National Physical Laboratory

# Report

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## ENVIRONMENTAL RADIOACTIVITY PROFICIENCY TEST EXERCISE 2008

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# Environmental Radioactivity Proficiency Test Exercise 2008

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## ABSTRACT

The results of NPL's fourteenth Environmental Radioactivity Proficiency Test Exercise are reported. This exercise included preparing 245 samples and distributing them to 37 participants in the UK and 41 overseas participants. Seven different sample types were offered: an aqueous mixture of nine alpha emitters at two concentration levels, an aqueous mixture of four beta emitters, an aqueous mixture of three beta emitters, an aqueous mixture of eight gamma emitters at two concentration levels and a solid neutron-activated concrete powder sample containing a variety of activation products. The level of performance was lower to that observed in the previous Exercise (2007); 67% of the results returned were in good agreement.

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# 1. INTRODUCTION

This environmental radioactivity proficiency test exercise was the fourteenth 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 have been run approximately once every eighteen months by NPL. The range of sample types available for analysis has been mainly aqueous. In the 2008 exercise, seven samples types were available for analysis:

(i) **AL**; a 'low-level' mixture of $\alpha$-emitting radionuclides in 500 g of dilute nitric acid (1 – 20 Bq $kg^{-1}$ per radionuclide)
(ii) **AH**; a 'high-level' mixture of $\alpha$-emitting radionuclides in 20 g of dilute nitric acid (1 – 20 Bq $g^{-1}$ per radionuclide)
(iii) **B1**; a mixture of $\beta$-emitting radionuclides in 500 g of very dilute hydrochloric acid (0.1 – 2 Bq $g^{-1}$ per radionuclide)
(iv) **B2**; a mixture of $\beta$-emitting radionuclides in 500 g of very dilute NaOH solution (0.1 – 2 Bq $g^{-1}$ per radionuclide)
(v) **GL**; a 'low-level' mixture of $\gamma$-emitting radionuclides in 500 g of dilute hydrochloric acid (1 – 20 Bq $kg^{-1}$ per radionuclide)
(vi) **GH**; a 'high-level' mixture of $\gamma$-emitting radionuclides in 100 g of dilute hydrochloric acid (1 – 20 Bq $g^{-1}$ per radionuclide)
(vii) **C**; neutron activated crushed concrete containing a variety of radionuclides (up to ~10 Bq $g^{-1}$ per radionuclide except for the tritium component)

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, except for the nuclides in the C sample in which case the consensus value of the returned results was taken as the assigned value. 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 C 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 and AH sources (both containing a mixture of $^{226}$Ra, $^{237}$Np, $^{234}$U, $^{235}$U, $^{238}$U, $^{238}$Pu, $^{239}$Pu, $^{241}$Am and $^{244}$Cm), the B1 sources (containing a mixture of $^{3}$H, $^{14}$C and $^{99}$Tc), the B2 sources (containing a mixture of $^{3}$H, $^{55}$Fe, $^{63}$Ni and $^{90}$Sr) and the C sources (a "real" solid sample containing a variety of nuclides including $^{3}$H, $^{14}$C, $^{40}$K, $^{41}$Ca, $^{55}$Fe, $^{60}$Co, $^{63}$Ni, $^{133}$Ba, $^{152}$Eu and $^{154}$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 2007 exercise, although a few minor changes were implemented and a separate data treatment for the C samples was added. 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 2007 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, (iv) 'Kiri plots', whose development had been inspired by 'Naji plots' and (v) Cox plots.

# 2. MATERIALS AND METHODS

## 2.1 Participants

A total of 78 participants took part in the exercise (37 from the United Kingdom and 41 from overseas organisations). A full listing is given in Appendix O. The majority of the samples taken were the GL and GH (55 and 44 participants, respectively). Uptake for the AL, AH, B1, B2 and C samples was 25, 16, 29, 31 and 32, respectively (for details see Appendix F).

## 2.2 Composition of samples

To prepare the AL, AH, B1, B2, GL and GH 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:

**$^{22}$Na**, **$^{133}$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.

**$^{63}$Ni**, **$^{90}$Sr** and **$^{99}$Tc** – standardised by liquid scintillation counting (using the CIEMAT / NIST efficiency tracing method with $^{3}$H).

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

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

**$^{95}$Zr** and **$^{95}$Nb** – standardised by high-resolution gamma-ray spectrometry.

**$^{234}$U**, **$^{235}$U** and **$^{238}$U –** calculated from the certified U amount content of IRMM 106 (natural $UO_2$ pellets) and nuclear data (and assuming the U is natural).

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). 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 daughter $^{240}$Pu and negligible amounts of contaminants ($^{245}$Cm, $^{246}$Cm, $^{247}$Cm and $^{248}$Cm combined). A detailed overview of the source preparation and dilution checks can be found in Appendices C and D, respectively.

### 2.3 Reference time

The reference time for all activity concentrations was 1 October 2008 12:00 UTC. The deadline for the submission of results was 1 December 2008. In some cases, an extension of the deadline was granted (see Appendix F 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. “Maggie” was used to determine the activity concentration of $^{95}$Zr and $^{95}$Nb. Impurity determinations of solutions assayed by ionisation chamber were performed on the same calibrated 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 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 $^{63}$Ni, $^{90}$Sr and $^{99}$Tc using the CIEMAT/NIST method. Each vial contained 10 g of liquid scintillation cocktail and 1.0 g of aqueous phase (containing either the $^{63}$Ni, $^{90}$Sr and $^{99}$Tc or the $^{3}$H standard source) resulting in a total volume of approximately 11 ml for all samples. Subsequently, the vials were swirled thoroughly and placed in the counter to cool and dark-adapt. Quenching was measured using the tSIE parameter (transformed Spectral Index of the External standard), which has a range of 0-1000, where 0 indicates a completely quenched sample and 1000 an unquenched sample. All count rates were corrected for background. The computer programmes CN2004 (PTB, Braunschweig, Germany), Matlab and Axum-7 were used to calculate the activities.

The same counter was also used to confirm Gravimetric Dilution Factors for the AL, AH, B1 and B2 samples using Cerenkov counting and liquid scintillation counting; (see Appendix D for more details).

### 2.4.3 Ionisation Chamber

A TPA MkII ionisation chamber, which contains a counting gas of argon at 2 MPa, was used. This chamber has been monitored daily for almost 30 years using the same radium test source, and its variation in response has been found to be less than 0.1% over that period. The chamber converts ionising radiation into electrical current, which is measured using a voltage integrator circuit; the important components of which are calibrated in a manner traceable to national standards every six months. The conversion from current to source activity in Becquerels is nuclide-dependent, and is derived by measuring a source that has been standardised using primary standardisation methods. The chamber is linear over a large dynamic range (sub-pA equivalent activities up to micro-amps) and is intrinsically free from dead-time. Operation at the high end of the current range is only limited by space-charge recombination effects, where the density of ions in the chamber approaches a level where ions recombine before they are swept by the applied high voltage to the charge collection wires, thus diminishing the measured current and introducing a non-linear component into the chamber response.

The geometry of the source affects the response of the chamber, and so sources are typically decanted into standard vials of known composition and suspended inside the chamber using a special holder; corrections for source volume are also applied, as the depth of liquid in the standard vial also has a small effect on the overall response. Analysis of results is exceptionally simple – the accumulated charge in the feedback capacitor is derived from the voltage drop across it, and an average current is worked out based on the elapsed time of the measurement. The average current is then converted to source activity by applying the appropriate calibration factor. If the source is discovered to be contaminated (deduced from gamma-spectroscopy measurements, or half-life determinations) then it may be necessary to analyse the result using a multi-component model for the source; this does not introduce any significant complexity into the analysis.

## 2.5 Nuclides

### 2.5.1 AL 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 slightly different from the similar samples offered in the last exercise: $^{234}$U and $^{235}$U were added.

#### 2.5.1.1 Radium-226

This naturally-occurring nuclide decays mainly 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 with an ionisation chamber. The $^{226}$Ra source contained $^{210}$Pb, $^{210}$Bi and $^{210}$Po (each ingrown to ~30% of the $^{226}$Ra activity).

#### 2.5.1.2 Neptunium-237

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 with an ionisation chamber.

#### 2.5.1.3 Uranium-234

This naturally occurring primordial nuclide decays mainly by emission of alpha particles to $^{230}$Th. It occurs widely in the environment. The $^{234}$U activity was calculated from the certified U amount content of IRMM 106 (natural $UO_2$ pellets) and nuclear data (assuming the U is natural).

#### 2.5.1.4 Uranium-235

This naturally occurring primordial nuclide decays mainly by emission of alpha particles to $^{231}$Th. It occurs in the environment. The $^{235}$U activity was calculated from the certified U amount content of IRMM 106 (natural $UO_2$ pellets) and nuclear data (assuming the U is natural).

#### 2.5.1.5 Uranium-238

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 activity was calculated from the certified U amount content of IRMM 106 (natural $UO_2$ pellets) and nuclear data (assuming the U is natural).

#### 2.5.1.6 Plutonium-238

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).

#### 2.5.1.7 Plutonium-239

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).

#### 2.5.1.8 Americium-241

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.

#### 2.5.1.9 Curium-244

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

### 2.5.2 B1 samples

The nuclides listed below were the principal radionuclides present in the B1 samples. The composition of the B1 sample was different from the B2 sample offered in the last exercise: Organically Bound Tritium (OBT), $^{36}$Cl and $^{129}$I were omitted whilst $^{99}$Tc 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).

### 2.5.3 B2 samples

The nuclides listed below were the principal radionuclides present in the B2 samples. The composition of the B2 sample was different from the BL and BH offered in the last exercise: $^{89}$Sr and $^{99}$Tc (which is now present in the B1 sample) were omitted.

#### 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 Nickel-63

This nuclide is produced by neutron activation of $^{62}$Ni. It undergoes beta minus decay ($E_{max}$ = 67 keV) to $^{63}$Cu. Nickel-63 may be present in environmental samples originating from the nuclear industry. The $^{63}$Ni source was standardised by liquid scintillation counting (CIEMAT / NIST efficiency tracing with $^{3}$H). It contained a small amount of $^{59}$Ni (at 1.00(25)% of the $^{63}$Ni activity).

#### 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: $^{125}Sb$, $^{144}Ce$ and $^{155}Eu$ were omitted, whilst $^{22}Na$ was added.

#### 2.5.4.1 Sodium-22

This nuclide, which may be produced by charged particle reactions, decays via beta plus emissions (90%) and electron capture (10%) to $^{22}Ne$. The probability of producing a gamma-ray emission at 511 keV and 1275 keV are 1.798(2) and 0.99940(14), respectively. This nuclide may show coincidence summing effects on high efficiency detectors. Sodium-22 may be present in some decommisioning waste and may be used as a calibration nuclide. Sodium-22 was standardised with an ionisation chamber.

#### 2.5.4.2 Cobalt-60

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

#### 2.5.4.3 Zirconium-95

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

#### 2.5.4.4 Niobium-95

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

#### 2.5.3.5 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 with an ionisation chamber.

#### 2.5.3.6 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 with an ionisation chamber.

#### 2.5.3.7 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 with an ionisation chamber.

#### 2.5.3.8 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 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 with an ionisation chamber.

### 2.5.5 C samples

The nuclides listed below were the principal radionuclides present in the C samples. The composition of the C samples was similar to that in the last exercise.

#### 2.5.5.1 Hydrogen-3 (Tritium)

This nuclide is produced in concrete by neutron activation of hydrogen ($^{2}$H), lithium ($^{6}$Li) and boron ($^{10}$B). It undergoes beta minus decay ($E_{max}$ = 18.6 keV) to $^{3}$He.

#### 2.5.5.2 Carbon-14

This nuclide is produced in concrete by neutron activation of carbon ($^{13}$C), nitrogen ($^{14}$N and $^{15}$N) and oxygen ($^{16}$O and $^{17}$O). It undergoes beta minus decay ($E_{max}$ = 156 keV) to $^{14}$N.

#### 2.5.5.3 Potassium-40

This naturally-occurring radionuclide decays by via electron capture (10.86%) mainly to the excited level of $^{40}$Ar (1460 keV) and by beta minus emissions (89.14%) to $^{40}$Ca.

#### 2.5.5.4 Iron-55

This nuclide is produced in concrete by neutron activation of iron ($^{54}$Fe). It decays via electron capture to $^{55}$Mn.

#### 2.5.5.5 Cobalt-60

This nuclide is produced in concrete by neutron activation of cobalt ($^{59}$Co). It undergoes beta minus decay to excited levels of $^{60}$Ni. This nuclide may show coincidence summing effects on high efficiency detectors.

#### 2.5.5.6 Nickel-63
This nuclide is produced in concrete by neutron activation of nickel ($^{62}Ni$). It undergoes beta minus decay ($E_{max}$ = 67 keV) to $^{63}Cu$.

#### 2.5.5.7 Barium-133
This nuclide is produced in concrete by activation of barium ($^{134}Ba$) with fast neutrons. It decays by electron capture to excited levels of $^{133}Cs$. Barium-133 is well known as a nuclide which shows coincidence summing effects on high efficiency detectors.

#### 2.5.5.9 Europium-152
This nuclide is produced in concrete by neutron activation of europium ($^{151}Eu$). It 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 well known as a nuclide which shows large coincidence summing effects on high efficiency detectors.

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

## 2.6 Treatment of data for aqueous samples

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$^{-1}$) |
| $u_{\mathrm{D}}$ | – standard uncertainty of the deviation | |
| $u_{\mathrm{L}}$ | – standard uncertainty of the laboratory value | (Bq kg$^{-1}$ or Bq g$^{-1}$) |
| $u_{\mathrm{N}}$ | – standard uncertainty of the assigned value | (Bq kg$^{-1}$ or Bq g$^{-1}$) |
| $\zeta$ | – zeta score | |
| $R_{\mathrm{L}}$ | – relative uncertainty of the laboratory value | |
| $z$ | – $z$-score | |
| $\sigma_{\mathrm{p}}$ | – standard uncertainty for proficiency assessment | (Bq kg$^{-1}$ or Bq g$^{-1}$) |
| $R_{\mathrm{med}}$ | – median of the $R_{\mathrm{L}}$ 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 (IQR) outlier test (see Appendix H) was used to determine whether the relative uncertainty of the laboratory value $R_{\mathrm{L}}$ 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 case the data set is smaller than 10, any $R_{\mathrm{med}} > 0.20$ was set at 0.20, and any $R_{\mathrm{med}} < 0.05$ was set at 0.05.

Results for which the absolute values of the zeta score and the $z$-score were both ≤ 2.576 (corresponding to a significance levels of $\alpha = 0.01$) and a relative uncertainty $R_L$ 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 the 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:

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

'Kiri' plots were constructed by plotting the squares of the ratio between the uncertainty $u_L$ and the target uncertainty $\sigma_P$ against the $z$-score. 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 $\leq 2.576$ and which are outside the $R_{\mathrm{lim}}$ parabola (i.e., for which $R_{\mathrm{L}} \leq R_{\mathrm{lim}}$) 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 $-2.576 \leq z$-score $\leq 2.576$ or

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

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

More information on the interpretation of Kiri plots is given in Appendix G.

[*] Please note that the z-test value $\geq (-N / \sigma_{\mathrm{p}})$ by definition

## 2.7 Treatment of data for C samples

The data was evaluated in case five or more results were received. Eleven results were not evaluated [$^{3}$H fixed (3 results), $^{22}$Na, $^{36}$Cl, $^{58}$Co, $^{137}$Cs, $^{226}$Ra, $^{228}$Ra, $^{228}$Th and $^{238}$U (all 1 result)]. The assigned value and its corresponding standard uncertainty were calculated in two different ways: (i) the weighted mean of the largest consistent subset LCS (see 2.7.1) and (ii) according to ISO standard 13528:2005 (see 2.7.2). The first method may not use the complete data set, but it does take the standard uncertainties of the laboratory values into account. The second method, which was used in the previous 2007 Exercise uses the complete data set, but it ignores the standard uncertainties of the laboratory values. It was decided to use the first method (Section 2.7.1) in case the LCS contained 75% or more of the results in the data set. The standard deviation for proficiency assessment was calculated according to Section 2.6. The second method (Section 2.7.2) was used in case the LCS contained less than 75% of results in the data set. In this case, the standard deviation for proficiency assessment was calculated in accordance with ISO standard 13528 (Section 2.7.2).

### 2.7.1 Weighted mean of the 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

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

Define:

$$e_i(x) = \left( \frac{L_i - x}{u_{\mathrm{L}}} \right)^2$$

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

Calculate $p$ $F_{\mathrm{r}}(x)$ functions for each of these 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 is given in Appendix I.

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* Cox MG (2007) Metrologia 44:187-200

### 2.7.2 ISO standard 13528:2005

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:

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

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 (see Section 2.8).

The results were evaluated using three tests:

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

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

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

| where: | | unit: |
|---|---|---|
| $L$ | – laboratory value | (Bq g$^{-1}$) |
| $N$ | – assigned value | (Bq g$^{-1}$) |
| $N^*$ | – robust estimate of the assigned value | (Bq g$^{-1}$) |
| $s^*$ | – robust estimate of standard deviation | (Bq g$^{-1}$) |
| $u_{\mathrm{L}}$ | – standard uncertainty of the laboratory value | (Bq g$^{-1}$) |
| $u_{\mathrm{cons}}$ | – standard uncertainty of the consensus value | (Bq g$^{-1}$) |
| $u_{\mathrm{N}}$ | – standard uncertainty of the assigned value | (Bq g$^{-1}$) |
| $\sigma_p$ | – standard deviation for proficiency assessment | (Bq g$^{-1}$) |
| $\zeta$ | – zeta score | |
| $R_{\mathrm{L}}$ | – relative uncertainty of the laboratory value | |
| z | – z-score | |
| $p$ | – number of results | |

The interquartile (IQR) outlier test (see Appendix H) were used to determine whether the relative uncertainty of the laboratory value $R_{\mathrm{L}}$ is significantly larger than the other values in the data set. Results for which the absolute values of the zeta score and the $z$-score were both ≤ t (corresponding to a significance levels of $\alpha = 0.01$; see Appendix K) and a relative uncertainty $R_{\mathrm{L}}$ 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 $R_{\mathrm{L}}$ is significantly larger than the other values in the data set, (ii) the result passes the zeta test but not the $z$-test (large deviation from the assigned value combined with a large uncertainty), or (iii) the result passes the $z$-test but not the zeta test (small deviation from the assigned value and combined with 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 > t, then the laboratory value is classified as '**discrepant**' from the assigned value (red points), whatever the value of its relative uncertainty $R_{\mathrm{L}}$.

## 2.8 Homogeneity testing of C samples

Fourteen randomly selected samples were kept at NPL and measured by high-resolution gamma spectrometry. The between-sample variance was determined by measuring all samples ($n$ = 62) once, while the measurement variance was determined by measuring a single sample $m$ times ($m$ = 10). For each sample, decay-corrected count rates per unit mass $x_i$ or $x_j$ for $^{60}$Co (1173 keV peak), $^{133}$Ba (356 keV peak), $^{152}$Eu (964 keV peak) and $^{154}$Eu (1274 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 $u_\mathrm{N}$ was obtained by quadrature summation of the relative homogeneity uncertainty and the relative uncertainty on the consensus value.

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

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

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

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

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

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

| 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$^{-1}$) |
| $u_{\mathrm{meas}}$ | – relative measurement uncertainty | |
| $u_{\mathrm{int}}$ | – mean of the relative uncertainties of $x_j$ | |
| $u_{\mathrm{cons}}$ | – standard uncertainty of the consensus value | |
| $u_{\mathrm{hom}}$ | – relative homogeneity uncertainty | |
| $u_{\mathrm{stab}}$ | – relative stability uncertainty | |
| $u_{N,rel}$ | – relative uncertainty of the assigned value $N$ | |

## 2.9 Comparison of the assigned values with the participants' values

The robust means and the robust standard deviations for the participants' results were calculated in accordance with the method described in Section 2.7 and subsequently compared with the assigned values (except for the nuclides in the C samples where the robust means are equal to the assigned values). The robust 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 $v_{\mathrm{eff}}$ were determined with the simplified Welch-Satterthwaite equation (it is assumed that the degrees of freedom for $u_{\mathrm{N}}$ are infinite).

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

The effective degrees of freedom $v_{\mathrm{eff}}$ were rounded and $t_{\mathrm{crit}}$ was identified from the values tabulated in Appendix K. 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.

## 2.10 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.

## 2.11 Nuclear data

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

## 2.12 Niobium-95 and Zirconium-95

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

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

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

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

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

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

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

The ratio between $^{95}$Nb and $^{95}$Zr at the reference time 1 October 2008 (12:00 UTC) was 1.843(21).

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

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

with:

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

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

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

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

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

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

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

with:

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

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

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

| where: | | value |
|---|---|---|
| $A_1(t)$ | – $^{95}$Zr activity at time $t$ | |
| $A_2(t)$ | – $^{95m}$Nb activity at time $t$ | |
| $A_3(t)$ | – $^{95}$Nb activity at time $t$ | |
| $\lambda_1$ | – decay constant $^{95}$Zr: | 0.0108250(10) d$^{-1}$ |
| $\lambda_2$ | – decay constant $^{95m}$Nb: | 0.1920(16) d$^{-1}$ |
| $\lambda_3$ | – decay constant $^{95}$Nb: | 0.019809(4) d$^{-1}$ |
| $p$ | – decay probability of $^{95}$Zr to $^{95m}$Nb: | 0.0112(10) |
| $q$ | – decay probability of $^{95m}$Nb to $^{95}$Nb: | 0.975(1) |
| $t$ | – time since separation | |
| $t_{ref}$ | – reference time | |
| $t_1$ | – start of the acquisition | |
| $t_2$ | – end of the acquisition | |
| $C_1$ | – reported $^{95}$Zr activity | |
| $C_2$ | – reported $^{95m}$Nb activity | |
| $C_3$ | – reported $^{95}$Nb activity | |

# 3. RESULTS AND DISCUSSION

## 3.1 AL 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 emanation techniques. The main difficulty in measuring the $^{226}$Ra activity concentration with alpha spectrometry, gas-flow proportional counting or liquid scintillation is the need for a radiochemical separation from the other radionuclides present in the sample.

Nine results were reported for the AL samples (see Figures 1A to 1D). Four results are in agreement with the assigned value, while three results are questionable. Two results are discrepant. The reported results show no significant bias. Three participants (Labs 25, 31 and 35) used gas-flow proportional counting to determine $^{226}$Ra, two participants (Labs 8 and 106) used alpha spectrometry, two participants (Labs 26 and 77) used gamma spectrometry, one participant (Lab 109) used ICP MS and one participant (Lab 65) used an emanation technique. Barium-133 was used yield tracer by Labs 25, 35 and 106. Two separation techniques was used to separate $^{226}$Ra from the matrix: precipitation techniques (Labs 25, 26, 35 and 106), ion-exchange chromatography (Labs 8 and 31). There is some indication that there are differences between the results obtained from the various techniques used, with all three gas-flow proportional counting failing to score an ‘in agreement’.

| | |
|---|---|
| Reported **AL** results: | 9 |
| In agreement with the assigned value: | 4 |
| Questionable result: | 3 |
| Discrepant from the assigned value: | 2 |

Nine results were reported for the AH samples (see Figures 11A to 11D). Six results are in agreement with the assigned value. Three results are discrepant. The reported results show no significant bias. Four participants (Labs 17, 21, 32 and 55) used gamma spectrometry to determine $^{226}$Ra, two participants (Labs 8 and 106) used alpha spectrometry, two participants (Labs 31 and 35) used gas-flow proportional counting and one participant (Lab 38) used liquid scintillation counting. Barium-133 was used as yield tracer by Labs 35 and 106. A variety of separation techniques was used to separate $^{226}$Ra from the matrix: precipitation techniques (Labs 35 and 106), ion-exchange chromatography (Labs 8 and 31) and extraction (Lab 38). There is some indication that there are differences between the results obtained from the various techniques used, with both alpha spectrometry and liquid scintillation counting resulting in relative accurate results.

| | |
|---|---|
| Reported **AH** results: | 9 |
| In agreement with the assigned value: | 6 |
| Questionable result: | 0 |
| Discrepant from the assigned value: | 3 |

### 3.1.2 Uranium-234

Uranium-234 can be measured by alpha spectrometry and mass spectrometry. The main difficulty in measuring the $^{234}U$ activity concentration with alpha spectrometry is the need for a radiochemical separation from the other radionuclides present in the sample.

Seventeen results were reported for the AL samples (see Figures 2A to 2D). Fifteen results are in agreement with the assigned value, while one result is questionable. One result is discrepant. The reported results show no significant bias. Most participants used alpha spectrometry to determine $^{234}U$, while two participants (Labs 8 and 109) used mass spectrometry. Eight participants (Labs 8, 25, 26, 28, 29, 35, 40 and 91) who used alpha spectrometry as the detection method used ion-exchange chromatography to separate the $^{234}U$ from the matrix. Seven participants (Labs 4, 17, 47, 65, 77, 106 and 107) used extraction chromatography. Most participants used $^{232}U$ as the yield tracer, while two participants (Labs 47 and 77) used $^{236}U$ and one participant (Lab 8) used $^{233}U$ parallel standards. Most participants who used alpha spectrometry as the detection method used electrodeposition to prepare the $^{234}U$ sources. Labs 65, 106 and 107 used microprecipitation ($CeF_3$ and $NdF_3$). There is no evidence that there are differences between the results obtained from the two techniques used. In most cases, the normalised $^{234}U$ / $^{238}U$ ratio obtained by the labs (see Figure 137A) is not significantly different from unity (except Labs 26 and 28).

| | |
|---|---|
| Reported **AL** results: | 17 |
| In agreement with the assigned value: | 15 |
| Questionable results: | 1 |
| Discrepant from the assigned value: | 1 |

Eleven results were reported for the AH samples (see Figures 12A to 12D). Seven results are in agreement with the assigned value, while three results are questionable. One result is discrepant. The reported results show no significant bias. Most participants used alpha spectrometry to determine $^{234}U$, while two participants (Labs 8 and 55) used mass spectrometry. Four participants (Labs 1, 8, 28 and 35) who used alpha spectrometry as the detection method used ion-exchange chromatography to separate the $^{234}U$ from the matrix. Five participants (Labs 7, 14, 17, 47 and 106) used extraction chromatography. Most participants used $^{232}U$ as the yield tracer, while one participant (Lab 47) used $^{236}U$ and one participants (Lab 8) used $^{233}U$ parallel standards. Most participants used electrodeposition to prepare the $^{234}U$ sources. Lab 14 and 106 used microprecipitation ($NdF_3$). There is no evidence that there are differences between the results obtained from the two techniques used. In all cases, the normalised $^{234}U$ / $^{238}U$ ratio obtained by the labs (see Figure 137B) is not significantly different from unity.

| | |
|---|---|
| Reported **AH** results: | 11 |
| In agreement with the assigned value: | 7 |
| Questionable result: | 3 |
| Discrepant from the assigned value: | 1 |

### 3.1.3 Uranium-235

Uranium-235 can be measured by alpha spectrometry, gamma spectrometry and mass spectrometry. The main difficulty in measuring the $^{235}U$ activity concentration with alpha spectrometry is the need for a radiochemical separation from the other radionuclides present in the sample.

Seventeen results were reported for the AL samples (see Figures 3A to 3D). Twelve results are in agreement with the assigned value, while four results are questionable. One result is discrepant. The reported results show a negative bias. Most participants used alpha spectrometry to determine $^{235}U$, while two participants (Labs 8 and 109) used mass spectrometry and one participant (Lab 42) used gamma spectrometry. Eight participants (Labs 8, 25, 26, 28, 29, 35, 40 and 91) who used alpha spectrometry as the detection method used ion-exchange chromatography to separate the $^{235}U$ from the matrix. Six participants (Labs 17, 47, 65, 77, 106 and 107) used extraction chromatography. Most participants used $^{232}U$ as the yield tracer, while two participants (Labs 47 and 77) used $^{236}U$ and one participant (Lab 8) used $^{233}U$ parallel standards. Most participants who used alpha spectrometry as the detection method used electrodeposition to prepare the $^{235}U$ sources. Labs 65, 106 and 107 used microprecipitation ($CeF_3$ and $NdF_3$). There is some evidence that there are differences between the results obtained from the three techniques used (with gamma spectrometry giving the only discrepant result). In most cases, the normalised $^{235}U$ / $^{238}U$ ratio obtained by the labs (see Figure 138A) is not significantly different from unity (except Labs 8 (mass spectrometry) and 35).

| | |
|---|---|
| Reported **AL** results: | 17 |
| In agreement with the assigned value: | 12 |
| Questionable results: | 4 |
| Discrepant from the assigned value: | 1 |

Thirteen results were reported for the AH samples (see Figures 13A to 13D). Eight results are in agreement with the assigned value, while four results are questionable. One result is discrepant. The reported results show a negative bias. Most participants used alpha spectrometry to determine $^{235}U$, while two participants (Labs 8 and 55) used mass spectrometry and two participants (Labs 21 and 32) used gamma spectrometry. Four participants (Labs 1, 8, 28 and 35) who used alpha spectrometry as the detection method used ion-exchange chromatography to separate the $^{235}U$ from the matrix. Five participants (Labs 7, 14, 17, 47 and 106) used extraction chromatography. Most participants used $^{232}U$ as the yield tracer, while one participant (Lab 47) used $^{236}U$ and one participants (Lab 8) used $^{233}U$ parallel standards. Most participants used electrodeposition to prepare the $^{235}U$ sources. Lab 14 and 106 used microprecipitation ($NdF_3$). There is no evidence that there are differences between the results obtained from the three techniques used. In most cases, the normalised $^{235}U$ / $^{238}U$ ratio obtained by the labs (see Figure 138B) is not significantly different from unity (except Labs 7 and 21).

| | |
|---|---|
| Reported **AH** results: | 13 |
| In agreement with the assigned value: | 8 |
| Questionable result: | 4 |
| Discrepant from the assigned value: | 1 |

### 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.

Seventeen results were reported for the AL samples (see Figures 4A to 4D). Fifteen results are in agreement with the assigned value, while one result is questionable. One result is discrepant. The reported results show no significant bias. Most participants used alpha spectrometry to determine $^{238}U$, while two participants (Labs 8 and 109) used mass spectrometry. Eight participants (Labs 8, 25, 26, 28, 29, 35, 40 and 91) who used alpha spectrometry as the detection method used ion-exchange chromatography to separate the $^{238}U$ from the matrix. Seven participants (Labs 4, 17, 47, 65, 77, 106 and 107) used extraction chromatography. Most participants used $^{232}U$ as the yield tracer, while two participants (Labs 47 and 77) used $^{236}U$ and one 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 65, 106 and 107 used microprecipitation ($CeF_3$ and $NdF_3$). There is no evidence that there are differences between the results obtained from the two techniques used.

| | |
|---|---|
| Reported **AL** results: | 17 |
| In agreement with the assigned value: | 15 |
| Questionable results: | 1 |
| Discrepant from the assigned value: | 1 |

Fourteen results were reported for the AH samples (see Figures 14A to 14D). Ten results are in agreement with the assigned value, while three results are questionable. One result is discrepant. The reported results show no significant bias. Most participants used alpha spectrometry to determine $^{238}U$, while three participants (Labs 8, 32 and 55) used mass spectrometry and one participant (Lab 21) used gamma spectrometry. Four participants (Labs 1, 8, 28 and 35) who used alpha spectrometry as the detection method used ion-exchange chromatography to separate the $^{238}U$ from the matrix. Six participants (Labs 7, 14, 17, 38, 47 and 106) used extraction chromatography. Most participants used $^{232}U$ as the yield tracer, while one participant (Lab 47) used $^{236}U$ and one participants (Lab 8) used $^{233}U$ parallel standards. Most participants used electrodeposition to prepare the $^{238}U$ sources. Lab 14 and 106 used microprecipitation ($NdF_3$). There is some evidence that there are differences between the results obtained from the three techniques used.

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

### 3.1.5 Neptunium-237

Neptunium-237 can be measured by three independent techniques: these include 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 $^{237}Np$).

Eight results were reported for the AL samples (see Figures 5A to 5D). Six results are in agreement with the assigned value. Two results are discrepant. The reported results show no significant bias. Four participants (Labs 25, 47, 65 and 91) used alpha spectrometry to determine $^{237}$Np, while other participants used mass spectrometry (Labs 8, 35 and 109) used gamma spectrometry (Lab 42).

| | |
|---|---|
| Reported **AL** results: | 8 |
| In agreement with the assigned value: | 6 |
| Questionable result: | 0 |
| Discrepant from the assigned value: | 2 |

Seven results were reported for the AH samples (see Figures 15A to 15D). Four results are in agreement with the assigned value, while two results are questionable. One result is discrepant. The reported results show no significant bias. Three participants used gamma spectrometry to determine $^{237}$Np (Labs 21, 32 and 55), while three used mass spectrometry (Labs 8, 35 and 38) and one used alpha spectrometry (Lab 47).

| | |
|---|---|
| Reported **AH** results: | 7 |
| In agreement with the assigned value: | 4 |
| Questionable result: | 2 |
| Discrepant from the assigned value: | 1 |

### 3.1.6 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)%.

Eighteen results were reported for the AL samples (see Figures 6A to 6D). Fourteen results are in agreement with the assigned value, while one result is questionable. Three results (Labs 25, 77 and 109) are discrepant. The $^{239}$Pu results of these labs were also discrepant, indicating a systematic problem (e.g., their yield tracer). The reported results show no significant bias. All participants used alpha spectrometry to determine $^{238}$Pu. Most participants used ion-exchange chromatography to separate the $^{238}$Pu from the matrix. Six participants (Labs 17, 47, 77, 101, 107 and 109) used extraction chromatography. Two participants (Labs 25 and 47) used $^{236}$Pu as the yield tracer, while the other participants used $^{242}$Pu. Most participants used electrodeposition to prepare the $^{238}$Pu sources. Labs 65 and 107 used microprecipitation ($LaF_3$ and $CeF_3$). There is no indication that there are significant differences between the results obtained from the various techniques used.

| | |
|---|---|
| Reported **AL** results: | 18 |
| In agreement with the assigned value: | 14 |
| Questionable results: | 1 |
| Discrepant from the assigned value: | 3 |

Ten results were reported for the AH samples (see Figures 16A to 16D). Eight results are in agreement with the assigned value. Two results (Labs 14 and 17) are discrepant.

The $^{239}Pu$ results of these labs were also discrepant, indicating a systematic problem (e.g., their yield tracer). 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. Four participant (Labs 7, 14, 17 and 47) used extraction chromatography. One participant (Lab 47) used $^{236}Pu$ as the yield tracer, while the other participants used $^{242}Pu$. Most participants used electrodeposition to prepare the $^{238}Pu$ sources. Lab 14 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: | 10 |
| In agreement with the assigned value: | 8 |
| Questionable result: | 0 |
| Discrepant from the assigned value: | 2 |

### 3.1.7 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.

Eighteen results were reported for the AL samples (see Figures 7A to 7D). Fourteen results are in agreement with the assigned value, while one result is questionable. Three results (Labs 25, 77 and 109) are discrepant. The $^{238}Pu$ results of these labs were also discrepant, indicating a systematic problem (e.g., their yield tracer). The reported results show no significant bias. All participants used alpha spectrometry to determine $^{239}Pu$. Most participants used ion-exchange chromatography to separate the $^{239}Pu$ from the matrix. Six participants (Labs 17, 47, 77, 101, 107 and 109) used extraction chromatography. Two participants (Labs 25 and 47) used $^{236}Pu$ as the yield tracer, while the other participants used $^{242}Pu$. Most participants used electrodeposition to prepare the $^{239}Pu$ sources. Labs 65 and 107 used microprecipitation ($LaF_3$ and $CeF_3$). There is no indication that there are significant differences between the results obtained from the various techniques used.

| | |
|---|---|
| Reported **AL** results: | 18 |
| In agreement with the assigned value: | 14 |
| Questionable result: | 1 |
| Discrepant from the assigned value: | 3 |

Ten results were reported for the AH samples (see Figures 17A to 17D). Seven results are in agreement with the assigned value. Three results (Labs 14, 17 and 35) are discrepant. The $^{238}Pu$ results of labs 14 and 17 were also discrepant, indicating a systematic problem (e.g., their yield tracer). The reported results show no significant bias. All participants used alpha spectrometry to determine $^{239}Pu$. Most participants separated the $^{239}Pu$ from the matrix by ion-exchange chromatography. Four participant (Labs 7, 14, 17 and 47) used extraction chromatography. One participant (Lab 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 14 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: | 10 |
| In agreement with the assigned value: | 7 |
| Questionable result: | 0 |
| Discrepant from the assigned value: | 3 |

### 3.1.8 Americium-241

Americium-241 can be measured by three independent techniques: these include 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-two results were reported for the AL samples (see Figures 8A to 8D). Seventeen results are in agreement with the assigned value, while four 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). Three participants (Labs 8, 42 and 59) used gamma spectrometry and one particiapant (Lab 109) used ICP-MS. Nine participants (Labs 4, 17, 40, 47, 65, 77, 101, 107 and 109) who used alpha spectrometry as the detection method separated the $^{241}$Am from the matrix by extraction chromatography. Eight participants (Labs 8, 13, 25, 26, 31, 35, 59 and 91) used ion-exchange chromatography, while X participant used solvent extraction (Lab 29). Most participants who used alpha spectrometry as the detection method used electrodeposition to prepare the $^{241}$Am sources. Labs 65 and 107 used microprecipitation ($LaF_3$ and $CeF_3$). There is no indication that there are significant differences between the results obtained from the various techniques used.

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

Fifteen results were reported for the AH samples (see Figures 18A to 18D). Eleven results are in agreement with the assigned value, while three results are questionable. One result is 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 8, 17, 21, 32 and 55) used gamma spectrometry. Four participants (Labs 7, 14, 38 and 47) who used alpha spectrometry as the detection method separated $^{241}$Am with extraction chromatography. Six participants (Labs 1, 8, 28, 31, 35, 41) used ion-exchange chromatography, Most participants who used alpha spectrometry as the detection method used electrodeposition to prepare the $^{241}$Am sources. Lab 14 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: | 15 |
| In agreement with the assigned value: | 11 |
| Questionable result: | 3 |
| Discrepant from the assigned value: | 1 |

### 3.1.9 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.

Fourteen results were reported for the AL samples (see Figures 9A to 9D). Nine results are in agreement with the assigned value, while three results are questionable. Two results are discrepant. The reported results show no significant bias. All participants used alpha spectrometry to determine $^{244}$Cm with most sources prepared by electrodeposition (except Labs 65 and 107 who used $LaF_3$ and $CeF_3$ microprecipitation). Participants used ion-exchange chromatography, liquid extraction and extraction chromatography to separate the $^{244}$Cm from the matrix. There is no indication that there are significant differences between the results obtained from the various techniques used. All participants used $^{243}$Am as the yield tracer. In most cases, the normalised $^{244}$Cm / $^{241}$Am ratio obtained by the labs (see Figure 139A) is 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 and/or discrepant results for $^{241}$Am and $^{244}$Cm of Labs 25 and 109 cannot be explained by this, since their normalised $^{244}$Cm / $^{241}$Am ratios are not significantly different from unity.

| | |
|---|---|
| Reported **AL** results: | 14 |
| In agreement with the assigned value: | 9 |
| Questionable result: | 3 |
| Discrepant from the assigned value: | 2 |

Eleven results were reported for the AH samples (see Figures 19A to 19D). Eight results are in agreement with the assigned value, while one result is questionable. Two results are discrepant. The reported results show a negative bias. All participants used alpha spectrometry to determine $^{244}$Cm. All participants prepared the sources by electrodeposition, except Labs 14 who used $NdF_3$ microprecipitation. Participants used ion-exchange chromatography, liquid extraction and extraction chromatography to separate the $^{244}$Cm from the matrix. There is no indication that there are significant differences between the results obtained from the various techniques used. All participants used $^{243}$Am as the yield tracer. In most cases, the normalised $^{244}$Cm / $^{241}$Am ratio obtained by the labs (see Figure 139B) were 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 and/or discrepant results for $^{241}$Am and/or $^{244}$Cm of Labs 1 and 28 cannot be explained by this, since their normalised $^{244}$Cm / $^{241}$Am ratios are not significantly different from unity.

| | |
|---|---|
| Reported **AH** results: | 11 |
| In agreement with the assigned value: | 8 |
| Questionable result: | 1 |
| Discrepant from the assigned value: | 2 |

#### 3.1.10 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.

Ten results were reported for the AL samples (see Figures 10A to 10D). Four results are in agreement with the assigned value, while two results are questionable. Four results are discrepant. The reported results show no significant bias. The results that were 'in agreement'were obtained using either alpha spectrometry (Lab 59), a ZnS scintillation detector (Labs 8 and 65) or liquid scintillation counting (Lab 26). The other six results (which were all either 'questionable' or 'discrepant') were all obtained using a gas-flow proportional counter.

| | |
|---|---|
| Reported **AL** results: | 10 |
| In agreement with the assigned value: | 4 |
| Questionable result: | 2 |
| Discrepant from the assigned value: | 4 |

Seven results were reported for the AH samples (see Figures 20A to 20D). Five 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 five results that were 'in agreement' were obtained using either gas-flow proportional counter (Labs 1, 41 and 106), a ZnS scintillation detector (Labs 8) or liquid scintillation counting (Lab 7).

| | |
|---|---|
| Reported **AH** results: | 7 |
| In agreement with the assigned value: | 5 |
| Questionable result: | 1 |
| Discrepant from the assigned value: | 1 |

### 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 and $^{99}$Tc.

Twenty-eight results were reported for this nuclide (see Figures 21A to 21D). Twenty results are in agreement with the assigned value, while four results are questionable. Four results are discrepant. The reported results show no significant bias. The large majority of the participants (except Labs 5, 32, 65 who used combustion, Lab 94 who used a tritium column and Labs 20, 48, 96 and 102 who did not chemically separate tritium) used distillation to separate tritium from the other nuclides. All participants used liquid scintillation counting as the detection method. However, it is interesting to note that the three labs (Labs 20, 48 and 96) that relied on LSC spectrum analysis without any chemical separation from $^{14}$C and $^{99}$Tc obtained in general relatively less accurate results than participants using different methods. The corresponding $^{14}$C and $^{99}$Tc results (see below) of these three labs were in general less accurate as well. Labs 1 and 59 obtained questionable (and similar) results for both B1 and B2.

| | |
|---|---|
| Reported results: | 28 |
| In agreement with the assigned value: | 20 |
| Questionable results: | 4 |
| Discrepant from the assigned value: | 4 |

### 3.2.2 Carbon-14

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

Twenty-two results were reported for this nuclide (see Figures 22A to 22D). Twelve results are in agreement with the assigned value, while five results are questionable. Five results are discrepant. The reported results show no significant bias. All participants used liquid scintillation counting as the detection method. Most of the participants used $[^{14}C]O_2$ gas generation (either by sample combustion or the addition of acid to the sample) as the separation technique. Other techniques used included LSC spectrum analysis (Labs 20 and 48) and $BaCO_3$ precipitation (Lab 55). It is interesting to note that the labs that relied on LSC spectrum analysis without any chemical separation from $^{3}H$ and $^{99}Tc$ (Labs 20 and 48) obtained in general relatively less accurate and precise results than participants using a separation method. The corresponding $^{3}H$ and $^{99}Tc$ results of these two participants (see above and below) were in general less accurate as well.

| | |
|---|---|
| Reported results: | 22 |
| In agreement with the assigned value: | 12 |
| Questionable results: | 5 |
| Discrepant from the assigned value: | 5 |

### 3.2.3 Technetium-99

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

Fourteen results were reported for for this nuclide (see Figures 23A to 23D). Thirteen results are in agreement with the assigned value, while one result is questionable. The reported results show no significant bias. There is no indication that either the detection method [mass spectrometry (Labs 8, 32 and 74), liquid scintillation counting (Labs 20, 35, 38, 48, 55, 59, 96 and 107), gas-flow proportional counting (Labs 8 and 25) or low level beta GM (Lab 83)], yield tracer [$^{99m}Tc$ (Labs 35 and 74) or stable Re (Labs 25, 32 and 83)] or the radiochemical separation technique (a wide variety of precipitation techniques, extraction, ion-exchange chromatography and extraction (TEVA) chromatography) led to any significant differences between the results. However, it is interesting to note that the three labs (Labs 20, 48 and 96) that relied on LSC spectrum analysis without any chemical separation from $^{3}H$ and $^{14}C$ obtained in general relatively less accurate results than participants using different methods. The corresponding $^{3}H$ and $^{14}C$ results (see above) of these three participants were in general less accurate as well.

| | |
|---|---|
| Reported results: | 14 |
| In agreement with the assigned value: | 13 |
| Questionable result: | 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-nine results were reported for this nuclide (see Figures 24A to 24D). Twenty-two results are in agreement with the assigned value, while four results are questionable. Three results are discrepant. The reported results show no significant bias. The large majority of the participants (except Labs 5, 32, 65 who used combustion, Labs 94 and 107 who used a tritium column and Lab 102 who did not chemically separate tritium) 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. Labs 1 and 59 obtained questionable (and similar) results for both B1 and B2.

| | |
|---|---|
| Reported results: | 29 |
| In agreement with the assigned value: | 22 |
| Questionable result: | 4 |
| Discrepant from the assigned value: | 3 |

#### 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).

Thirteen results were reported for this nuclide (see Figures 25A to 25D). Seven results are in agreement with the assigned value. Six results are discrepant. The reported results show a negative bias. There is some indication that the detection method [liquid scintillation counting (Labs 1, 16, 32, 38, 56, 59, 65, 74, 91 and 94), gas-flow proportional counting (Lab 25) or gamma- or X-ray spectrometry (Labs 7 and 107)] led to a significant difference between the results, with the LSC results in general being more accurate than the gamma- or X-ray spectrometry results.

| | |
|---|---|
| Reported results: | 13 |
| In agreement with the assigned value: | 7 |
| Questionable result: | 0 |
| Discrepant from the assigned value: | 6 |

#### 3.3.3 Nickel-63

The main difficulty in measuring the $^{63}Ni$ activity concentration is the need for a radiochemical separation from the other radionuclides present in the sample.

Fourteen results were reported for this nuclide (see Figures 26A to 26D). Six results are in agreement with the assigned value, while one result is questionable. Seven results are discrepant. The reported results show no significant bias. All participants used liquid scintillation counting. There is no indication that the radiochemical separation technique [DMG precipitation and/or extraction combined with ion-exchange chromatography (Labs 1, 7, 25, 31, 65, 107) and Ni-extraction chromatography (Labs 14, 32, 38, 74, 91 and 94)] led to a significant difference between the results.

| | |
|---|---|
| Reported results: | 14 |
| In agreement with the assigned value: | 6 |
| Questionable result: | 1 |
| Discrepant from the assigned value: | 7 |

### 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. Several 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-three results were reported for this nuclide (see Figures 27A to 27D). Fifteen results are in agreement with the assigned value, while five results are questionable. Three results are discrepant. The reported results show no significant bias. Twelve participants (Labs 7, 26, 32, 38, 40, 41, 55, 56, 74, 91, 94 and 107) used LSC or Cerenkov counting to detect $^{90}Sr$ or its daughter $^{90}Y$, while eleven participants (Labs 1, 8, 13, 14, 25, 28, 29, 35, 65, 92 and 109) used gas flow proportional counting. Ten participants used $^{85}Sr$ as the yield tracer for $^{90}Sr$ (Labs 7, 13, 28, 29, 38, 40, 41, 55, 74 and 107), while nine participants used stable Sr (Labs 1, 26, 32, 35, 56, 65, 91, 92 and 94). Lab 25 used stable Y as the yield tracer and no information about the use of a yield tracer was received from Labs 8, 14 and 109. The most popular method for separating $^{90}Sr$ was extraction chromatography, with the exception of Labs 1, 13, 14, 25, 29, 55, 65, 91, 92 and 109 (precipitation techniques) and Lab 28 (ion-exchange chromatography). There is some indication that using a $^{85}Sr$ tracer led to more accurate results than using stable Sr. There is no indication that either the detection method or the radiochemical separation technique led to any significant differences between the results.

| | |
|---|---|
| Reported results: | 23 |
| In agreement with the assigned value: | 15 |
| Questionable result: | 5 |
| Discrepant from the assigned value: | 3 |

### 3.2.5 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., $^{3}H$, $^{55}Fe$ and $^{63}Ni$). Two different assigned values were used (one for ISO method 9697 gas-flow proportional counting and one for liquid scintillation counting (Labs 7, 59 and 94); see Appendix C4).

Ten results were reported for for this nuclide (see Figures 28A to 28D). Three results are in agreement with the assigned value, while four results are questionable. Three results are discrepant. There is no indication that the detection method led to any significant differences between the results.

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

### 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 Sodium-22

The main difficulty in measuring $^{22}$Na is the need to correct for coincidence summing between the 511 keV and the 1275 keV peaks combined with the possibility of mistaking this nuclide for $^{154}$Eu (which gives rise to a 1274 keV peak).

Fifty-one results were reported for the GL samples (see Figures 29A to 29D). Twenty-eight results are in agreement with the assigned value, while ten results are questionable. Thirteen results are discrepant. The reported results show a negative bias.

| | |
|---|---|
| Reported **GL** results: | 51 |
| In agreement with the assigned value: | 28 |
| Questionable results: | 10 |
| Discrepant from the assigned value: | 13 |
| Missing results: | 4 |

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

| | |
|---|---|
| Reported **GH** results: | 39 |
| In agreement with the assigned value: | 18 |
| Questionable results: | 12 |
| Discrepant from the assigned value: | 9 |
| Missing results: | 5 |

#### 3.4.2 Cobalt-60

There are no specific measurement problems for this nuclide.

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

| | |
|---|---|
| Reported **GL** results: | 54 |
| In agreement with the assigned value: | 38 |
| Questionable results: | 10 |
| Discrepant from the assigned value: | 6 |
| Missing results: | 1 |

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

| | |
|---|---|
| Reported **GH** results: | 43 |
| In agreement with the assigned value: | 31 |
| Questionable results: | 10 |
| Discrepant from the assigned value: | 2 |
| Missing results: | 1 |

### 3.4.3 Zirconium-95

There are no specific measurement problems for this nuclide.

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

| | |
|---|---|
| Reported **GL** results: | 53 |
| In agreement with the assigned value: | 42 |
| Questionable results: | 6 |
| Discrepant from the assigned value: | 5 |
| Missing results: | 2 |

Forty-three results were reported for the GH samples (see Figures 39A to 39D). Twenty-nine results are in agreement with the assigned value, while nine results are questionable. Five results are discrepant. The reported results show a positive bias.

| | |
|---|---|
| Reported **GH** results: | 43 |
| In agreement with the assigned value: | 29 |
| Questionable results: | 9 |
| Discrepant from the assigned value: | 5 |
| Missing results: | 1 |

### 3.4.4 Niobium-95

The main difficulty in the determination of the $^{95}$Nb activity concentration is the decay correction to the reference time. Lesser, but still significant difficulties are the fact that the $^{95}$Nb/$^{95}$Zr activity ratio increases during measurement and the need to use a modified form of the Bateman equations taking account of the multiple branching of the parents $^{95}$Zr and $^{95m}$Nb.

Fifty-one results were reported for the GL samples (see Figures 32A to 32D). Thirty-four results are in agreement with the assigned value, while eight results are questionable. Nine results are discrepant. The reported results show a positive bias.

| | |
|---|---|
| Reported **GL** results: | 51 |
| In agreement with the assigned value: | 34 |
| Questionable results: | 8 |
| Discrepant from the assigned value: | 9 |
| Missing results: | 4 |

Forty-two results were reported for the GH samples (see Figures 40A to 40D). Twenty-seven results are in agreement with the assigned value, while six results are questionable. Nine results are discrepant. The reported results show a positive bias.

| | |
|---|---|
| Reported **GH** results: | 42 |
| In agreement with the assigned value: | 27 |
| Questionable results: | 6 |
| Discrepant from the assigned value: | 9 |
| Missing results: | 2 |

### 3.4.5 Barium-133

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

Fifty results were reported for the GL samples (see Figures 33A to 33D). Thirty-nine results are in agreement with the assigned value, while nine results are questionable. Two results are discrepant. The reported results show a negative bias.

| | |
|---|---|
| Reported **GL** results: | 50 |
| In agreement with the assigned value: | 39 |
| Questionable results: | 9 |
| Discrepant from the assigned value: | 2 |
| Missing results: | 5 |

Forty-two results were reported for the GH samples (see Figures 41A to 41D). Twenty-five results are in agreement with the assigned value, while twelve results are questionable. Five results are discrepant. The reported results show a negative bias.

| | |
|---|---|
| Reported **GH** results: | 42 |
| In agreement with the assigned value: | 25 |
| Questionable results: | 12 |
| Discrepant from the assigned value: | 5 |
| Missing results: | 2 |

### 3.4.6 Caesium-134

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

Fifty-four results were reported for the GL samples (see Figures 34A to 34D). Thirty-six results are in agreement with the assigned value, while eight results are questionable. Ten results are discrepant. The reported results show a negative bias.

| | |
|---|---|
| Reported **GL** results: | 54 |
| In agreement with the assigned value: | 36 |
| Questionable results: | 8 |
| Discrepant from the assigned value: | 10 |
| Missing results: | 1 |

Forty-four results were reported for the GH samples (see Figures 42A to 42D). Thirty results are in agreement with the assigned value, while seven results are questionable. Seven results are discrepant. The reported results show no significant bias.

| | |
|---|---|
| Reported **GH** results: | 44 |
| In agreement with the assigned value: | 30 |
| Questionable results: | 7 |
| Discrepant from the assigned value: | 7 |
| Missing results: | 0 |

### 3.4.7 Caesium-137

There are no specific measurement problems for this nuclide.

Fifty-five results were reported for the GL samples (see Figures 35A to 35D). Forty-two results are in agreement with the assigned value, while seven results are questionable. Six results are discrepant. The reported results show no significant bias.

| | |
|---|---|
| Reported **GL** results: | 55 |
| In agreement with the assigned value: | 42 |
| Questionable results: | 7 |
| Discrepant from the assigned value: | 6 |
| Missing results: | 0 |

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

| | |
|---|---|
| Reported **GH** results: | 44 |
| In agreement with the assigned value: | 30 |
| Questionable results: | 10 |
| Discrepant from the assigned value: | 4 |
| Missing results: | 0 |

### 3.4.8 Europium-152

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

Fifty-four results were reported for the GL samples (see Figures 36A to 36D). Thirty-eight results are in agreement with the assigned value, while nine results are questionable. Seven results are discrepant. The reported results show no significant bias.

| | |
|---|---|
| Reported **GL** results: | 54 |
| In agreement with the assigned value: | 38 |
| Questionable results: | 9 |
| Discrepant from the assigned value: | 7 |
| Missing results: | 1 |

Forty-three results were reported for the GH samples (see Figures 44A to 44D). Twenty-four results are in agreement with the assigned value, while twelve results are questionable. Seven results are discrepant. The reported results show a negative bias.

| | |
|---|---|
| Reported **GH** results: | 43 |
| In agreement with the assigned value: | 24 |
| Questionable results: | 12 |
| Discrepant from the assigned value: | 7 |
| Missing results: | 1 |

## 3.5 C samples

### 3.5.1 Hydrogen-3 (total)

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.

Fourteen results were reported for HTO (see Figure 45). All results are in agreement with the assigned value. All participants except Labs 7 and 31 used combustion and conversion to $H_2O$ to separate $^{3}H$ from the concrete matrix and the other nuclides. All participants used liquid scintillation counting as the detection method.

| | |
|---|---|
| Reported results: | 14 |
| In agreement with the assigned value: | 14 |
| Questionable results: | 0 |
| Discrepant from the assigned value: | 0 |

### 3.5.2 Hydrogen-3 (leachable)

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

Five results were reported for this nuclide (see Figure 46). All results are in agreement with the assigned value. Most participants leached the concrete sample with water (except Lab 29 which heated the sample at 108 °C). All participants used liquid scintillation counting as the detection method.

| | |
|---|---|
| Reported results: | 5 |
| In agreement with the assigned value: | 5 |
| Questionable results: | 0 |
| Discrepant from the assigned value: | 0 |

### 3.5.3 Carbon-14

The main difficulty in measuring the $^{14}C$ activity concentration is the need for a radiochemical separation from the other radionuclides present in the sample.

Twelve results were reported for this nuclide (see Figure 47). Ten results are in agreement with the assigned value, while one result is questionable. One result is discrepant. All participants except Labs 7, 14 and 94 used combustion and conversion to $CO_2$ to separate $^{14}C$ from the concrete matrix and the other nuclides. All participants used liquid scintillation counting as the detection method.

| | |
|---|---|
| Reported results: | 12 |
| In agreement with the assigned value: | 10 |
| Questionable results: | 1 |
| Discrepant from the assigned value: | 1 |

### 3.5.4 Potassium-40

There are no specific measurement problems for this nuclide.

Seven results were reported for this nuclide (see Figure 48). All results are in agreement with the assigned value. All participants used gamma spectrometry as the detection method.

| | |
|---|---|
| Reported results: | 7 |
| In agreement with the assigned value: | 7 |
| Questionable results: | 0 |
| Discrepant from the assigned value: | 0 |

### 3.5.5 Iron-55

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

Five results were reported for this nuclide (see Figure 49). Four results are in agreement with the assigned value. One result is discrepant. Two participants (Labs 74 and 78) used anion-exchange chromatography to separate $^{55}Fe$ from the concrete matrix and the other nuclides, while Labs 32, 38 and 78 used solvent extraction. All participants used liquid scintillation counting as the detection method.

| | |
|---|---|
| Reported results: | 5 |
| In agreement with the assigned value: | 4 |
| Questionable results: | 0 |
| Discrepant from the assigned value: | 1 |

### 3.5.6 Cobalt-60

There are no specific measurement problems for this nuclide.

Thirty-one results were reported for this nuclide (see Figures 50A to 50E). Twenty-one results are in agreement with the assigned value, while seven results are questionable. Three results are discrepant. All participants used gamma spectrometry as the detection method.

| | |
|---|---|
| Reported results: | 31 |
| In agreement with the assigned value: | 21 |
| Questionable results: | 7 |
| Discrepant from the assigned value: | 3 |

### 3.5.7 Nickel-63

The main difficulty in measuring the $^{63}$Ni activity concentration is the need for a radiochemical separation from the other radionuclides present in the sample.

Six results were reported for this nuclide (see Figure 51). Four results are in agreement with the assigned value, while one result is questionable. One result is discrepant. All participants except Lab 31 used DMG extraction chromatography to separate $^{63}$Ni from the concrete matrix and the other nuclides. All participants used liquid scintillation counting as the detection method.

| | |
|---|---|
| Reported results: | 6 |
| In agreement with the assigned value: | 4 |
| Questionable results: | 1 |
| Discrepant from the assigned value: | 1 |

### 3.5.8 Barium-133

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

Fifteen results were reported for this nuclide (see Figures 52A to 52E). Thirteen results are in agreement with the assigned value. Two results are discrepant. All participants used gamma spectrometry as the detection method.

| | |
|---|---|
| Reported results: | 15 |
| In agreement with the assigned value: | 13 |
| Questionable results: | 0 |
| Discrepant from the assigned value: | 2 |

### 3.5.9 Europium-152

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

Thirty-one results were reported for this nuclide (see Figures 53A to 53E). Twenty-three results are in agreement with the assigned value, while five results are questionable. Three results are discrepant. All participants used gamma spectrometry as the detection method.

| | |
|---|---|
| Reported results: | 31 |
| In agreement with the assigned value: | 23 |
| Questionable results: | 5 |
| Discrepant from the assigned value: | 3 |

### 3.5.10 Europium-154

The challenge in the measurement of this nuclide is the need for coincidence summing corrections. Additionally, there is potential inference from $^{152}$Eu emissions.

Twenty-eight results were reported for this nuclide (see Figures 54A to 54E). Twenty results are in agreement with the assigned value, while three results are questionable. Five results are discrepant. All participants used gamma spectrometry as the detection method.

| | |
|---|---|
| Reported results: | 28 |
| In agreement with the assigned value: | 20 |
| Questionable results: | 3 |
| Discrepant from the assigned value: | 5 |

### 3.5.11 Gross beta

Six results were reported for this nuclide (see Figure 55). Five results are in agreement with the assigned value, while one result is questionable.

| | |
|---|---|
| Reported results: | 6 |
| In agreement with the assigned value: | 5 |
| Questionable results: | 1 |
| Discrepant from the assigned value: | 0 |

### 3.6 Result summary

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

**Table 3.1 – Results AL**

| Nuclide | In agreement | Questionable | Discrepant |
|---|---|---|---|
| $^{226}Ra$ | 4 (44%) | 3 (33%) | 2 (22%) |
| $^{234}U$ | 15 (88%) | 1 (6%) | 1 (6%) |
| $^{235}U$ | 12 (71%) | 4 (24%) | 1 (6%) |
| $^{238}U$ | 15 (88%) | 1 (6%) | 1 (6%) |
| $^{237}Np$ | 6 (75%) | 0 | 2 (25%) |
| $^{238}Pu$ | 14 (78%) | 1 (6%) | 3 (17%) |
| $^{239}Pu$ | 14 (78%) | 1 (6%) | 3 (17%) |
| $^{241}Am$ | 17 (77%) | 4 (18%) | 1 (5%) |
| $^{244}Cm$ | 9 (64%) | 3 (21%) | 2 (14%) |
| gross alpha | 4 (40%) | 2 (20%) | 4 (40%) |
| Total | **110** | **20** | **20** |
| Total (%) | 73 | 13 | 13 |

**Table 3.2 – Results AH**

| Nuclide | In agreement | Questionable | Discrepant |
|---|---|---|---|
| $^{226}Ra$ | 6 (67%) | 0 | 3 (33%) |
| $^{234}U$ | 7 (64%) | 3 (27%) | 1 (9%) |
| $^{235}U$ | 8 (62%) | 4 (31%) | 1 (8%) |
| $^{238}U$ | 10 (71%) | 3 (21%) | 1 (7%) |
| $^{237}Np$ | 4 (57%) | 2 (29%) | 1 (14%) |
| $^{238}Pu$ | 8 (80%) | 0 | 2 (20%) |
| $^{239}Pu$ | 7 (70%) | 0 | 3 (30%) |
| $^{241}Am$ | 11 (73%) | 3 (20%) | 1 (7%) |
| $^{244}Cm$ | 8 (73%) | 1 (9%) | 2 (18%) |
| gross alpha | 5 (71%) | 1 (14%) | 1 (14%) |
| Total | **74** | **17** | **16** |
| Total (%) | 69 | 16 | 15 |

**Table 3.3 – Results B1**

| Nuclide | In agreement | Questionable | Discrepant |
|---|---|---|---|
| $^{3}H$ | 20 (71%) | 4 (14%) | 4 (14%) |
| $^{14}C$ | 12 (55%) | 5 (23%) | 5 (23%) |
| $^{99}Tc$ | 13 (93%) | 1 (7%) | 0 |
| Total | **45** | **10** | **9** |
| Total (%) | 70 | 16 | 14 |

**Table 3.4 – Results B2**

| Nuclide | In agreement | Questionable | Discrepant |
|---|---|---|---|
| $^{3}H$ | 22 (76%) | 4 (14%) | 3 (10%) |
| $^{55}Fe$ | 7 (54%) | 0 | 6 (46%) |
| $^{63}Ni$ | 6 (43%) | 1 (7%) | 7 (50%) |
| $^{90}Sr$ | 15 (65%) | 5 (22%) | 3 (13%) |
| gross beta | 3 (30%) | 4 (40%) | 3 (30%) |
| Total | **53** | **14** | **22** |
| Total (%) | 60 | 16 | 25 |

**Table 3.5 – Results GL**

| Nuclide | In agreement | Questionable | Discrepant | Missing |
|---|---|---|---|---|
| $^{22}Na$ | 29 (53%) | 10 (18%) | 12 (22%) | 4 (7%) |
| $^{60}Co$ | 38 (69%) | 10 (18%) | 6 (11%) | 1 (2%) |
| $^{95}Zr$ | 42 (76%) | 6 (11%) | 5 (9%) | 2 (4%) |
| $^{95}Nb$ | 34 (62%) | 8 (15%) | 9 (16%) | 4 (7%) |
| $^{133}Ba$ | 39 (71%) | 9 (16%) | 2 (4%) | 5 (9%) |
| $^{134}Cs$ | 36 (65%) | 8 (15%) | 10 (18%) | 1 (2%) |
| $^{137}Cs$ | 42 (76%) | 7 (13%) | 6 (11%) | 0 |
| $^{152}Eu$ | 38 (69%) | 9 (16%) | 7 (13%) | 1 (2%) |
| Total | **298** | **67** | **57** | **18** |
| Total (%) | 68 | 15 | 13 | 4 |

**Table 3.6 – Results GH**

| Nuclide | In agreement | Questionable | Discrepant | Missing |
|---|---|---|---|---|
| $^{22}Na$ | 18 (41%) | 12 (27%) | 9 (20%) | 5 (11%) |
| $^{60}Co$ | 31 (70%) | 10 (23%) | 2 (5%) | 1 (2%) |
| $^{95}Zr$ | 29 (66%) | 9 (20%) | 5 (11%) | 1 (2%) |
| $^{95}Nb$ | 27 (61%) | 6 (14%) | 9 (20%) | 2 (5%) |
| $^{133}Ba$ | 25 (57%) | 12 (27%) | 5 (11%) | 2 (5%) |
| $^{134}Cs$ | 30 (68%) | 7 (16%) | 7 (16%) | 0 |
| $^{137}Cs$ | 30 (68%) | 10 (23%) | 4 (9%) | 0 |
| $^{152}Eu$ | 24 (55%) | 12 (27%) | 7 (16%) | 1 (2%) |
| Total | **214** | **78** | **48** | **12** |
| Total (%) | 61 | 22 | 14 | 3 |

**Table 3.7 – Results C**

| Nuclide | In agreement | Questionable | Discrepant |
|---|---|---|---|
| $^{3}H$ total | 14 (100%) | 0 | 0 |
| $^{3}H$ leachable | 5 (100%) | 0 | 0 |
| $^{14}C$ | 10 (83%) | 1 (8%) | 1 (8%) |
| $^{40}K$ | 7 (100%) | 0 | 0 |
| $^{55}Fe$ | 4 (80%) | 0 | 1 (20%) |
| $^{60}Co$ | 21 (68%) | 7 (23%) | 3 (10%) |
| $^{63}Ni$ | 4 (67%) | 1 (17%) | 1 (17%) |
| $^{133}Ba$ | 13 (87%) | 0 | 2 (13%) |
| $^{152}Eu$ | 23 (74%) | 5 (16%) | 3 (10%) |
| $^{154}Eu$ | 20 (71%) | 3 (11%) | 5 (18%) |
| Gross beta | 5 (83%) | 1 (17%) | 0 |
| Total | **126** | **18** | **16** |
| Total (%) | 79 | 11 | 10 |

### 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) | 5 | Background |
| $^{46}$Sc (GL) | 1 | Unknown |
| $^{54}$Mn (GL) | 1 | Unknown |
| $^{57}$Co (GL) | 2 | Mistaken for $^{152}$Eu |
| $^{106}$Ru (GL) | 1 | Unknown |
| $^{109}$Cd (GL) | 1 | Unknown |
| $^{155}$Eu (GL) | 1 | Unknown |
| $^{207}$Bi (GL) | 2 | Mistaken for $^{134}$Cs |
| $^{210}$Pb (GL) | 1 | Background |
| $^{40}$K (GH) | 1 | Background |
| $^{58}$Co (GH) | 4 | Mistaken for $^{152}$Eu |
| $^{65}$Zn (GH) | 1 | Unknown |
| $^{109}$Cd (GH) | 1 | Unknown |
| $^{154}$Eu (GH) | 4 | Mistaken for $^{22}$Na |
| $^{155}$Eu (GH) | 1 | Unknown |
| $^{170}$Tm (GH) | 2 | Unknown |

## 3.8 Analysis of results by participant

The combined results for each participant are presented in Tables 3.9 (all samples excluding the C samples) and 3.10 (C samples). The individual deviation results are presented in Figures 57 to 134.

**Table 3.9 – Individual results (excluding concrete C samples)**

| Participant | Results in agreement | Questionable results | Discrepant results | Missing results |
|---|---|---|---|---|
| 1 | 7 (47%) | 7 | 1 | 0 |
| 4 | 16 (73%) | 6 | 0 | 0 |
| 5 | 8 (40%) | 3 | 8 | 1 |
| 7 | 13 (57%) | 5 | 4 | 1 |
| 8 | 45 (88%) | 4 | 2 | 0 |
| 11 | 3 (38%) | 1 | 4 | 0 |
| 13 | 14 (93%) | 1 | 0 | 0 |
| 14 | 11 (65%) | 1 | 5 | 0 |
| 15 | 9 (56%) | 4 | 3 | 0 |
| 16 | 9 (69%) | 2 | 2 | 0 |
| 17 | 12 (41%) | 7 | 9 | 1 |
| 18 | 16 (100%) | 0 | 0 | 0 |
| 19 | 8 (80%) | 0 | 2 | 0 |
| 20 | 8 (73%) | 2 | 0 | 1 |
| 21 | 21 (91%) | 1 | 1 | 0 |
| 23 | 8 (100%) | 0 | 0 | 0 |
| 24 | 15 (94%) | 0 | 1 | 0 |
| 25 | 23 (68%) | 3 | 8 | 0 |
| 26 | 12 (80%) | 1 | 2 | 0 |
| 27 | 1 (6%) | 14 | 0 | 1 |
| 28 | 22 (76%) | 4 | 3 | 0 |
| 29 | 24 (100%) | 0 | 0 | 0 |
| 31 | 1 (4%) | 5 | 12 | 6 |
| 32 | 19 (83%) | 4 | 0 | 0 |
| 33 | 3 (38%) | 3 | 1 | 1 |
| 35 | 28 (72%) | 5 | 6 | 0 |
| 38 | 21 (95%) | 0 | 1 | 0 |
| 40 | 10 (59%) | 4 | 3 | 0 |
| 41 | 10 (63%) | 5 | 1 | 0 |

continues

continued

| Participant | Results in agreement | Questionable results | Discrepant results | Missing results |
|---|---|---|---|---|
| 42 | 10 (91%) | 0 | 1 | 0 |
| 43 | 7 (88%) | 1 | 0 | 0 |
| 44 | 0 | 0 | 6 | 2 |
| 45 | 7 (88%) | 0 | 1 | 0 |
| 46 | 16 (100%) | 0 | 0 | 0 |
| 47 | 27 (84%) | 5 | 0 | 0 |
| 48 | 7 (64%) | 3 | 1 | 0 |
| 51 | 7 (88%) | 1 | 0 | 0 |
| 52 | 16 (100%) | 0 | 0 | 0 |
| 53 | 8 (100%) | 0 | 0 | 0 |
| 54 | 6 (38%) | 7 | 2 | 1 |
| 55 | 21 (84%) | 1 | 3 | 0 |
| 56 | 2 (67%) | 1 | 0 | 0 |
| 59 | 16 (80%) | 4 | 0 | 0 |
| 62 | 6 (75%) | 0 | 2 | 0 |
| 65 | 12 (75%) | 0 | 4 | 0 |
| 68 | 9 (56%) | 2 | 4 | 0 |
| 72 | 8 (89%) | 1 | 0 | 0 |
| 74 | 7 (50%) | 3 | 4 | 0 |
| 76 | 8 (100%) | 0 | 0 | 0 |
| 77 | 11 (69%) | 3 | 2 | 0 |
| 81 | 8 (80%) | 2 | 0 | 0 |
| 82 | 5 (31%) | 10 | 1 | 0 |
| 83 | 2 (12%) | 1 | 2 | 12 |
| 88 | 16 (100%) | 0 | 0 | 0 |
| 89 | 8 (44%) | 9 | 1 | 0 |
| 90 | 14 (88%) | 2 | 0 | 0 |
| 91 | 15 (75%) | 3 | 2 | 0 |
| 92 | 0 | 4 | 5 | 0 |
| 93 | 3 (38%) | 3 | 2 | 0 |
| 94 | 12 (80%) | 1 | 2 | 0 |
| 95 | 5 (50%) | 2 | 3 | 0 |
| 96 | 8 (44%) | 5 | 5 | 0 |

continues

| continued | | | | |
|---|---|---|---|---|
| Participant | Results in agreement | Questionable results | Discrepant results | Missing results |
| 97 | 3 (38%) | 3 | 2 | 0 |
| 98 | 2 (13%) | 14 | 0 | 0 |
| 101 | 4 (100%) | 0 | 0 | 0 |
| 102 | 2 (67%) | 0 | 1 | 0 |
| 103 | 2 (100%) | 0 | 0 | 0 |
| 104 | 3 (38%) | 1 | 4 | 0 |
| 105 | 3 (19%) | 5 | 7 | 1 |
| 106 | 21 (81%) | 0 | 5 | 0 |
| 107 | 19 (83%) | 3 | 1 | 0 |
| 108 | 8 (100%) | 0 | 0 | 0 |
| 109 | 12 (60%) | 5 | 3 | 0 |
| 110 | 8 (100%) | 0 | 0 | 0 |
| 111 | 1 (13%) | 0 | 6 | 1 |
| 112 | 0 | 7 | 0 | 1 |
| 113 | 2 (14%) | 1 | 11 | 0 |
| Total | **794 (66%)** | **206 (17%)** | **172 (14%)** | **30 (2%)** |

**Table 3.10 – Individual results concrete C samples**

| Participant | Results in agreement | Questionable results | Discrepant results | Results not evaluated |
|---|---|---|---|---|
| 1 | 2 (33%) | 3 | 1 | 0 |
| 4 | 3 (75%) | 1 | 0 | 0 |
| 5A | 3 (60%) | 1 | 1 | 0 |
| 5B | 3 (60%) | 1 | 1 | 0 |
| 7 | 3 (60%) | 2 | 0 | 0 |
| 8 | 5 (100%) | 0 | 0 | 0 |
| 14 | 2 (100%) | 0 | 0 | 0 |
| 17 | 5 (83%) | 1 | 0 | 0 |
| 21 | 4 (100%) | 0 | 0 | 5 |
| 24 | 3 (100%) | 0 | 0 | 0 |
| 28 | 3 (75%) | 1 | 0 | 0 |
| 29 | 4 (80%) | 1 | 0 | 2 |
| 31 | 2 (67%) | 0 | 1 | 0 |
| 32 | 9 (100%) | 0 | 0 | 2 |
| 35 | 6 (100%) | 0 | 0 | 0 |
| 38 | 7 (100%) | 0 | 0 | 0 |
| 48 | 3 (75%) | 0 | 1 | 0 |
| 52 | 3 (100%) | 0 | 0 | 0 |
| 54 | 1 (33%) | 2 | 0 | 0 |
| 55 | 2 (67%) | 1 | 0 | 0 |
| 65 | 2 (67%) | 0 | 1 | 0 |
| 68 | 3 (75%) | 1 | 0 | 0 |
| 74 | 4 (100%) | 0 | 0 | 0 |
| 78 | 7 (70%) | 1 | 2 | 0 |
| 81 | 3 (100%) | 0 | 0 | 0 |
| 88 | 4 (100%) | 0 | 0 | 0 |
| 94 | 9 (100%) | 0 | 0 | 0 |
| 95 | 5 (63%) | 0 | 3 | 1 |
| 96 | 2 (50%) | 0 | 2 | 0 |
| 97 | 1 (33%) | 0 | 2 | 0 |
| 105 | 1 (25%) | 2 | 1 | 0 |
| 106 | 2 (100%) | 0 | 0 | 1 |
| 109 | 5 (100%) | 0 | 0 | 0 |
| 113 | 5 (100%) | 0 | 0 | 0 |
| Total | **126 (79%)** | **18 (11%)** | **16 (10%)** | **11** |

## 3.9 Results UK / non-UK and 2007 / 2008 participants

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

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

| Participant sector | Results in agreement (%) | Number of results |
|---|---|---|
| UK participants in 2007 | 74 | 677 (56%) |
| UK participants in 2008 | 66 | 673 (56%) |
| non-UK participants in 2007 | 69 | 540 (44%) |
| non-UK participants in 2008 | 66 | 529 (44%) |
| 2008 participants in 2007 | 74 | 886 (73%) |
| 2007 participants in 2008 | 72 | 794 (66%) |
| non-2008 participants in 2007 | 65 | 331 (27%) |
| non-2007 participants in 2008 | 54 | 408 (34%) |
| **Total 2007** | **72** | **1217** |
| **Total 2008** | **66** | **1202** |

The following conclusions can be drawn from this table:

(i) The overall performance in 2008 was below the overall performance in 2007.
(ii) The performance of the UK participants was equal to the overall performance in 2008.
(iii) The performance of the participants who participated in both Exercises was slightly better in 2007 than in 2008.
(iv) The performance of the participants who participated only in one Exercise was better in 2007 than in 2008

### 3.10 Weighted mean of the largest consistent subset values participants

The weighted mean of the largest consistent subset (LCS) for the participants' results were calculated and compared with the assigned values (except for the nuclides in the C samples).

The weighted mean of the LCS for the participants' results for $^{235}$U (AL and AH), $^{244}$Cm (AH), $^{55}$Fe (B2), gross beta (B2), $^{22}$Na (GL and GH), $^{133}$Ba (GL and GH), $^{134}$Cs (GL) and $^{152}$Eu (GH) were significantly lower than assigned value, while the weighted mean of the LCS for the participants' results for $^{95}$Zr (GH) and $^{95}$Nb (GL and GH) were significantly higher than assigned value.

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

| Nuclide | Assigned value *N* | WM LCS | Size of the LCS (%) | Zeta test | Critical value |
|---|---|---|---|---|---|
| | Bq kg$^{-1}$ | Bq kg$^{-1}$ | | | |
| $^{226}$Ra **(AL)** | 4.71(6) | 4.52(17) | 71 | –1.08 | 3.50 |
| $^{234}$U | 14.6(14) | 14.23(20) | 94 | –0.28 | 2.58 |
| $^{235}$U | 0.680(3) | 0.579(19) | 94 | –5.36 D | 2.95 |
| $^{238}$U | 14.76(4) | 14.68(25) | 88 | –0.31 | 2.95 |
| $^{237}$Np | 9.38(10) | 9.8(4) | 100 | 1.16 | 3.50 |
| $^{238}$Pu | 11.86(4) | 11.78(13) | 94 | –0.59 | 2.86 |
| $^{239/240}$Pu | 10.19(5) | 10.01(12) | 94 | –1.36 | 2.83 |
| $^{241}$Am | 13.57(4) | 13.26(14) | 100 | –2.23 | 2.85 |
| $^{244}$Cm | 6.96(3) | 6.67(10) | 100 | –2.95 | 3.05 |
| gross alpha | 92(8) | 86(4) | 40 | –0.71 | 2.59 |
| | Bq g$^{-1}$ | Bq g$^{-1}$ | | | |
| $^{226}$Ra **(AH)** | 4.77(6) | 4.86(14) | 75 | 0.59 | 3.17 |
| $^{234}$U | 11.1(10) | 11.54(14) | 73 | 0.38 | 2.58 |
| $^{235}$U | 0.5188(19) | 0.468(12) | 77 | –4.23 D | 3.05 |
| $^{238}$U | 11.262(17) | 11.33(12) | 86 | 0.60 | 3.01 |
| $^{237}$Np | 3.20(4) | 3.30(6) | 71 | 1.75 | 3.11 |
| $^{238}$Pu | 5.807(18) | 5.58(11) | 80 | –2.10 | 3.25 |
| $^{239/240}$Pu | 15.42(7) | 14.6(3) | 70 | –2.82 | 3.17 |
| $^{241}$Am | 3.369(7) | 3.27(4) | 93 | –2.55 | 3.01 |
| $^{244}$Cm | 4.708(14) | 4.44(7) | 90 | –3.61 D | 3.25 |
| gross alpha | 65(8) | 57.1(8) | 50 | –1.01 | 2.58 |
| | Bq g$^{-1}$ | Bq g$^{-1}$ | | | |
| $^{3}$H **(B1)** | 0.925(7) | 0.910(8) | 86 | –1.55 | 2.64 |
| $^{14}$C | 0.702(5) | 0.718(9) | 68 | 1.63 | 2.74 |
| continues | | | | | |

| continued | | | | | |
|---|---|---|---|---|---|
| **Nuclide** | **Assigned value *N*** | **WM LCS** | **Size of the LCS (%)** | **Zeta test** | **Critical value** |
| | Bq g$^{-1}$ | Bq g$^{-1}$ | | | |
| $^{99}$Tc | 1.612(4) | 1.583(17) | 100 | –1.64 | 2.98 |
| $^{3}$H **(B2)** | 0.487(4) | 0.489(4) | 92 | 0.44 | 2.62 |
| $^{55}$Fe | 1.65(4) | 1.37(4) | 62 | –5.21 D | 2.67 |
| $^{63}$Ni | 0.596(24) | 0.586(12) | 54 | –0.39 | 2.59 |
| $^{90}$Sr | 0.5712(11) | 0.562(7) | 86 | –1.26 | 2.81 |
| gross beta P | 1.1423(23) | 1.00(3) | 33 | –4.40 D | 4.03 |
| gross beta L | 2.5(5) | – | – | – | – |
| | Bq kg$^{-1}$ | Bq kg$^{-1}$ | | | |
| $^{22}$Na **(GL)** | 8.19(3) | 7.45(5) | 82 | –12.57 D | 2.63 |
| $^{60}$Co | 7.201(22) | 7.24(4) | 83 | 0.82 | 2.63 |
| $^{95}$Zr | 7.30(7) | 7.42(6) | 91 | 1.28 | 2.59 |
| $^{95}$Nb | 13.46(7) | 14.00(11) | 75 | 4.22 D | 2.63 |
| $^{133}$Ba | 6.12(5) | 5.90(5) | 92 | –3.55 D | 2.60 |
| $^{134}$Cs | 11.93(8) | 11.40(5) | 81 | –5.49 D | 2.58 |
| $^{137}$Cs | 9.02(6) | 9.17(6) | 87 | 1.75 | 2.59 |
| $^{152}$Eu | 12.35(9) | 12.15(9) | 80 | –1.55 | 2.60 |
| | Bq g$^{-1}$ | Bq g$^{-1}$ | | | |
| $^{22}$Na **(GH)** | 5.529(20) | 5.28(4) | 69 | –6.27 D | 2.65 |
| $^{60}$Co | 4.641(14) | 4.698(21) | 88 | 2.24 | 2.63 |
| $^{95}$Zr | 7.35(8) | 7.61(5) | 84 | 3.02 D | 2.58 |
| $^{95}$Nb | 13.54(7) | 13.86(9) | 76 | 2.74 D | 2.63 |
| $^{133}$Ba | 2.754(19) | 2.599(14) | 81 | –6.53 D | 2.59 |
| $^{134}$Cs | 4.63(4) | 4.55(3) | 77 | –1.81 | 2.60 |
| $^{137}$Cs | 9.56(7) | 9.69(5) | 86 | 1.62 | 2.59 |
| $^{152}$Eu | 17.86(12) | 17.31(8) | 77 | –3.73 D | 2.59 |

### 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 135 and 136. $R_{med}$ was used to calculate the standard uncertainty for proficiency assessment $\sigma_p$ 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 3.6% to 13.1%, but in general were of the order of 5% (Figure 135). The IQR outlier test (see Appendix H) was used to determine whether a relative uncertainty was significantly different from the other results in the data set, resulting in the exclusion of 36 relative uncertainty results (3% of the total results). For 24 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 12 results were already classified as 'questionable' or 'discrepant', because they failed the $z$-test as well. $R_{lim}$, which is used to defines the "upper" limit in the Kiri plots, ranged from 11.6% to 42.7% (Figure 136).

**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 $R_{lim}$ (%) |
|---|---|---|---|---|
| $^{226}$Ra (AL) | 9 | 6.9 | 0 | 31.4 |
| $^{234}$U | 16 | 6.0 | 1 | 12.4 |
| $^{235}$U | 17 | 13.1 | 1 | 40.1 |
| $^{238}$U | 16 | 5.9 | 0 | 16.2 |
| $^{237}$Np | 8 | 10.3 | 0 | 24.4 |
| $^{238}$Pu | 17 | 5.7 | 1 | 16.1 |
| $^{239}$Pu | 17 | 5.8 | 1 | 15.2 |
| $^{241}$Am | 22 | 6.0 | 0 | 21.9 |
| $^{244}$Cm | 14 | 5.9 | 0 | 24.1 |
| gross alpha | 10 | 5.1 | 0 | 33.4 |
| $^{226}$Ra (AH) | 9 | 8.0 | 0 | 25.0 |
| $^{234}$U | 11 | 4.5 | 0 | 19.0 |
| $^{235}$U | 13 | 10.8 | 1 | 42.7 |
| $^{238}$U | 14 | 5.0 | 1 | 17.6 |
| $^{237}$Np | 7 | 6.0 | 0 | 27.2 |
| $^{238}$Pu | 10 | 5.7 | 0 | 17.0 |
| $^{239}$Pu | 10 | 5.1 | 0 | 11.7 |
| $^{241}$Am | 15 | 4.5 | 0 | 20.3 |
| $^{244}$Cm | 11 | 5.2 | 0 | 20.9 |
| gross alpha | 7 | 3.2# | 0 | 11.6 |
| continues | | | | |

continued

| Nuclide | Number of results | Median relative uncertainty $R_{med}$ (%) | Number of outliers | Outlier limit $R_{lim}$ (%) |
|---|---|---|---|---|
| $^{3}$H (B1) | 28 | 5.7 | 0 | 29.1 |
| $^{14}$C | 22 | 5.9 | 0 | 25.2 |
| $^{99}$Tc | 14 | 5.7 | 0 | 26.7 |
| $^{3}$H (B2) | 29 | 4.3 | 0 | 17.6 |
| $^{55}$Fe | 13 | 6.6 | 0 | 32.9 |
| $^{63}$Ni | 14 | 6.0 | 0 | 26.4 |
| $^{90}$Sr | 23 | 7.3 | 1 | 26.3 |
| gross beta | 10 | 6.0 | 0 | 24.5 |
| $^{22}$Na (GL) | 51 | 5.3 | 1 | 23.5 |
| $^{60}$Co | 54 | 4.6 | 2 | 20.2 |
| $^{95}$Zr | 53 | 6.6 | 2 | 27.0 |
| $^{95}$Nb | 51 | 5.9 | 1 | 25.6 |
| $^{133}$Ba | 50 | 6.1 | 3 | 21.8 |
| $^{134}$Cs | 54 | 4.3 | 0 | 19.0 |
| $^{137}$Cs | 55 | 5.1 | 1 | 21.0 |
| $^{152}$Eu | 54 | 5.5 | 0 | 26.6 |
| $^{22}$Na (GH) | 39 | 4.0 | 2 | 13.0 |
| $^{60}$Co | 43 | 3.6 | 2 | 17.1 |
| $^{95}$Zr | 43 | 3.9 | 3 | 14.0 |
| $^{95}$Nb | 42 | 4.9 | 2 | 21.7 |
| $^{133}$Ba | 42 | 4.5 | 3 | 13.0 |
| $^{134}$Cs | 44 | 3.9 | 2 | 16.0 |
| $^{137}$Cs | 44 | 3.8 | 2 | 15.3 |
| $^{152}$Eu | 43 | 3.9 | 3 | 13.8 |

# Set at a value of 5.0%

The median relative uncertainties $R_{med}$ and the outlier limit $R_{lim}$ for the concrete samples are listed in Table 3.14 and plotted in Figures 135 and 136. $R_{med}$ was used to calculate the standard uncertainty for proficiency assessment $\sigma_p$ and the $z$-score for $^{55}$Fe, $^{60}$Co, $^{133}$Ba, $^{152}$Eu and $^{154}$Eu. For these nuclides, $R_{med}$ values ranged from to 4.3% to 14.0% (Figure 135). The IQR outlier test (see Appendix H) was used to determine whether a relative uncertainty was significantly different from the other results in the data set, resulting in the exclusion of 4 relative uncertainty results (3% of the total results). For one result this meant that, although it passed both the zeta test and $z$-test, the failure to pass the $R_{lim}$ test resulted in a 'questionable' classification (this results is close to the assigned value, but have an unacceptably large $u_L$). The other 3 results were already classified as 'questionable' or 'discrepant', because they failed the $z$-test as well. $R_{lim}$, which is used to defines the "upper" limit in the Kiri plots, ranged from 19.8% to 54.5% (Figure 136).

**Table 3.14 – Median relative uncertainties and outlier limits concrete samples**

| Nuclide | Number of results | Median relative uncertainty $R_{med}$ (%) | Number of outliers | Outlier limit $R_{lim}$ (%) |
|---|---|---|---|---|
| $^{55}Fe$ | 5 | 14.0 | – | – |
| $^{60}Co$ | 31 | 5.3 | 2 | 24.9 |
| $^{133}Ba$ | 15 | 12.5 | 0 | 54.5 |
| $^{152}Eu$ | 31 | 4.3 | 0 | 19.8 |
| $^{154}Eu$ | 28 | 7.7 | 2 | 36.5 |

# 4. CONCLUSION

The 2008 proficiency test exercise was successfully completed, with all but five of the laboratories returning data. In total, 260 samples were shipped to 83 participants and 1372 results were submitted. All 78 data sets were submitted electronically. In total, 67% of the results was 'in agreement', 16% of the results was 'questionable', 14% of the results was 'discrepant', 2% of the results was 'missing' and 1% of the results was 'not evaluated' [100% is represented by 1373 results]. Twenty-nine 'false positives' were received. The overall level of performance was lower to that observed in the previous Exercise (2007). The performance of the participants who participated in both Exercises was slightly worse in 2008 than in 2007. The performance of the new participants was worse than the established participants. For the aqueous samples, 33 participants scored 80% or higher 'in agreement' results, 17 participants scored 90% or higher 'in agreement' results and 12 participants scored 100% 'in agreement' results.

For the AL and AH samples, 73% and 69% of the results were 'in agreement'. For the AL samples, the most problematic nuclides were $^{226}$Ra, $^{244}$Cm and gross alpha, while for the AH samples the most problematic nuclides were $^{234}$U, $^{235}$U and $^{237}$Np. There was a significant negative bias between the assigned result and the participants results for $^{235}$U (AL and AH) and $^{244}$Cm (AH).

For the B1 samples, 70% of the results were 'in agreement'. For the B1 samples, the most problematic nuclide was $^{14}$C. For the B2 samples, 60% of the results were 'in agreement'. The most problematic nuclides were $^{55}$Fe, $^{63}$Ni and gross beta. There was a significant negative bias between the assigned result and the participants results for $^{55}$Fe and gross beta.

Most participants were able to identify all the nuclides in the GL and GH samples. The number of 'false positives' results was 29. More than one false positive result was returned for $^{40}$K (GL), $^{57}$Co (GL), $^{207}$Bi (GL), $^{58}$Co (GH), $^{154}$Eu (GH) and $^{170}$Tm (GH), (reported by 5, 2, 2, 4, 4 and 2 participants, respectively). For the GL and GH samples, 68% and 61% of the results were 'in agreement'. For the GL samples, the most problematic nuclides were $^{22}$Na, $^{95}$Nb and $^{134}$Cs, while for the GH samples, the most problematic nuclides were $^{22}$Na, $^{133}$Ba and $^{152}$Eu. There was a significant negative bias between the assigned result and the participants results for $^{22}$Na (GL and GH), $^{133}$Ba (GL and GH), $^{134}$Cs (GL) and $^{152}$Eu (GH). There was a significant positive bias between the assigned result and the participants results for $^{95}$Zr (GH) and $^{95}$Nb (GL and GH). Coincidence summing has been discussed in previous exercises, and is a problem for some of the nuclides included in this exercise (i.e., $^{22}$Na, $^{60}$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.

Finally, 79% of the results for the solid C samples were 'in agreement'. The data treatment for these samples was different, because the assigned values were derived from the consensus values (making this a comparison rather than a proficiency test), while the corresponding uncertainties were derived from the uncertainty of the consensus value, the stability uncertainty and the homogeneity uncertainty.

# FIGURES

Figures 1 to 44

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 individual 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 contructed by plotting the squared ratio between the laboratory uncertainty $u_L$ and the standard uncertainty for proficiency assessment $\sigma_p$ 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.

Figures 45 to 55

Participants' results $L$ '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 $u_L$ (with a coverage factor of $k$=1). The black dotted lines represent acceptable $z$-scores.

Figures 50, 52, 53 and 54

B 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. The dotted line represents the outlier limit $R_{lim}$.

