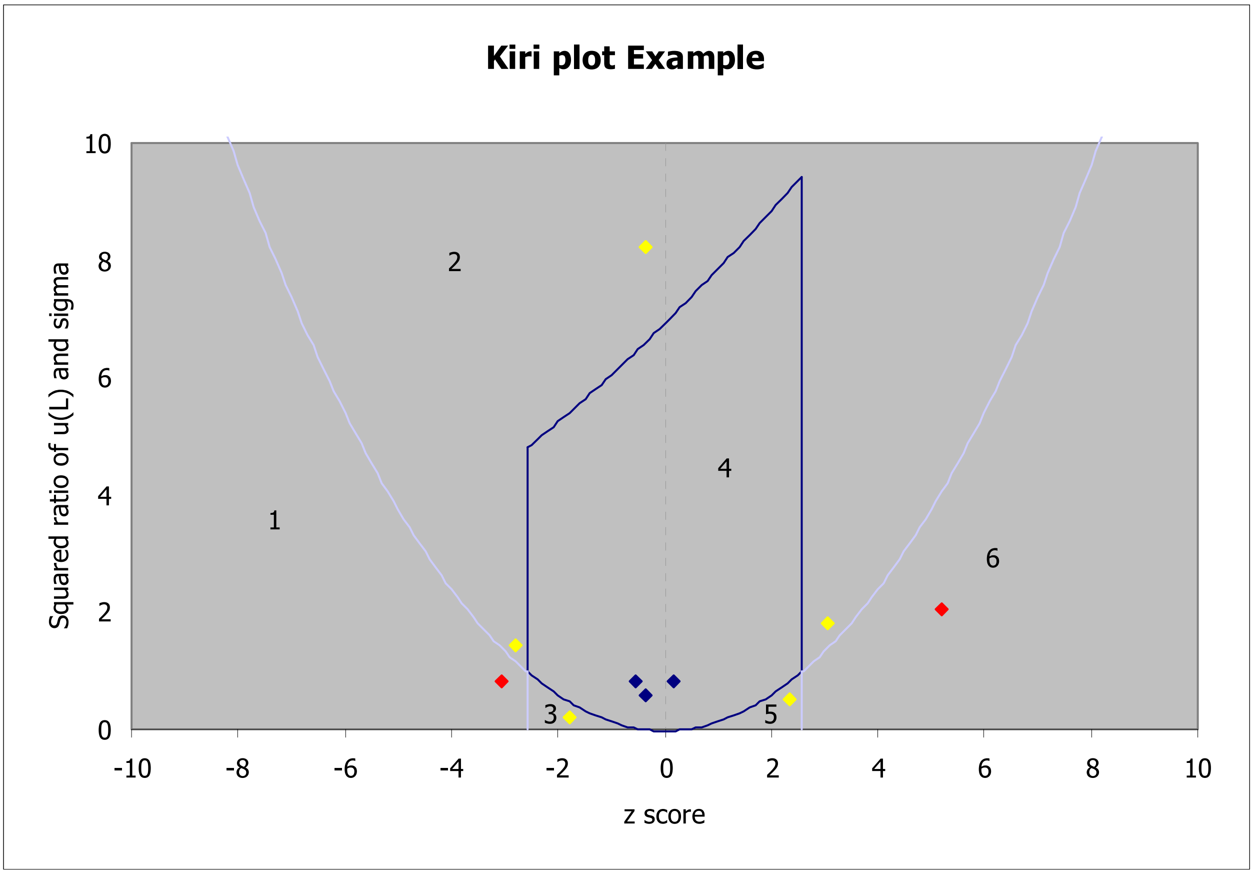


Table F1 – Data classification

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 uncertainty is 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 their 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 their 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 (%)
^{232}Th AL	42	34.2	27.3
^{14}C B1	5*	15.0	14.1
	108*	15.1	14.1
^{99}Tc B1	55	100	21.2
^{55}Fe B2	31	50.0	22.3
^{89}Sr B2	55	56.5	55.5
^{60}Co GL	126*	26.9	20.3
^{65}Zn GL	126	28.7	26.7
	5*	30.2	26.7
	40*	35.1	26.7
^{85}Sr GL	126	27.3	20.7
^{133}Ba GL	126*	27.2	26.3
^{134}Cs GL	126*	26.2	20.0
	26	31.3	20.0
^{152}Eu GL	23*	30.0	29.5
	126*	30.8	29.5
^{60}Co GH	126	26.1	15.7
	7	28.2	15.7
^{65}Zn GH	126	26.2	14.0
^{85}Sr GH	126	26.4	15.3
^{125}Sb GH	126	26.3	20.4
^{133}Ba GH	126*	26.1	16.0
^{134}Cs GH	126*	26.0	16.7
continues			

continued			
^{137}Cs GH	126	26.3	15.1
^{152}Eu GH	126*	26.0	18.8

* 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
^{14}C	$2.082(11) \times 10^{6}$	DDEP
^{55}Fe	1003(3)	DDEP
^{60}Co	1925.2(3)	DDEP
^{65}Zn	244.01(9)	DDEP
^{85}Sr	64.850(7)	DDEP
^{89}Sr	50.57(3)	DDEP
^{90}Sr	10520(30)	DDEP
^{99}Tc	$7.8(3) \times 10^{7}$	DDEP
^{125}Sb	1007.54(9)	DDEP
^{129}I	$5.88(26) \times 10^{9}$	DDEP
^{133}Ba	3849.7(22)	DDEP
^{134}Cs	753.5(10)	IAEA
^{137}Cs	10976(30)	DDEP
^{152}Eu	4939(6)	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}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. Standard deviation for proficiency assessment; NPL and ISO approach

For all samples in this exercise the standard uncertainty for proficiency assessment is calculated according to:

$$\sigma_p = R_{med} N \qquad \text{(see Section 2.6)}$$

The values are used to calculate the *z* scores:

$$z = \frac{L - N}{\sigma_p}$$

According to ISO 13528:2005 the standard deviation for proficiency assessment can be determined by:

6.2 Prescribed value
6.3 Perception
6.4 From a general model
6.5 From the results of a precision experiment
6.6 From data obtained in a round of a proficiency testing scheme