C Kiri plots were contructed by plotting the squared ratio between the laboratory uncertainty $u_L$ and the standard uncertainty for proficiency assessment $\sigma_p$ 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.

| | |
|---|---|
| D | The truncated sum of squares (TSS) function $F_r$ for the LCS (dark blue curve) and the LCS plus 1 (light blue curve) as a function of the specific activity. The horizontal dark blue dotted line represents the critical value of the chi-squared distribution for the LCS at a significance level of 0.01. The horizontal light blue dotted line represents the critical value of the chi-squared distribution for the LCS plus 1 at a significance level of 0.01. |
| E | The normal kernel mixture-model probability density function (MM-PDF). The black dotted line represents the mixture-model mode. The white line represents the mixture-model median. |
| Figure 56 | Homogeneity tests for $^{60}Co$ (A), $^{133}Ba$ (B), $^{152}Eu$ (C) and $^{154}Eu$ (D) |
| Figures 57 to 134 | 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 135 | The medians of the relative uncertainties of the laboratory values $R_{med}$ are represented by the light blue bars. |
| Figure 136 | The outlier limits for the relative uncertainties $R_{lim}$ are represented by the light blue bars. |
| Figure 137 | Normalised $^{234}U$ / $^{238}U$ ratios AL (A) and AH (B). The values significantly different from unity are represented by the red points. |
| Figure 138 | Normalised $^{235}U$ / $^{238}U$ ratios AL (A) and AH (B). The values significantly different from unity are represented by the red points. |
| Figure 139 | Normalised $^{244}Cm$ / $^{241}Am$ ratios AL (A) and AH (B). The values significantly different from unity are represented by the red points. |

**Figure 1A – Deviation Ra-226 AL**

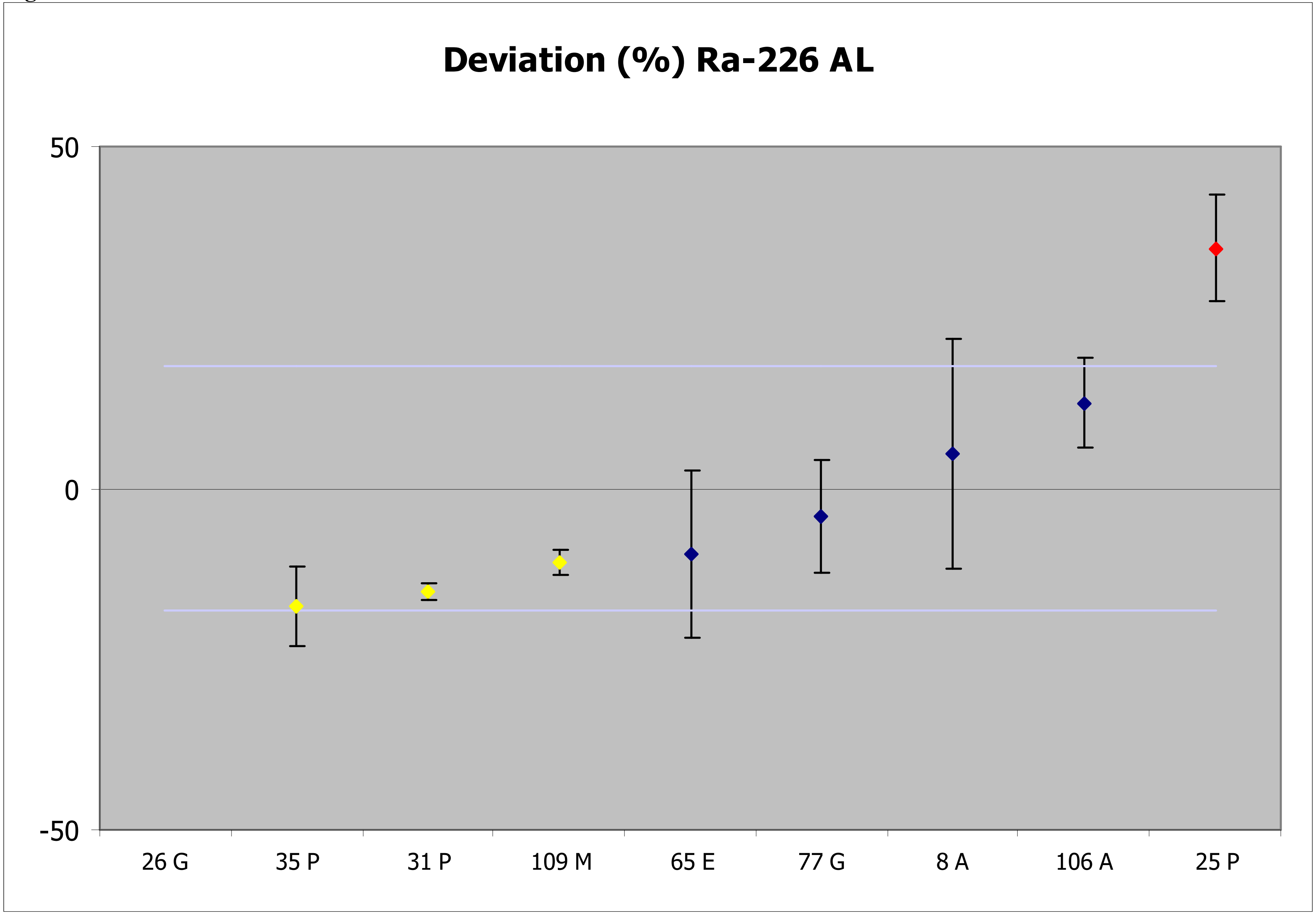


**Figure 1B – Zeta score Ra-226 AL**

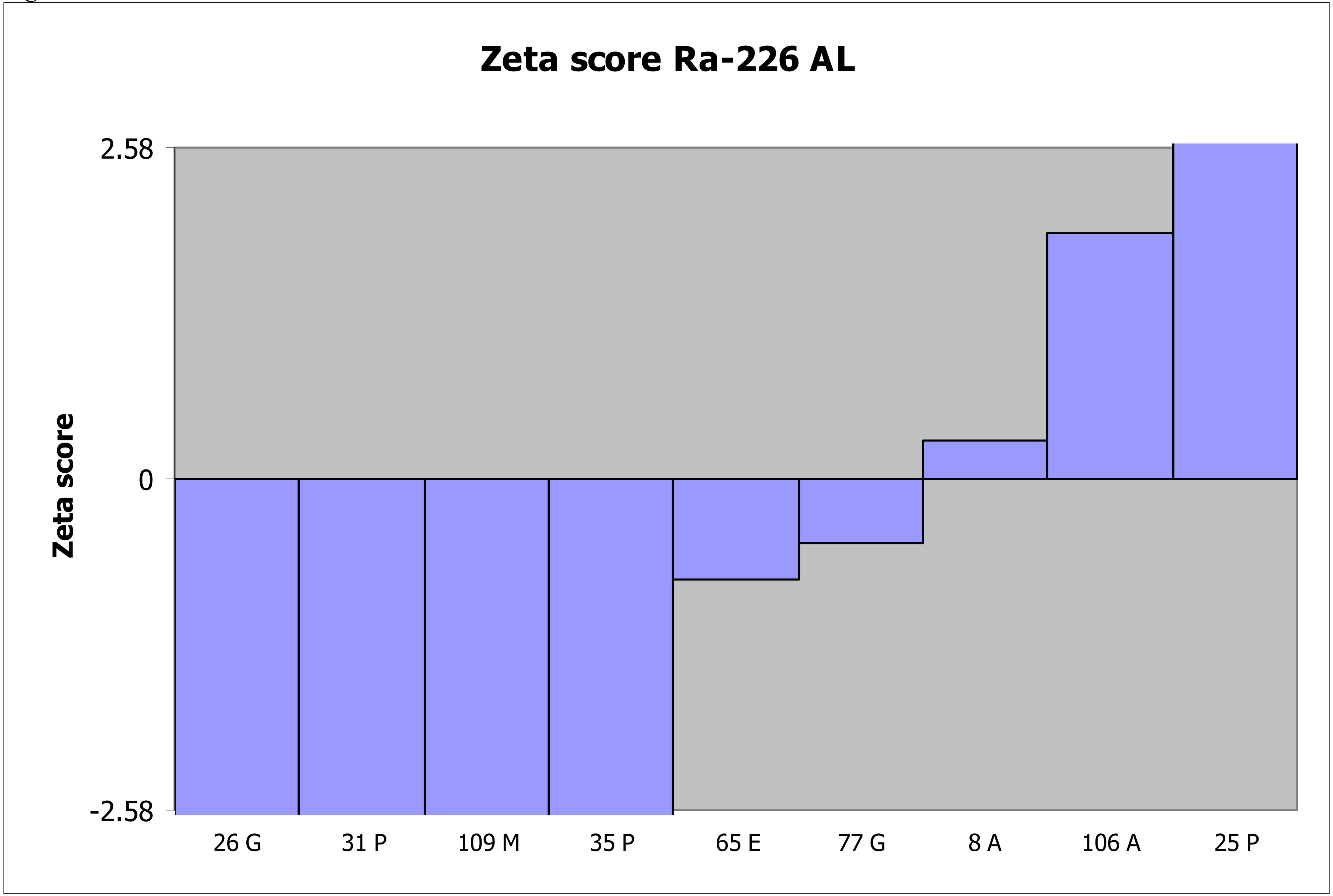


**Figure 1C – Relative uncertainty Ra-226 AL**

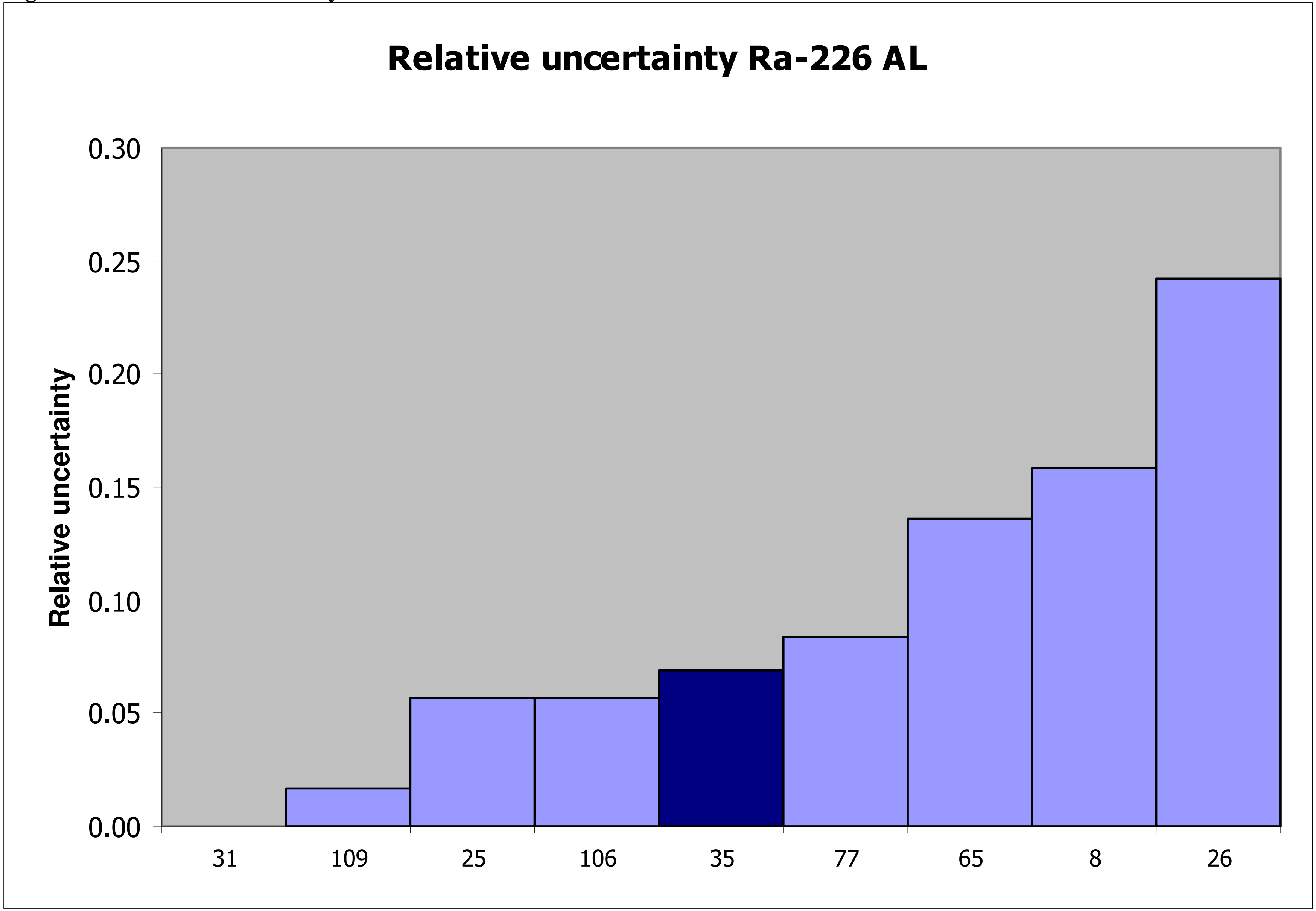


**Figure 1D – Kiri plot Ra-226 AL**

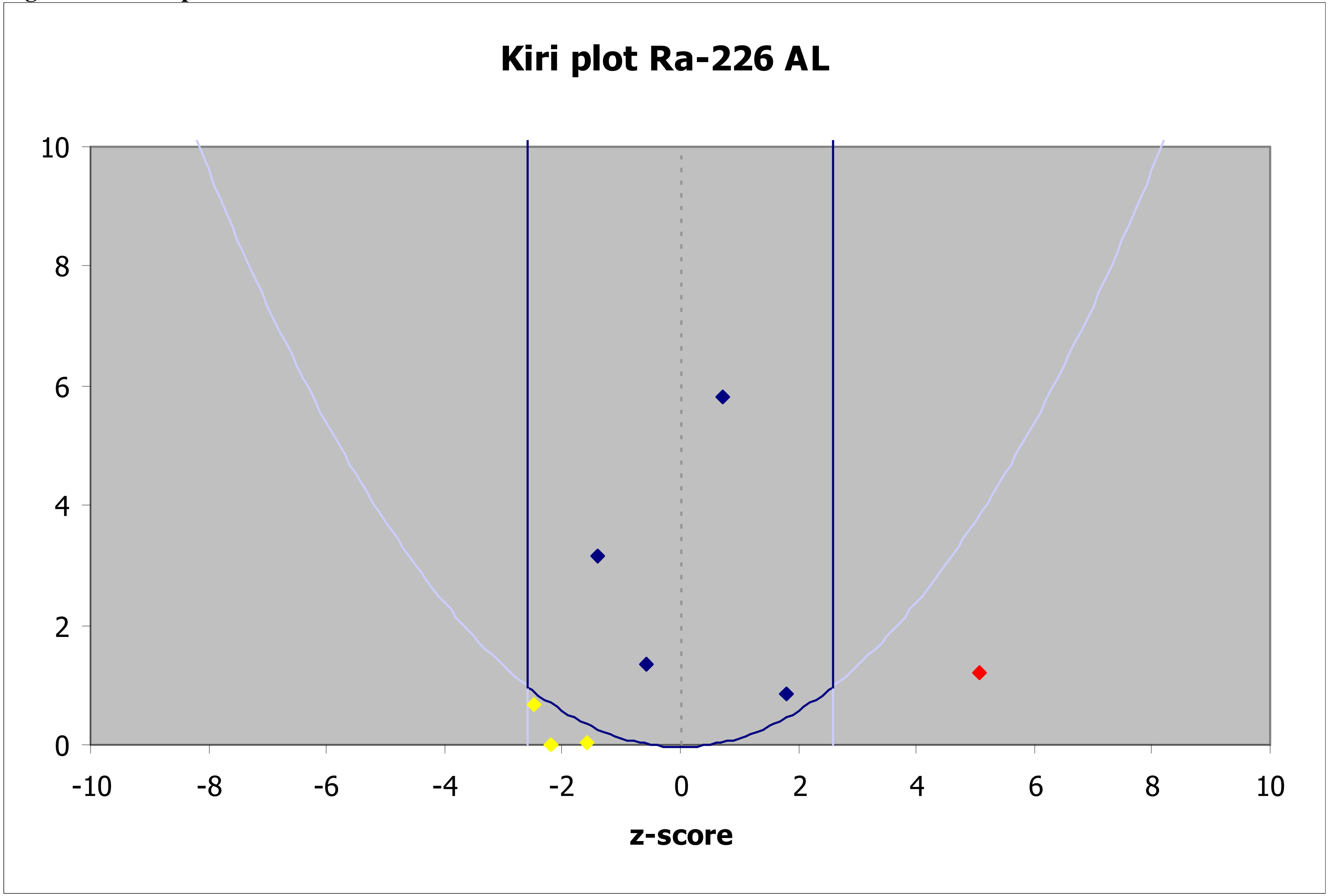


**Figure 2A – Deviation U-234 AL**

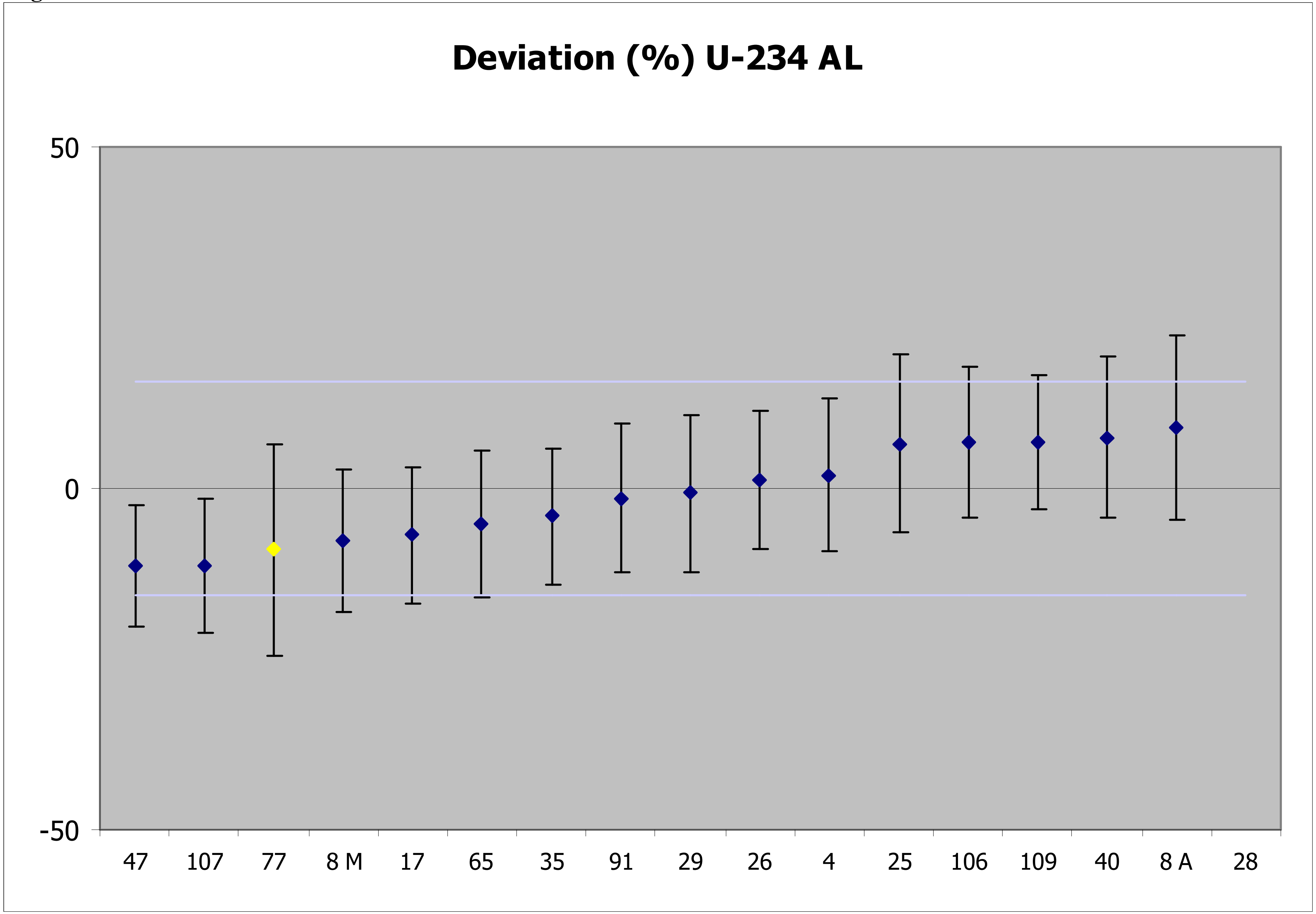


**Figure 2B – Zeta score U-234 AL**

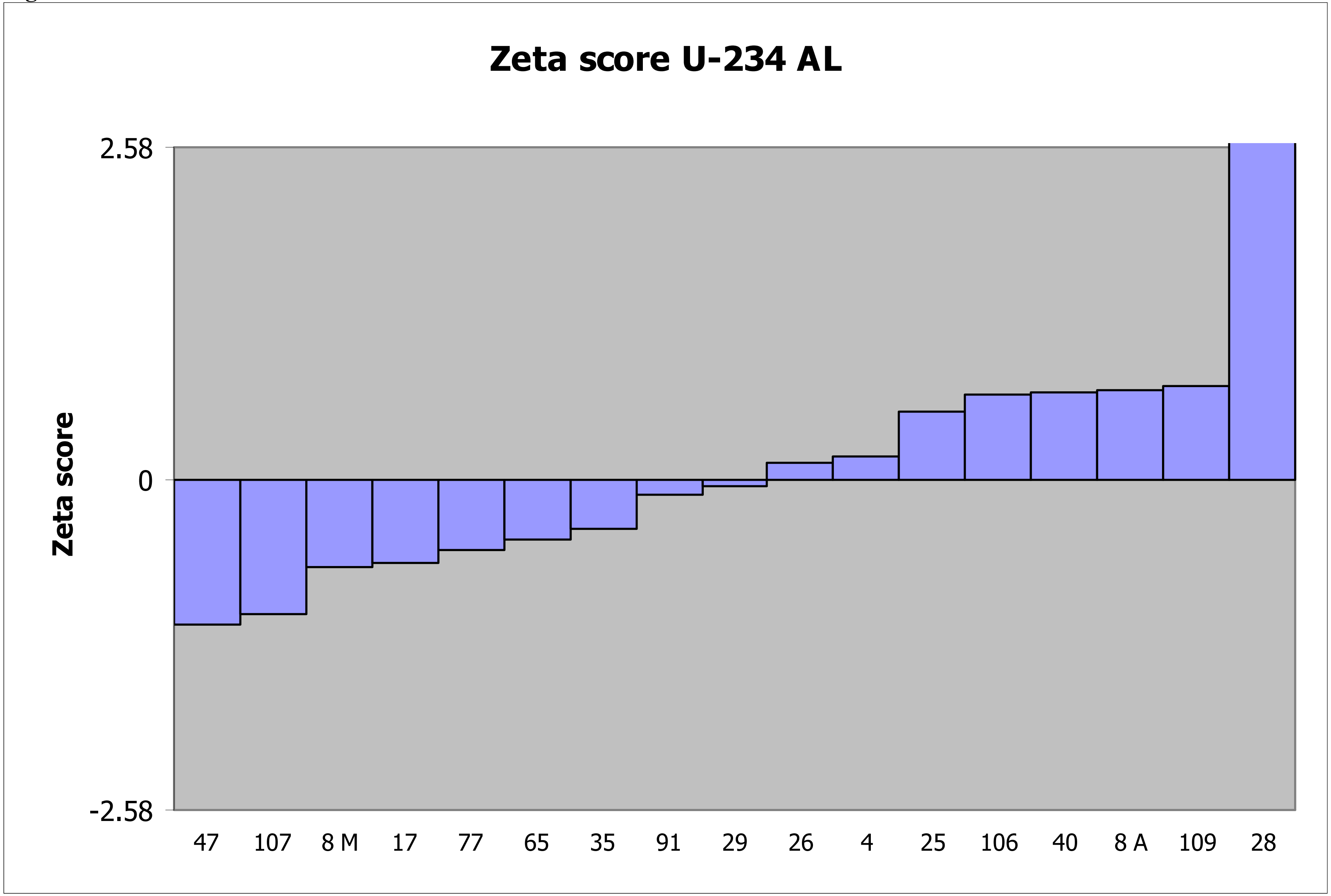


**Figure 2C – Relative uncertainty U-234 AL**

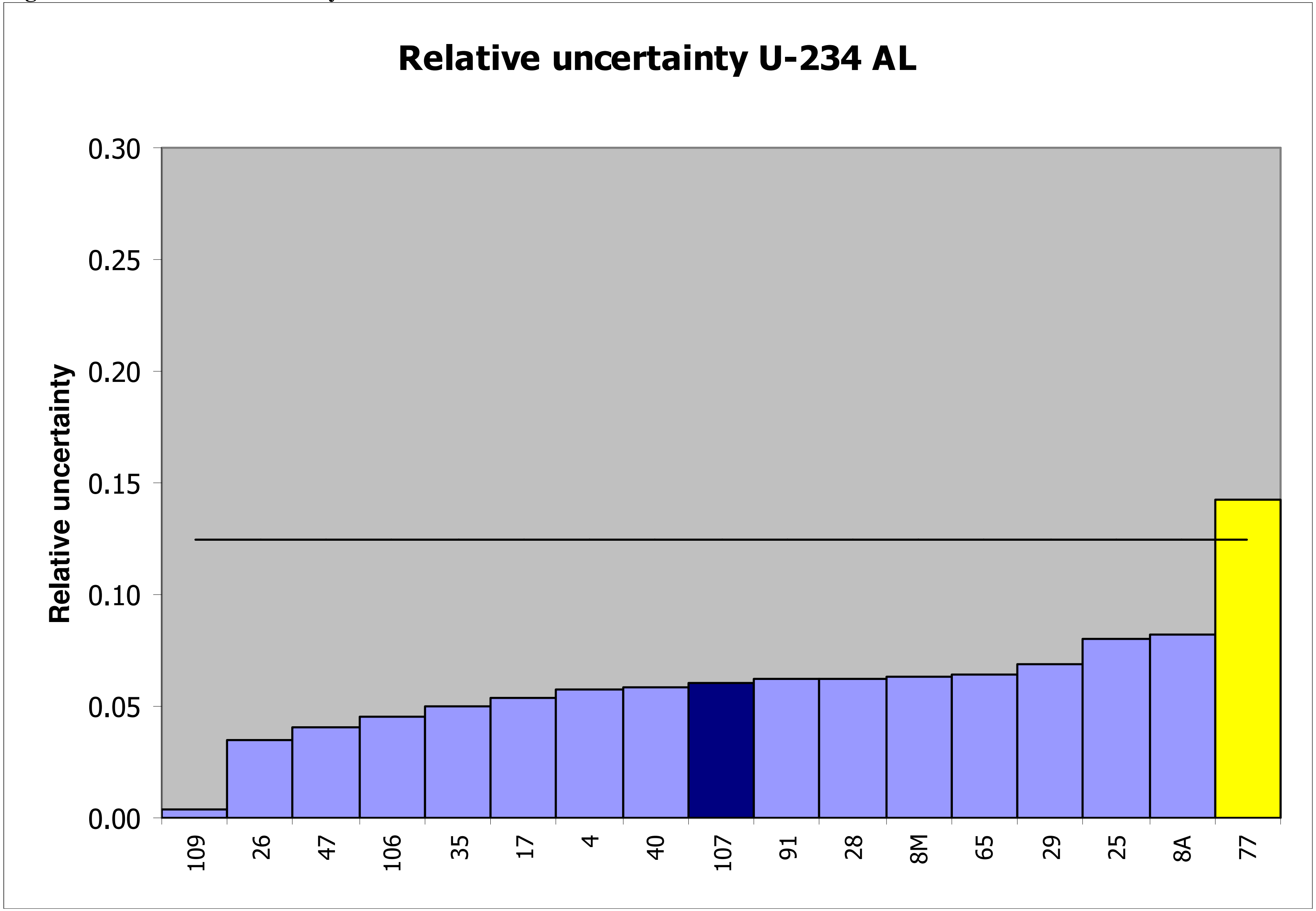


**Figure 2D – Kiri plot U-234 AL**

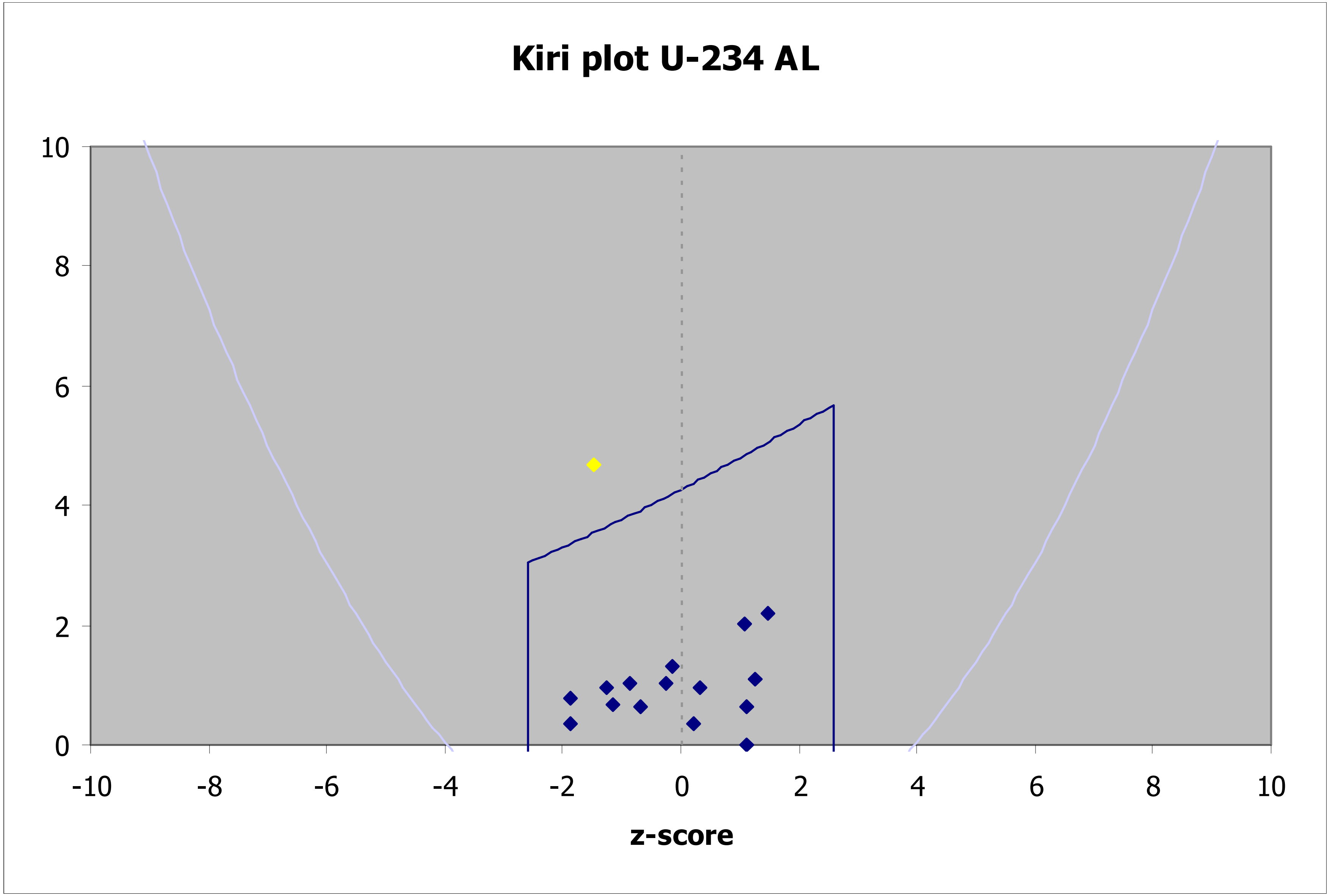


**Figure 3A – Deviation U-235 AL**

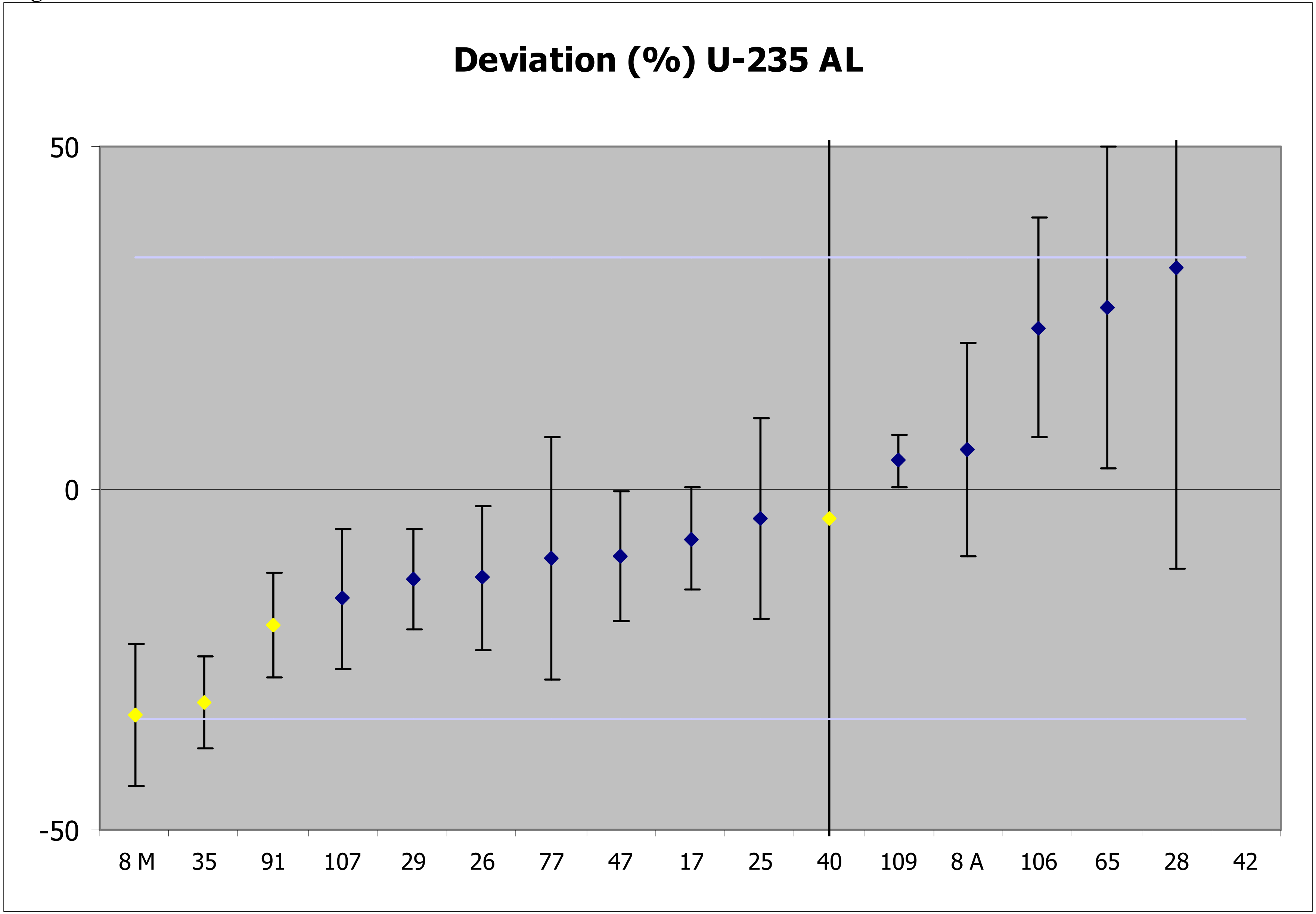


**Figure 3B – Zeta score U-235 AL**

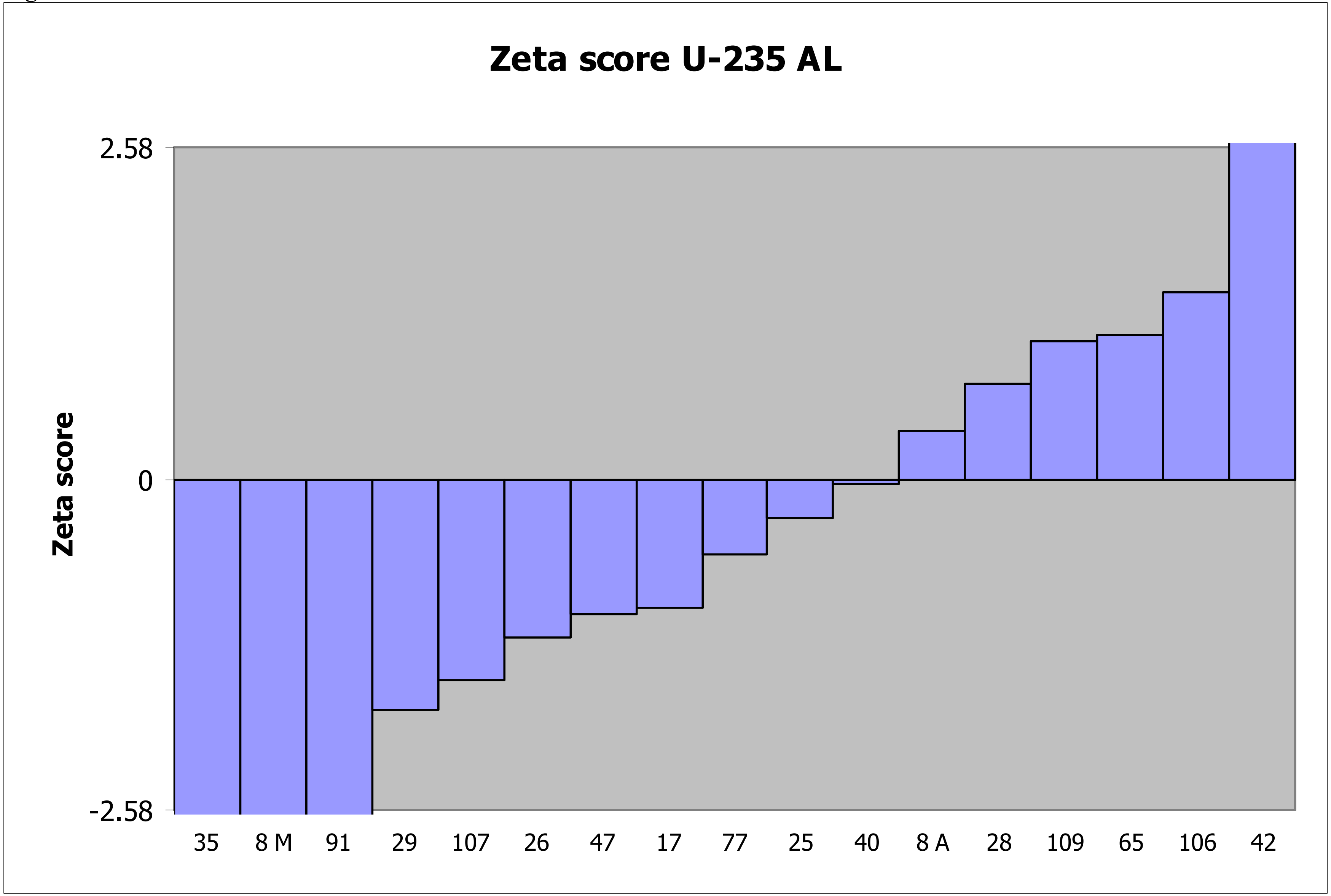


**Figure 3C – Relative uncertainty U-235 AL**

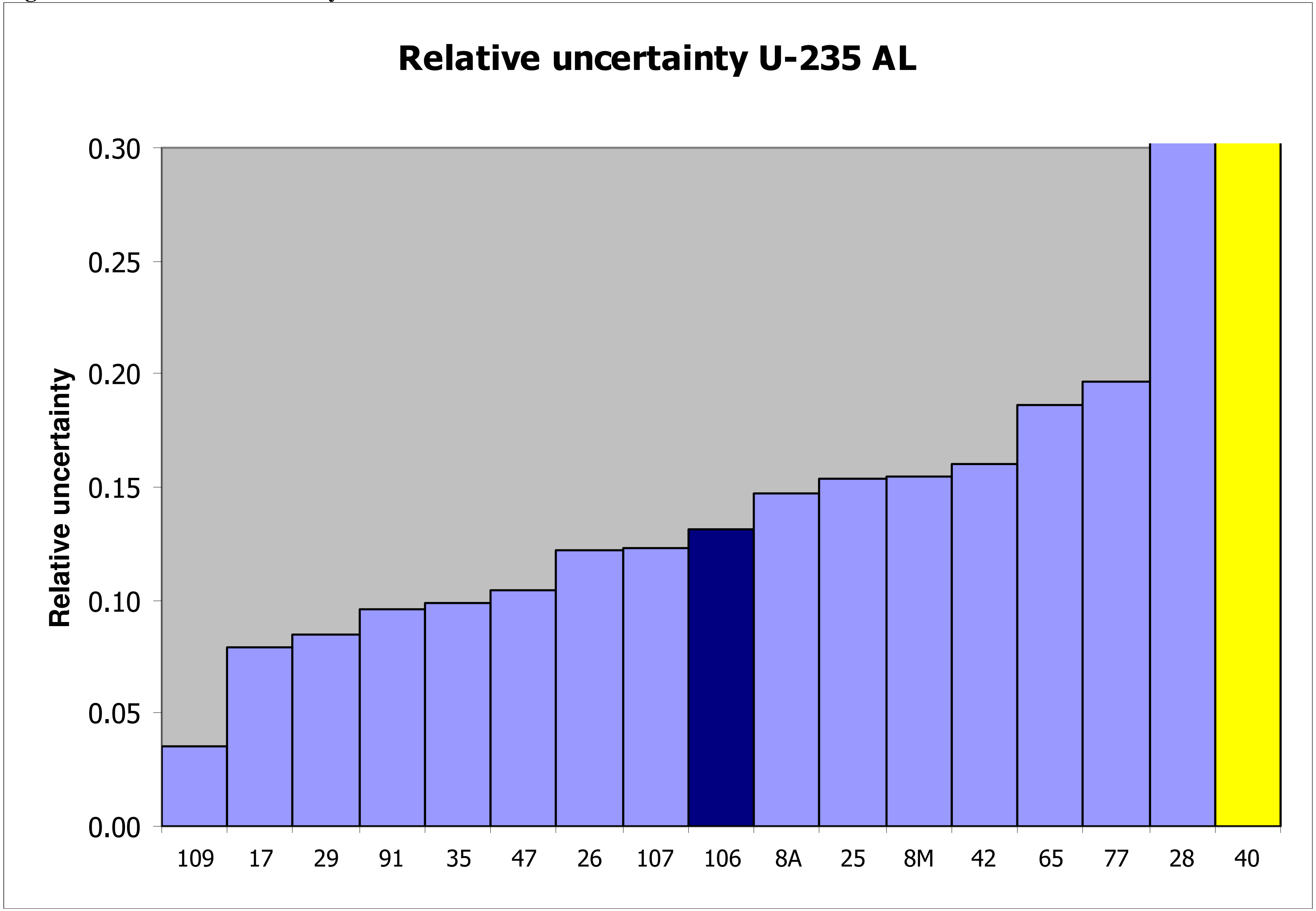


**Figure 3D – Kiri plot U-235 AL**

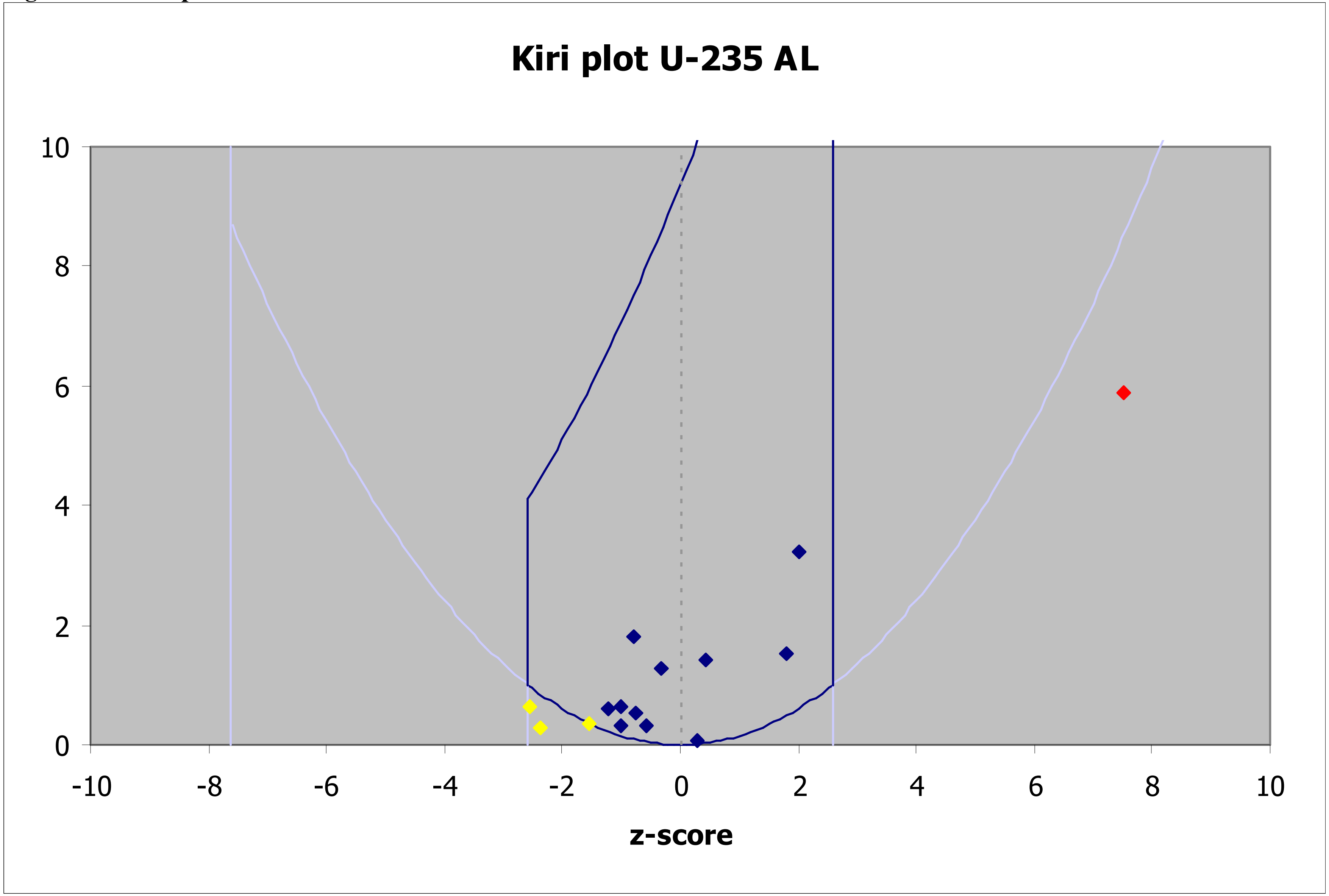


**Figure 4A – Deviation U-238 AL**

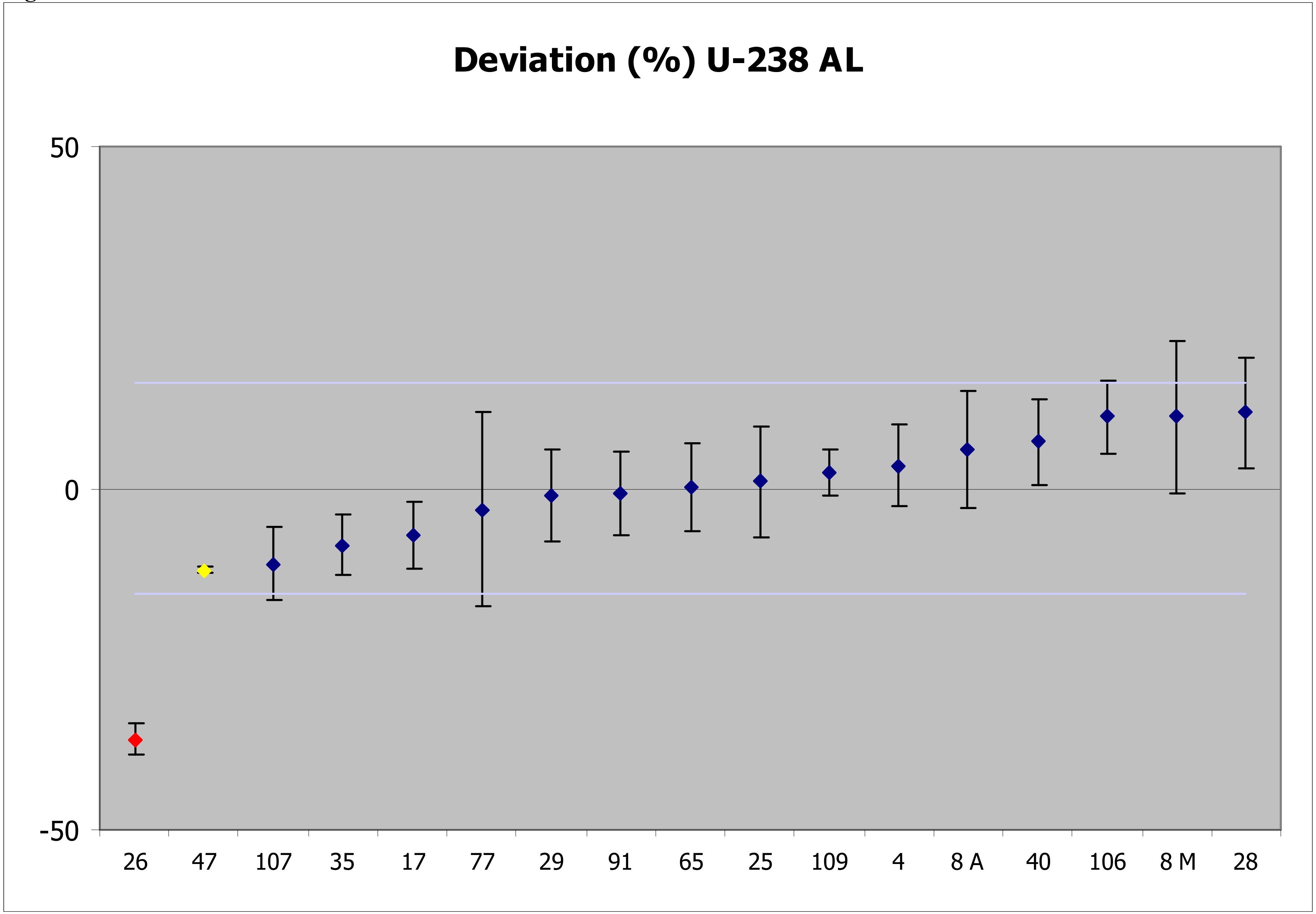


**Figure 4B – Zeta score U-238 AL**

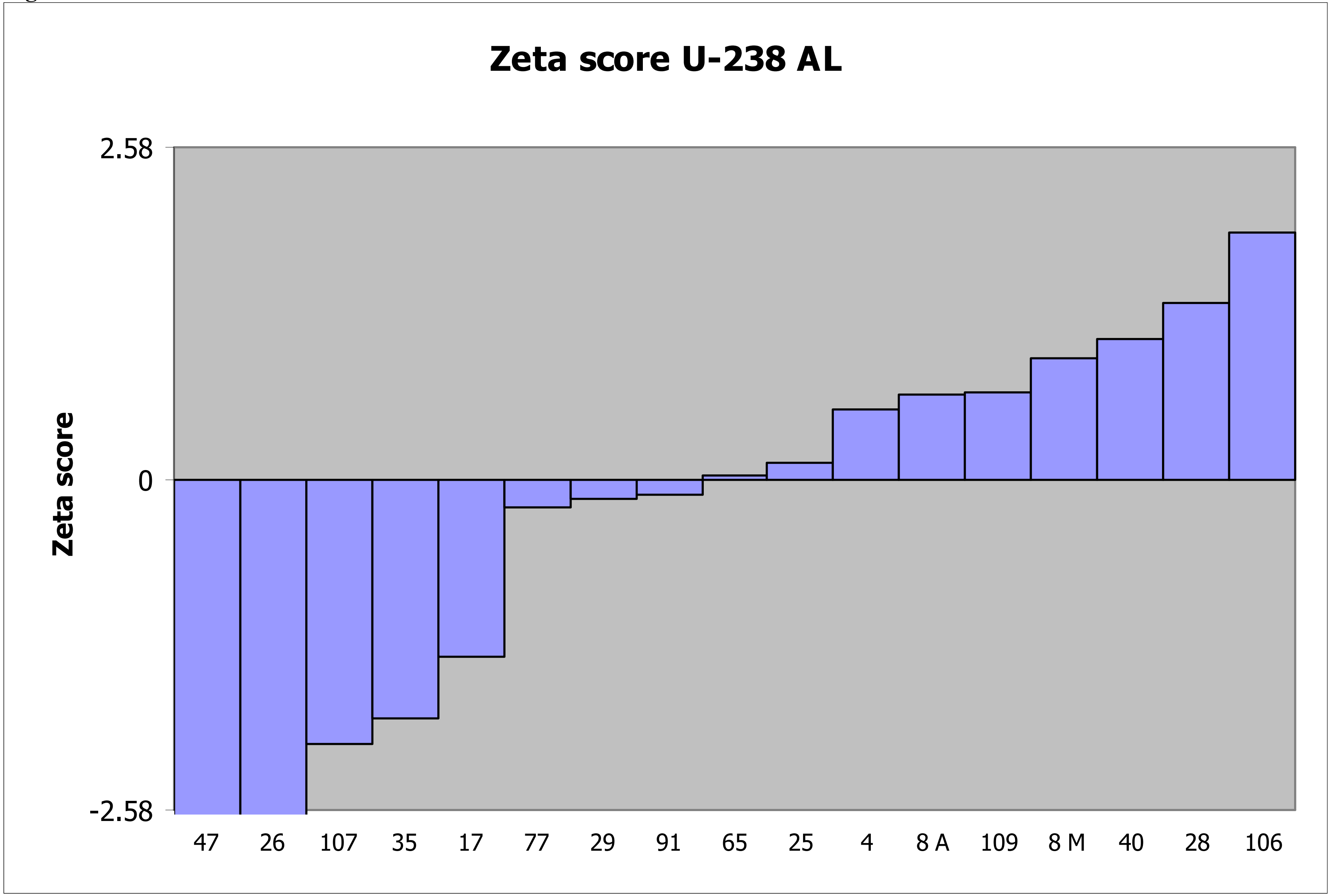


**Figure 4C – Relative uncertainty U-238 AL**

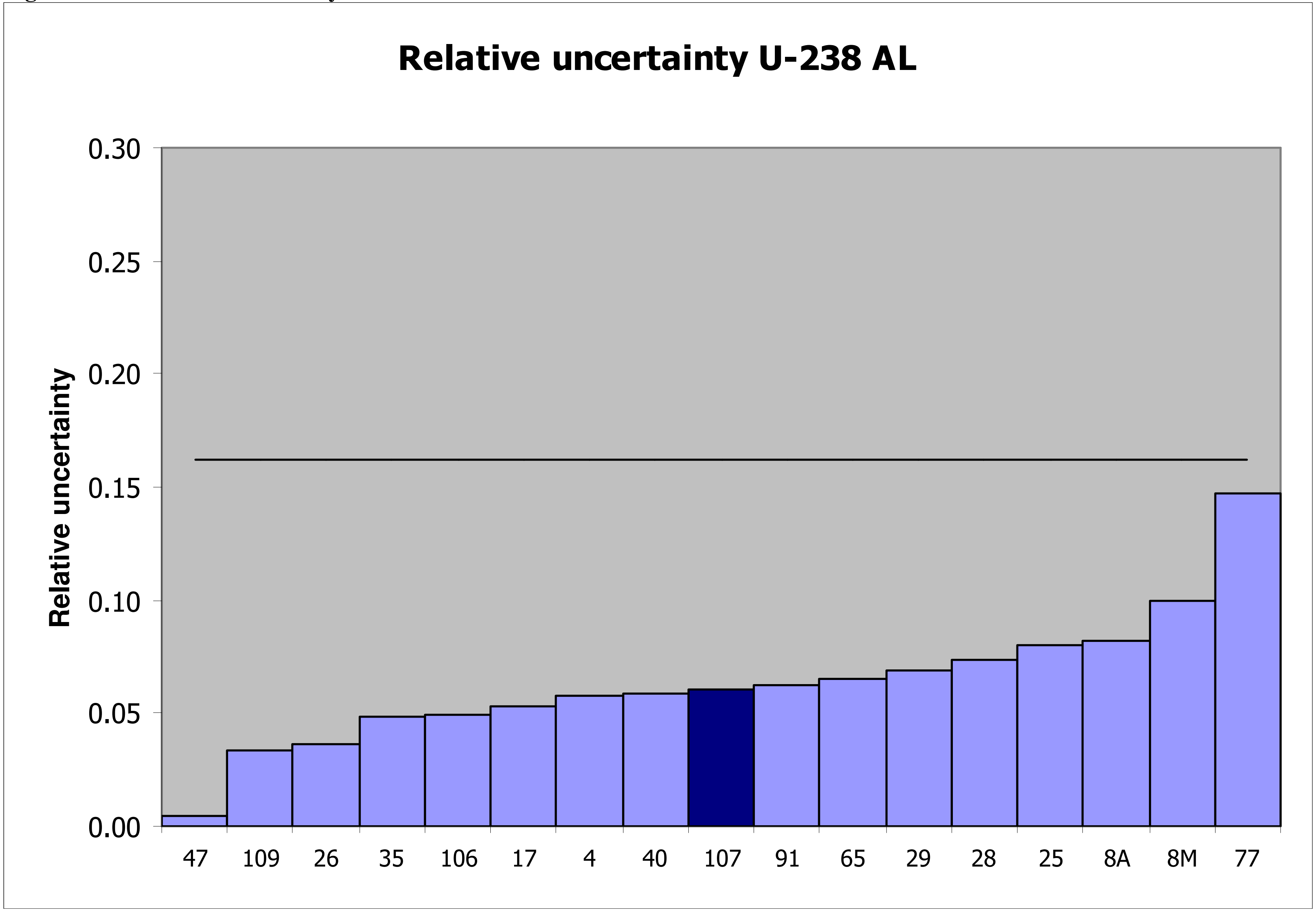


**Figure 4D – Kiri plot U-238 AL**

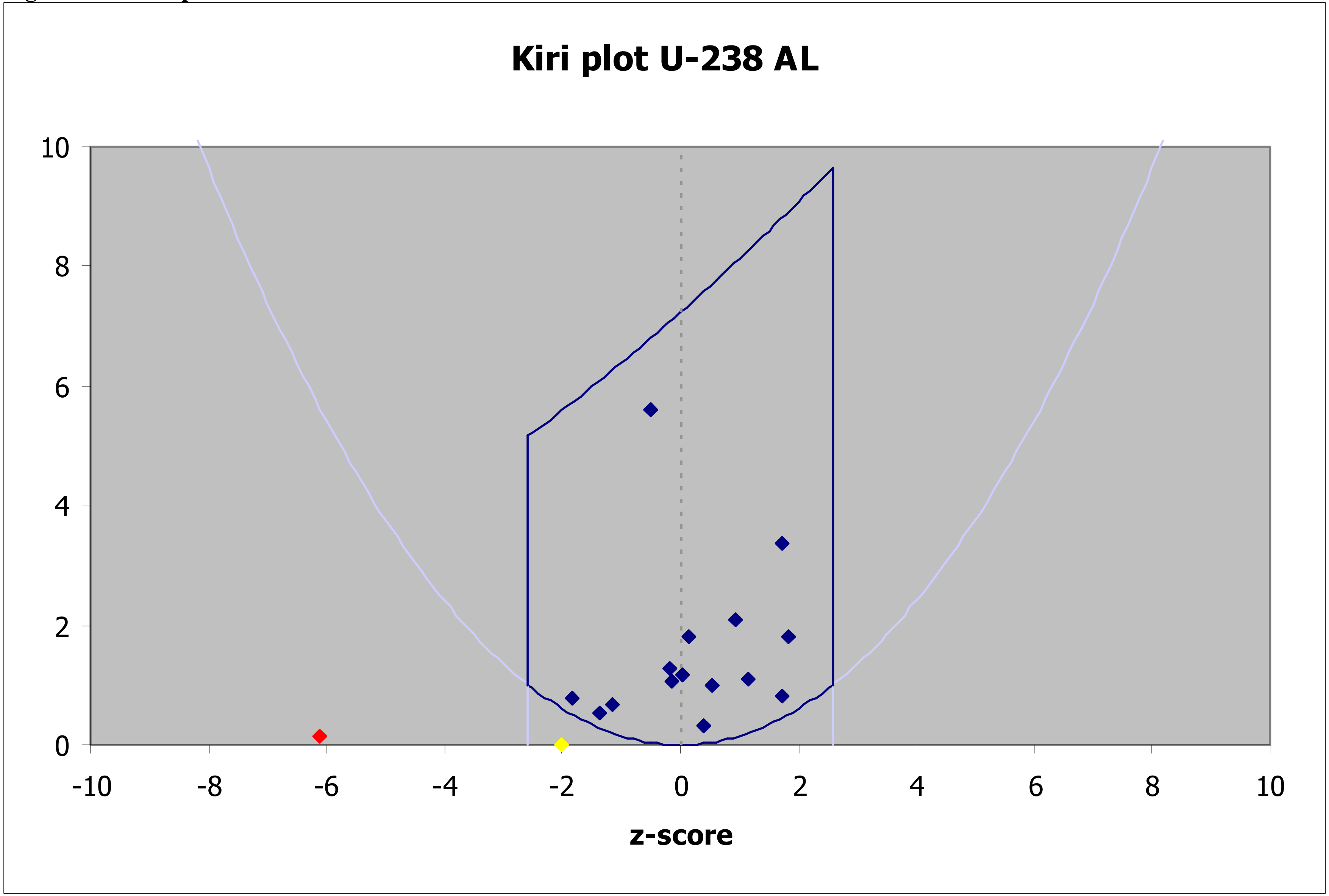


**Figure 5A – Deviation Np-237 AL**

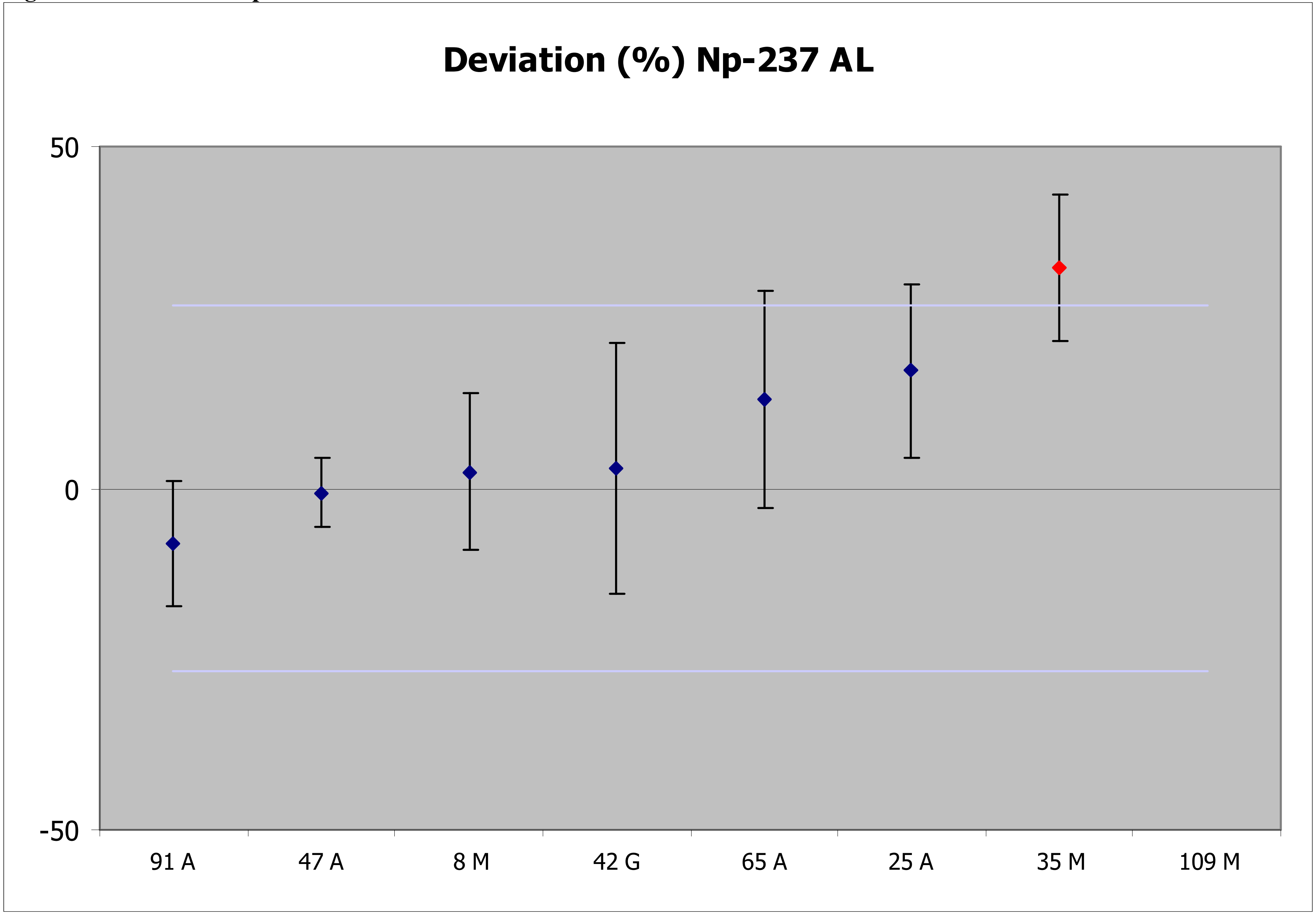


**Figure 5B – Zeta score Np-237 AL**

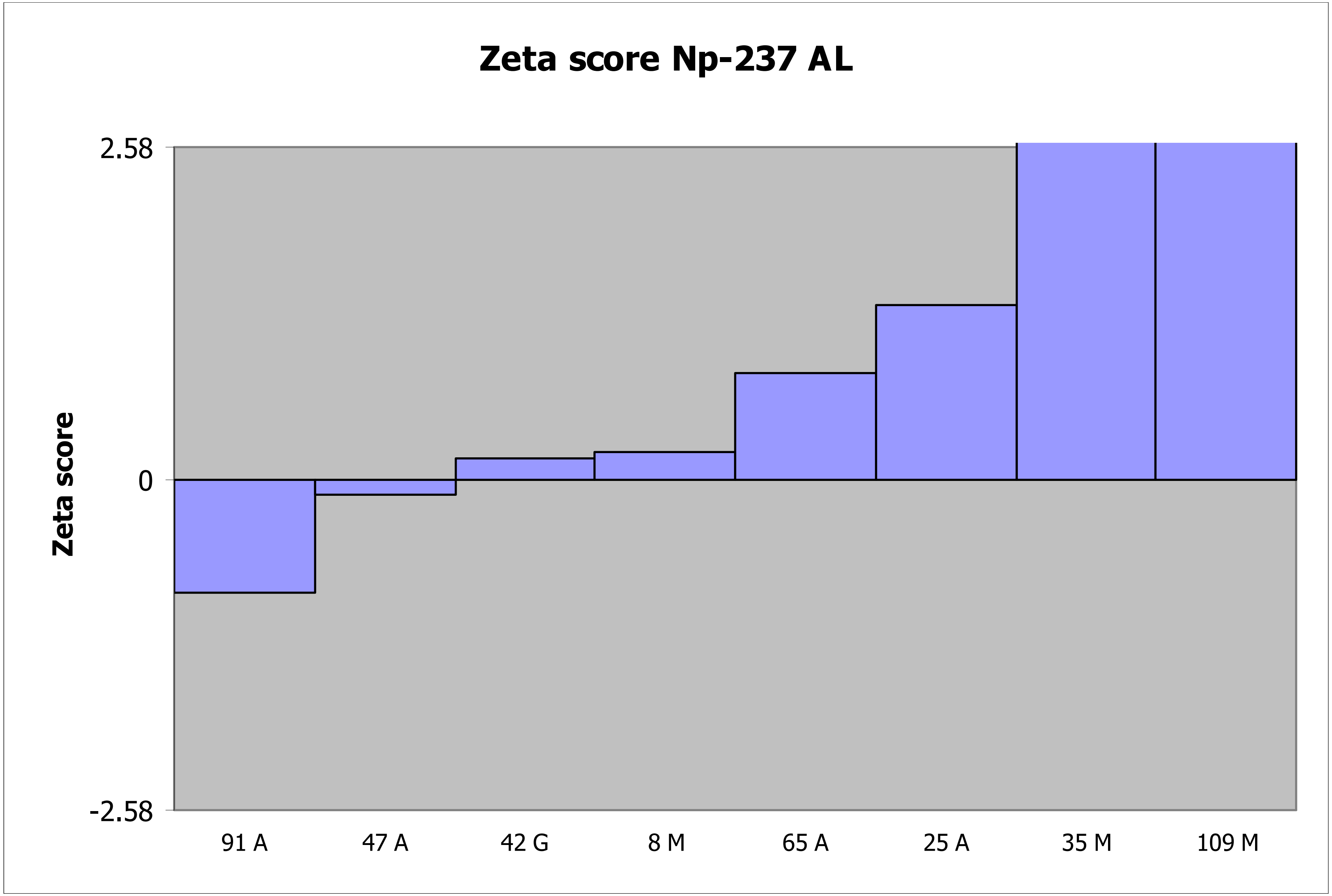


**Figure 5C – Relative uncertainty Np-237 AL**

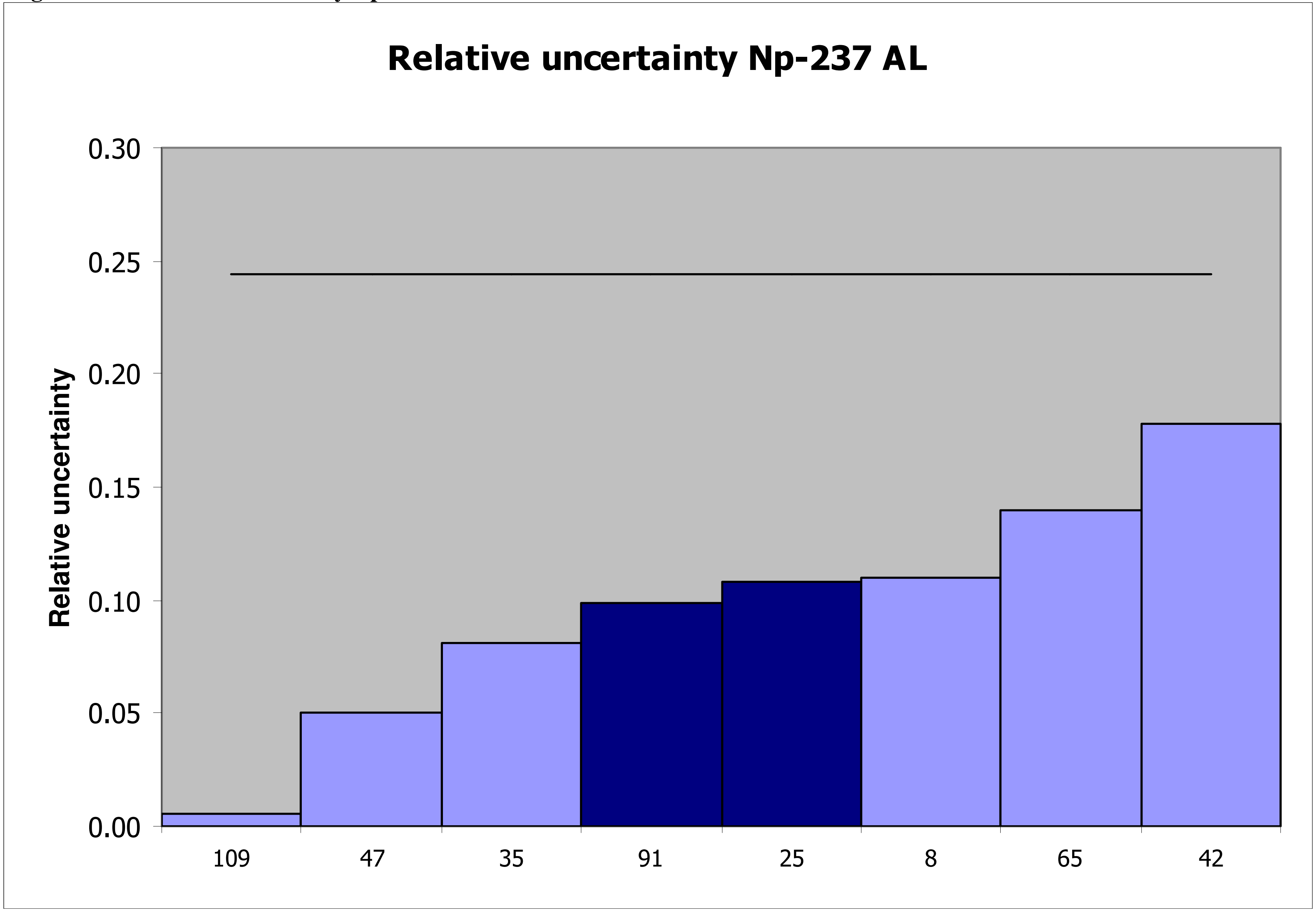


**Figure 5D – Kiri plot Np-237 AL**

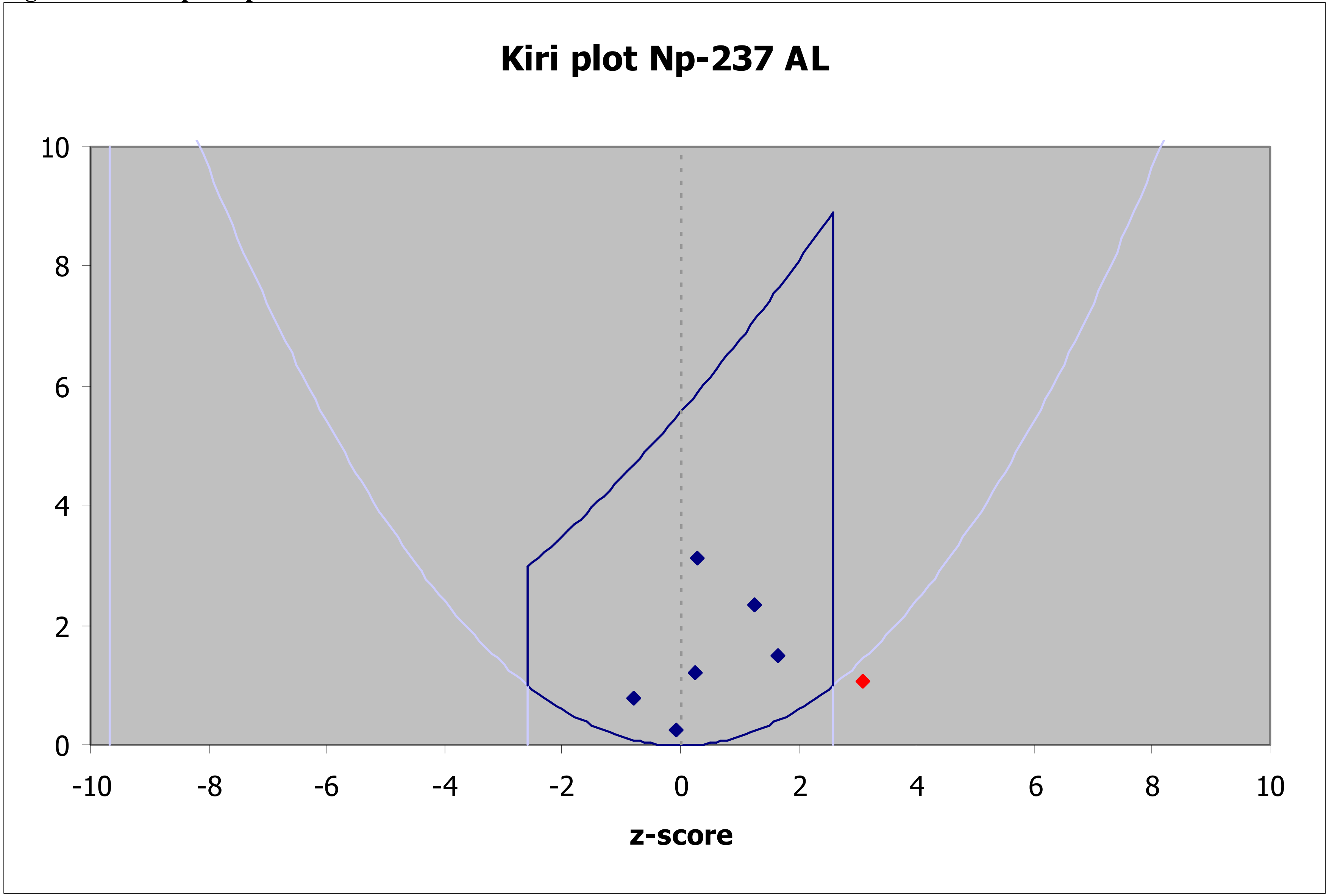


**Figure 6A – Deviation Pu-238 AL**

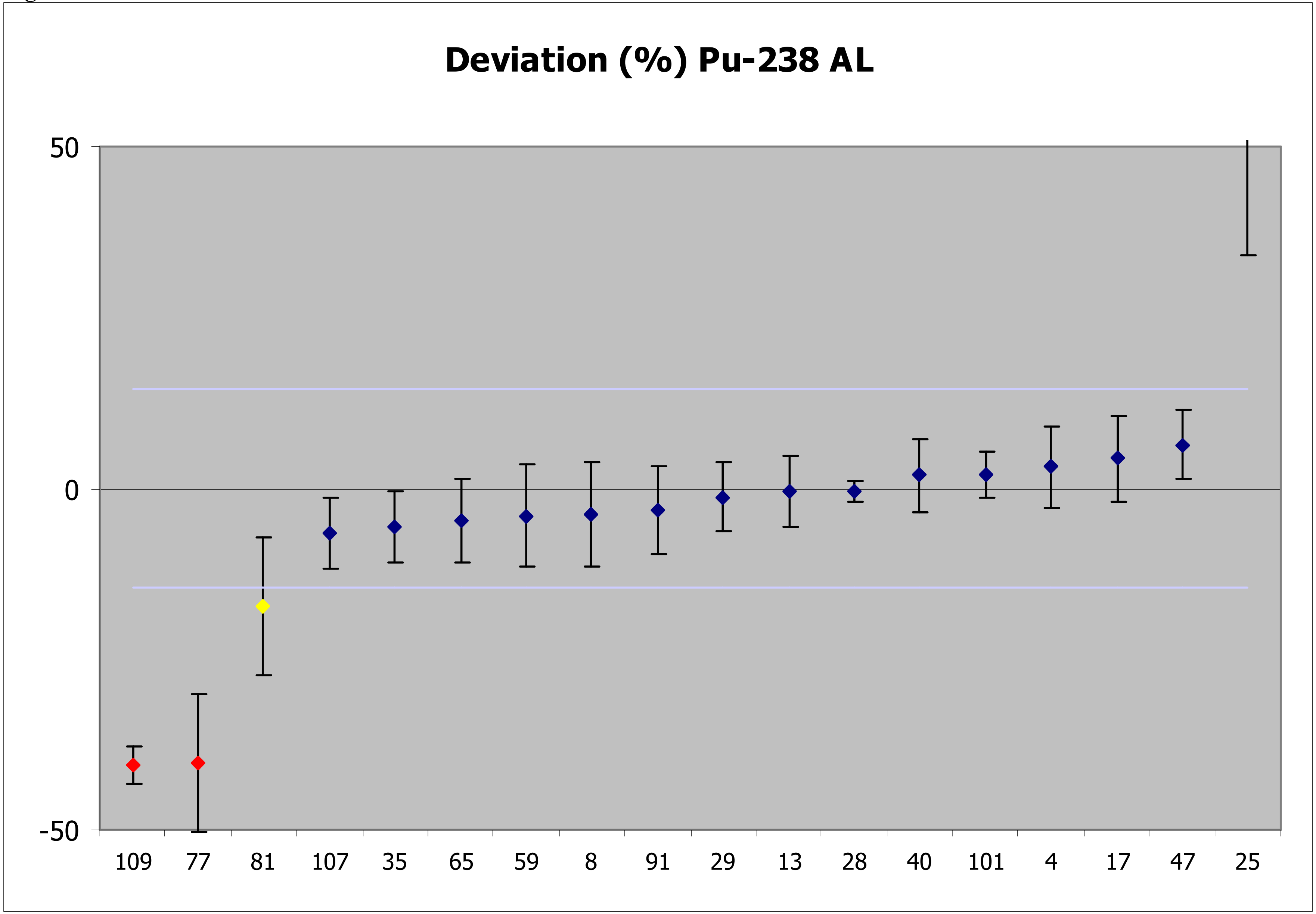


**Figure 6B – Zeta score Pu-238 AL**

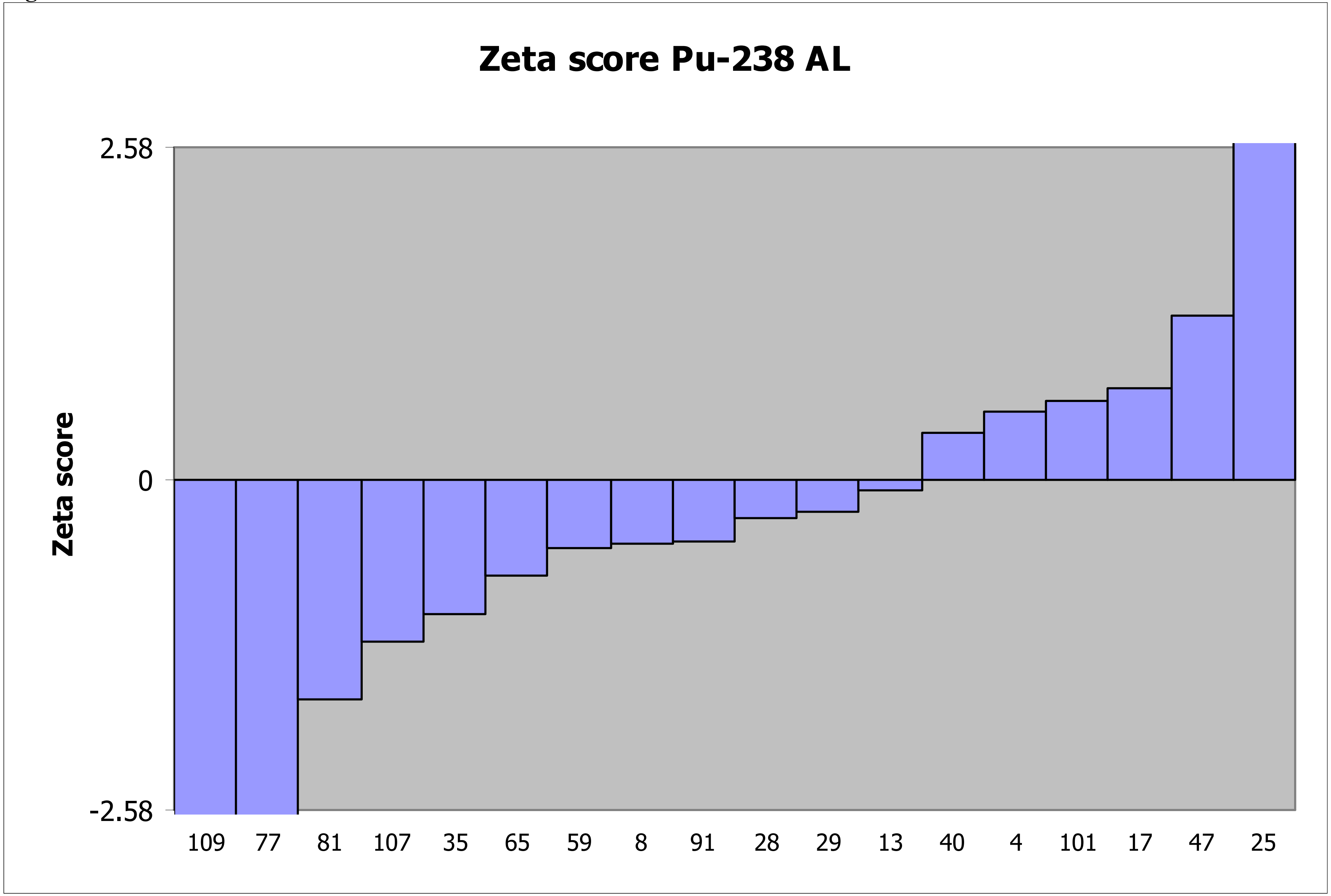


**Figure 6C – Relative uncertainty Pu-238 AL**

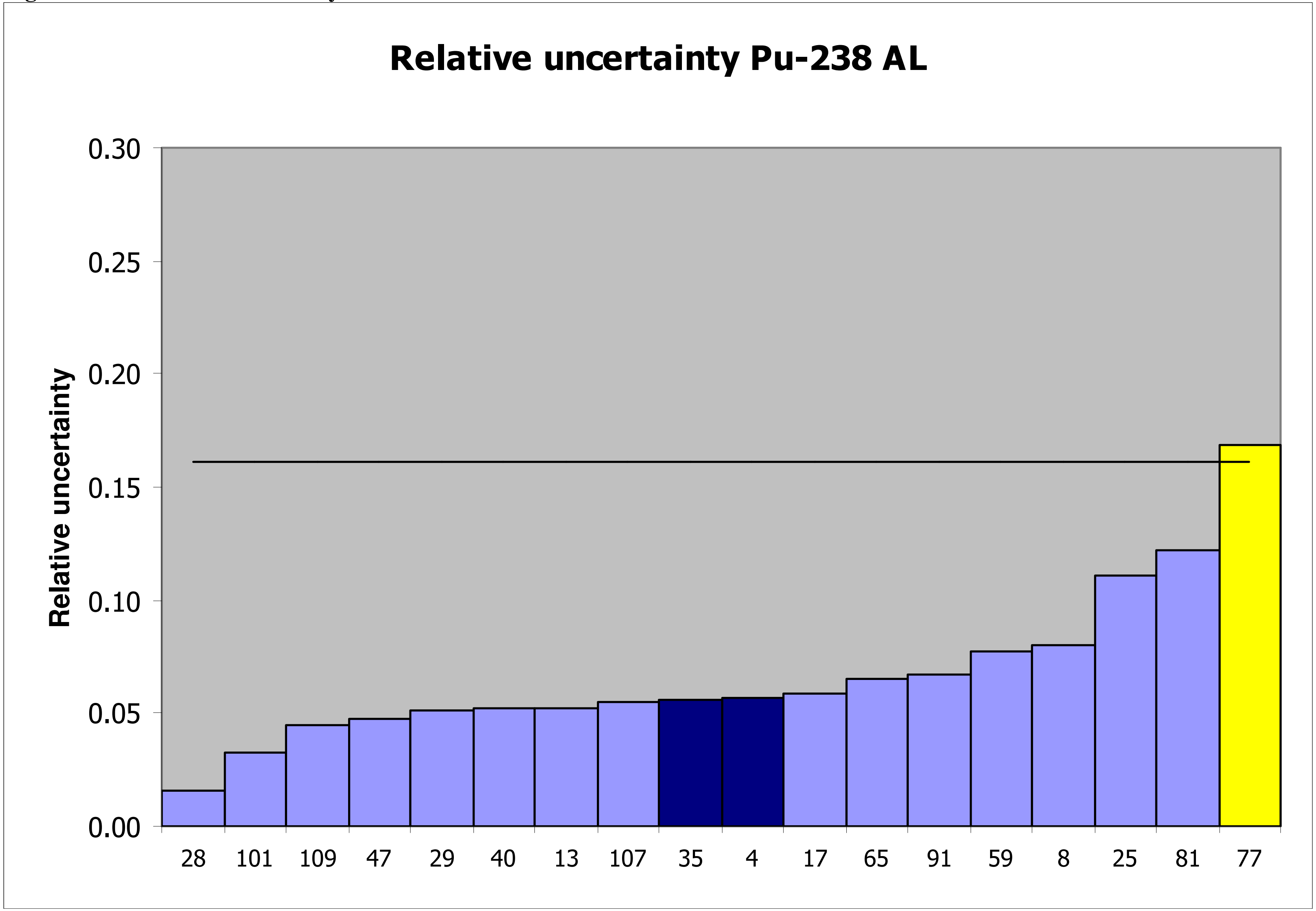


**Figure 6D – Kiri plot Pu-238 AL**

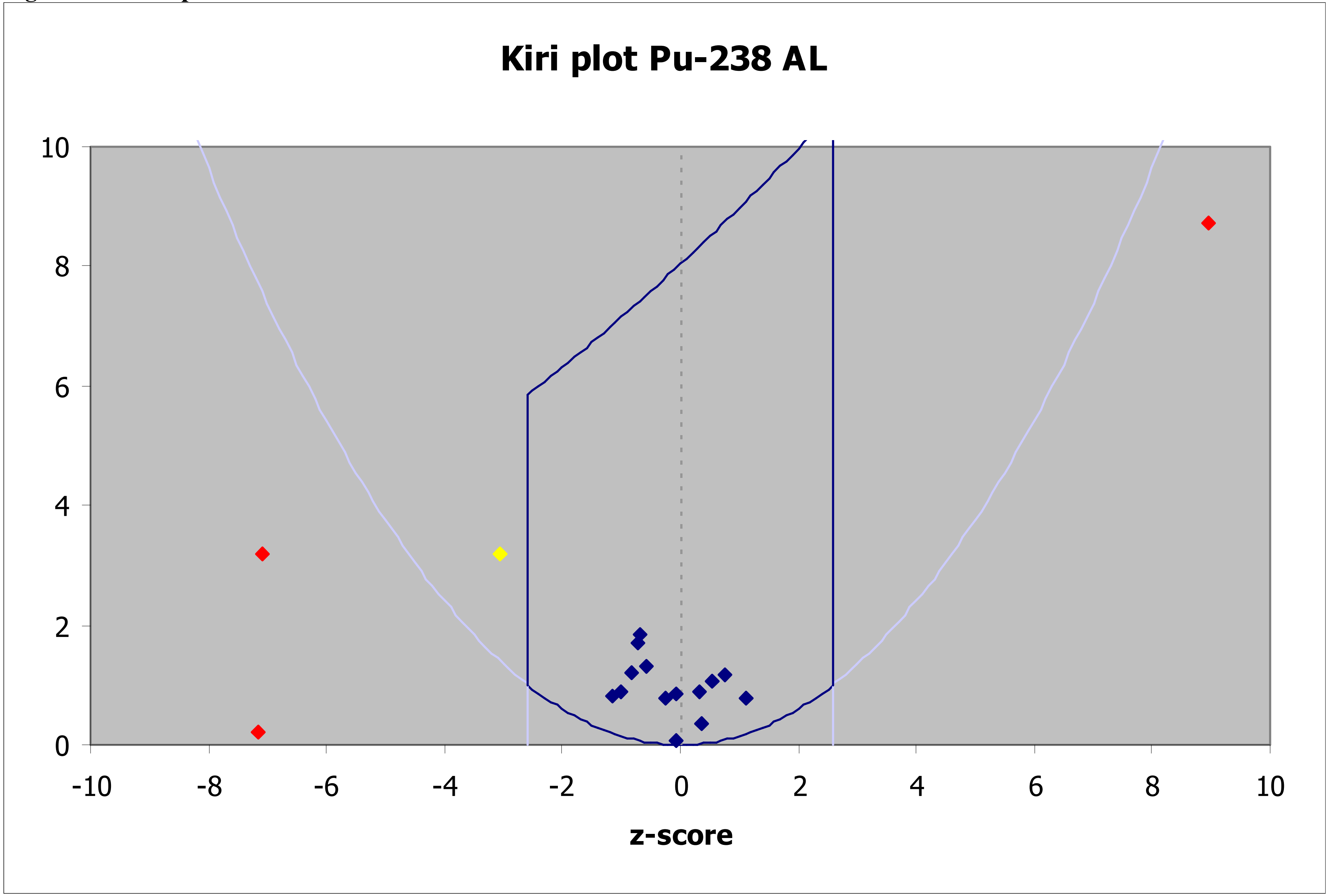


**Figure 7A – Deviation Pu-239 AL**

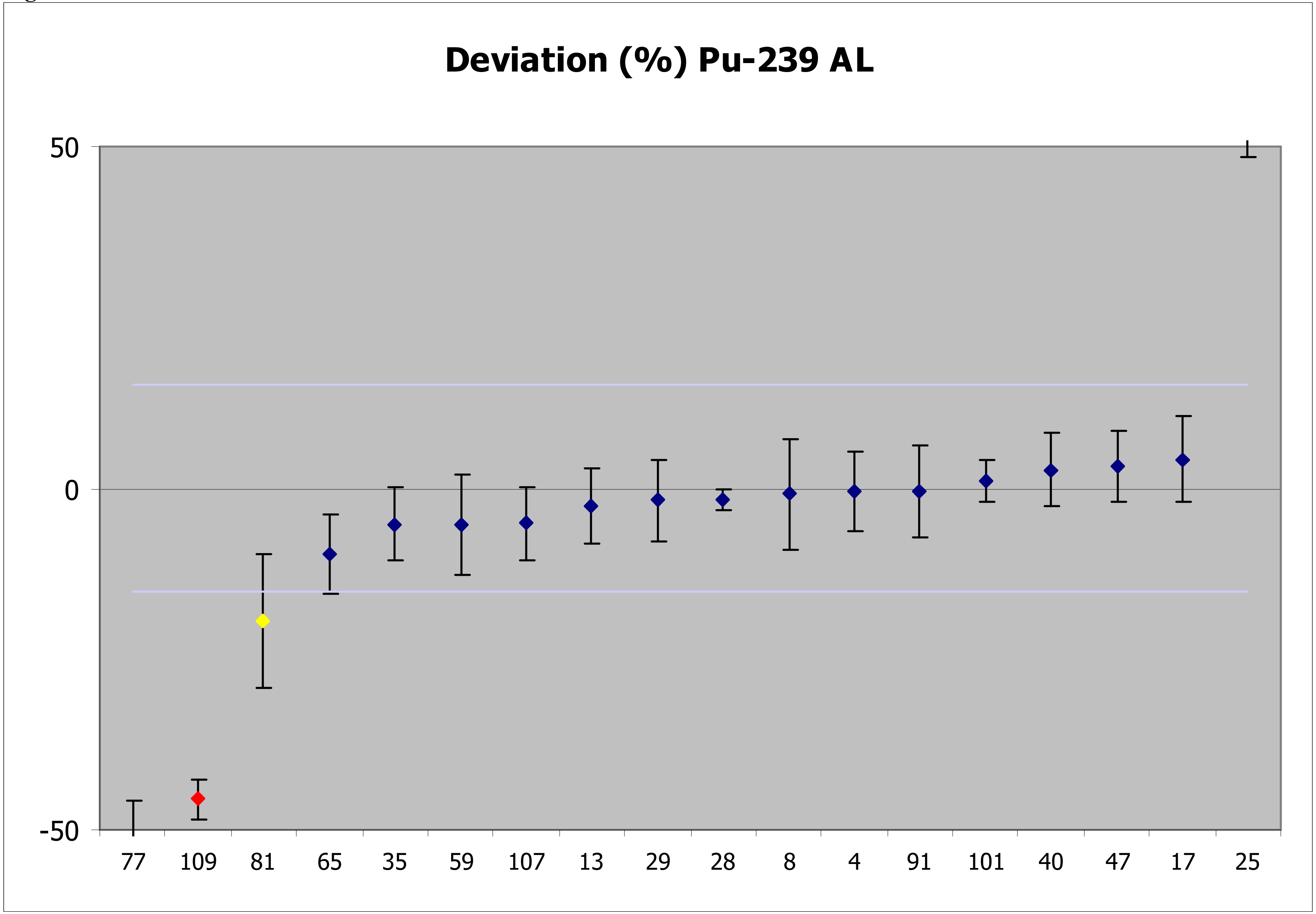


**Figure 7B – Zeta score Pu-239 AL**

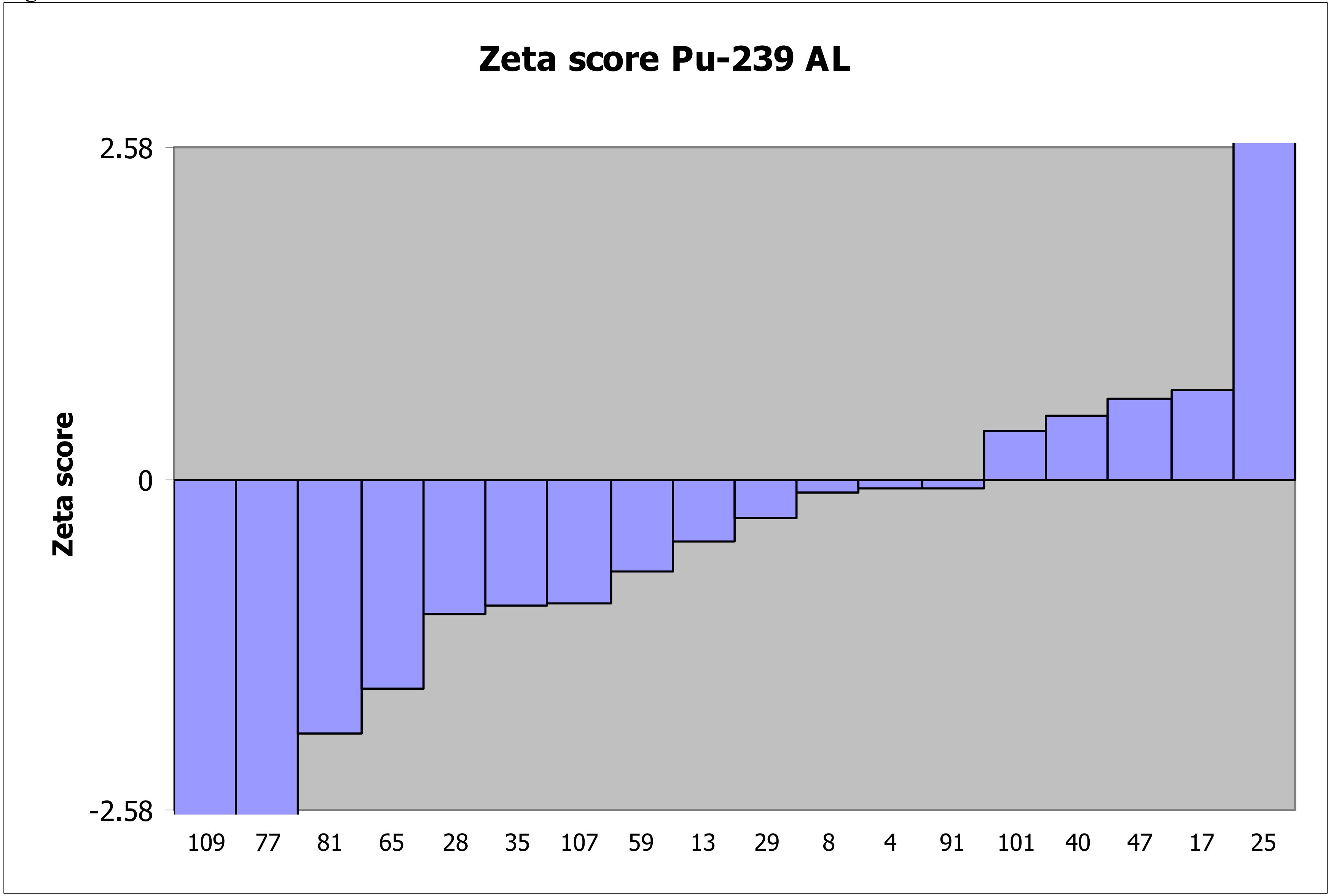


**Figure 7C – Relative uncertainty Pu-239 AL**

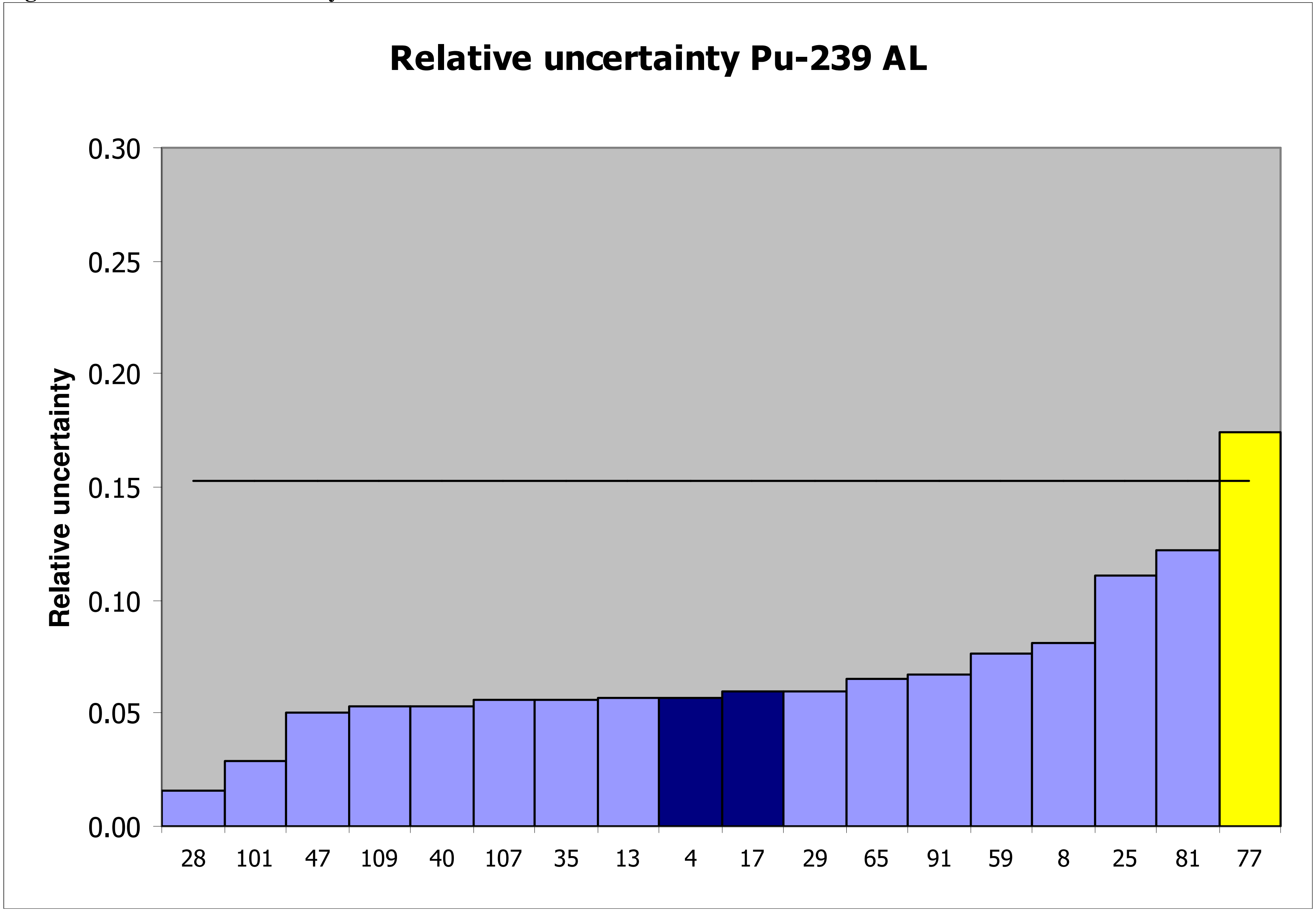


**Figure 7D – Kiri plot Pu-239 AL**

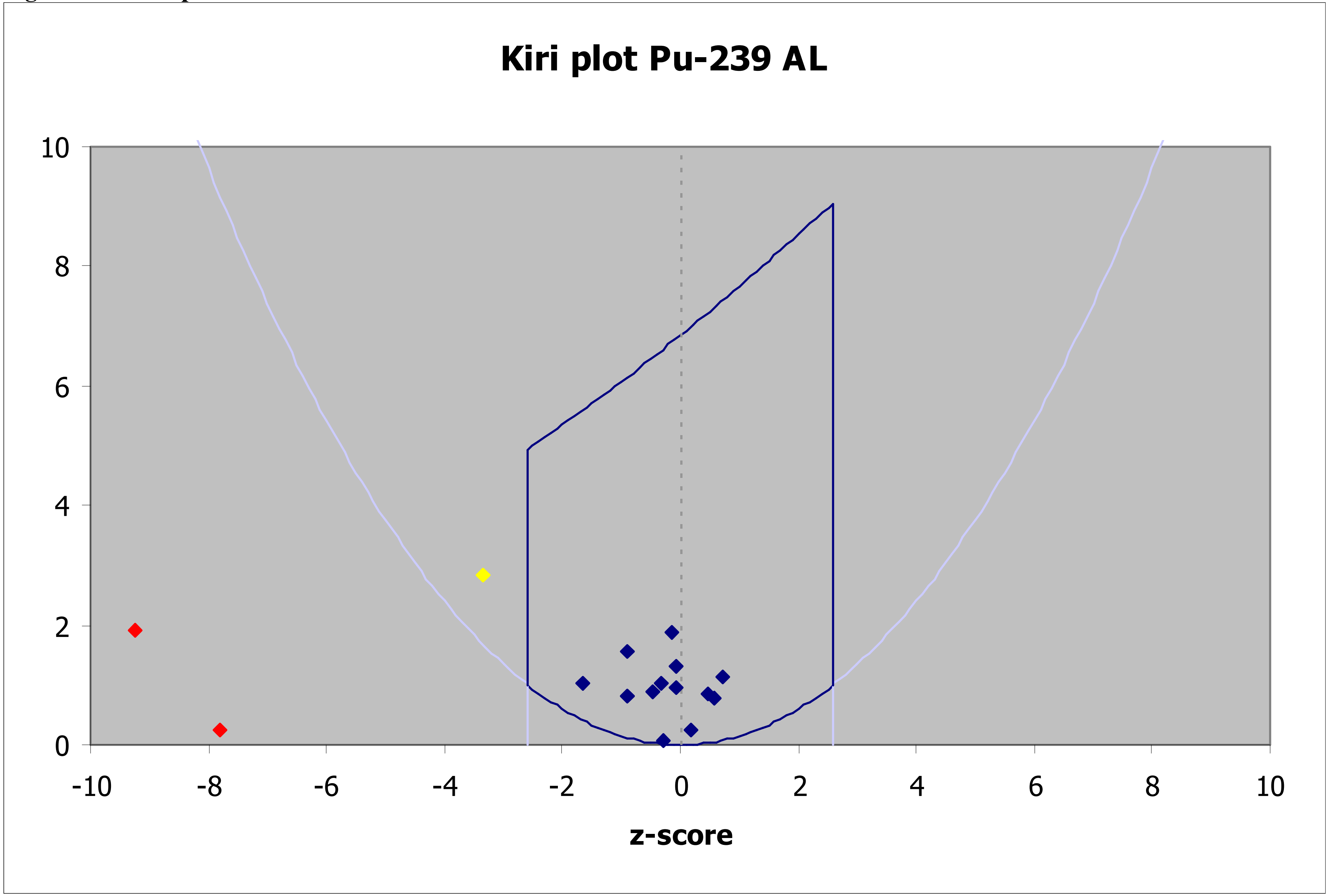


**Figure 8A – Deviation Am-241 AL**

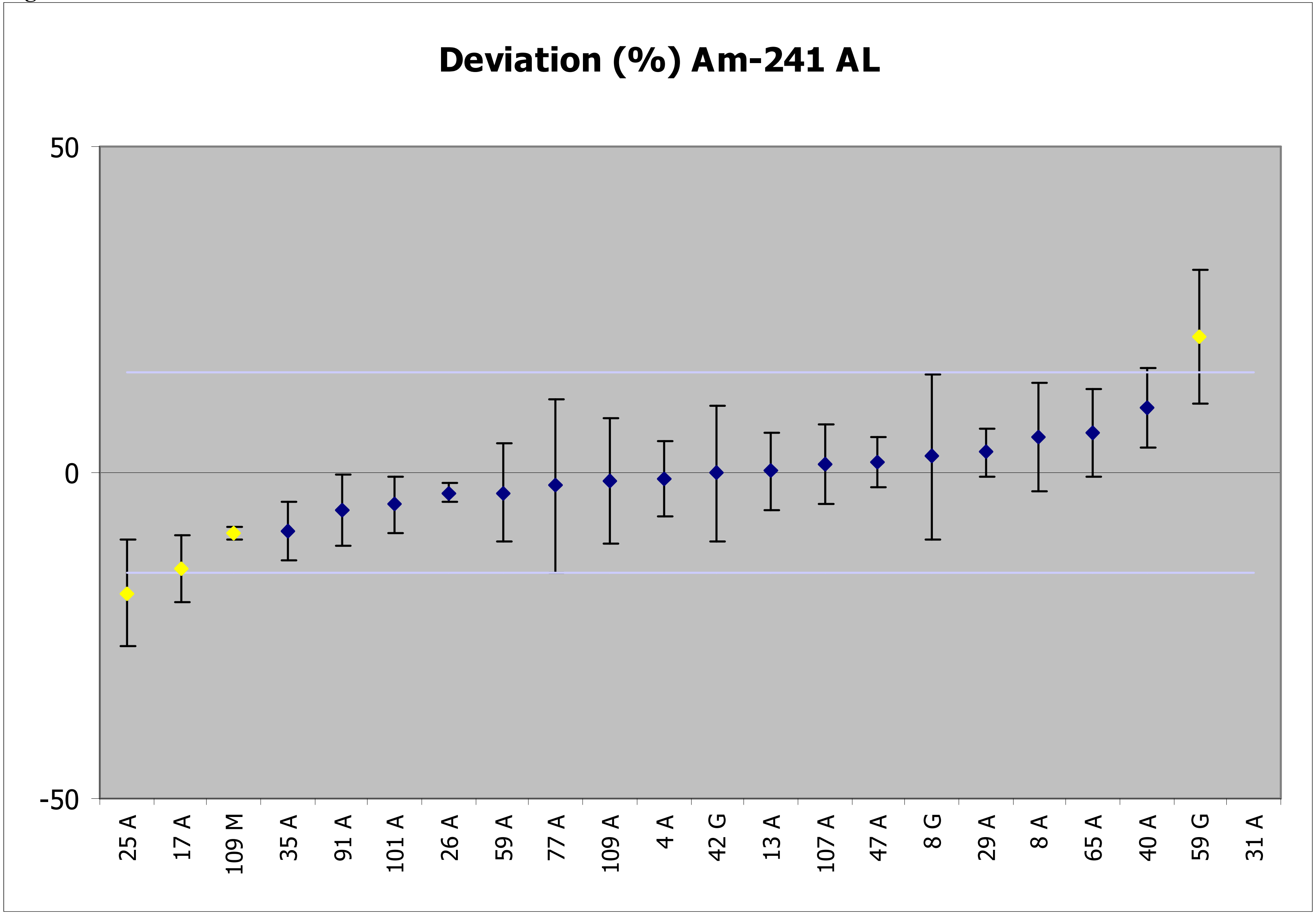


**Figure 8B – Zeta score Am-241 AL**

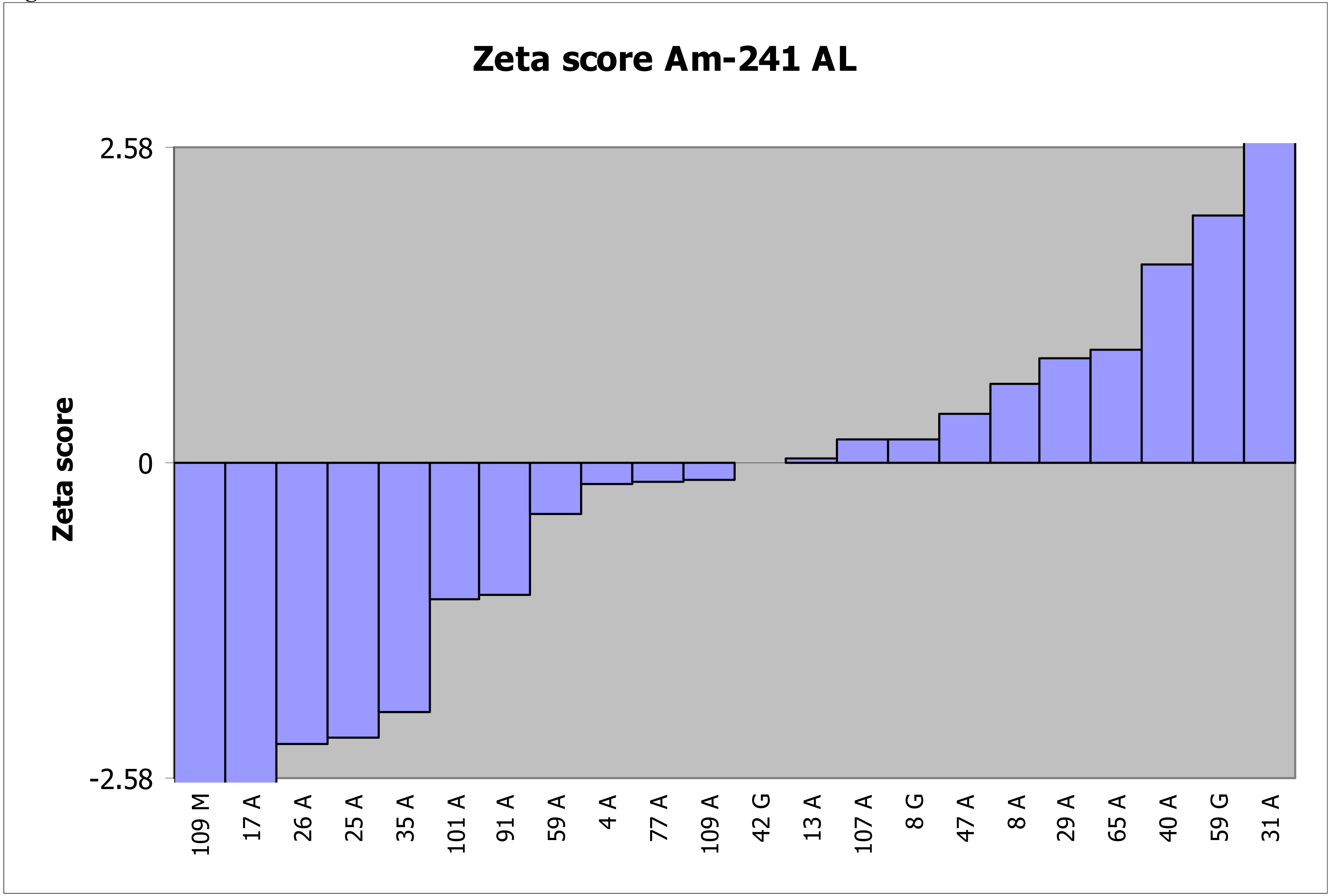


**Figure 8C – Relative uncertainty Am-241 AL**

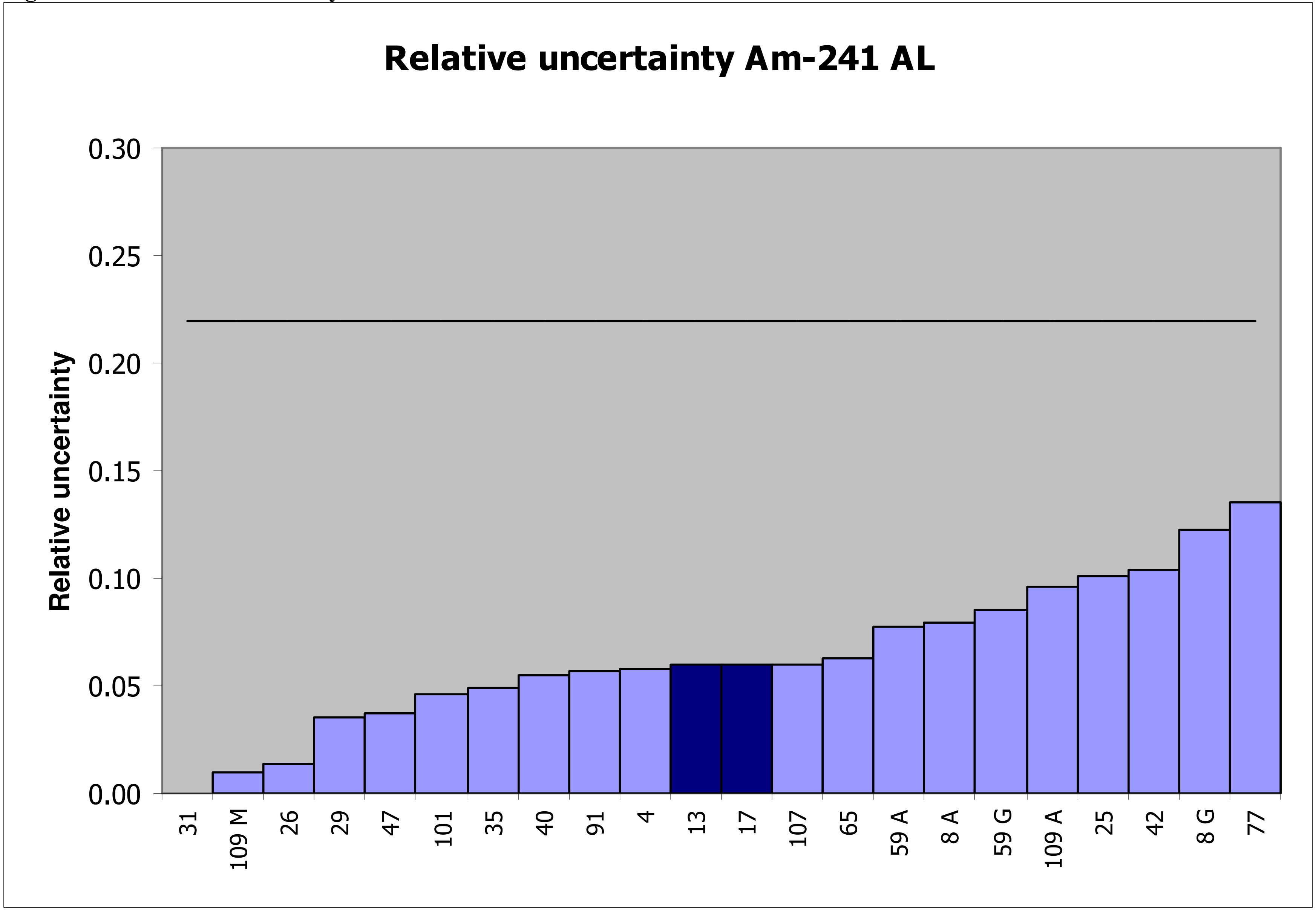


**Figure 8D – Kiri plot Am-241 AL**

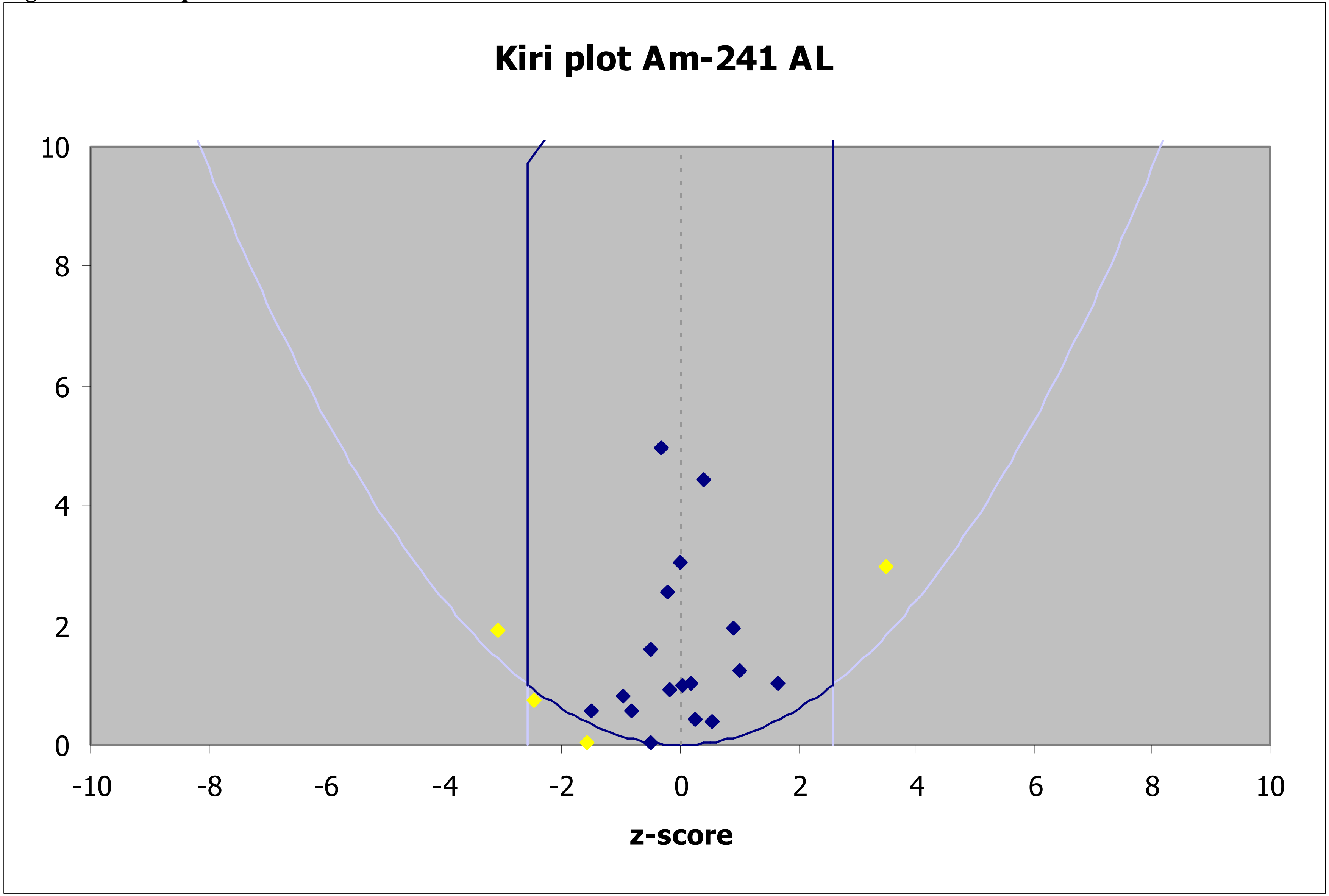


**Figure 9A – Deviation Cm-244 AL**

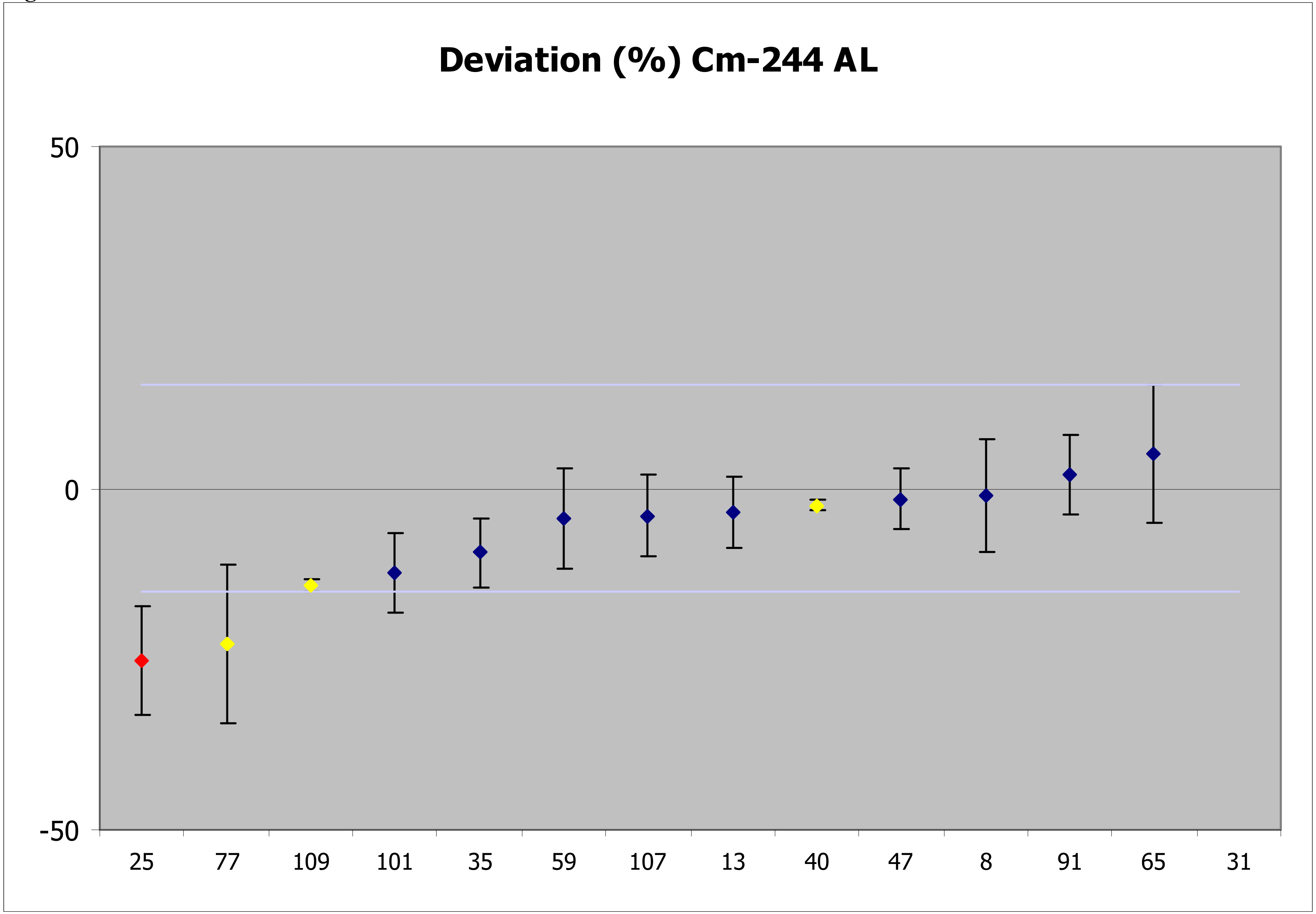