In case of ISO Sections 6.2 and 6.3, the standard deviation for proficiency assessment value is simply set at a value (e.g., at 5% or 10%), which we feel is not appropriate for the NPL exercise. ISO sections 6.4 and 6.5 are not applicable, because in the NPL Environmental Radioactivity PTE there is no standard measurement method and, consequently, there is no information on the repeatability and reproducibility of this method. Instead, the participants are asked to submit a result with its corresponding uncertainty, which is likely to consist mostly of Type B uncertainty (e.g., counting statistics, calibration uncertainty, weighing, etc.). The dominance of Type B uncertainty set this type of exercise apart from exercises where Type A uncertainties are more prevalent (e.g., in chemistry PTEs) or exercises where there is no requirement to submit an uncertainty value.
The philosophy of the NPL approach to calculation of the standard deviation for proficiency assessment for all aqueous samples is similar to ISO Section 6.6 but the calculation differs from the ISO approach. Instead of using the robust standard deviation (see below) of the results themselves, the product of median of the participants' submitted relative uncertainties and the assigned value is used. (see Section 2.6). The ISO approach ignores the submitted uncertainties and the calculation of the standard deviation for proficiency assessment (and ultimately the *z* score) is based on the spread of the submitted results. The NPL approach is analogous to selecting the internal uncertainty when calculating the uncertainty of a weighted mean, instead of selecting the external uncertainty (ISO approach). In practice, the obtained values for median of the participants' submitted relative uncertainties vary between 3.7% and 13.1%, which is not surprising considering the different techniques used (alpha spectrometry, mass spectrometry, liquid scintillation counting, gas-flow proportional counting and gamma spectrometry), but are generally close to 5% (see Section 3.11). The expected uncertainties also depend on the activity levels in the samples and the composition of the samples (e.g., certain radionuclides interfere with the measurement of other radionuclides), which will differ for every exercise (although the values for the 2009 Exercise were in general very similar to the values obtained for the 2005, 2007 and 2008 Exercises). Table K1 lists the results of both approaches and shows the ratios between the ISO σ_p and the NPL σ_p. In general, the ratios have values between 1 and 2; only in few cases, where there is a large spread in the submitted results, is the ratio much larger than unity [e.g., ^{237}Np AL, gross alpha AL and AH and ^{89}Sr B2].