**Figure 9B – Zeta score Cm-244 AL**

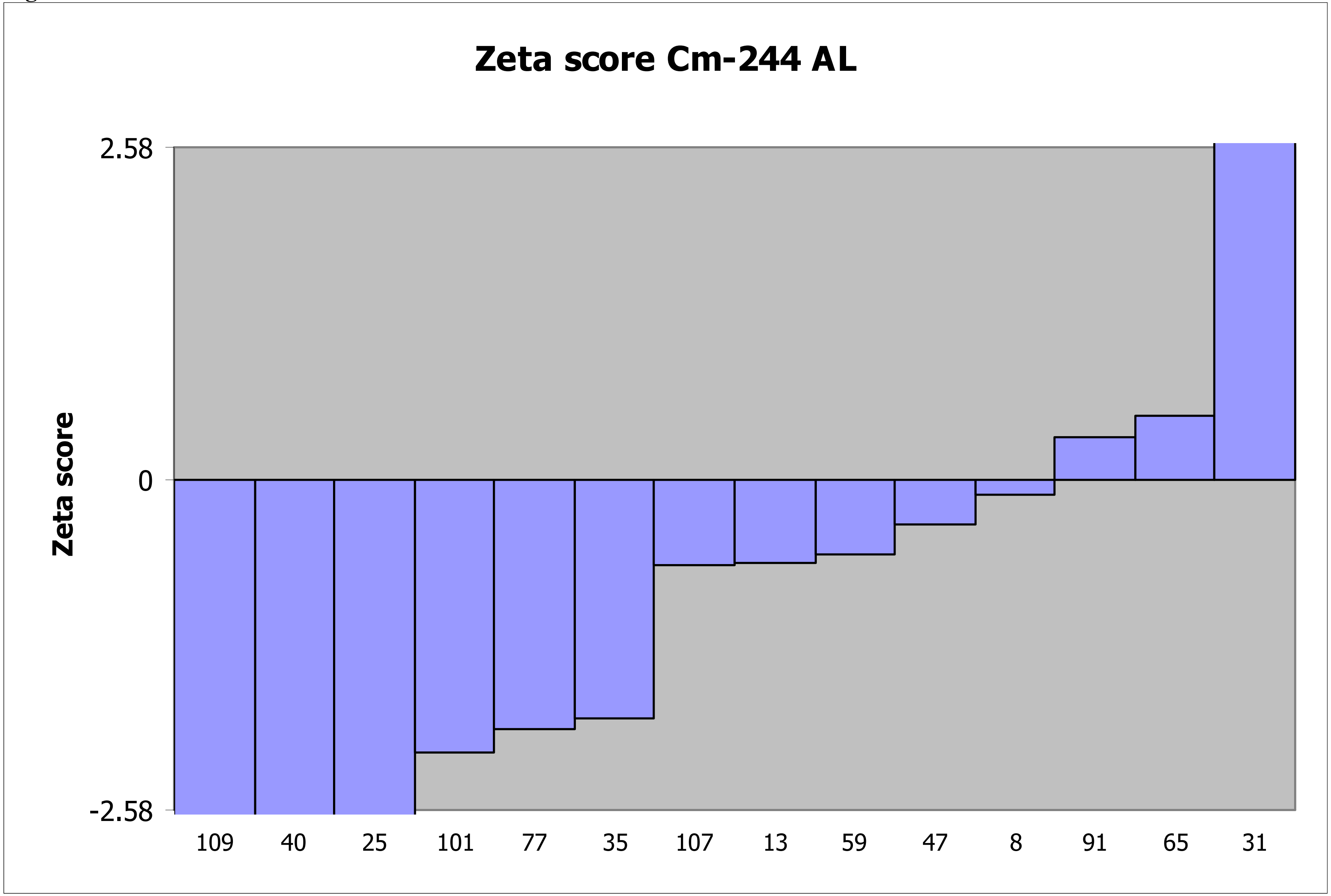


**Figure 9C – Relative uncertainty Cm-244 AL**

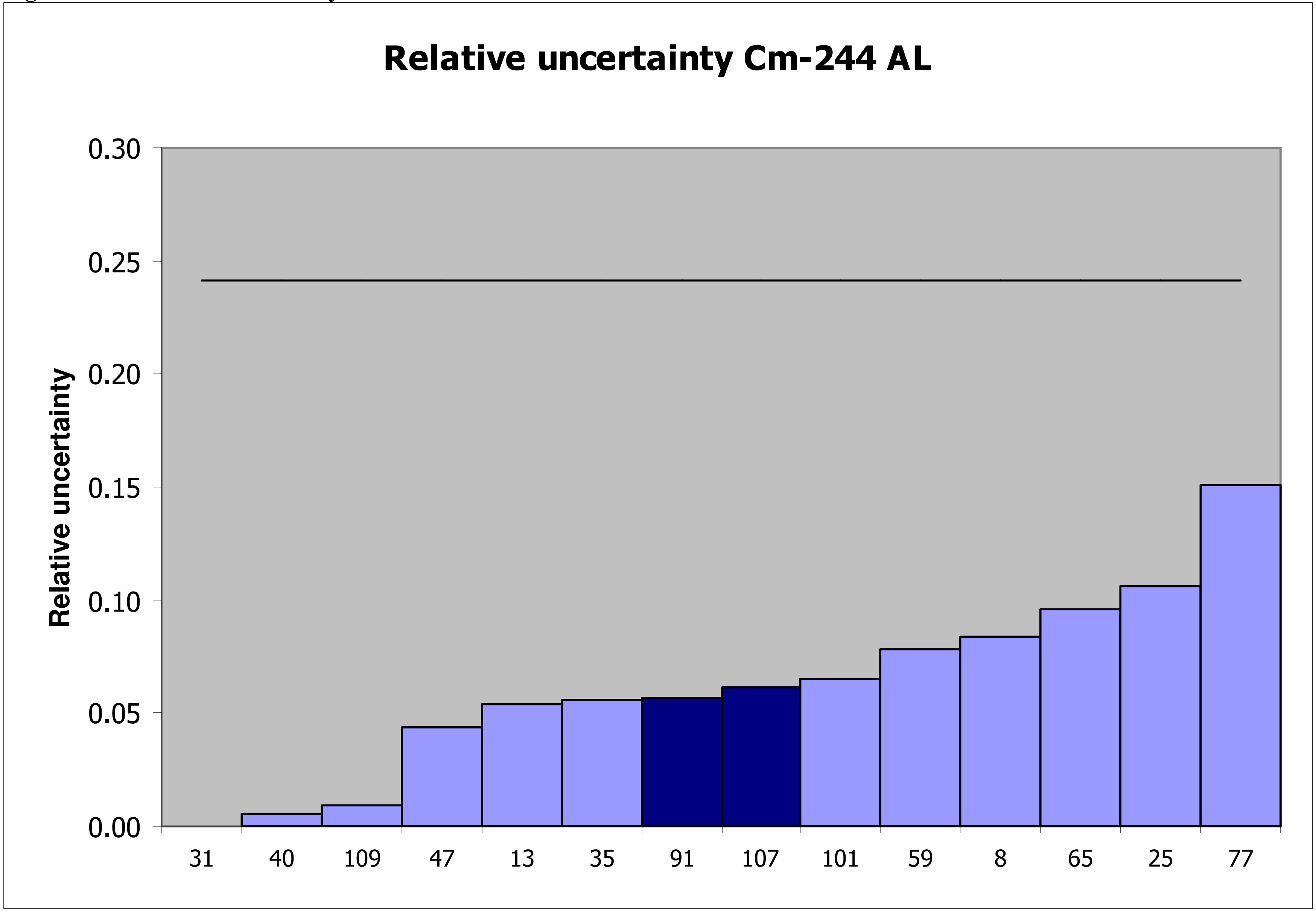


**Figure 9D – Kiri plot Cm-244 AL**

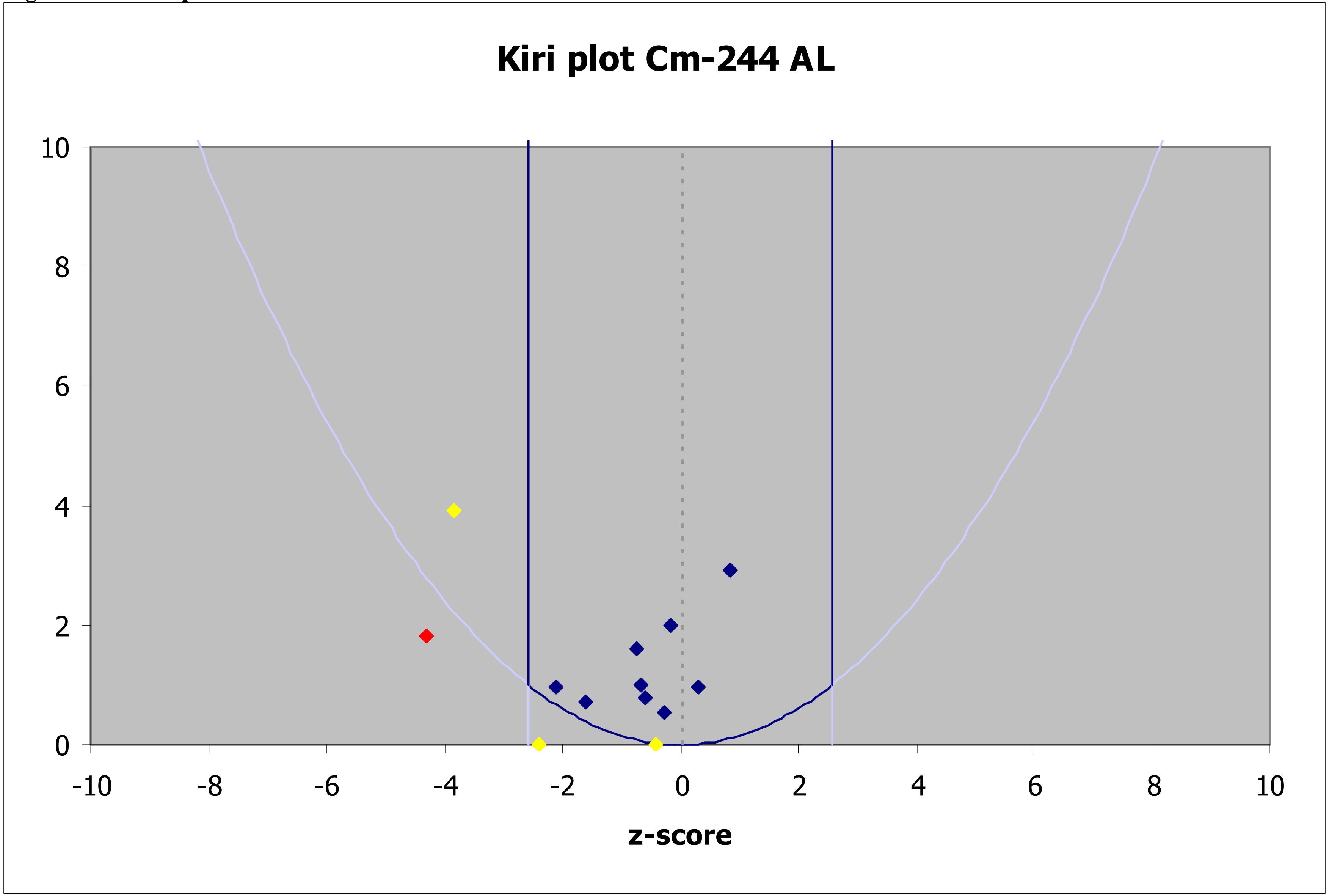


**Figure 10A – Deviation gross alpha AL**

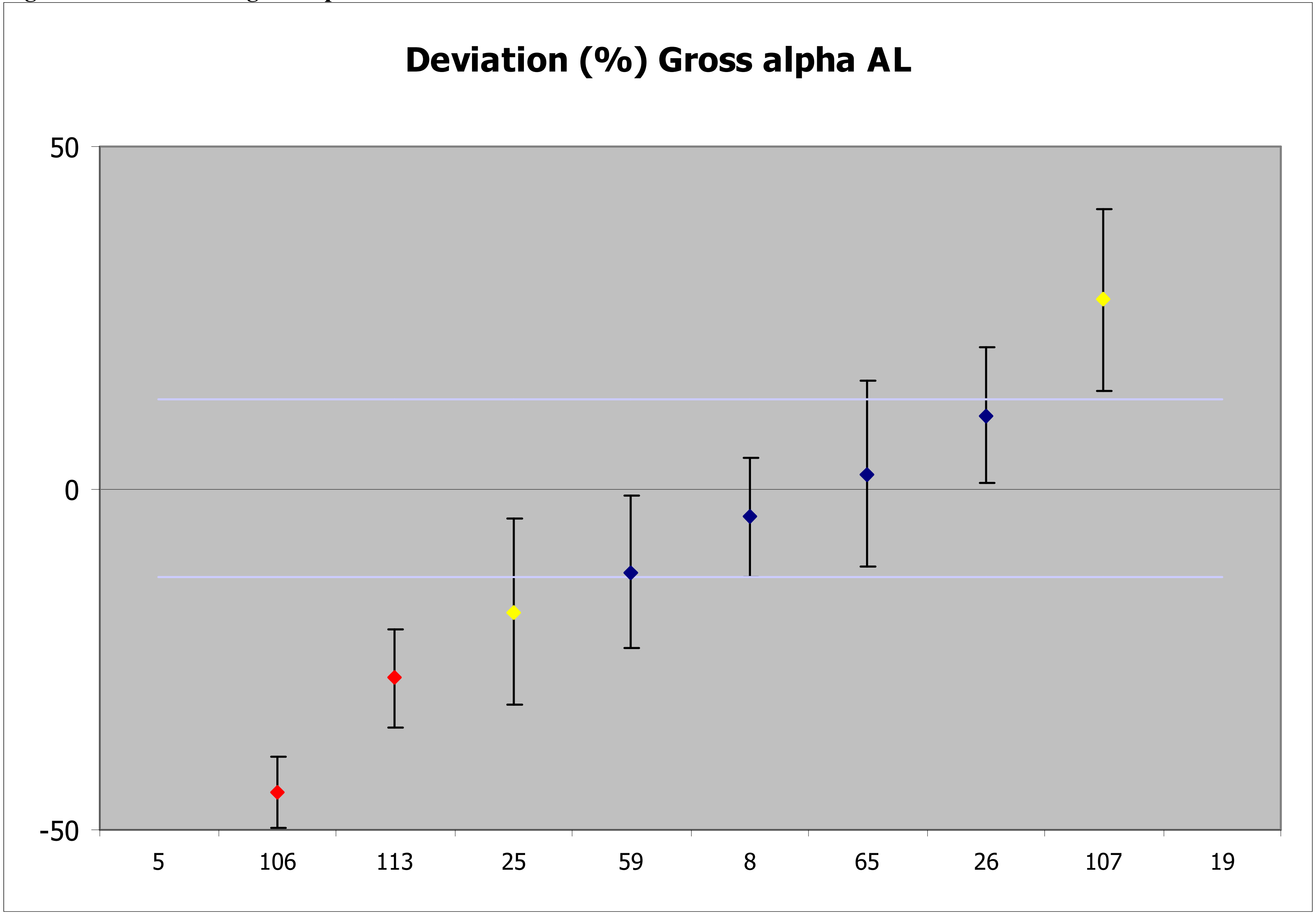


**Figure 10B – Zeta score gross alpha AL**

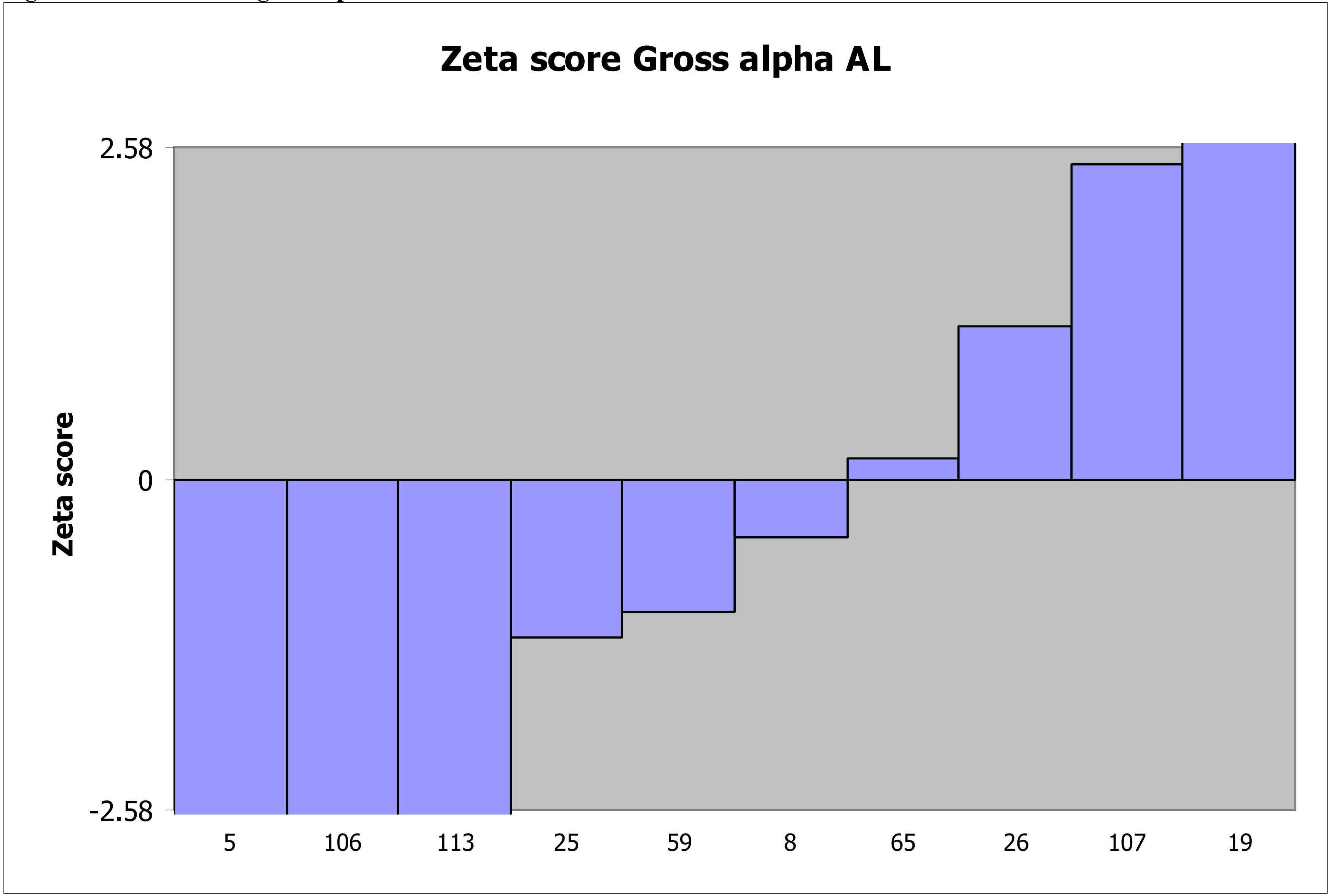


**Figure 10C – Relative uncertainty gross alpha AL**

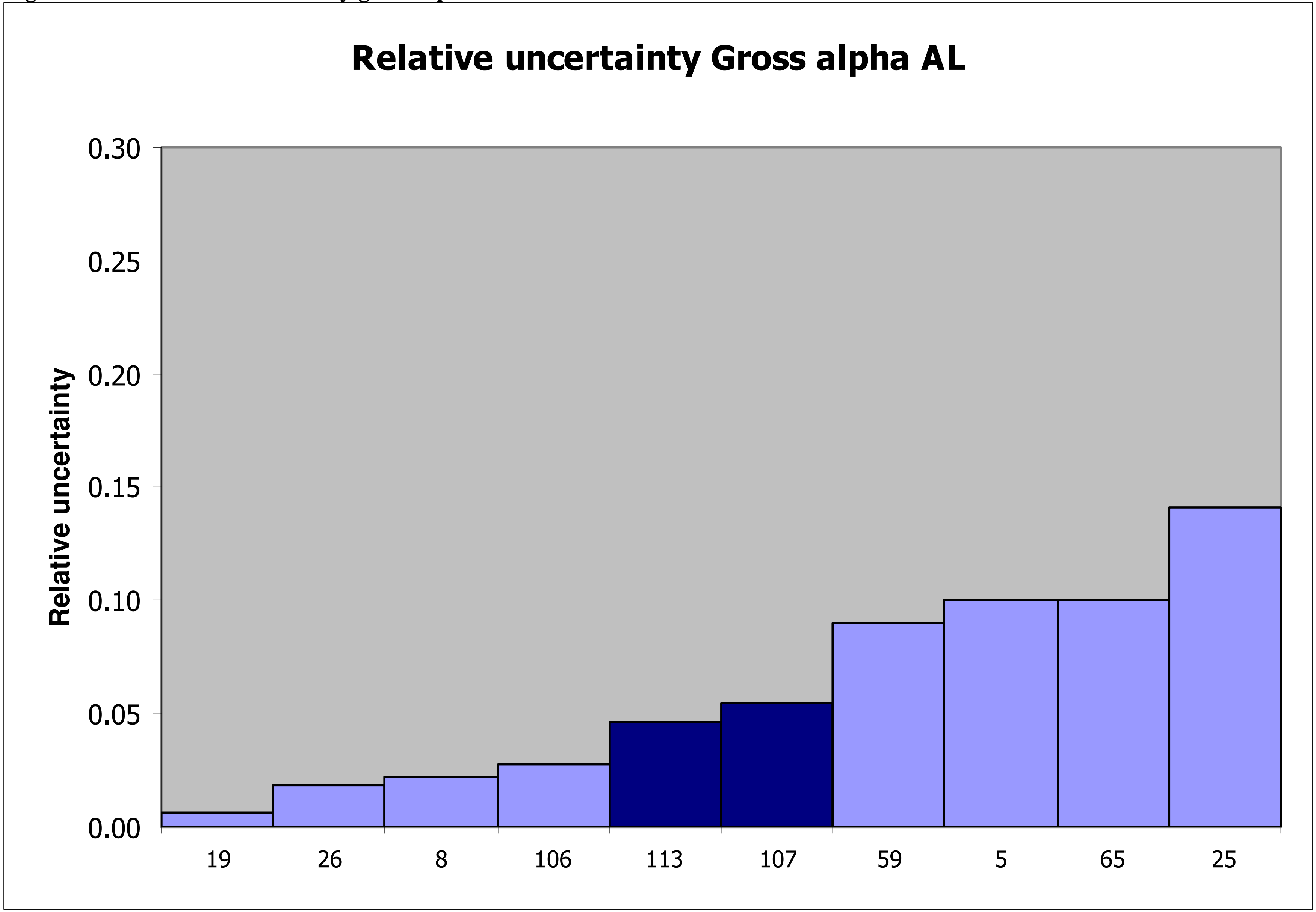


**Figure 10D – Kiri plot gross alpha AL**

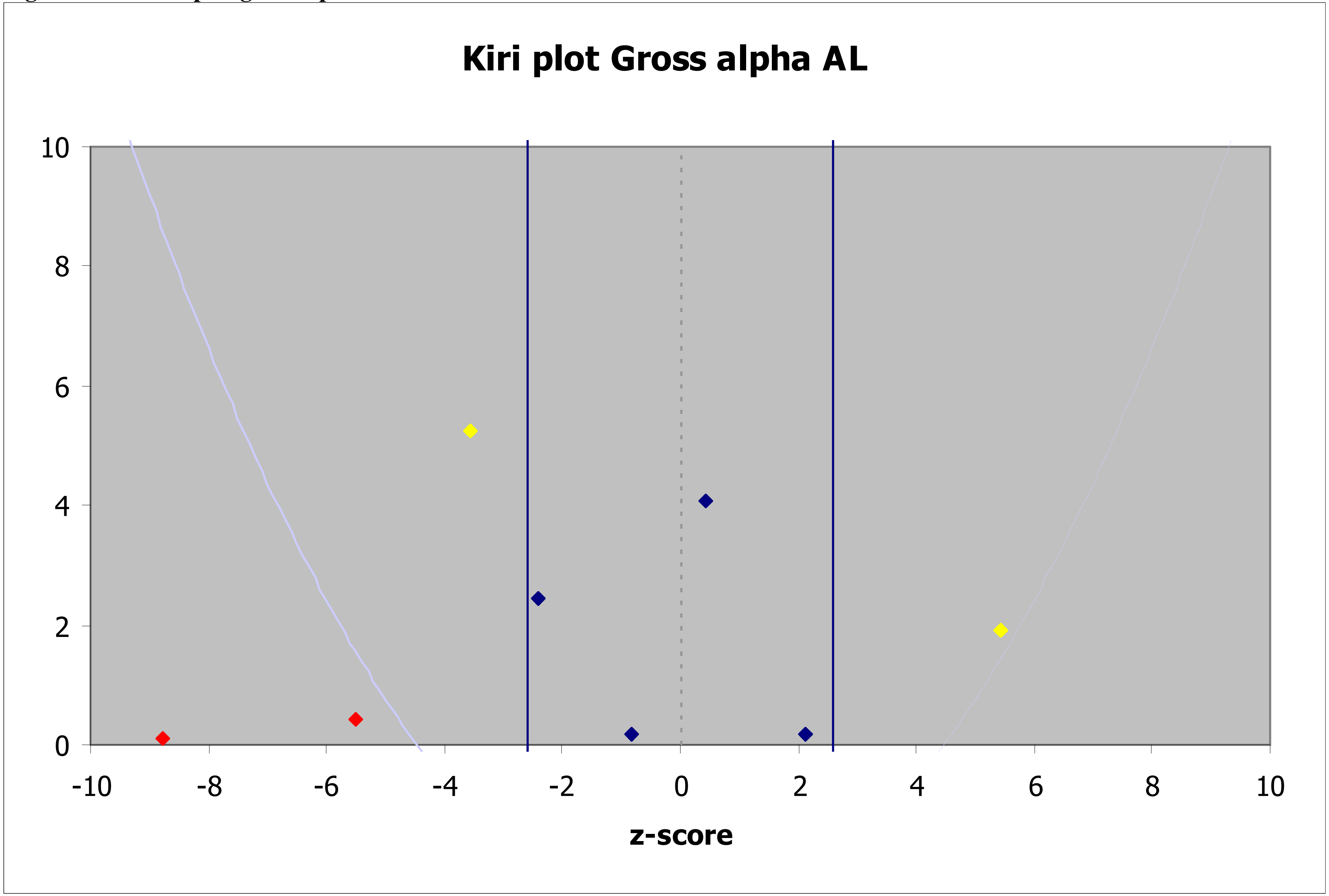


**Figure 11A – Deviation Ra-226 AH**

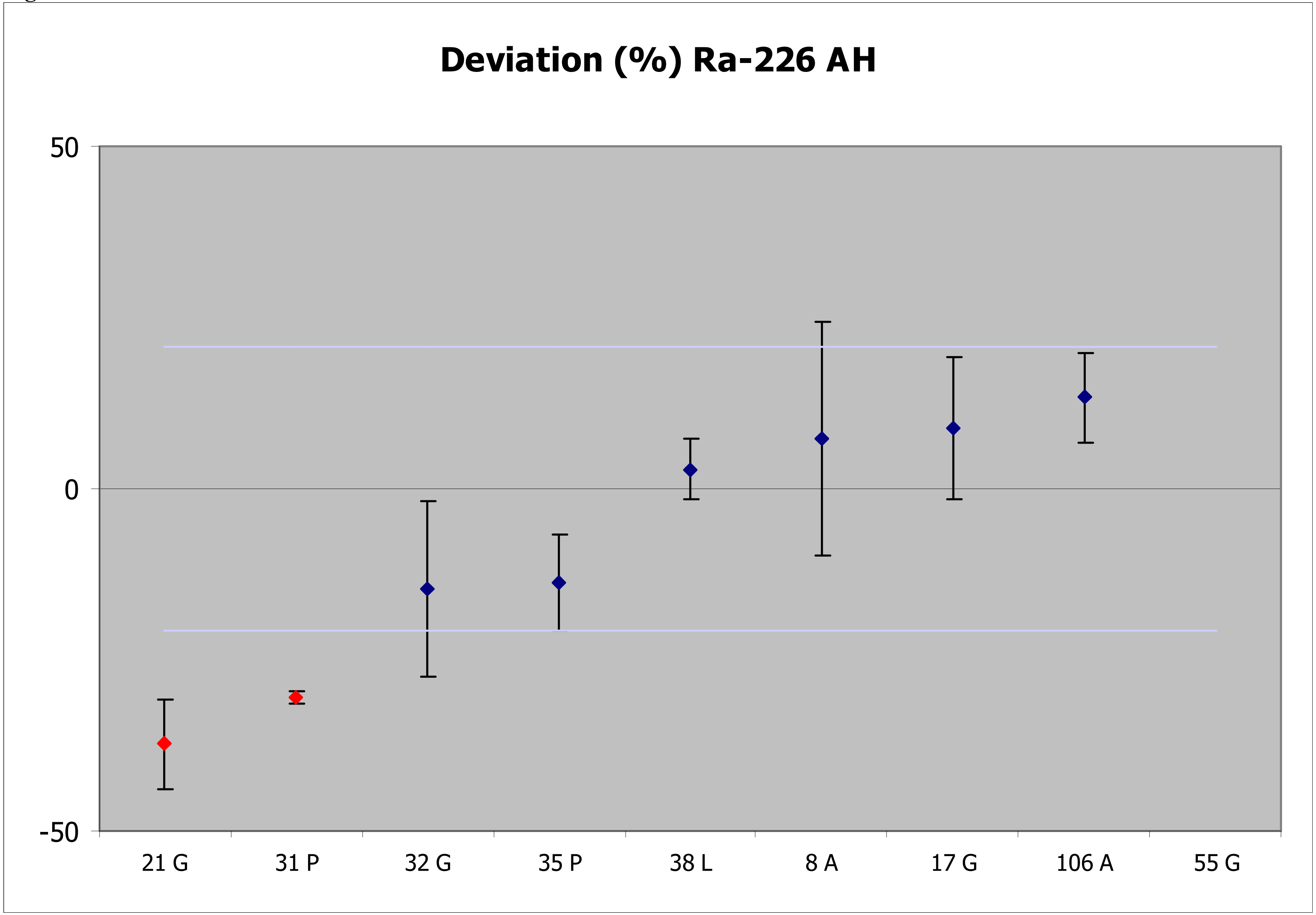


**Figure 11B – Zeta score Ra-226 AH**

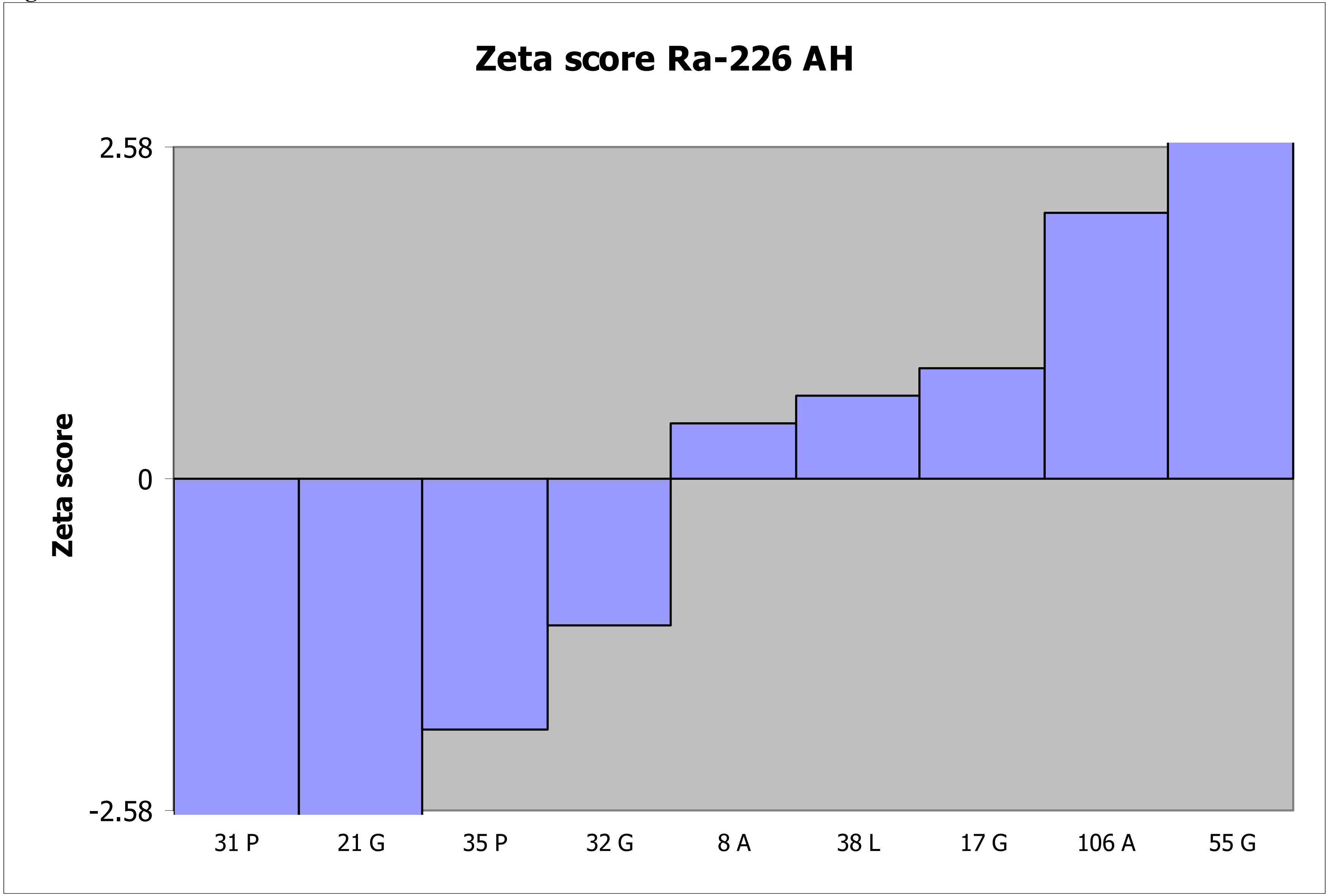


**Figure 11C – Relative uncertainty Ra-226 AH**

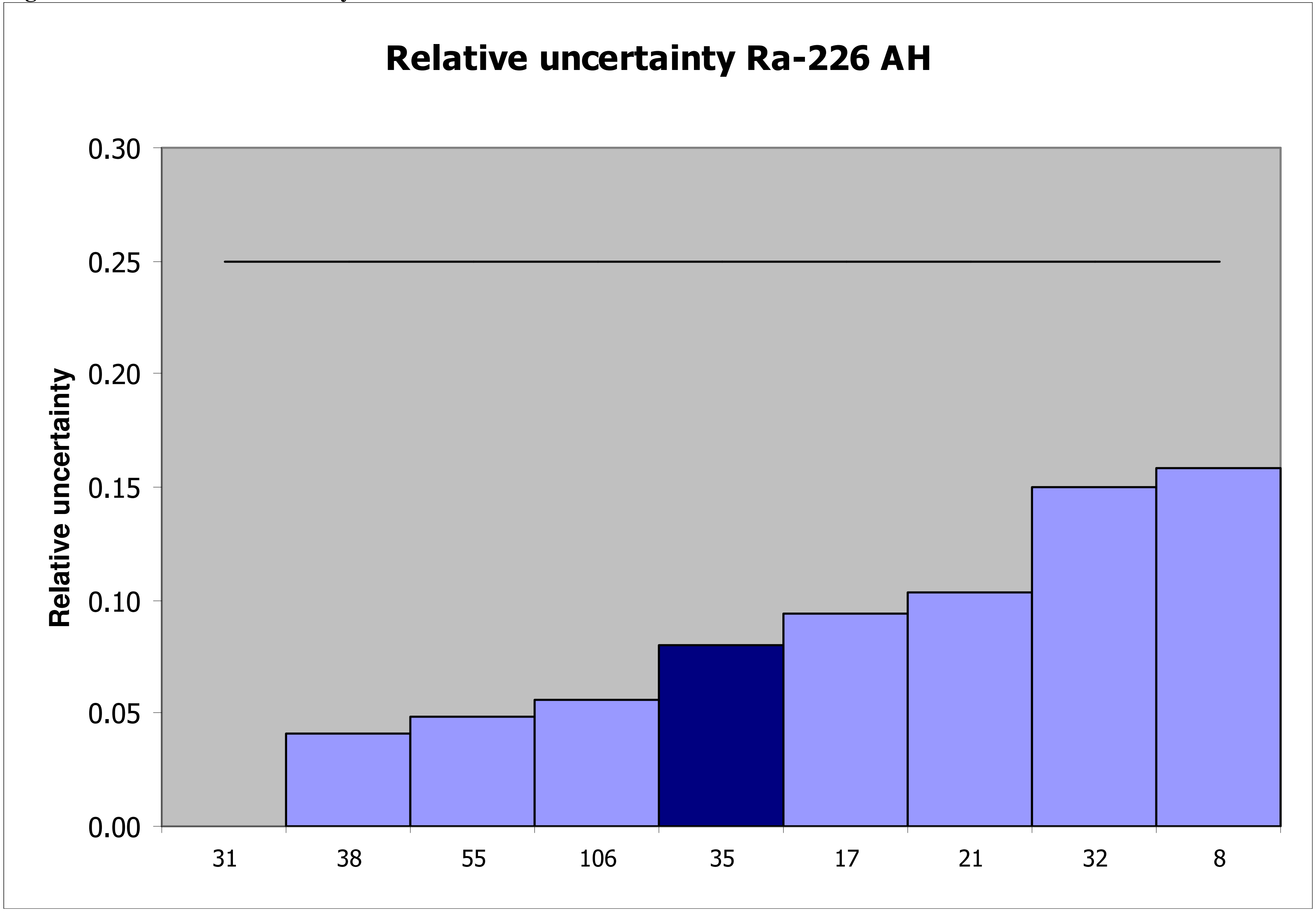


**Figure 11D – Kiri plot Ra-226 AH**

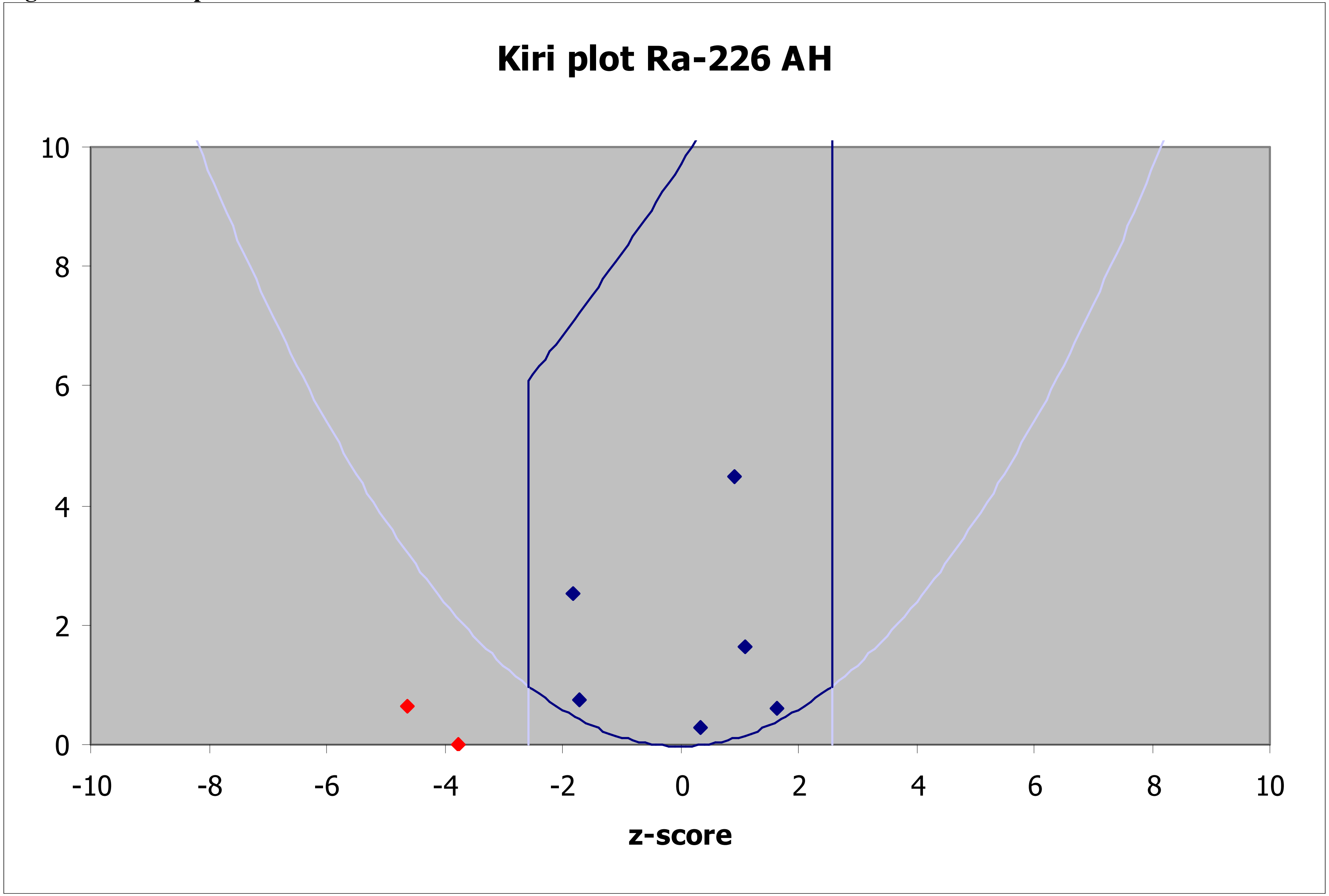


**Figure 12A – Deviation U-234 AH**

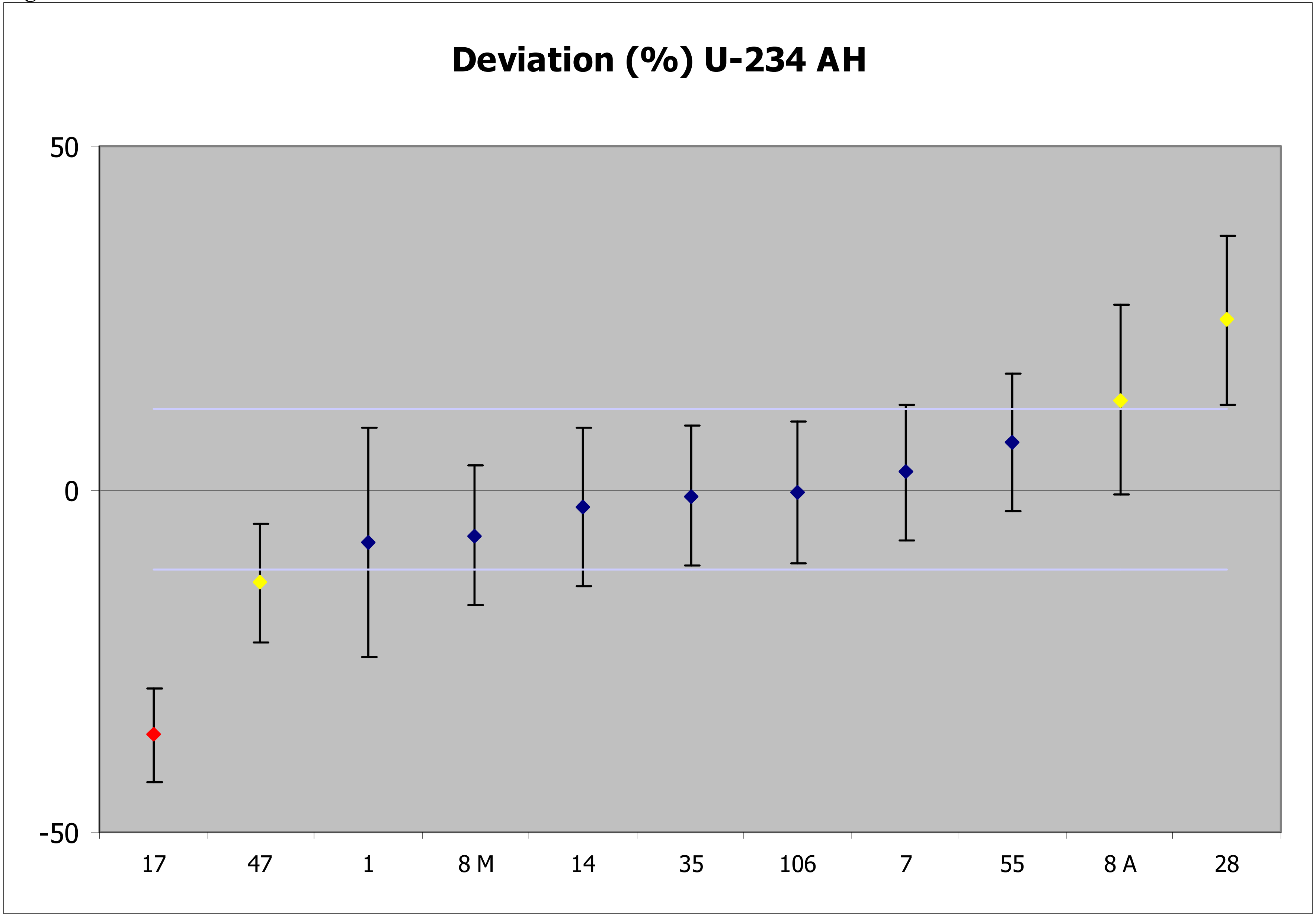


**Figure 12B – Zeta score U-234 AH**

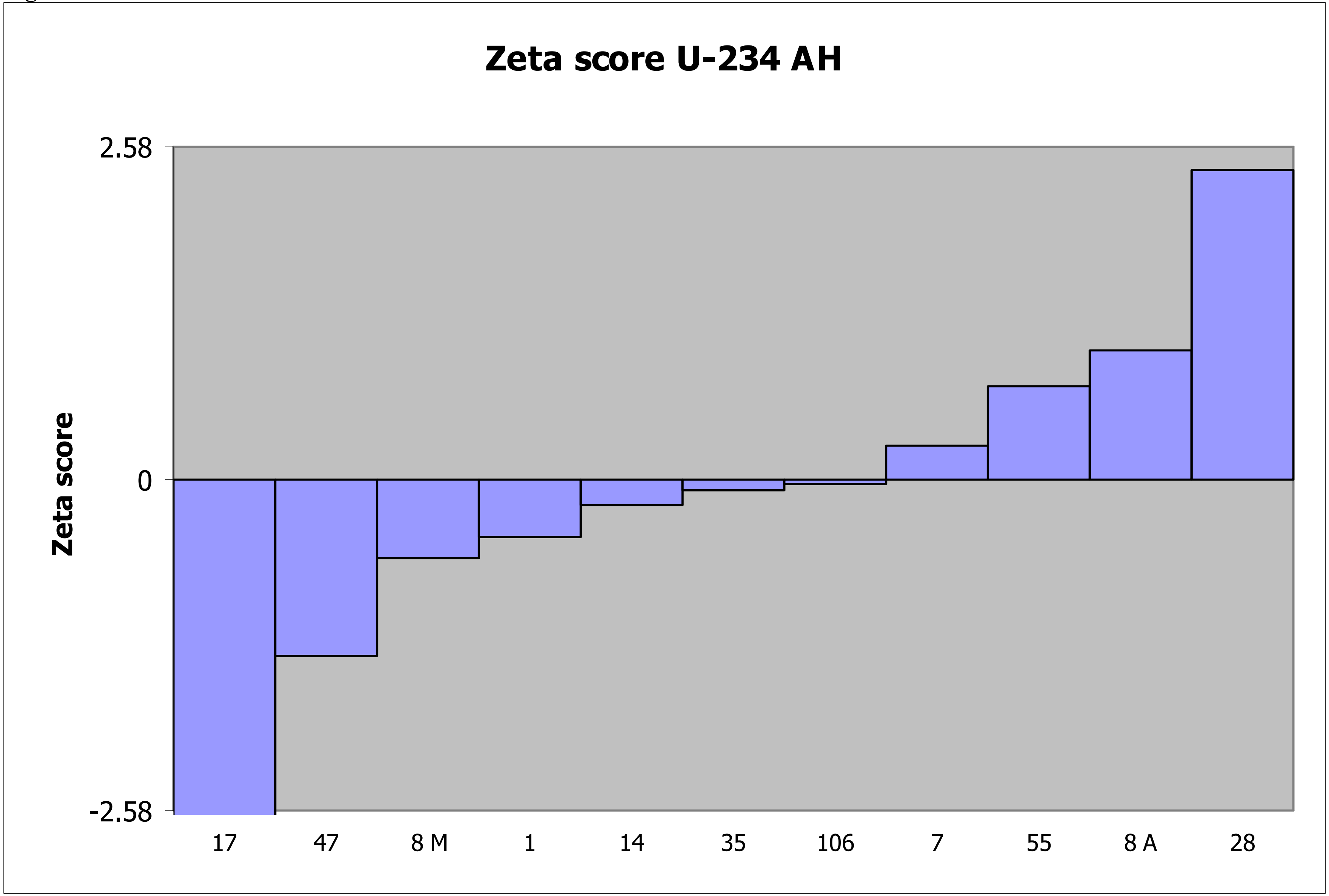


**Figure 12C – Relative uncertainty U-234 AH**

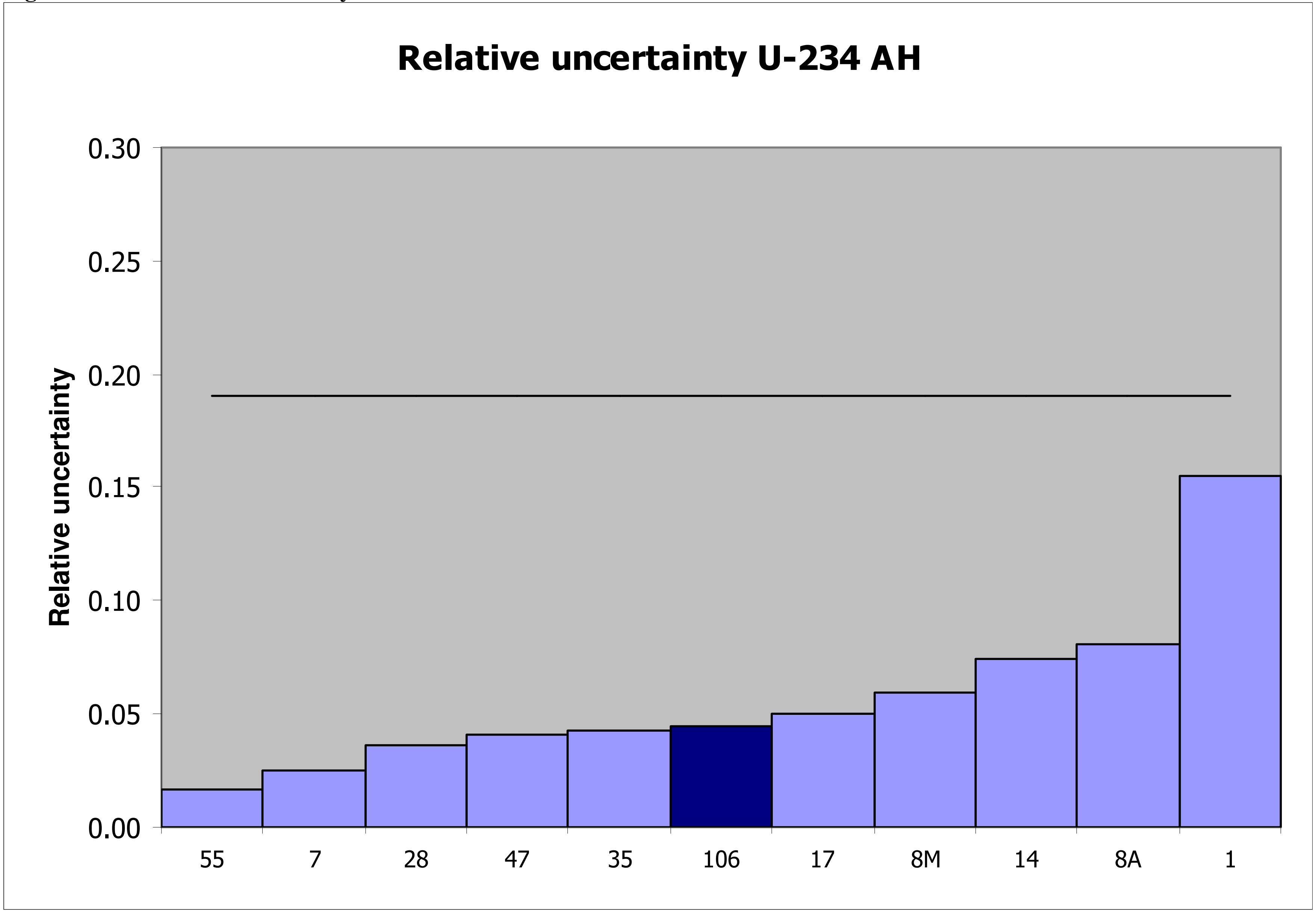


**Figure 12D – Kiri plot U-234 AH**

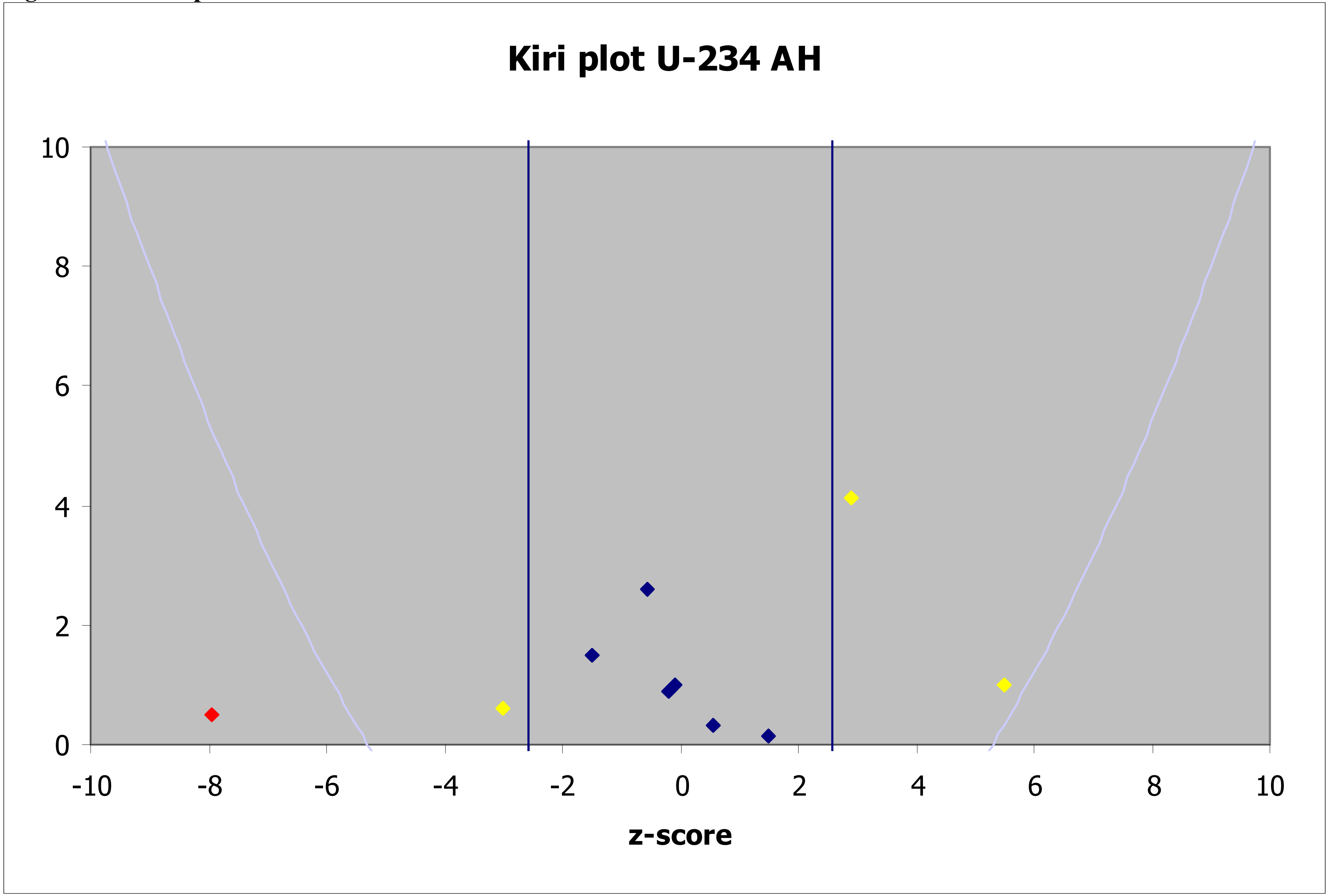


**Figure 13A – Deviation U-235 AH**

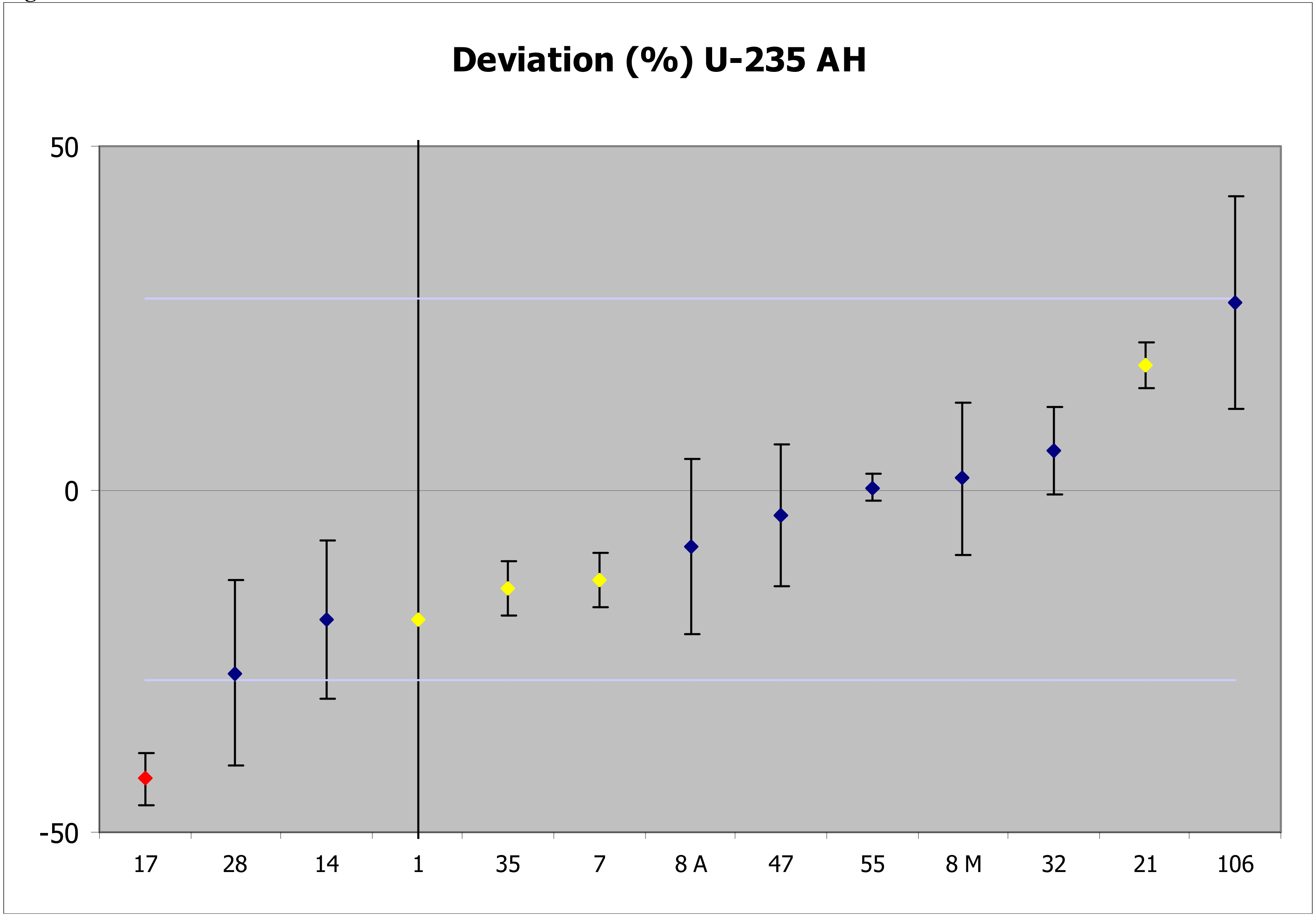


**Figure 13B – Zeta score U-235 AH**

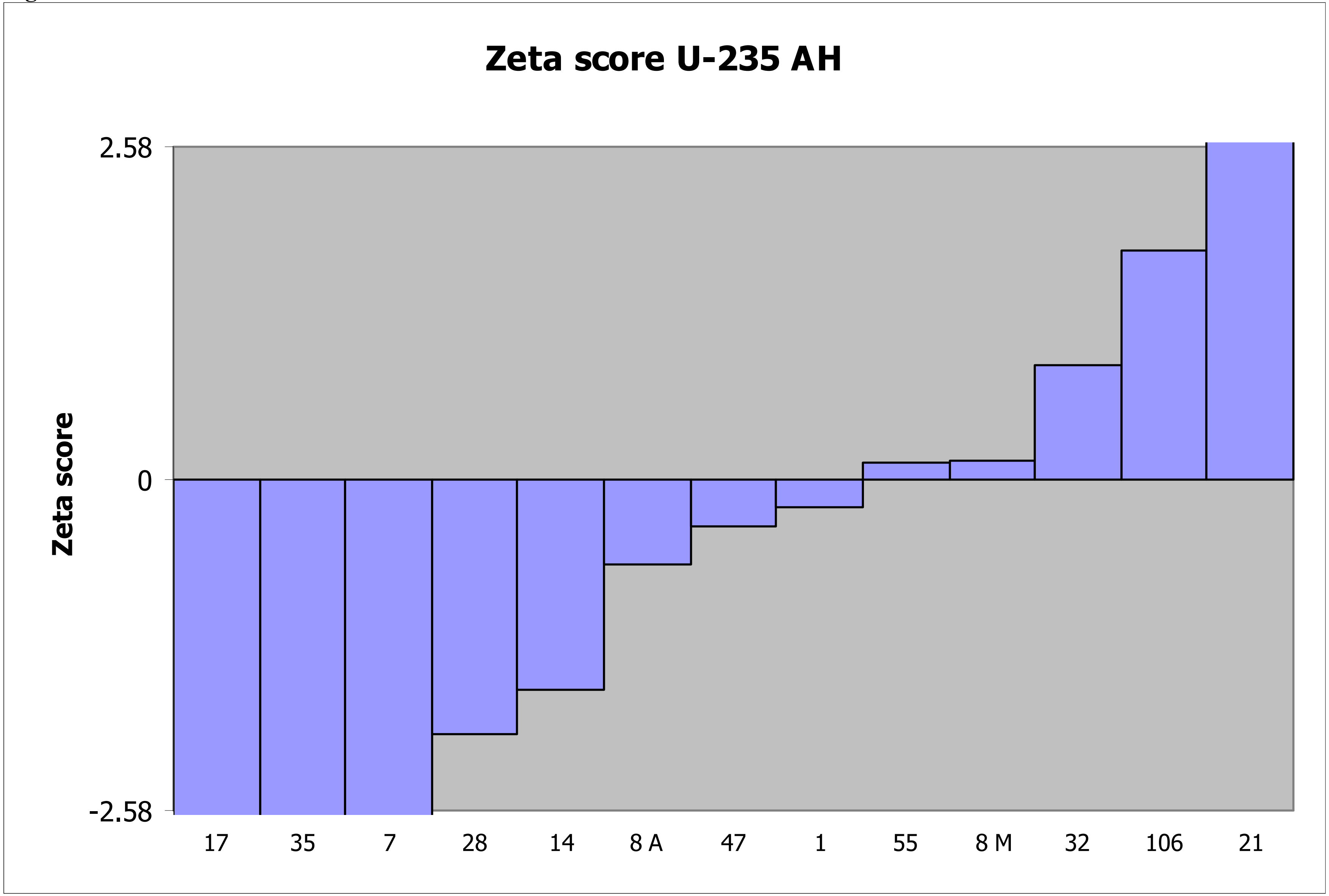


**Figure 13C – Relative uncertainty U-235 AH**

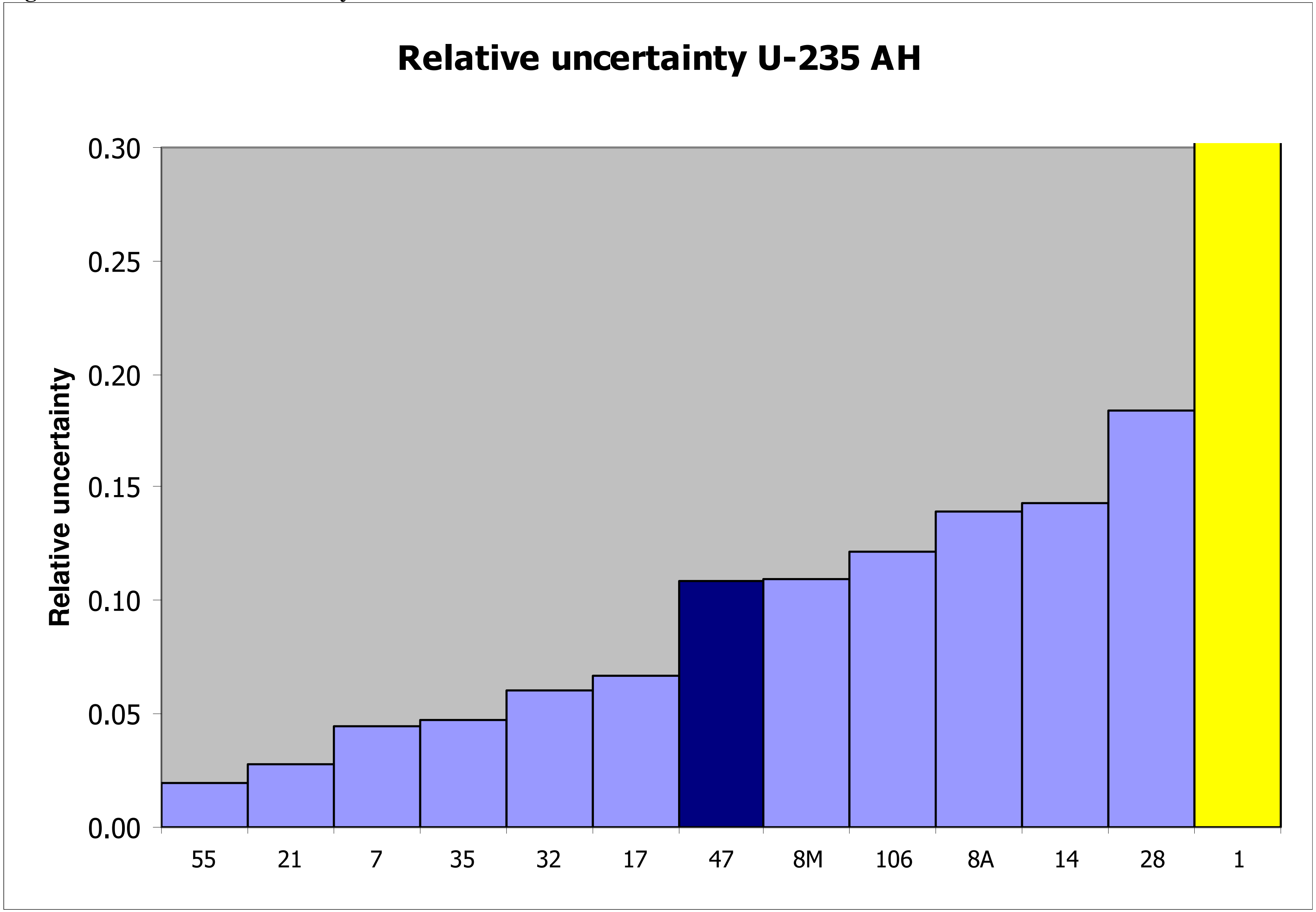


**Figure 13D – Kiri plot U-235 AH**

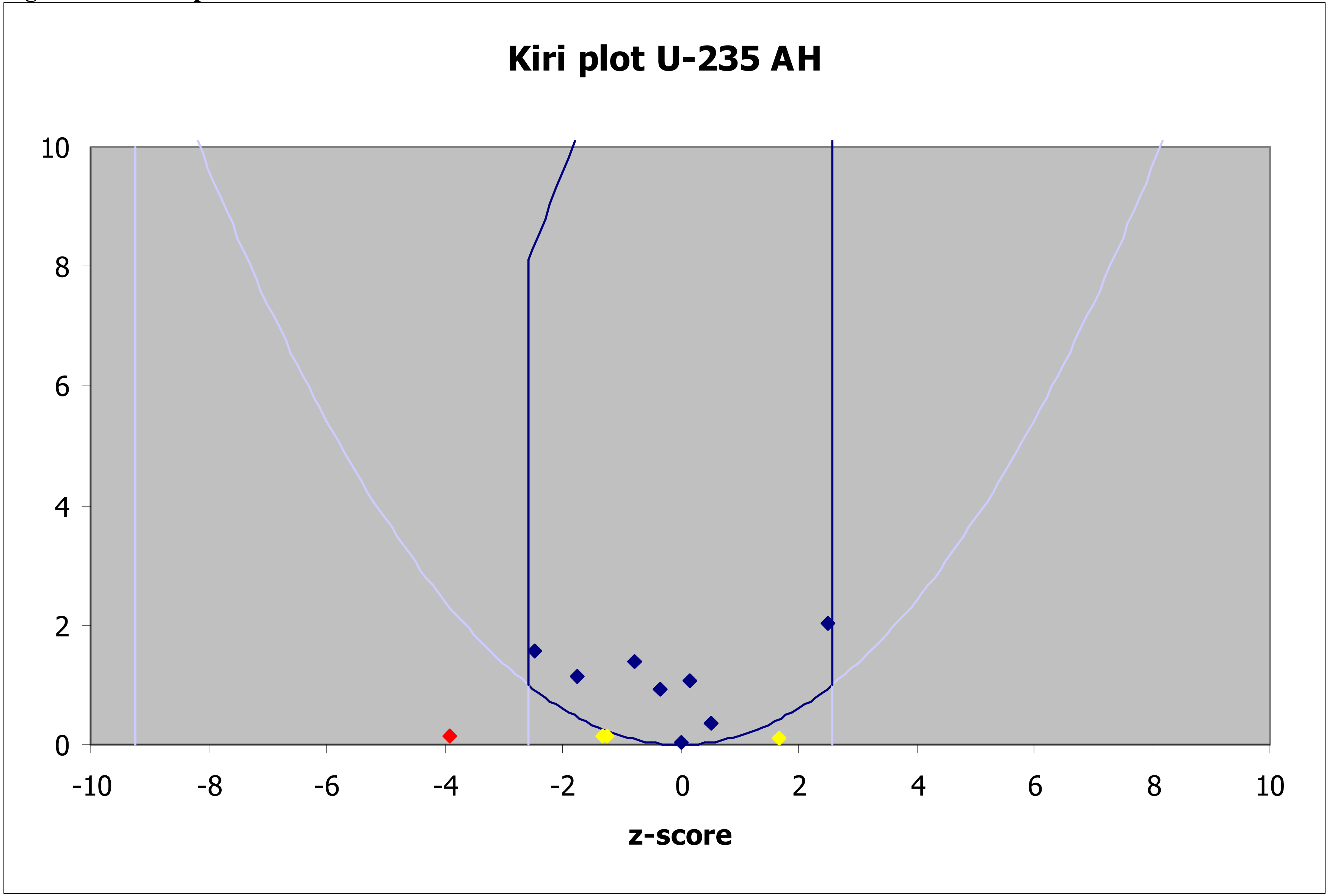


**Figure 14A – Deviation U-238 AH**

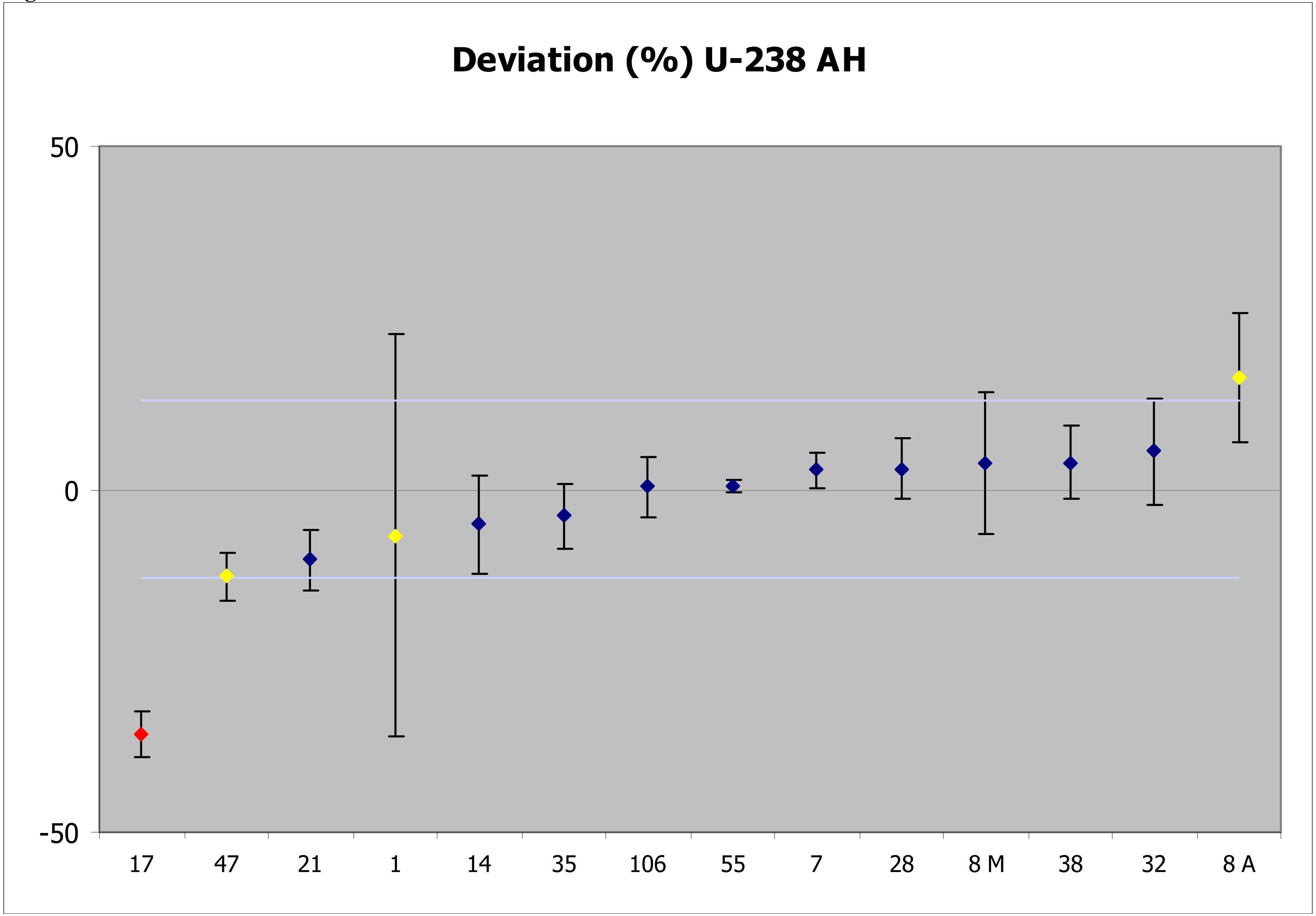


**Figure 14B – Zeta score U-238 AH**

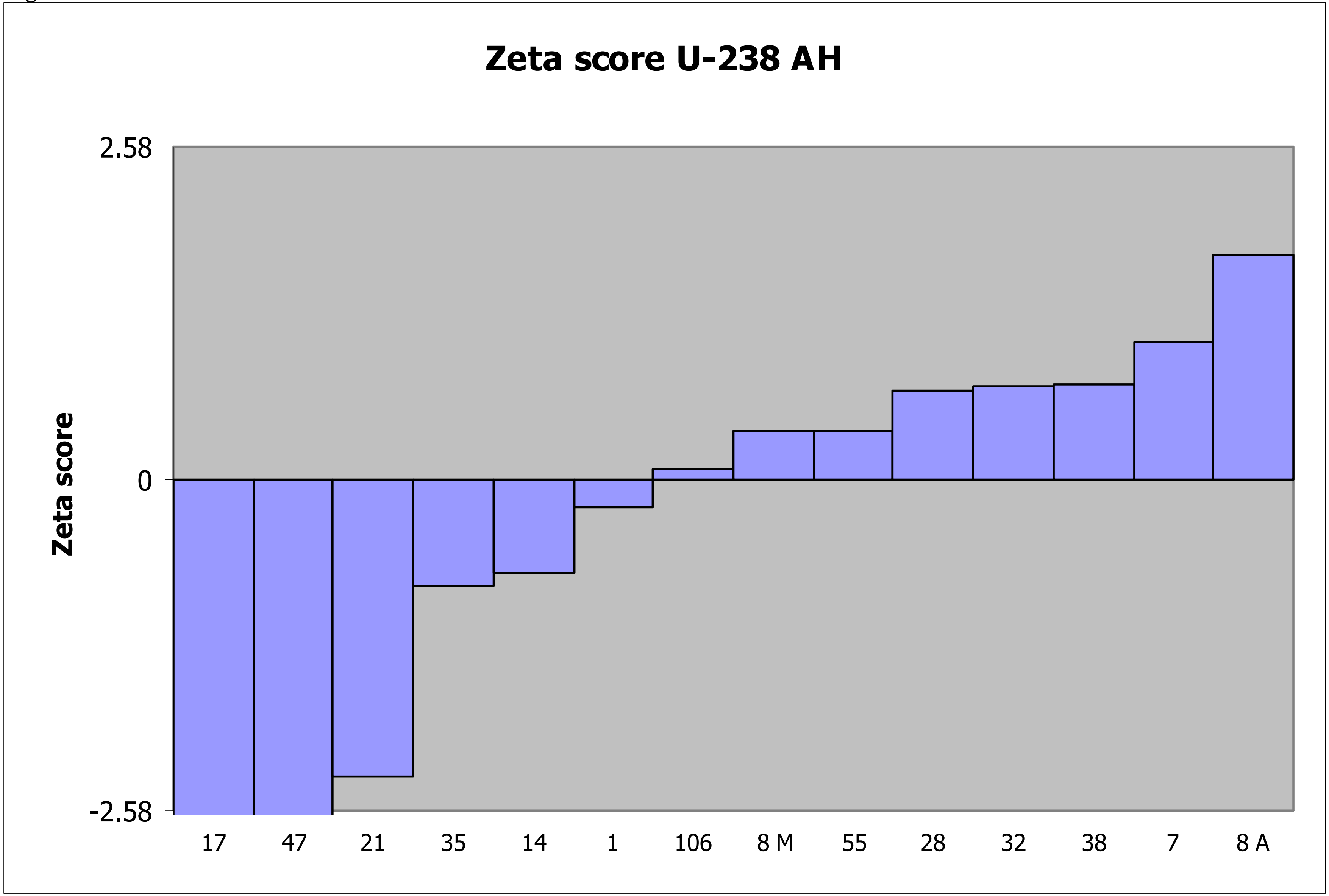


**Figure 14C – Relative uncertainty U-238 AH**

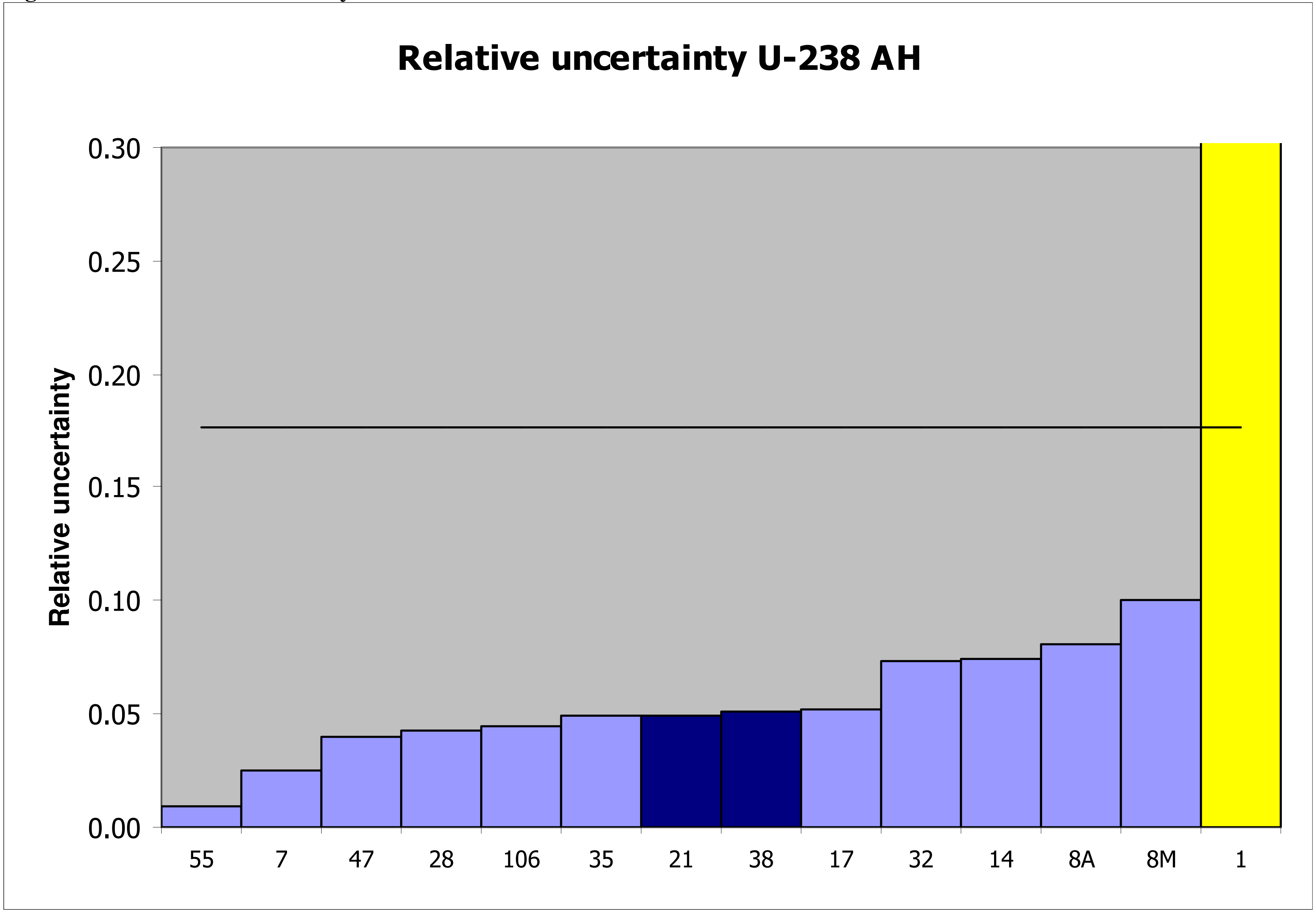


**Figure 14D – Kiri plot U-238 AH**

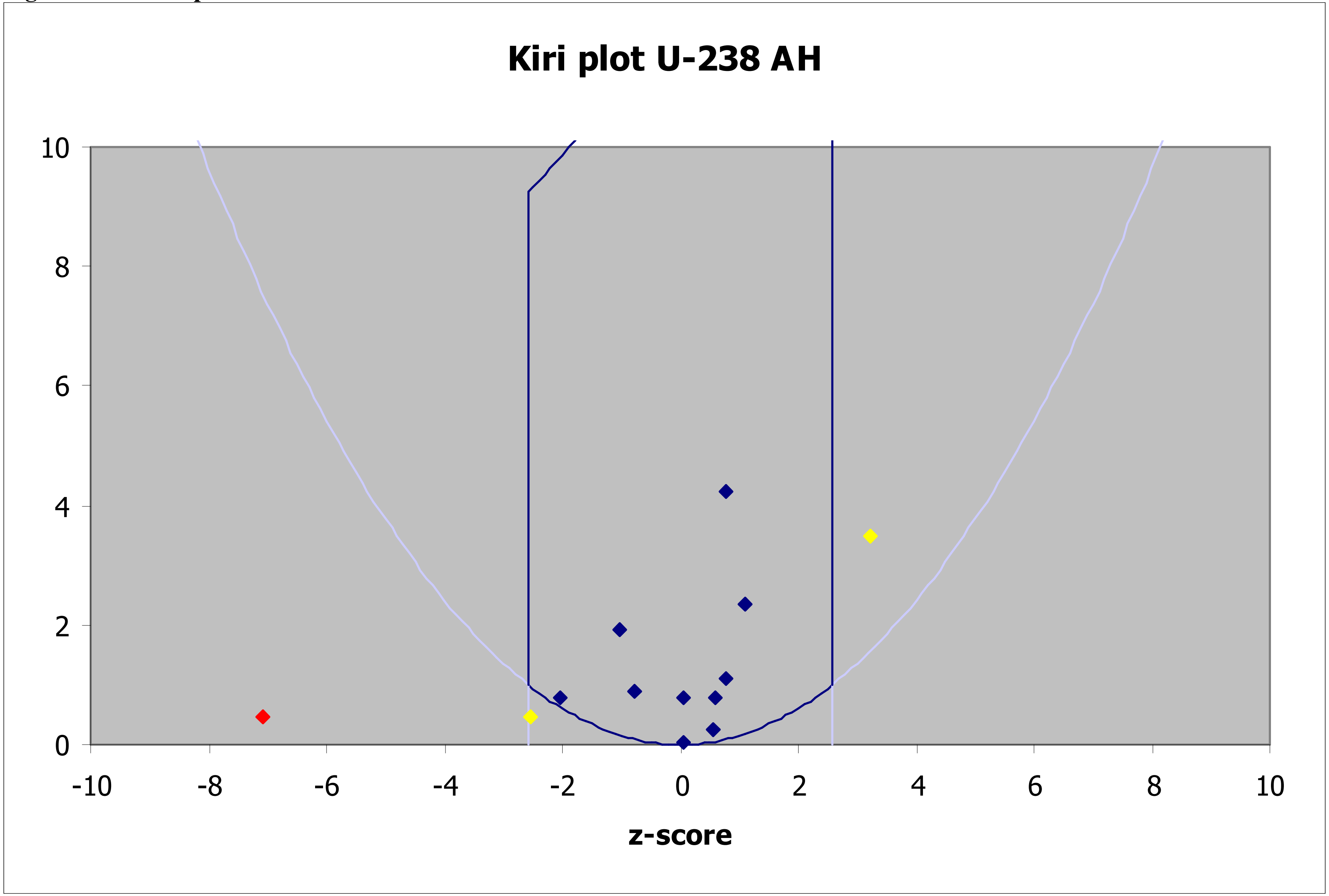


**Figure 15A – Deviation Np-237 AH**

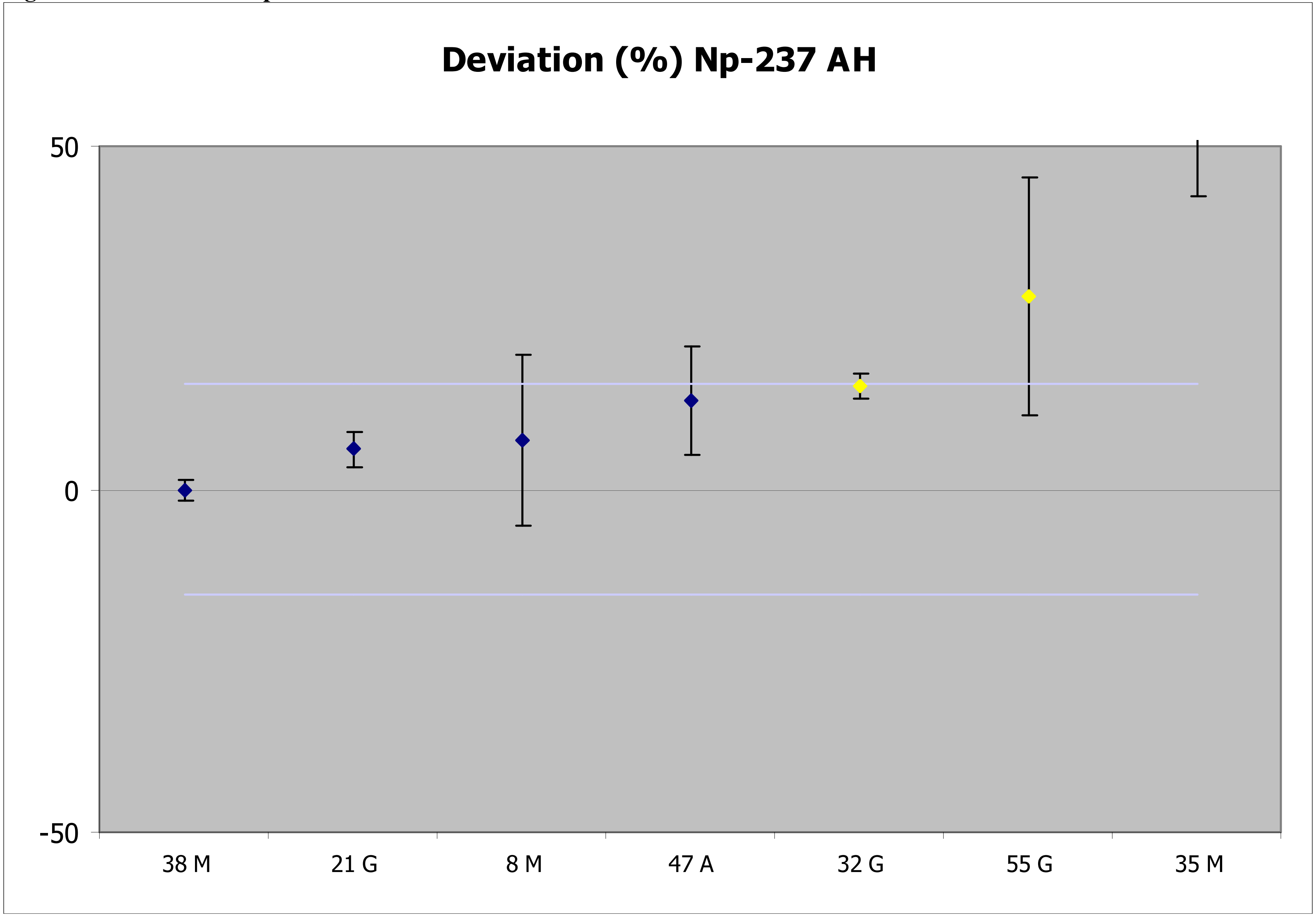


**Figure 15B – Zeta score Np-237 AH**

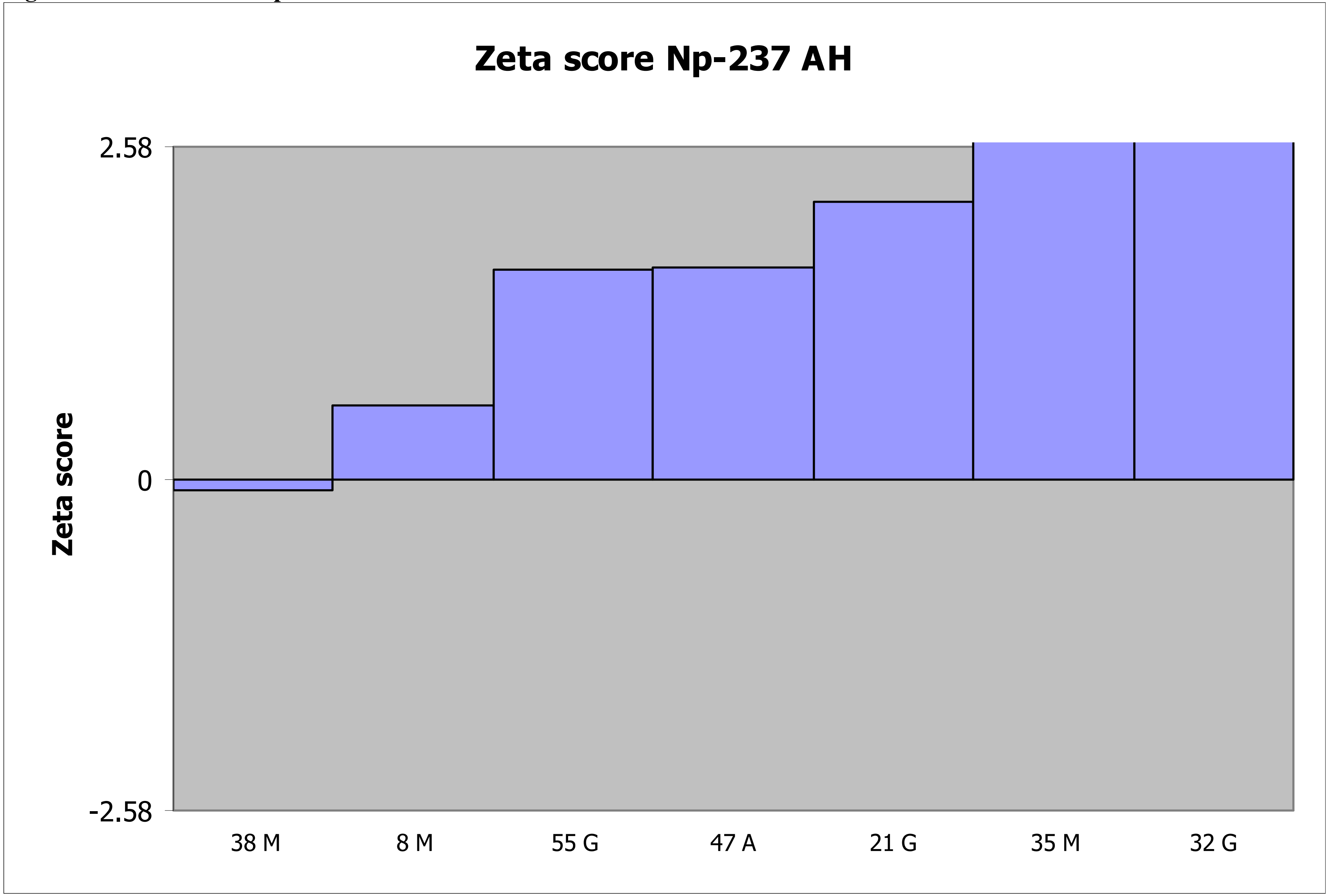


**Figure 15C – Relative uncertainty Np-237 AH**

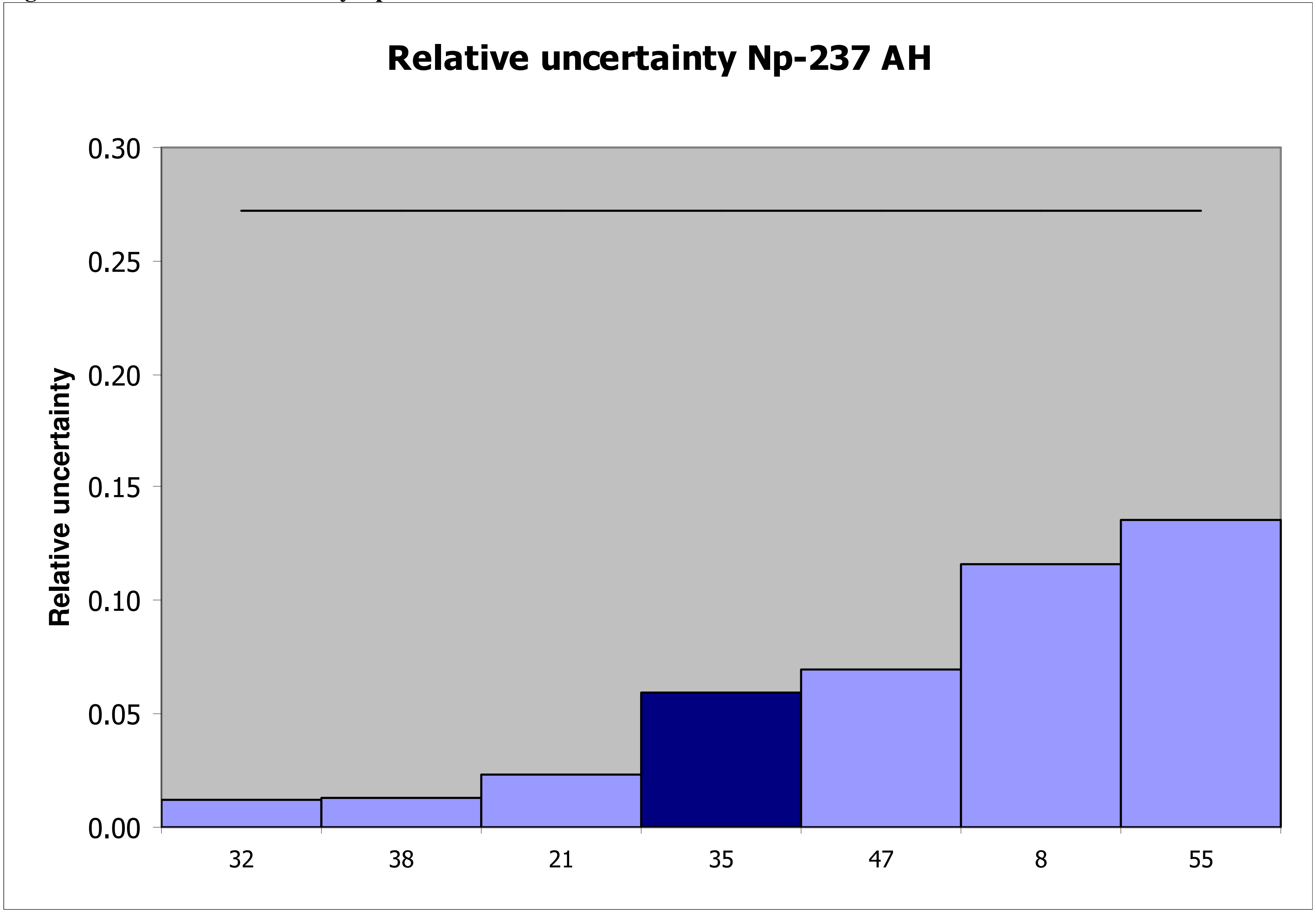


**Figure 15D – Kiri plot Np-237 AH**

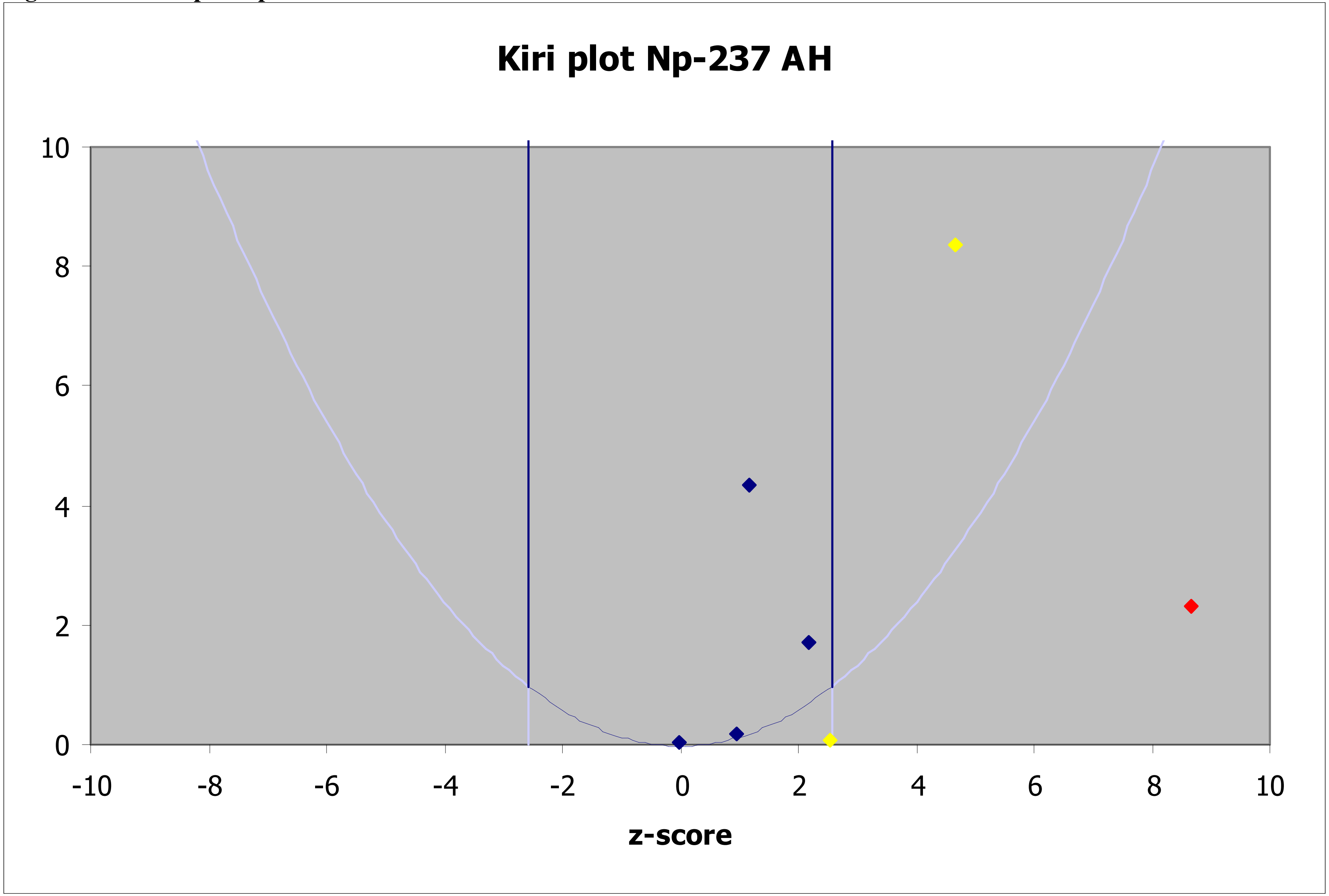


**Figure 16A – Deviation Pu-238 AH**

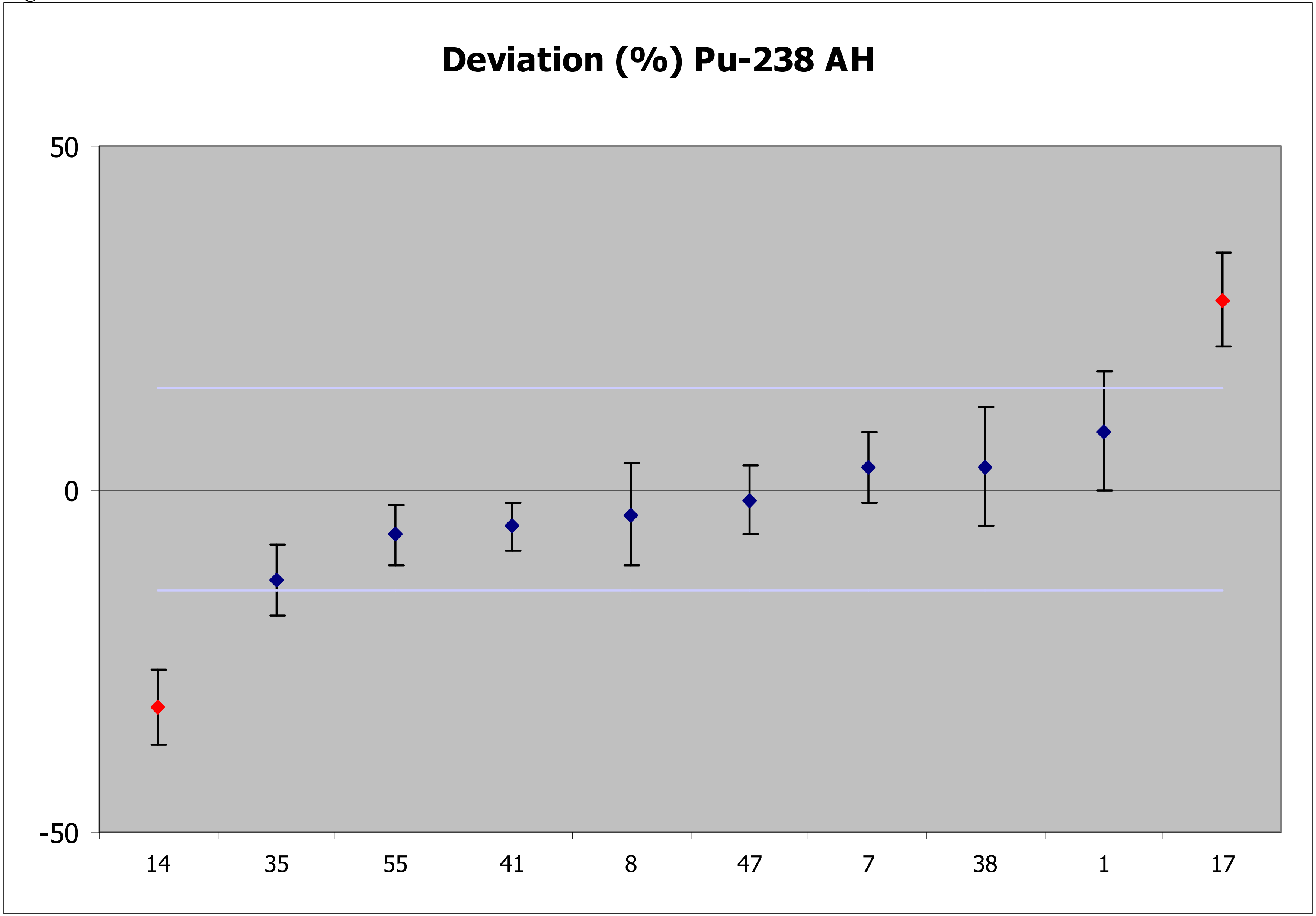


**Figure 16B – Zeta score Pu-238 AH**

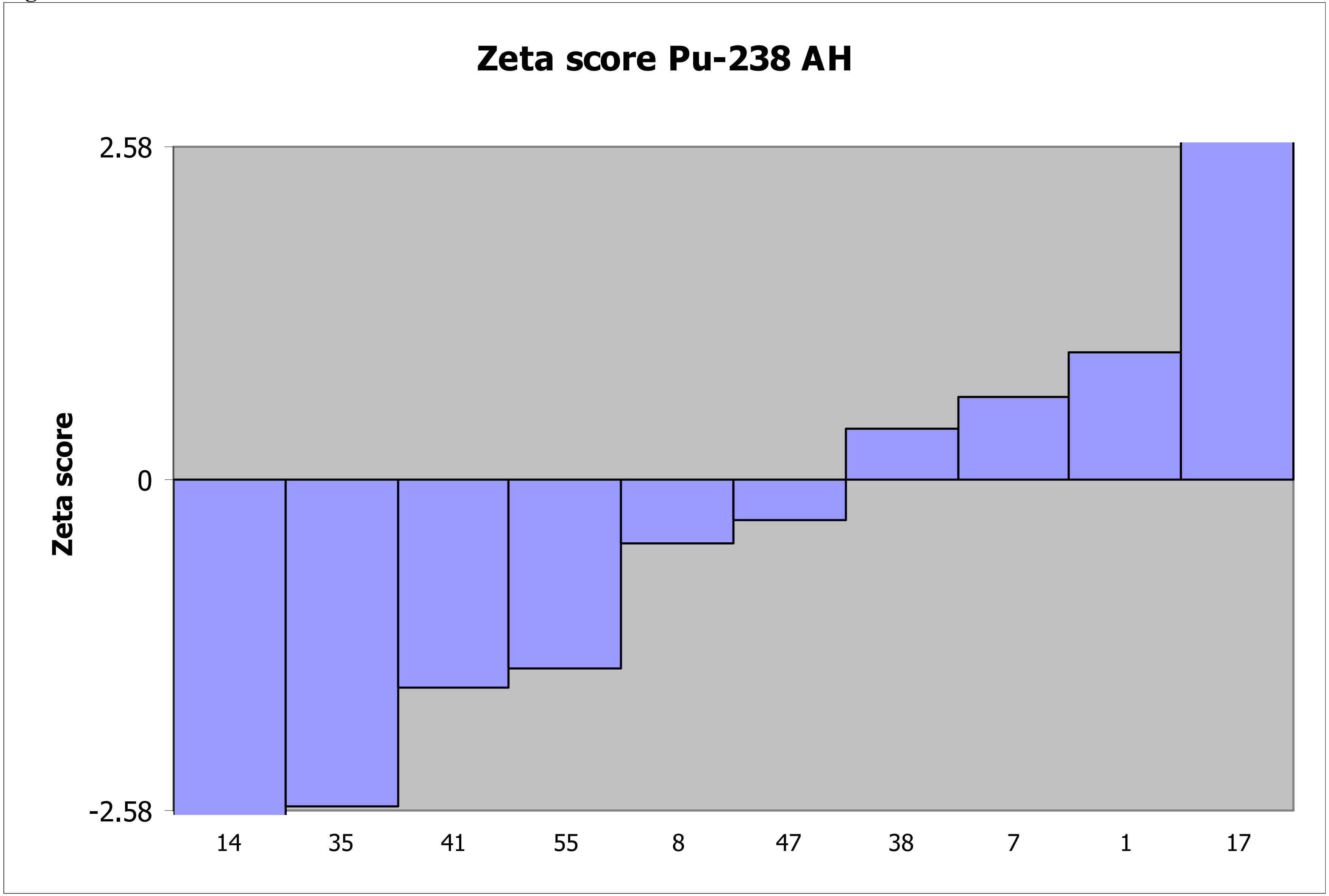


**Figure 16C – Relative uncertainty Pu-238 AH**

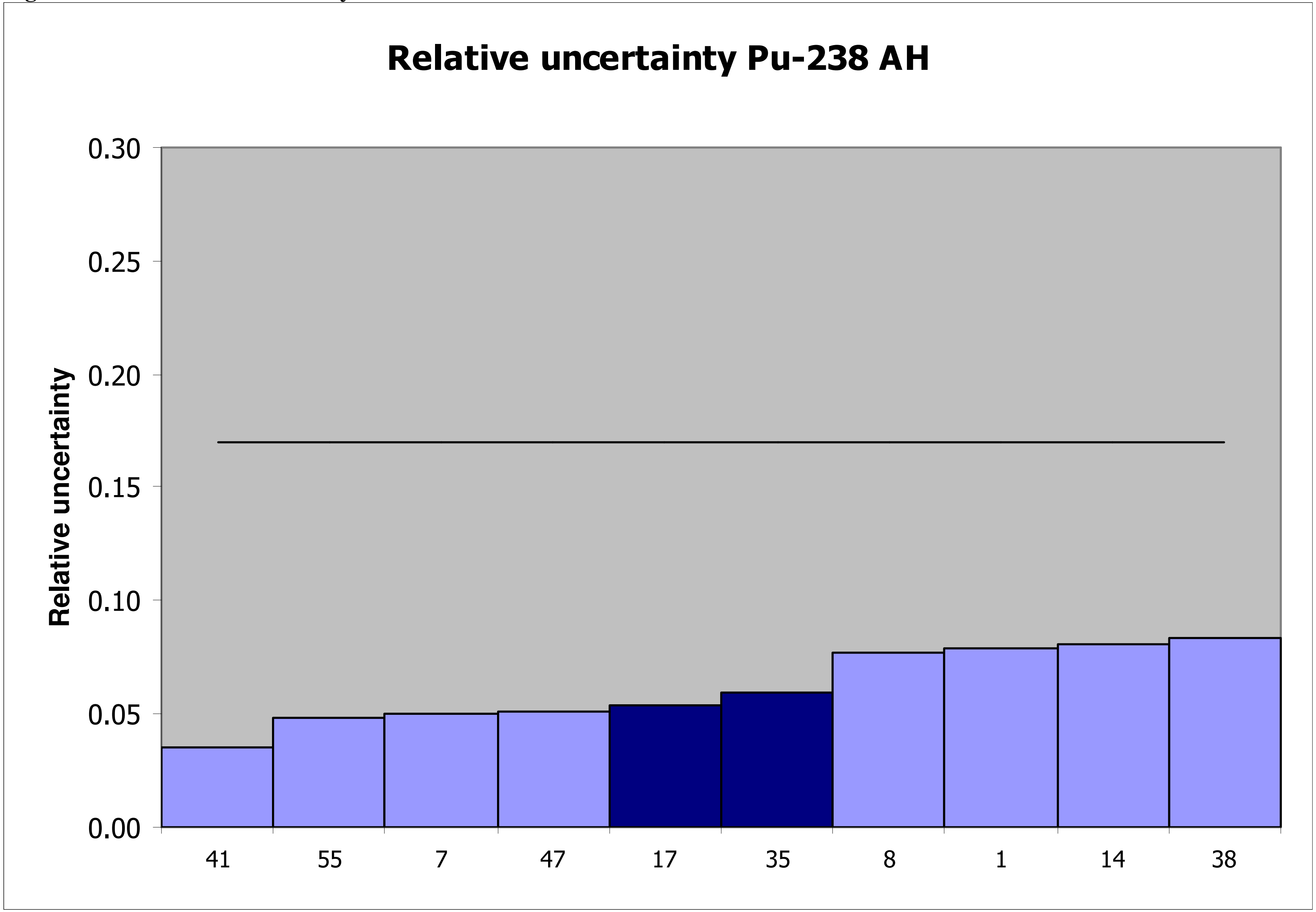


**Figure 16D – Kiri plot Pu-238 AH**

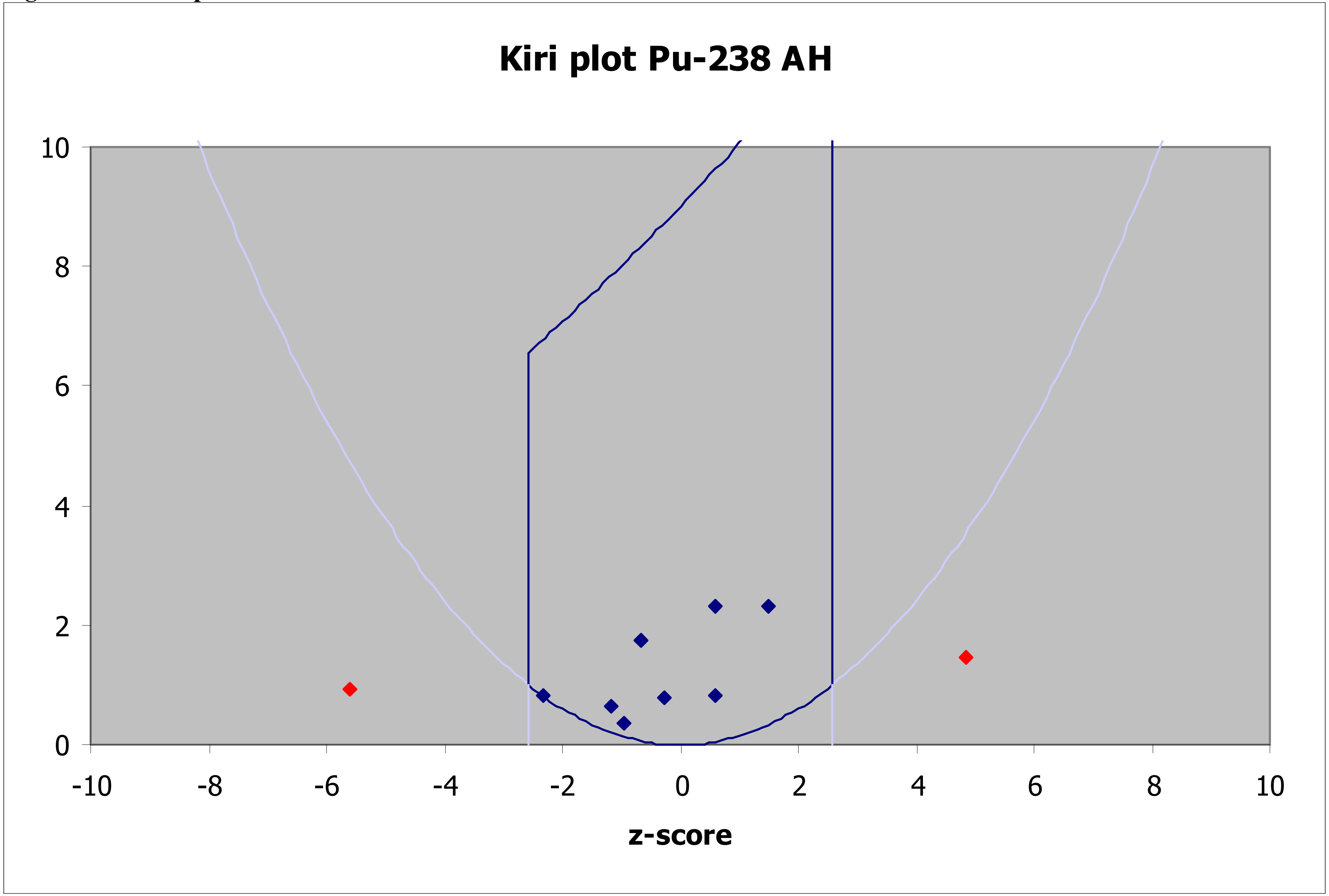


**Figure 17A – Deviation Pu-239 AH**

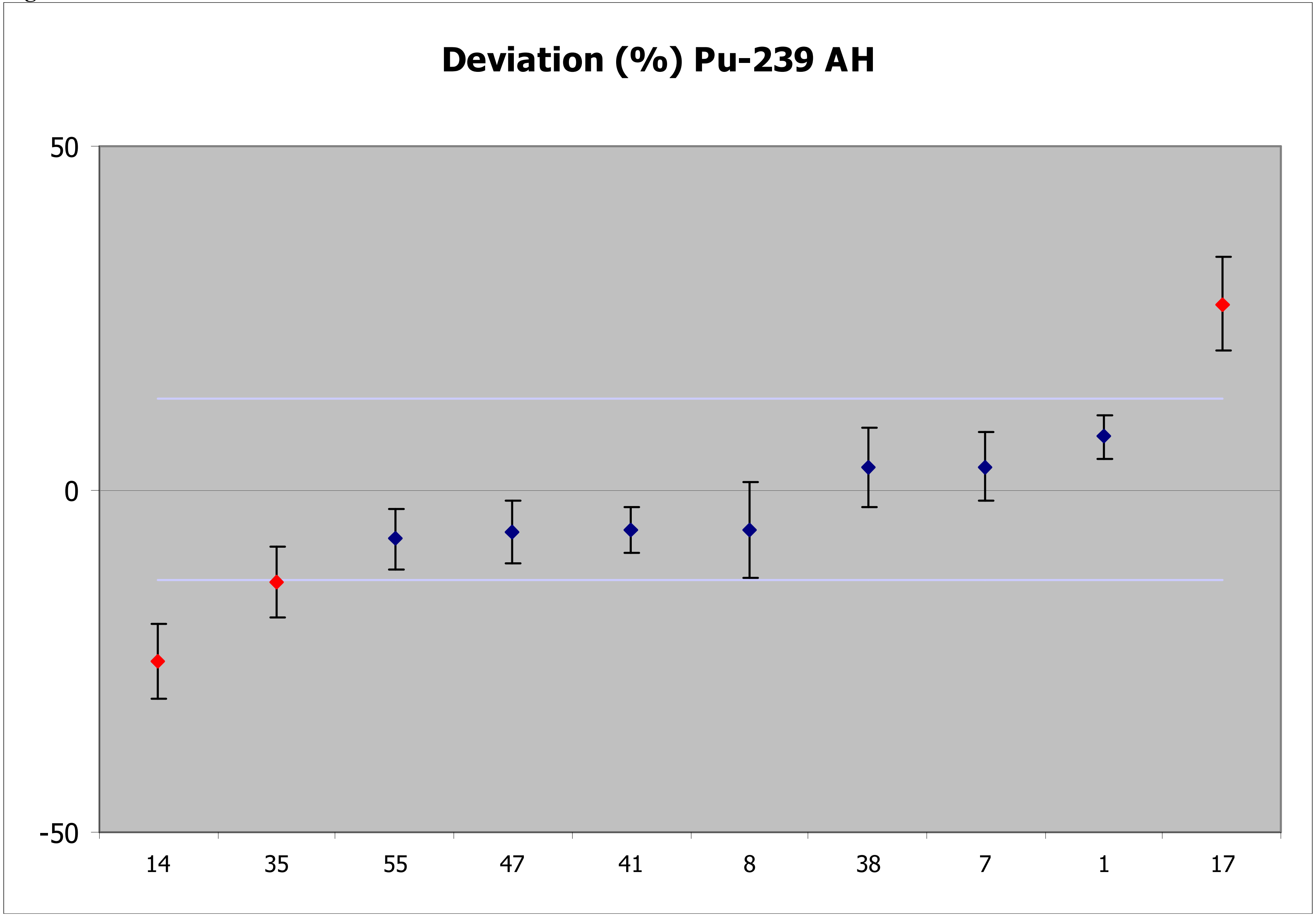


**Figure 17B – Zeta score Pu-239 AH**

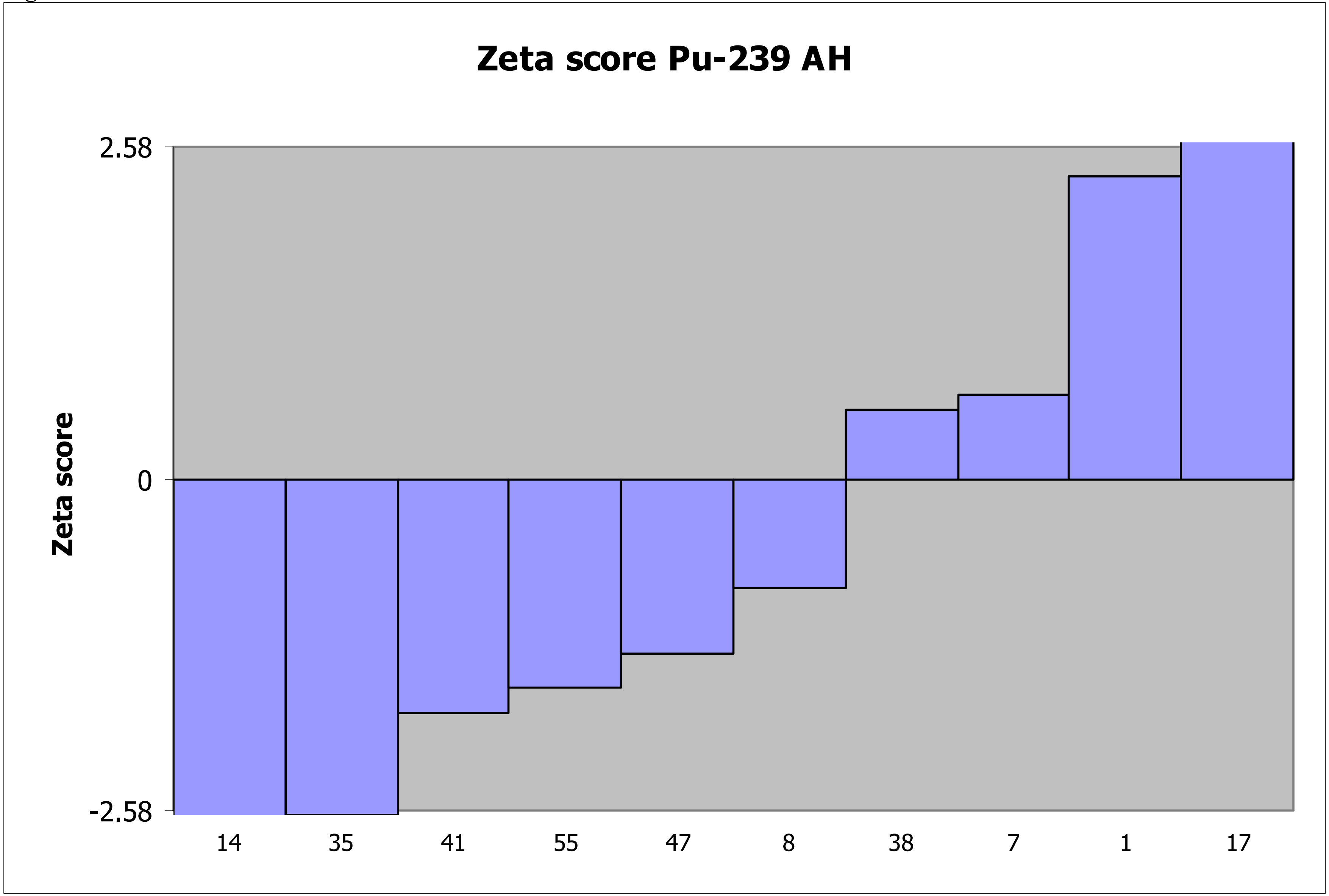