Table K1 – Standard deviation for proficiency assessment; NPL and ISO approach

Nuclide	Number of results	σ_p (NPL)	σ_p (ISO 13528)	σ_p (ISO) / σ_p (NPL) Ratio
		(Bq kg^{-1})	(Bq kg^{-1})	
^{232}Th (AL)	21	**0.30**	0.57	1.9
^{237}Np	11	**0.48**	2.1	4.3
^{238}U	30	**0.91**	0.86	0.94
^{239}Pu	26	**0.62**	0.70	1.1
^{241}Am	29	**0.23**	0.17	0.73
^{244}Cm	20	**0.68**	0.96	1.4
Gross alpha	13	**3.7**	14	3.8
		(Bq g^{-1})	(Bq g^{-1})	
^{226}Ra (AH)	14	**0.94**	2.1	2.3
^{237}Np	11	**0.45**	0.68	1.5
^{238}Pu	11	**0.78**	1.1	1.4
^{239}Pu	13	**0.55**	0.91	1.6
^{241}Am	17	**0.27**	0.43	1.6
^{244}Cm	11	**0.35**	0.85	2.4
Gross alpha	10	**3.9**	13	3.4
^{3}H (B1)	23	**0.099**	0.052	0.52
^{14}C	19	**0.046**	0.12	2.5
^{99}Tc	16	**0.010**	0.013	1.2
^{129}I	10	**0.011**	0.016	1.5
^{3}H (B2)	24	**0.056**	0.11	2.0
^{55}Fe	12	**0.11**	0.28	2.6
^{89}Sr	15	**0.044**	0.16	3.6
^{90}Sr	22	**0.083**	0.14	1.7
		(Bq kg^{-1})	(Bq kg^{-1})	
^{60}Co (GL)	48	**0.27**	0.35	1.3
^{65}Zn	46	**0.40**	0.50	1.3
^{85}Sr	47	**0.37**	0.57	1.5
^{125}Sb	32	**0.18**	0.22	1.2
^{133}Ba	47	**0.26**	0.24	0.90
^{134}Cs	49	**0.75**	0.83	1.1
^{137}Cs	50	**0.28**	0.32	1.2

continues

continued				
Nuclide	**Number of results**	**σ_p (NPL)**	**σ_p (ISO 13528)**	**σ_p (ISO) / σ_p (NPL) Ratio**
		(Bq kg^{-1})	(Bq kg^{-1})	
^{152}Eu	39	**0.18**	0.22	1.2
		(Bq g^{-1})	(Bq g^{-1})	
^{60}Co (GH)	39	**0.22**	0.26	1.2
^{65}Zn	38	**0.23**	0.47	2.0
^{85}Sr	37	**0.32**	0.38	1.2
^{125}Sb	37	**0.076**	0.10	1.3
^{133}Ba	38	**0.18**	0.36	2.0
^{134}Cs	39	**0.62**	1.1	1.7
^{137}Cs	40	**0.20**	0.21	1.1
^{152}Eu	38	**0.10**	0.16	1.7
^{55}Fe (S)	3	**0.29**	0.79	2.7
^{90}Sr	9	**0.045**	0.052	1.2
^{133}Ba	22	**0.23**	0.43	1.9
^{134}Cs	23	**0.44**	0.98	2.2
^{137}Cs	24	**0.20**	0.31	1.5
^{152}Eu	22	**0.20**	0.39	2.0

More information can be found in ISO 13528:2005 and Harms, A., 2009. A new approach for proficiency test exercise data evaluation. Accreditation and Quality Assurance, 14, 253-261.

The robust standard deviation according to ISO 13528:2005 is calculated as follows:

Calculate initial values for N^* and s^*

$$N^* = median\ of\ L_i$$

$$s^* = 1.483\ median\left|L_i - N^*\right|$$

Update the values of N^* and s^* as follows. Calculate:

$$\delta = 1.5\ s^*$$

For each L_i, calculate:

$$L_i^* = \begin{cases} N^* - \delta & \text{if } L_i < N^* - \delta \\ N^* + \delta & \text{if } L_i > N^* + \delta \\ L_i & \text{otherwise} \end{cases}$$

Calculate the new values of N^* and s^*

$$N^* = \sum \frac{L_i^*}{p}$$

$$s^* = 1.134 \sqrt{\frac{\sum \left(L_i^* - N^*\right)^2}{p-1}}$$

where the summation is over i.

The robust estimates N^* and s^* are derived by an iterative calculation, i.e., by updating the values of N^* and s^* several times using the modified data, until the process converges. Subsequently, the updated value of the robust mean N^* is assigned to the assigned value N.

$$N = N^*$$

The standard uncertainty of the consensus value is calculated using this equation.

$$u_{cons} = 1.25 \frac{s^*}{\sqrt{p}} = 1.42 \sqrt{\frac{\sum \left(L_i^* - N^*\right)^2}{p(p-1)}}$$

The updated value for the standard deviation s^* is assigned to the standard deviation for proficiency assessment.

$$\sigma_p = s^*$$

Finally, the standard uncertainty of the assigned value is calculated by combining the standard uncertainty of the consensus value with the homogeneity uncertainty and the stability uncertainty (see Section 2.7).

Appendix L. Acknowledgements

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Appendix M. Literature

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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 N. Assigned NPL values

Nuclide	Assigned value *N*
	Bq kg^{-1}
^{232}Th **(AL)**	5.01(5)
^{237}Np	4.65(5)
^{238}U	18.0(4)
$^{239/240}$Pu	11.77(12)
^{241}Am	3.099(6)
^{244}Cm	15.41(5)
gross alpha	72(7)
	Bq g^{-1}
^{226}Ra **(AH)**	15.90(21)
^{237}Np	4.84(5)
^{238}Pu	16.63(5)
$^{239/240}$Pu	11.31(5)
^{241}Am	5.356(10)
^{244}Cm	6.980(22)
gross alpha	$8(3) \times 10^{1}$
^{3}H **(B1)**	1.688(12)
^{14}C	0.905(6)
^{99}Tc	0.1562(4)
^{129}I	0.1504(9)
^{3}H **(B2)**	1.389(15)
^{55}Fe	1.53(3)
^{89}Sr	0.463(4)
^{90}Sr	1.153(10)
gross beta P	2.769(15)
gross beta L	5.68(4)
	Bq kg^{-1}
^{60}Co **(GL)**	5.035(12)
^{65}Zn	5.50(4)
^{85}Sr	7.01(5)
^{125}Sb	1.366(7)
^{133}Ba	3.571(25)
continues	

continued	
^{134}Cs	14.02(10)
^{137}Cs	4.47(3)
^{152}Eu	1.789(12)
	Bq g^{-1}
^{60}Co **(GH)**	5.418(12)
^{65}Zn	5.92(4)
^{85}Sr	7.54(5)
^{125}Sb	1.470(7)
^{133}Ba	3.84(3)
^{134}Cs	15.09(11)
^{137}Cs	4.81(4)
^{152}Eu	1.925(13)
^{55}Fe **(S)**	4.38(13)
^{90}Sr	0.810(20)
^{133}Ba	4.91(13)
^{134}Cs	11.8(3)
^{137}Cs	5.05(13)
^{152}Eu	4.84(13)