**Figure 17C – Relative uncertainty Pu-239 AH**

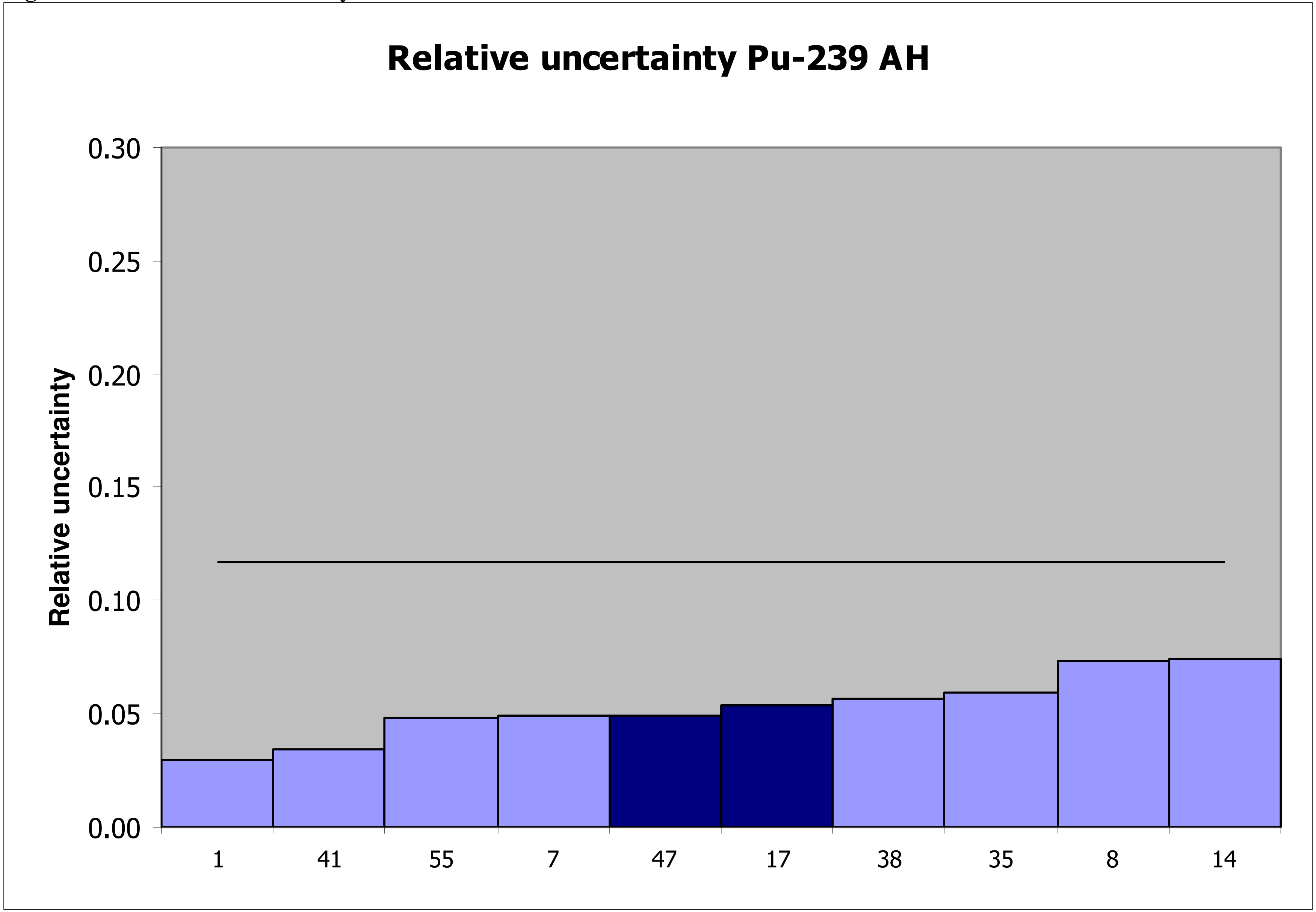


**Figure 17D – Kiri plot Pu-239 AH**

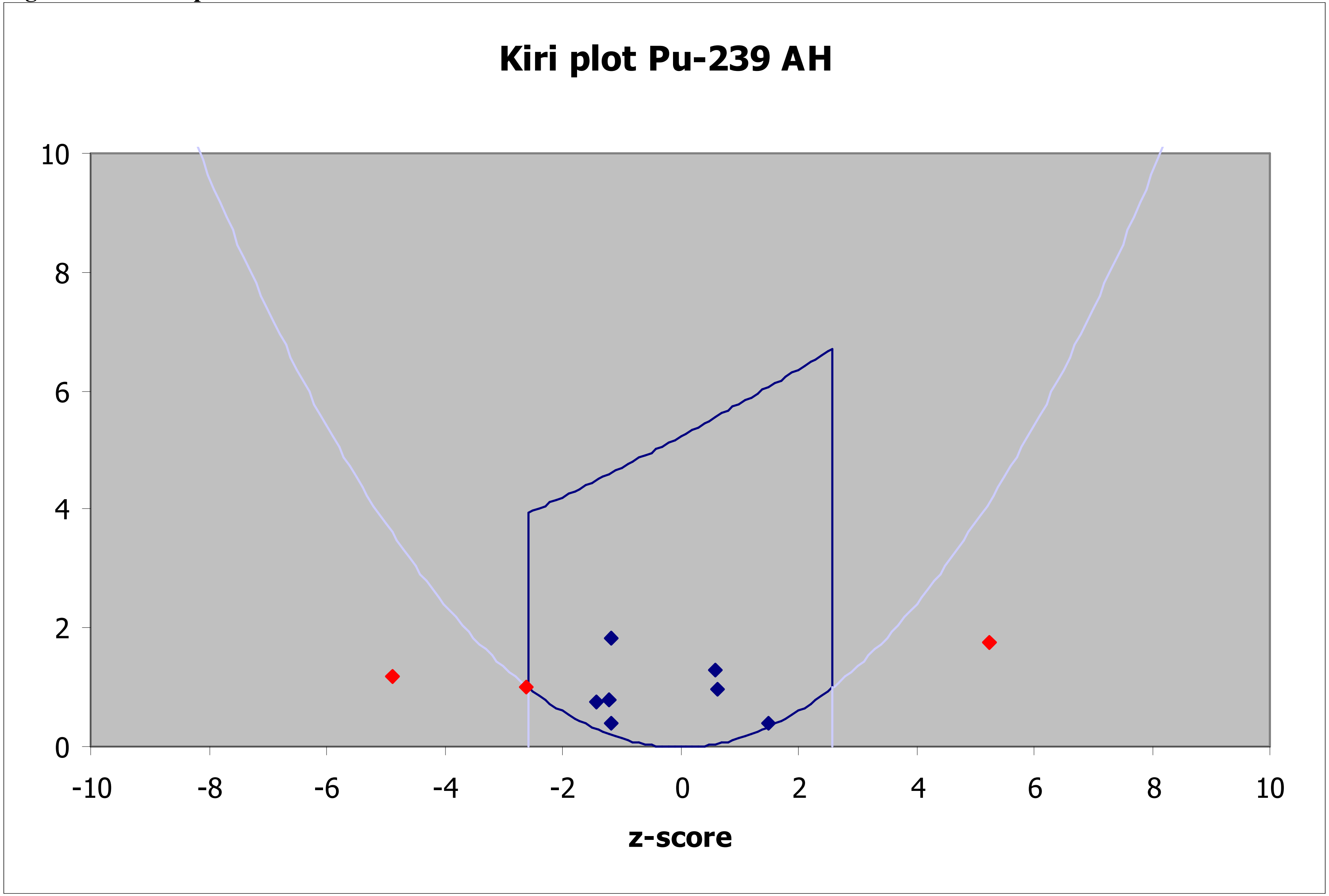


**Figure 18A – Deviation Am-241 AH**

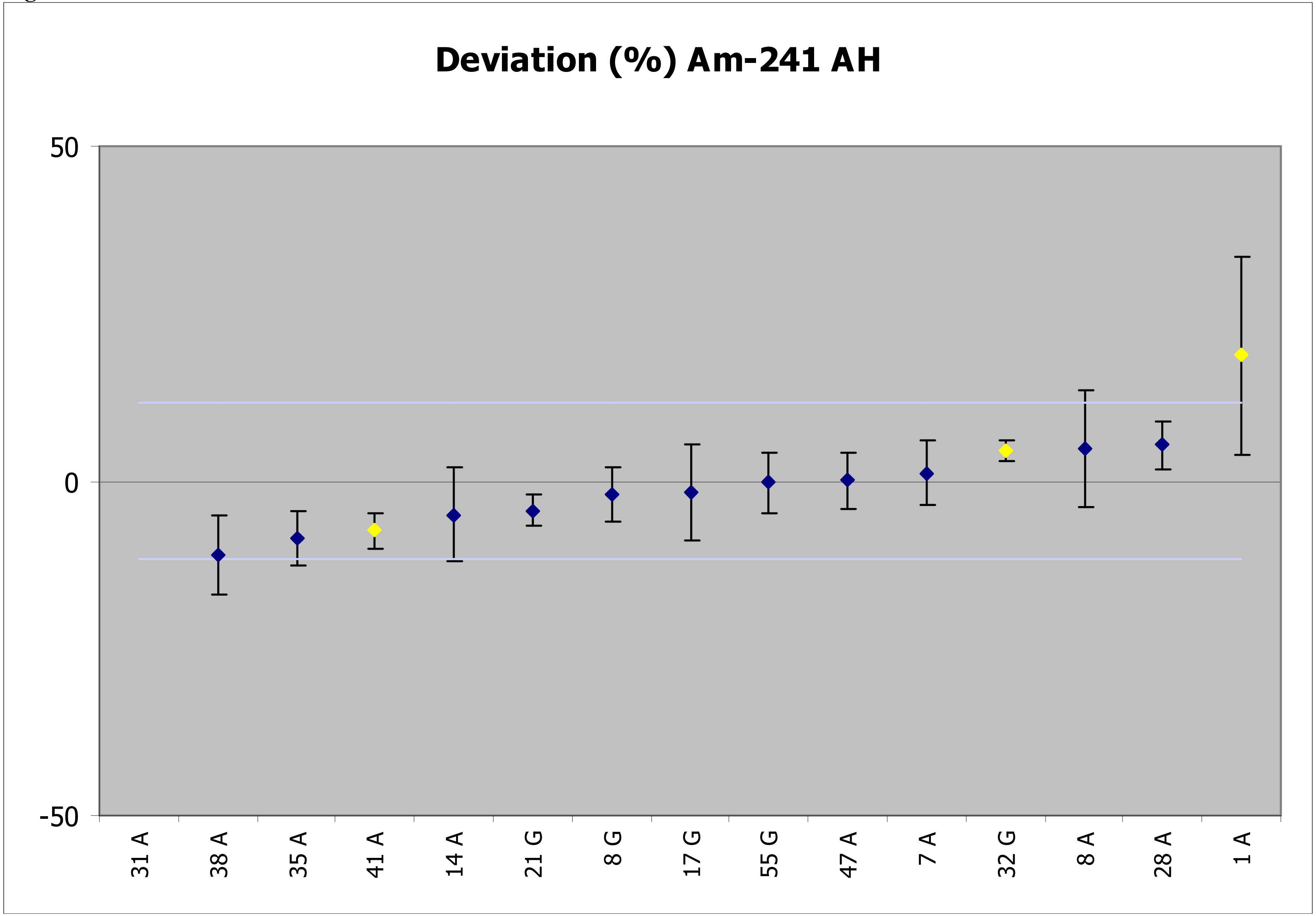


**Figure 18B – Zeta score Am-241 AH**

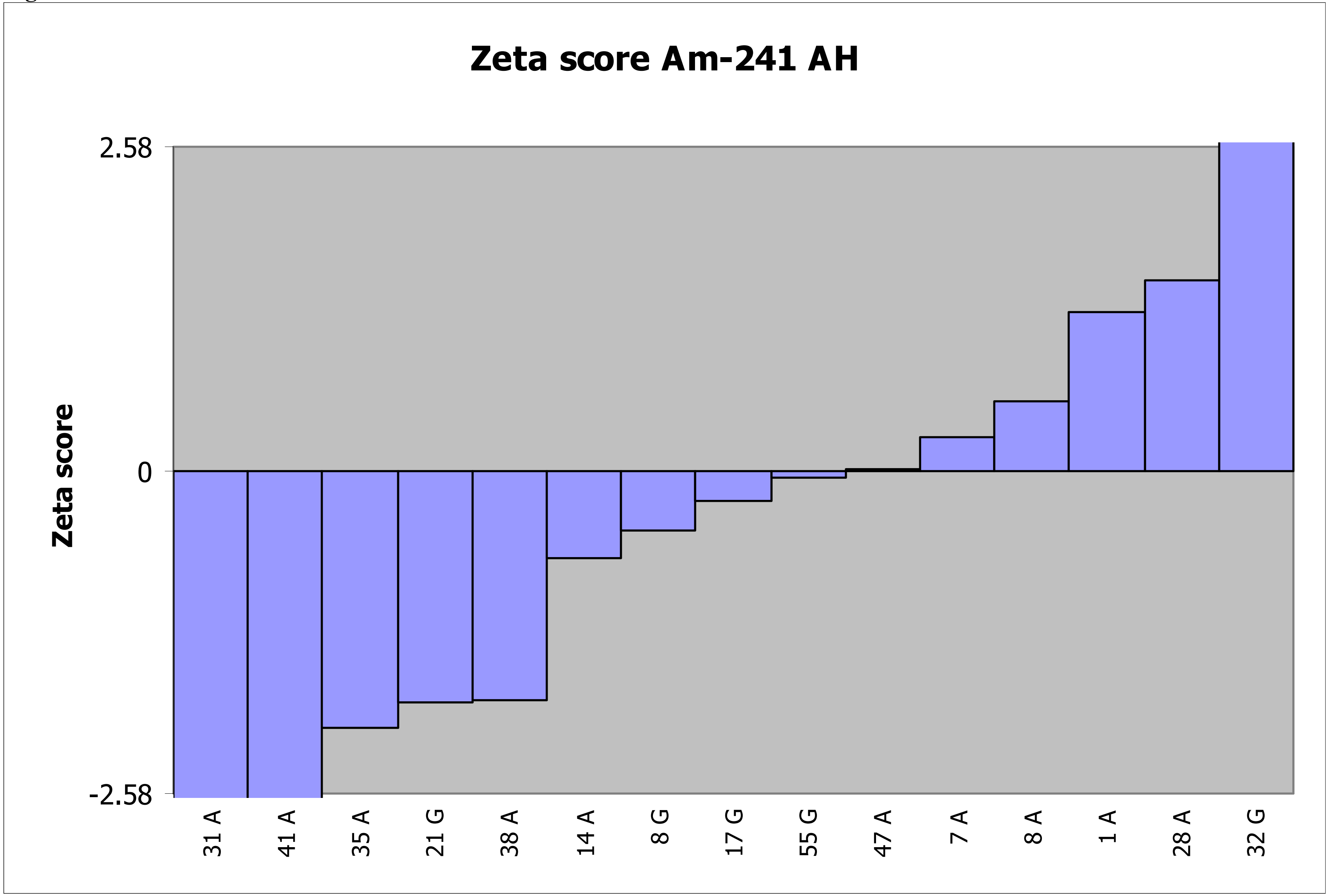


**Figure 18C – Relative uncertainty Am-241 AH**

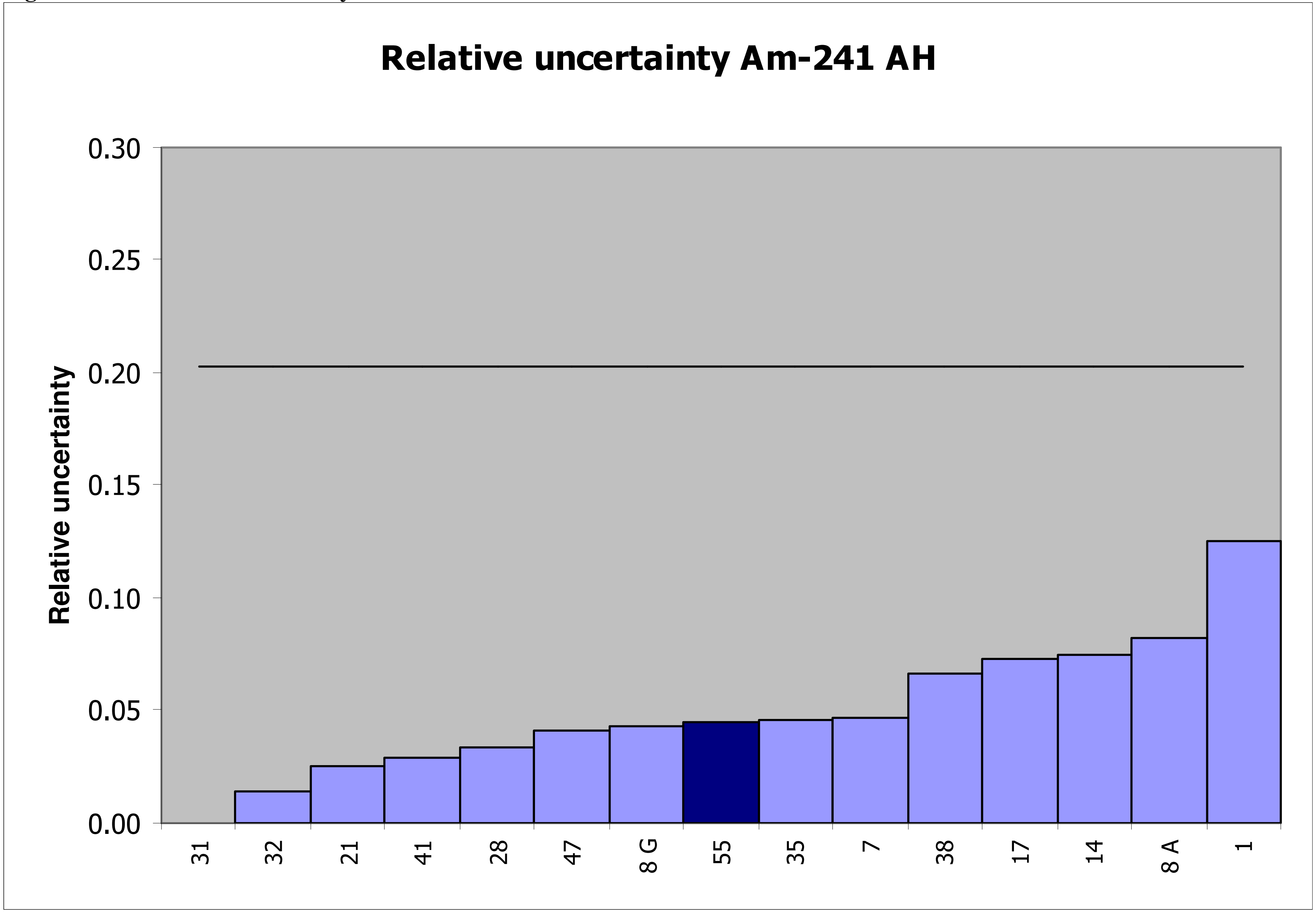


**Figure 18D – Kiri plot Am-241 AH**

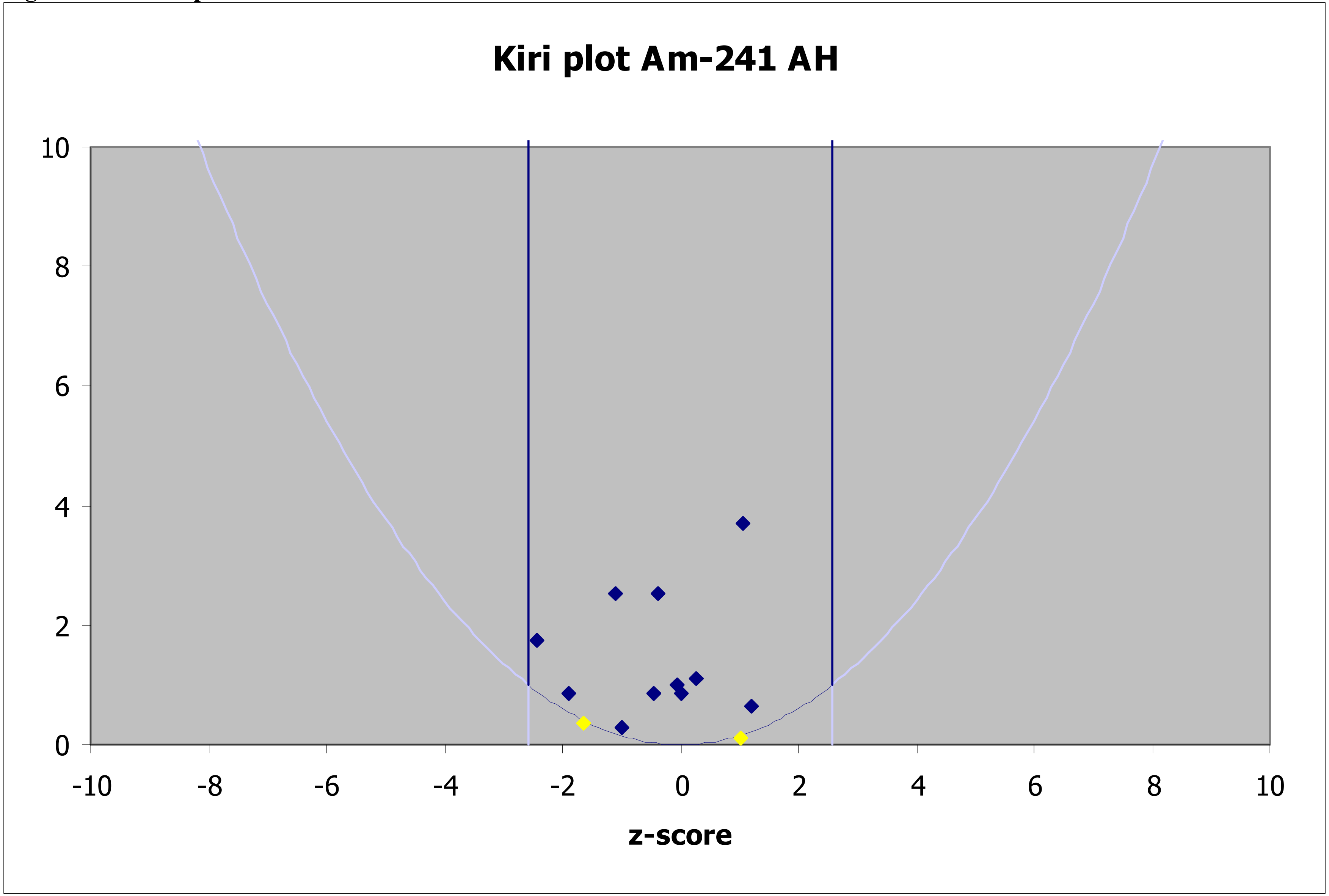


**Figure 19A – Deviation Cm-244 AH**

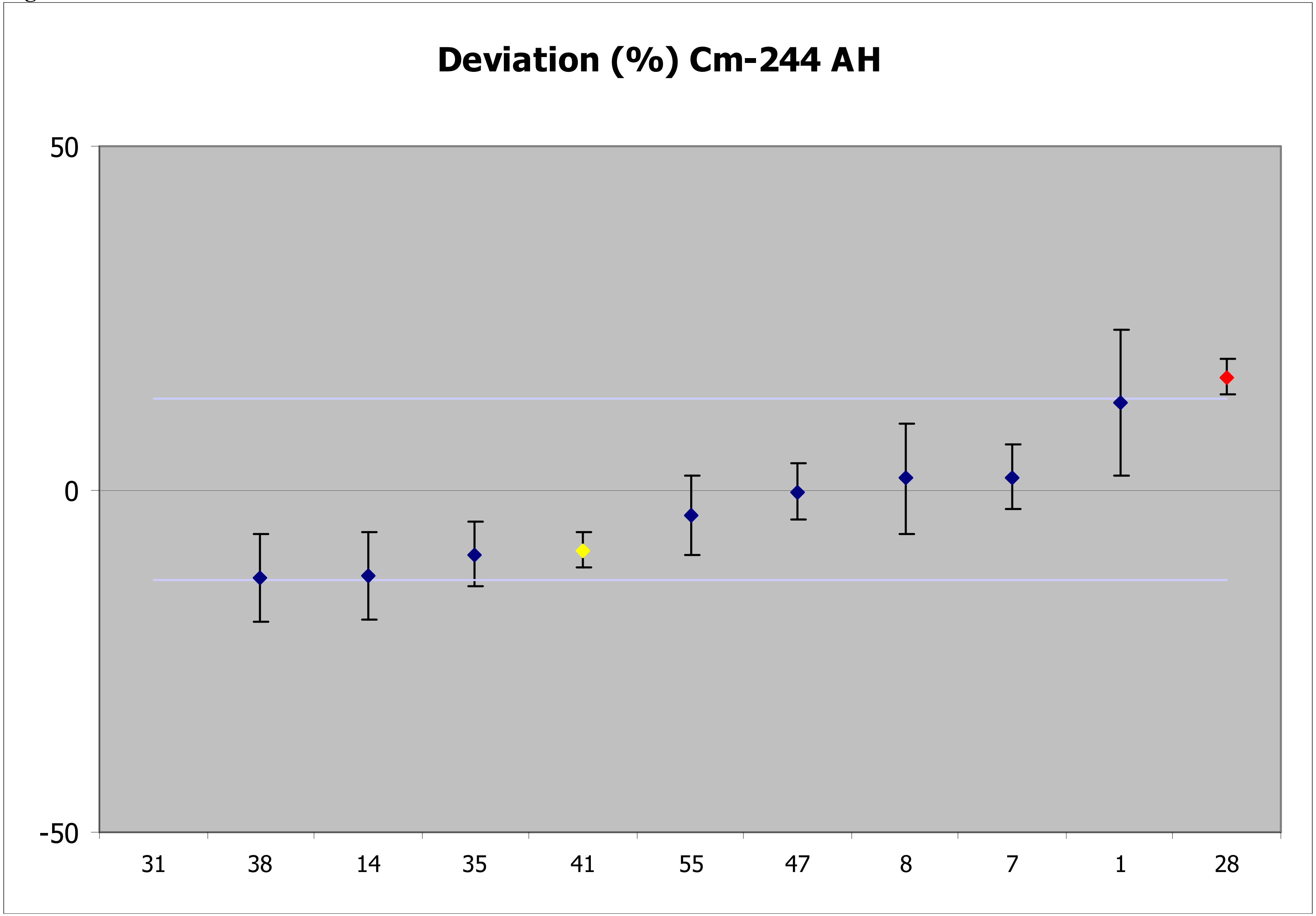


**Figure 19B – Zeta score Cm-244 AH**

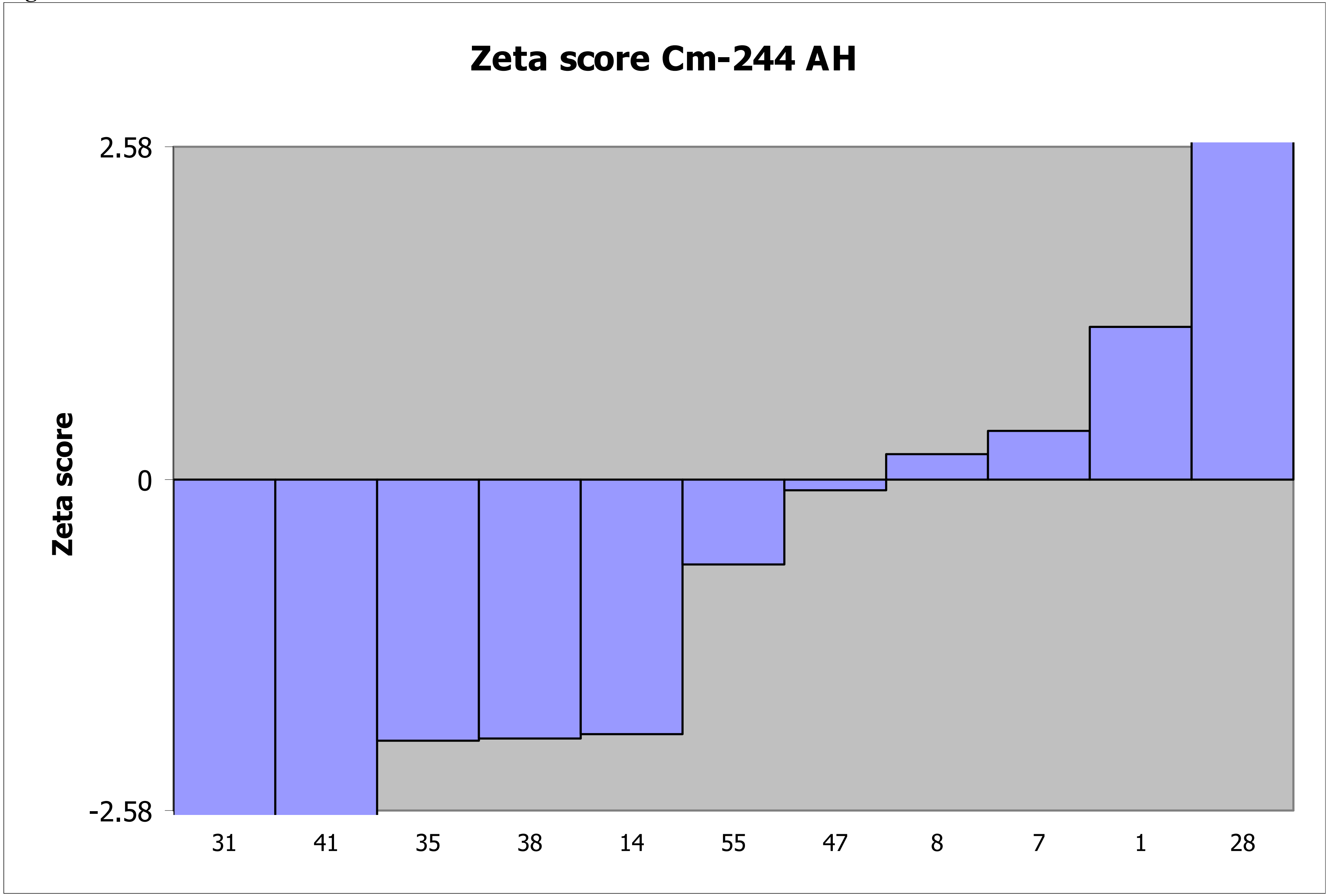


**Figure 19C – Relative uncertainty Cm-244 AH**

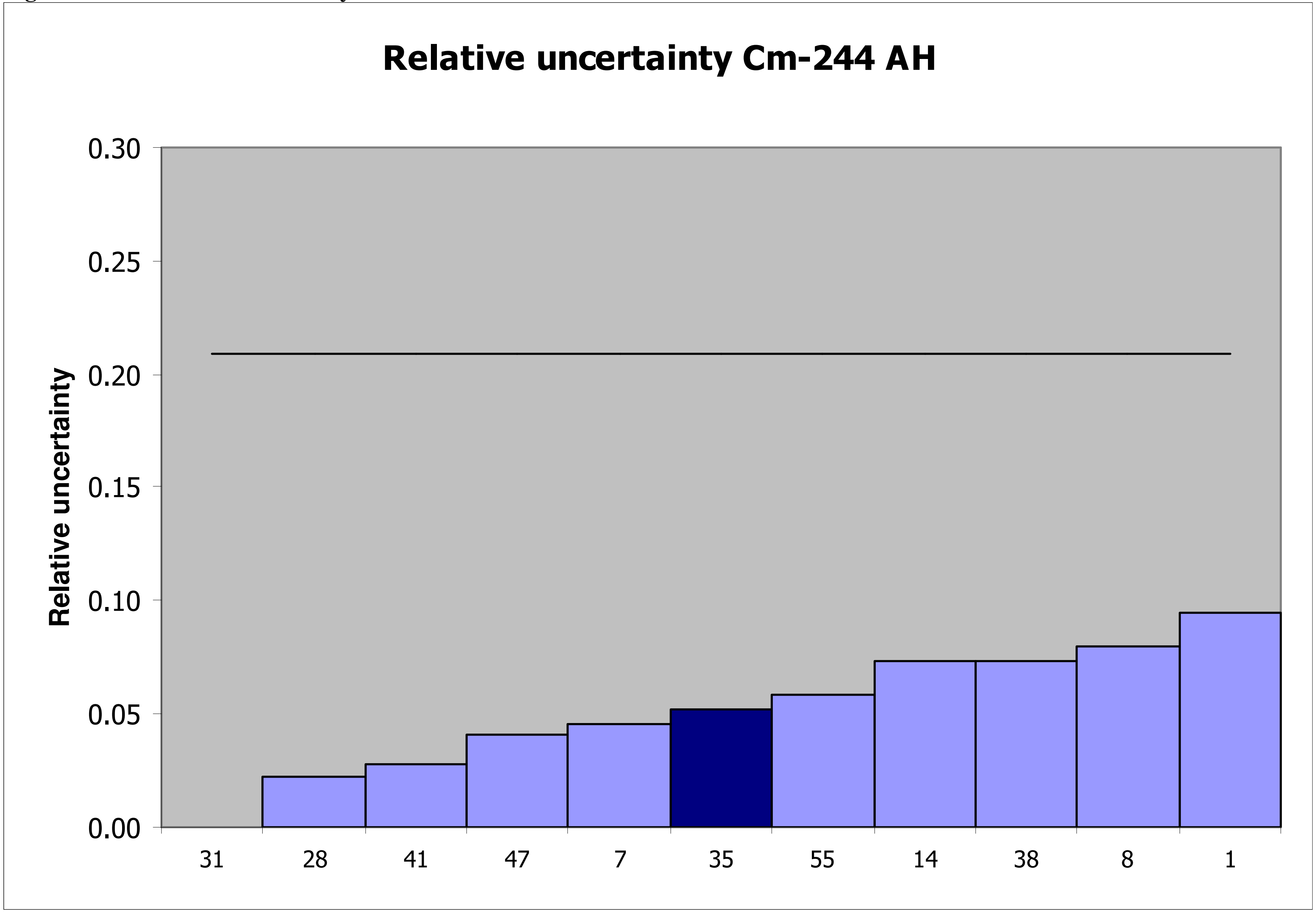


**Figure 19D – Kiri plot Cm-244 AH**

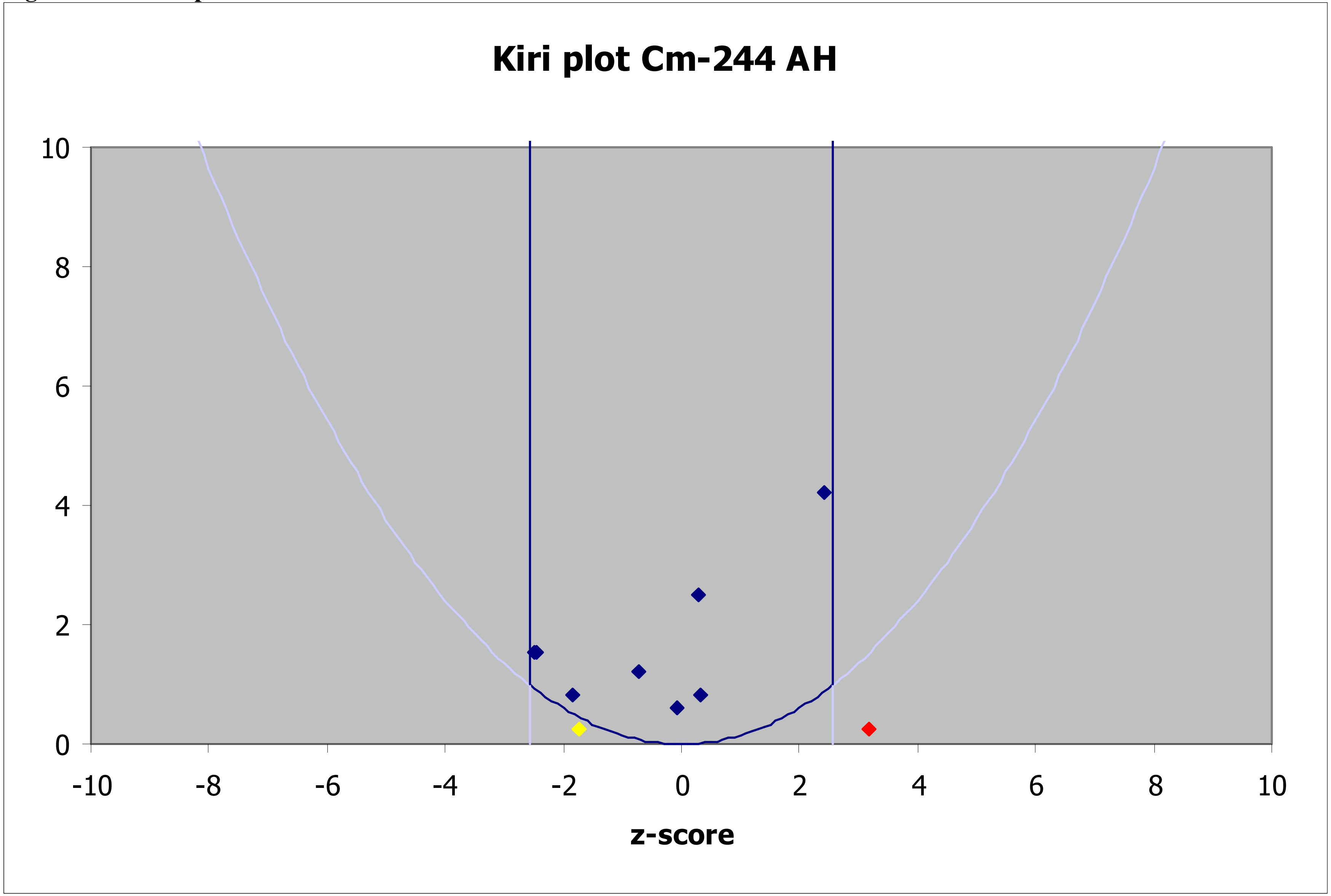


**Figure 20A – Deviation gross alpha AH**

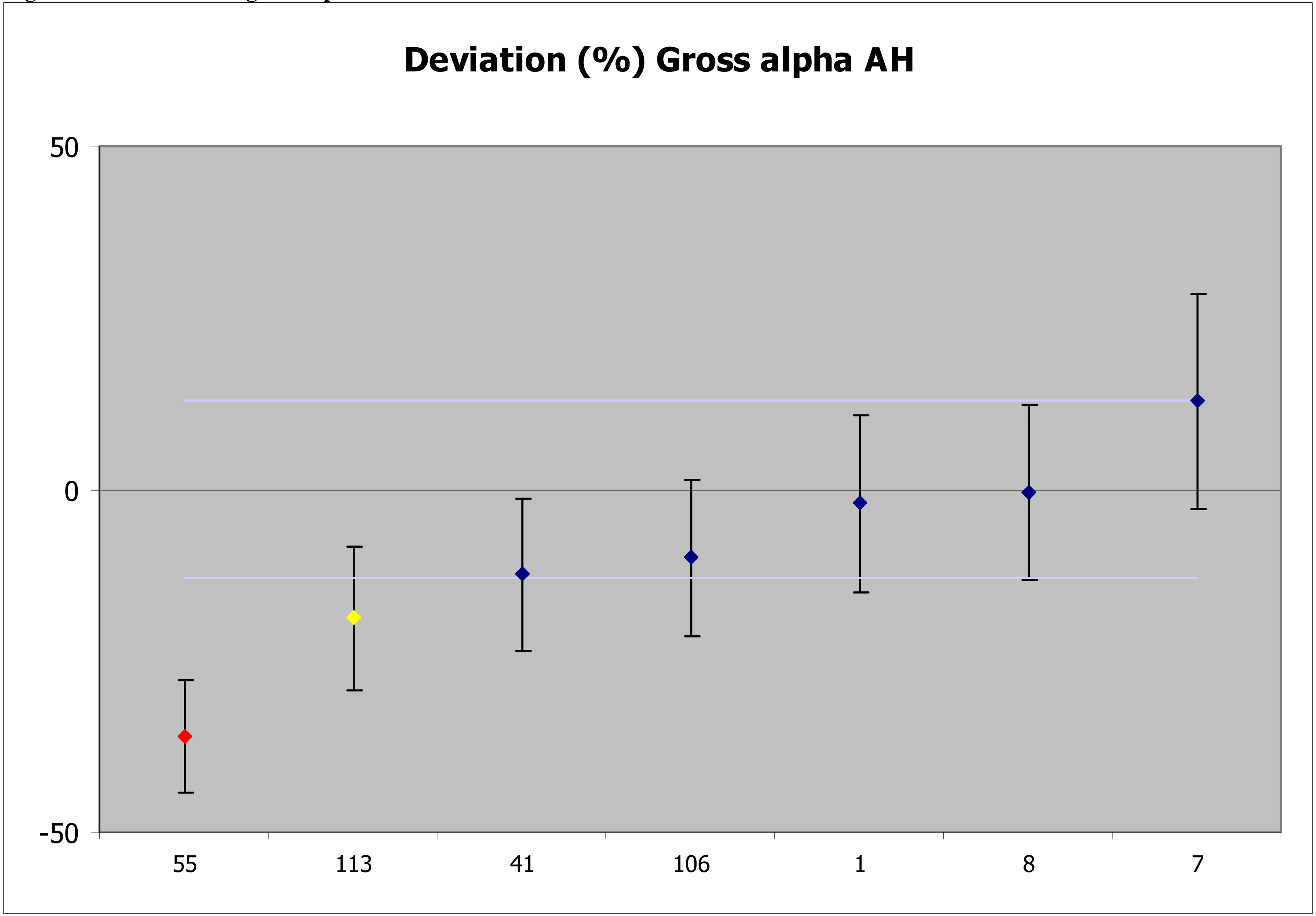


**Figure 20B – Zeta score gross alpha AH**

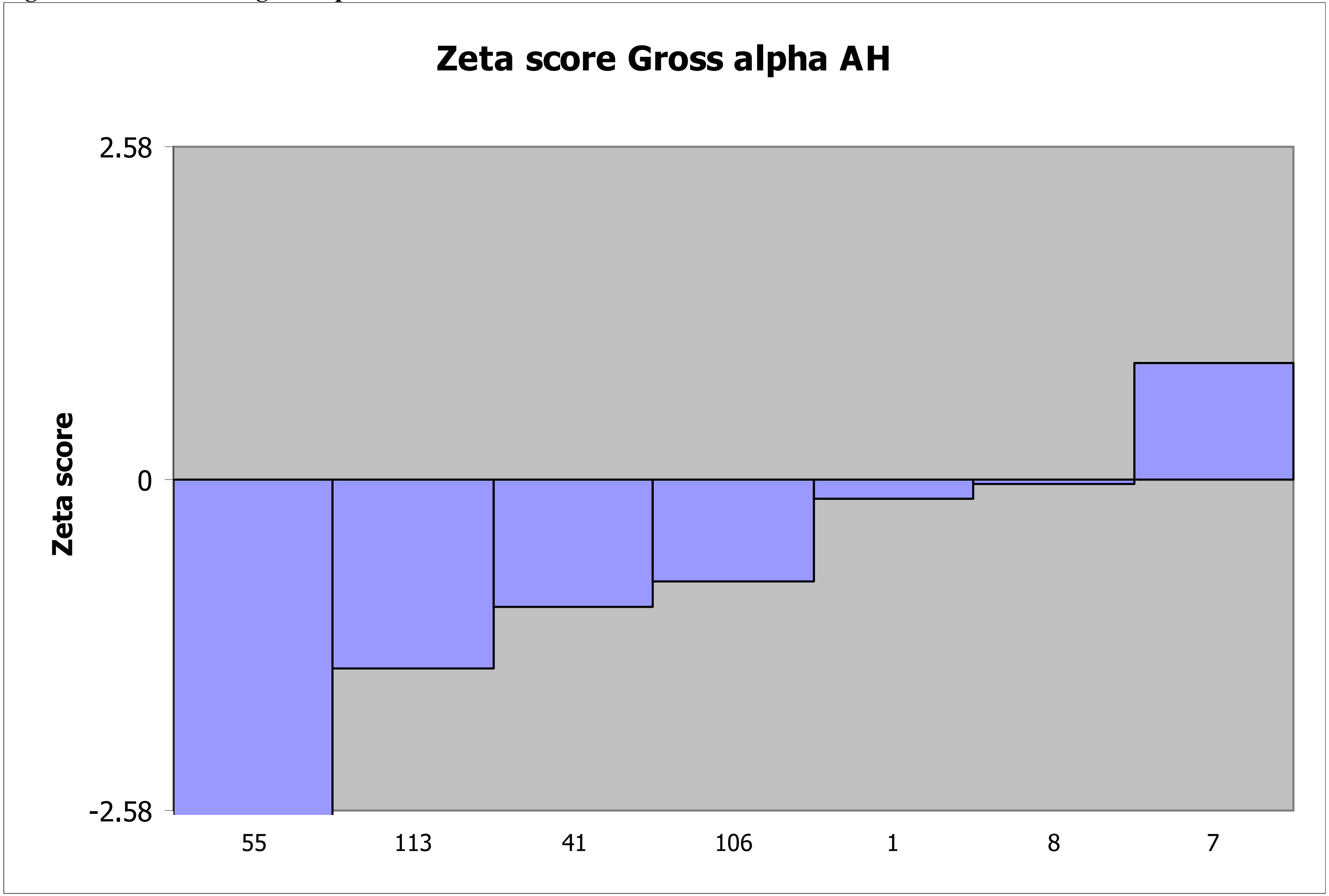


**Figure 20C – Relative uncertainty gross alpha AH**

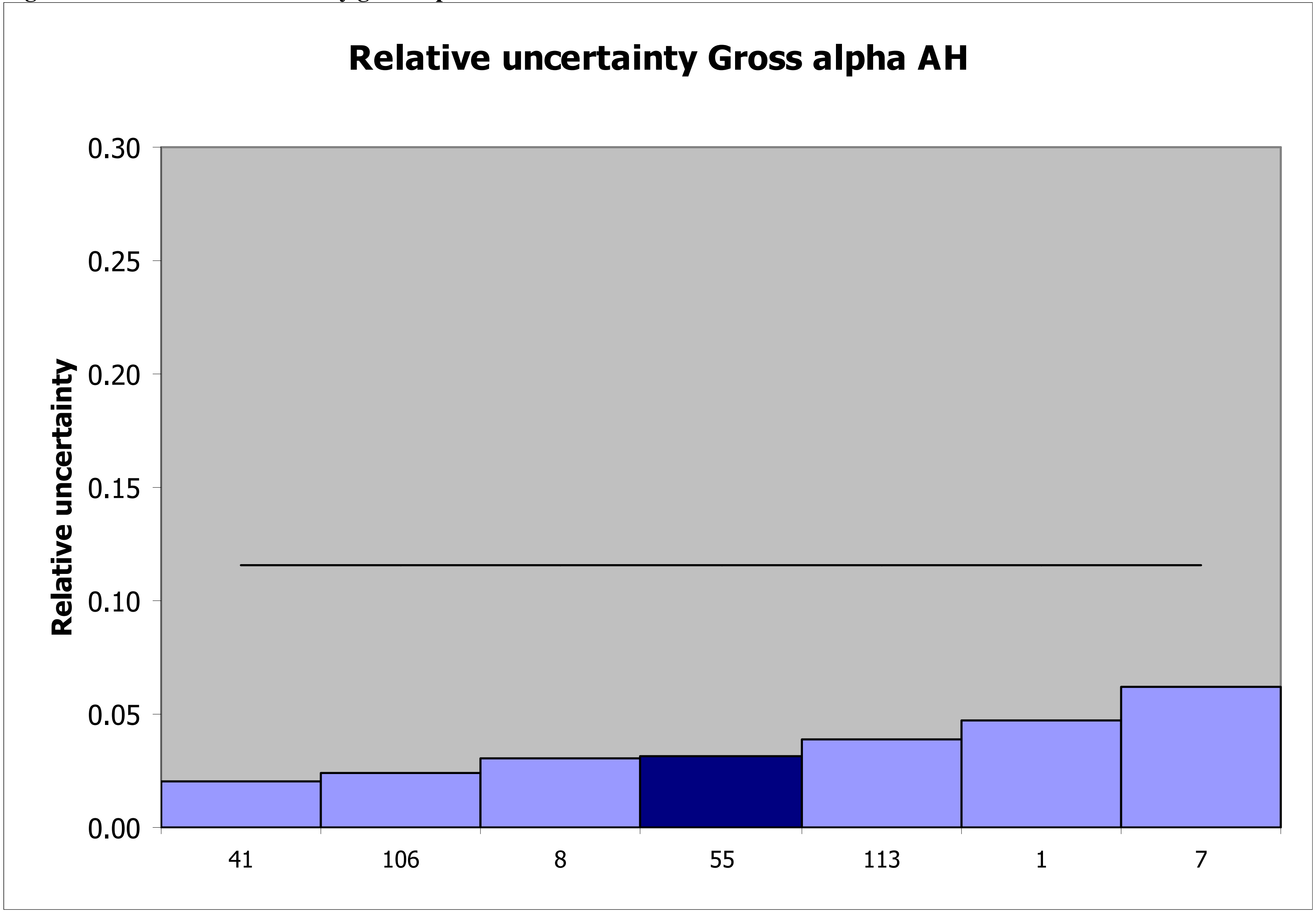


**Figure 20D – Kiri plot gross alpha AH**

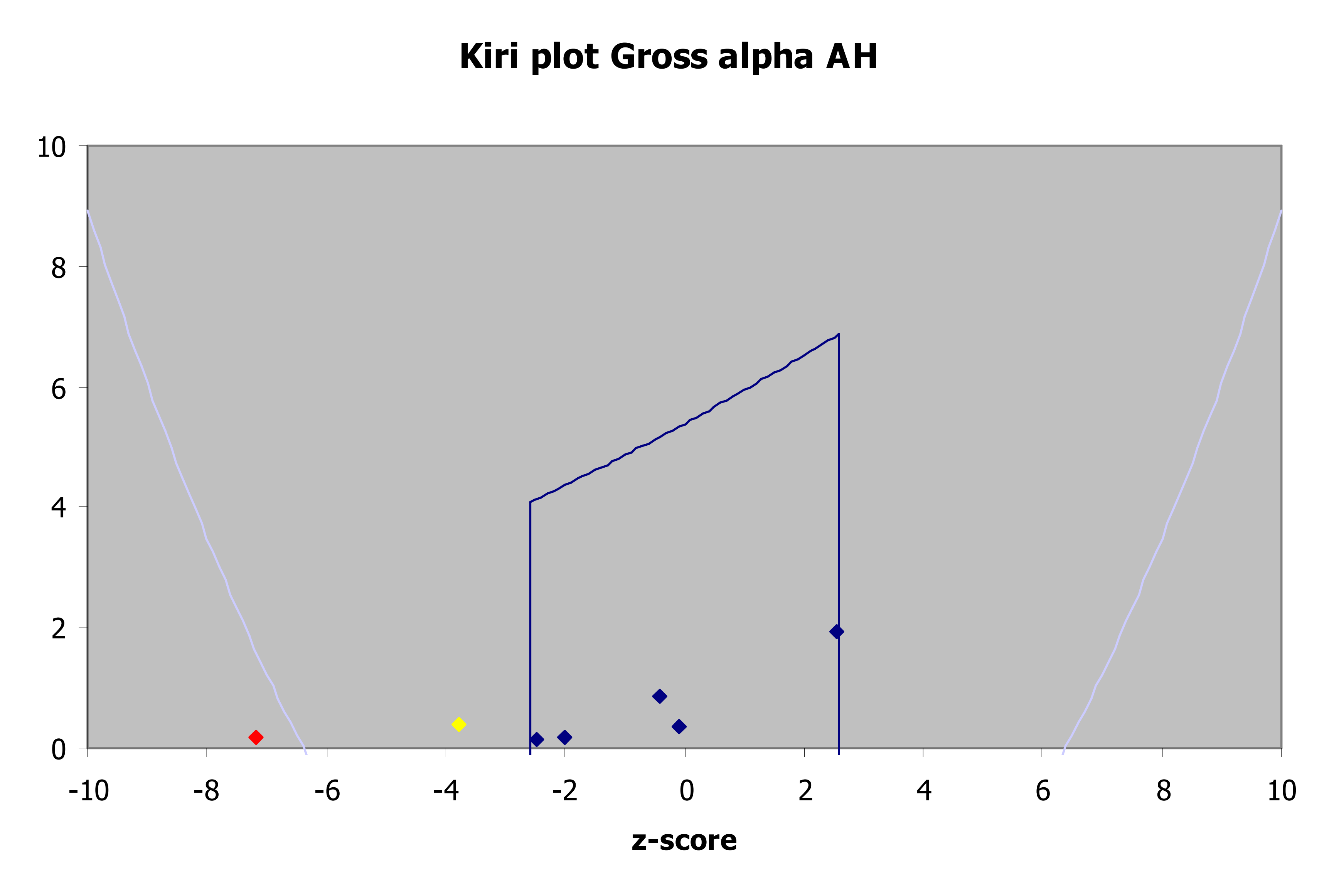


**Figure 21A – Deviation H-3 B1**

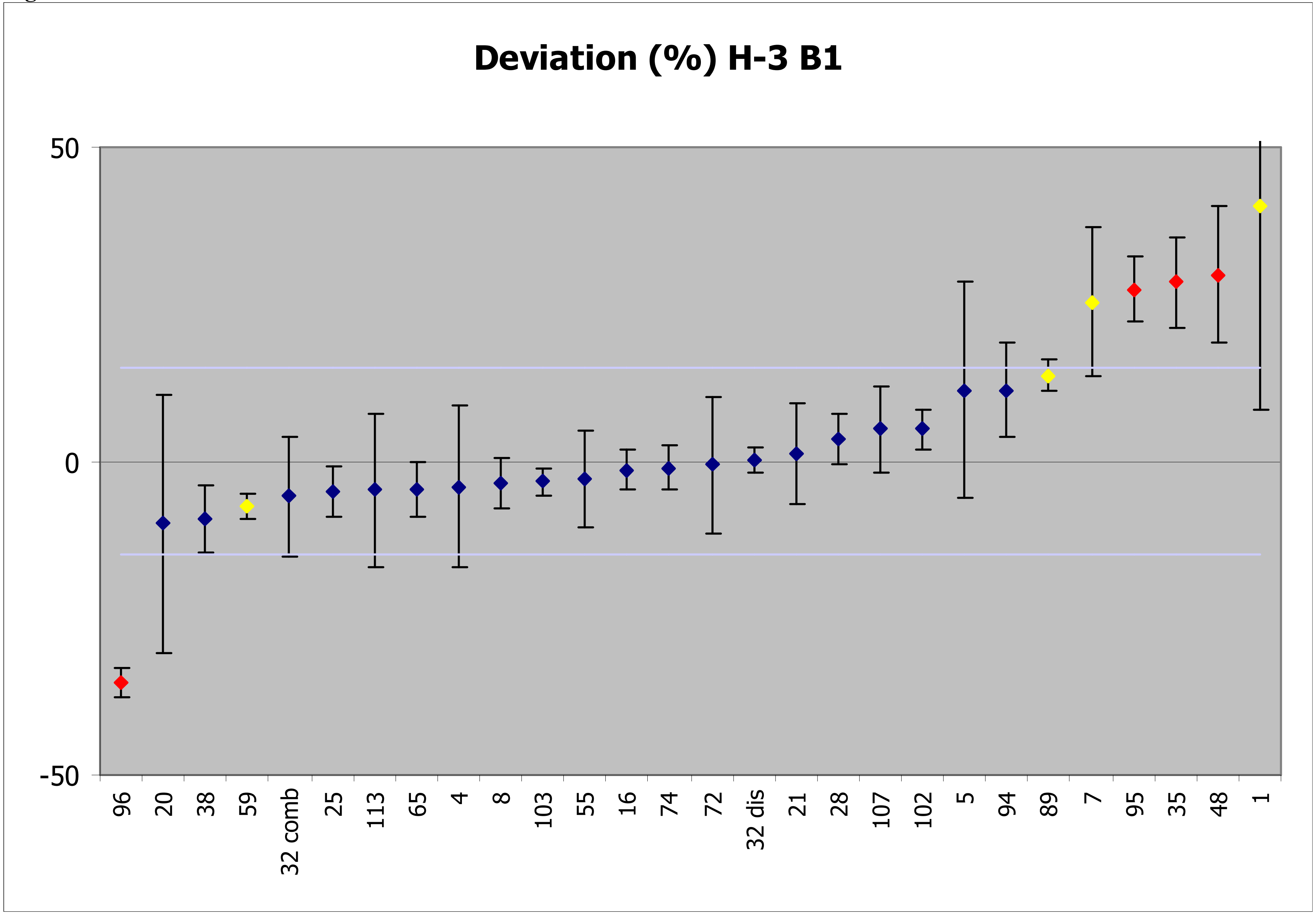


**Figure 21B – Zeta score H-3 B1**

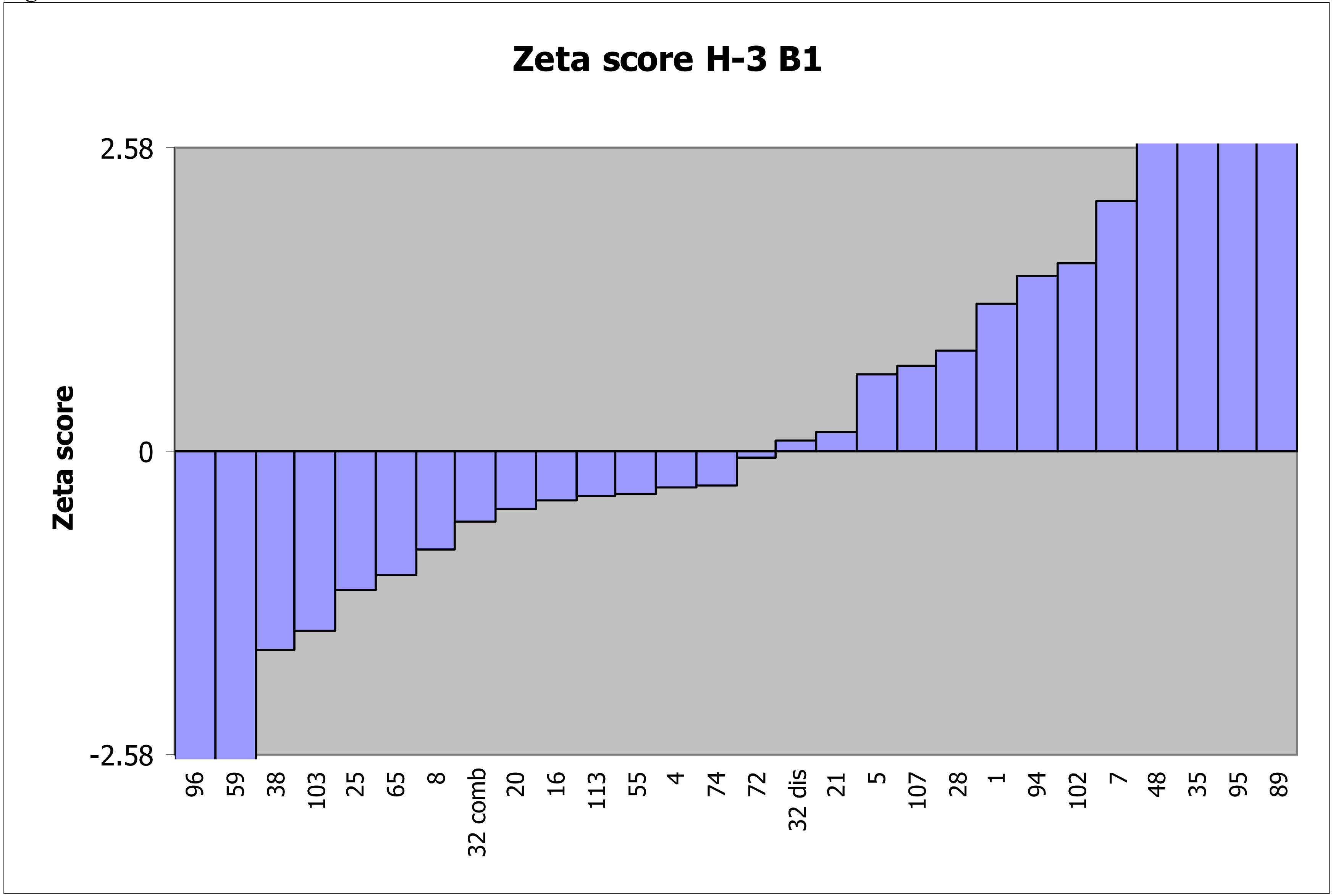


**Figure 21C – Relative uncertainty H-3 B1**

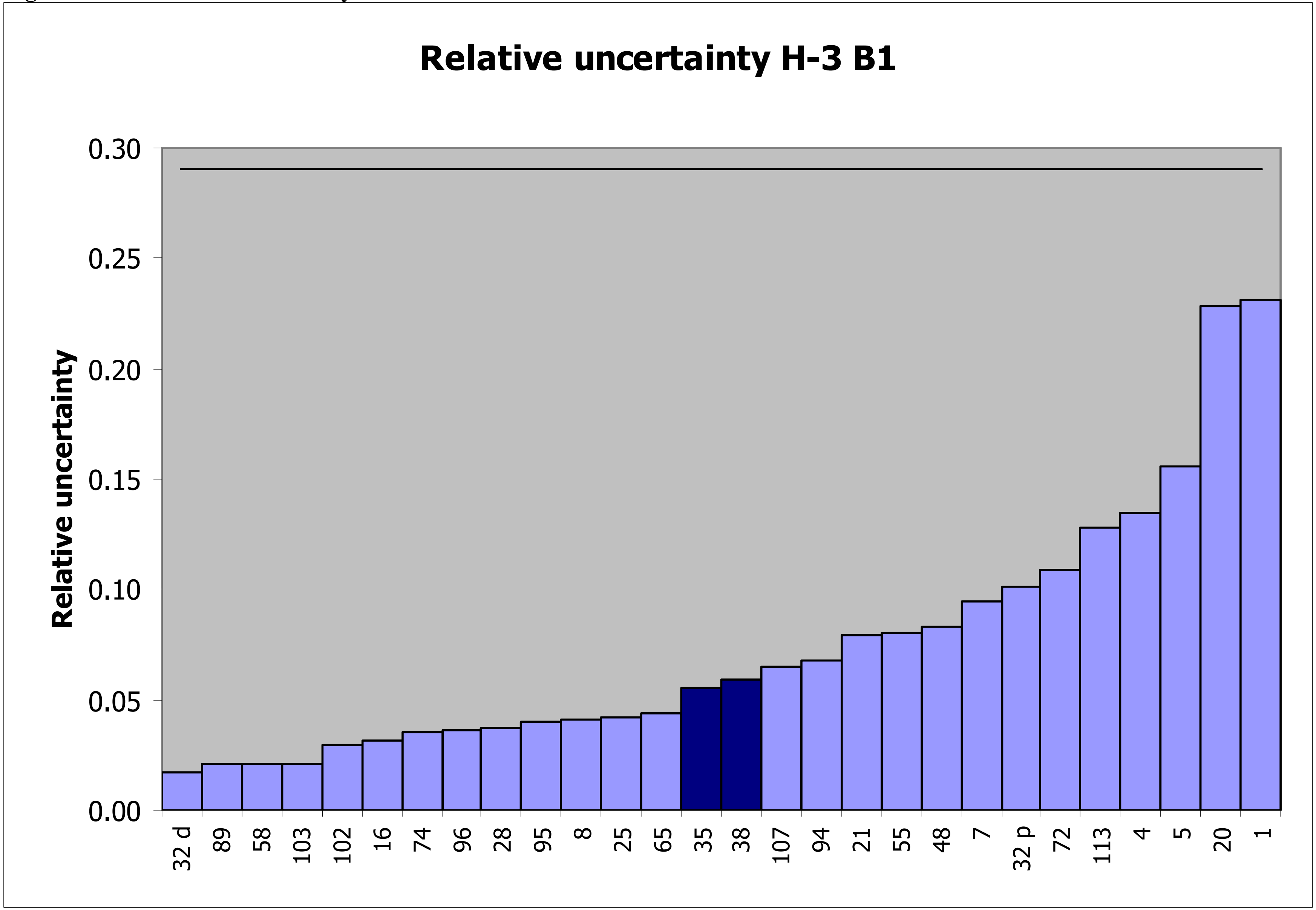


**Figure 21D – Kiri plot H-3 B1**

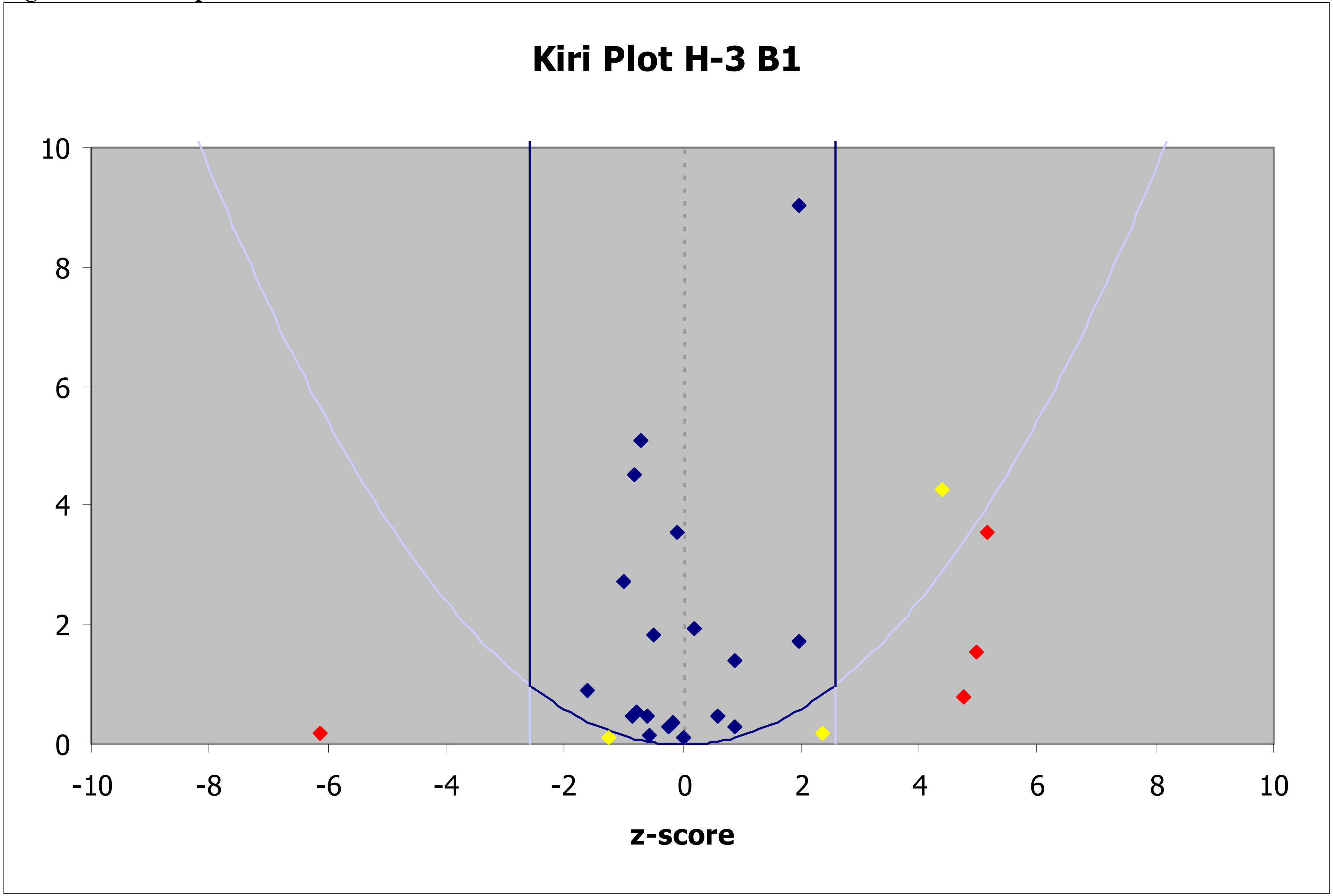


**Figure 22A – Deviation C-14 B1**

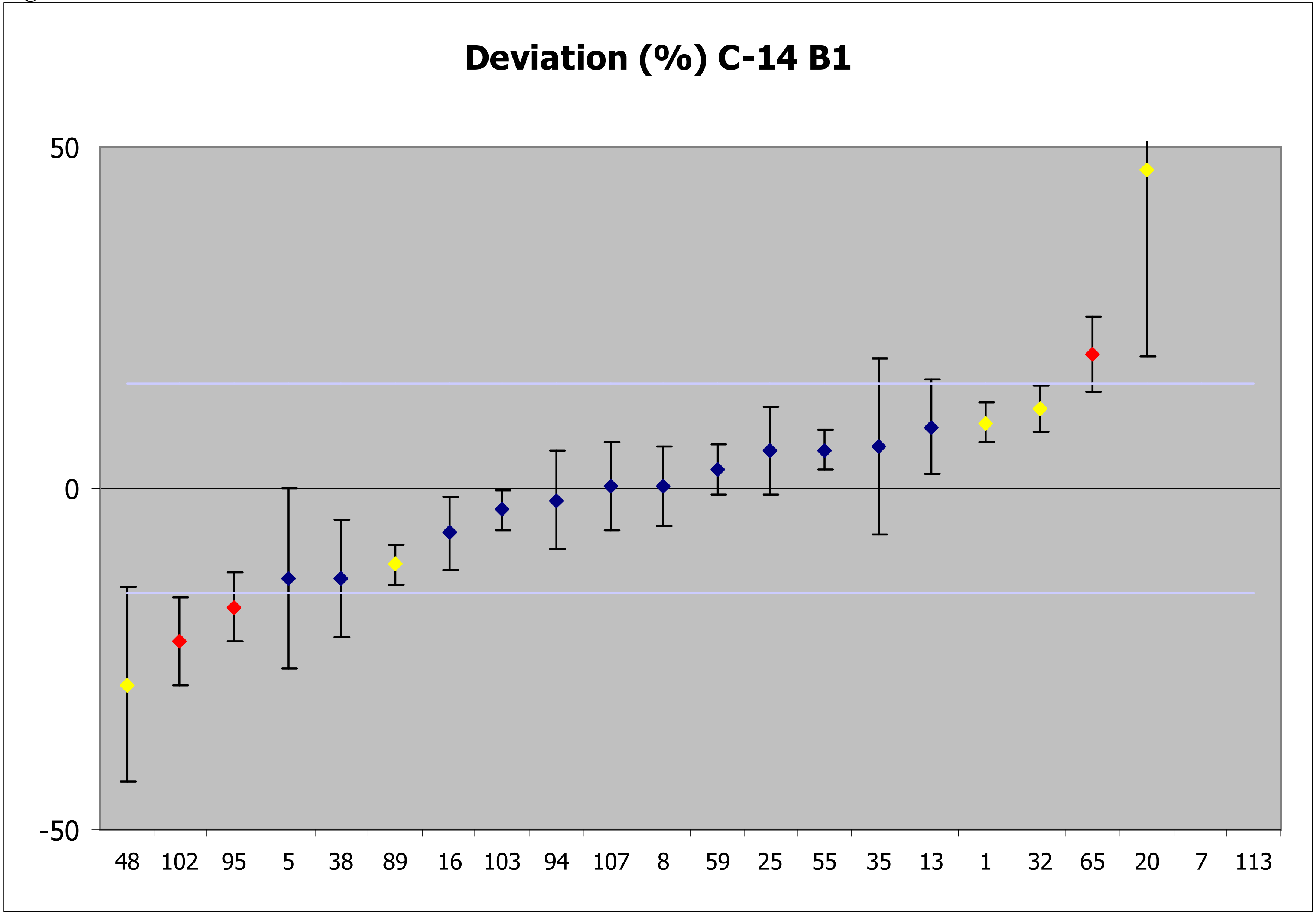


**Figure 22B – Zeta score C-14 B1**

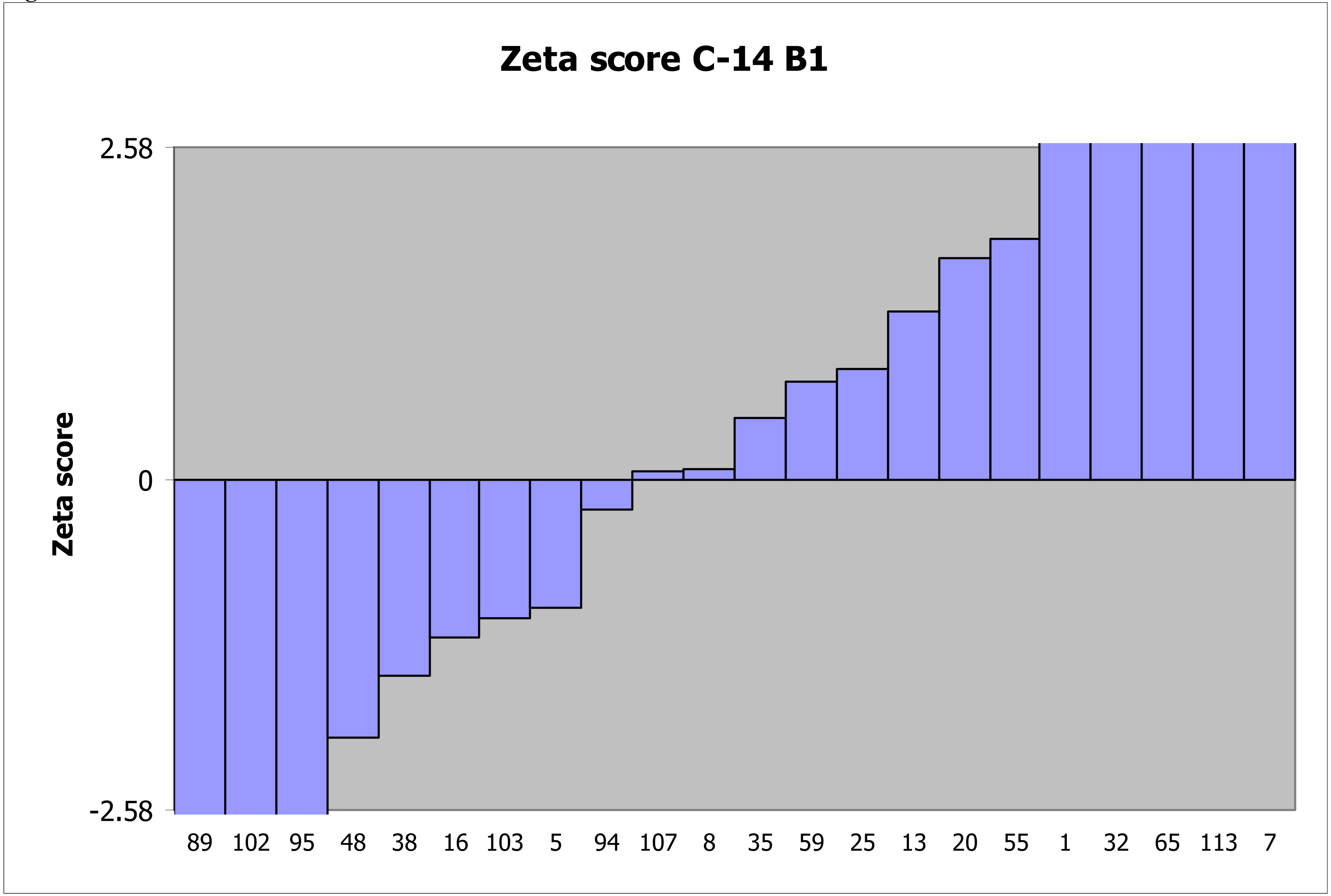


**Figure 22C – Relative uncertainty C-14 B1**

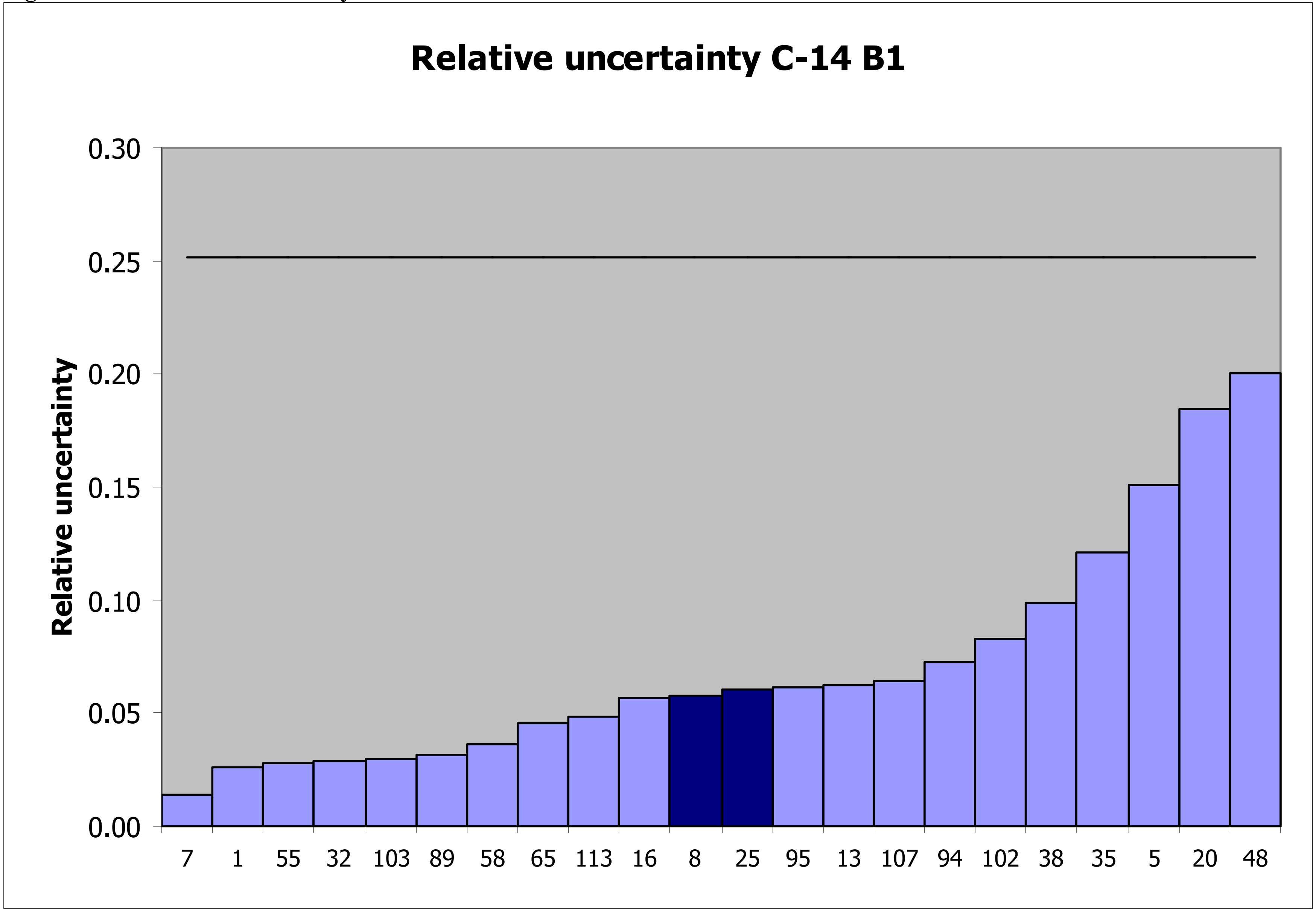


**Figure 22D – Kiri plot C-14 B1**

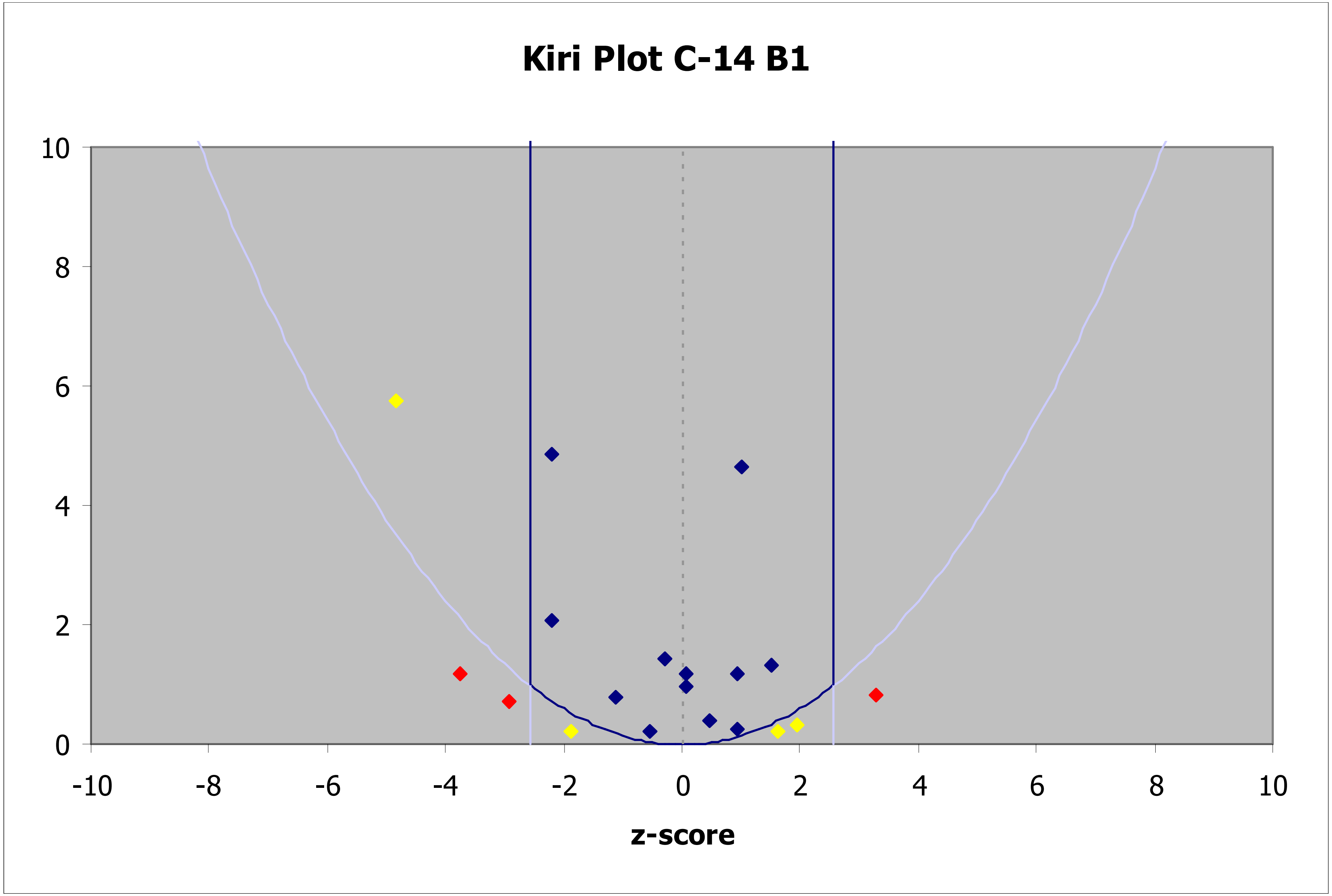


**Figure 23A – Deviation Tc-99 B1**

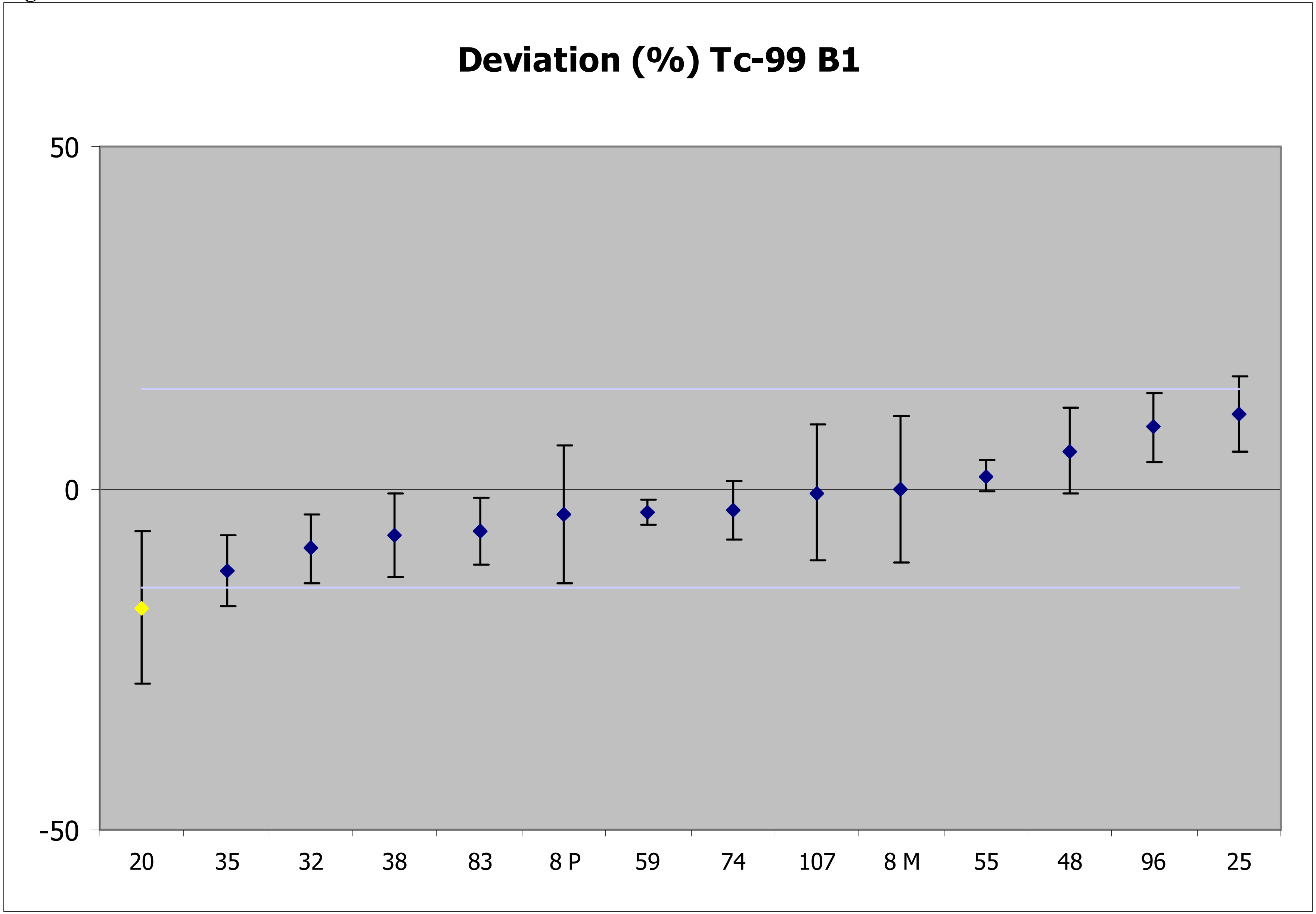


**Figure 23B – Zeta score Tc-99 B1**

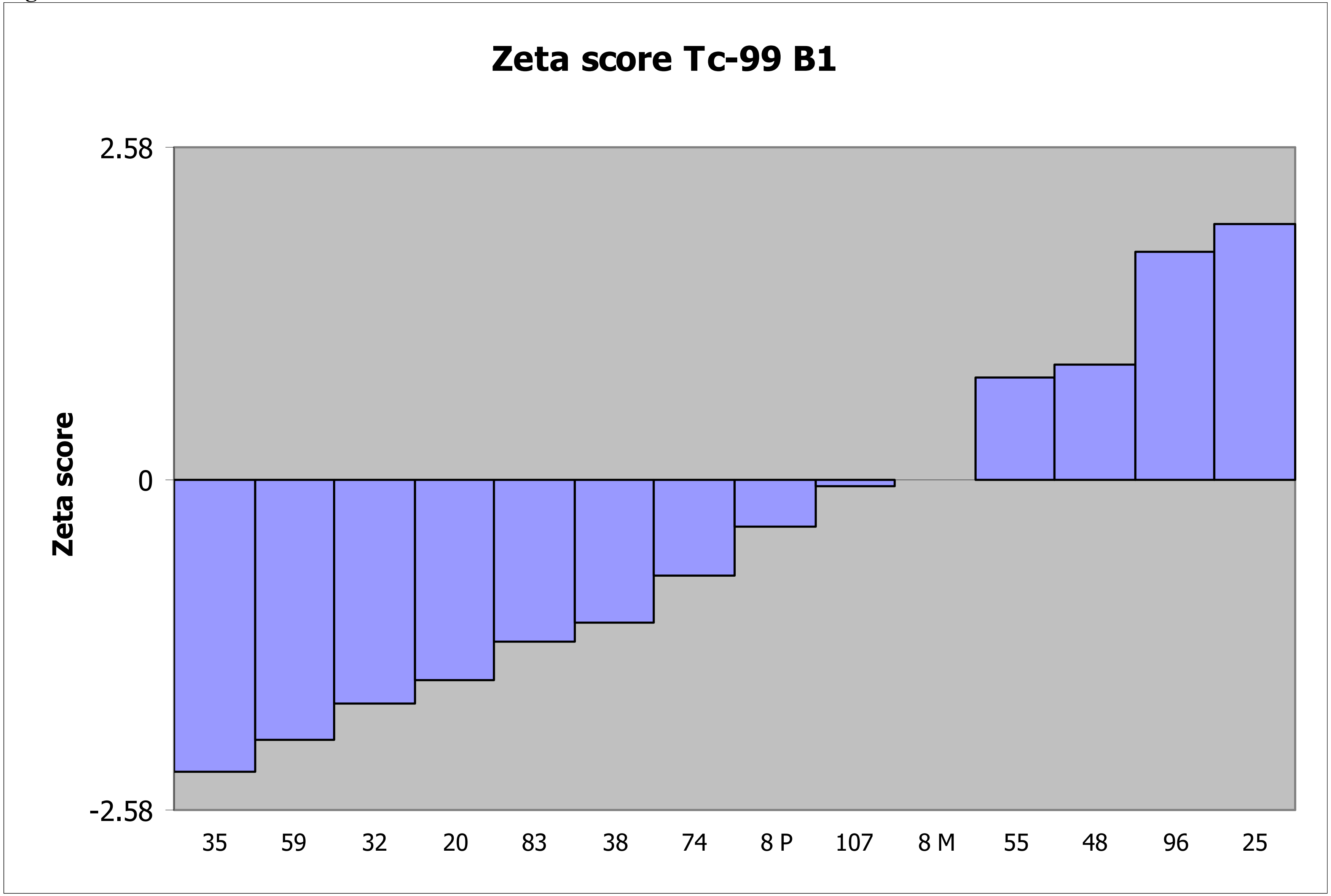


**Figure 23C – Relative uncertainty Tc-99 B1**

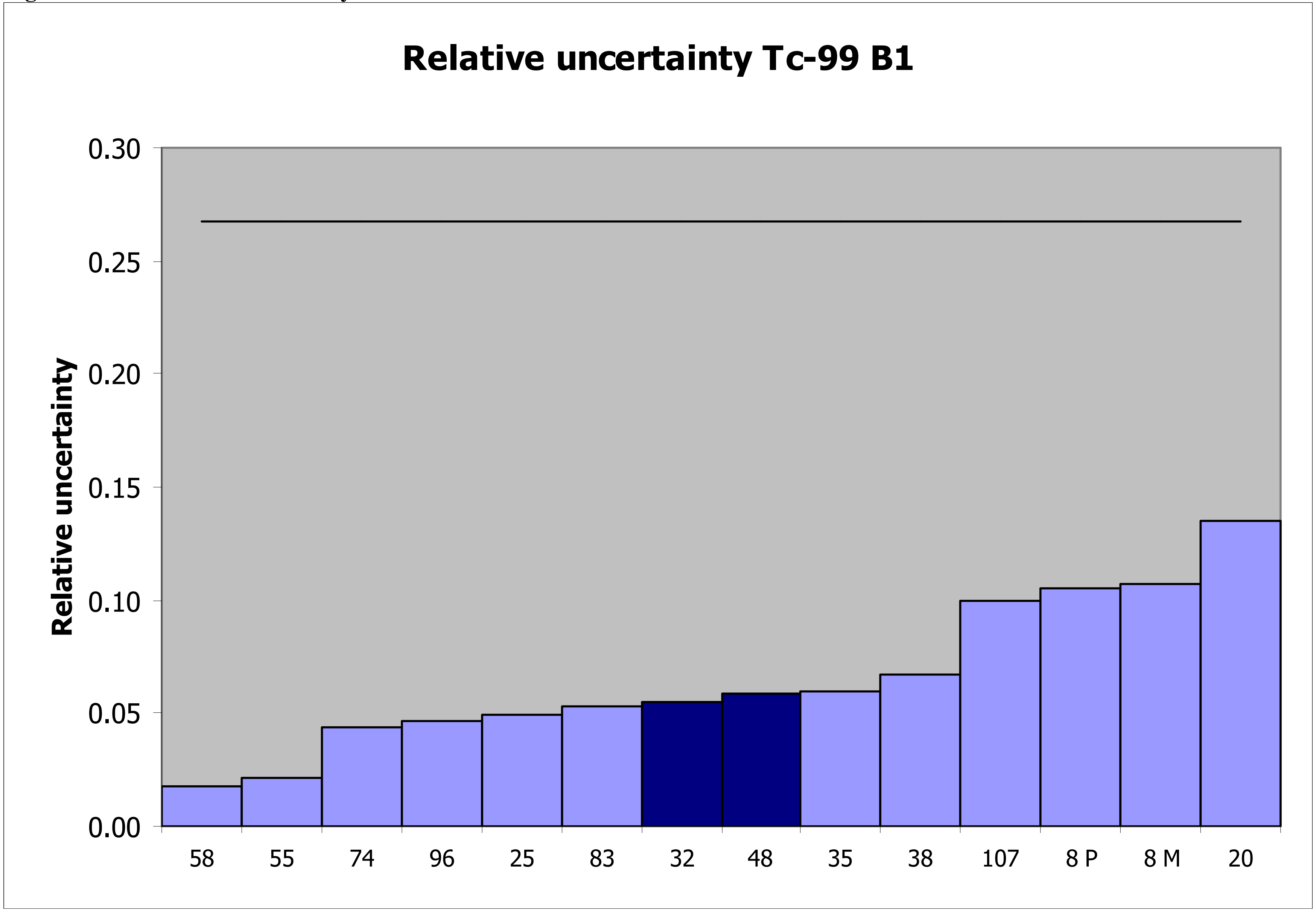


**Figure 23D – Kiri plot Tc-99 B1**

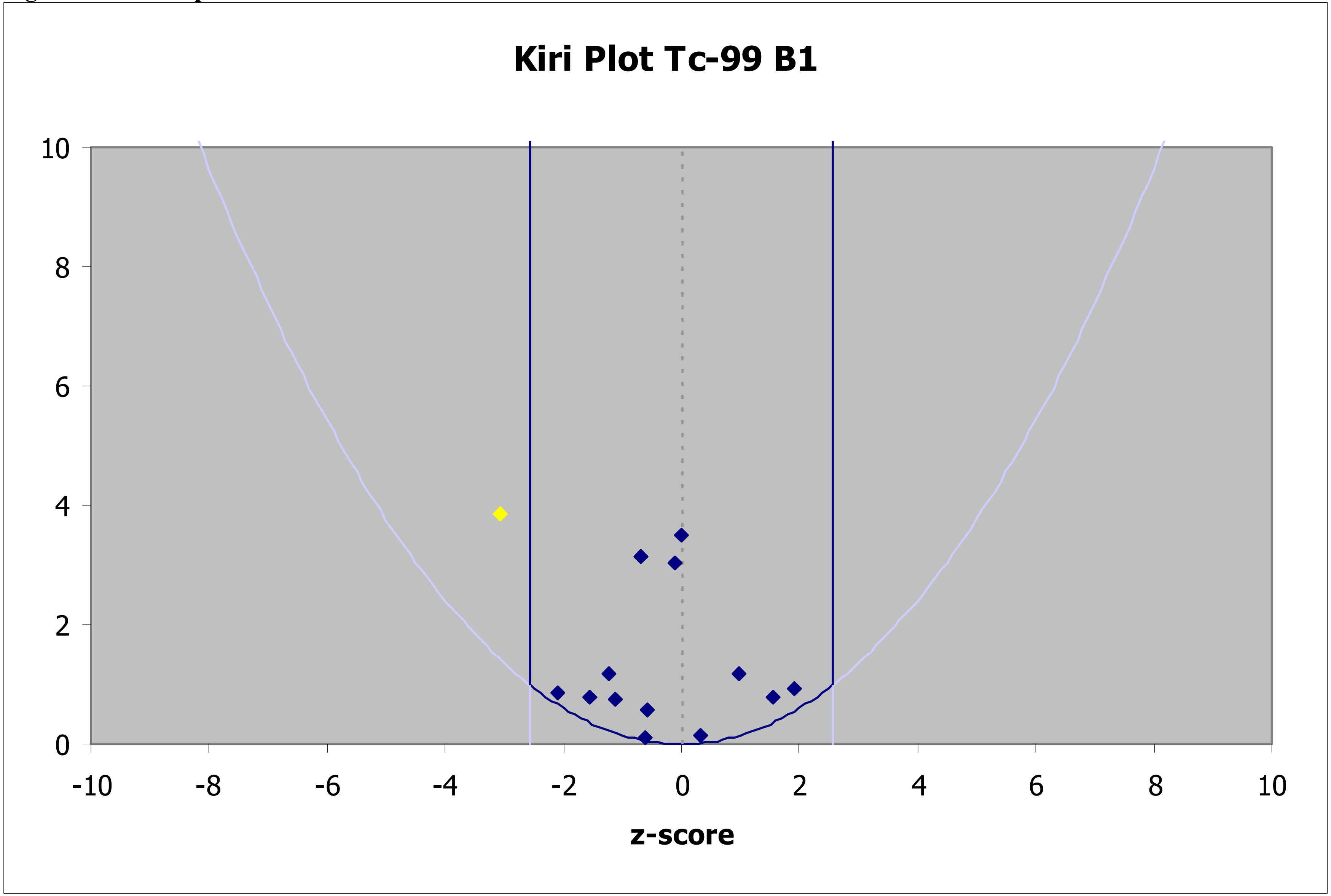


**Figure 24A – Deviation H-3 B2**

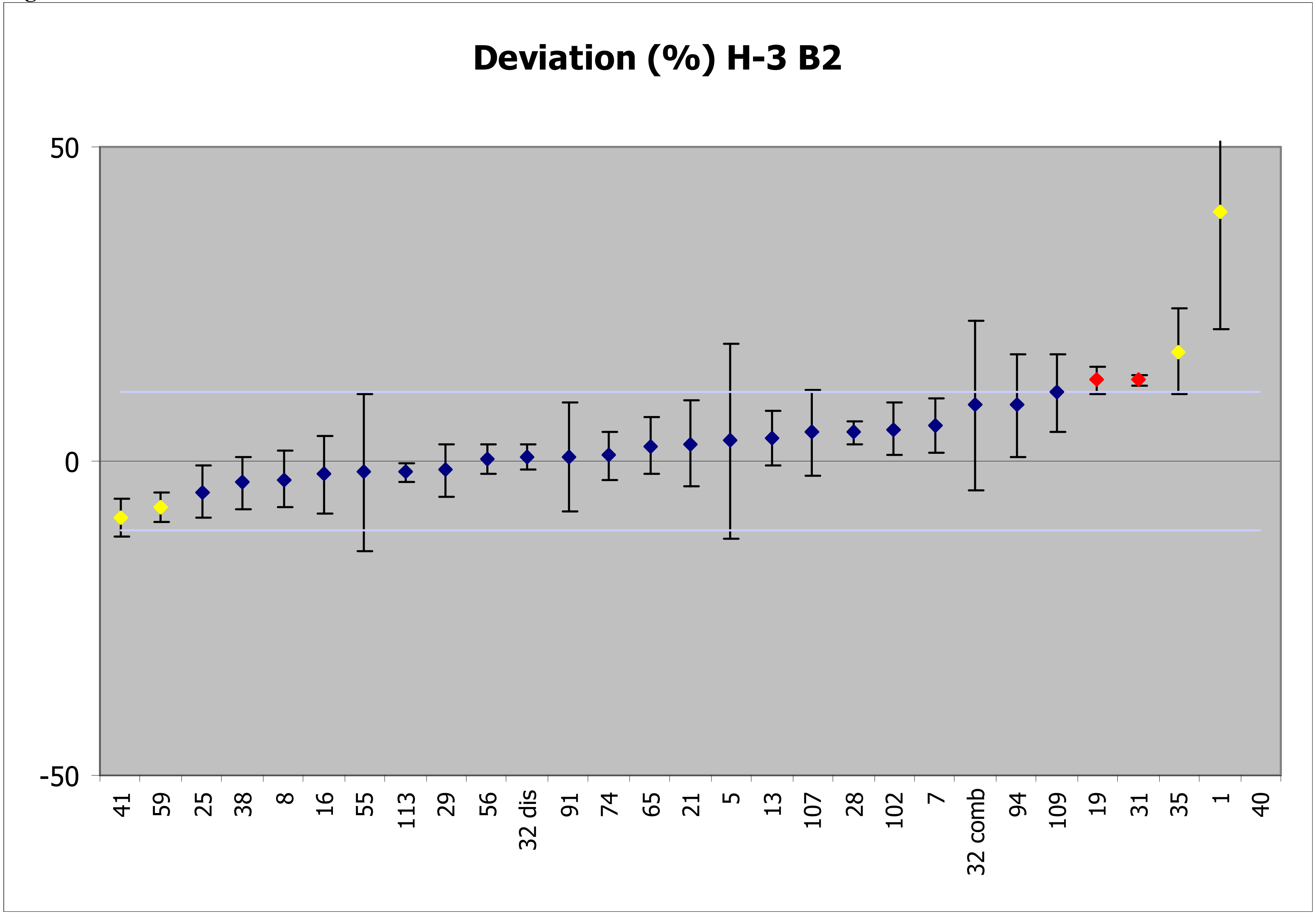


**Figure 24B – Zeta score H-3 B2**

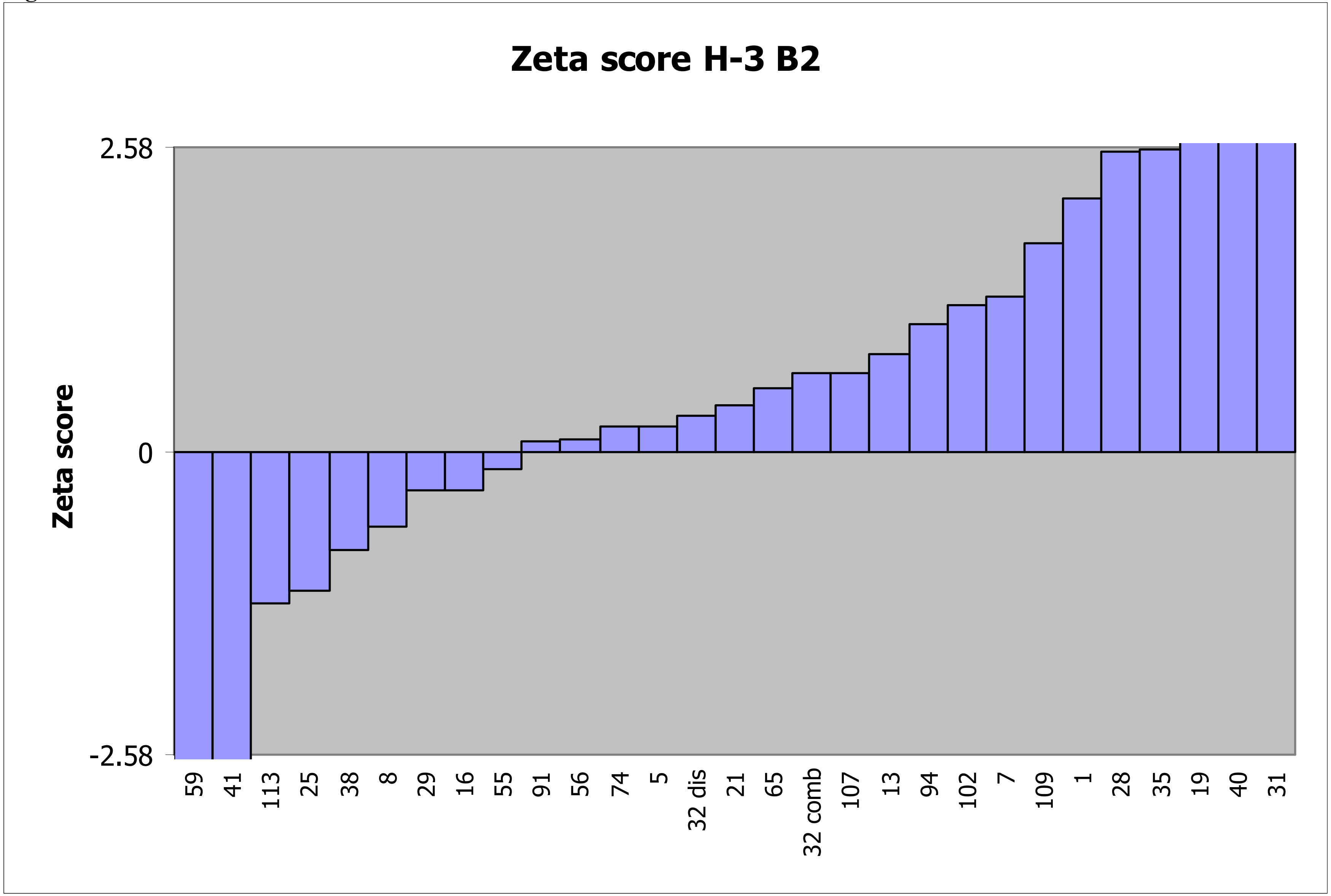


**Figure 24C – Relative uncertainty H-3 B2**

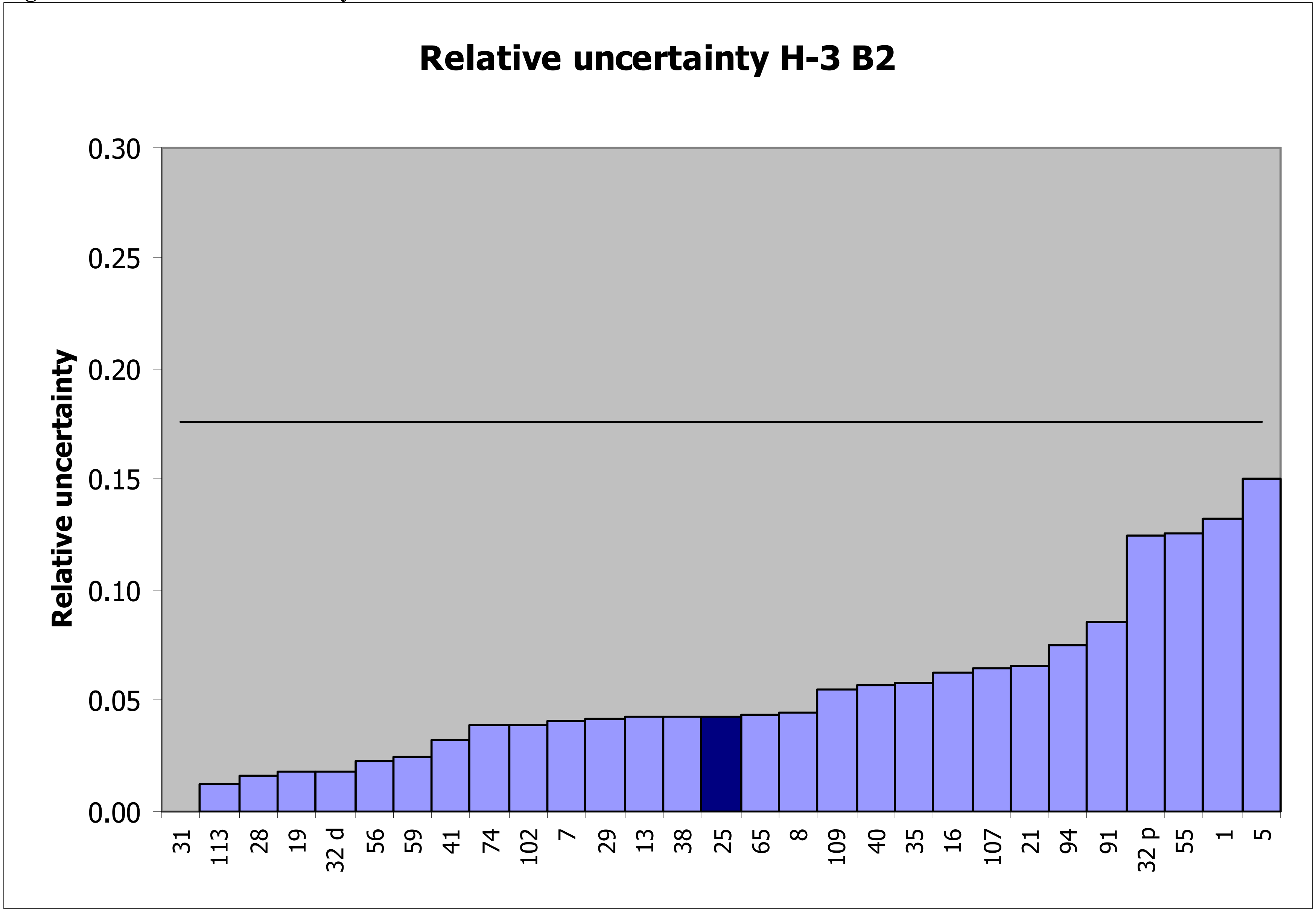


**Figure 24D – Kiri plot H-3 B2**

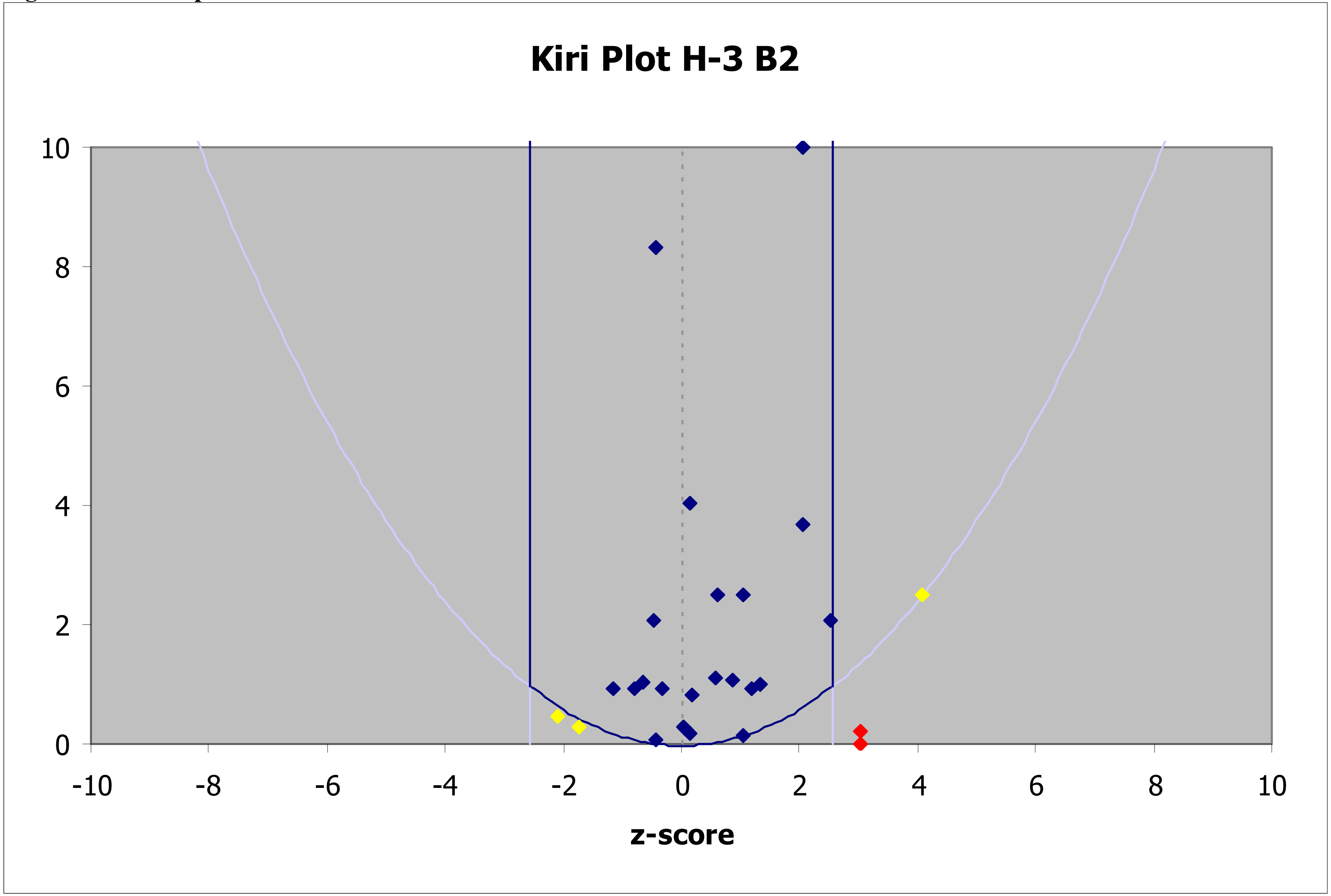


**Figure 25A – Deviation Fe-55 B2**

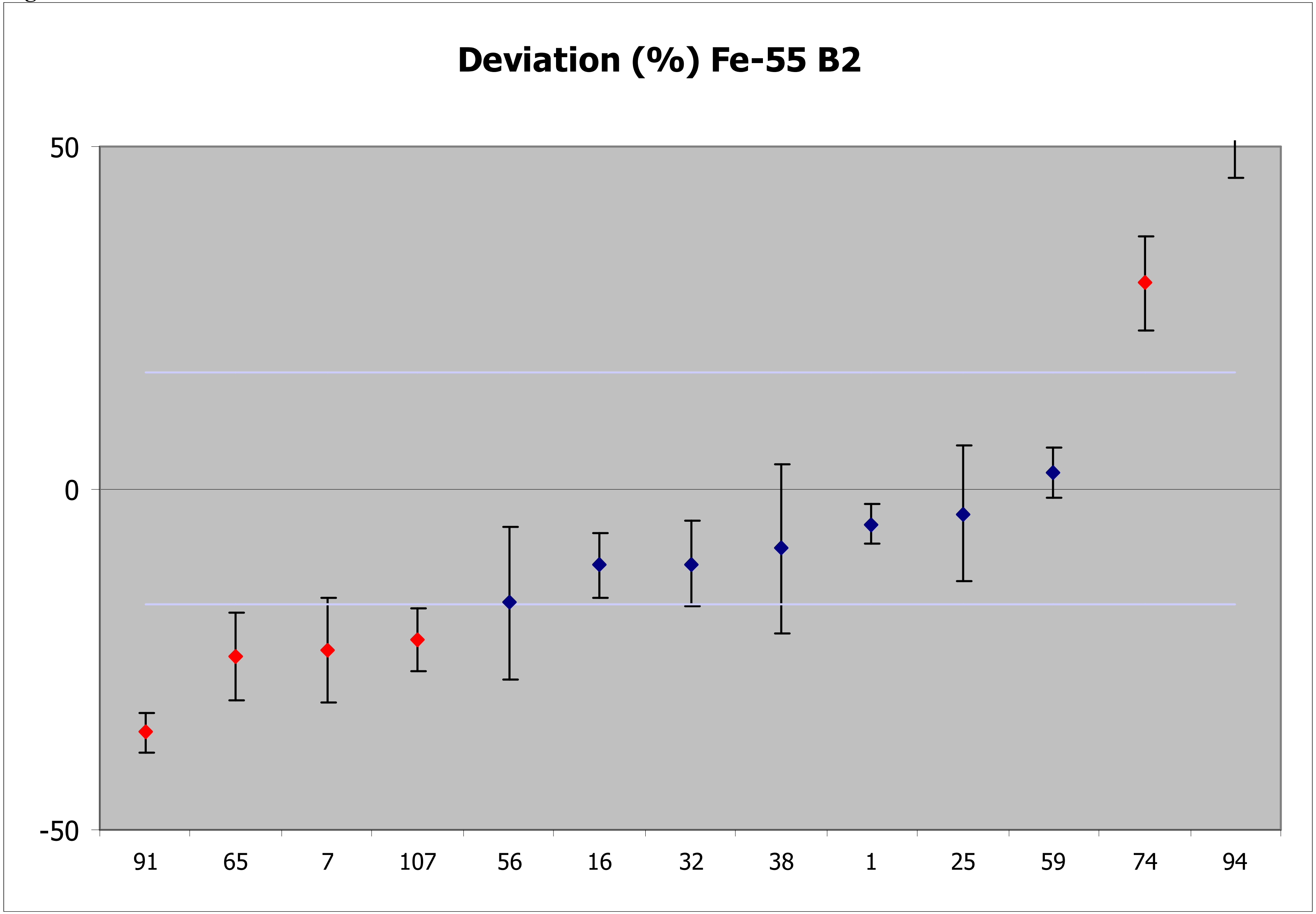


**Figure 25B – Zeta score Fe-55 B2**

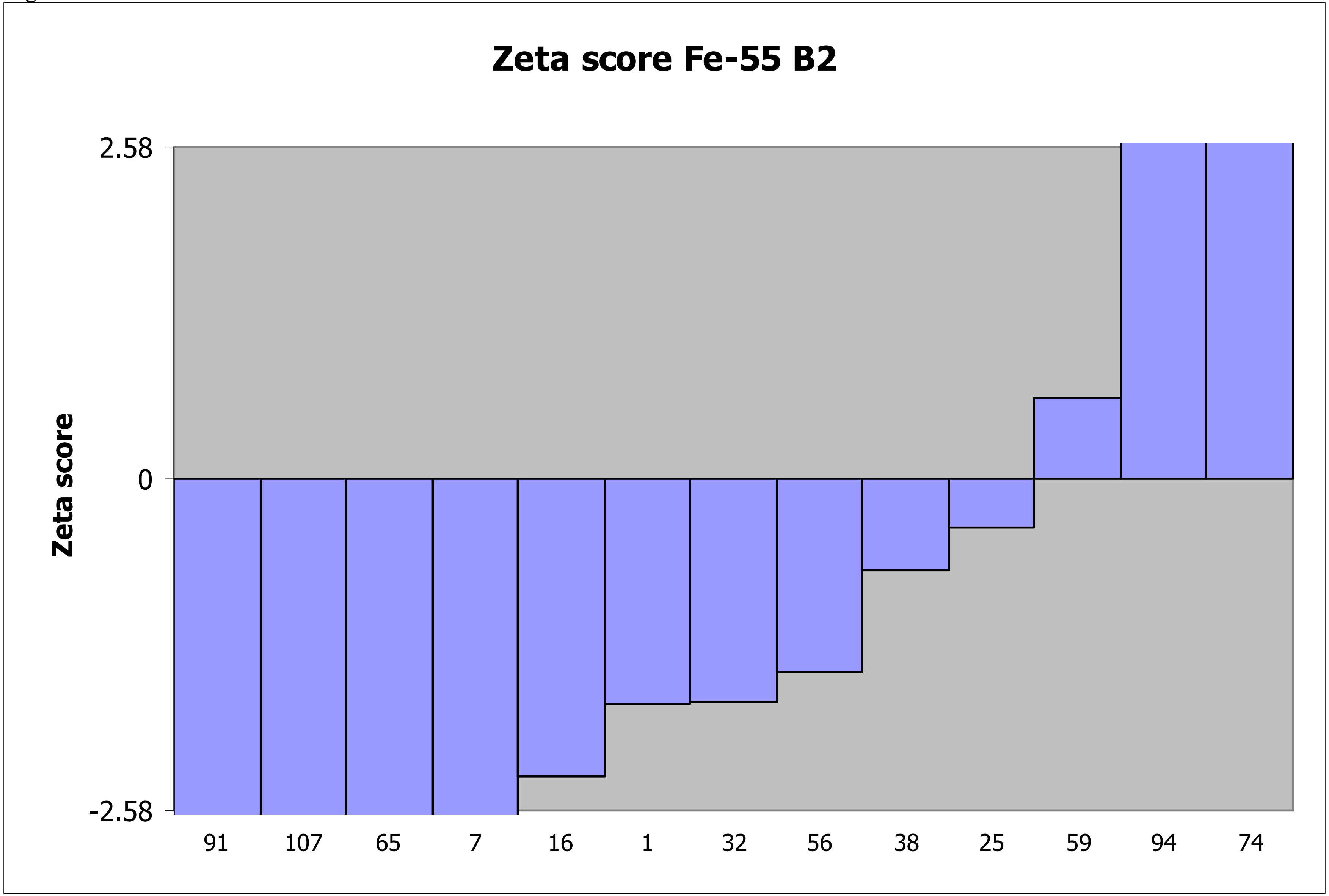


**Figure 25C – Relative uncertainty Fe-55 B2**

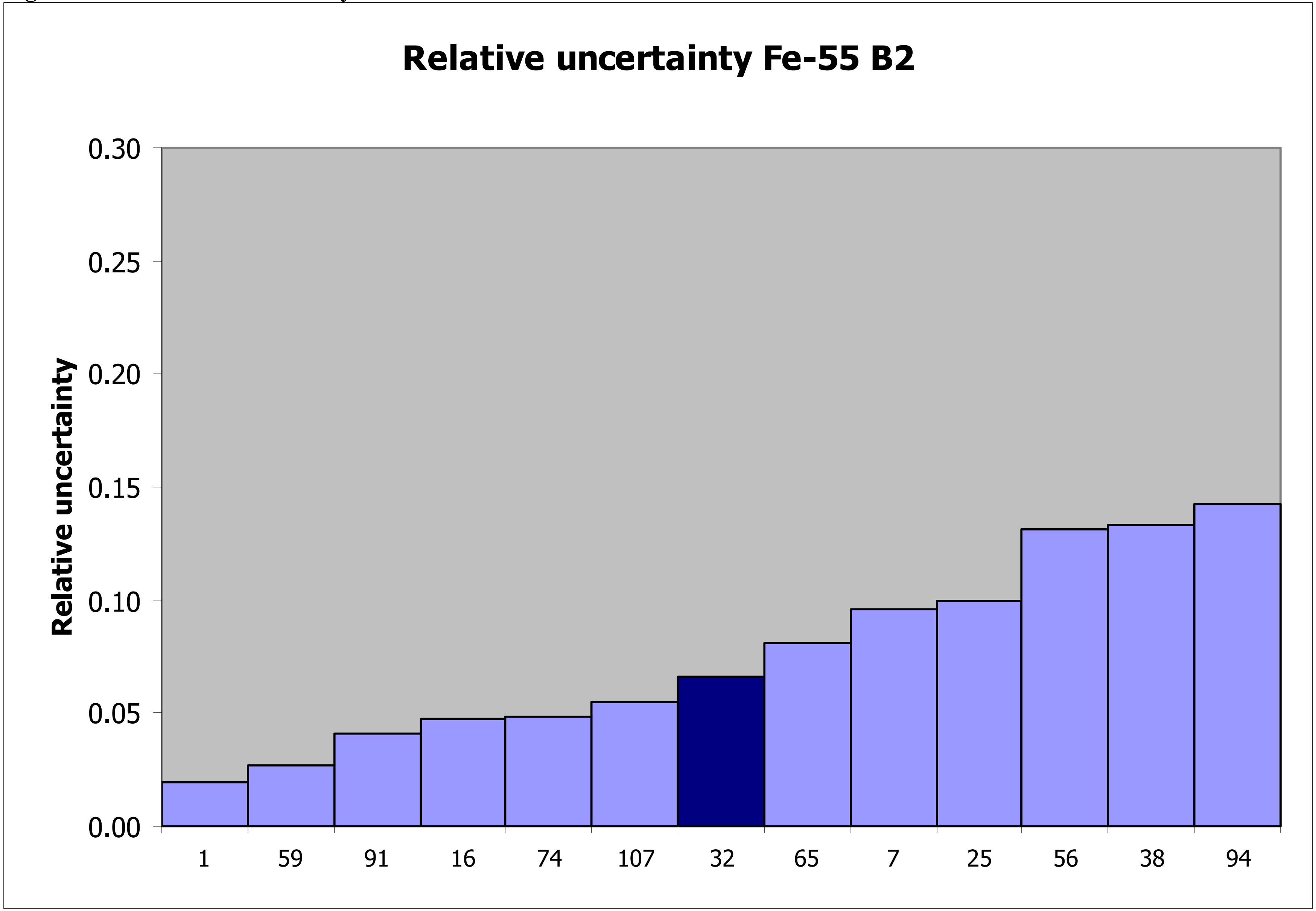