Appendix O. List of participating laboratories

BELGIUM

E. Andreotti and M. Hult
European Commission
Joint Research Centre
Institute for Reference Materials and Measurements
Retieseweg 111
2440 Geel
Belgium

BULGARIA

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

L. Kinova
Institute for Nuclear Research and Nuclear Energy
72 Tzarigradsko chaussee
1784 Sofia
Bulgaria

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

DENMARK

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

FINLAND

A.-P. Leppänen
Radiation & Nuclear Safety Authority
STUK
Louhikkotie 28
96500 Rovaniemi
Finland

FRANCE

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

A. Royer
Société Pe@rL
83 Rue d'isle
87000 Limoges
France

GERMANY

H. Simgen, J. Schreiner and M. Weber
Max-Planck-Institut für Kernphysik
Saupfercheckweg 1
69117 Heidelberg
Germany

GREECE

K. Kehagia
Greek Atomic Energy Commission
P.O. Box 60092
15310 Agia Paraskevi
Greece

ICELAND

Ó. Halldórsson Holm
Icelandic Radiation Protection Institute
Raudararstigur 10
150 Reykjavik
Iceland

IRELAND

J. Wong and K. Kelleher
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

ITALY

C. Cantaluppi
Istituto di Chimica Inorganica e delle Superfici
Consiglio Nazionale delle Ricerche
Area della Ricerca
Corso Stati Uniti 4
35127 Padova
Italy

THE NETHERLANDS

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

G.C. Krijger
RIKILT
Bornsesteeg 45
6708 PD Wageningen
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. Nalbandyan
Norwegian Radiation Protection Authority
Polar Environmental Centre
Hjalmar Johansens gate 14
9296 Tromsø
Norway

L. Skipperud
Norwegian University of Life Sciences
Fougnerbakken 3
1432 Ås
Norway

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

POLAND

J. Rachubik
National Veterinary Research Institute
Al. Partyzantów 57
24-100 Puławy
Poland

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

E. Cincu
IFIN-HH-National Institute of Physics and Nuclear Engineering
Strada Atomistilor 407
Mãgurele, Ilfov
077125
Romania

A. Stochioiu
IFIN-HH-National Institute of Physics and Nuclear Engineering
Strada Atomistilor 407
Mãgurele
077125 Ilfov
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

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

SPAIN

F. Legarda Ibáñez
LMBA
Universidad del País Vasco / Euskal Herriko Unibertsitatea
Alda. Urquijo s/n
48013 Bilbao
Spain

A. Suáñez Fidalgo
CIEMAT
Laboratorio de Radioactividad Ambiental
Avda. Complutense 22
28230 Madrid
Spain

SWITZERLAND

S. Estier
Bundesamt für Gesundheit (BAG)
Environmental Radioactivity Section
Schwarzenburgstrasse 165
3097 Liebefeld
Switzerland

TURKEY

E. Yeltepe
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

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

C. Barnett
CEH Lancaster
Lancaster Environment Centre
Library Avenue
Bailrigg, Lancaster LA1 4AP
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

D. Culton
British Energy
Torness Power Station
Dunbar
East Lothian EH42 1QS
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

S. Judge and A. Wright
Magnox South Limited
Dungeness Station
Romney Marsh
Kent TN29 9PP
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

R. Lukey
Veterinary Laboratories Agency - Weybridge
New Haw
Addlestone
Surrey KT15 3NB
United Kingdom

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

A. Morgan
VT Nuclear Services
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

C. Stewart
DSRL Ltd
Dounreay
Thurso
Caithness KW14 7TZ
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

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