**Figure 25D – Kiri plot Fe-55 B2**

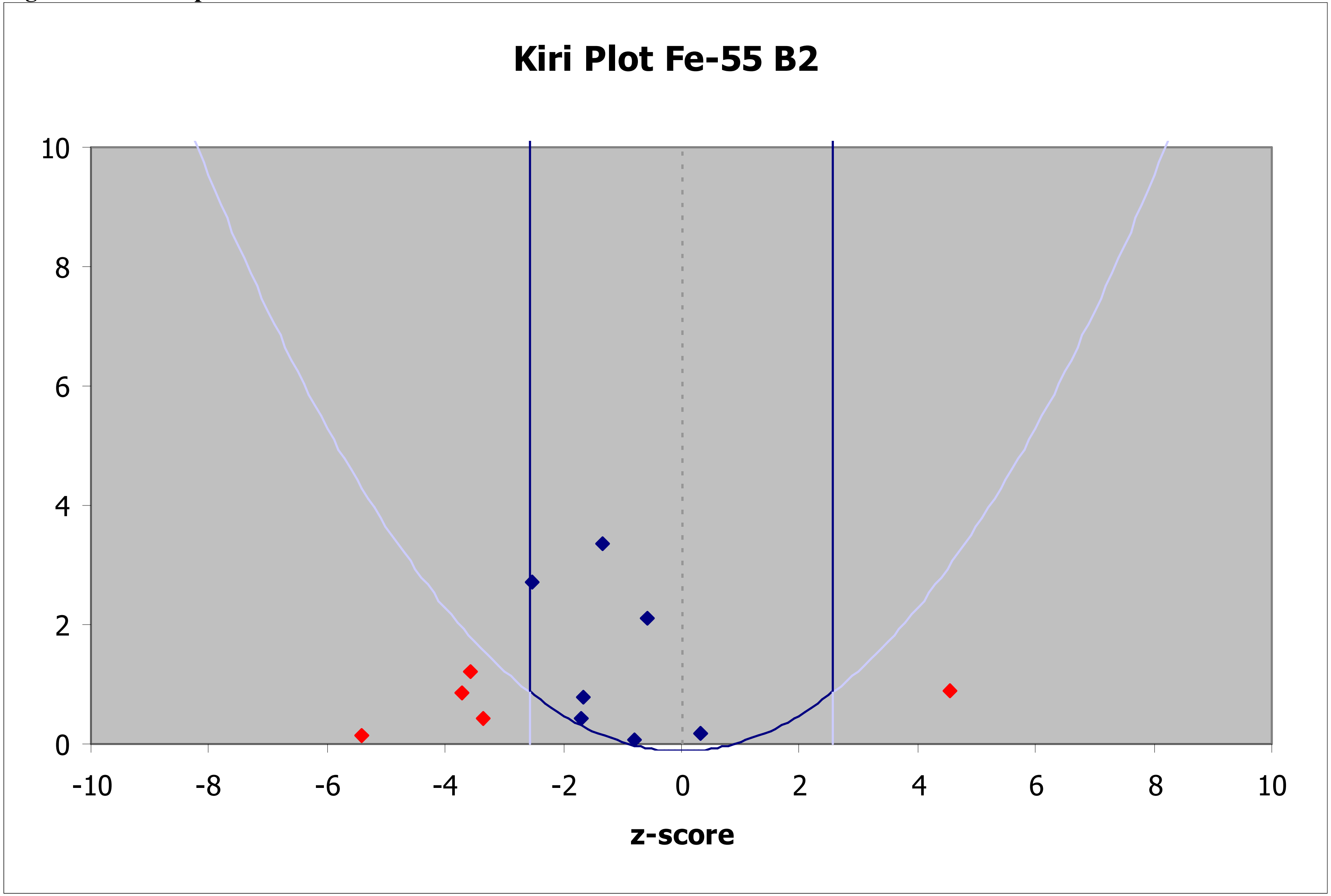


**Figure 26A – Deviation Ni-63 B2**

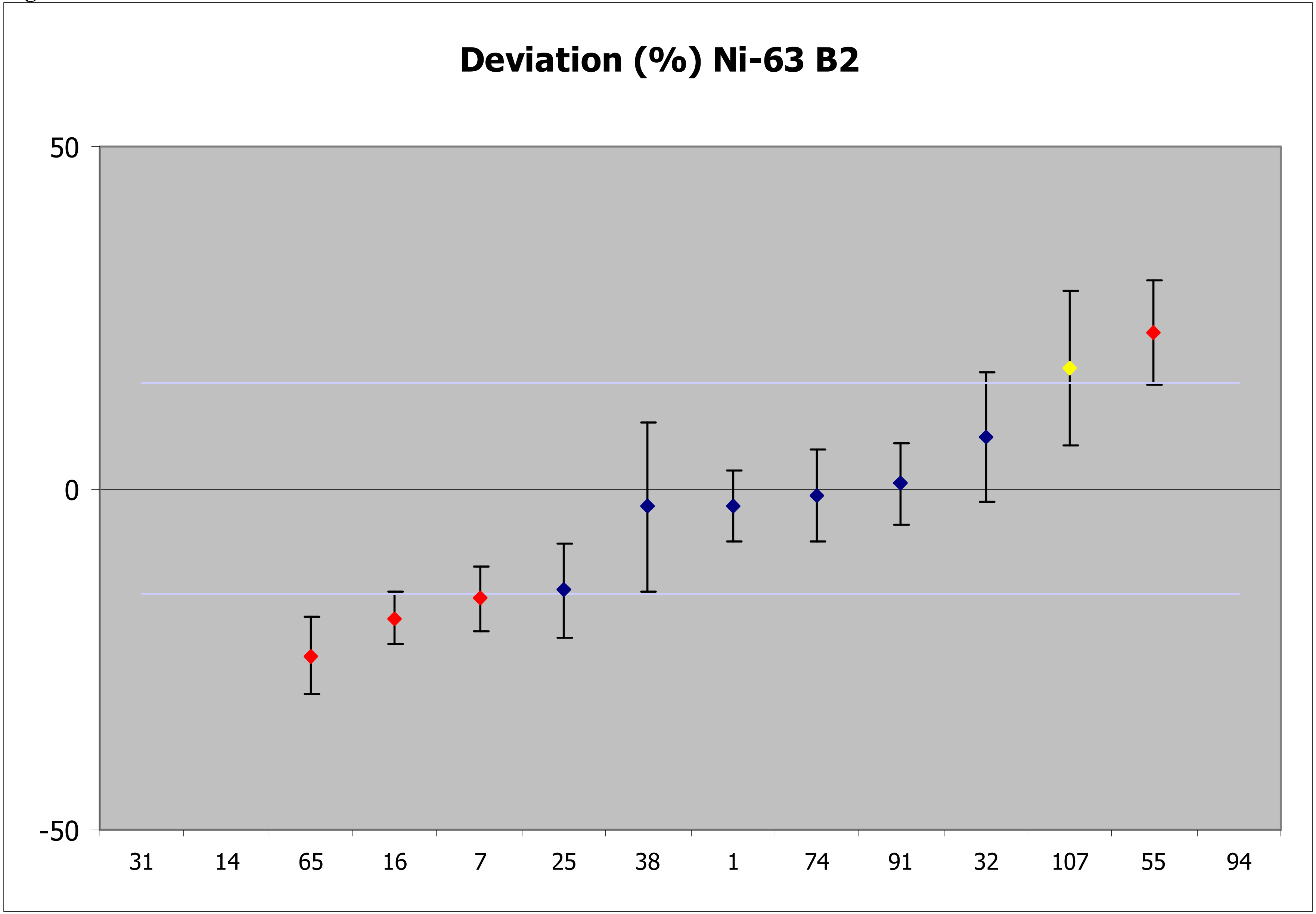


**Figure 26B – Zeta score Ni-63 B2**

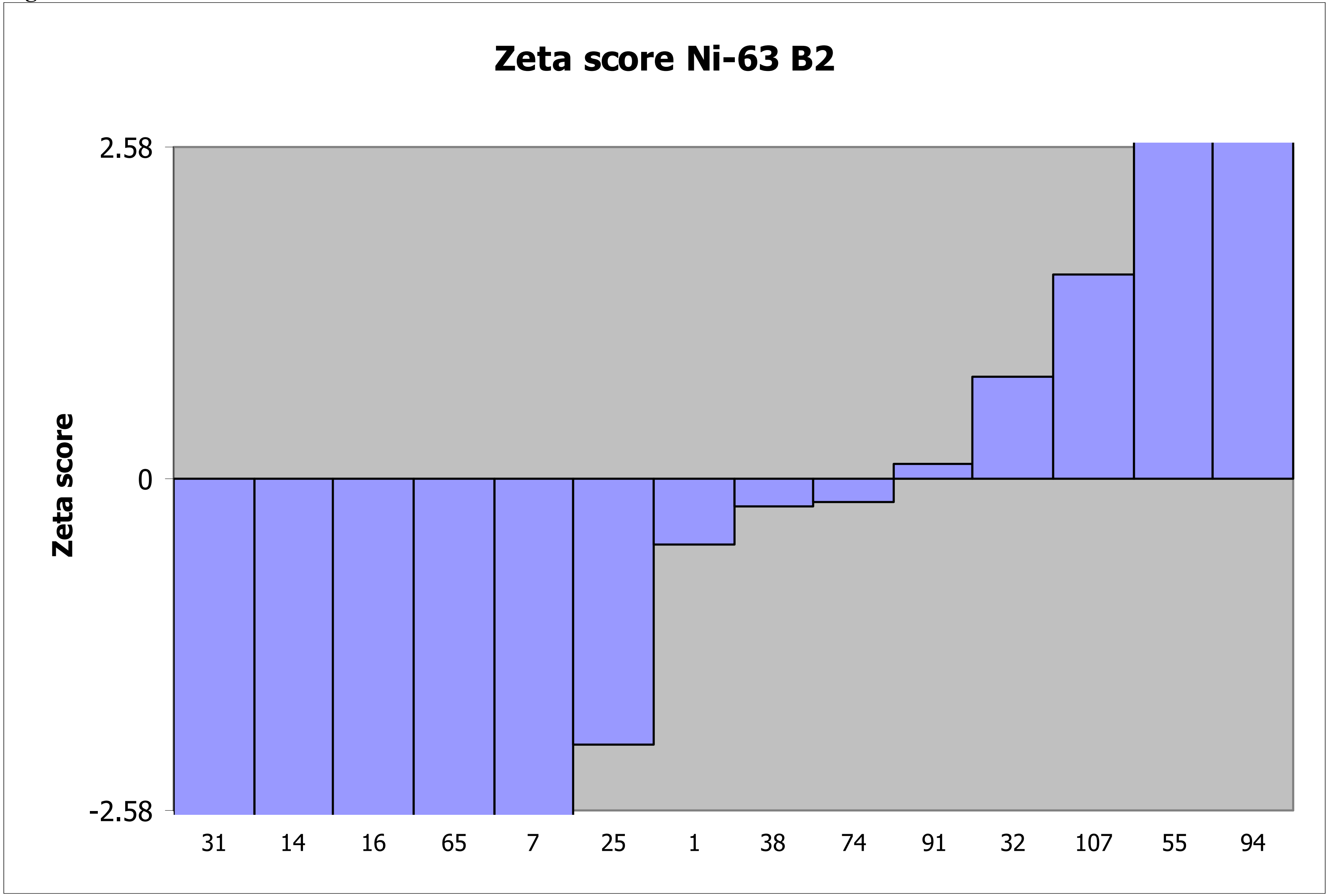


**Figure 26C – Relative uncertainty Ni-63 B2**

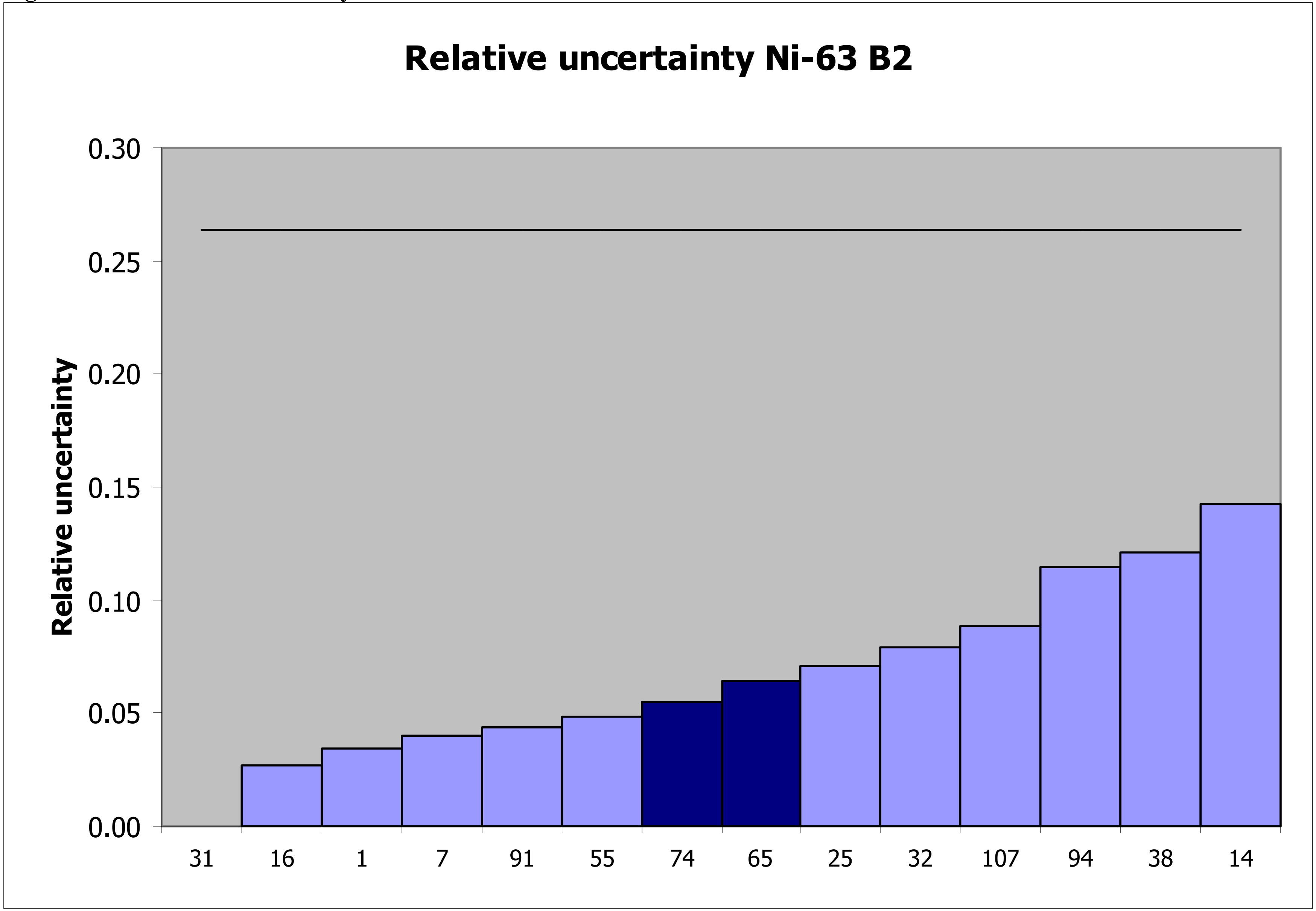


**Figure 26D – Kiri plot Ni-63 B2**

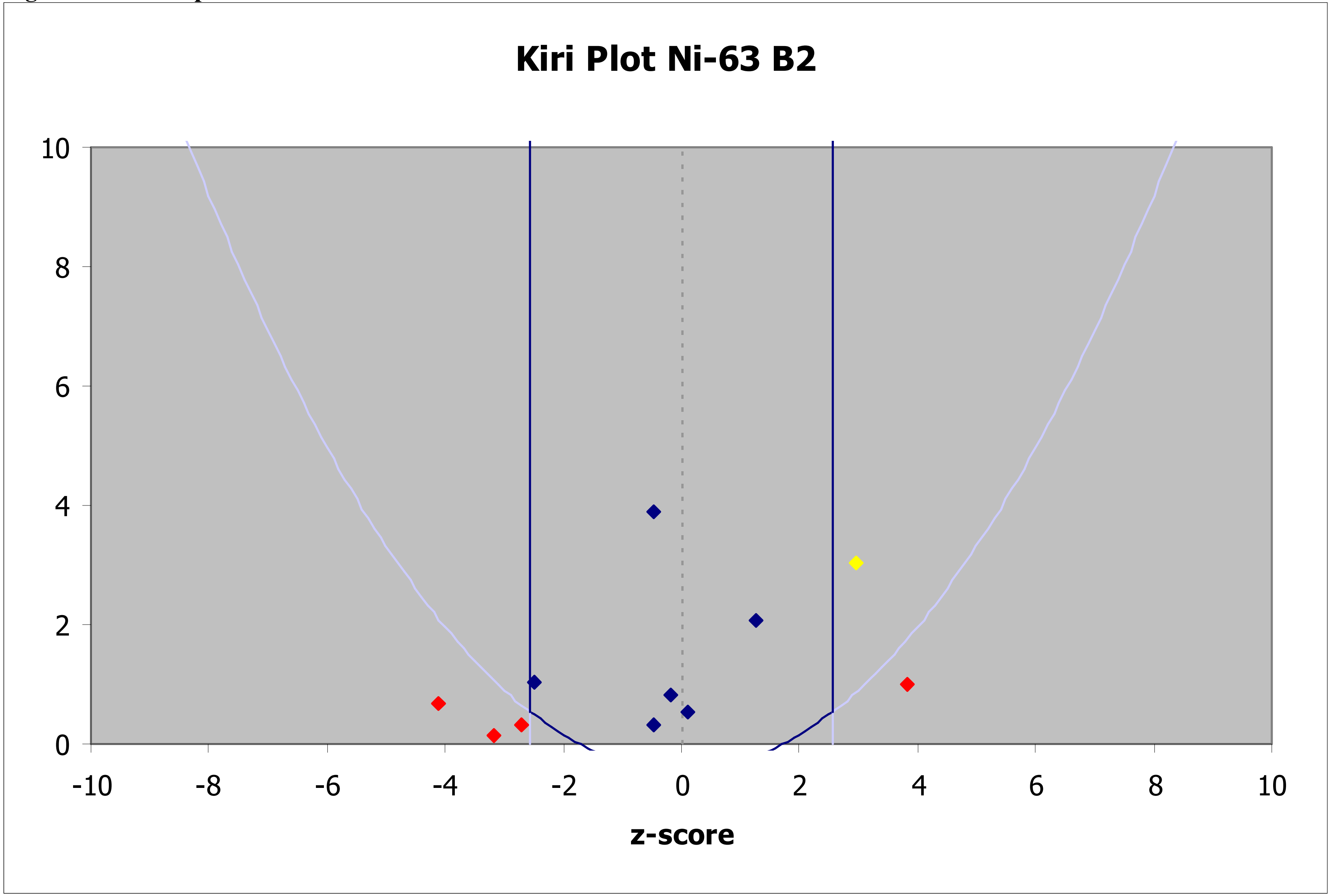


**Figure 27A – Deviation Sr-90 B2**

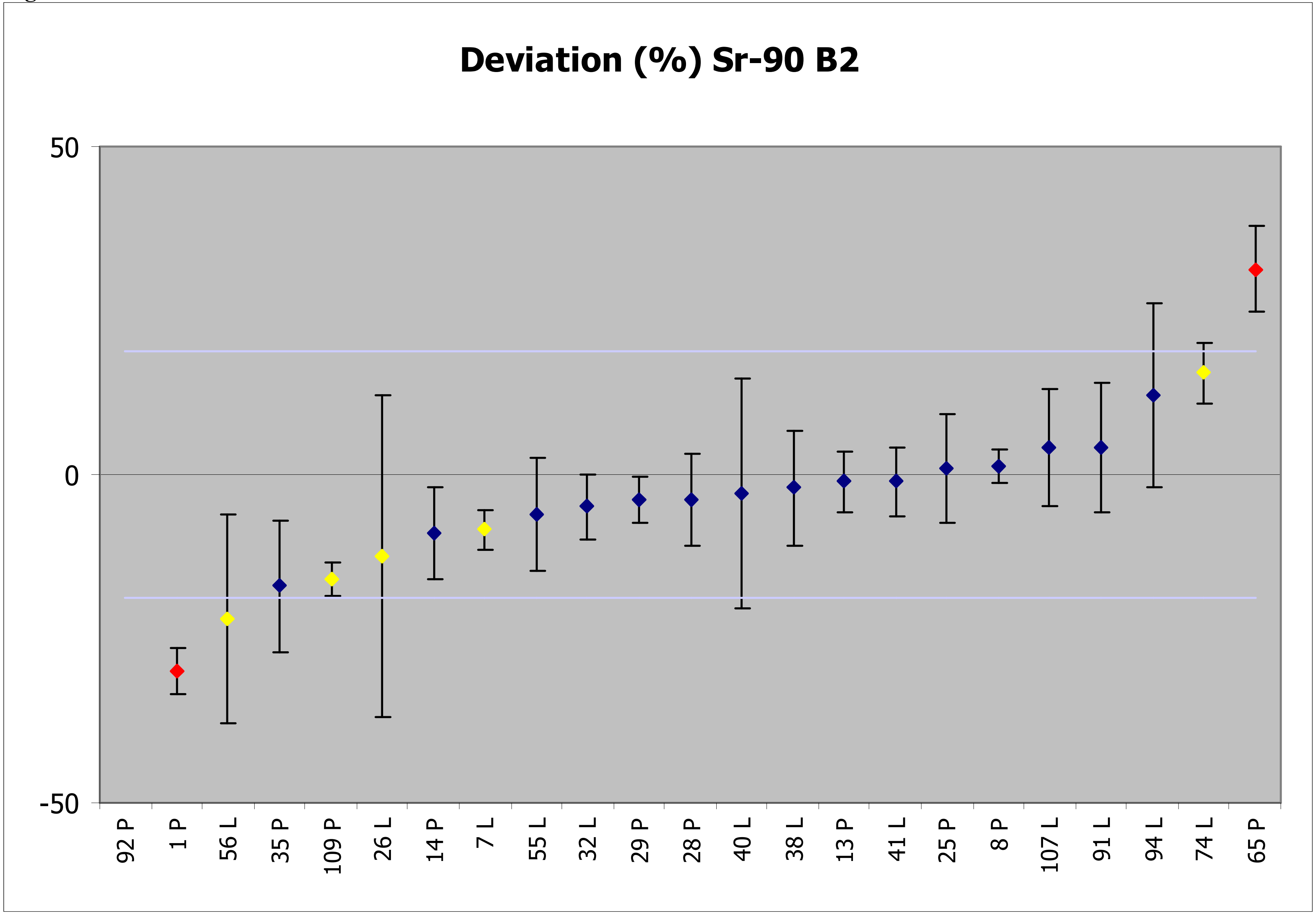


**Figure 27B – Zeta score Sr-90 B2**

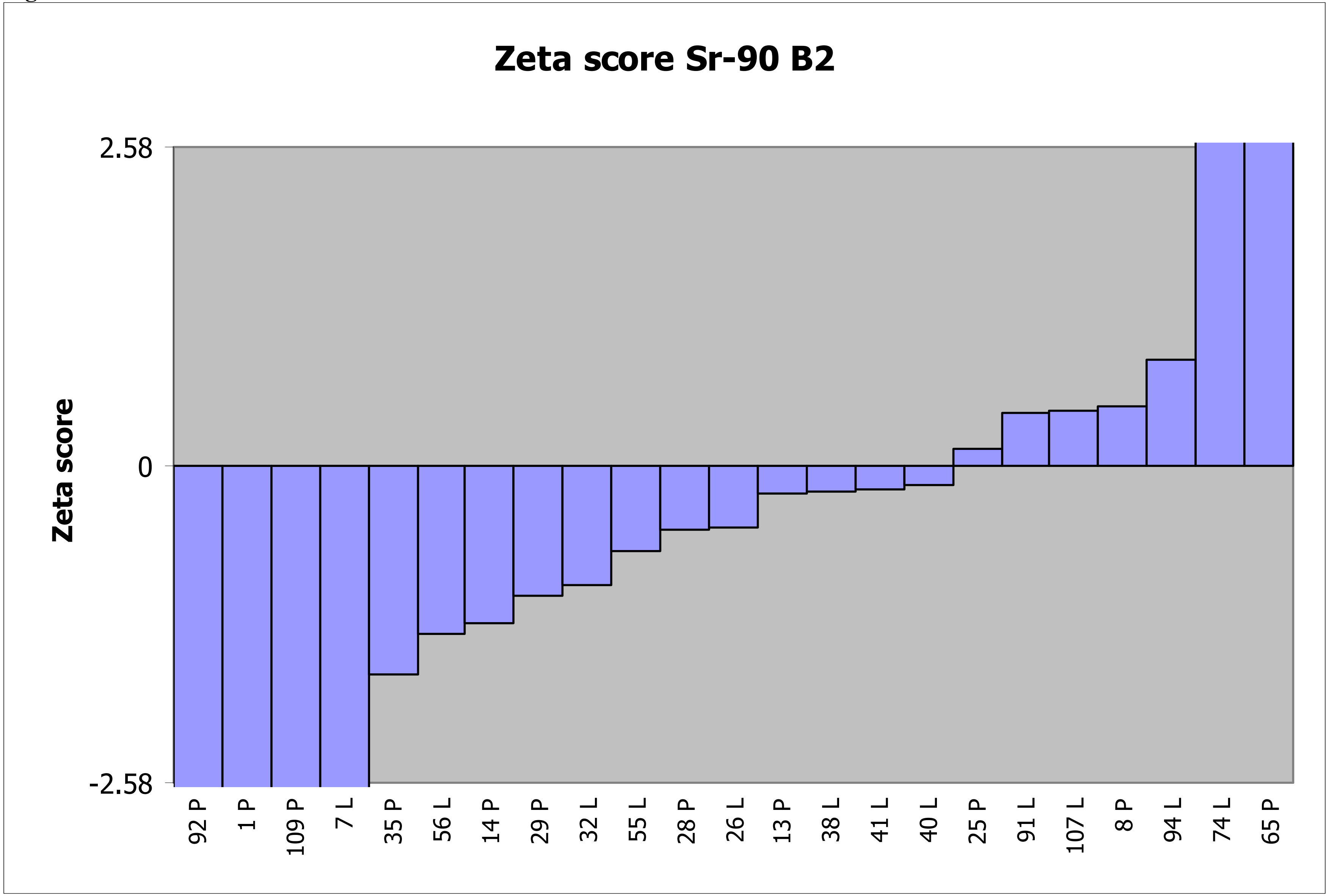


**Figure 27C – Relative uncertainty Sr-90 B2**

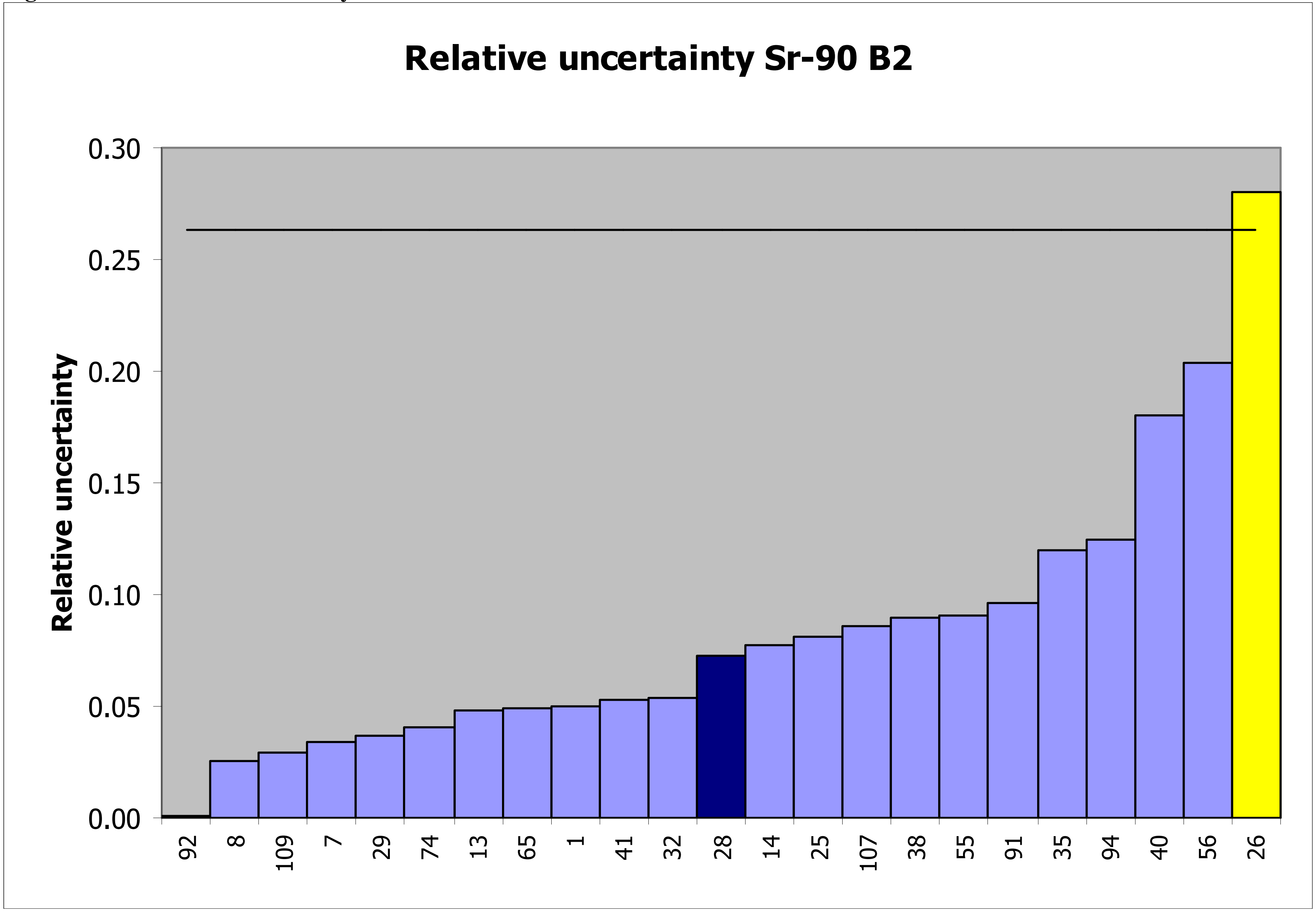


**Figure 27D – Kiri plot Sr-90 B2**

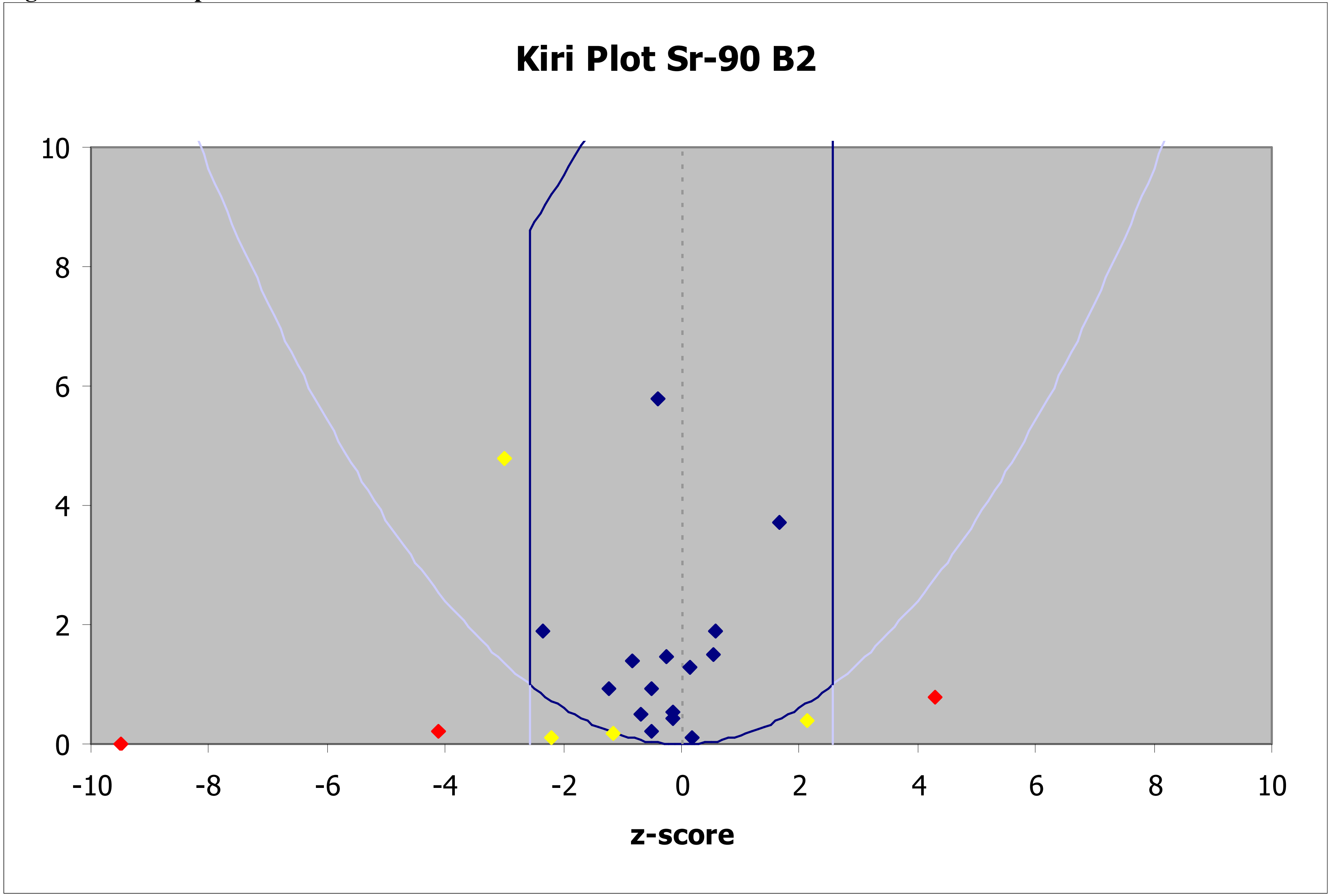


**Figure 28A – Deviation gross beta B2**

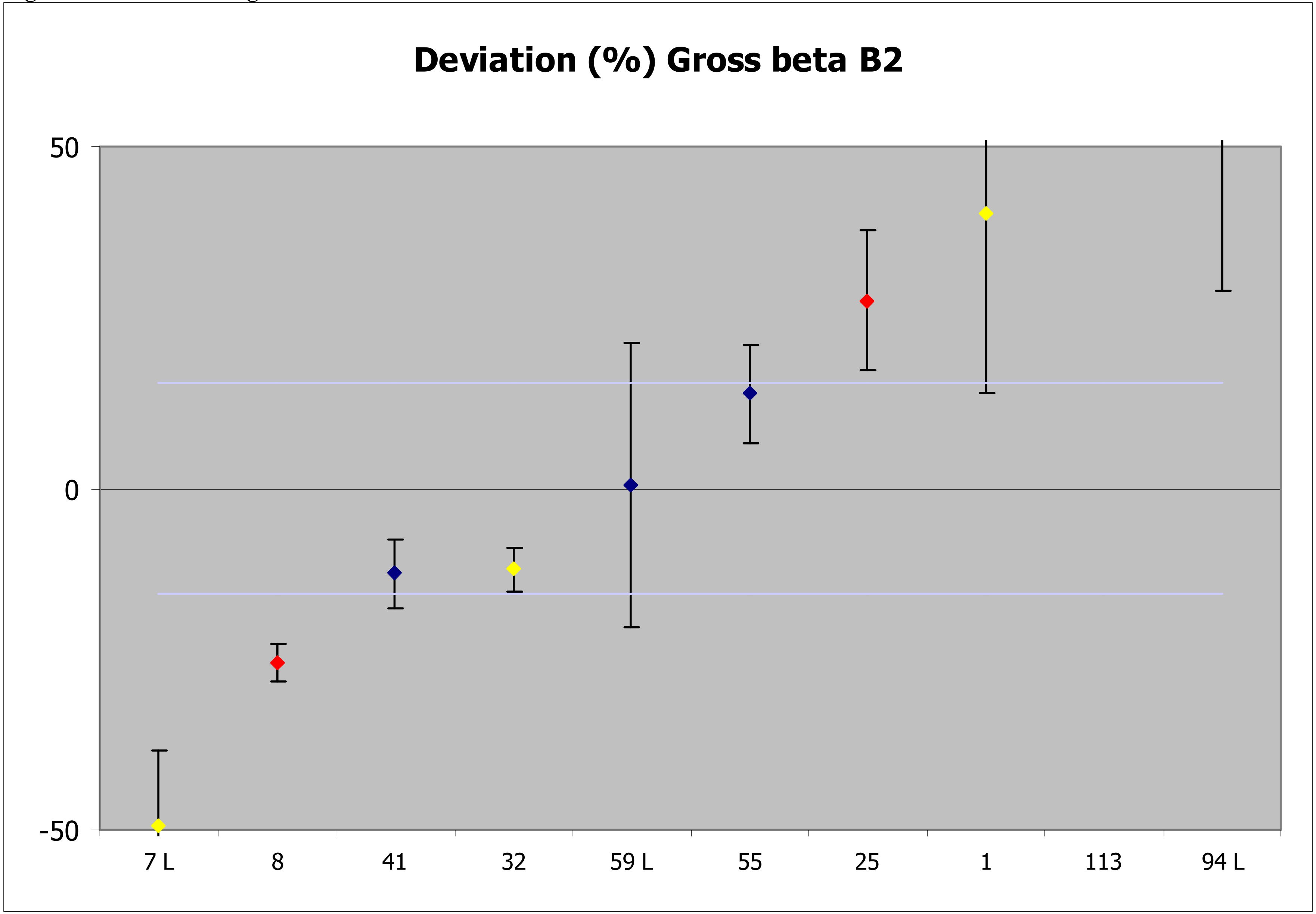


**Figure 28B – Zeta score gross beta B2**

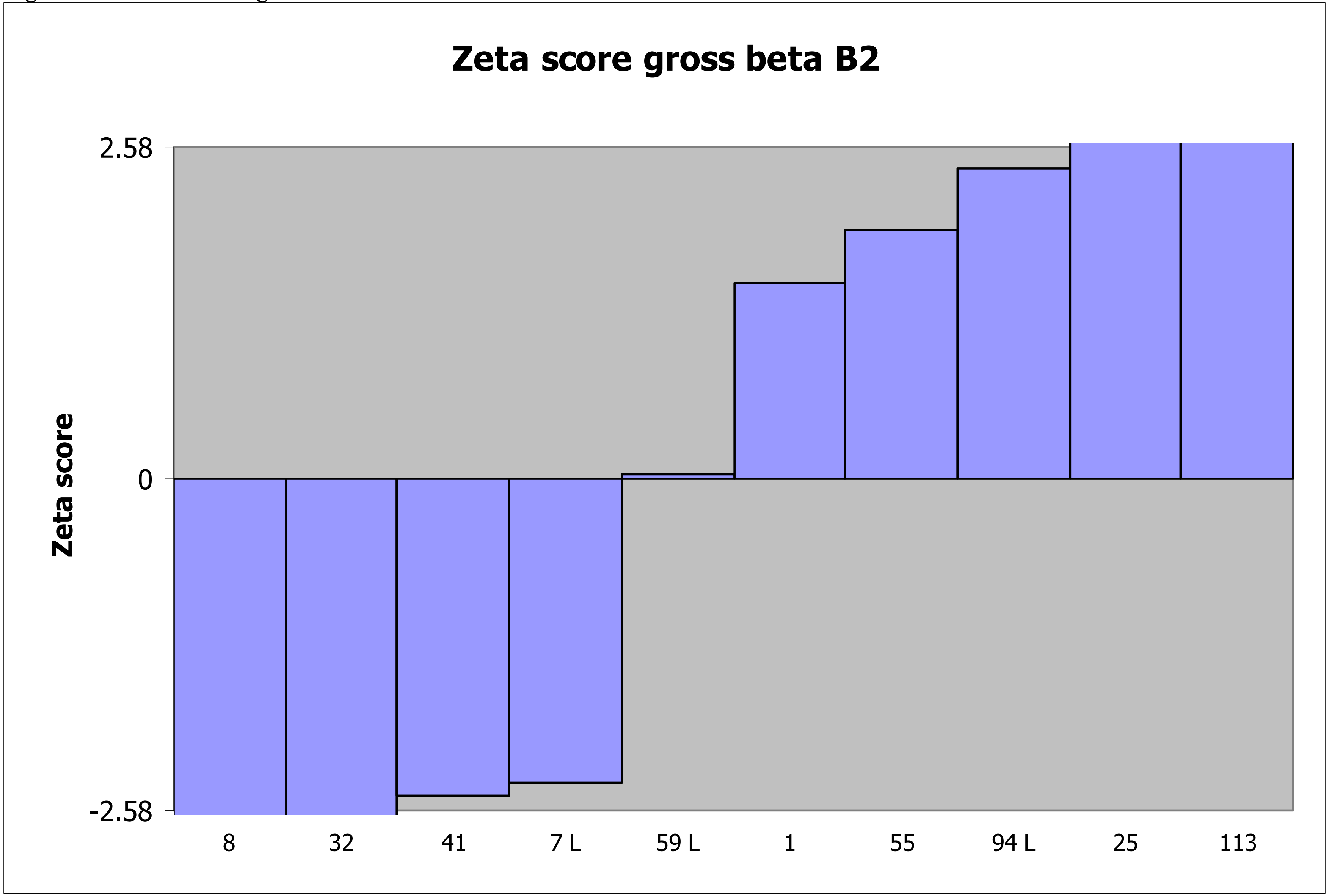


**Figure 28C – Relative uncertainty gross beta B2**

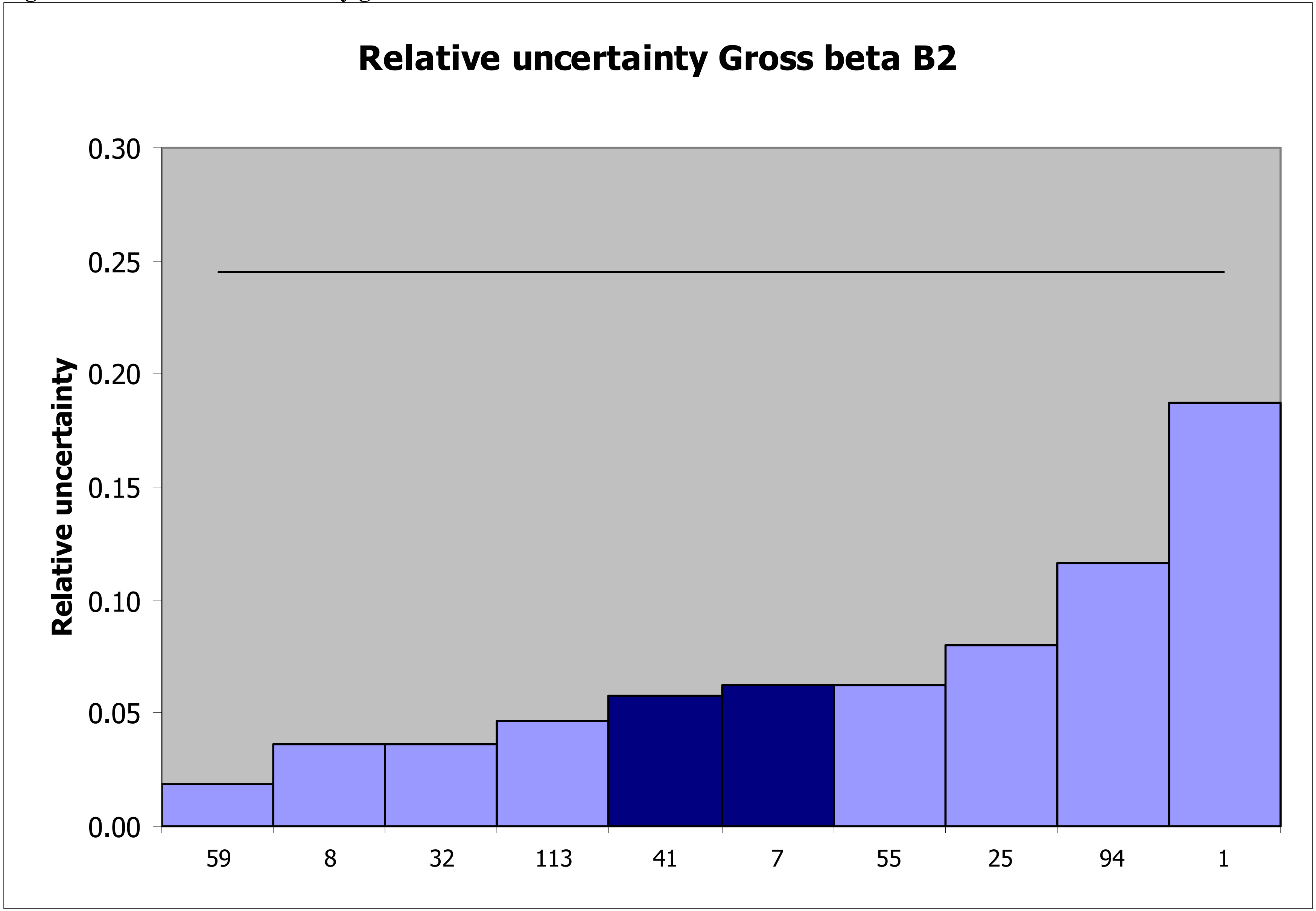


**Figure 28D – Kiri plot gross beta B2**

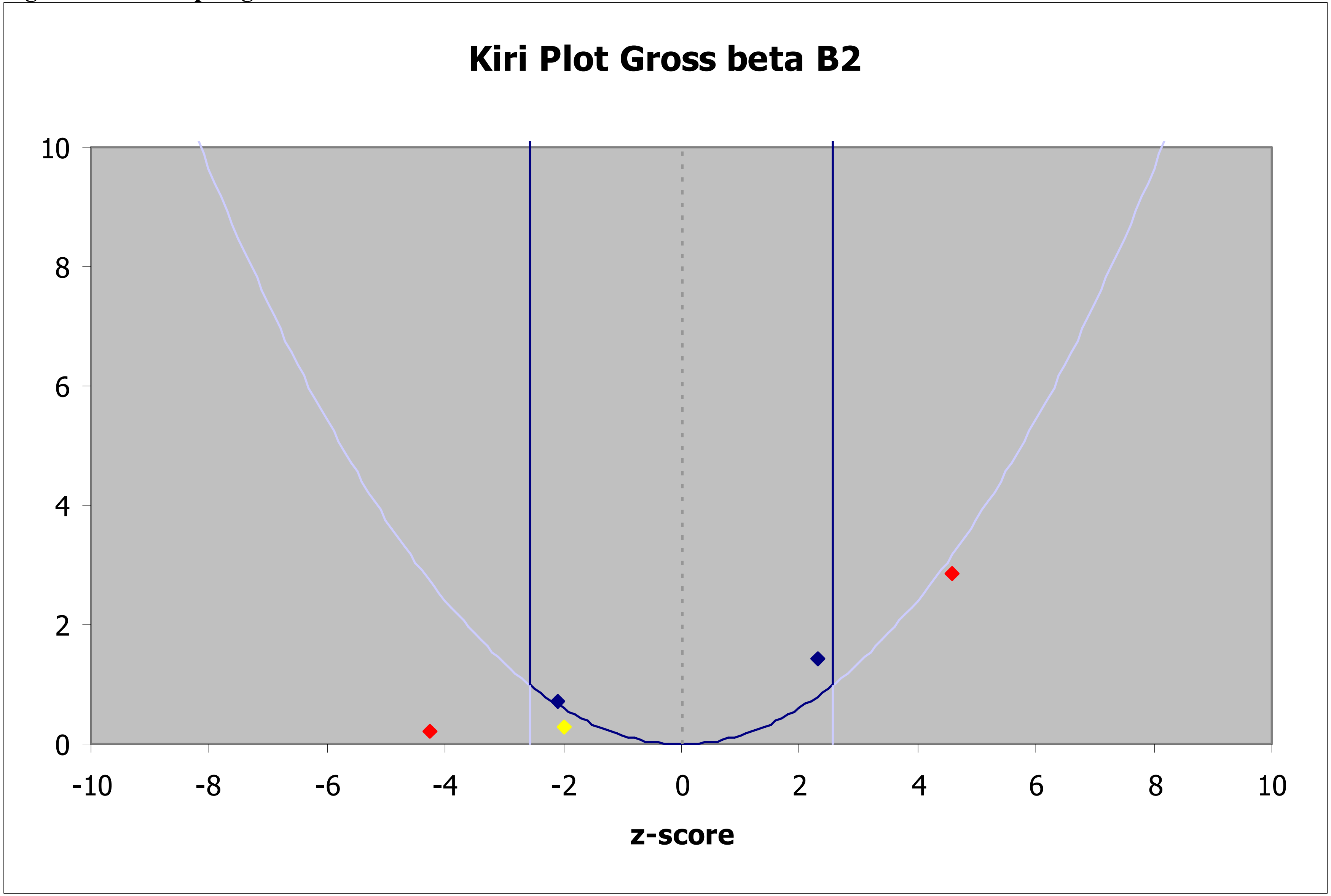


**Figure 29A – Deviation Na-22 GL**

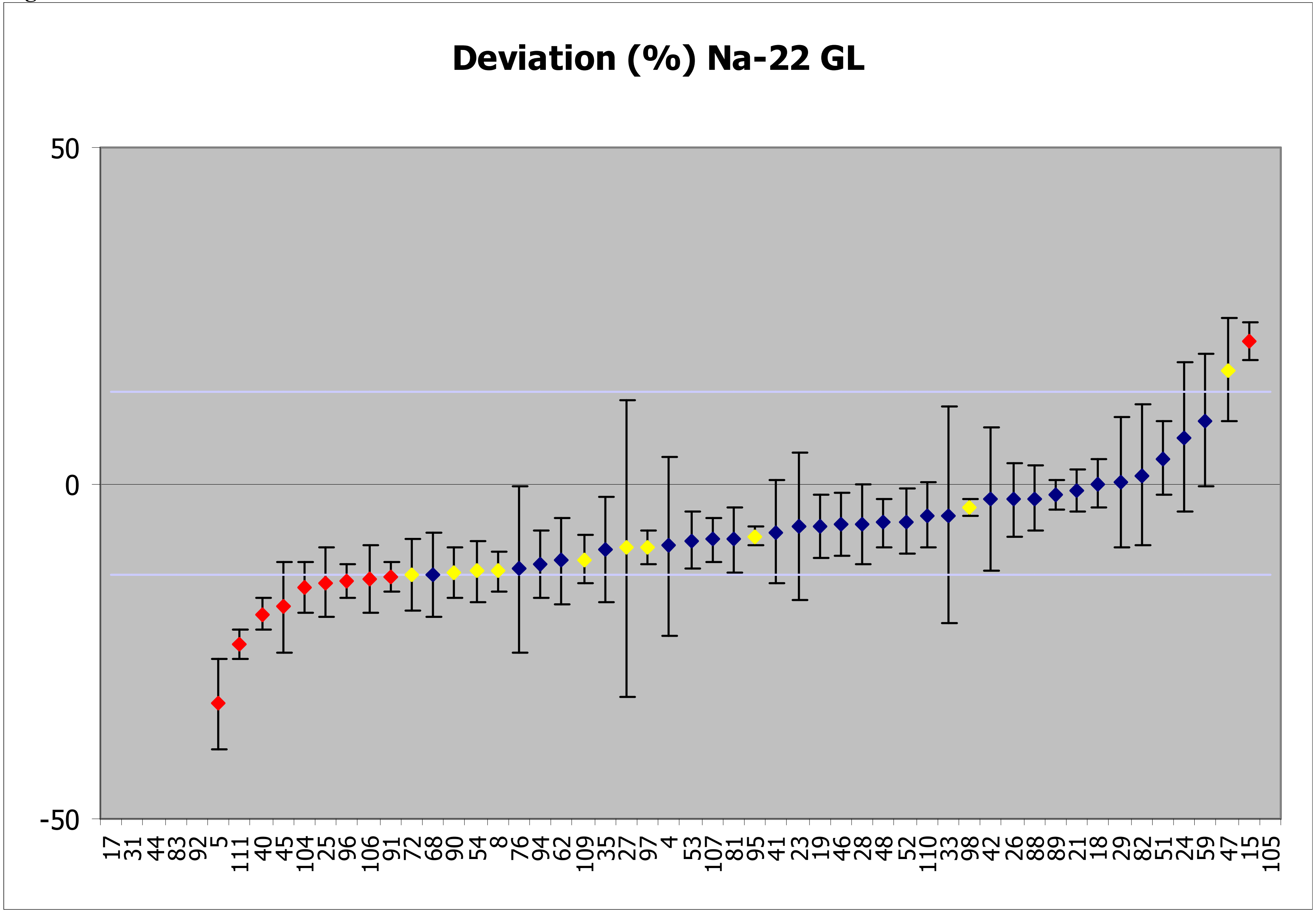


**Figure 29B – Zeta score Na-22 GL**

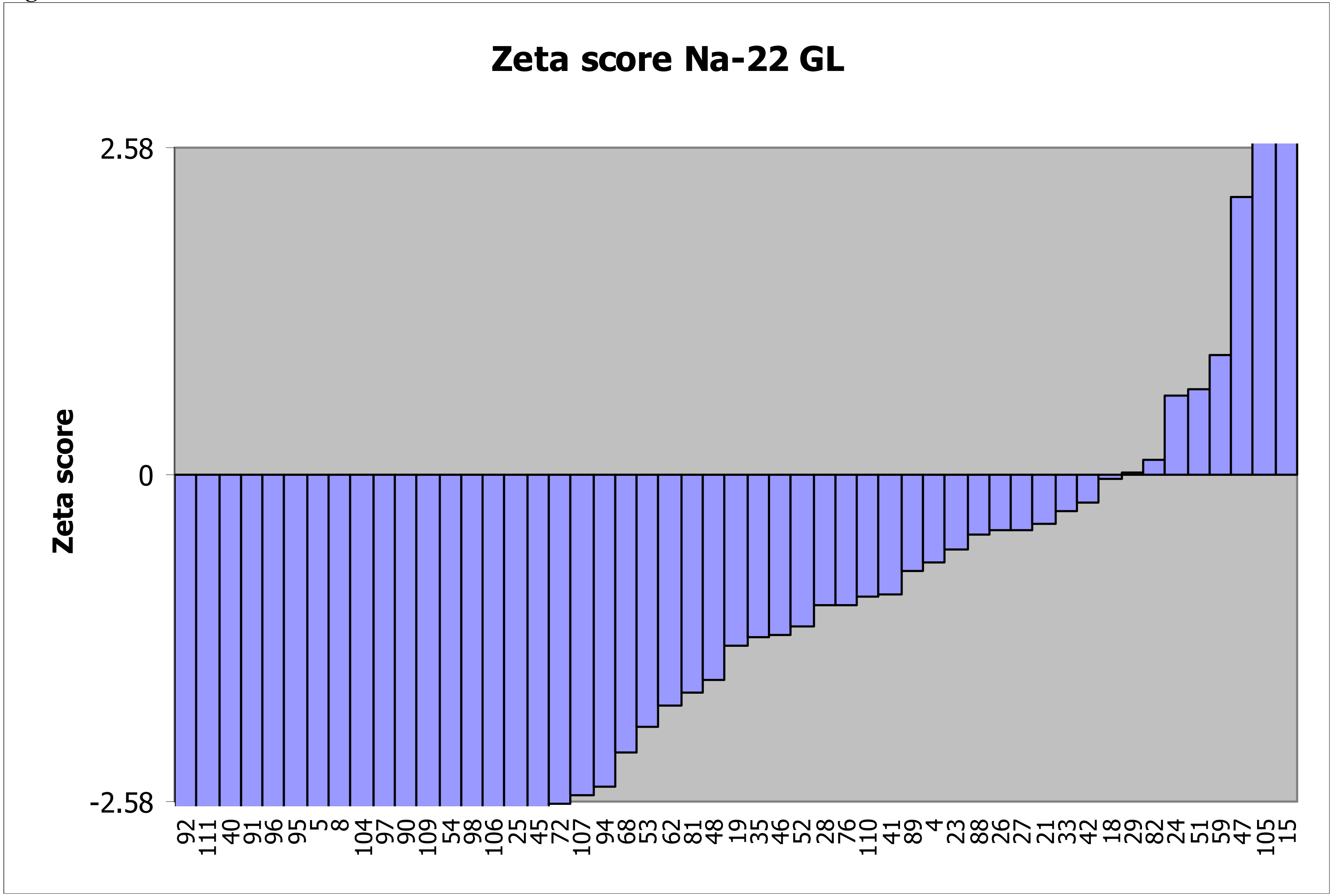


**Figure 29C – Relative uncertainty Na-22 GL**

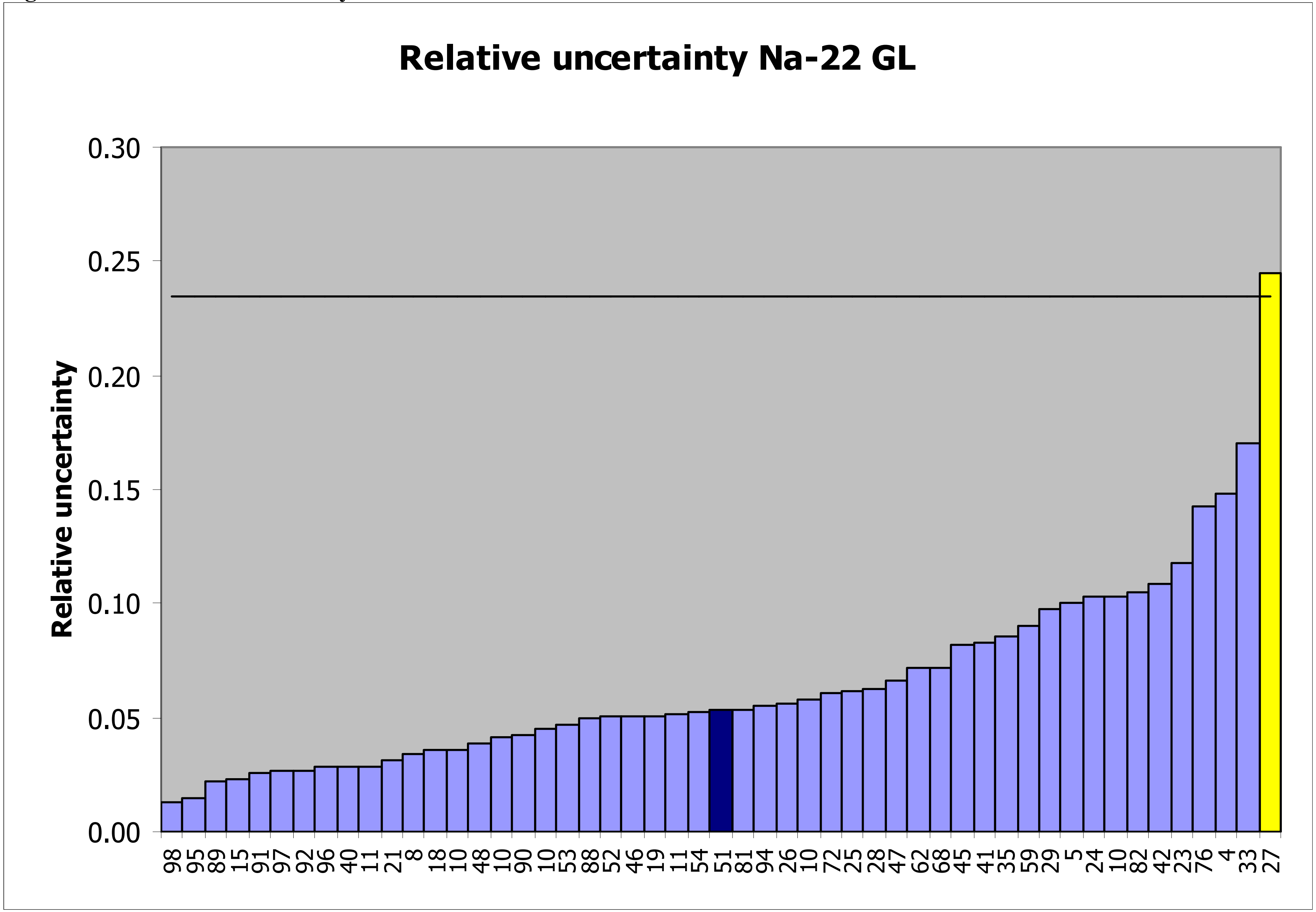


**Figure 29D – Kiri plot Na-22 GL**

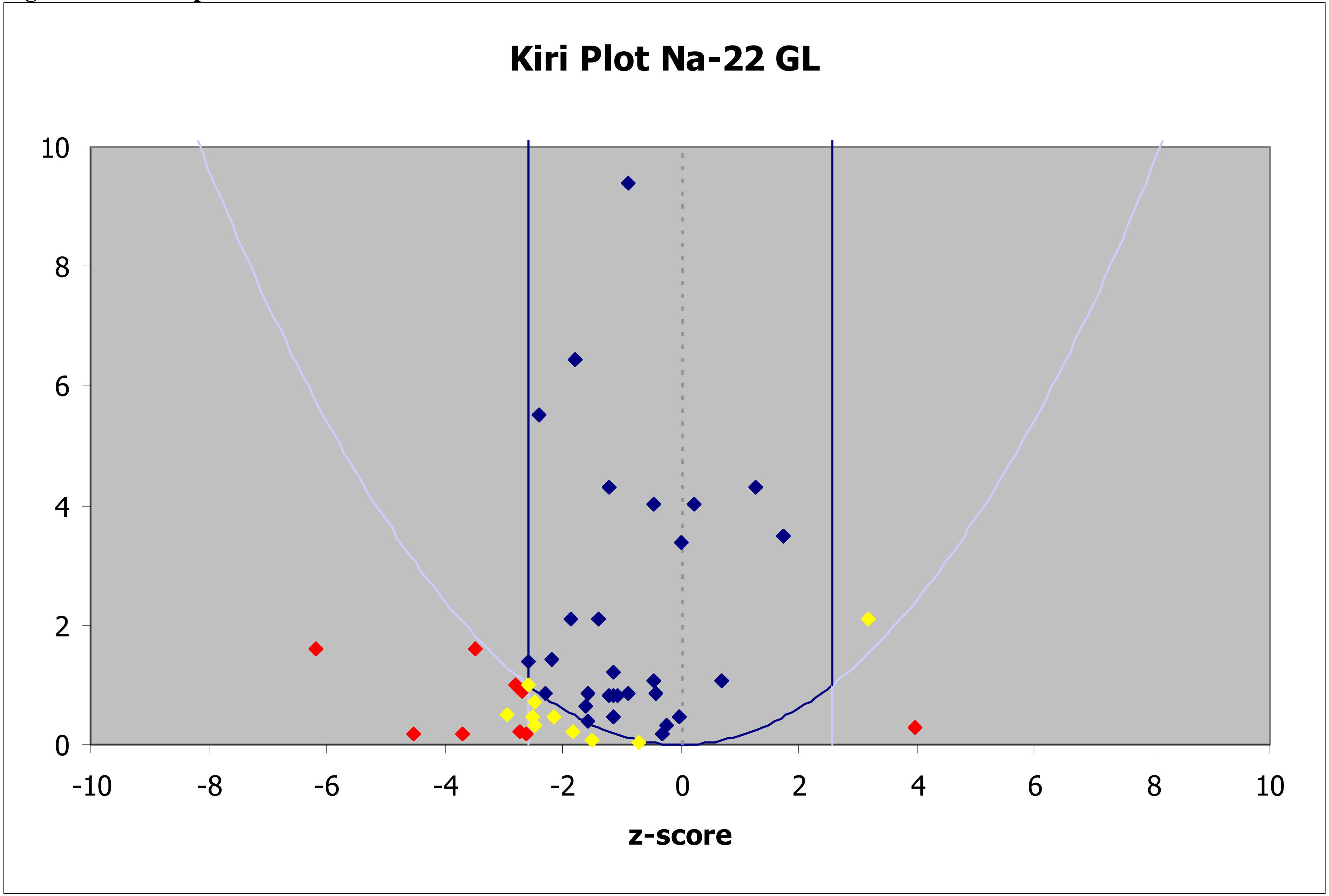


**Figure 30A – Deviation Co-60 GL**

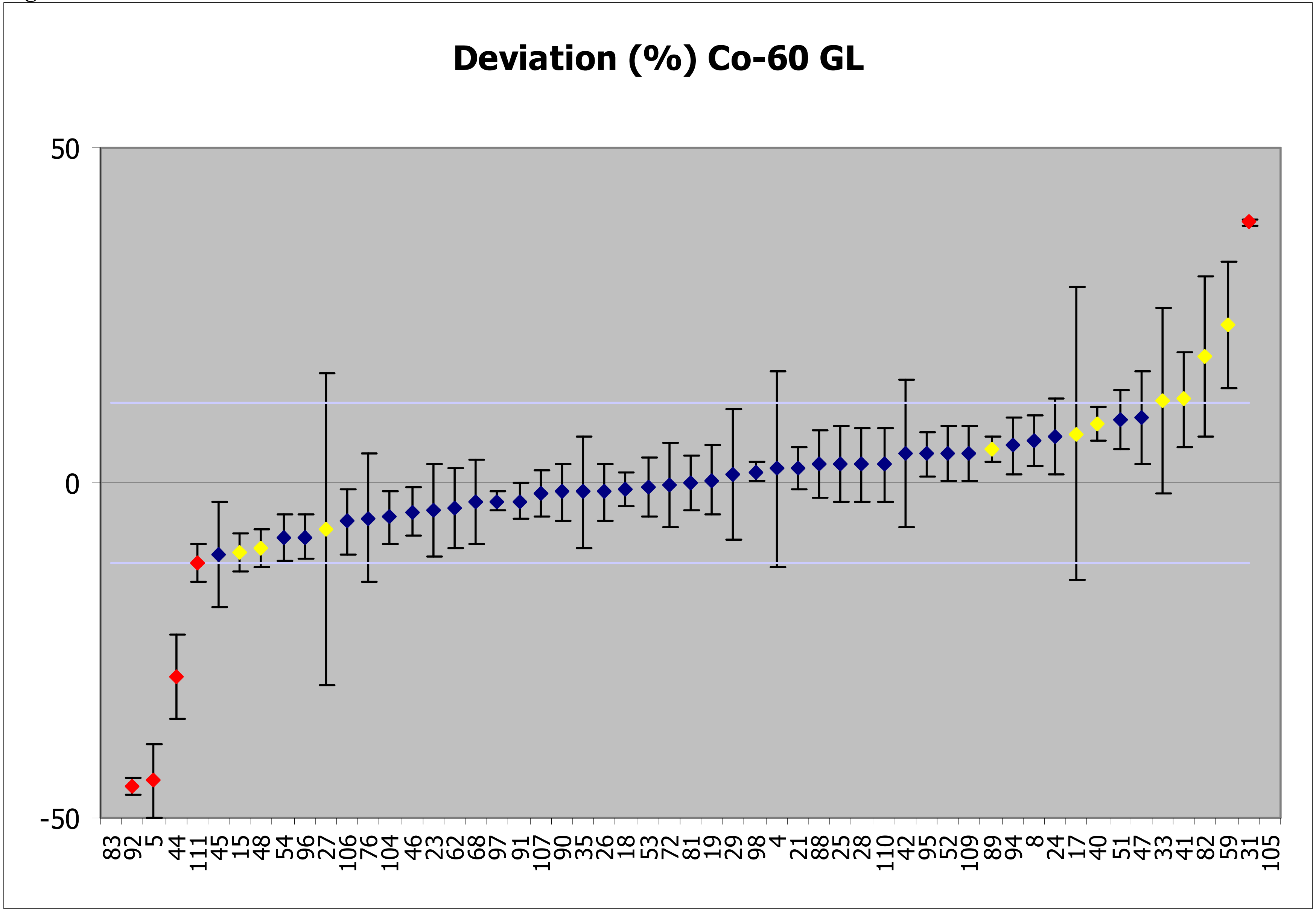


**Figure 30B – Zeta score Co-60 GL**

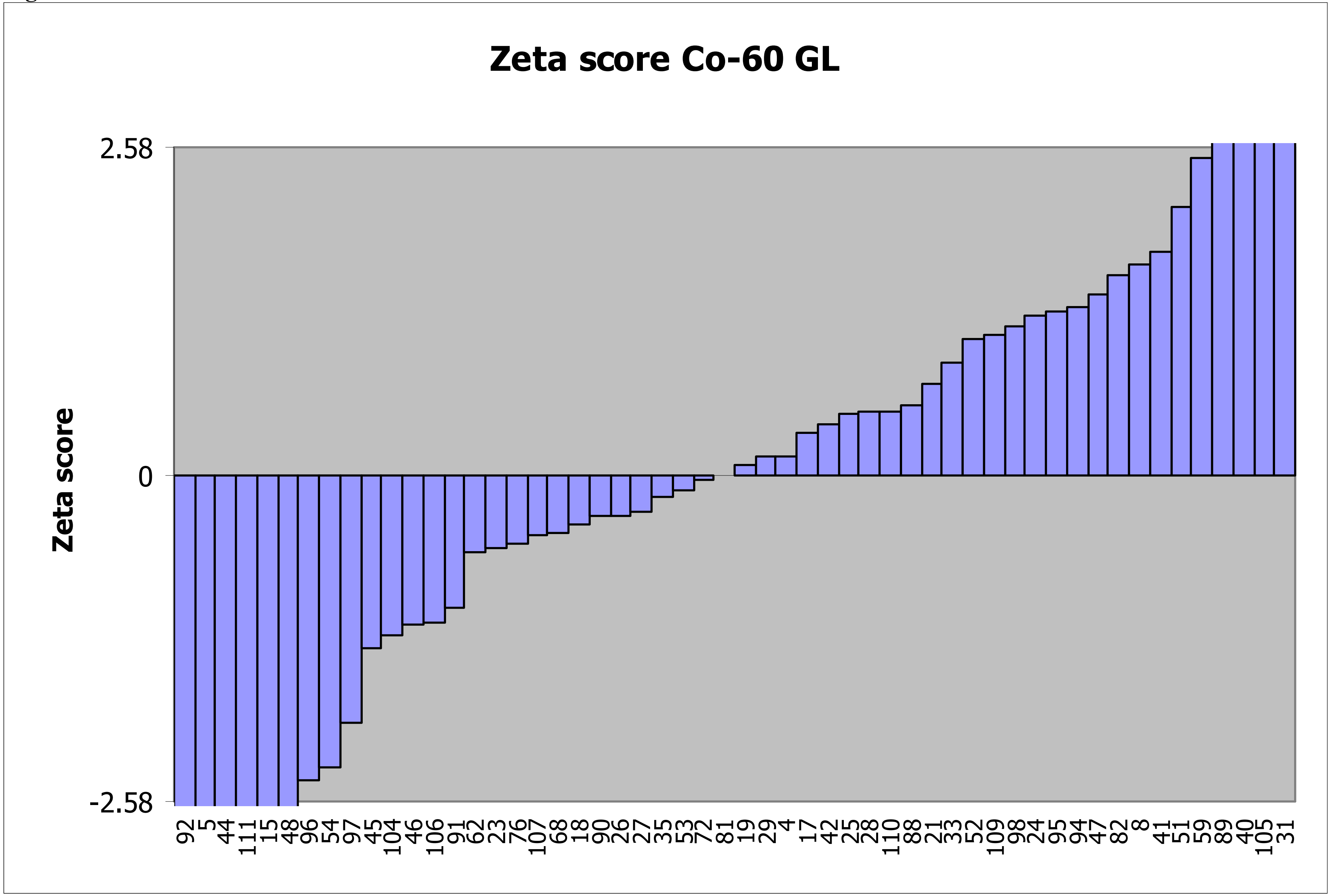


**Figure 30C – Relative uncertainty Co-60 GL**

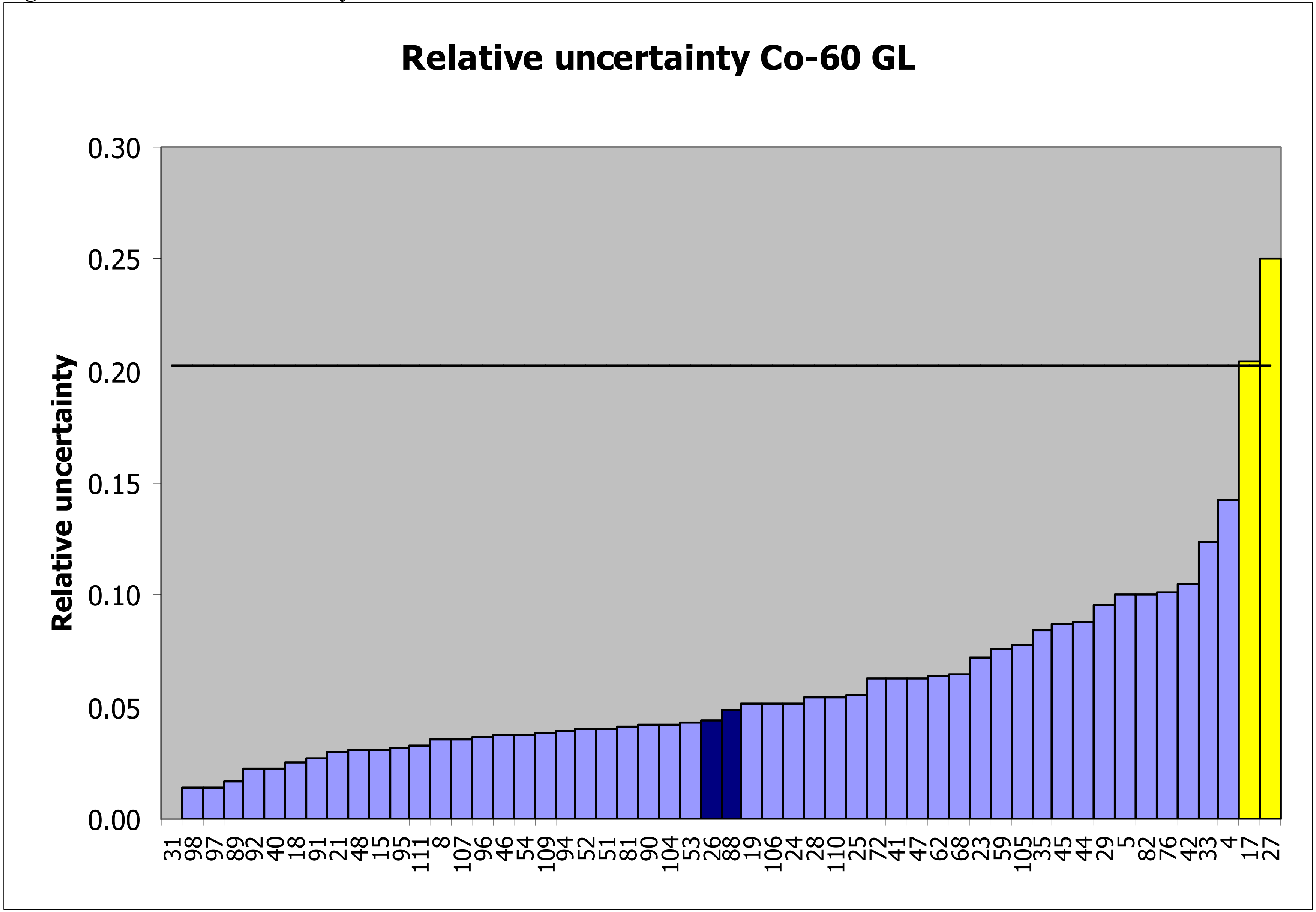


**Figure 30D – Kiri plot Co-60 GL**

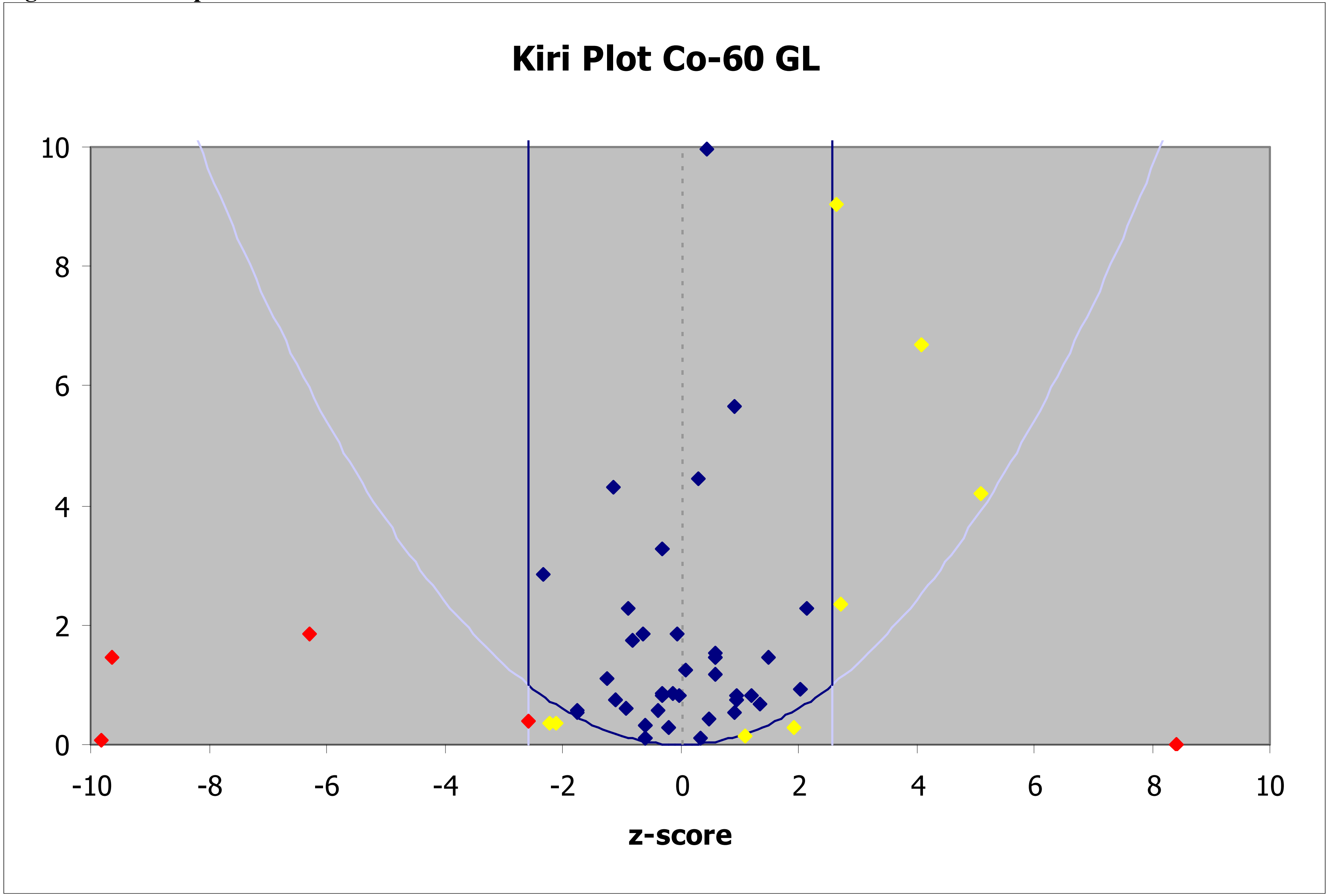


**Figure 31A – Deviation Zr-95 GL**

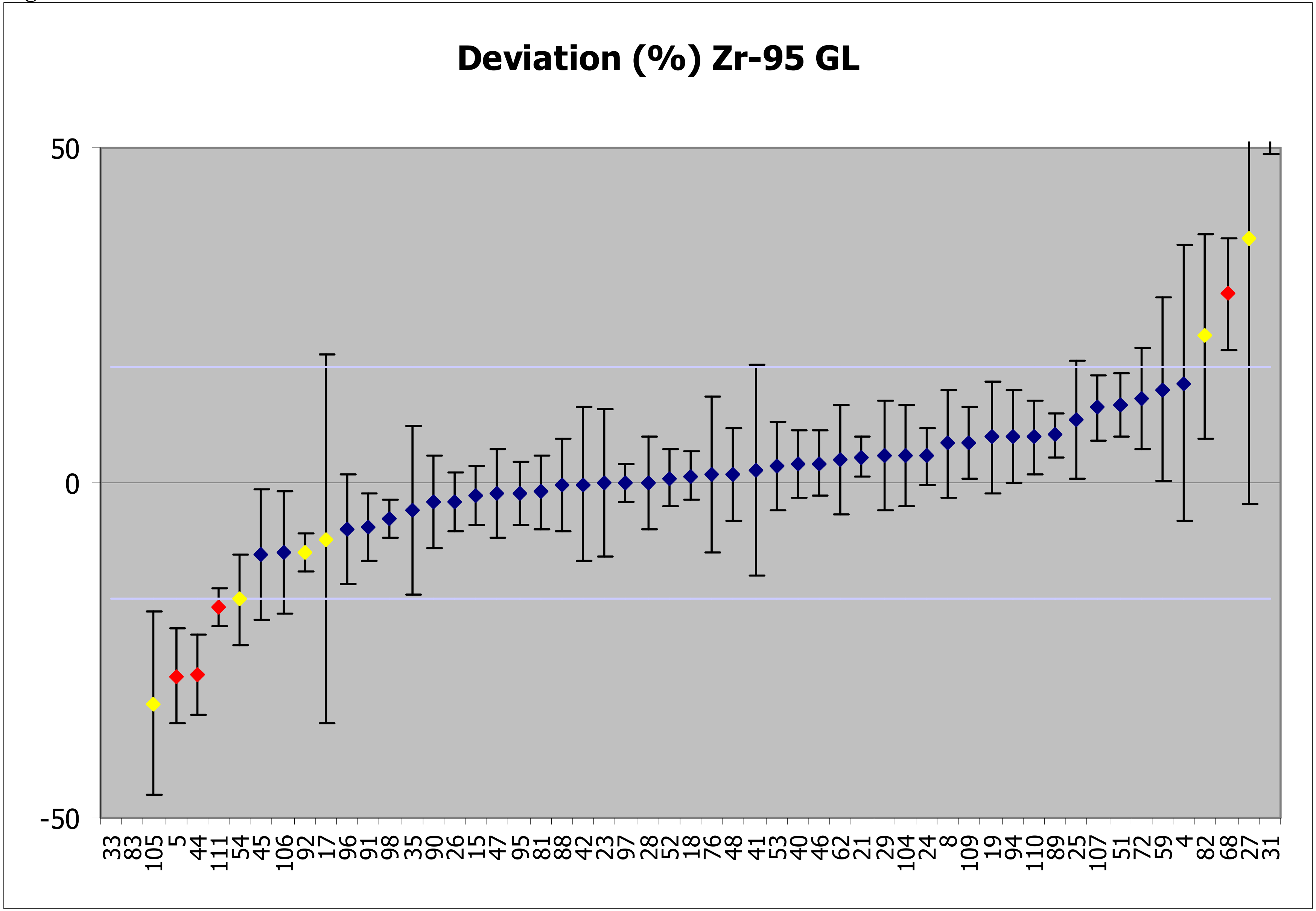


**Figure 31B – Zeta score Zr-95 GL**

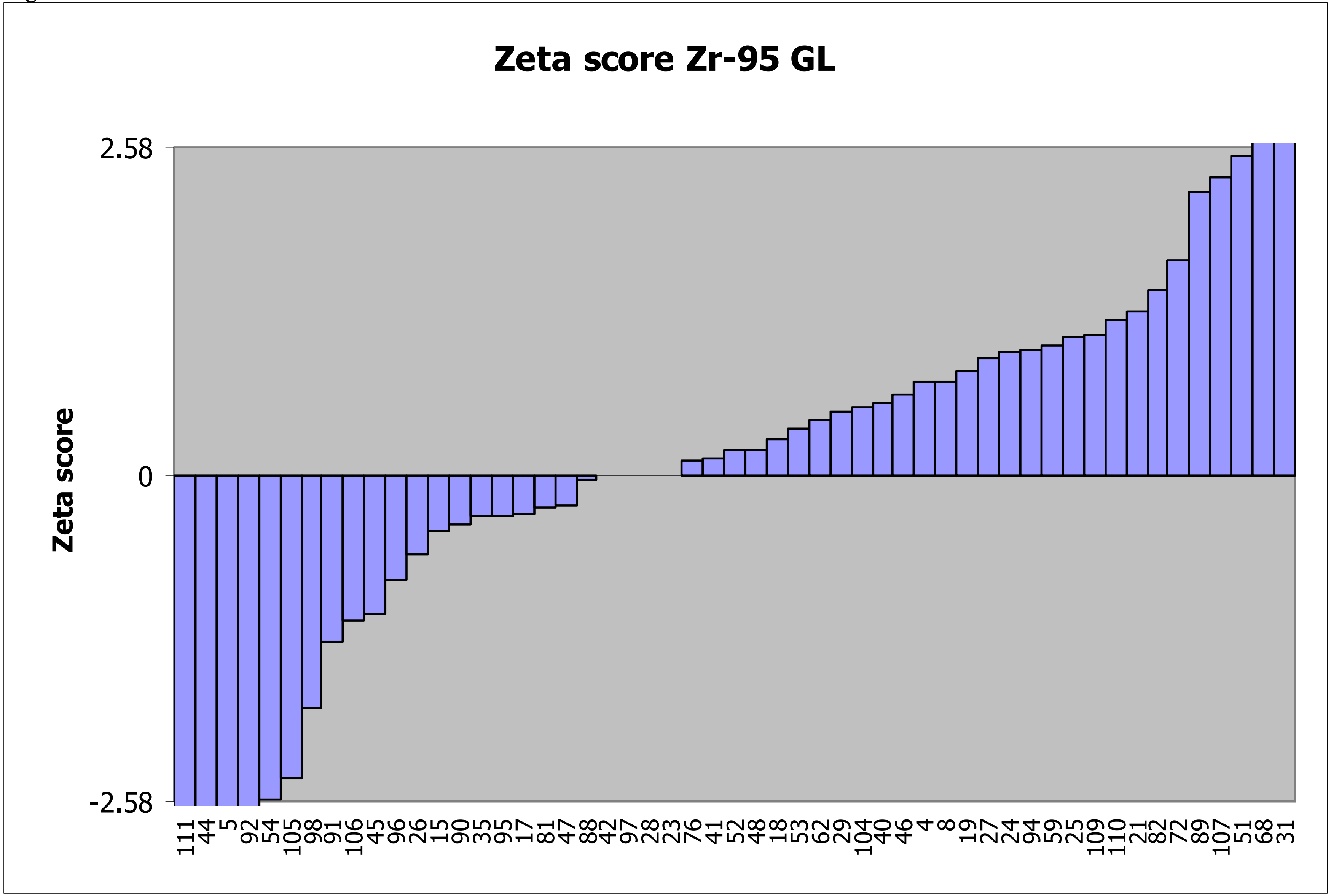


**Figure 31C – Relative uncertainty Zr-95 GL**

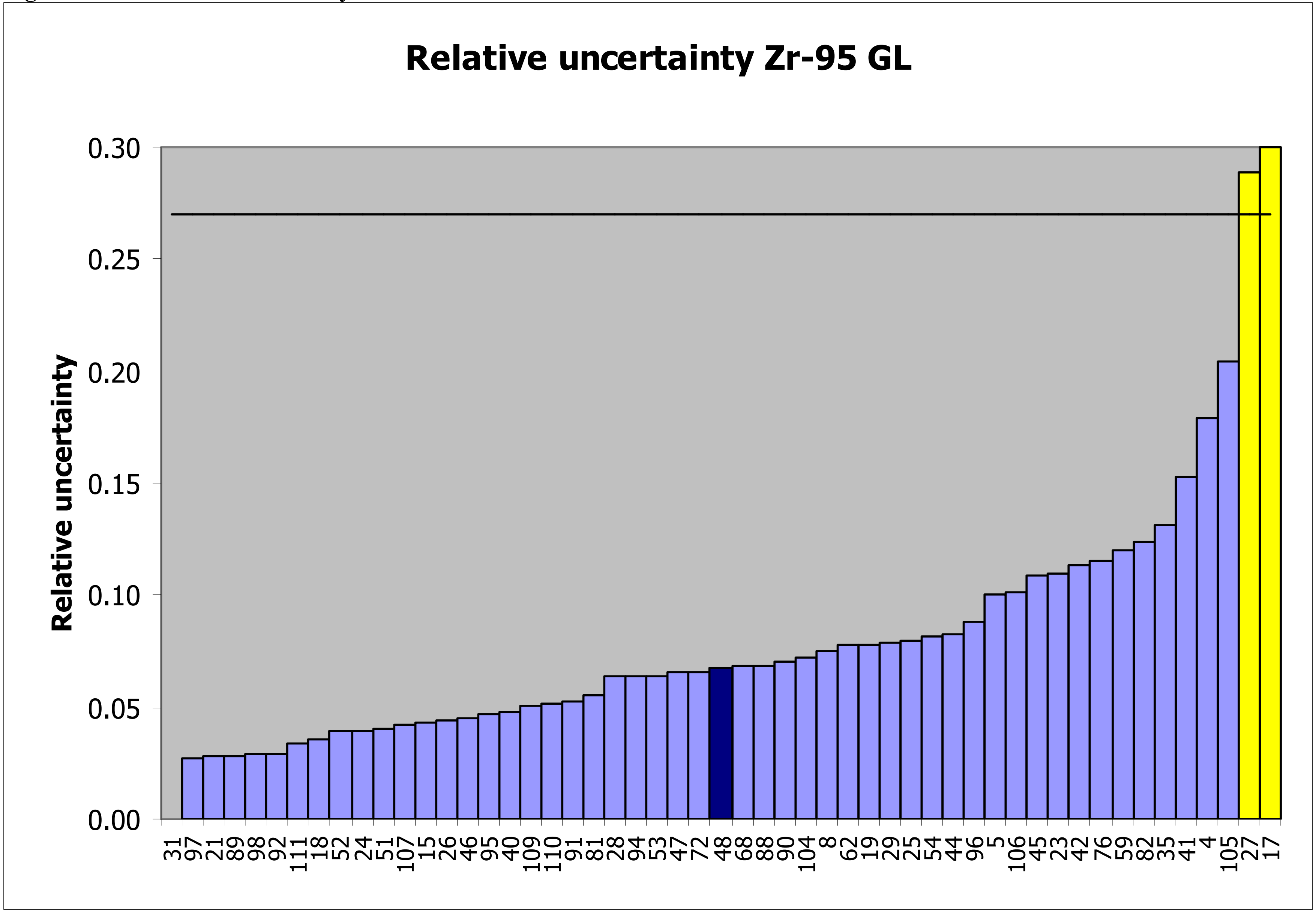


**Figure 31D – Kiri plot Zr-95 GL**

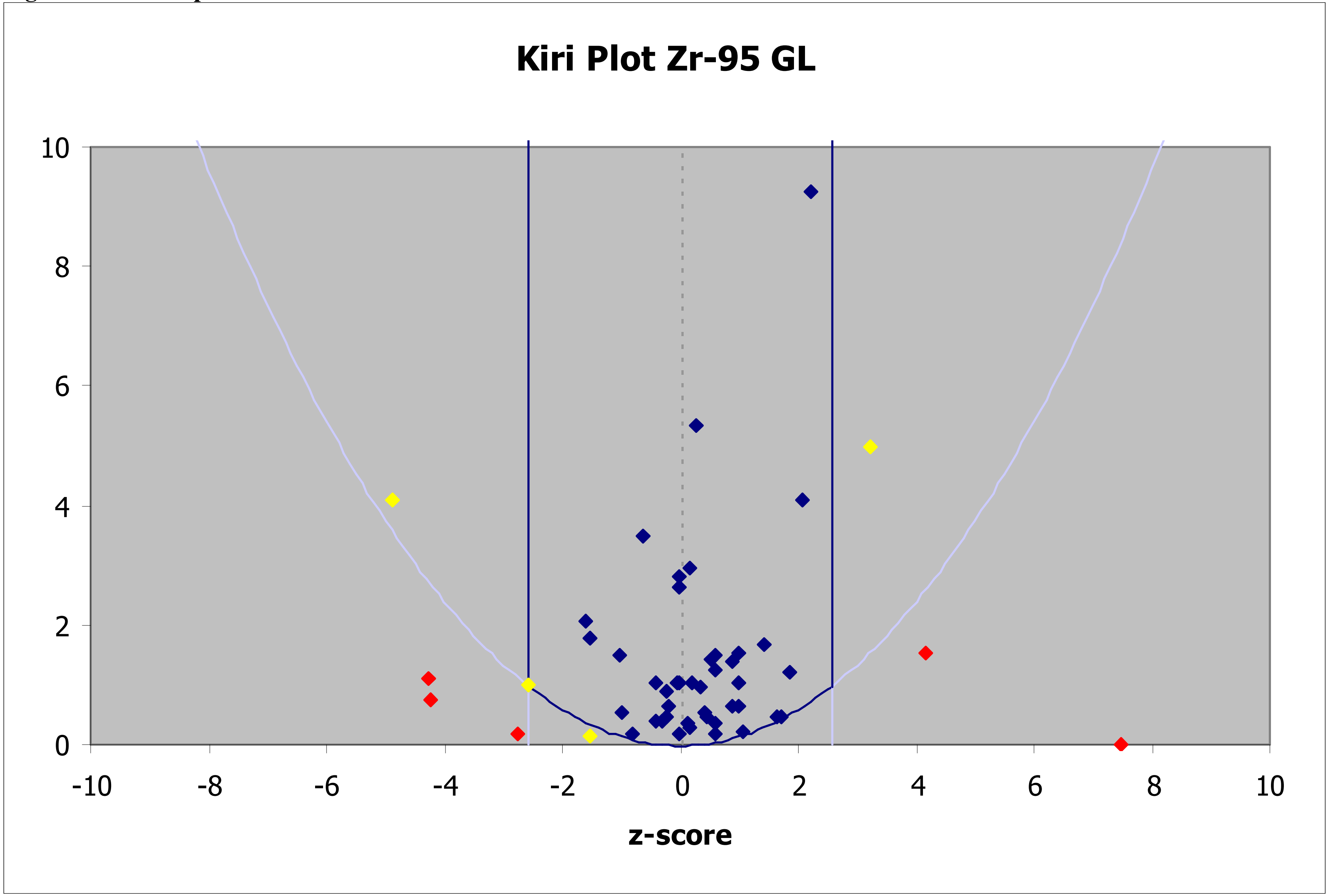


**Figure 32A – Deviation Nb-95 GL**

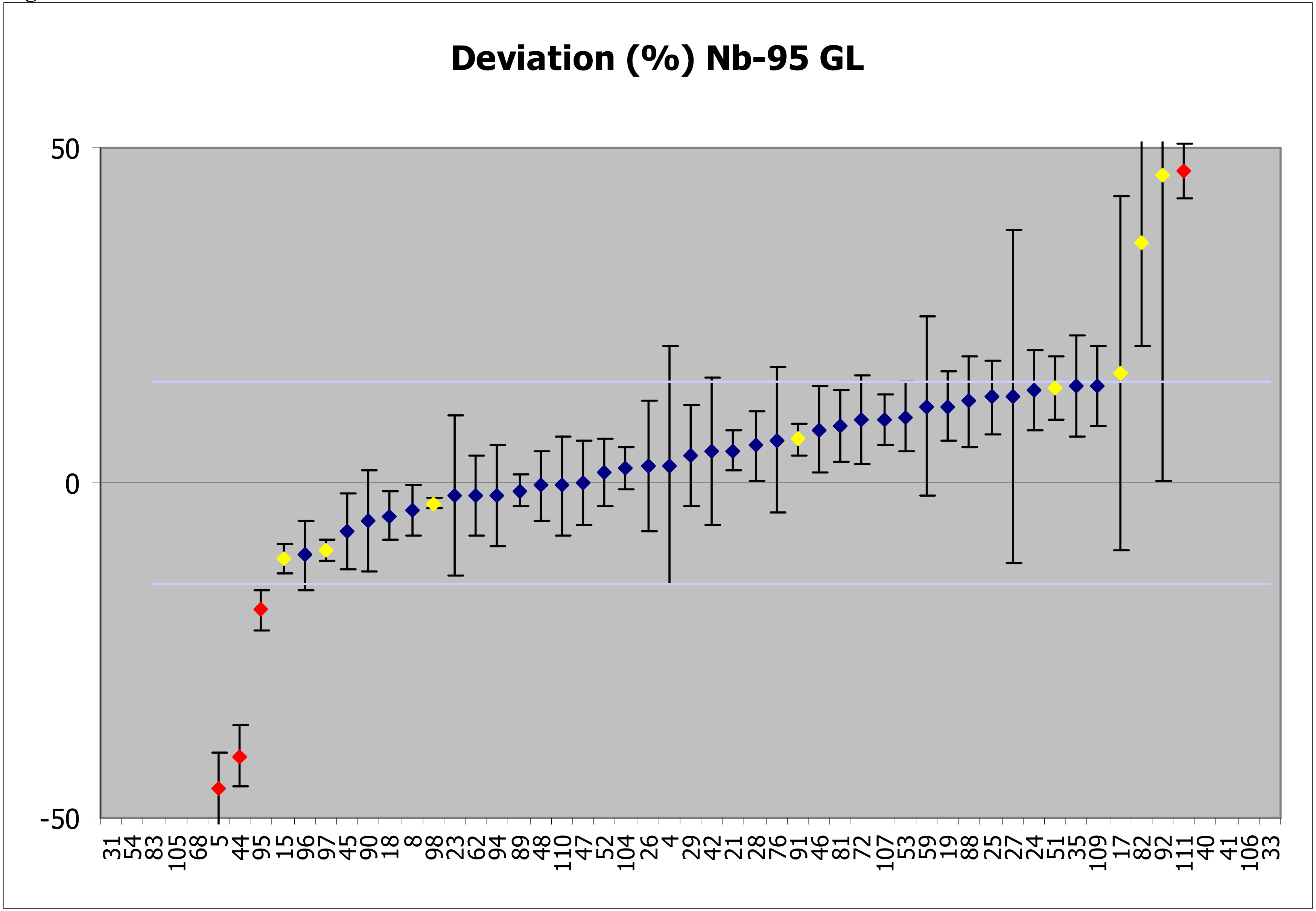


**Figure 32B – Zeta score Nb-95 GL**

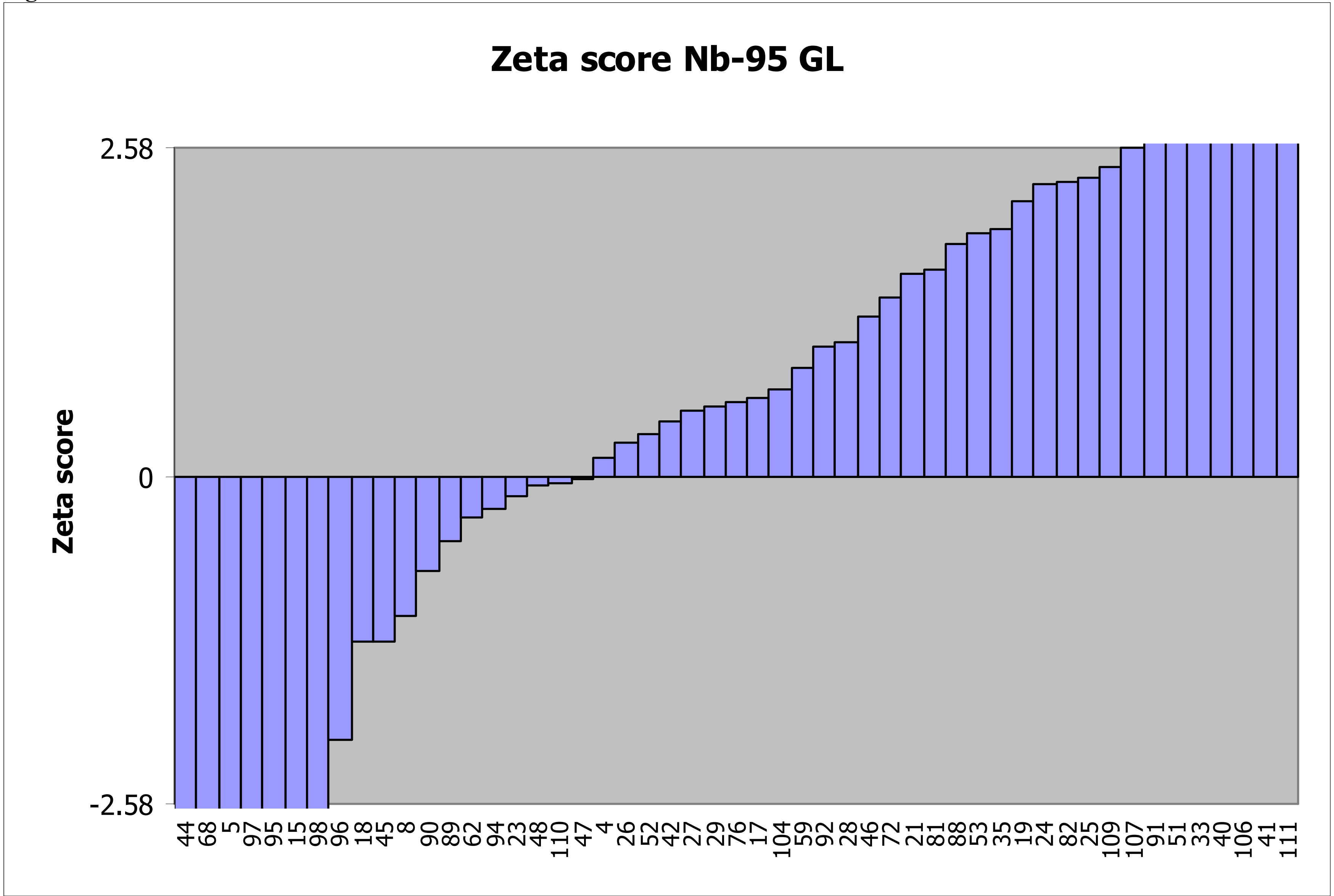


**Figure 32C – Relative uncertainty Nb-95 GL**

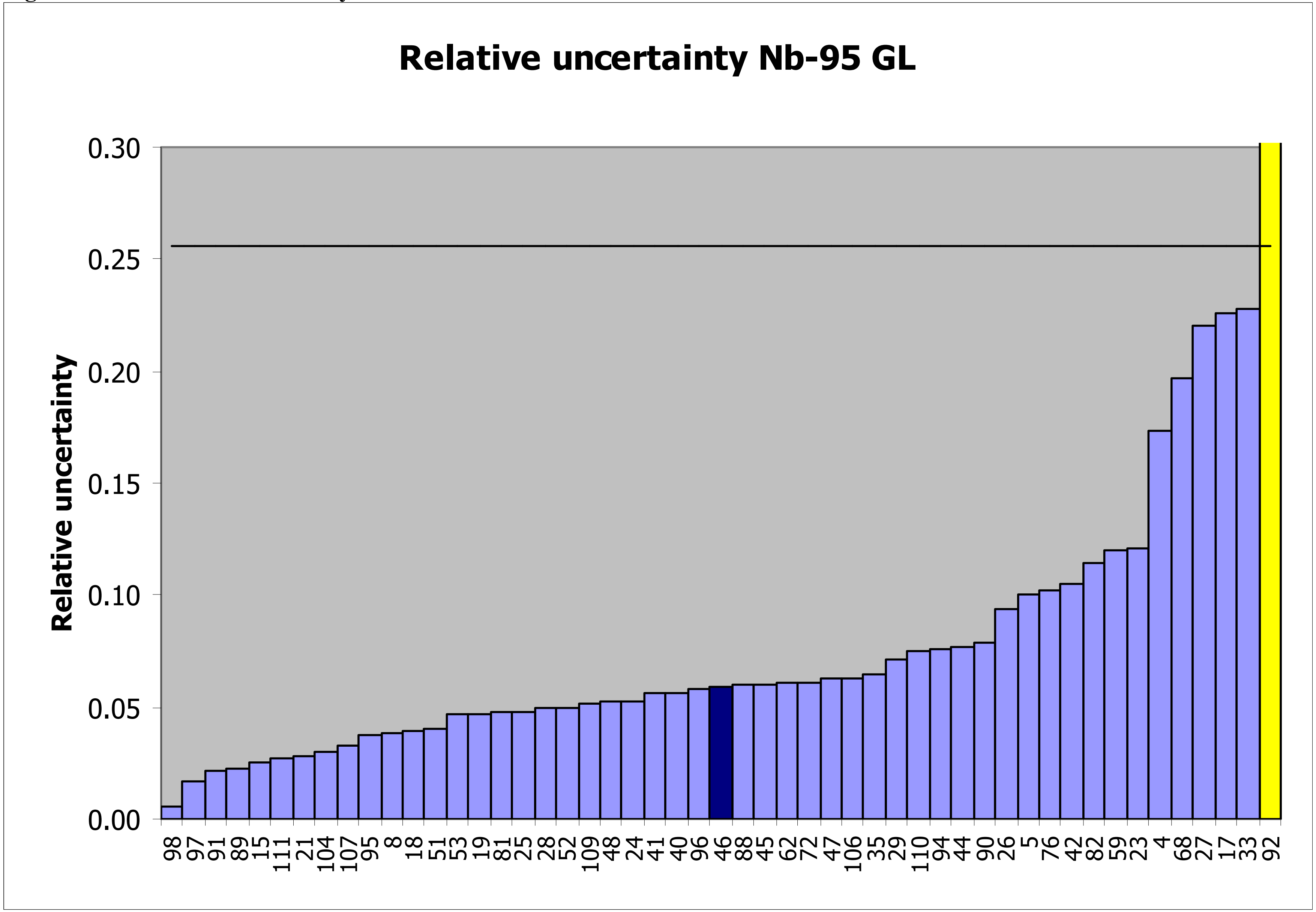


**Figure 32D – Kiri plot Nb-95 GL**

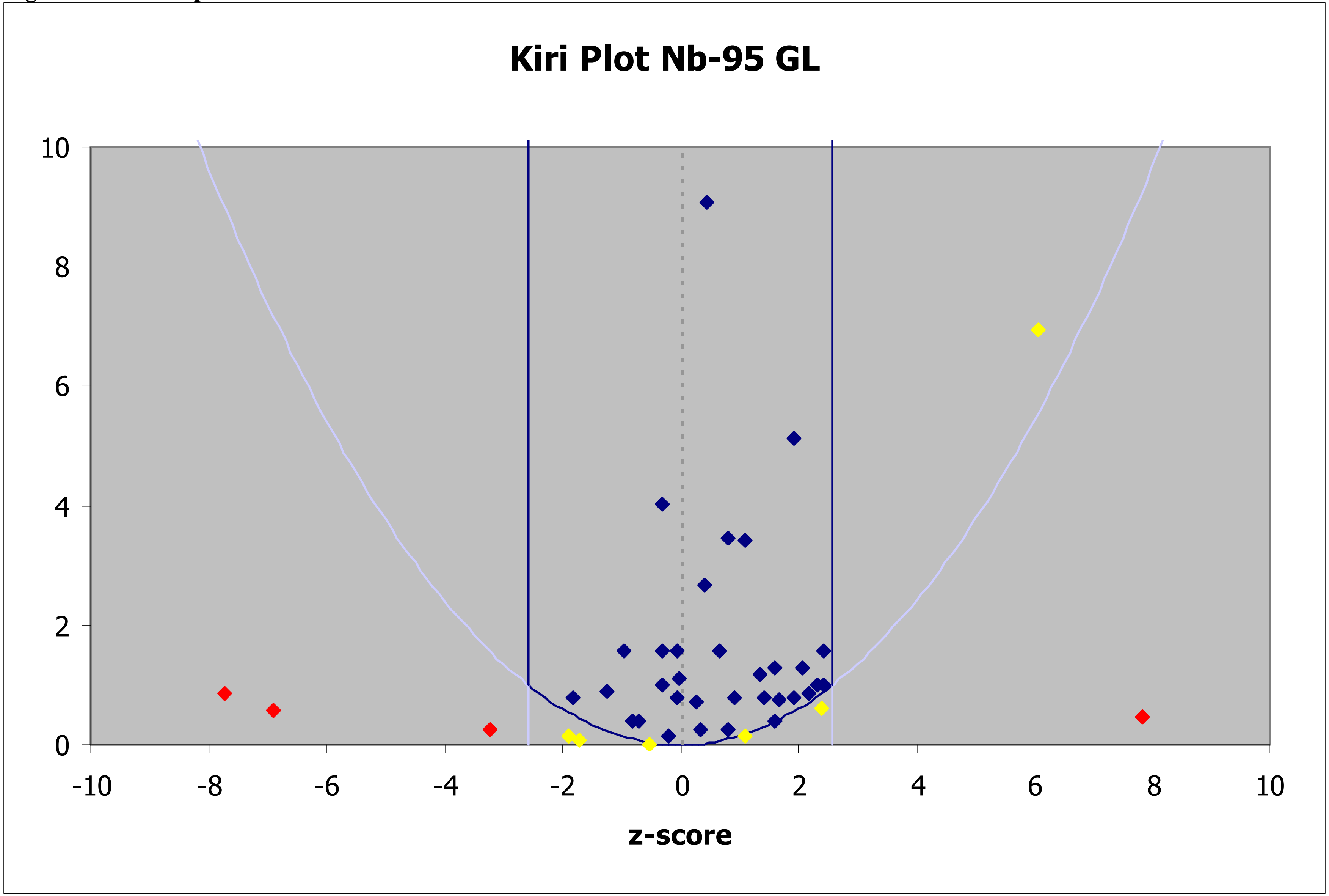


**Figure 33A – Deviation Ba-133 GL**

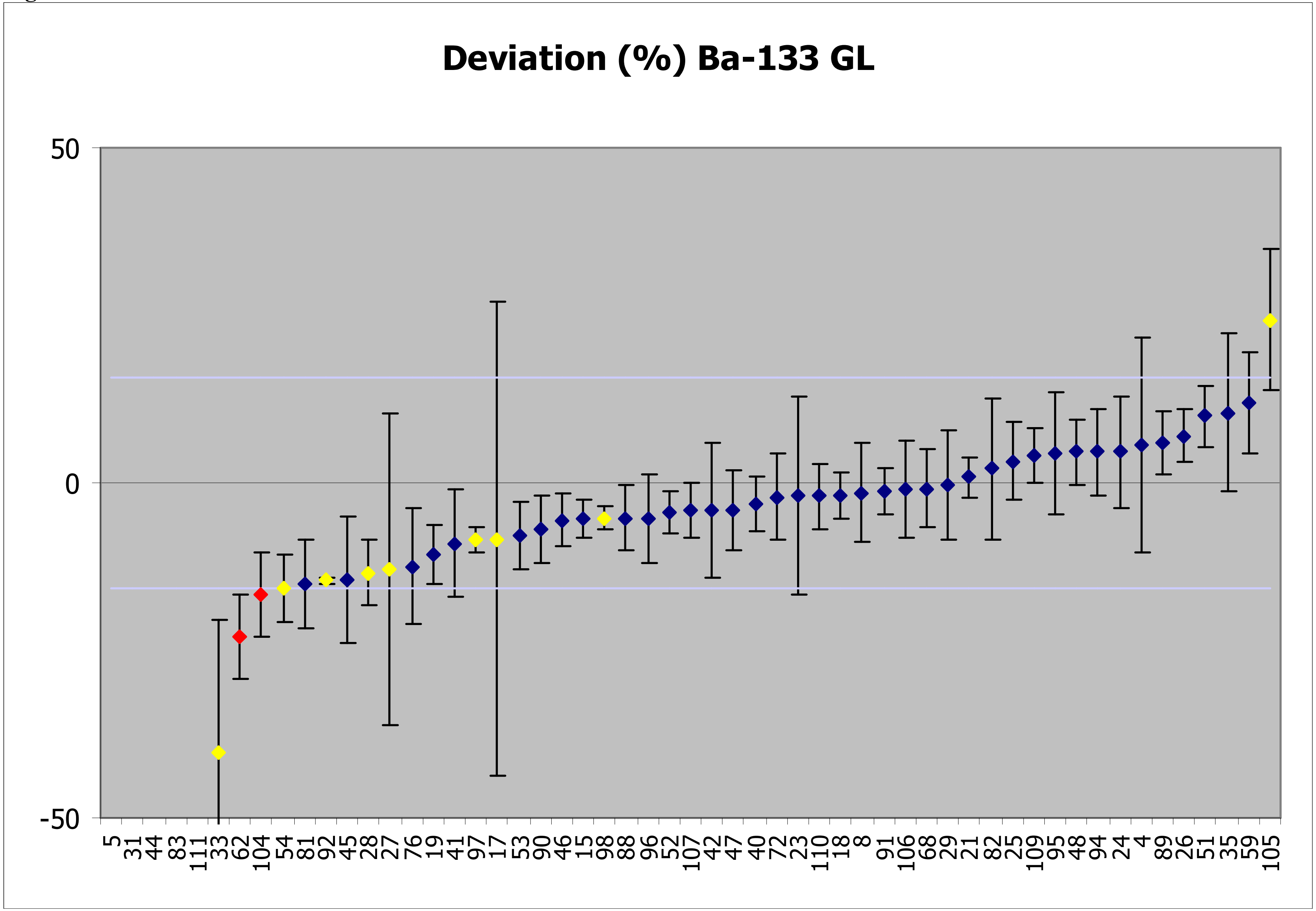


**Figure 33B – Zeta score Ba-133 GL**

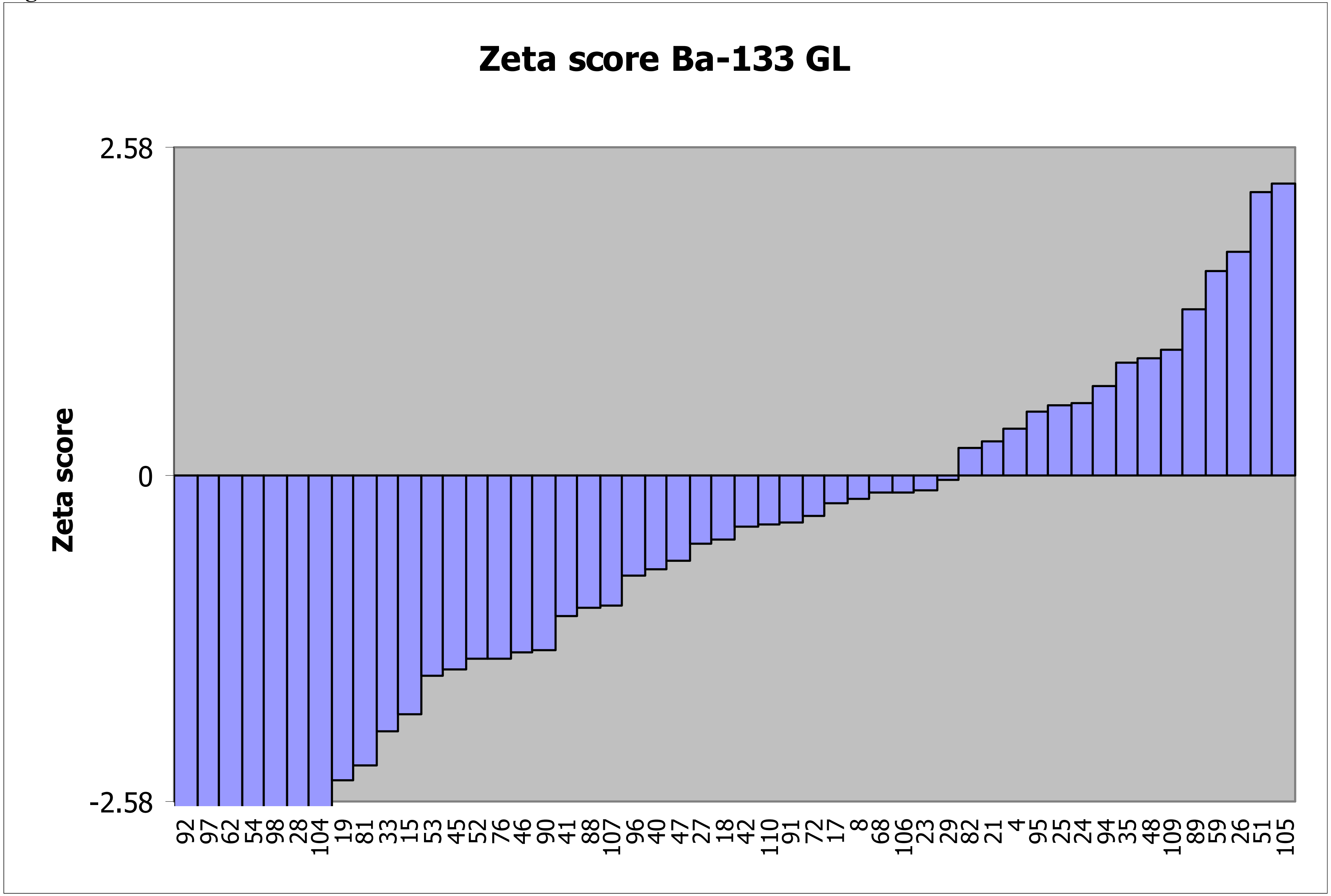


**Figure 33C – Relative uncertainty Ba-133 GL**

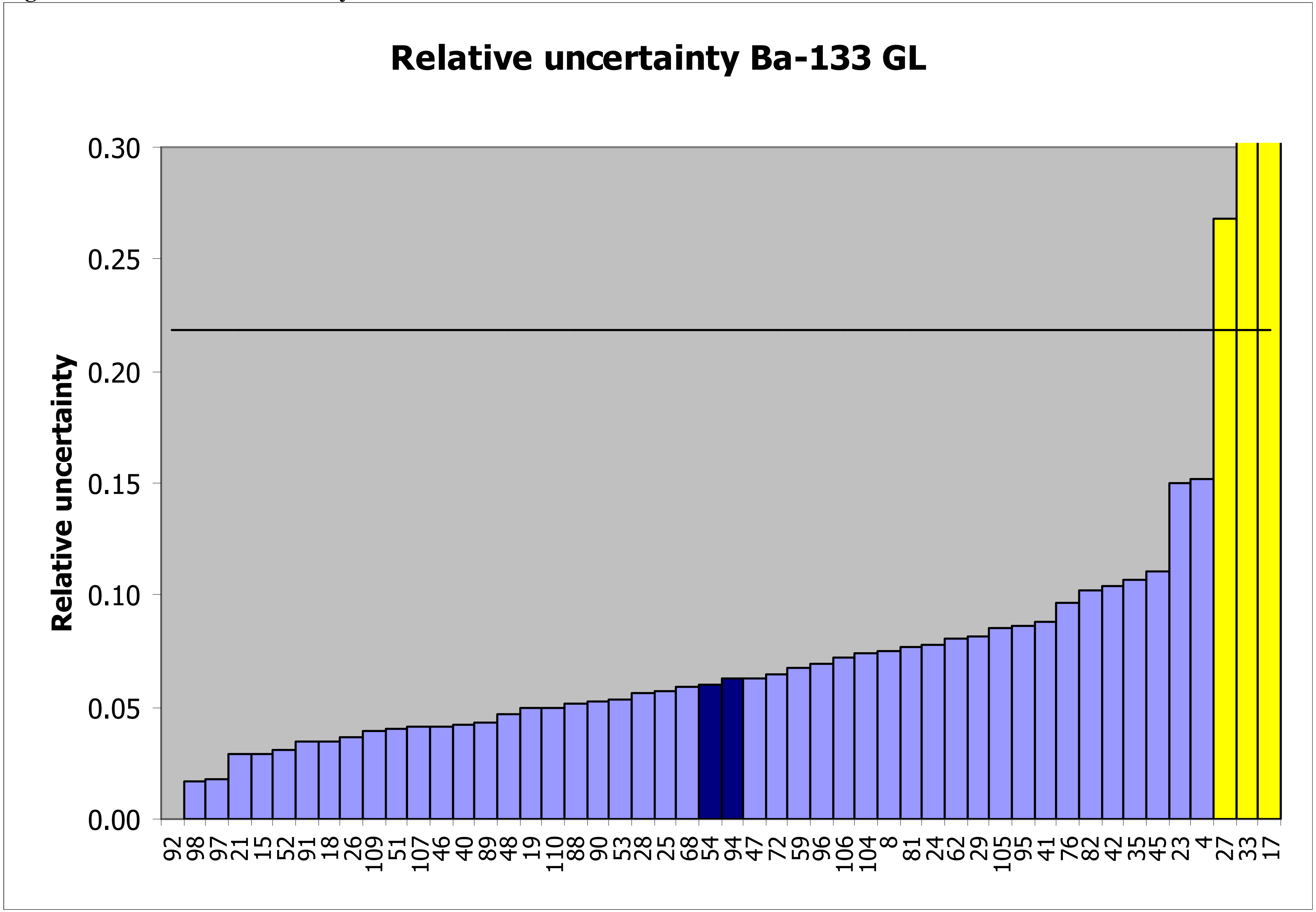


**Figure 33D – Kiri plot Ba-133 GL**

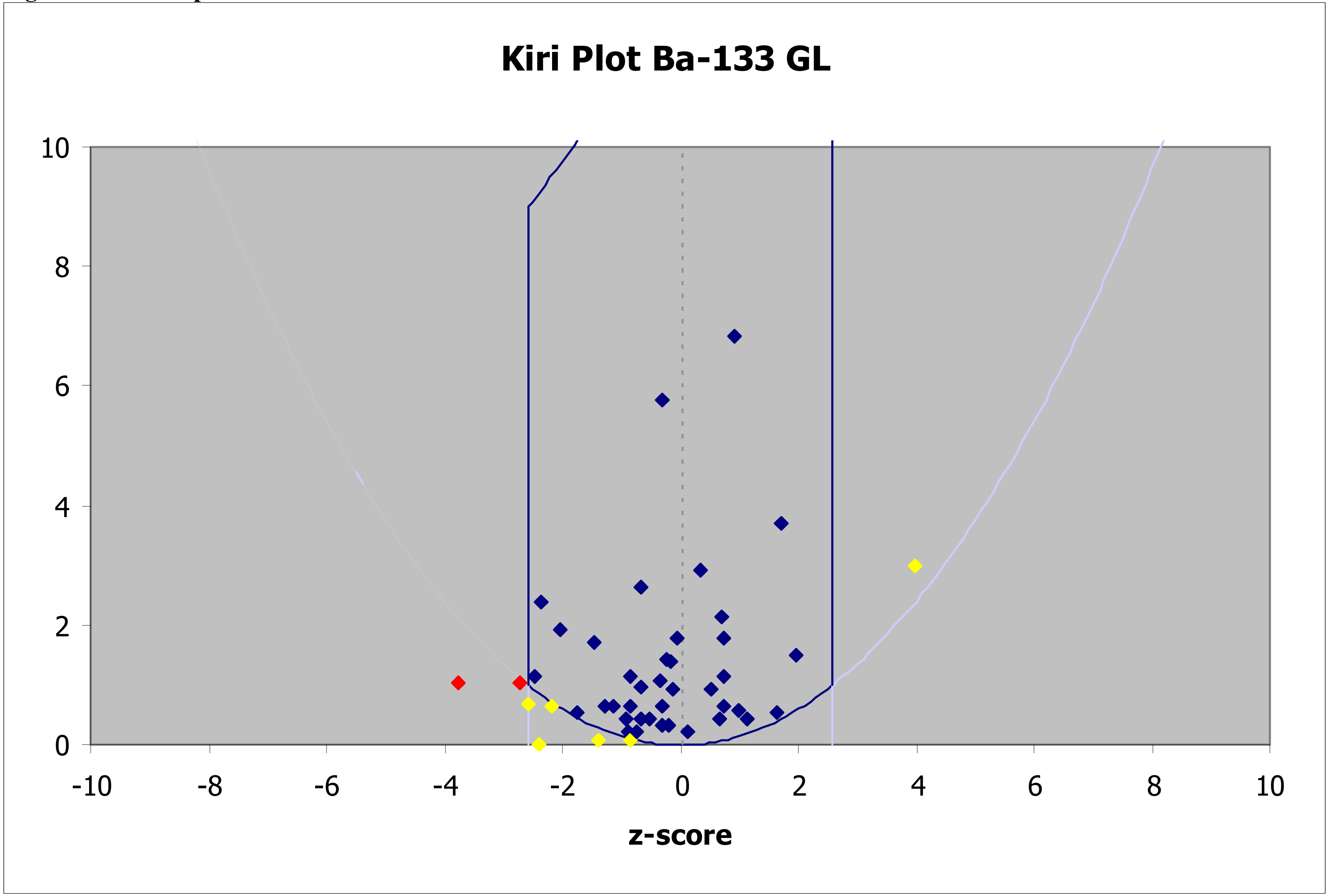


**Figure 34A – Deviation Cs-134 GL**

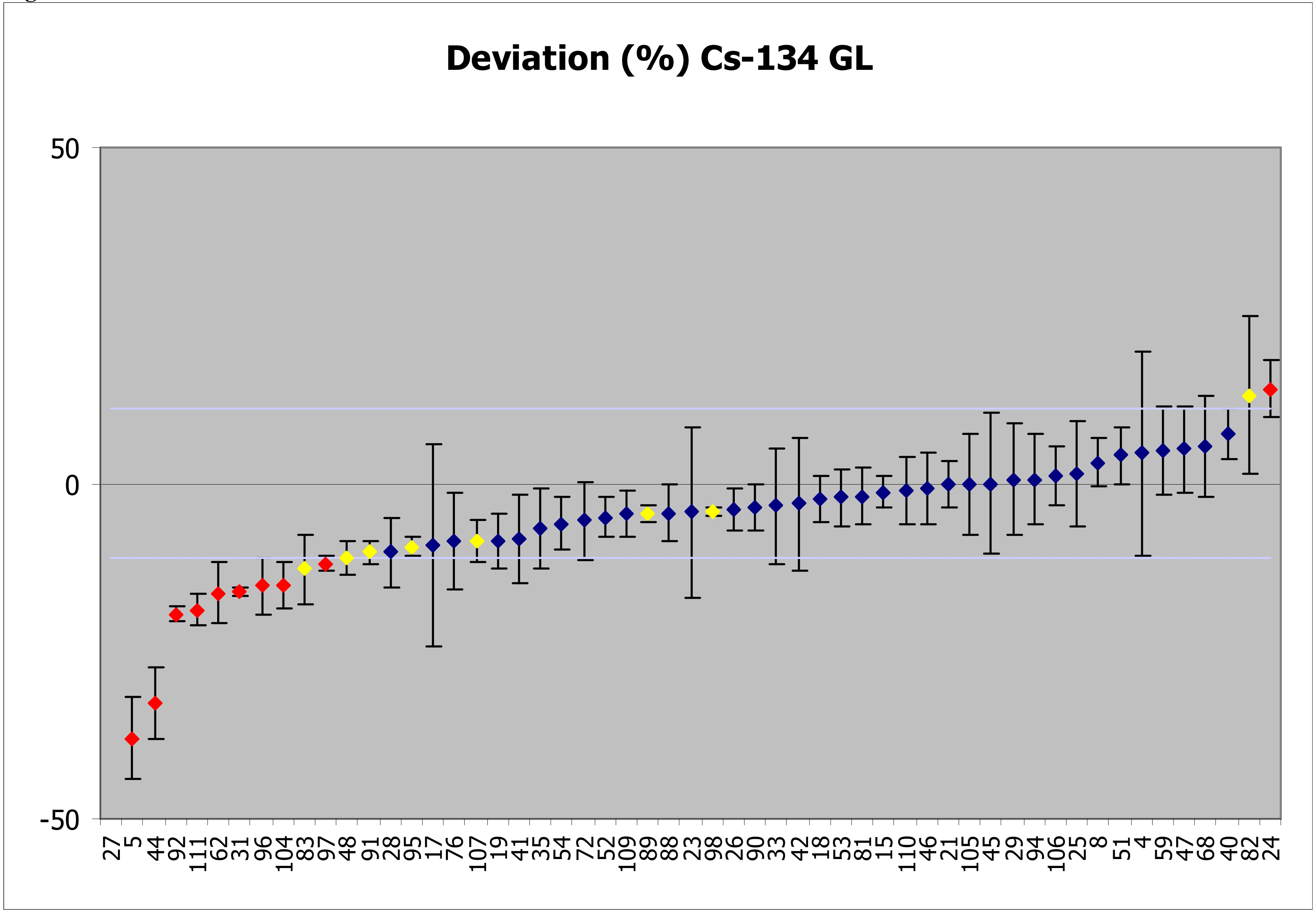


**Figure 34B – Zeta score Cs-134 GL**

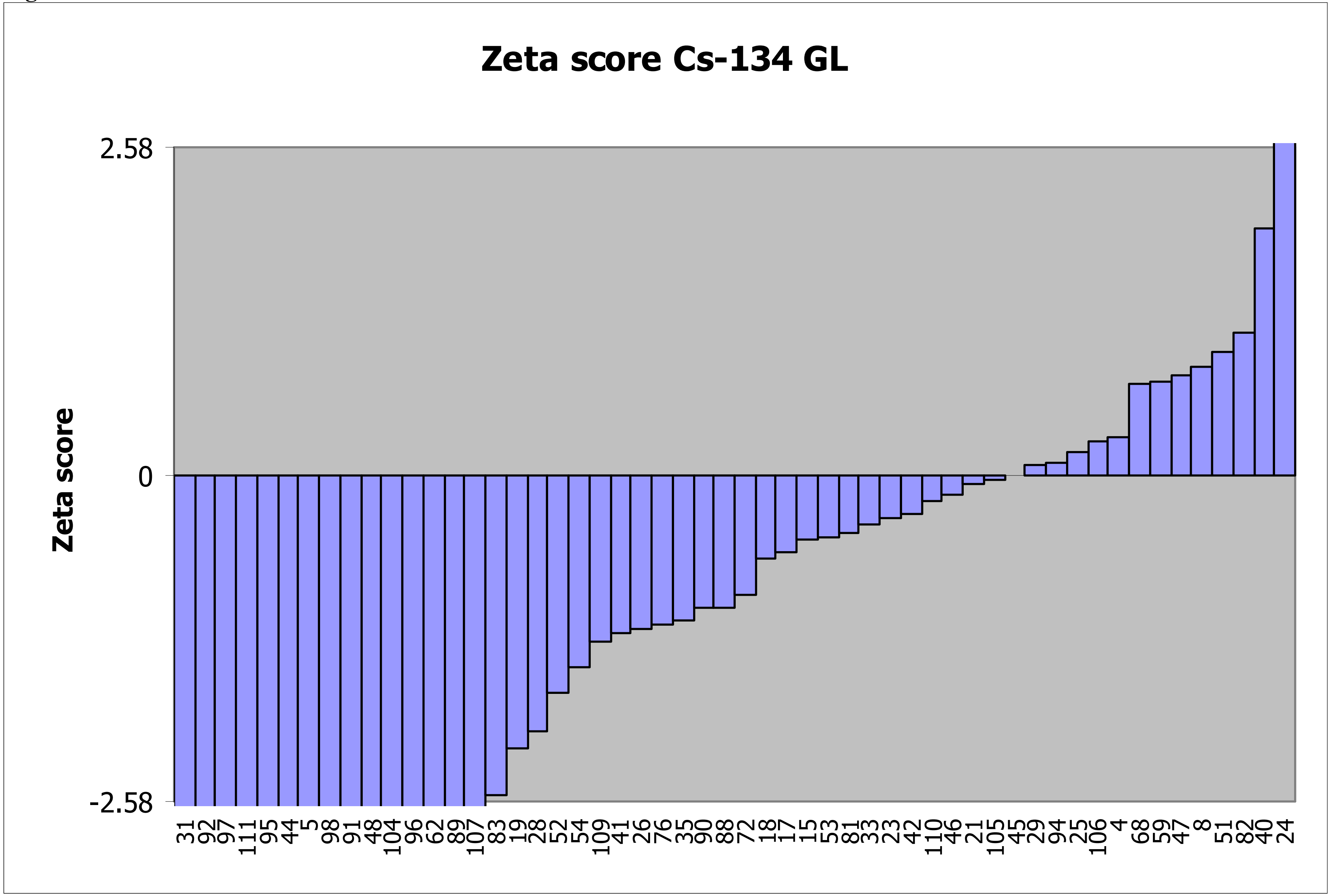


**Figure 34C – Relative uncertainty Cs-134 GL**

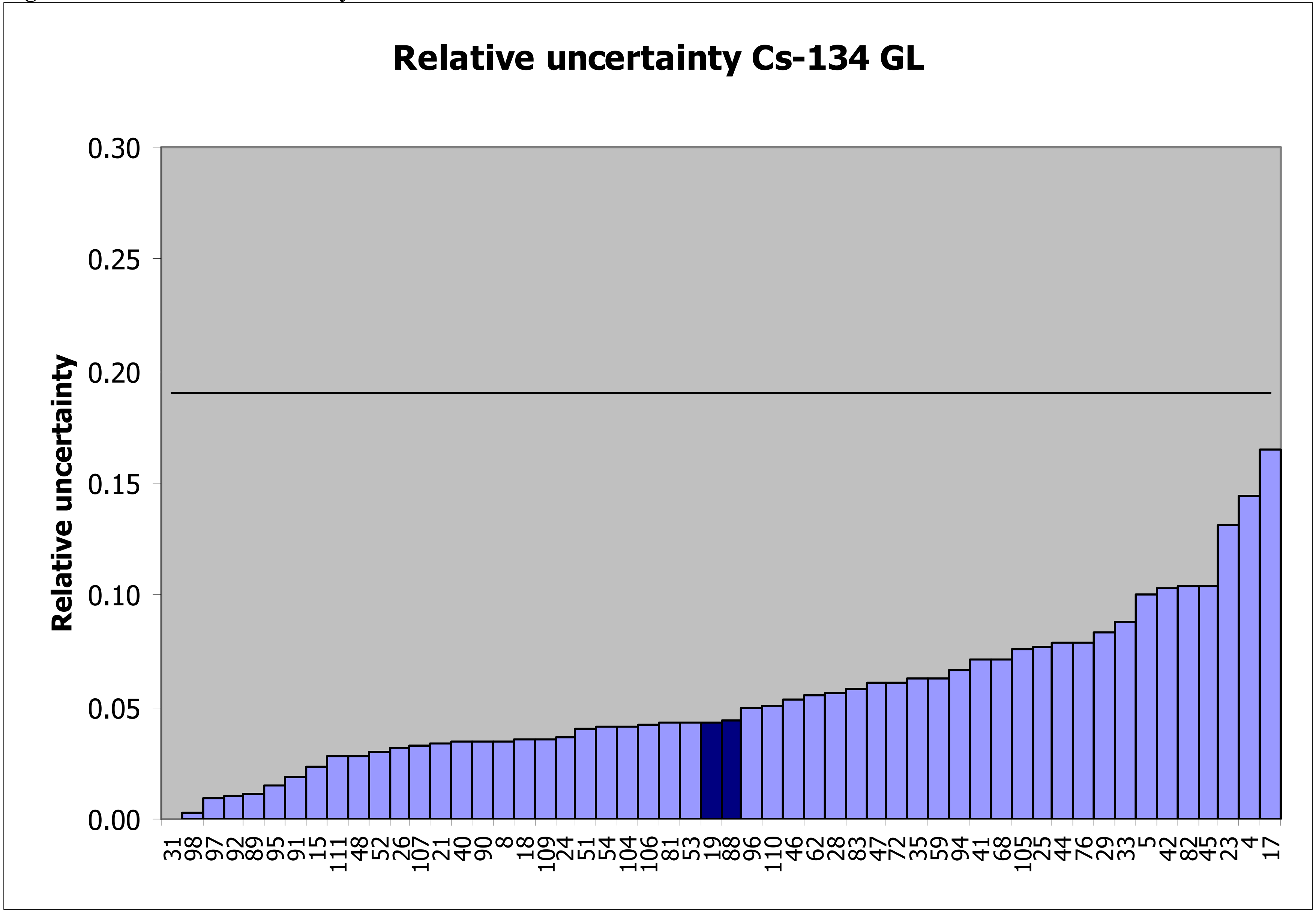


**Figure 34D – Kiri plot Cs-134 GL**

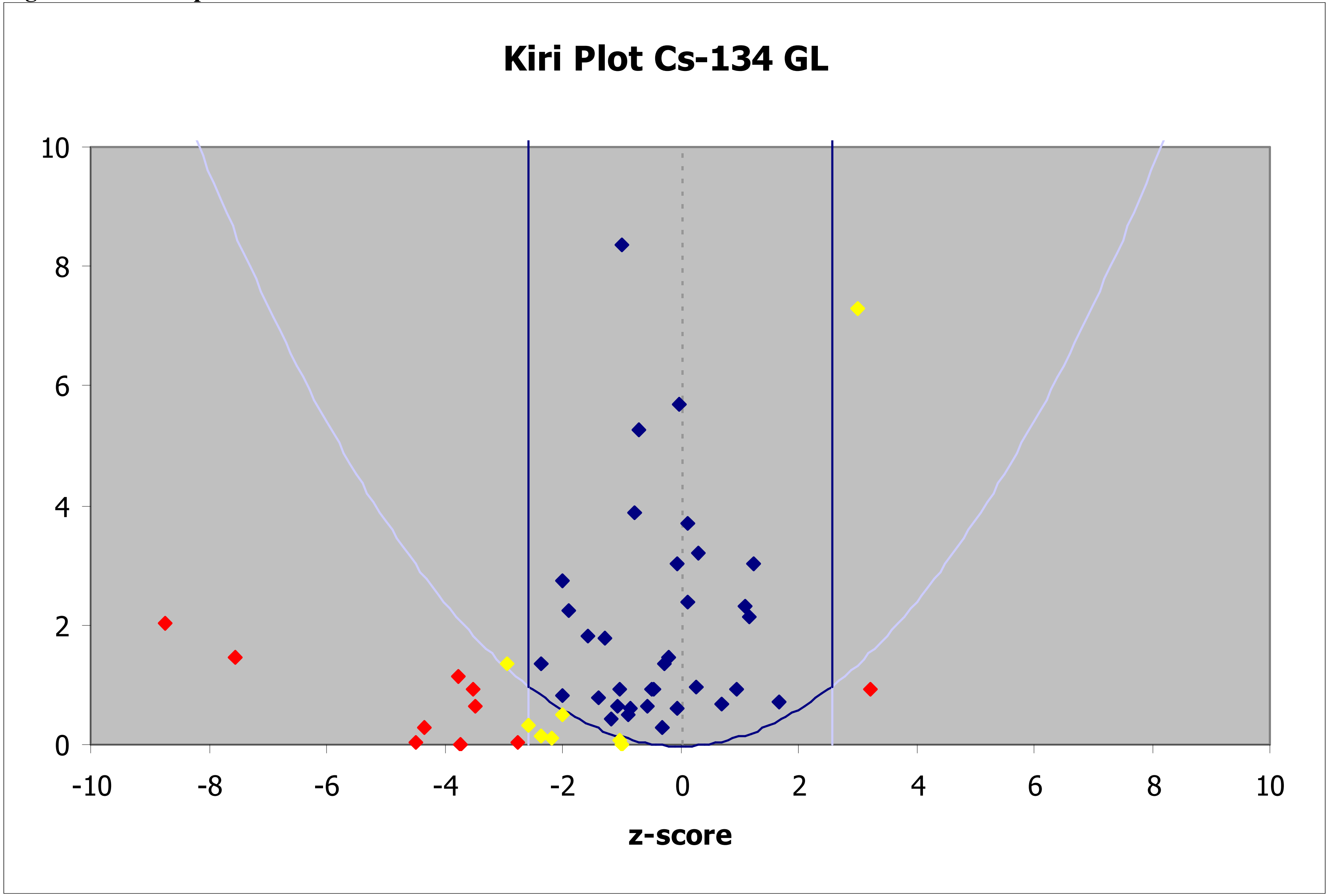


**Figure 35A – Deviation Cs-137 GL**

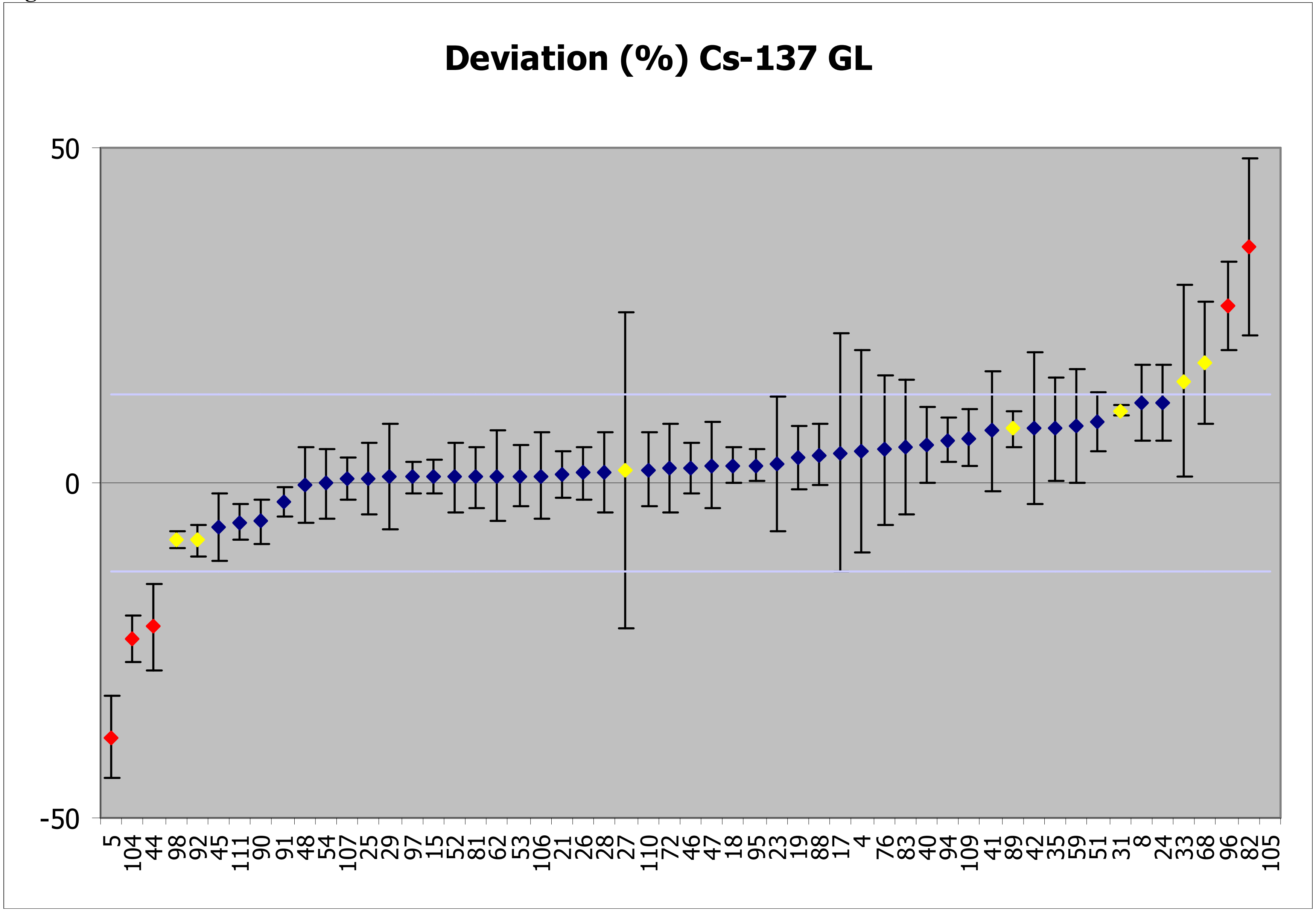


**Figure 35B – Zeta score Cs-137 GL**

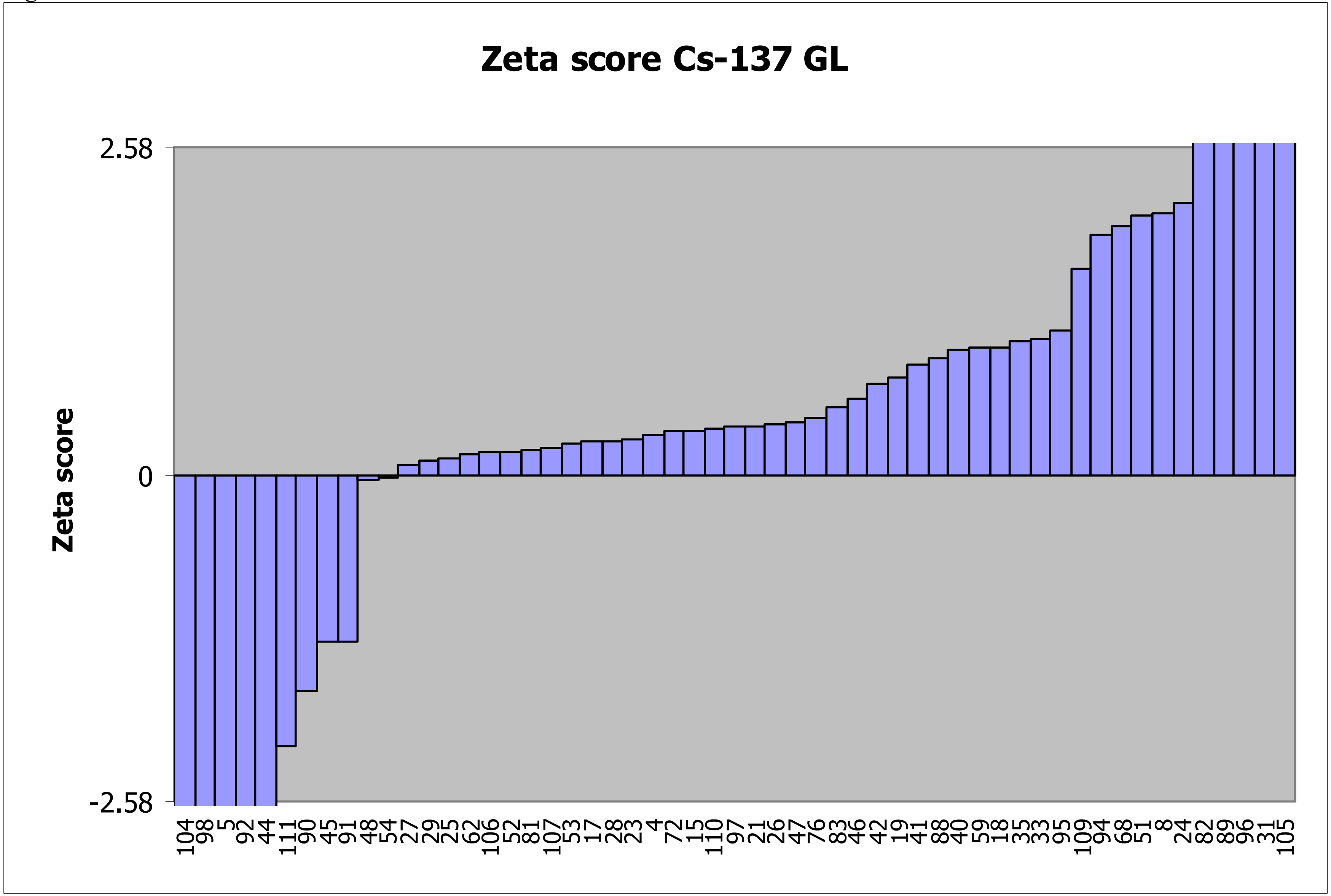


**Figure 35C – Relative uncertainty Cs-137 GL**

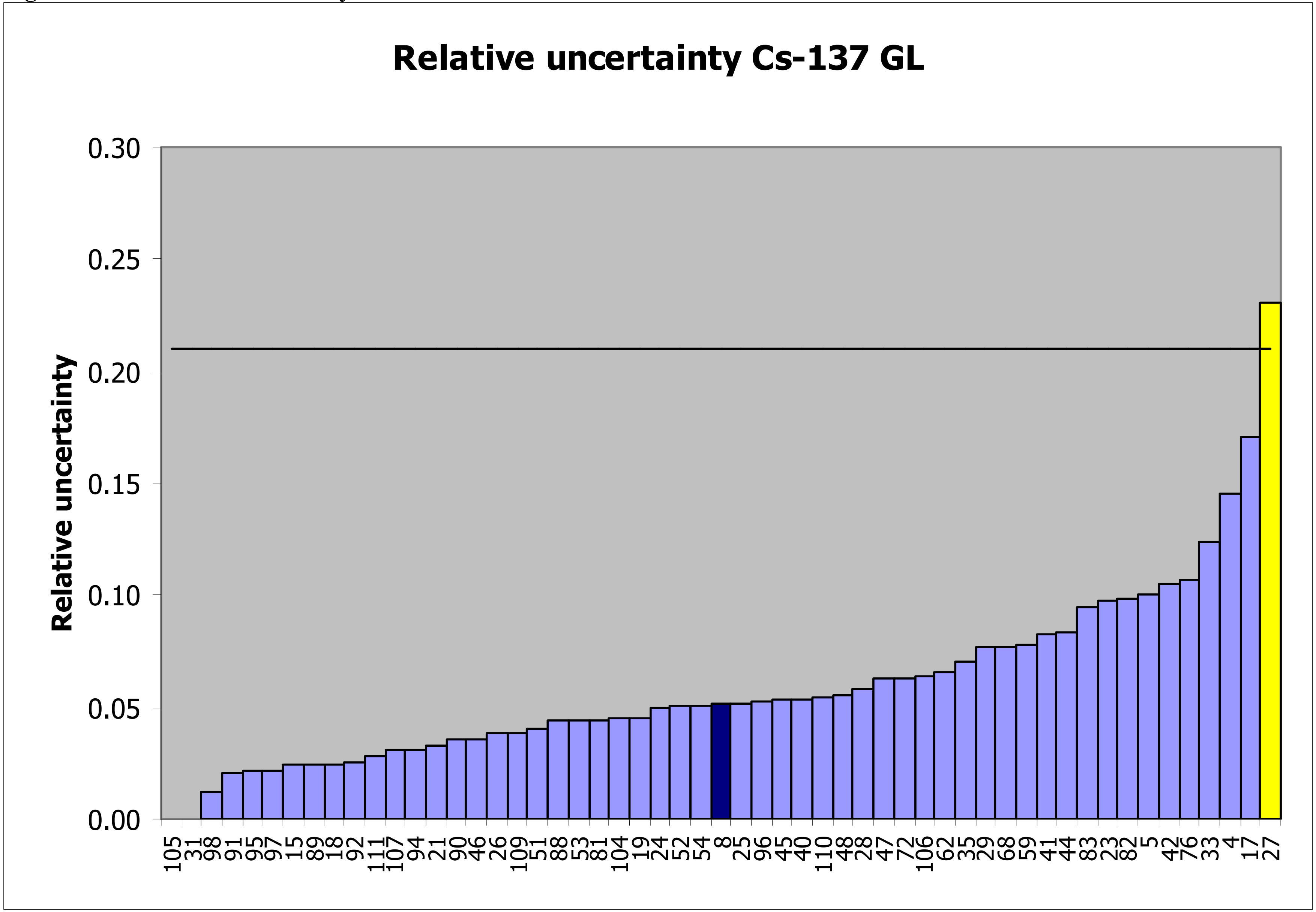


**Figure 35D – Kiri plot Cs-137 GL**

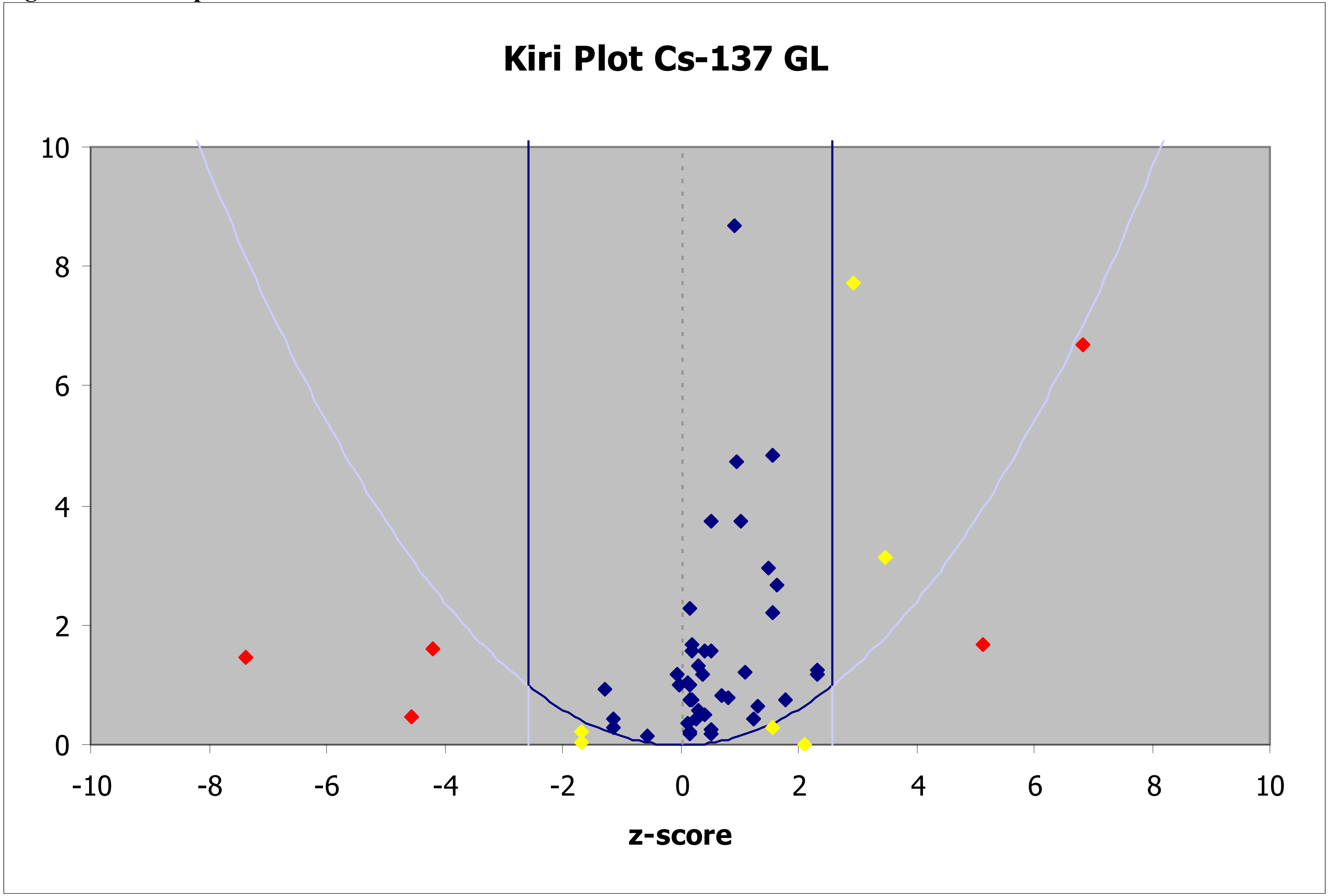


**Figure 36A – Deviation Eu-152 GL**

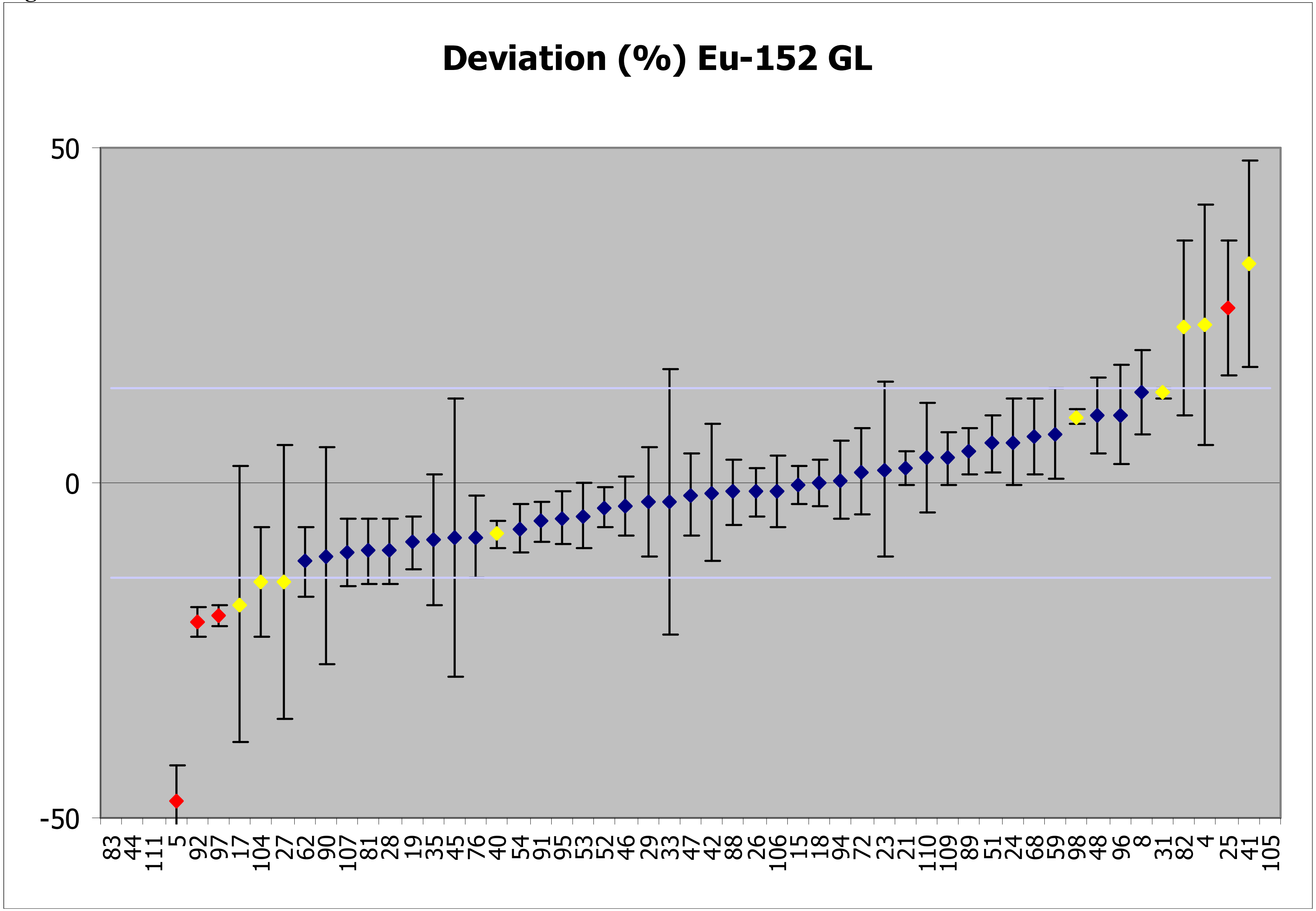


**Figure 36B – Zeta score Eu-152 GL**

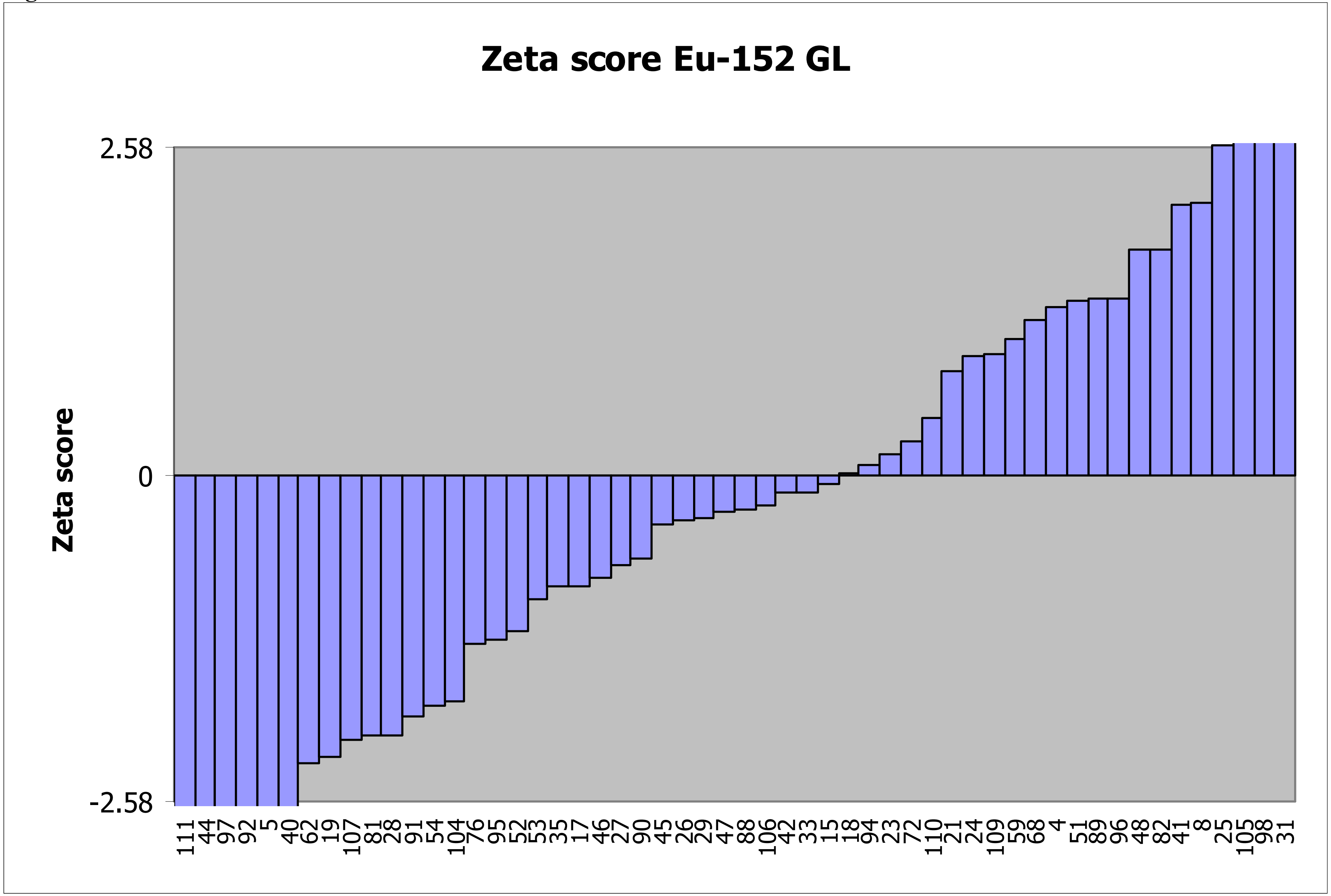


**Figure 36C – Relative uncertainty Eu-152 GL**

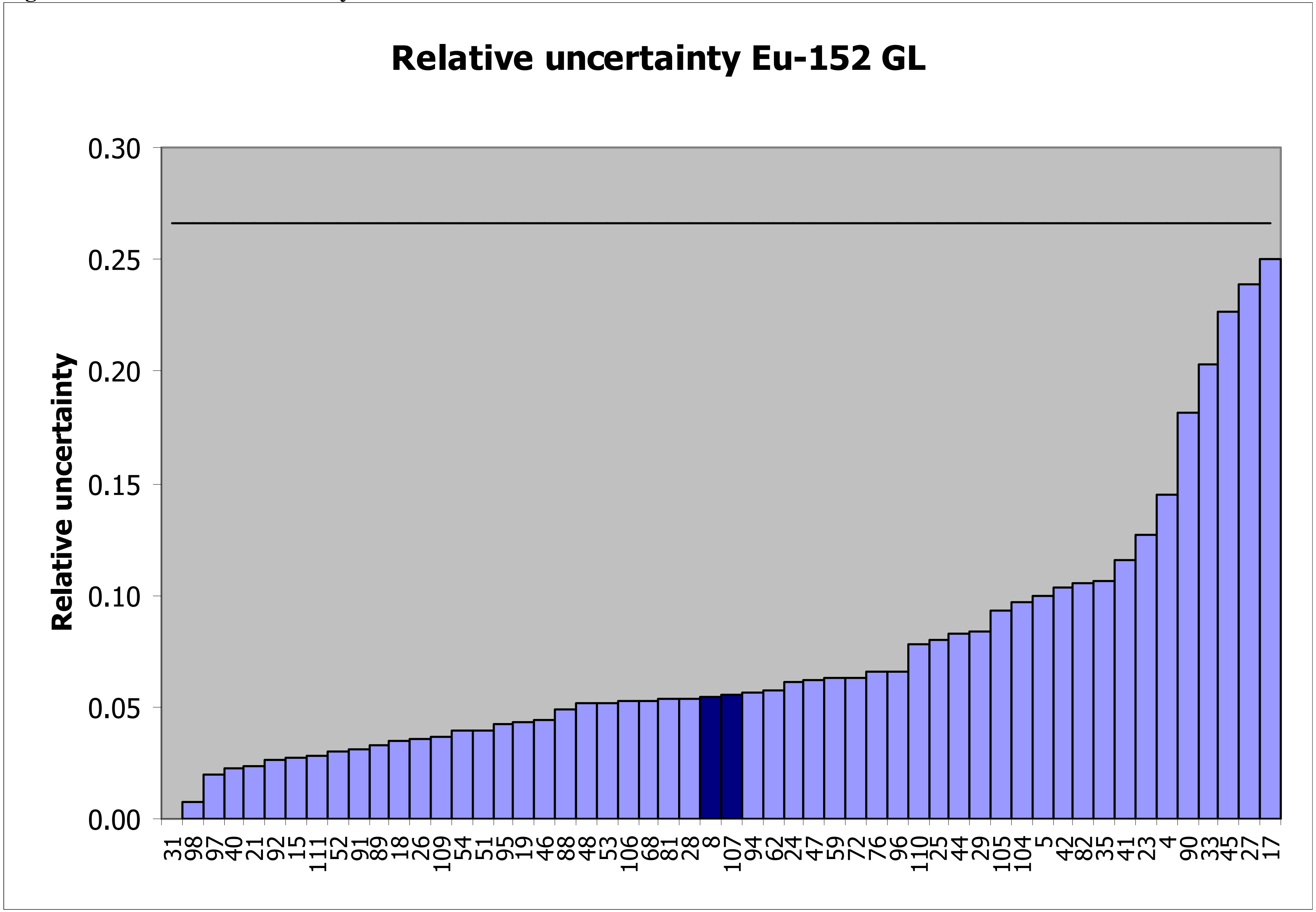


**Figure 36D – Kiri plot Eu-152 GL**

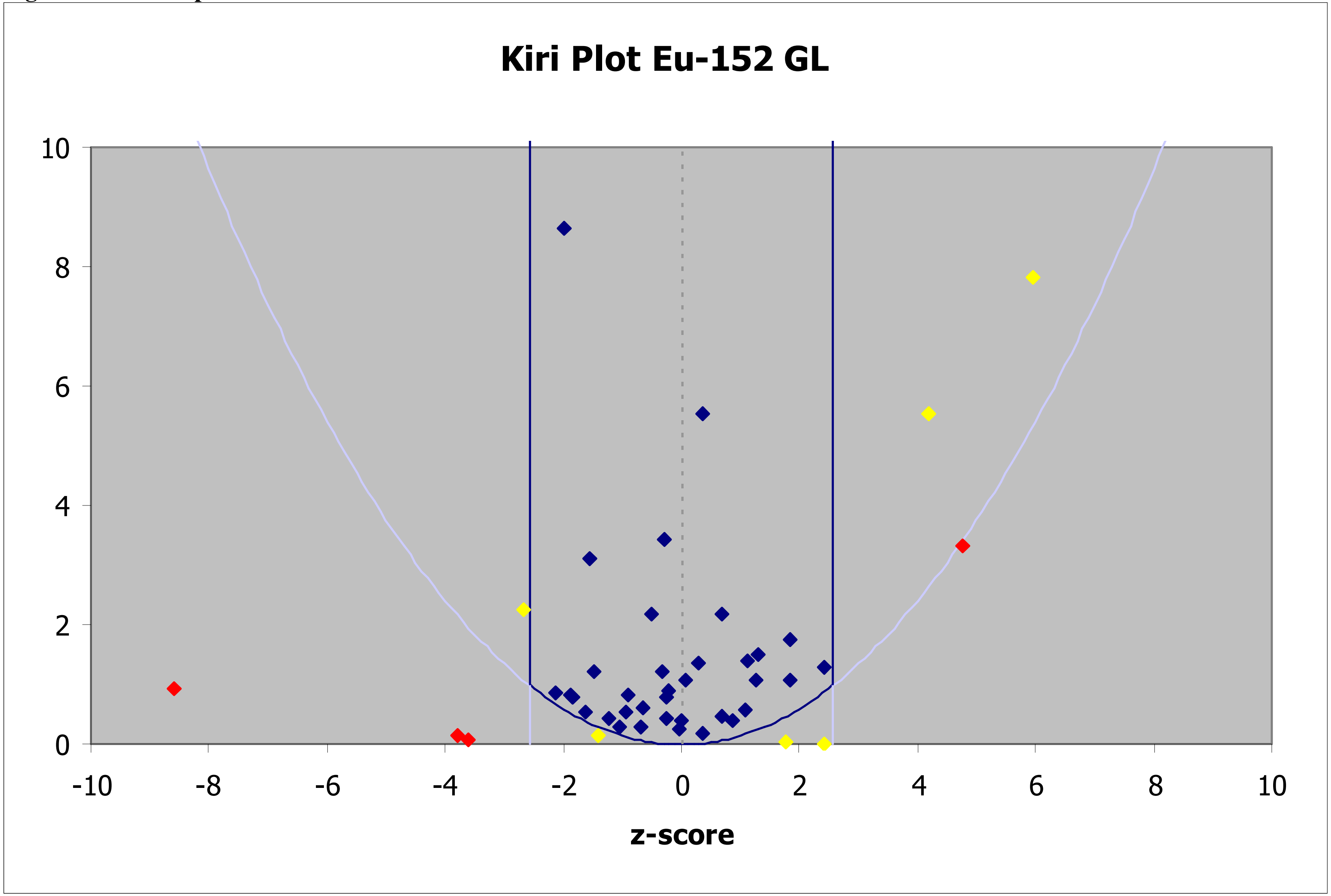


**Figure 37A – Deviation Na-22 GH**

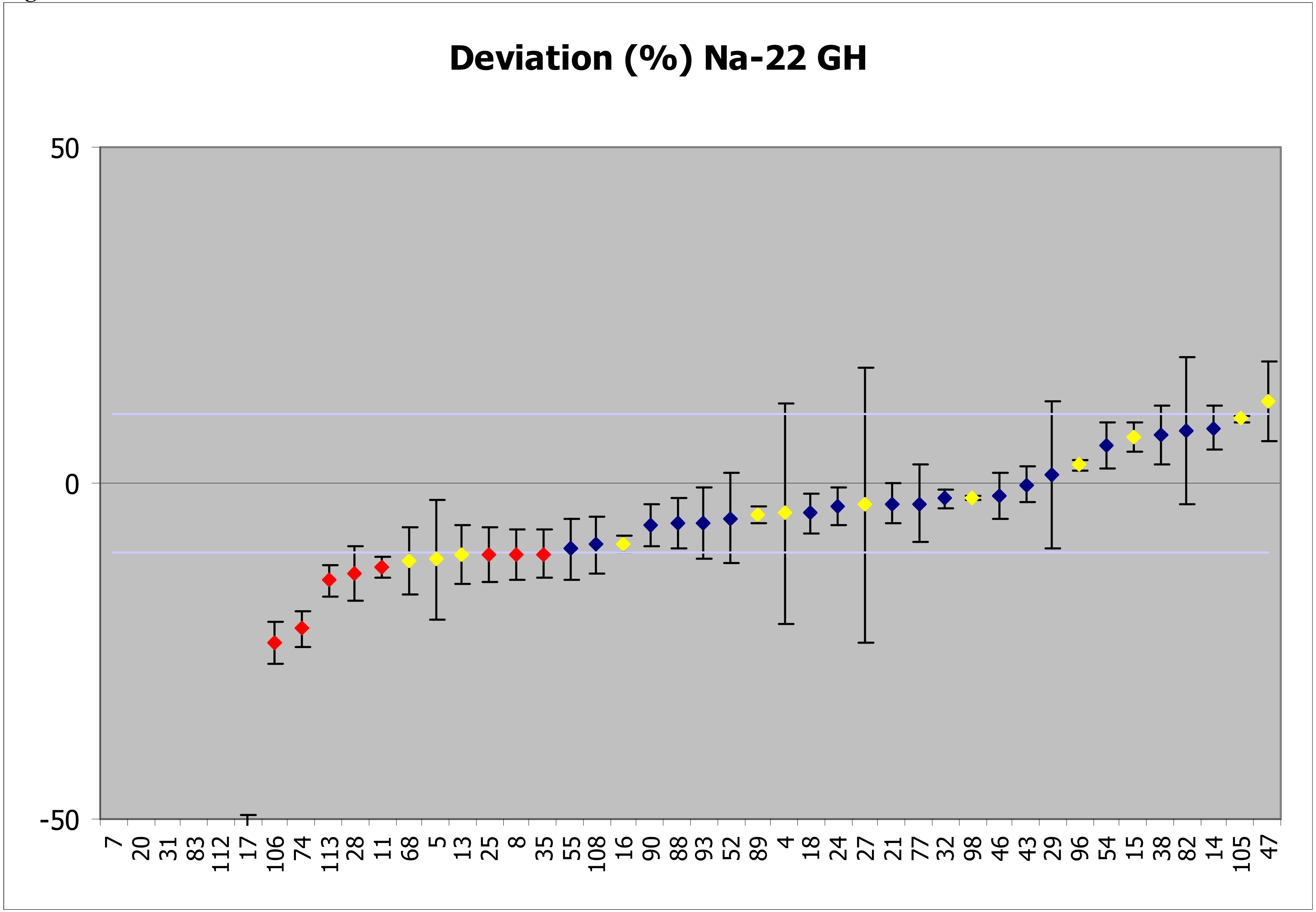


**Figure 37B – Zeta score Na-22 GH**

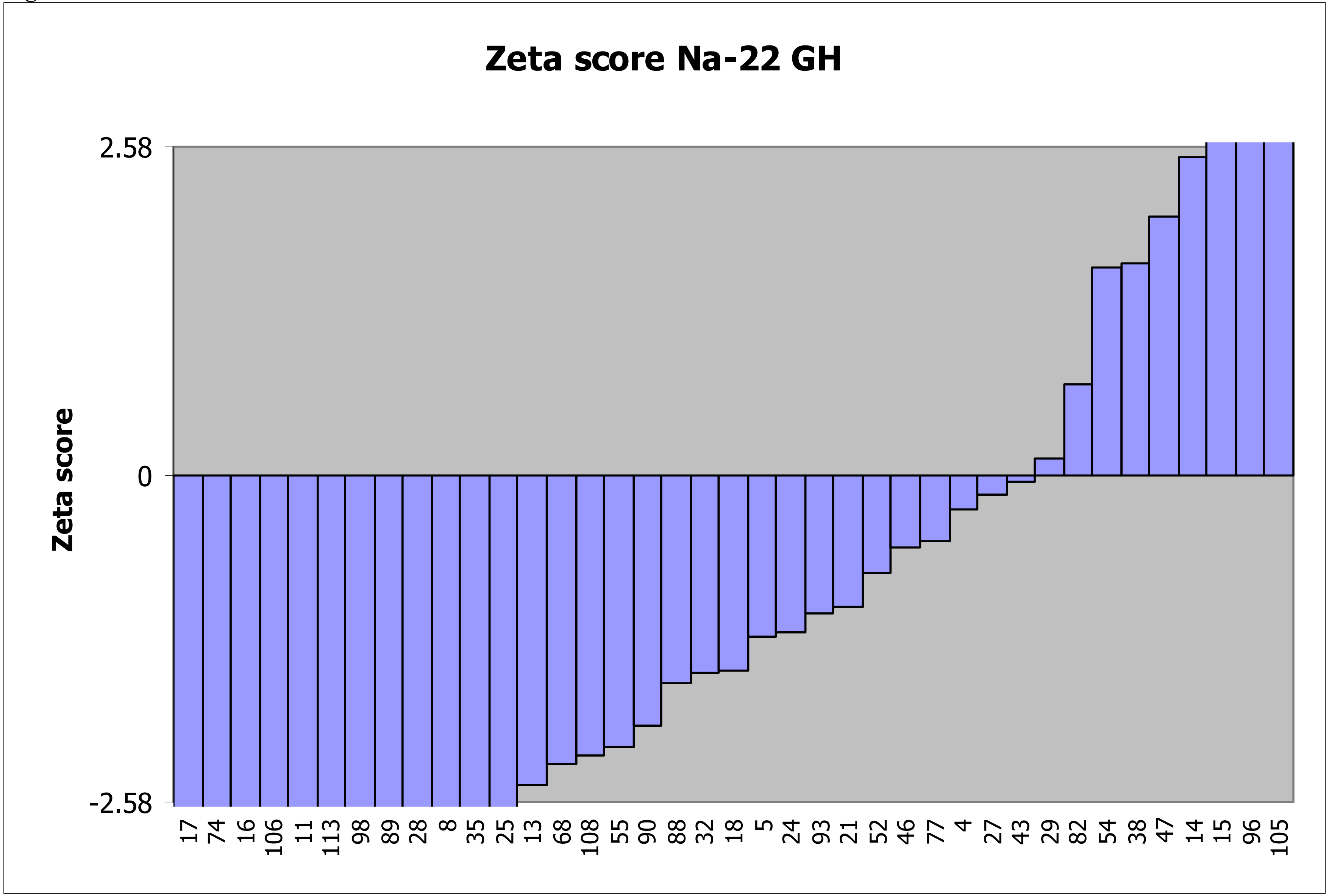


**Figure 37C – Relative uncertainty Na-22 GH**

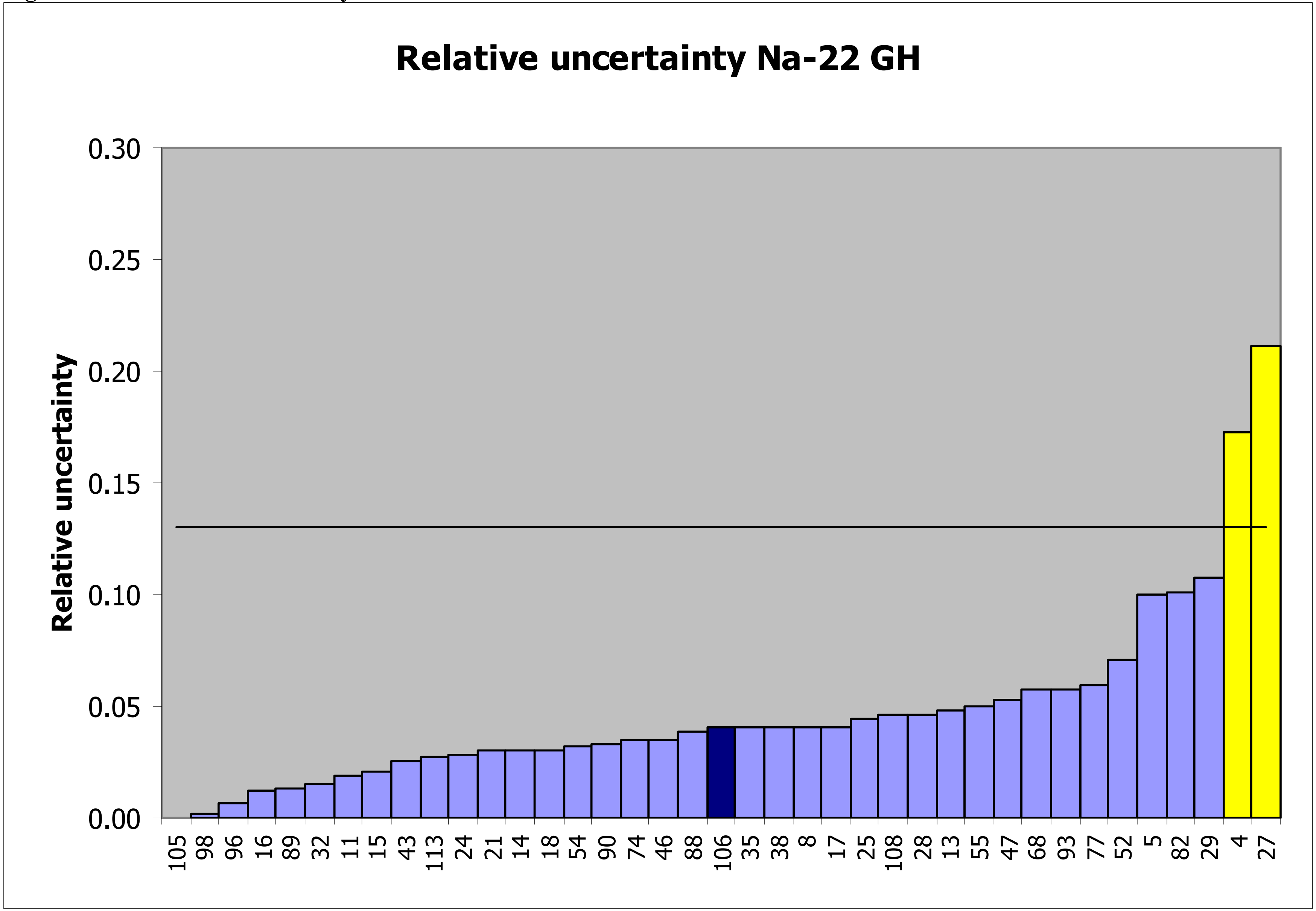


**Figure 37D – Kiri plot Na-22 GH**

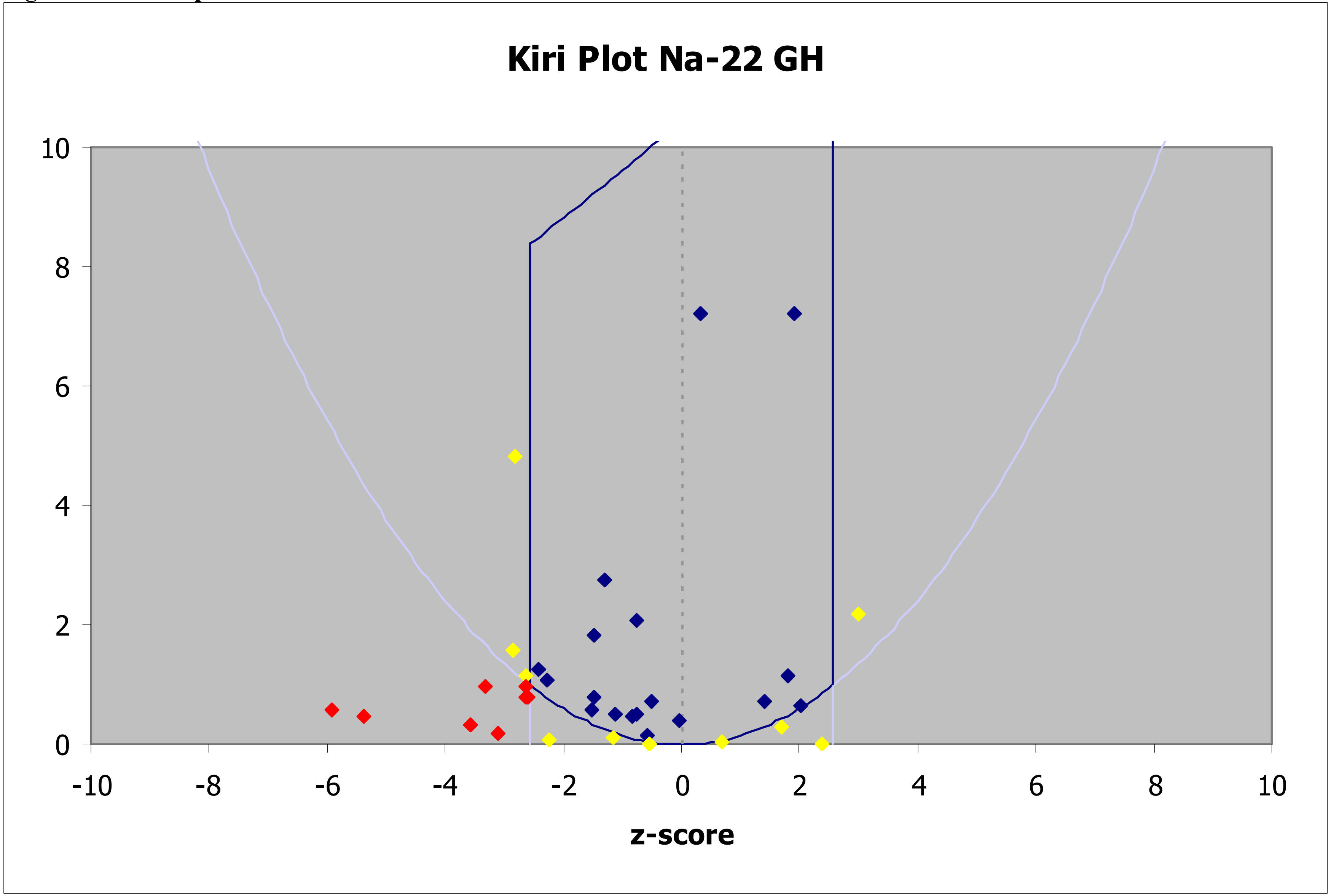


**Figure 38A – Deviation Co-60 GH**

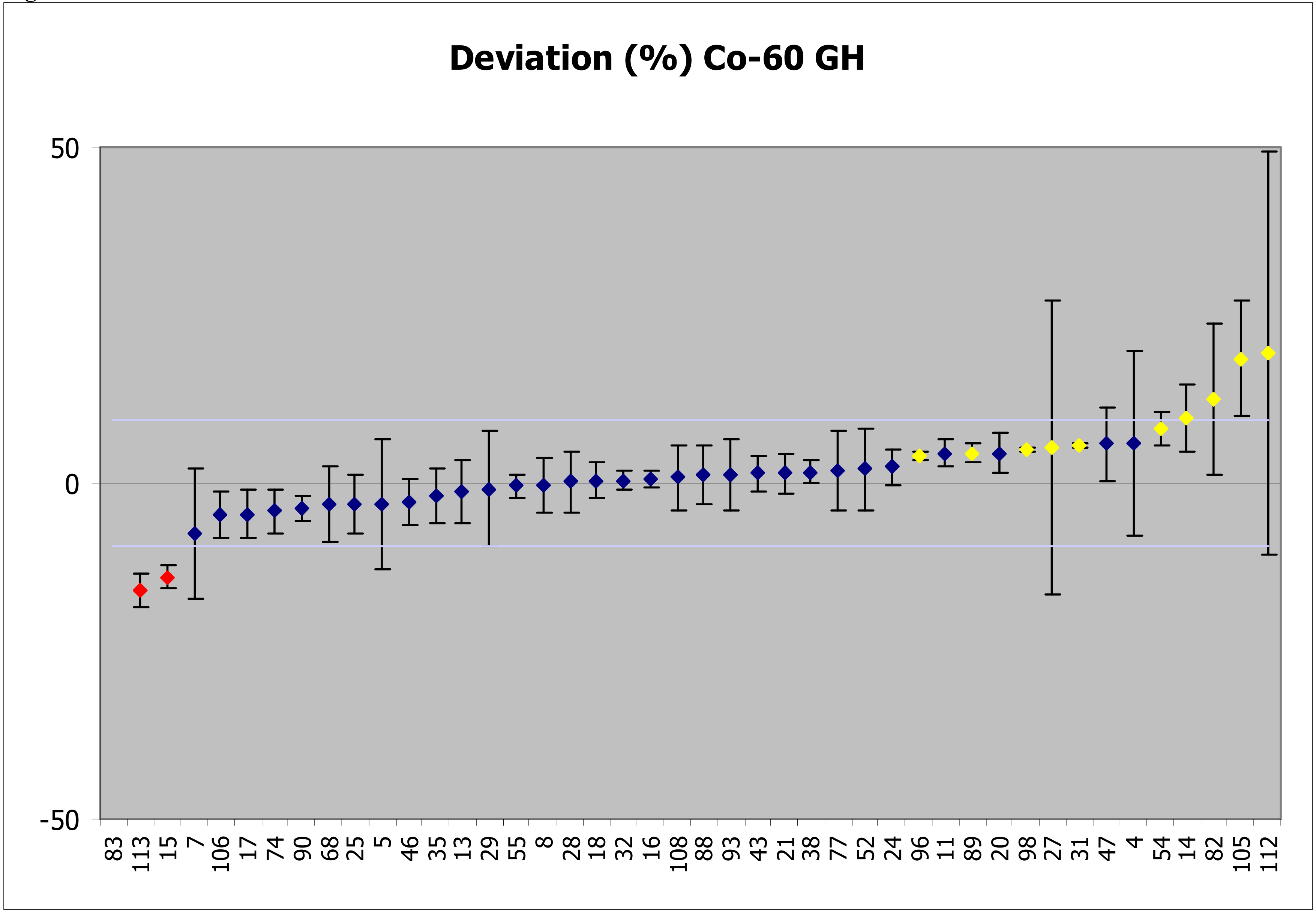


**Figure 38B – Zeta score Co-60 GH**

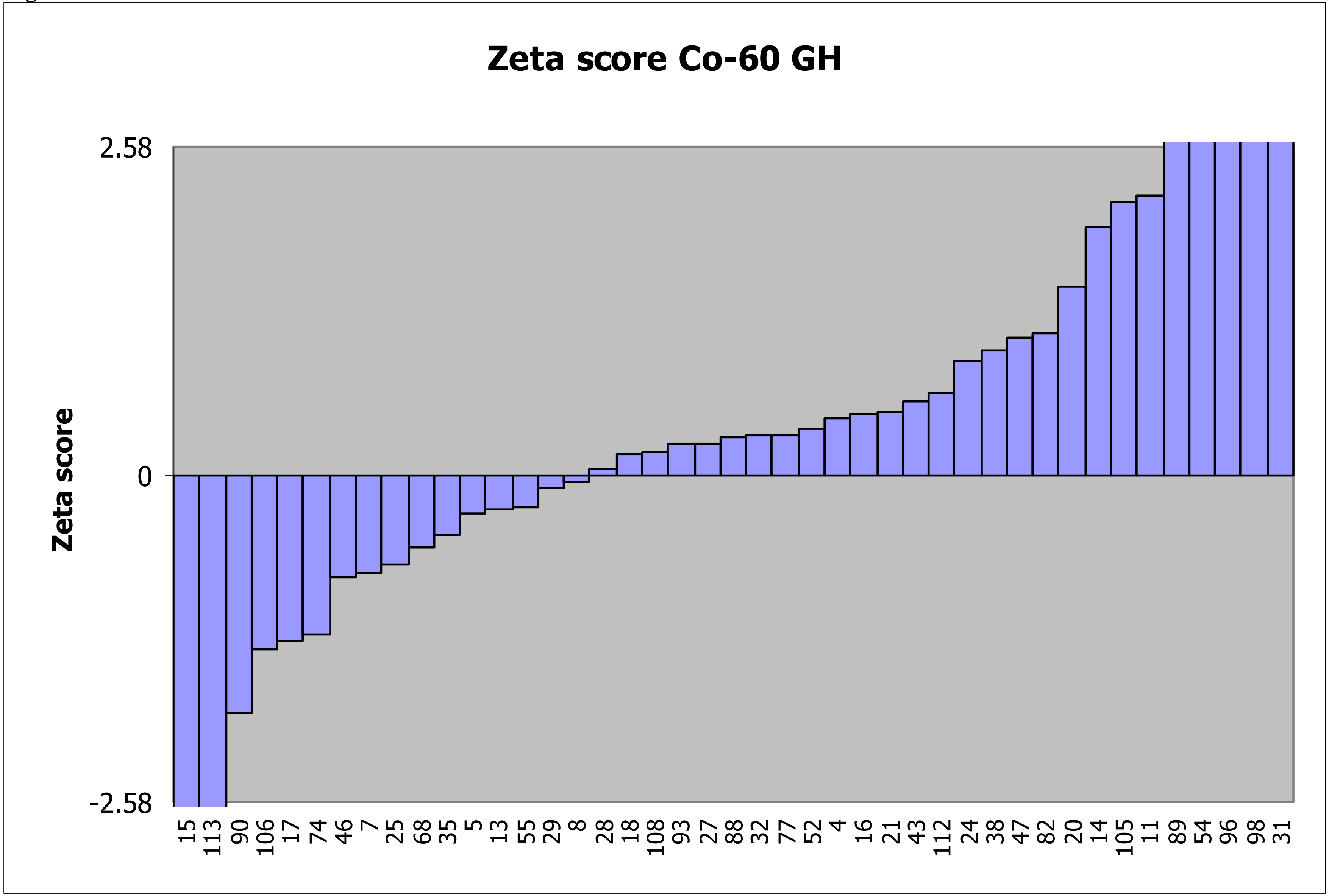


**Figure 38C – Relative uncertainty Co-60 GH**

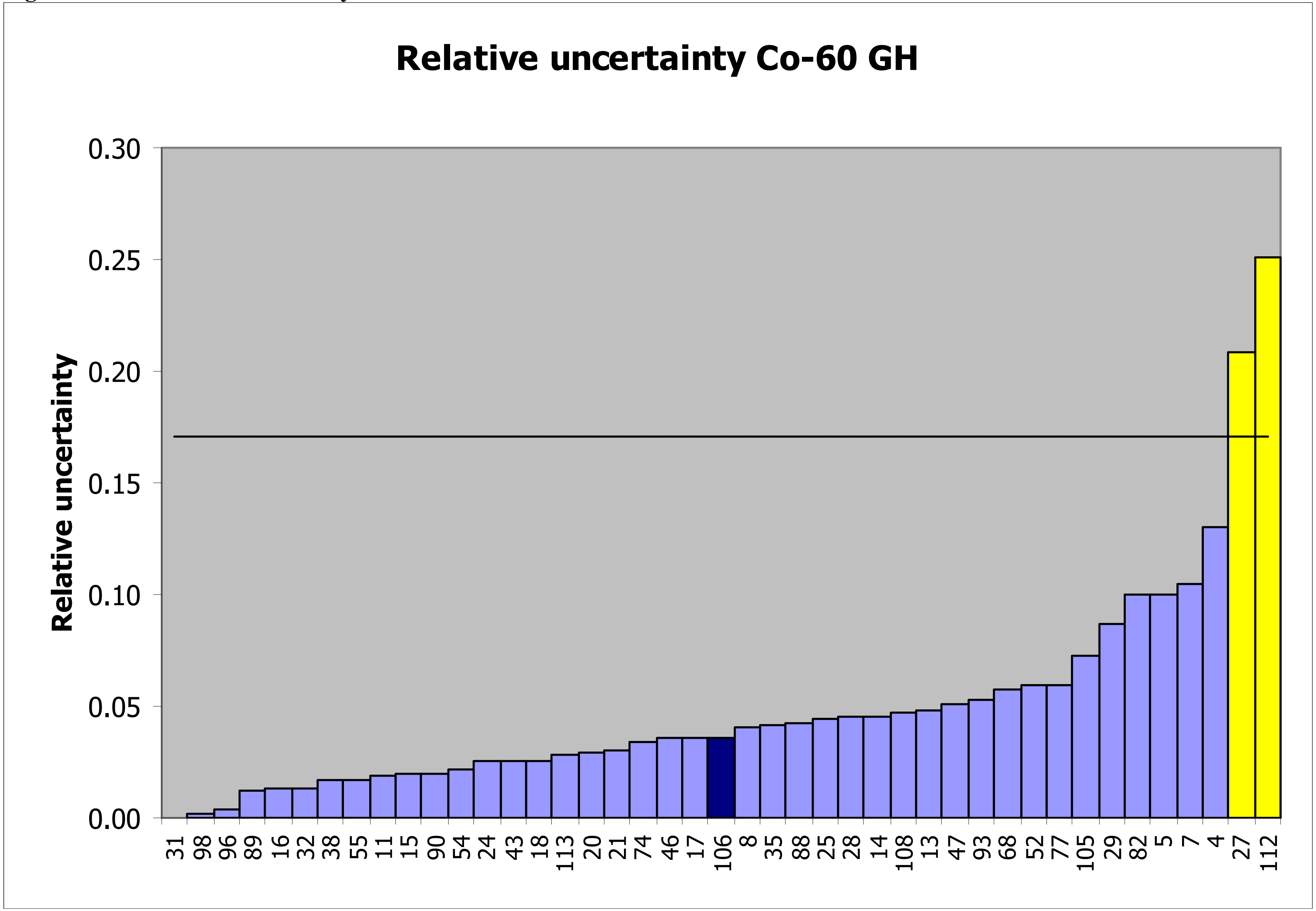


**Figure 38D – Kiri plot Co-60 GH**

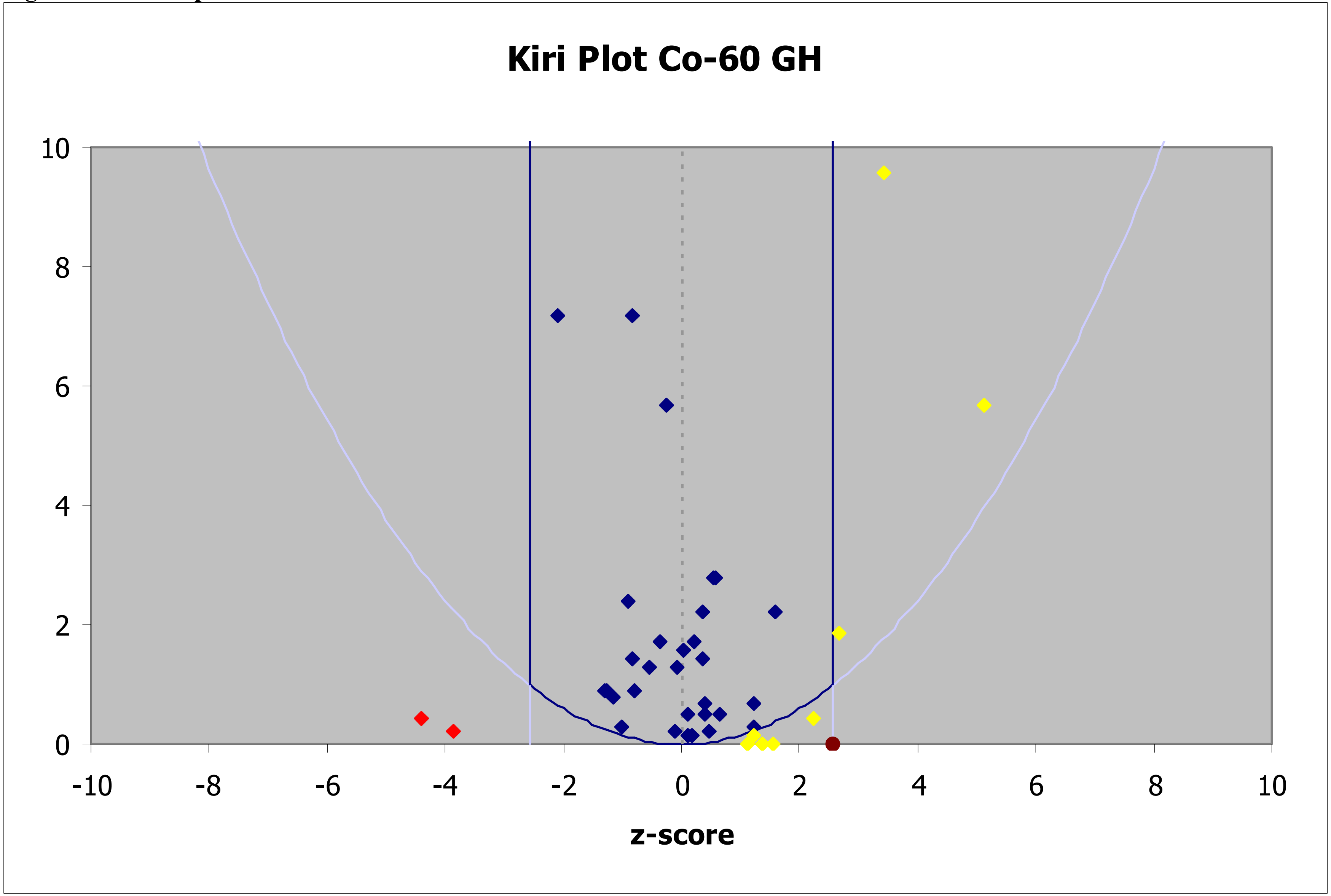


**Figure 39A – Deviation Zr-95 GH**

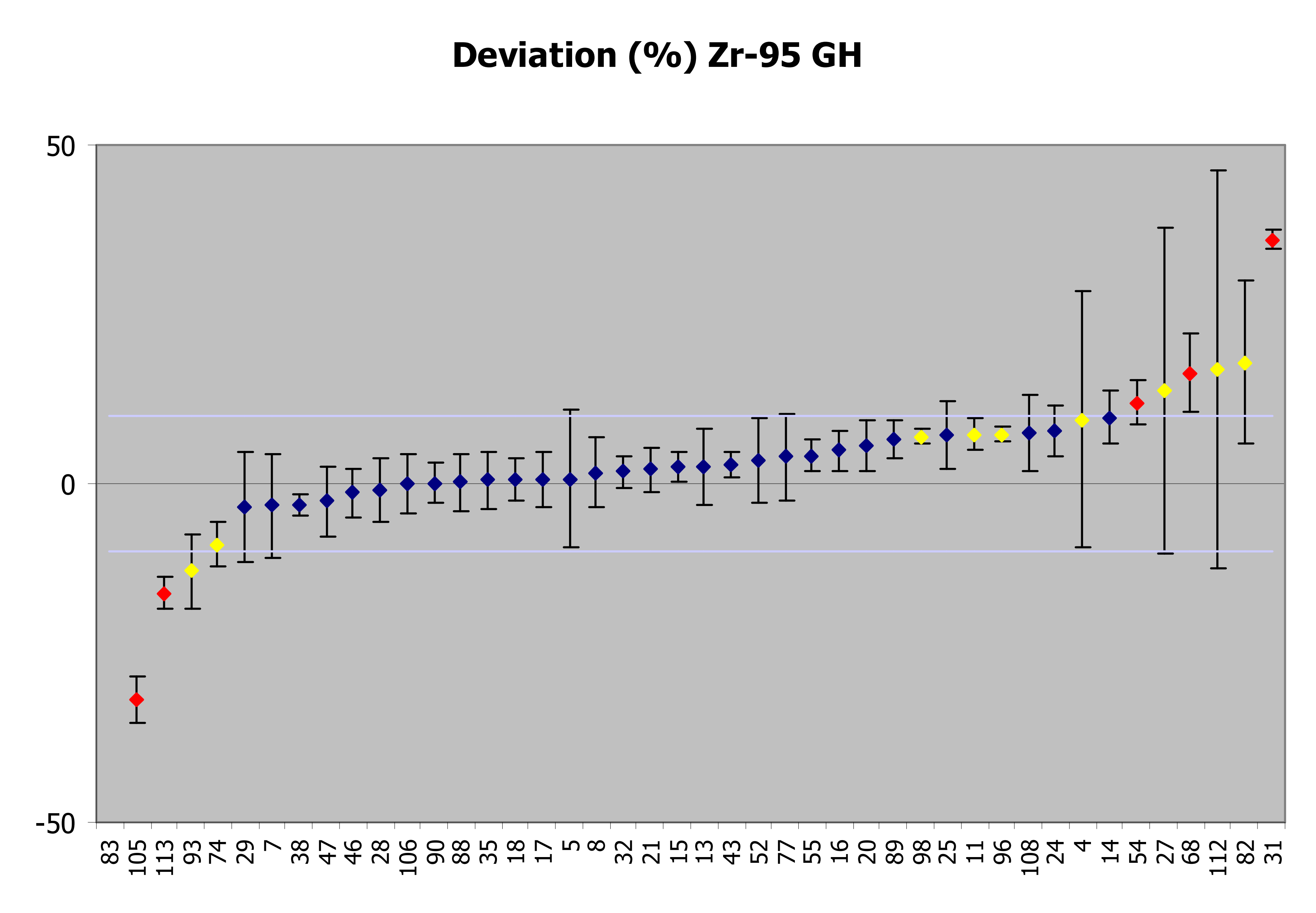


**Figure 39B – Zeta score Zr-95 GH**

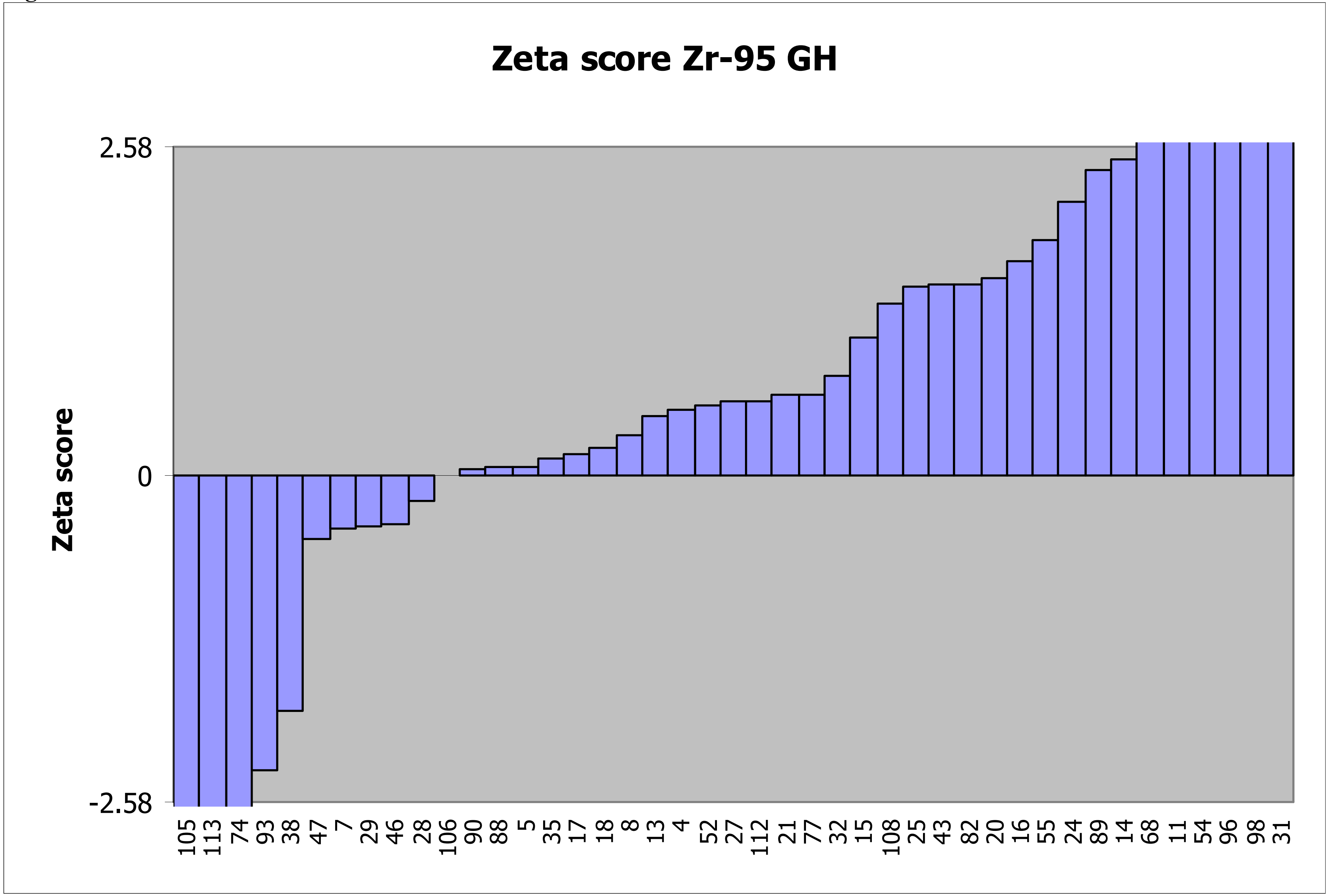


**Figure 39C – Relative uncertainty Zr-95 GH**

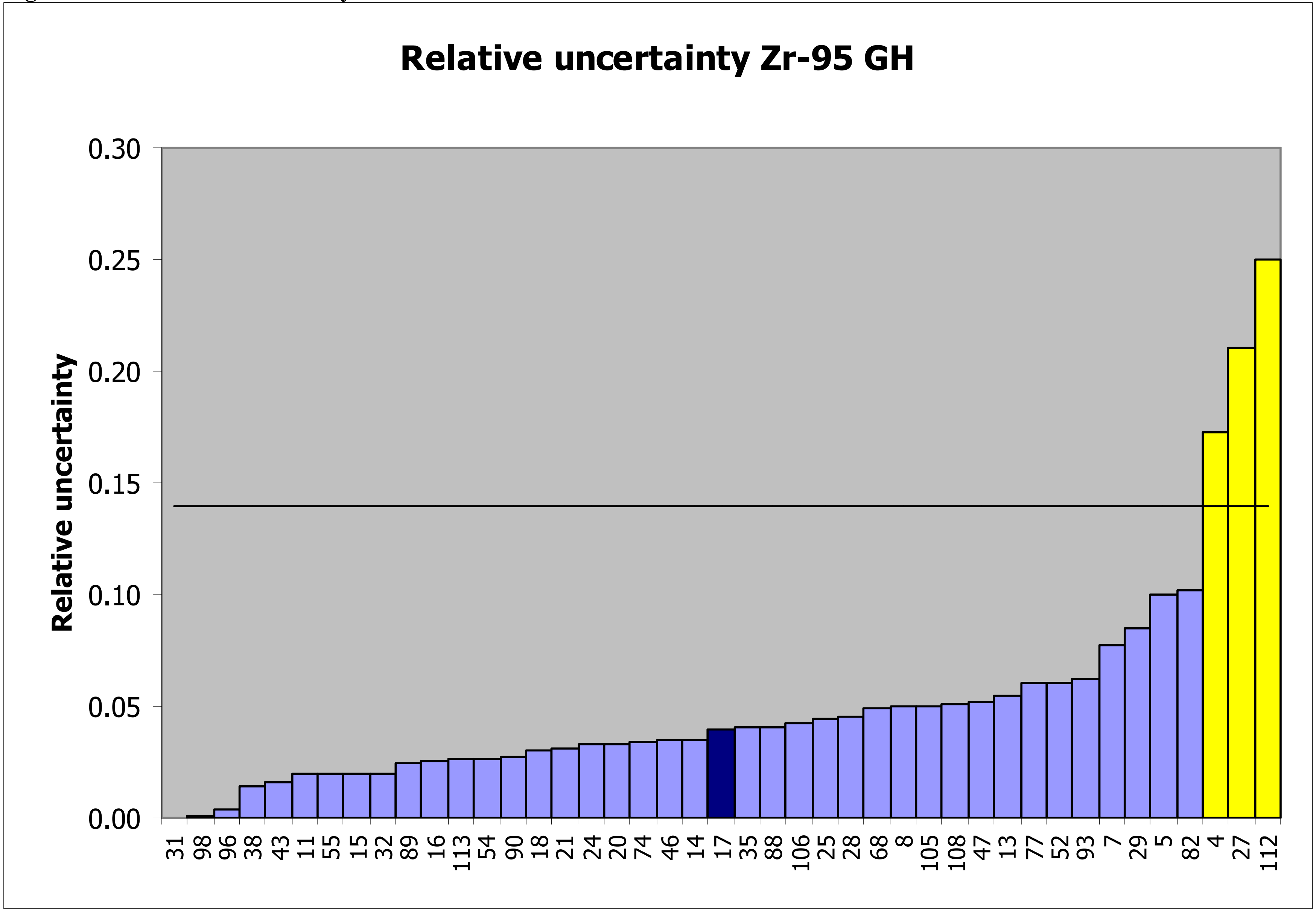


**Figure 39D – Kiri plot Zr-95 GH**

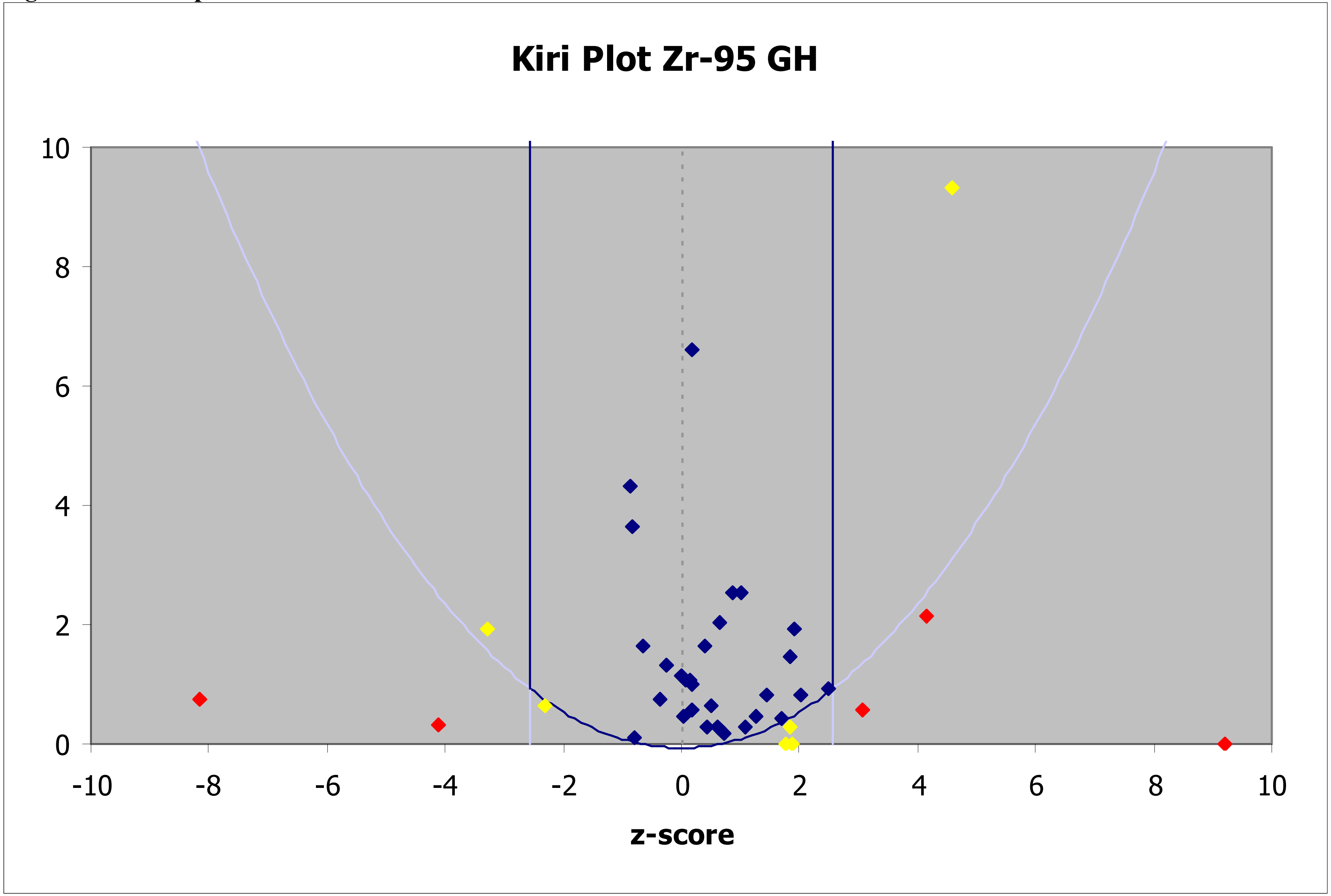


**Figure 40A – Deviation Nb-95 GH**

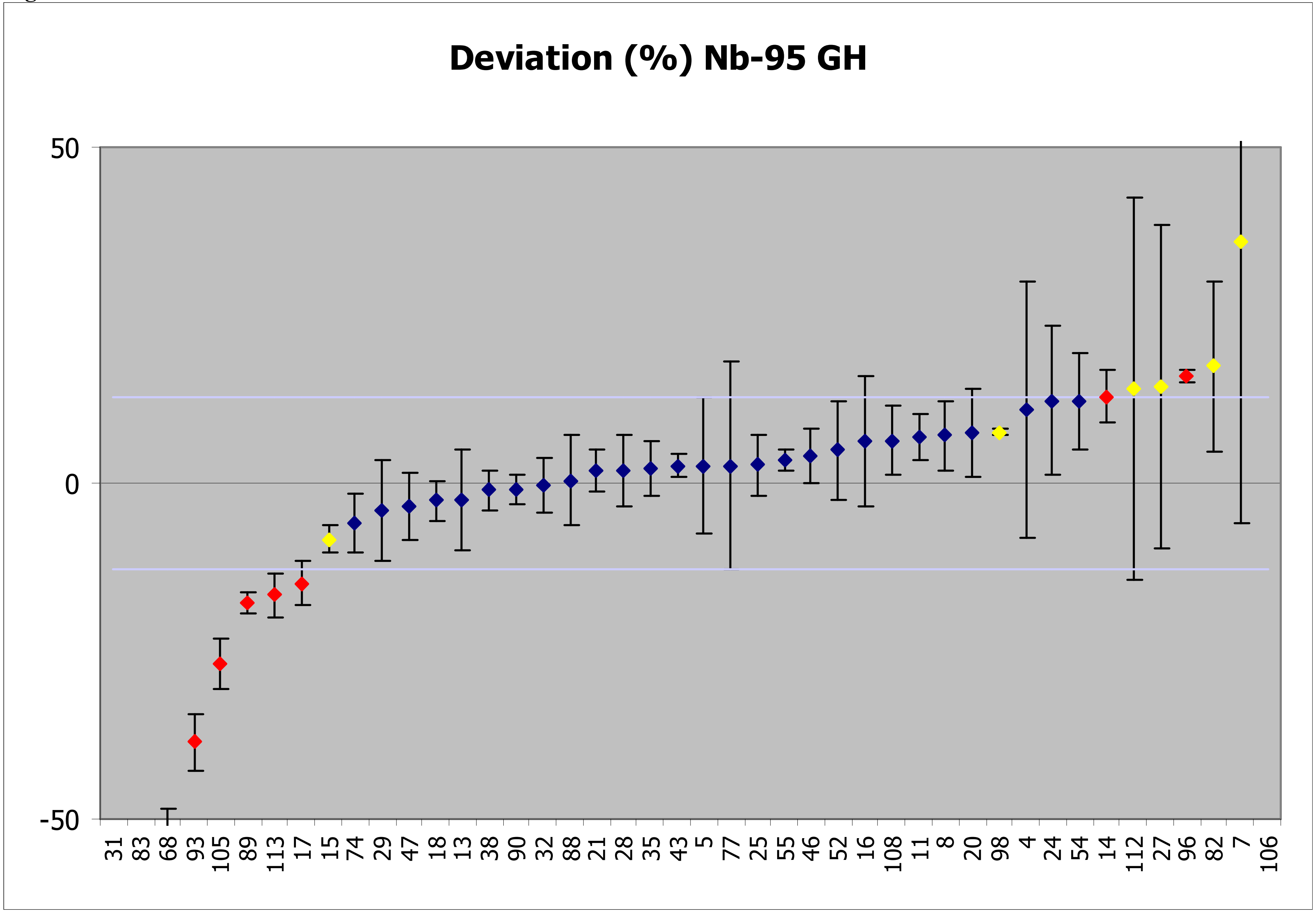


**Figure 40B – Zeta score Nb-95 GH**

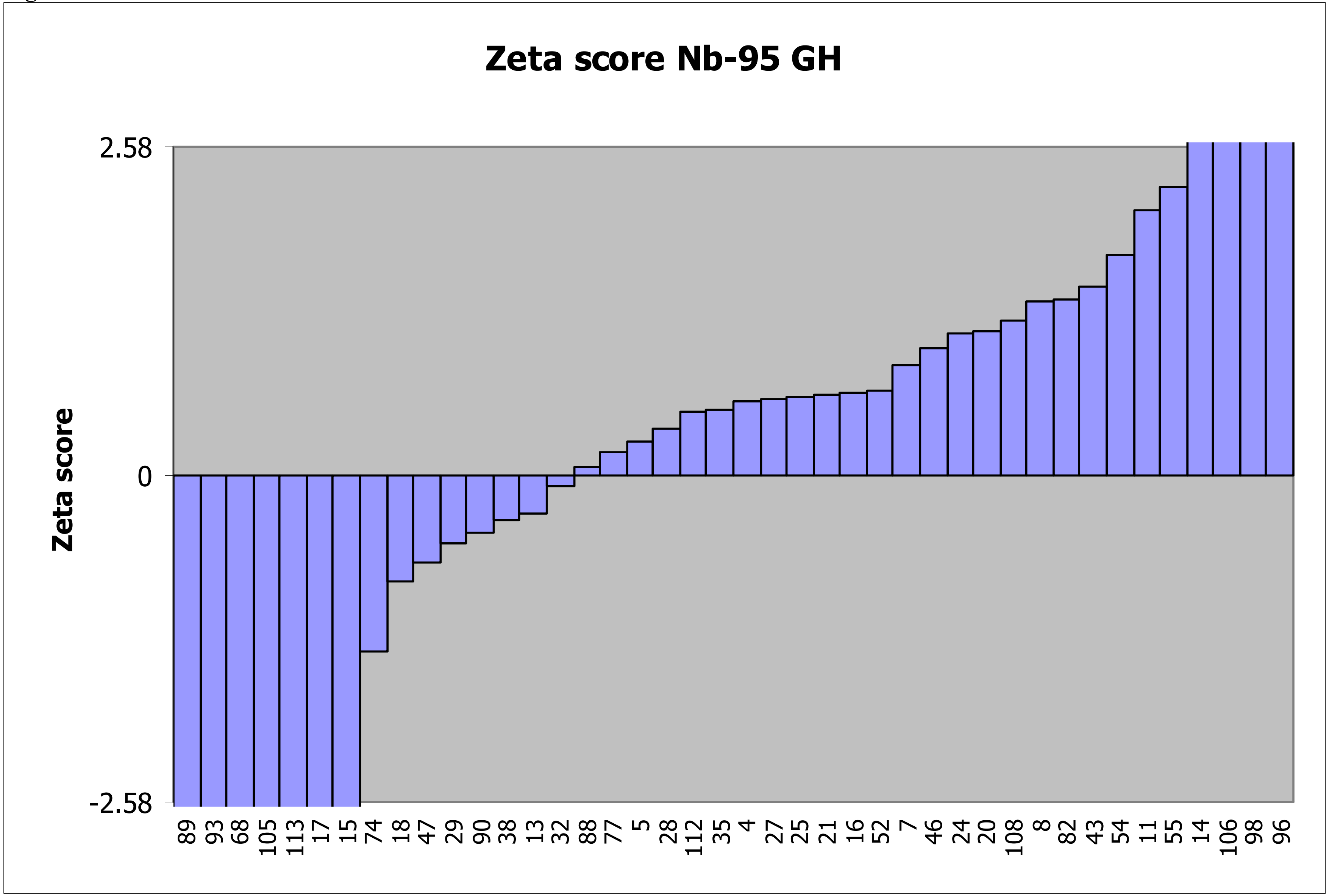


**Figure 40C – Relative uncertainty Nb-95 GH**

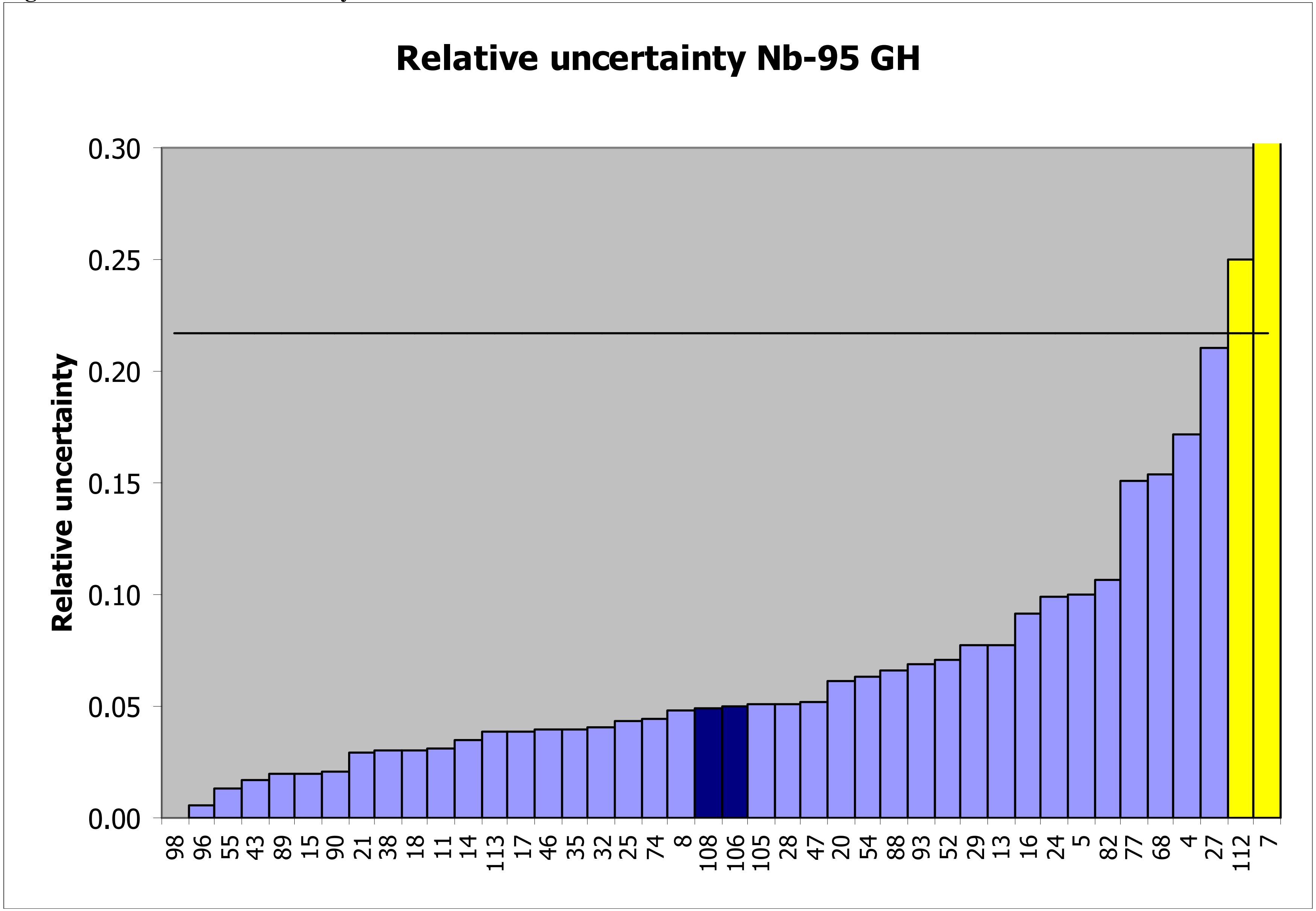


**Figure 40D – Kiri plot Nb-95 GH**

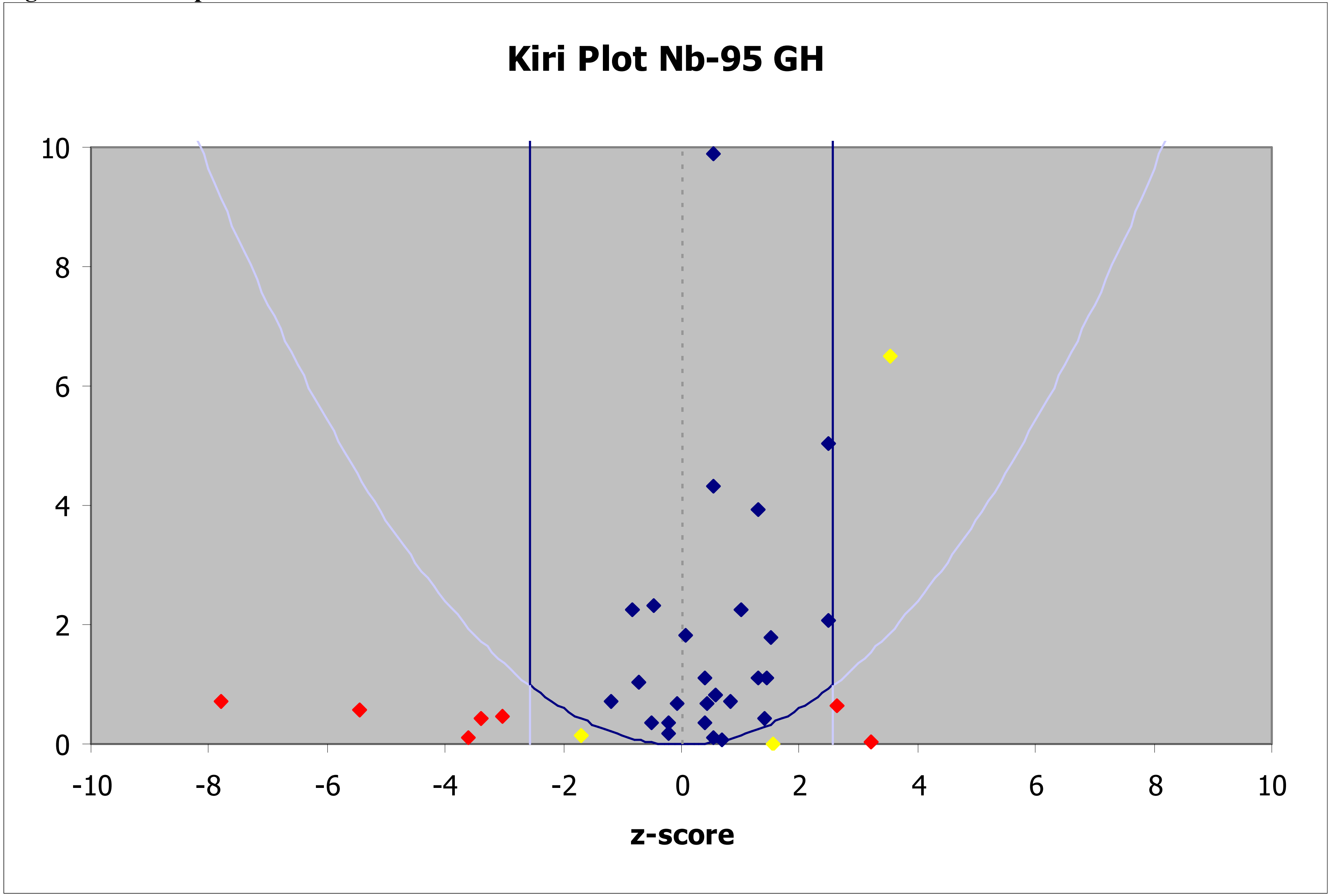


**Figure 41A – Deviation Ba-133 GH**

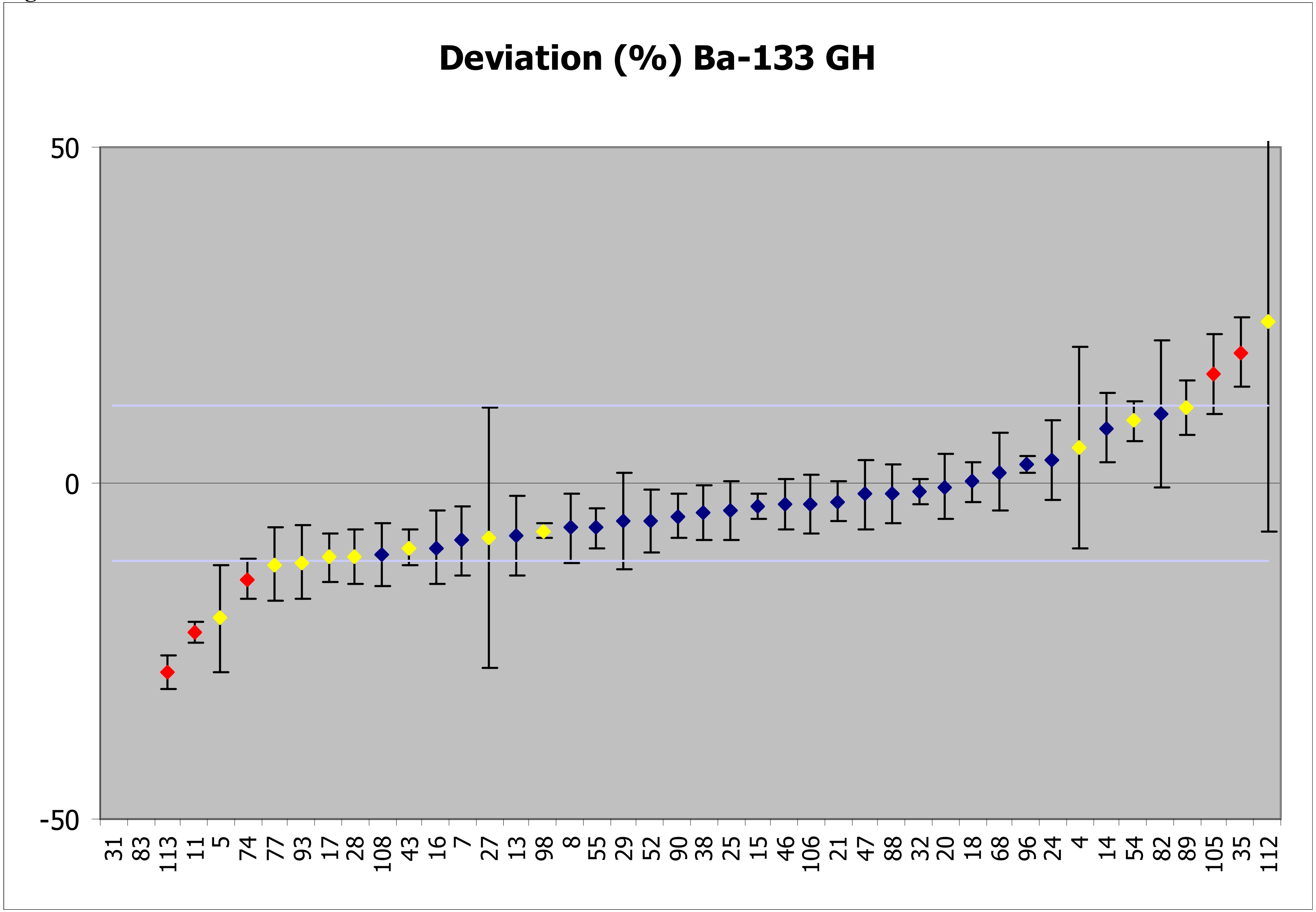


**Figure 41B – Zeta score Ba-133 GH**

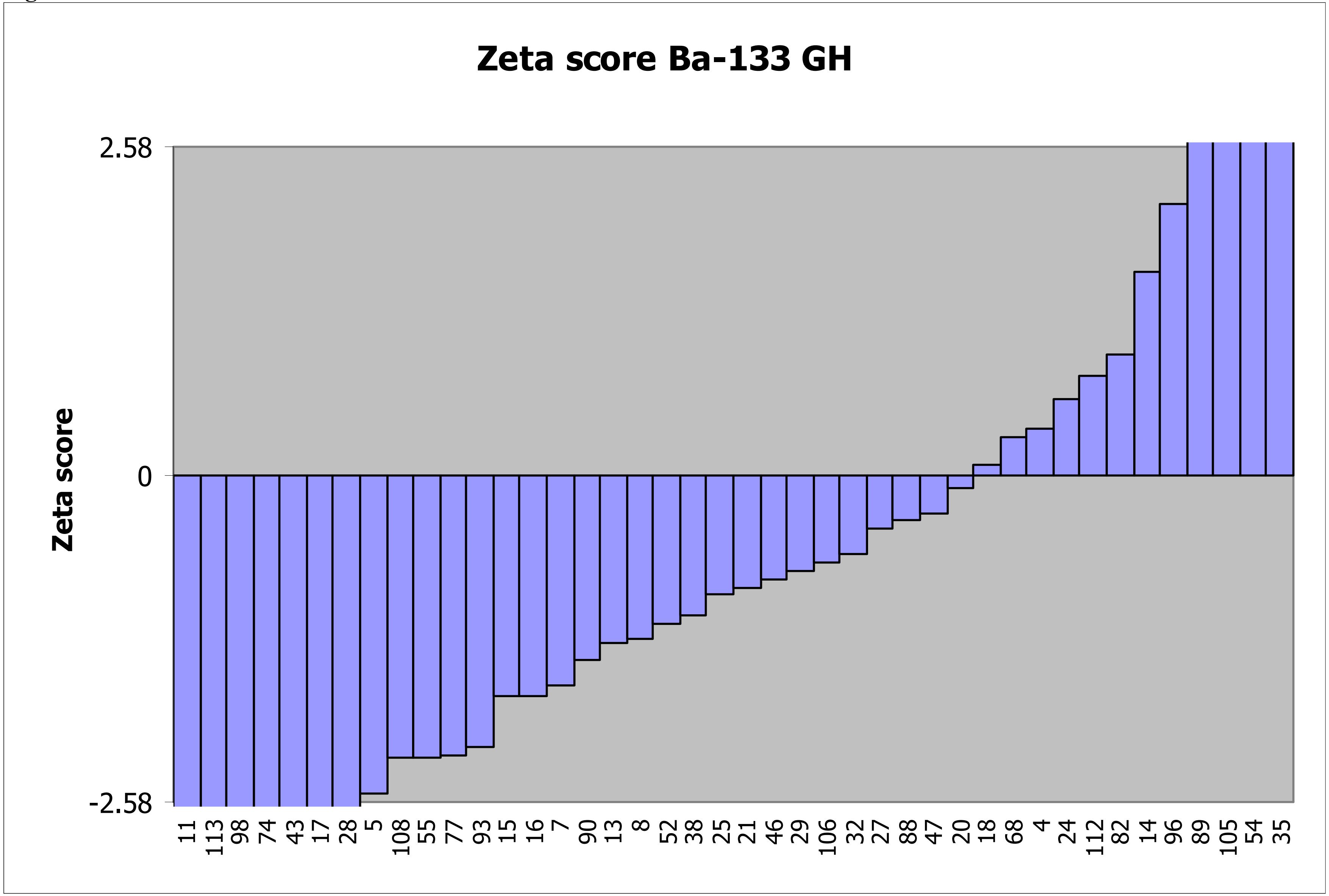


**Figure 41C – Relative uncertainty Ba-133 GH**

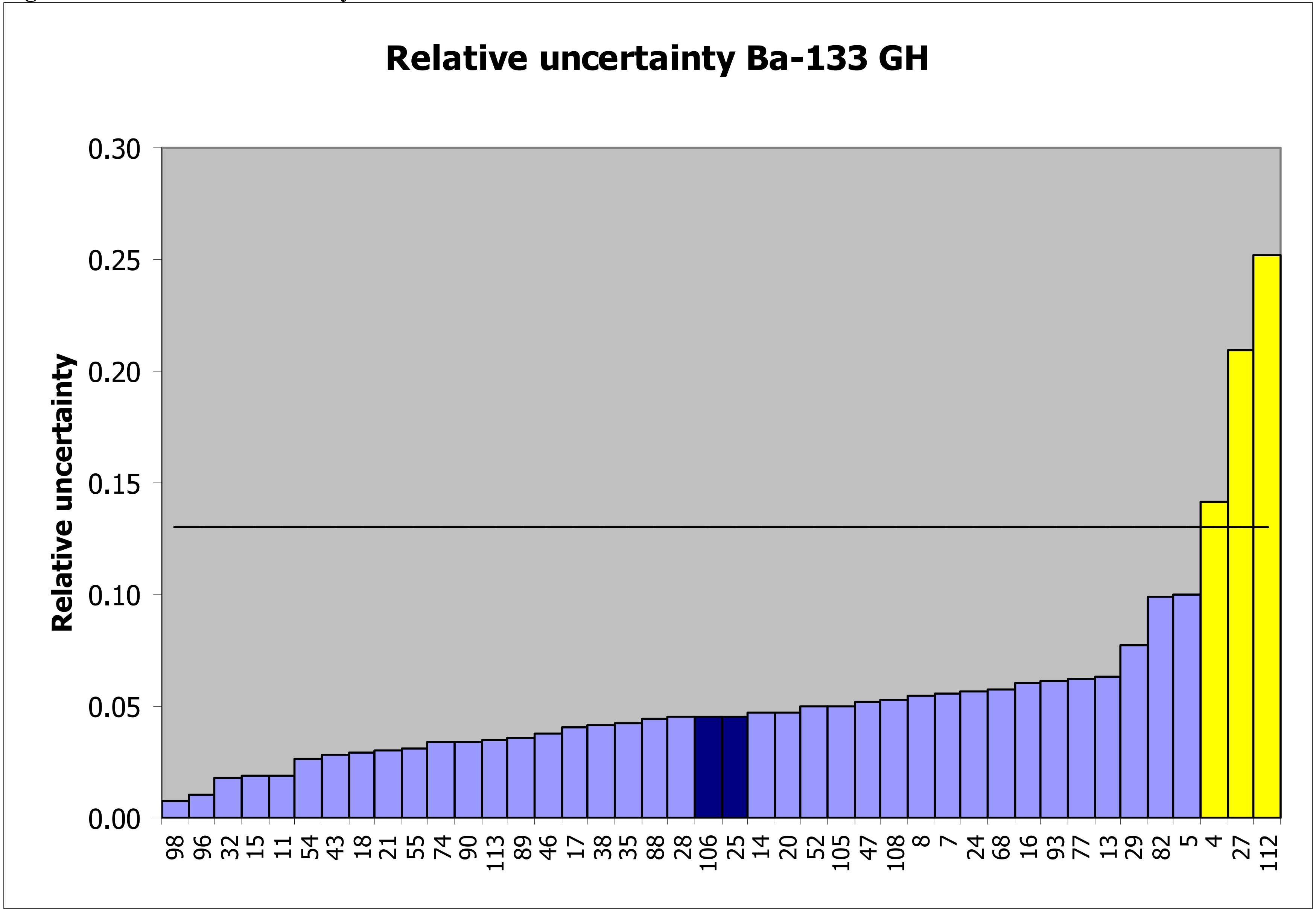


**Figure 41D – Kiri plot Ba-133 GH**

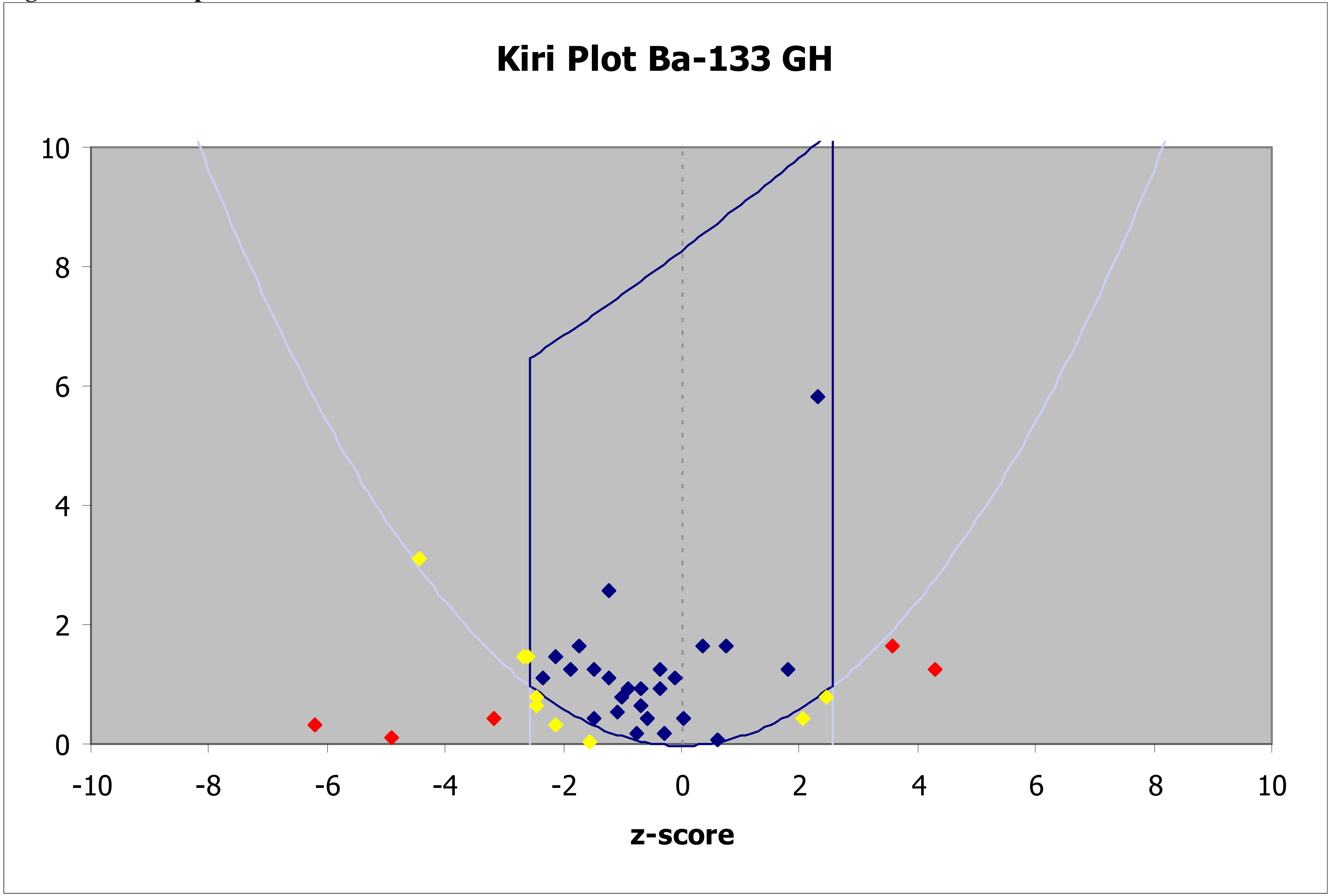


**Figure 42A – Deviation Cs-134 GH**

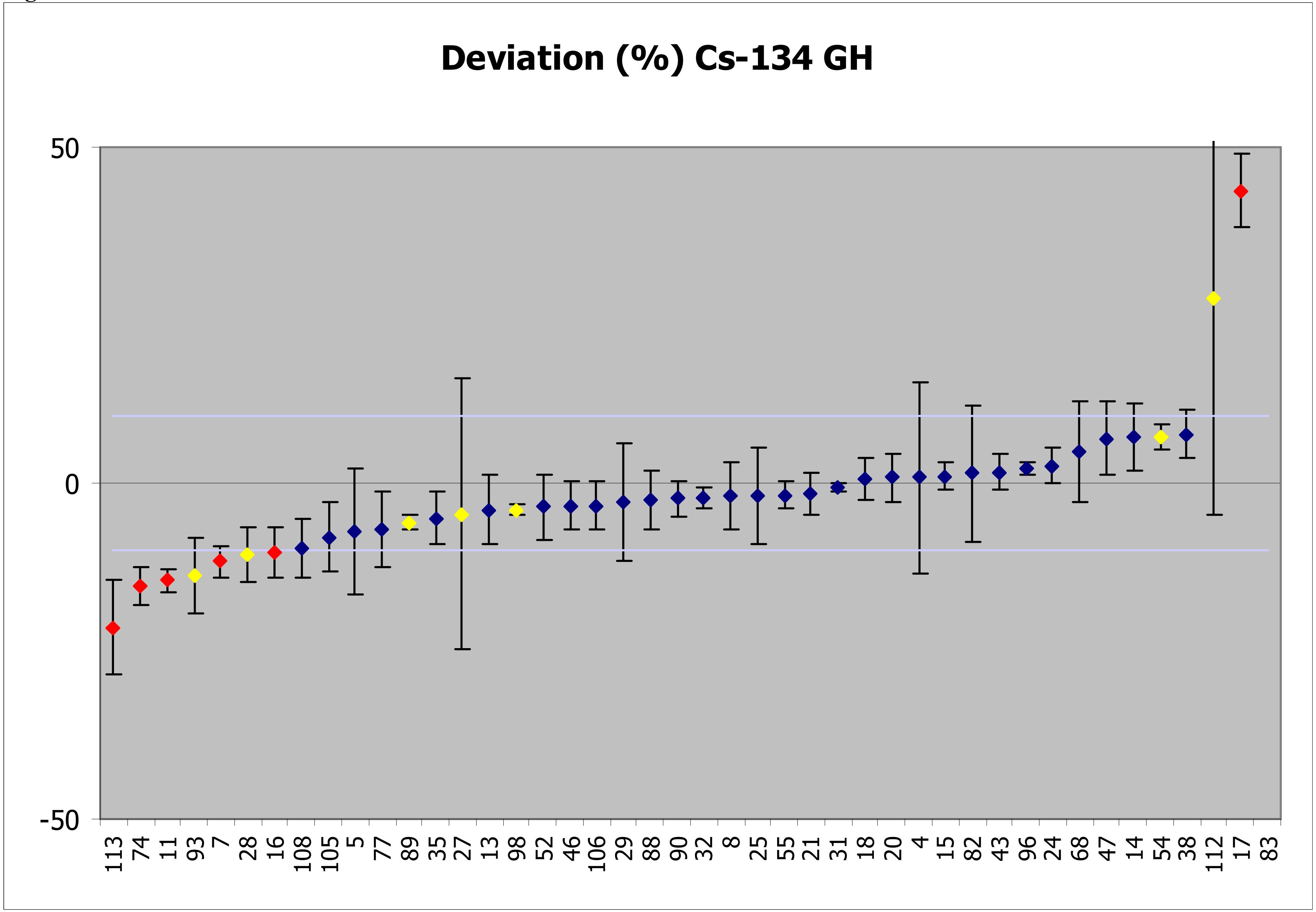


**Figure 42B – Zeta score Cs-134 GH**

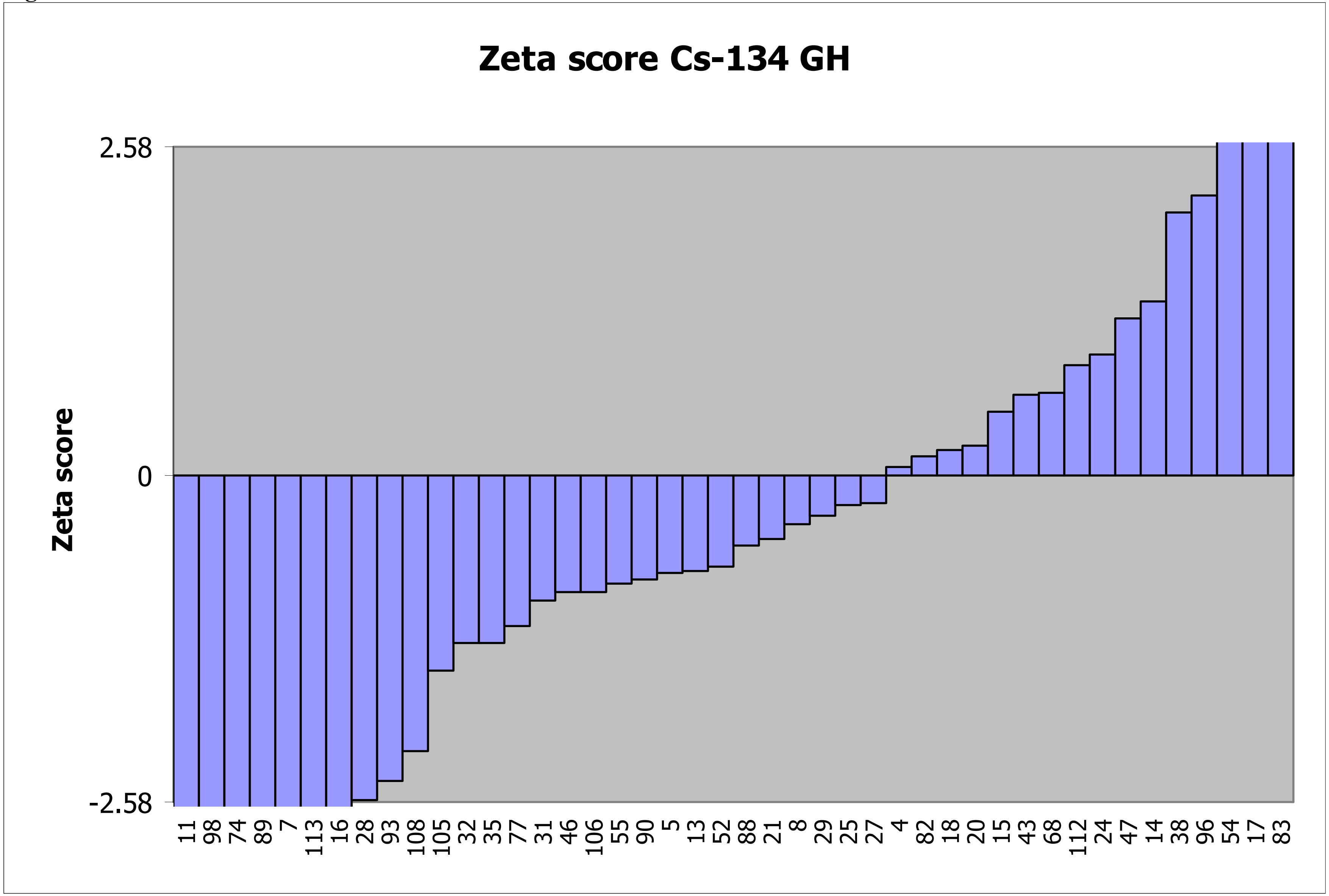


**Figure 42C – Relative uncertainty Cs-134 GH**

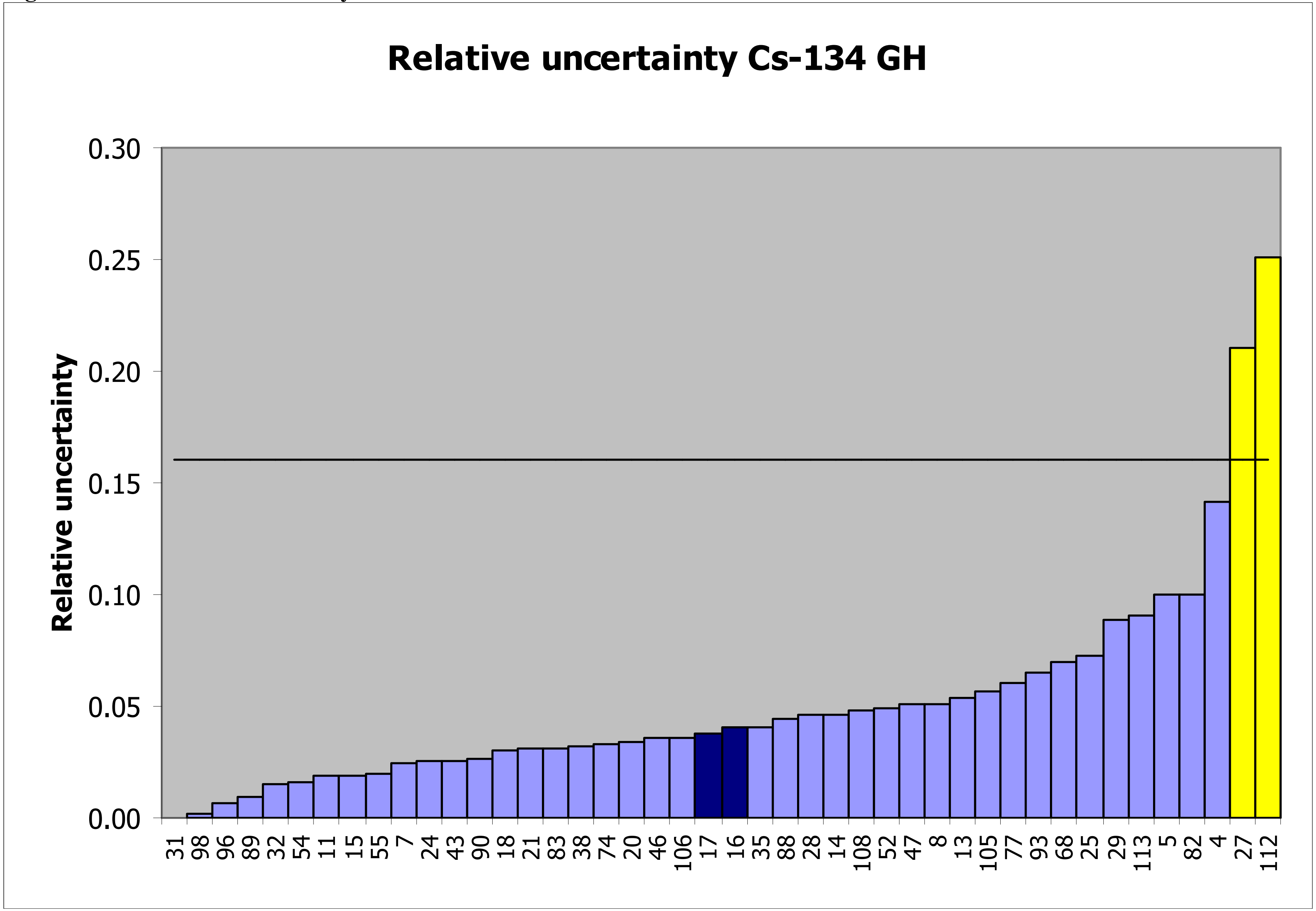


**Figure 42D – Kiri plot Cs-134 GH**

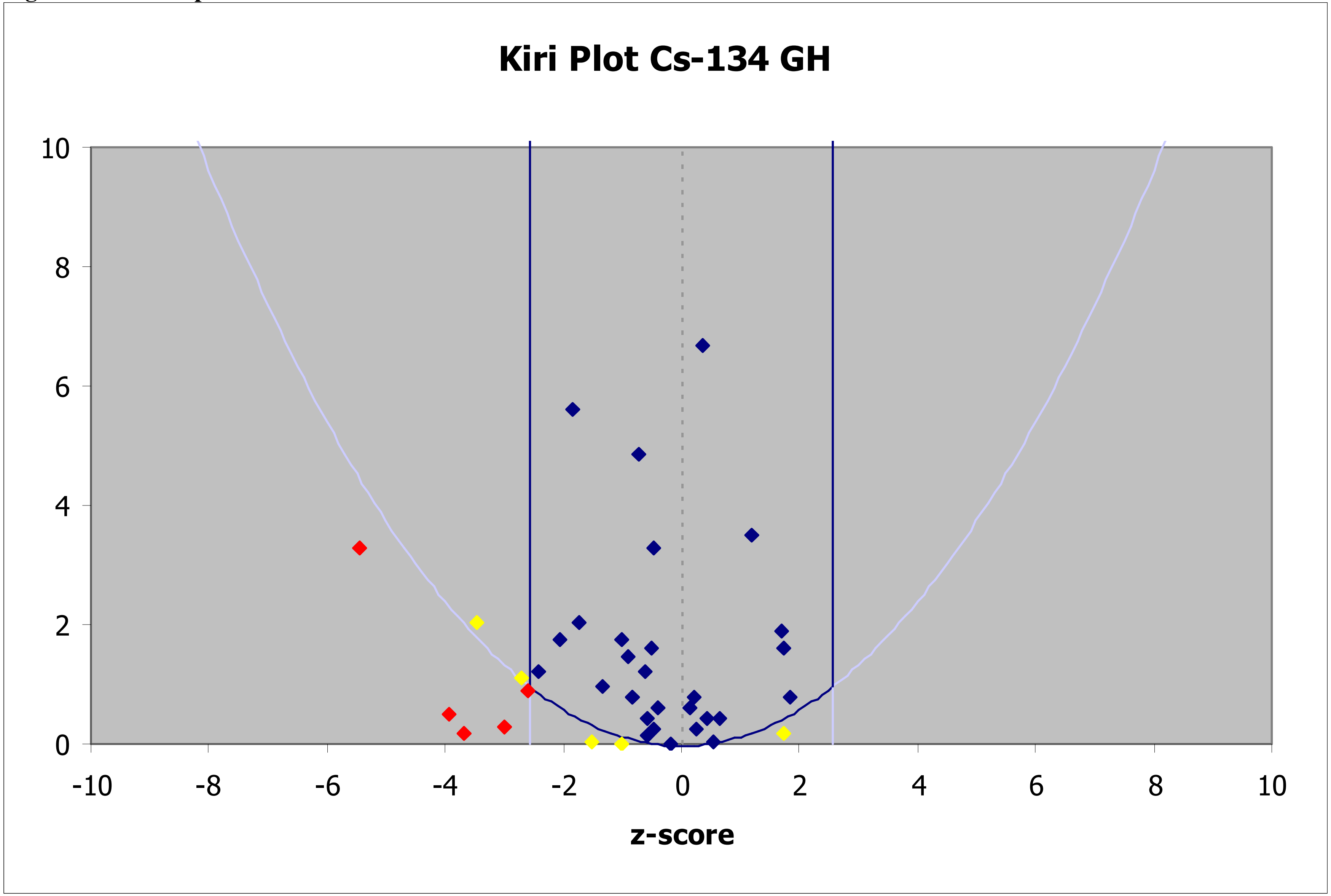


**Figure 43A – Deviation Cs-137 GH**

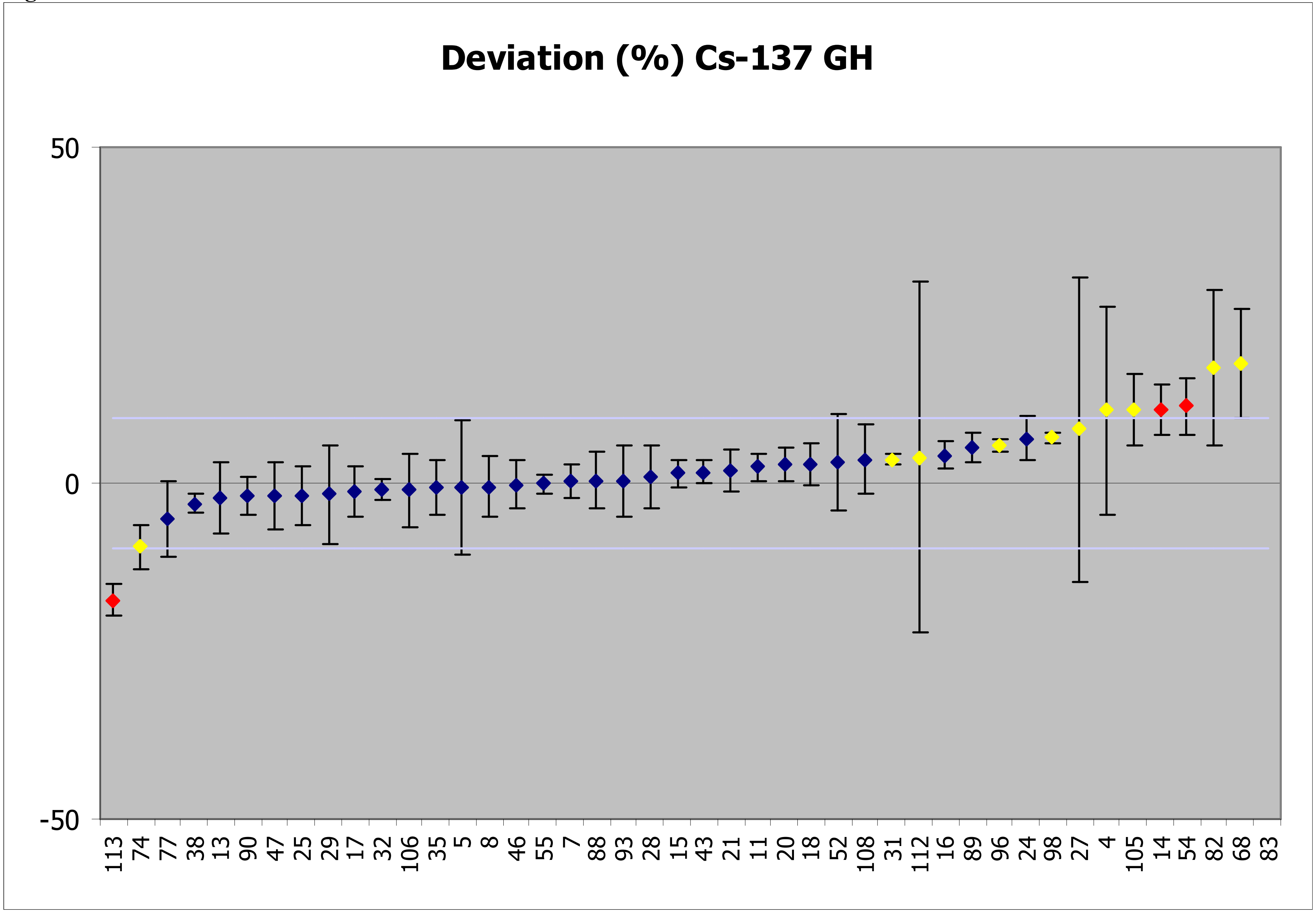


**Figure 43B – Zeta score Cs-137 GH**

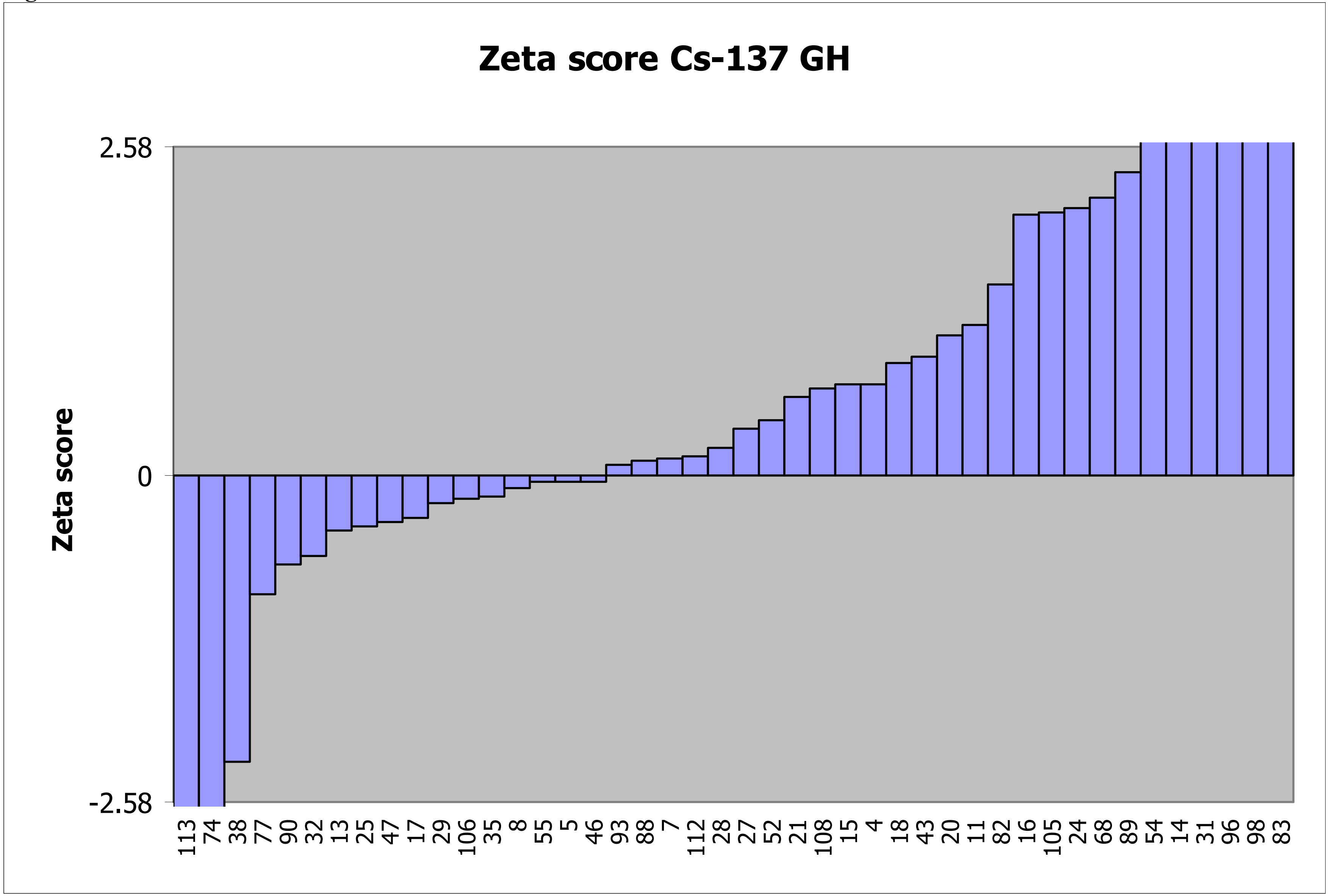


**Figure 43C – Relative uncertainty Cs-137 GH**

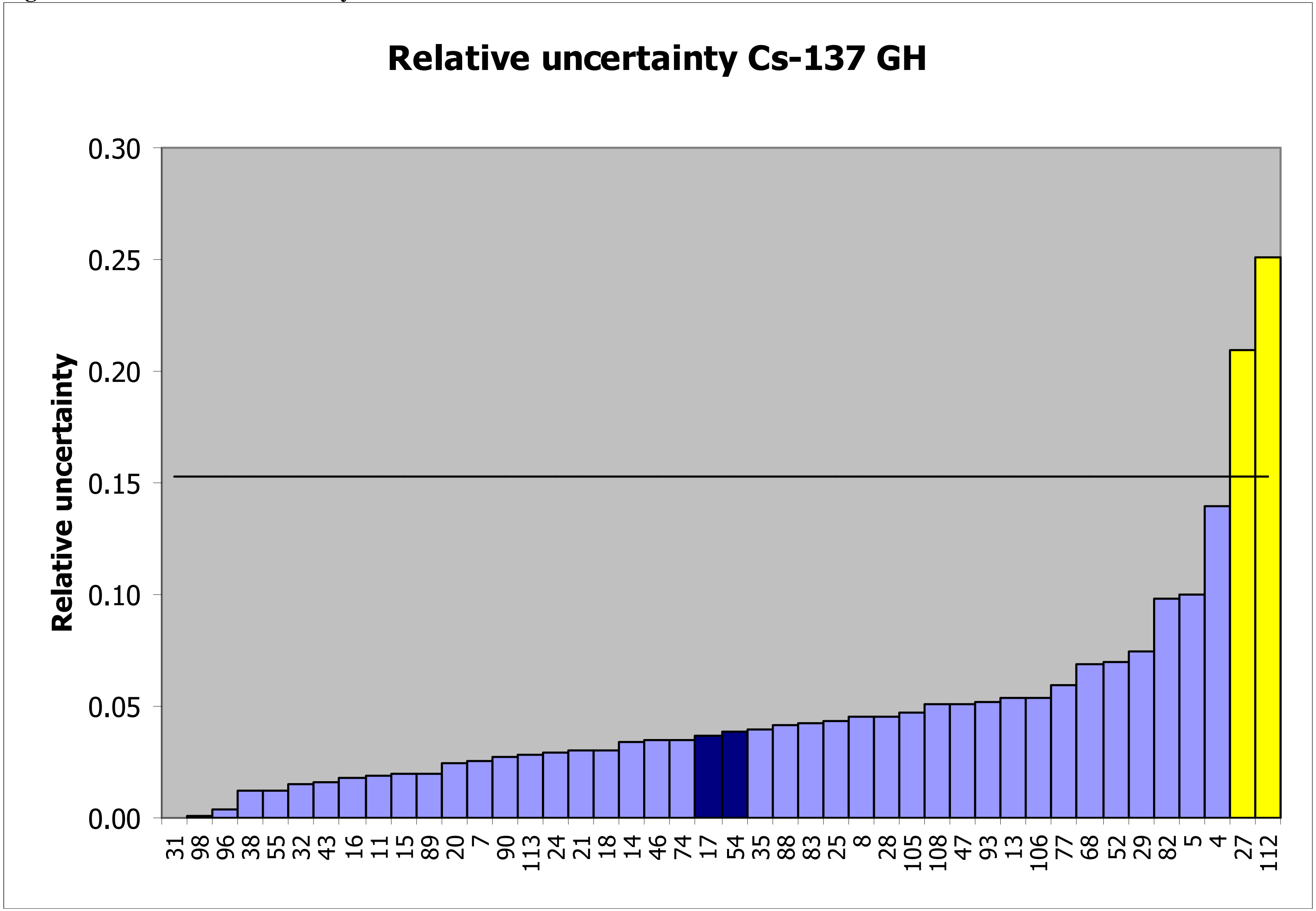


**Figure 43D – Kiri plot Cs-137 GH**

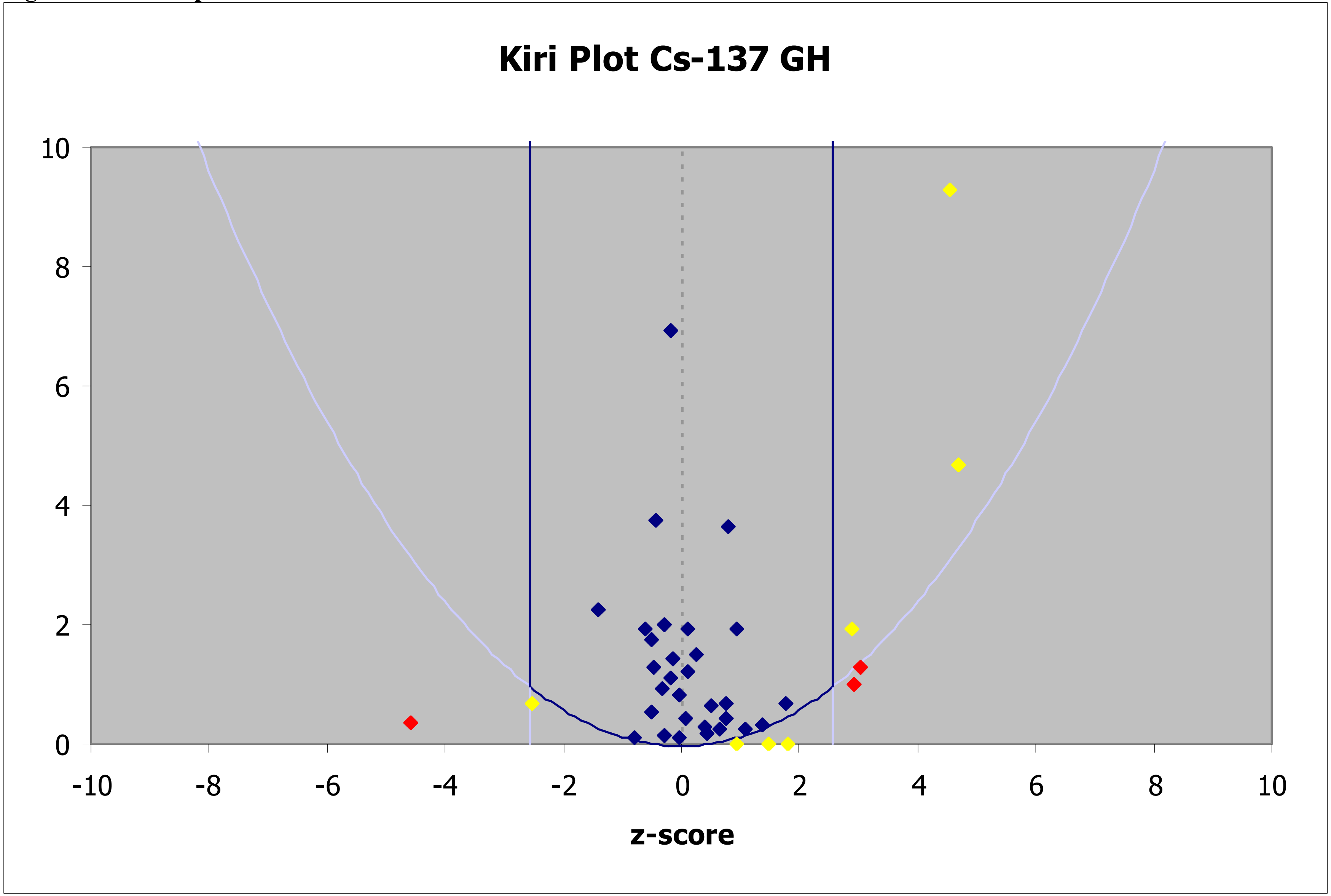


**Figure 44A – Deviation Eu-152 GH**

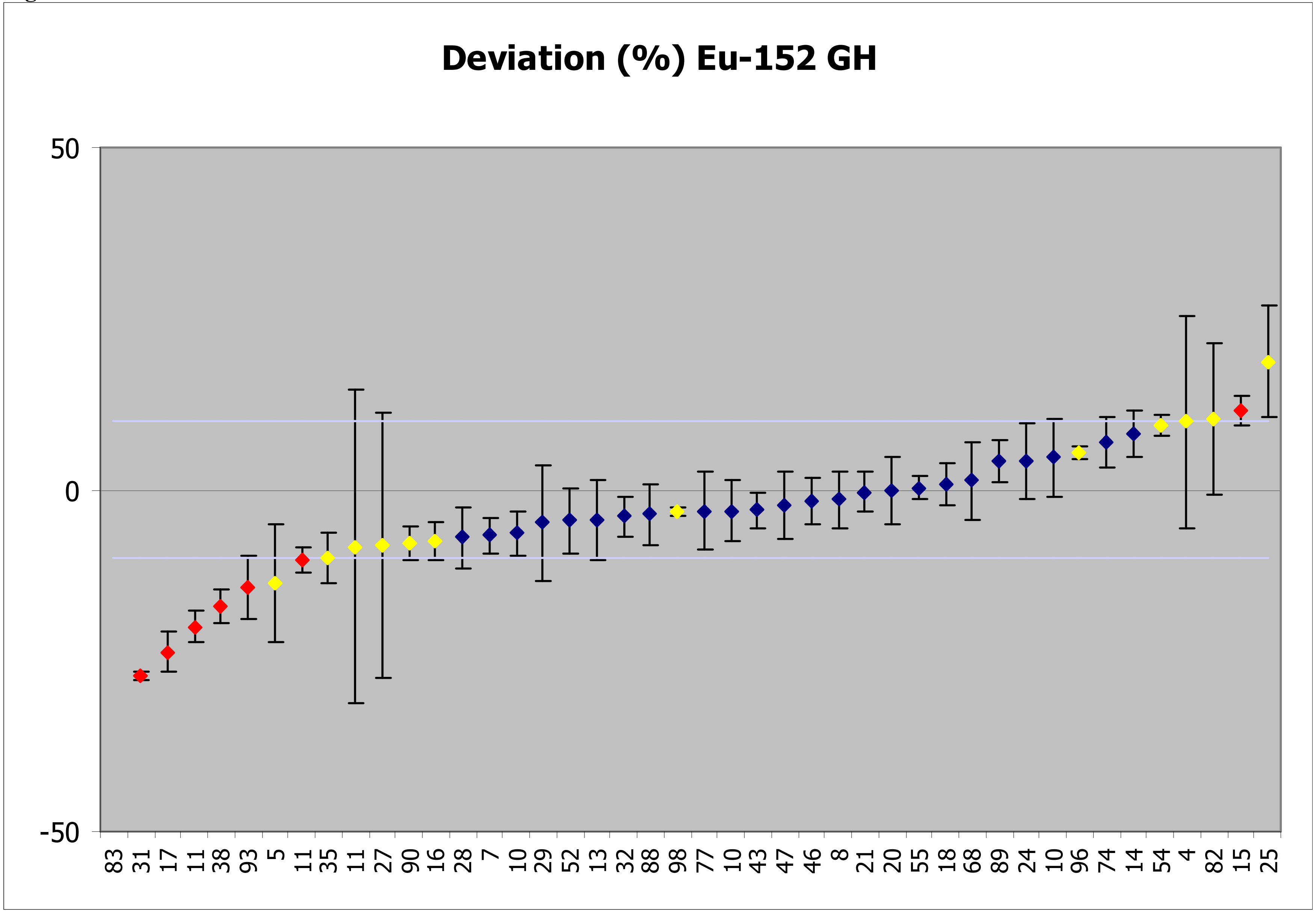


**Figure 44B – Zeta score Eu-152 GH**

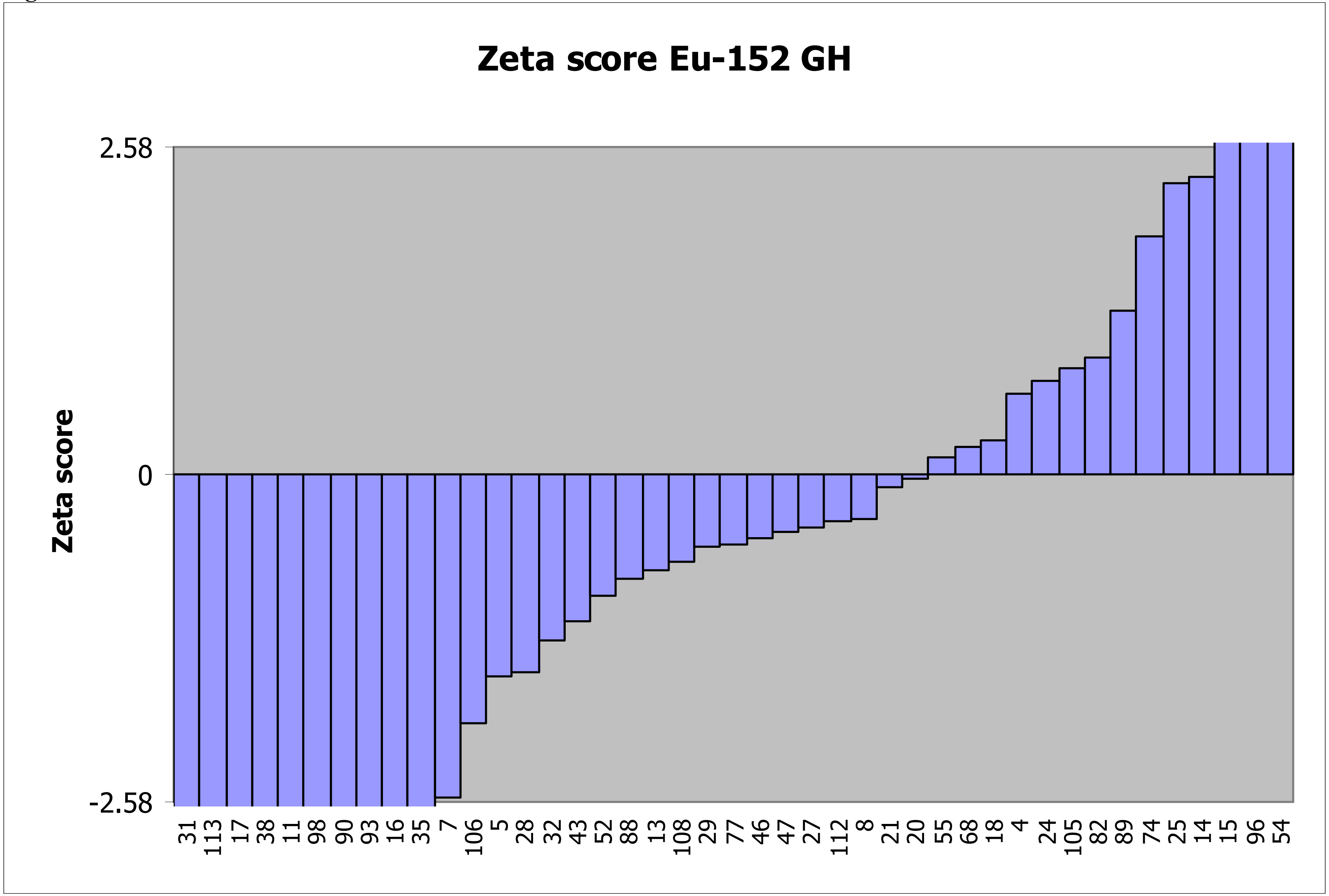


**Figure 44C – Relative uncertainty Eu-152 GH**

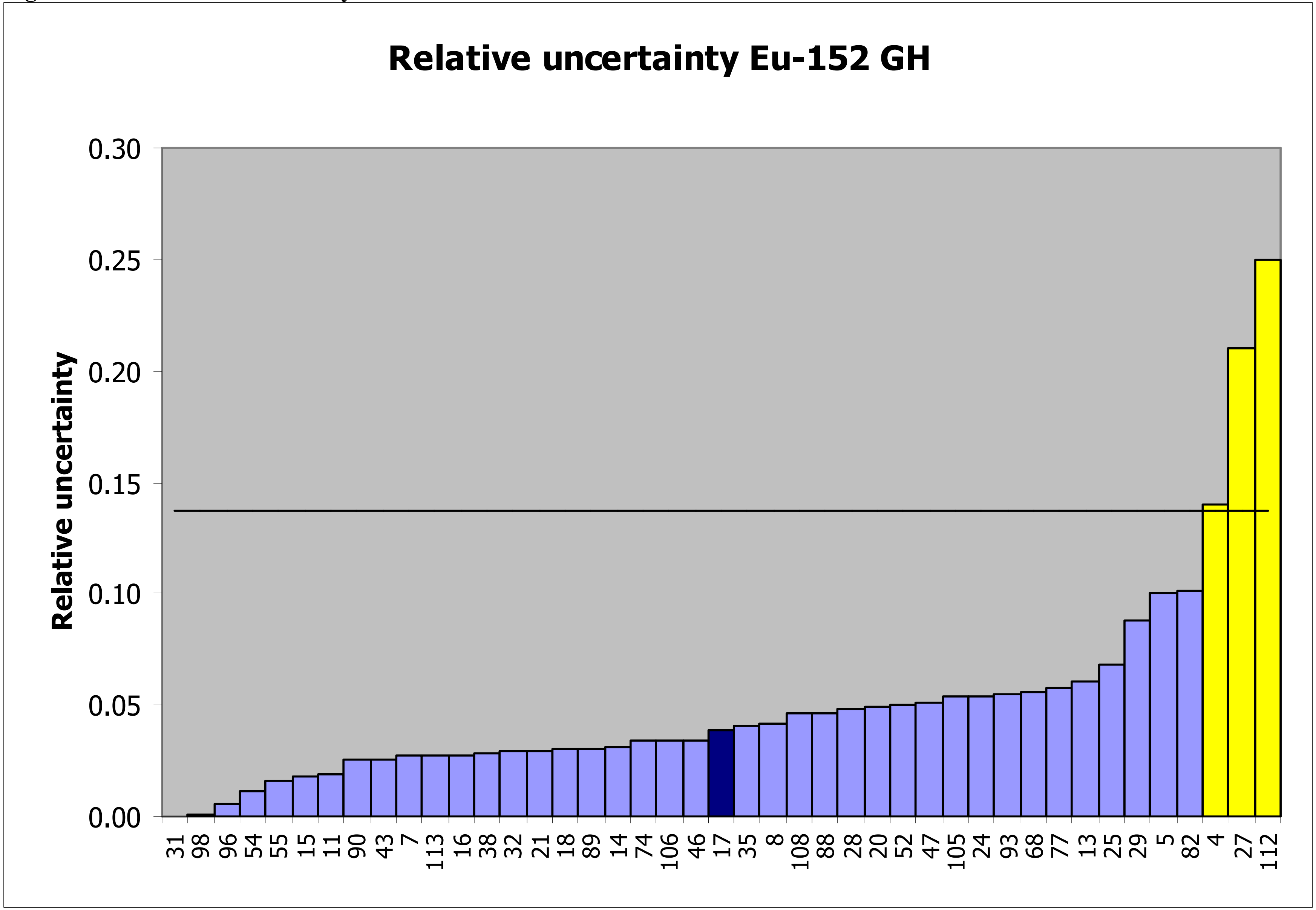


**Figure 44D – Kiri plot Eu-152 GH**

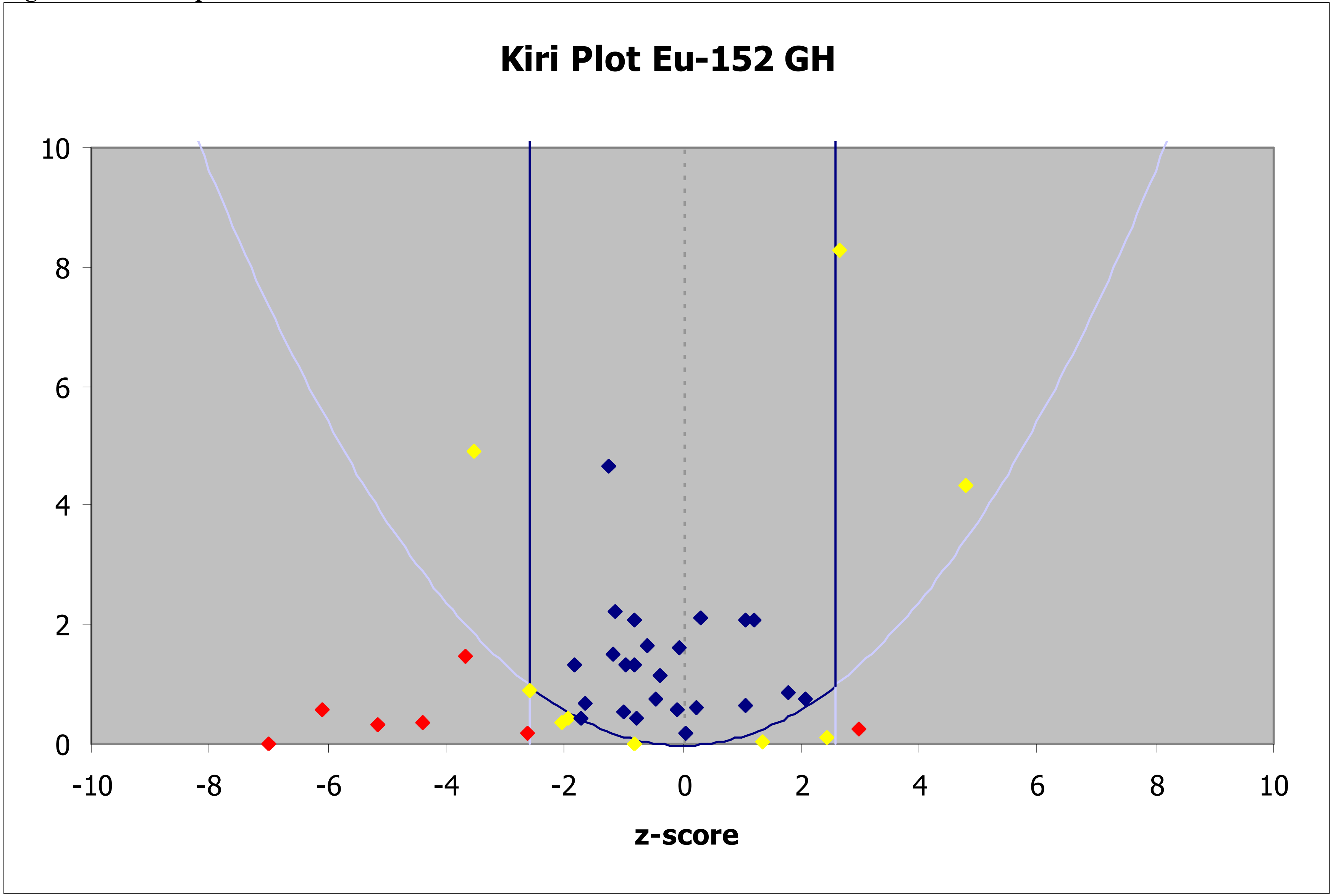


**Figure 45 – H-3 total C**

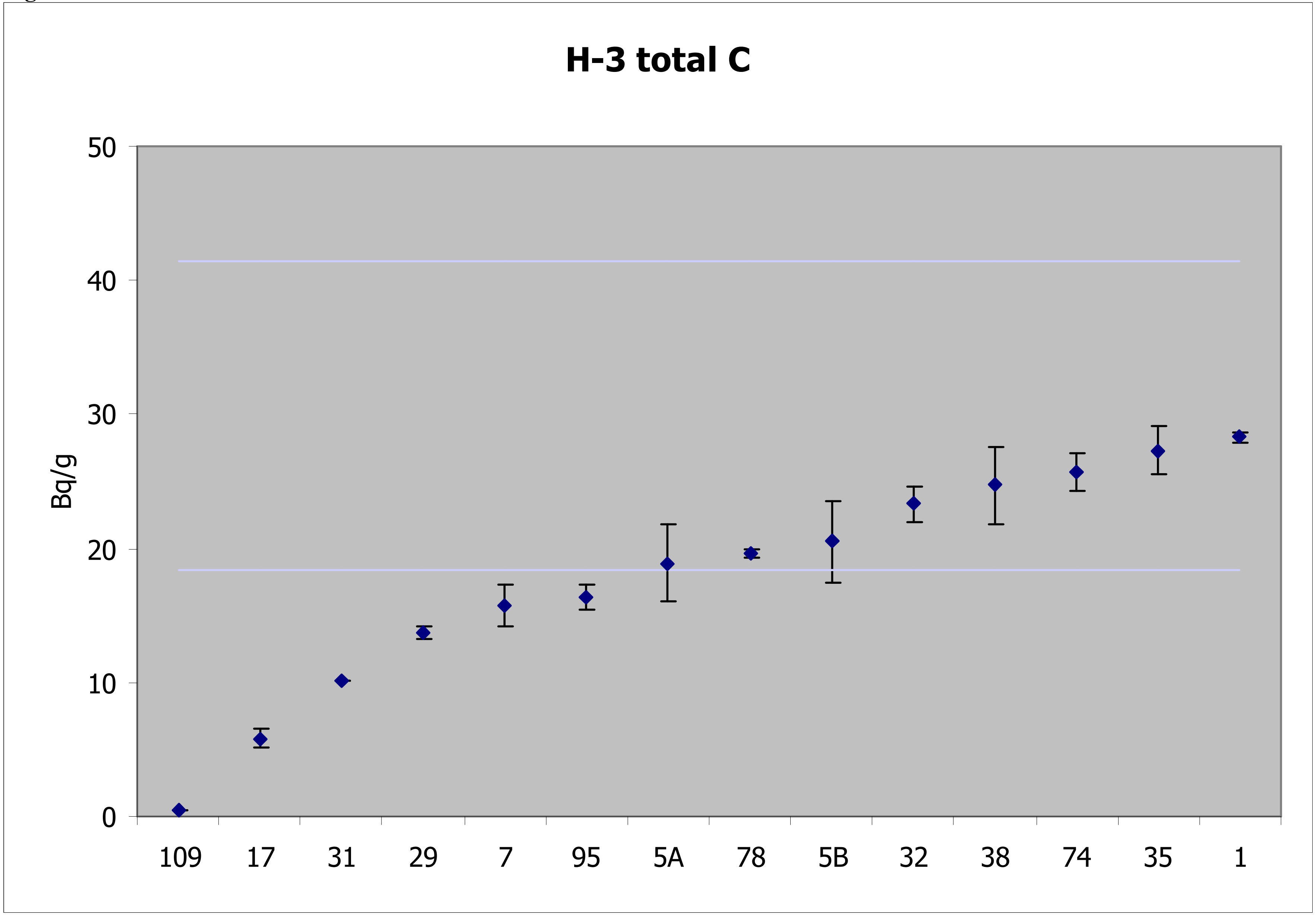


**Figure 46 – H-3 leachable C**

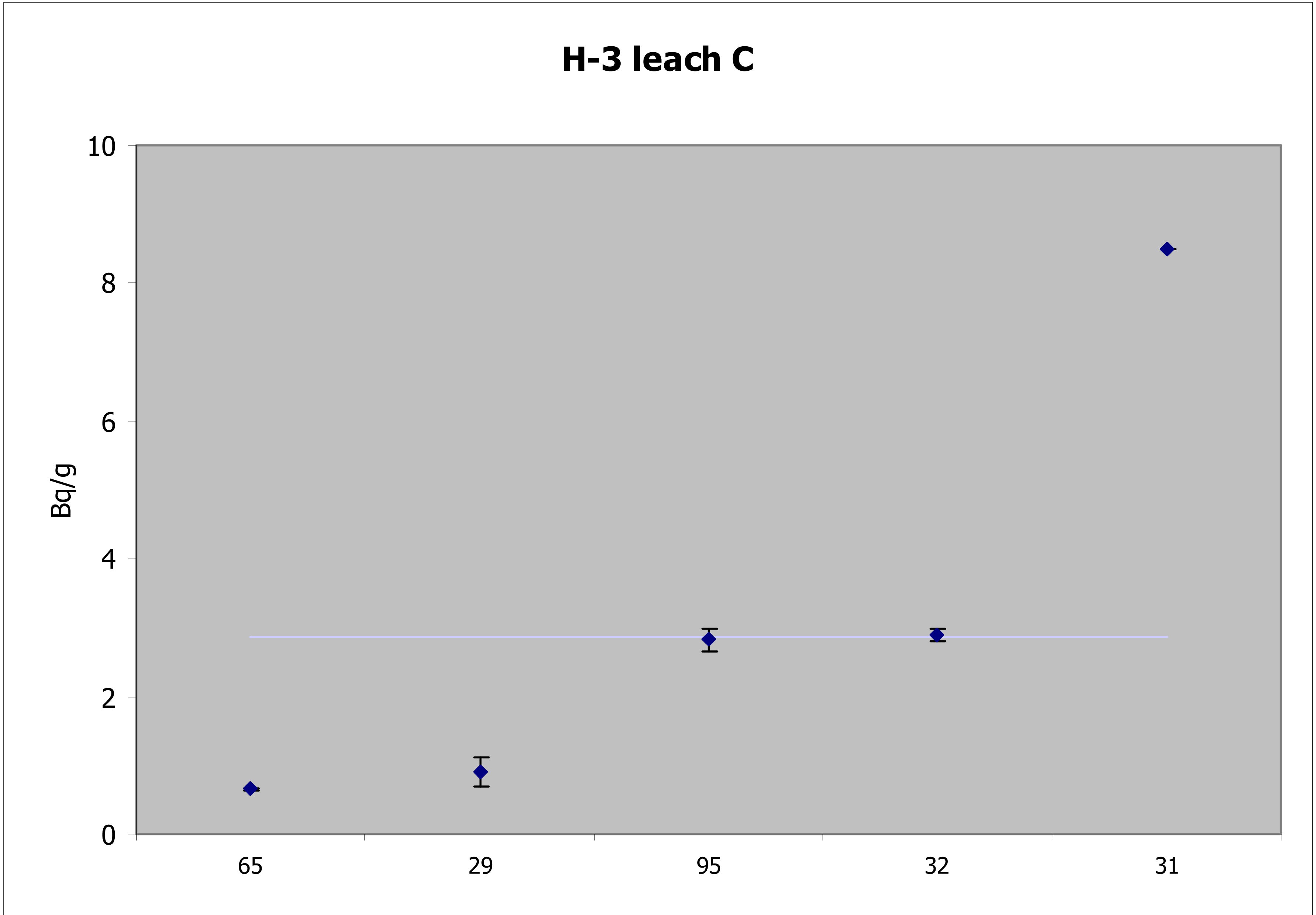


**Figure 47 – C-14 C**

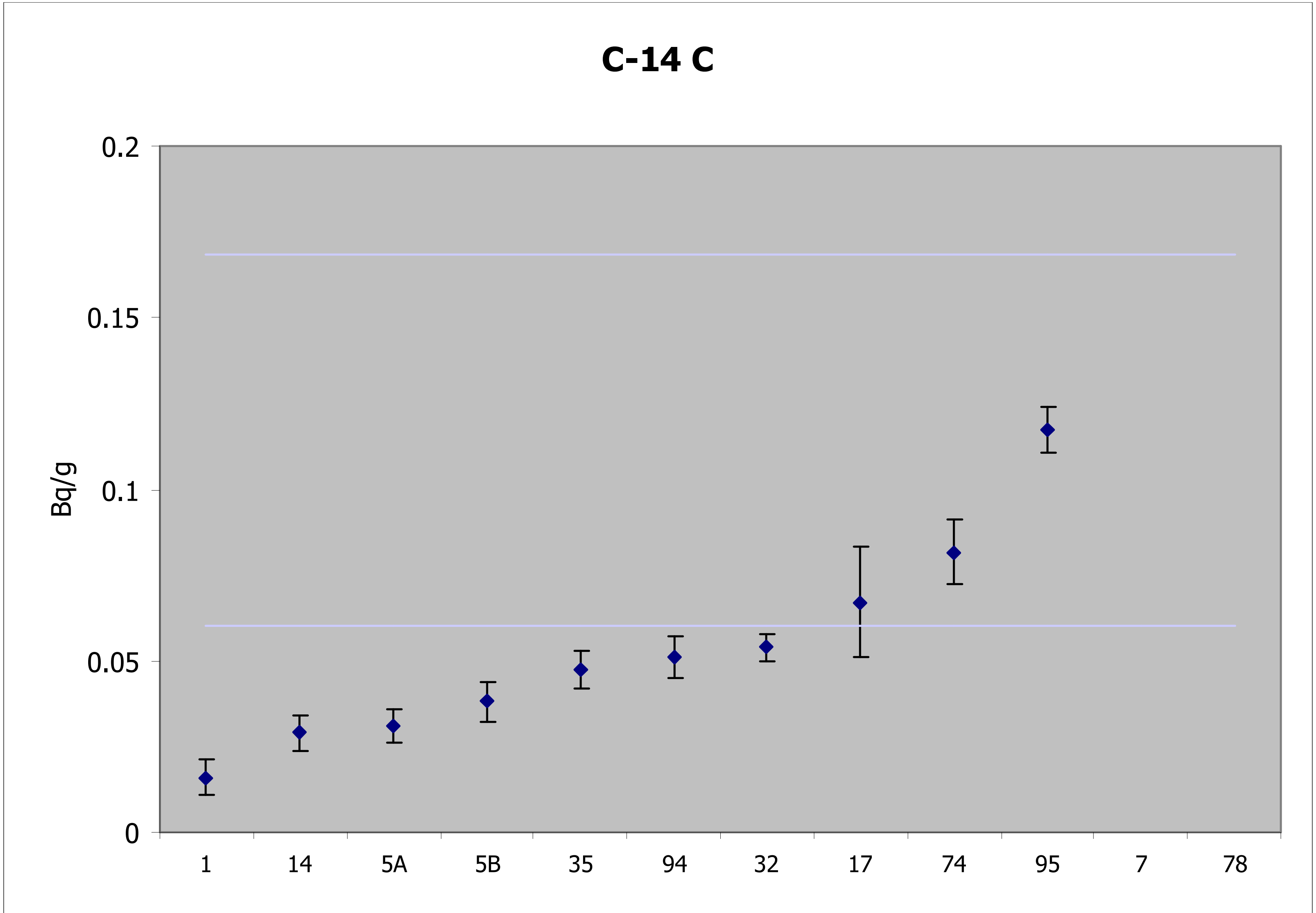


**Figure 48 – K-40 C**

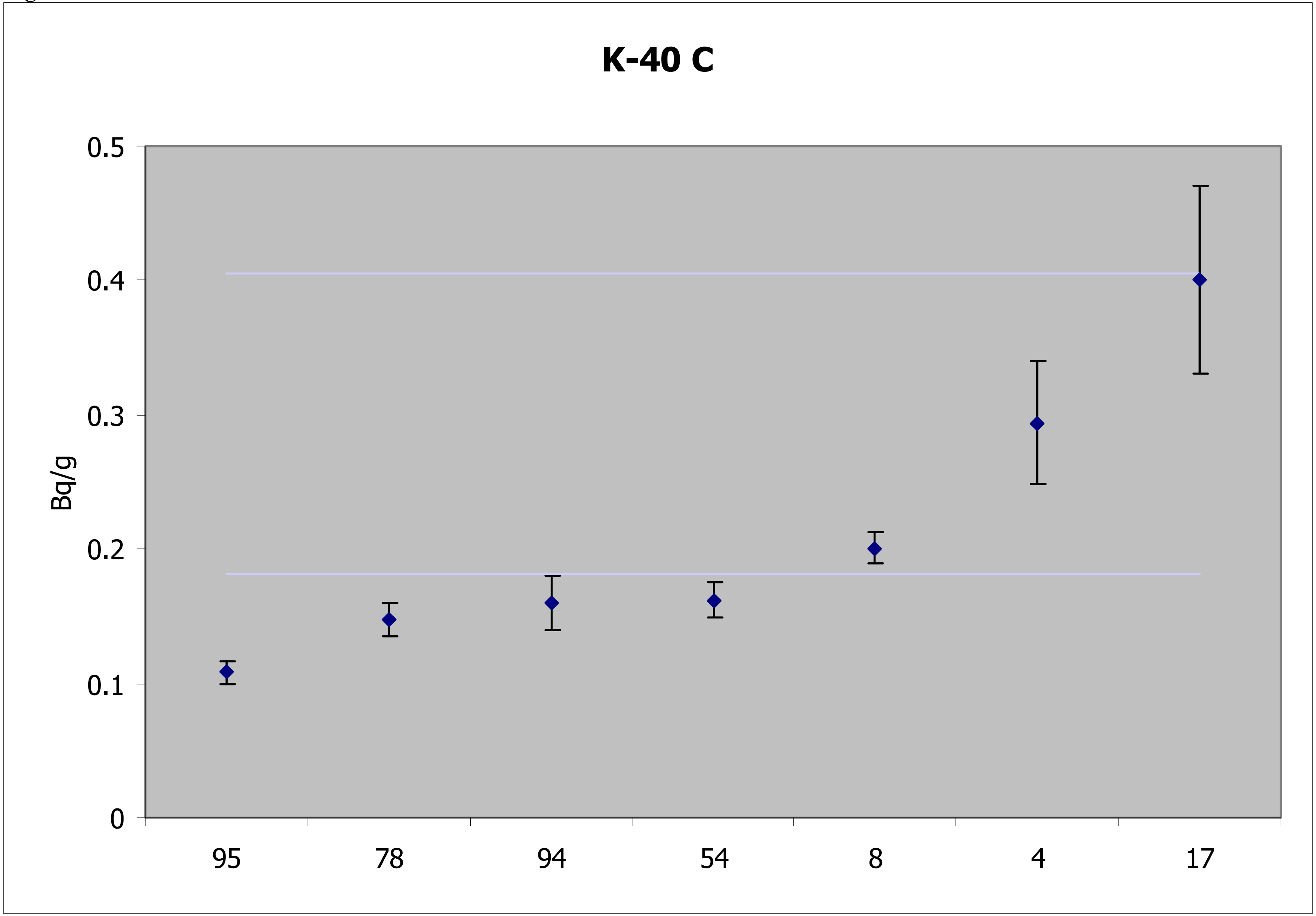


**Figure 49 – Fe-55 C**

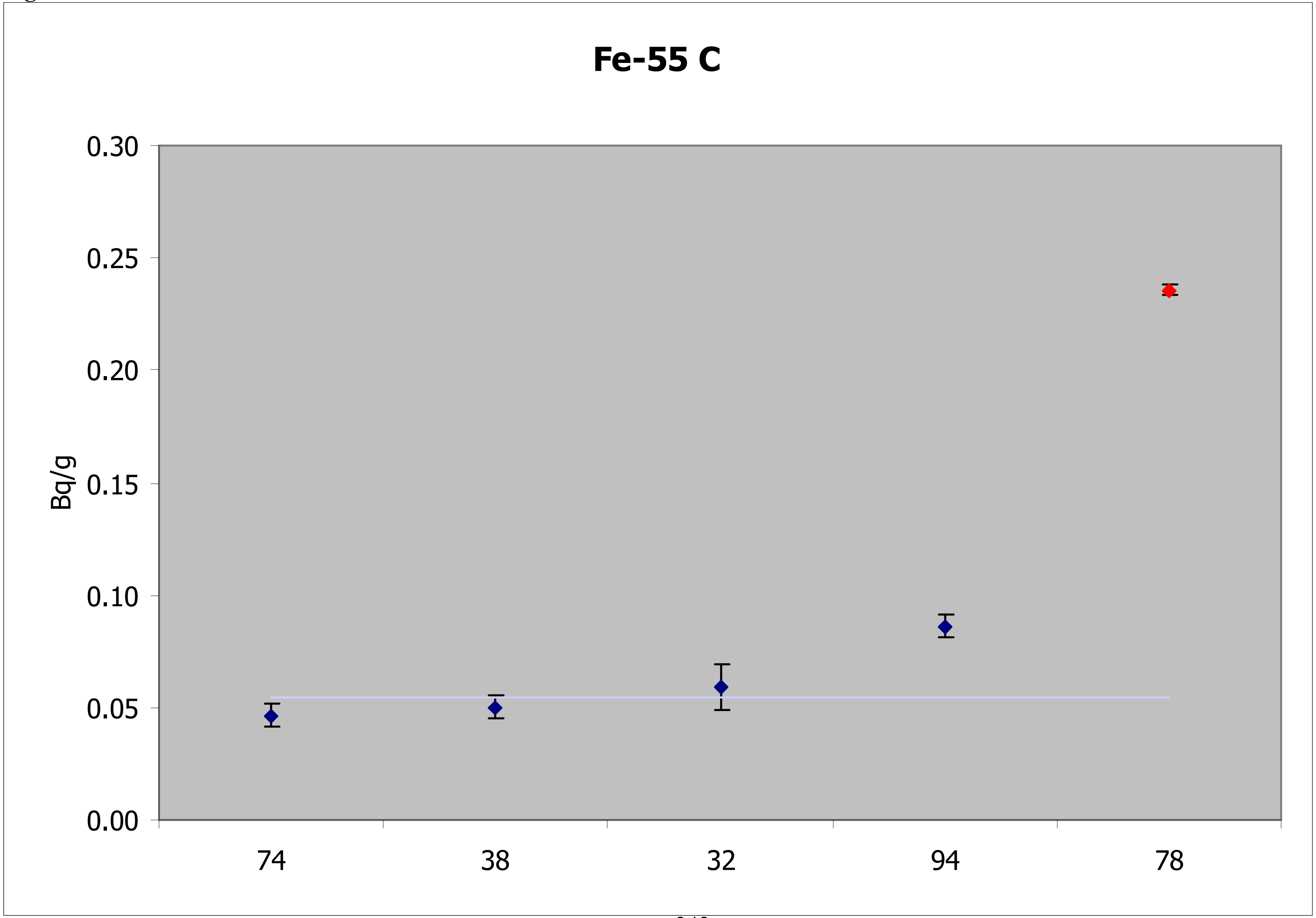


**Figure 50A – Co-60 C**

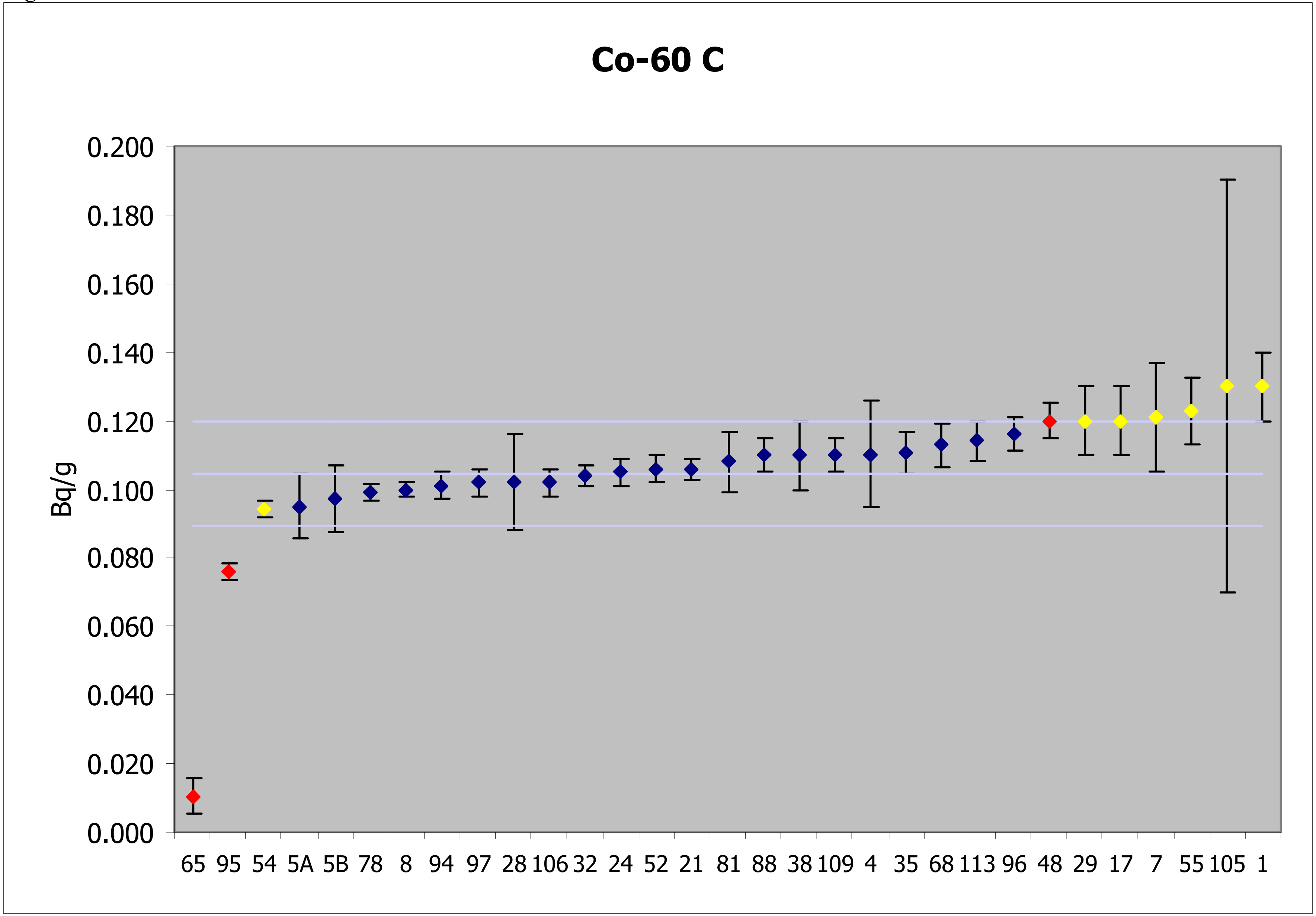


**Figure 50B – Relative uncertainty Co-60 C**

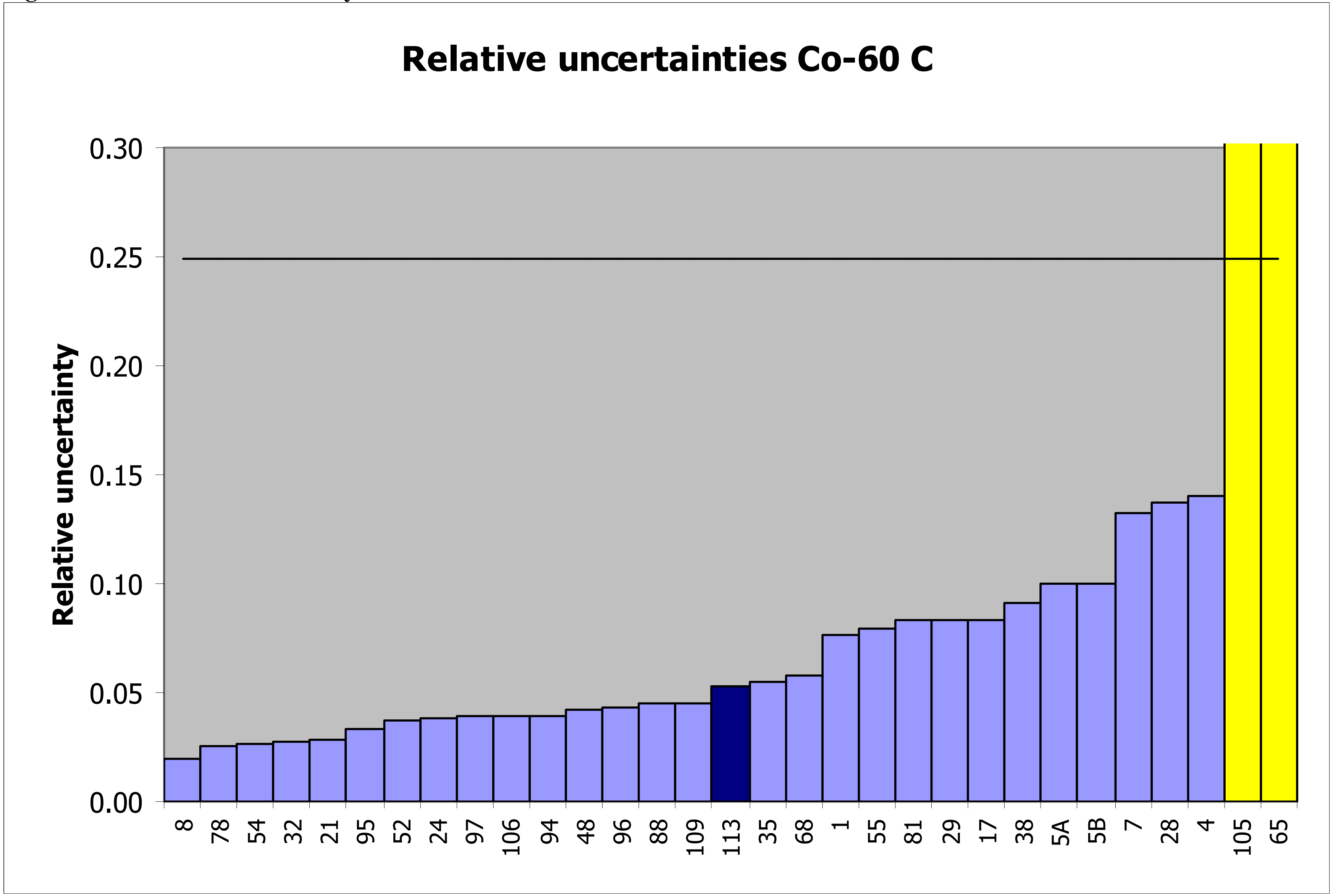


**Figure 50C – Kiri plot Co-60 C**

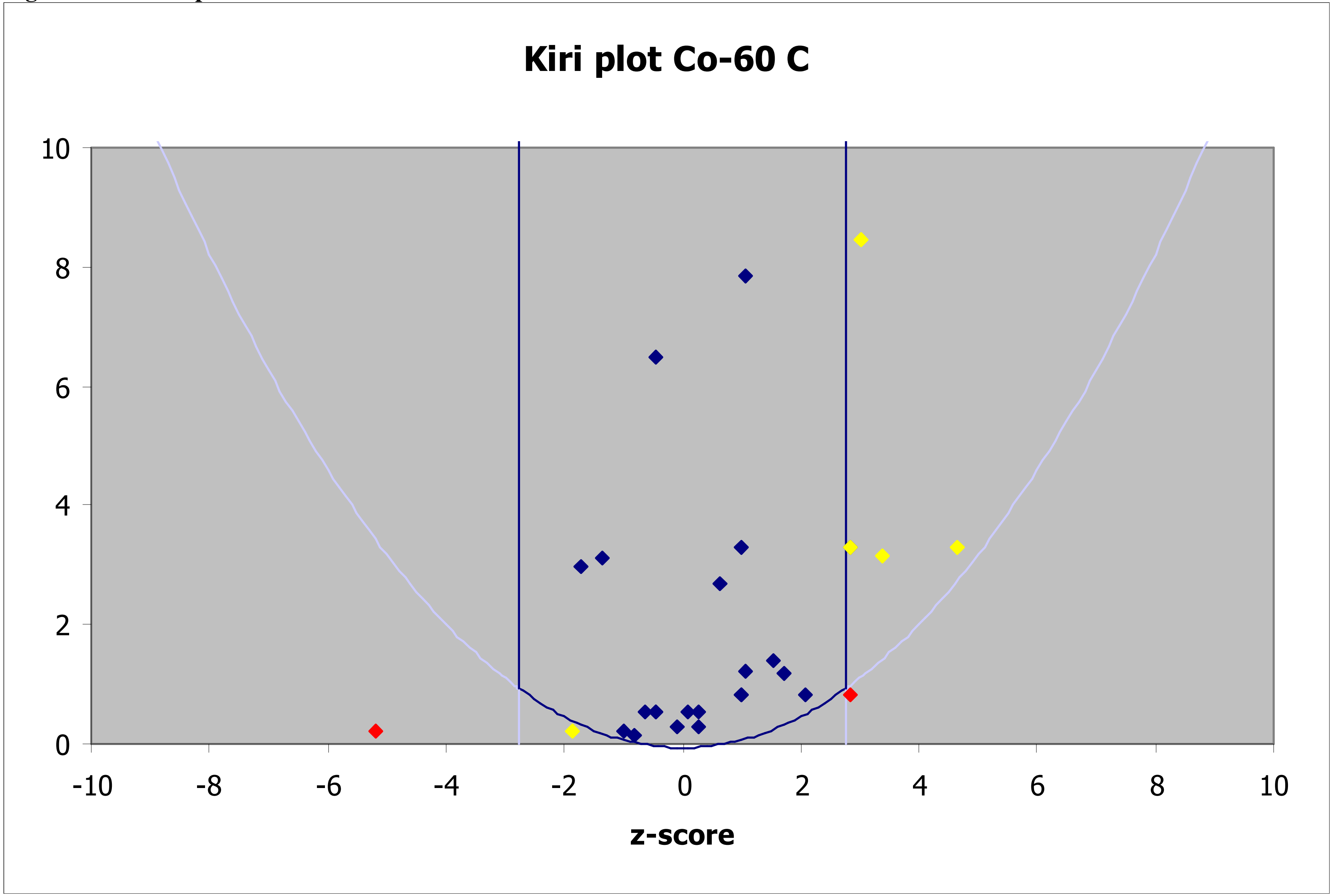


**Figure 50D – Truncated sum of squares (TSS) function $F_r$ plot Co-60 C**

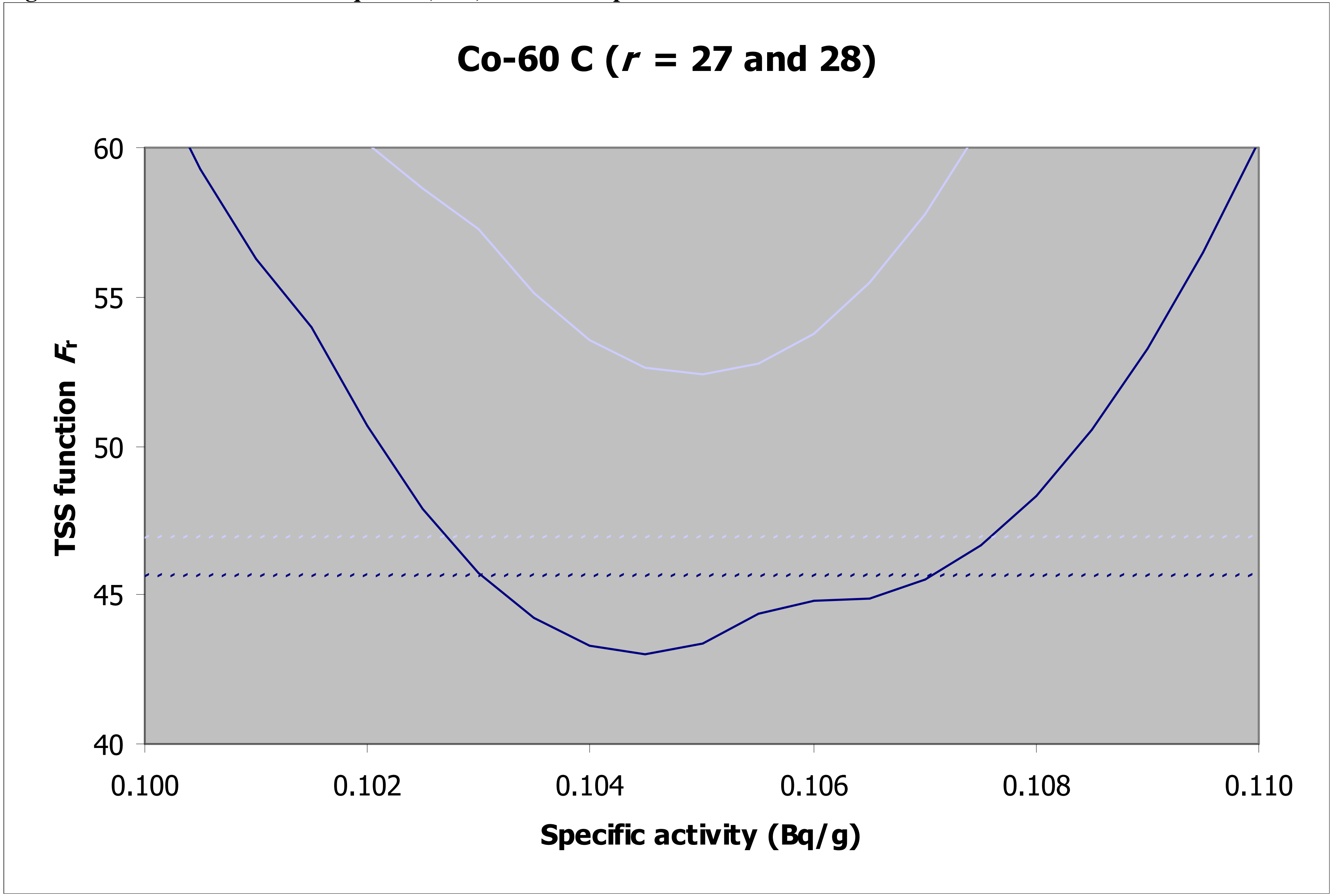


**Figure 50E – MM-PDF plot Co-60 C**

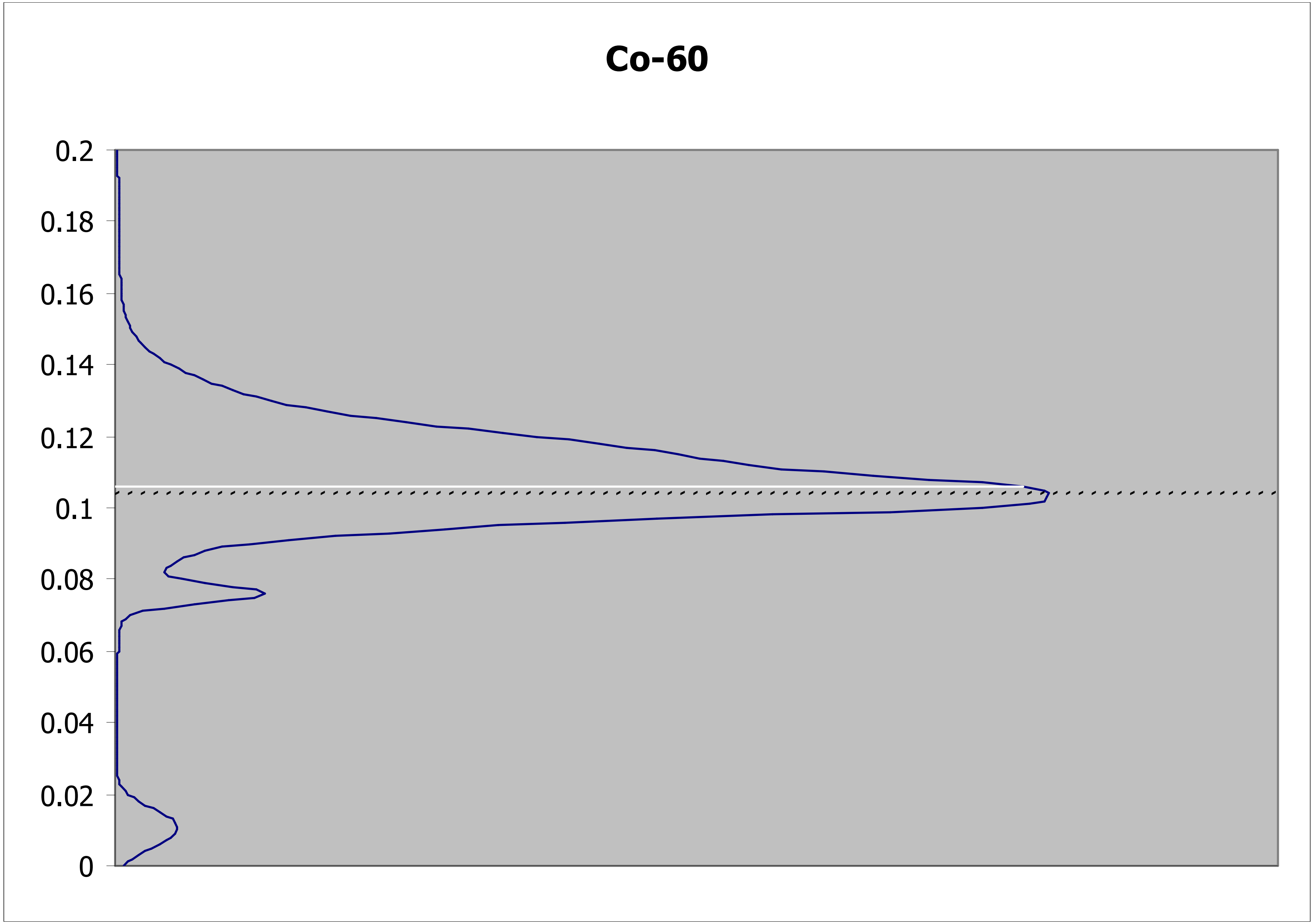


**Figure 51 – Ni-63 C**

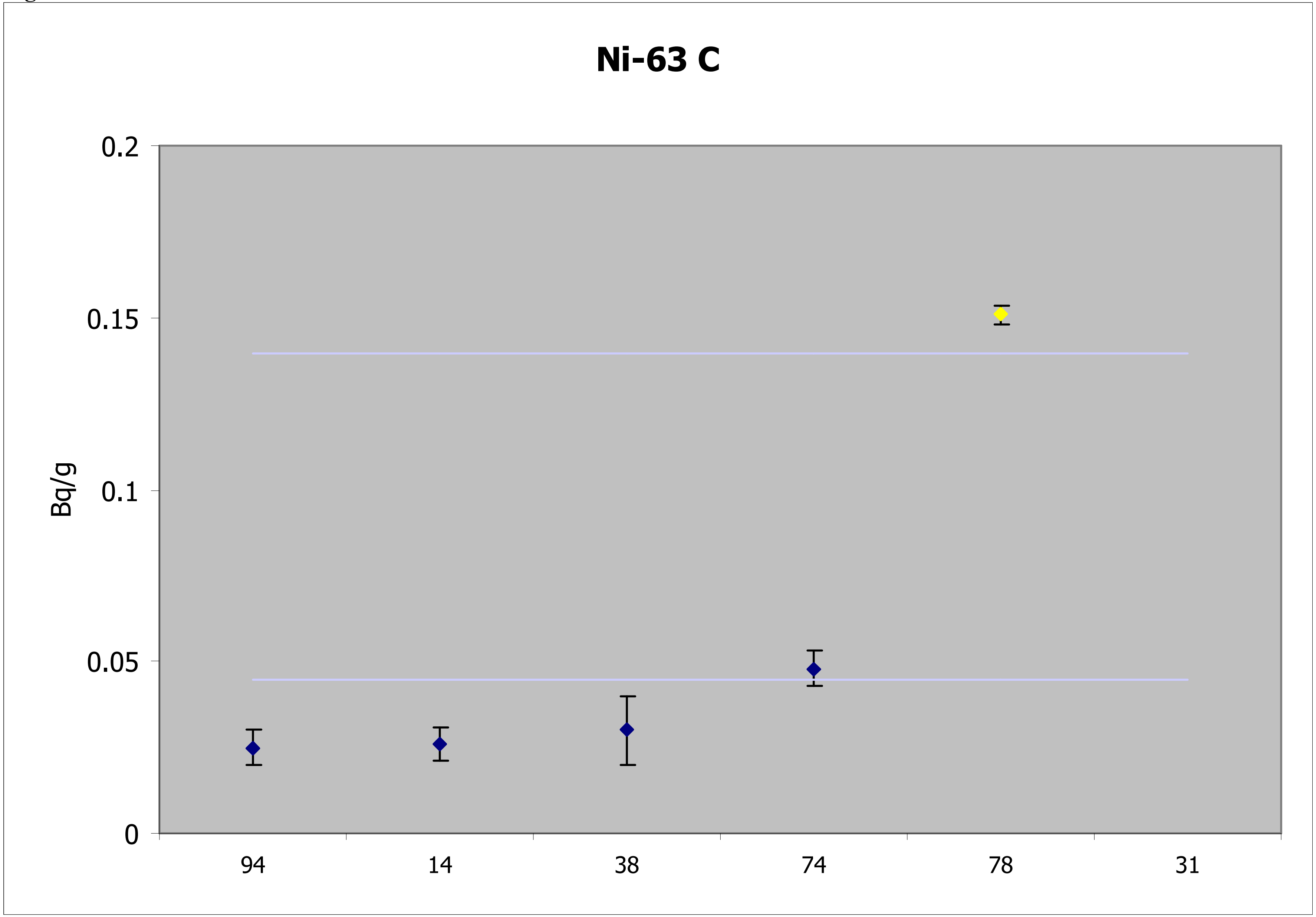


**Figure 52A – Ba-133 C**

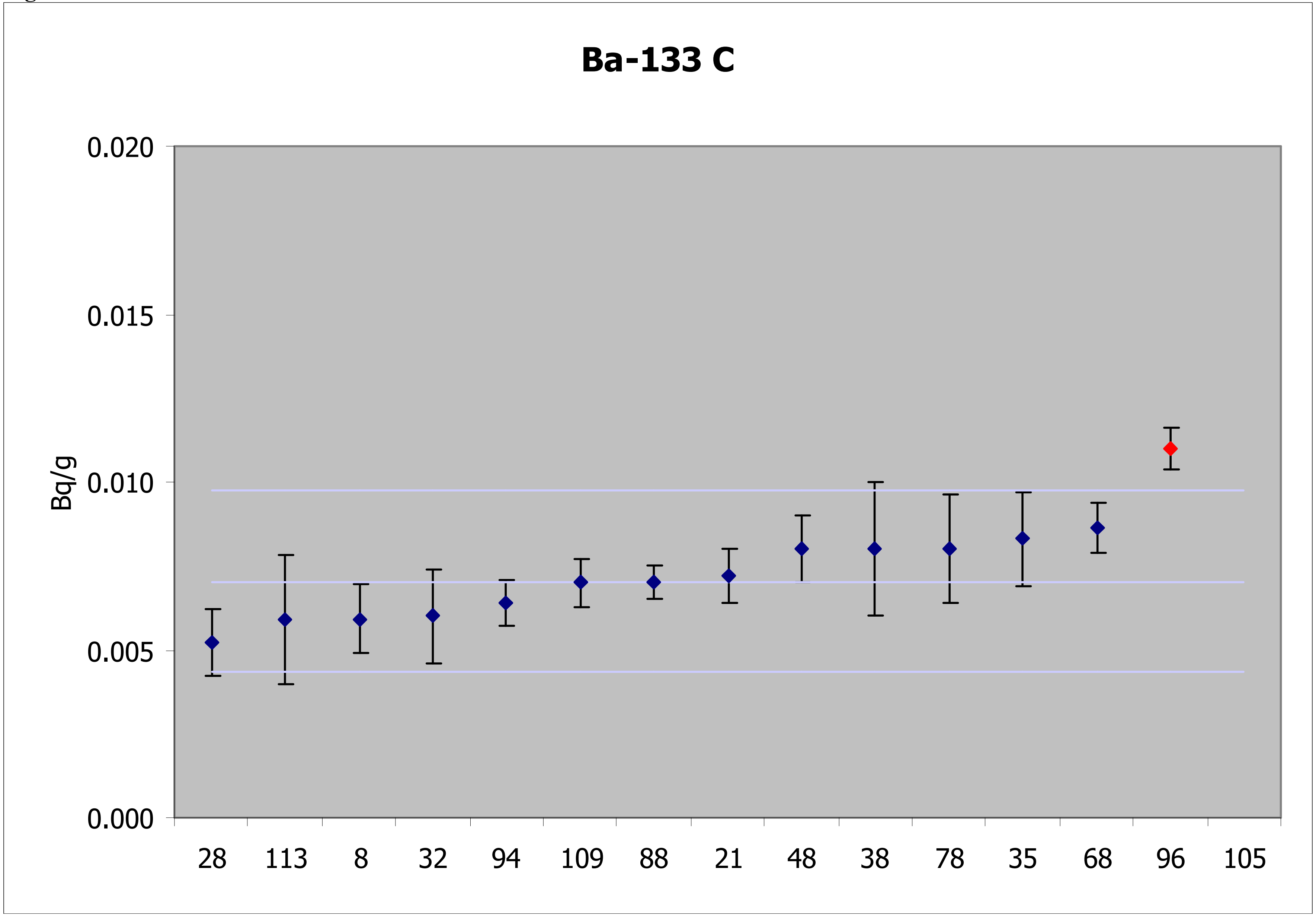


**Figure 52B – Relative uncertainty Ba-133 C**

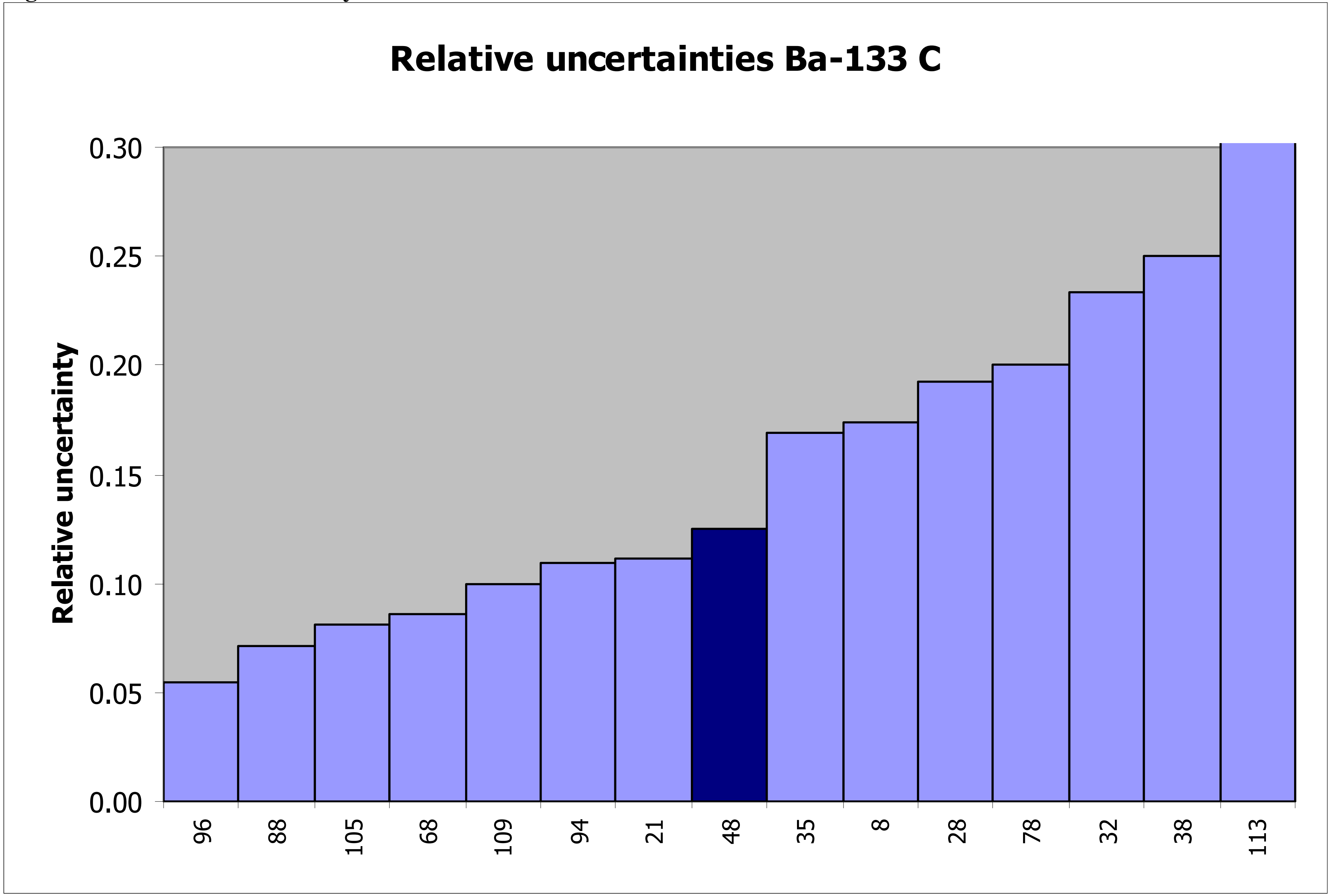


**Figure 52C – Kiri plot Ba-133 C**

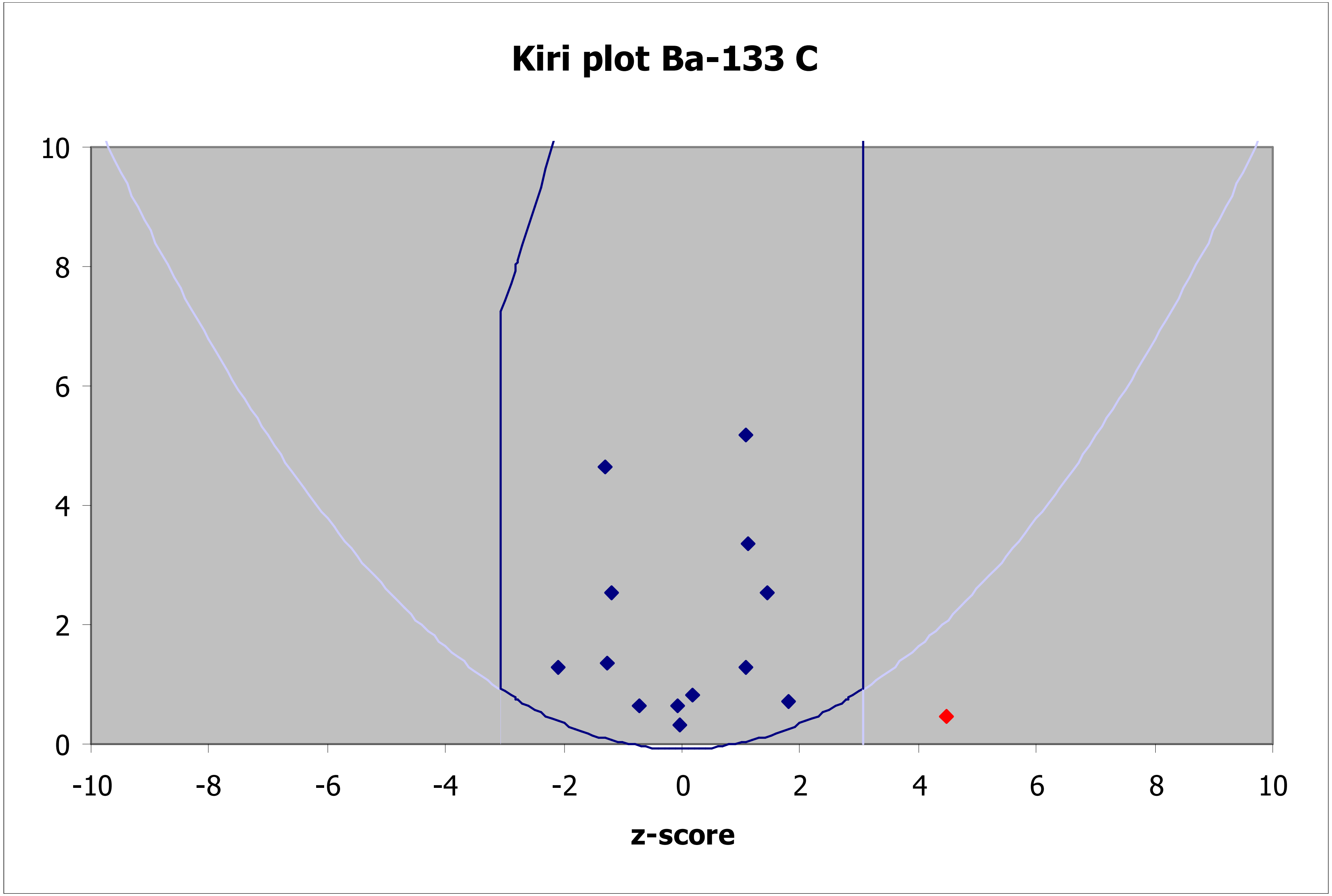


**Figure 52D – Truncated sum of squares (TSS) function $F_r$ plot Ba-133 C**

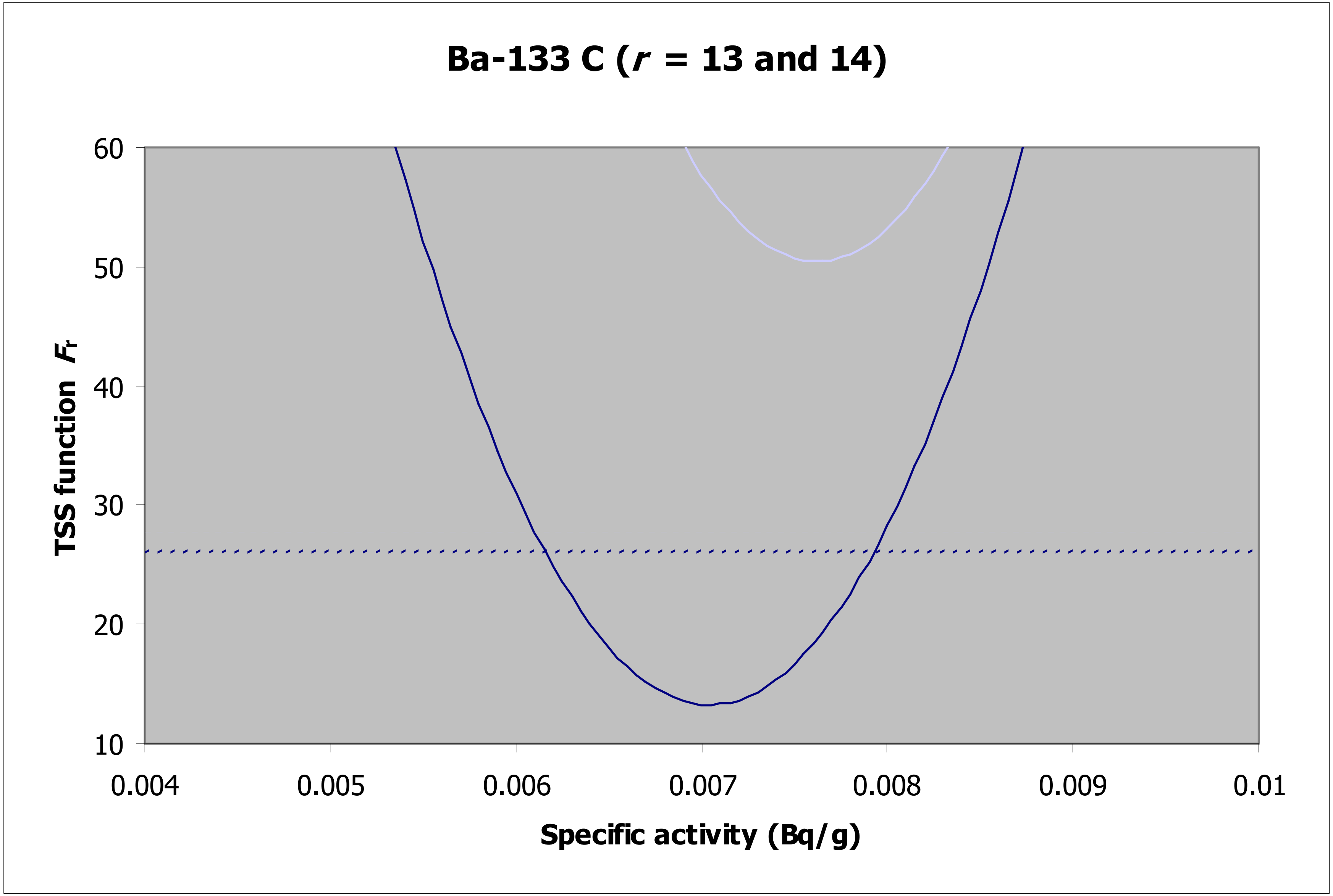


**Figure 52E – MM-PDF plot Ba-133 C**

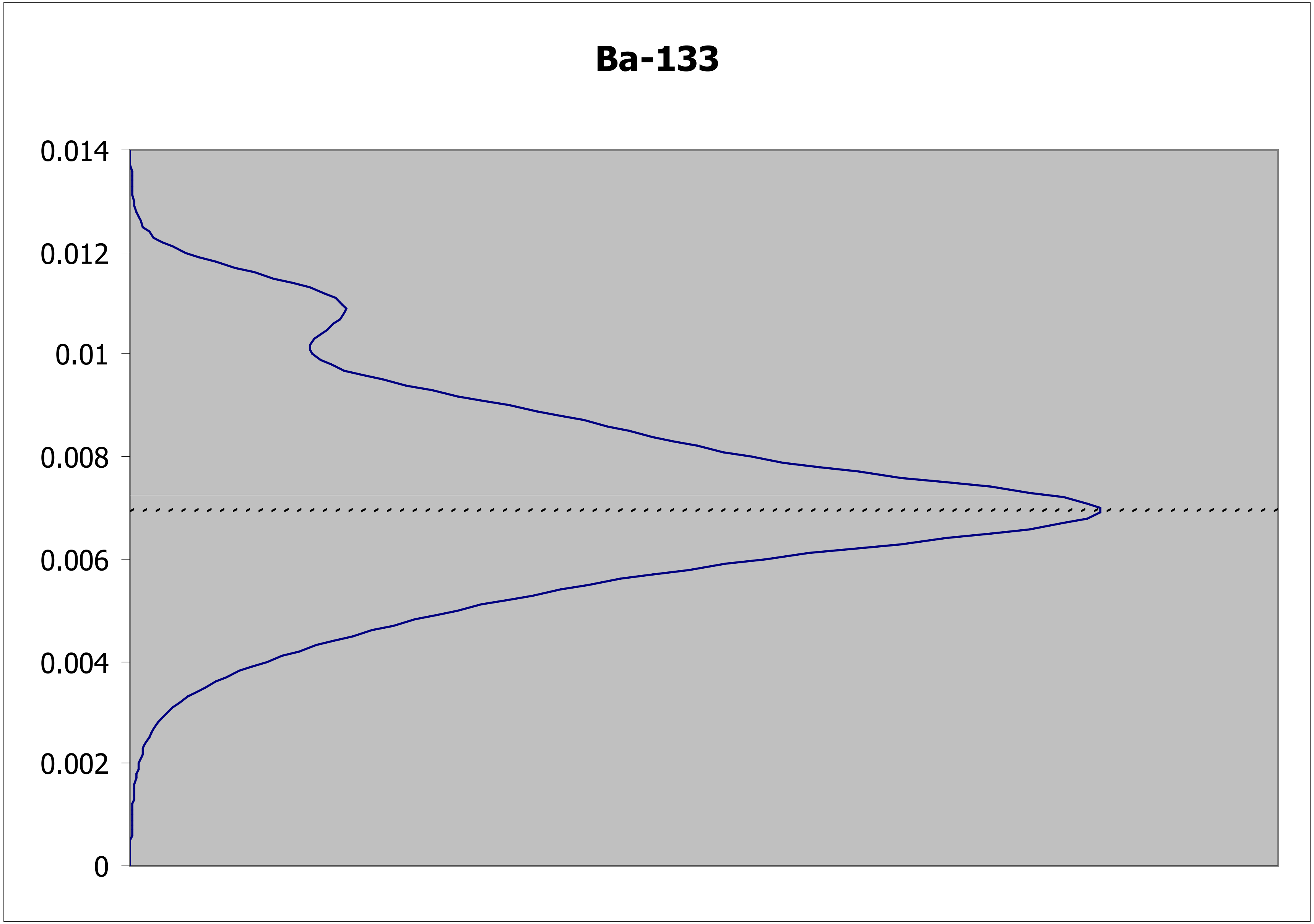


**Figure 53A – Eu-152 C**

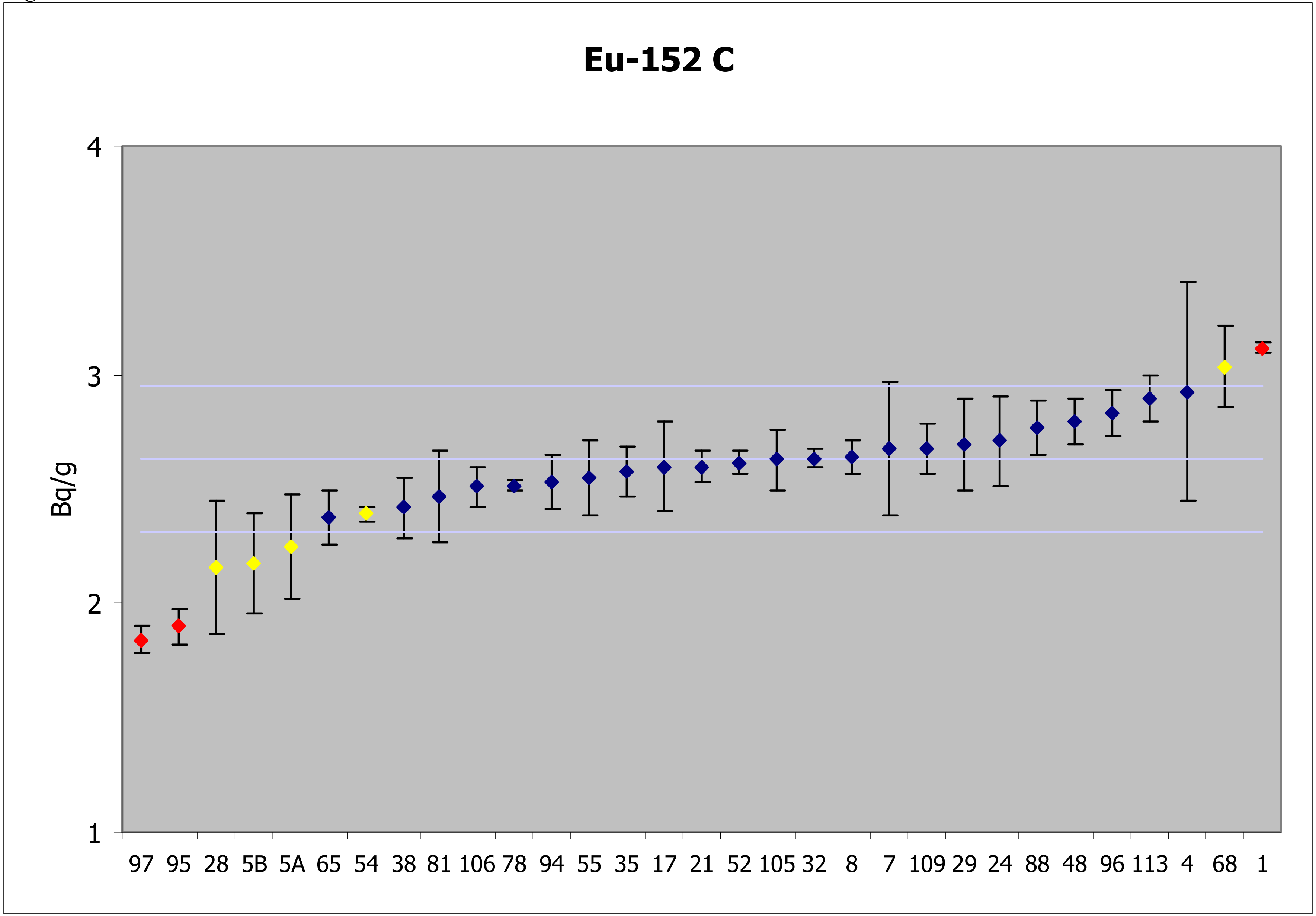


**Figure 53B – Relative uncertainty Eu-152 C**

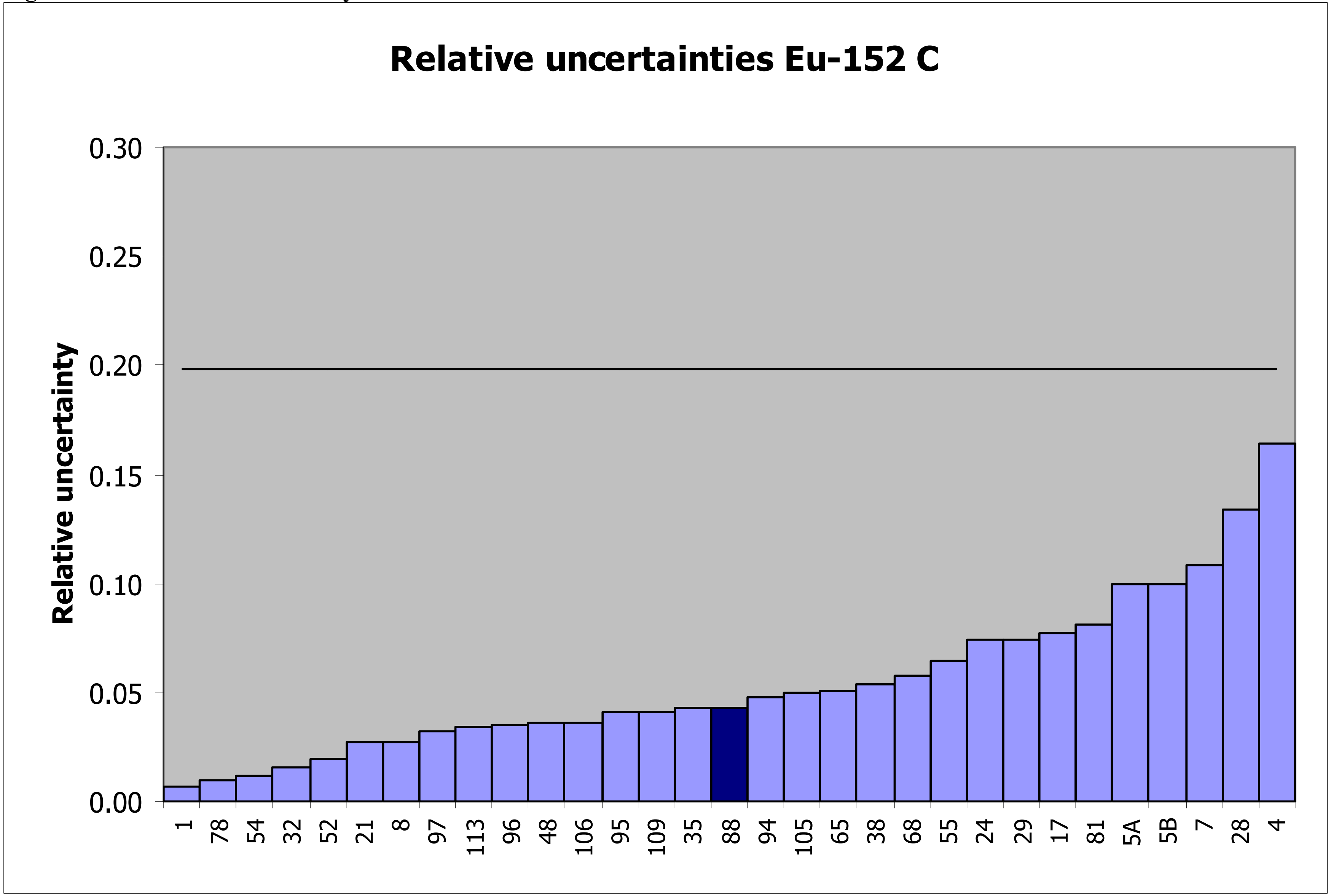


**Figure 53C – Kiri plot Eu-152 C**

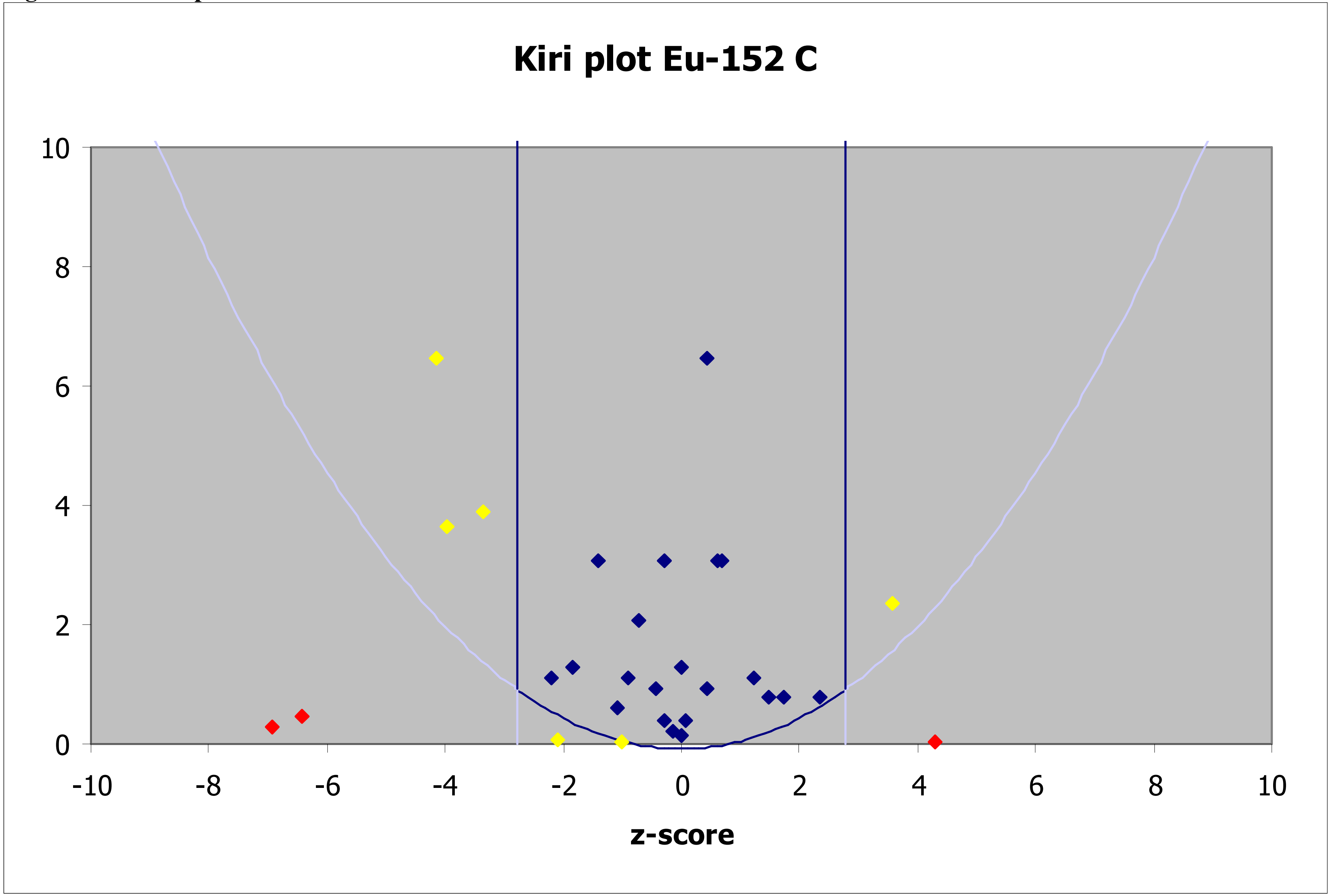


**Figure 53D – Truncated sum of squares (TSS) function $F_r$ plot Eu-152 C**

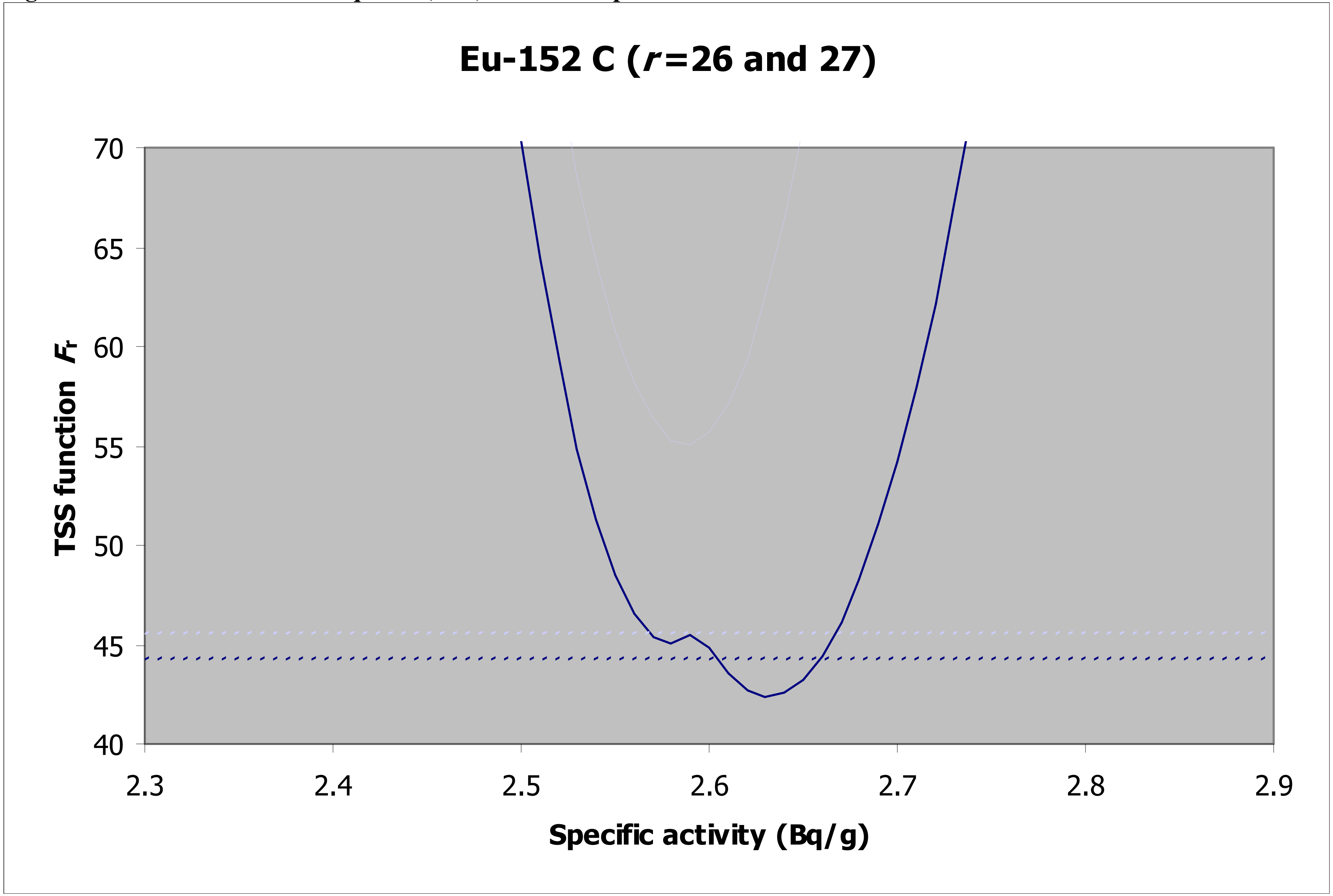


**Figure 53E – MM-PDF Eu-152 C**

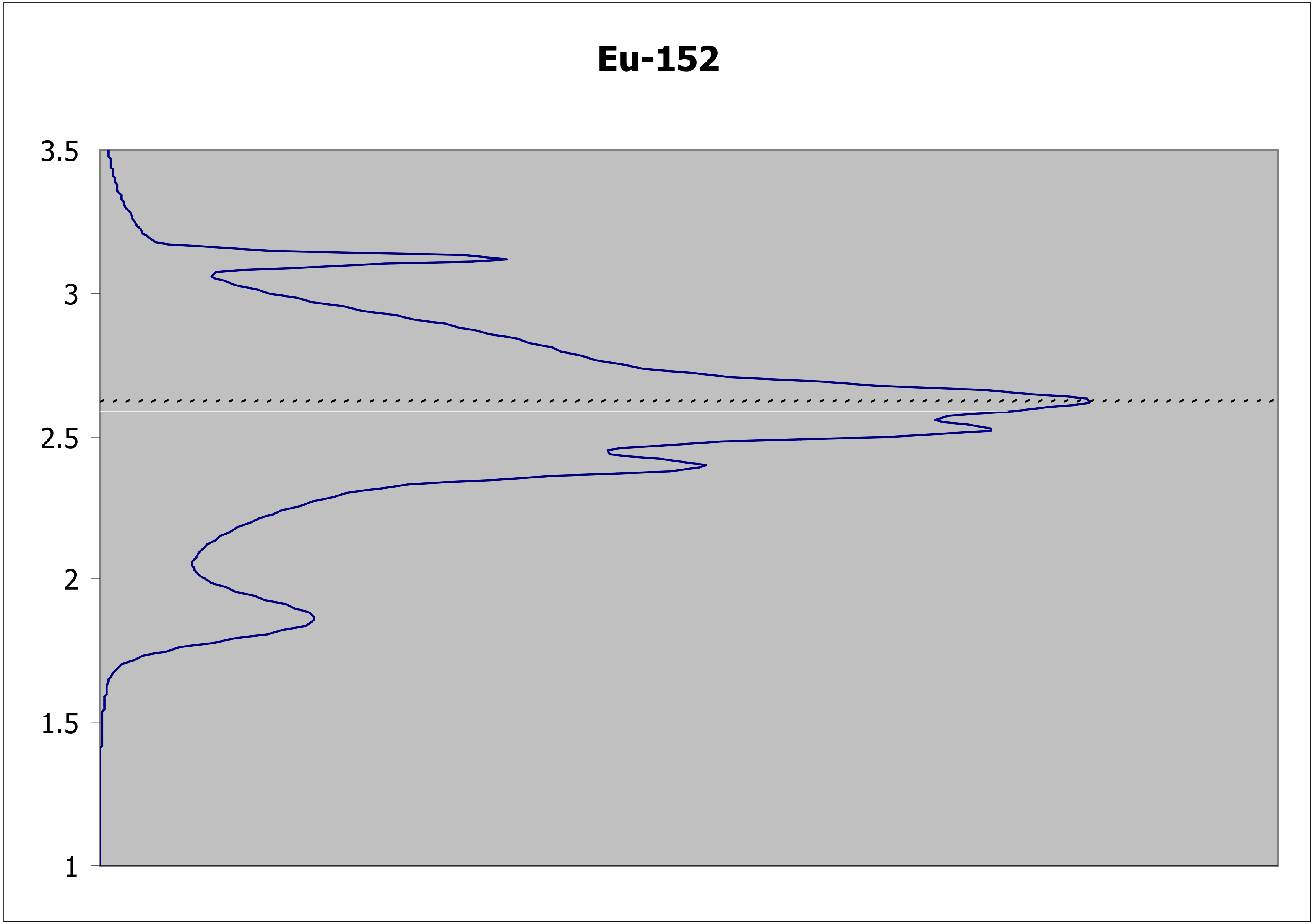


**Figure 54A – Eu-154 C**

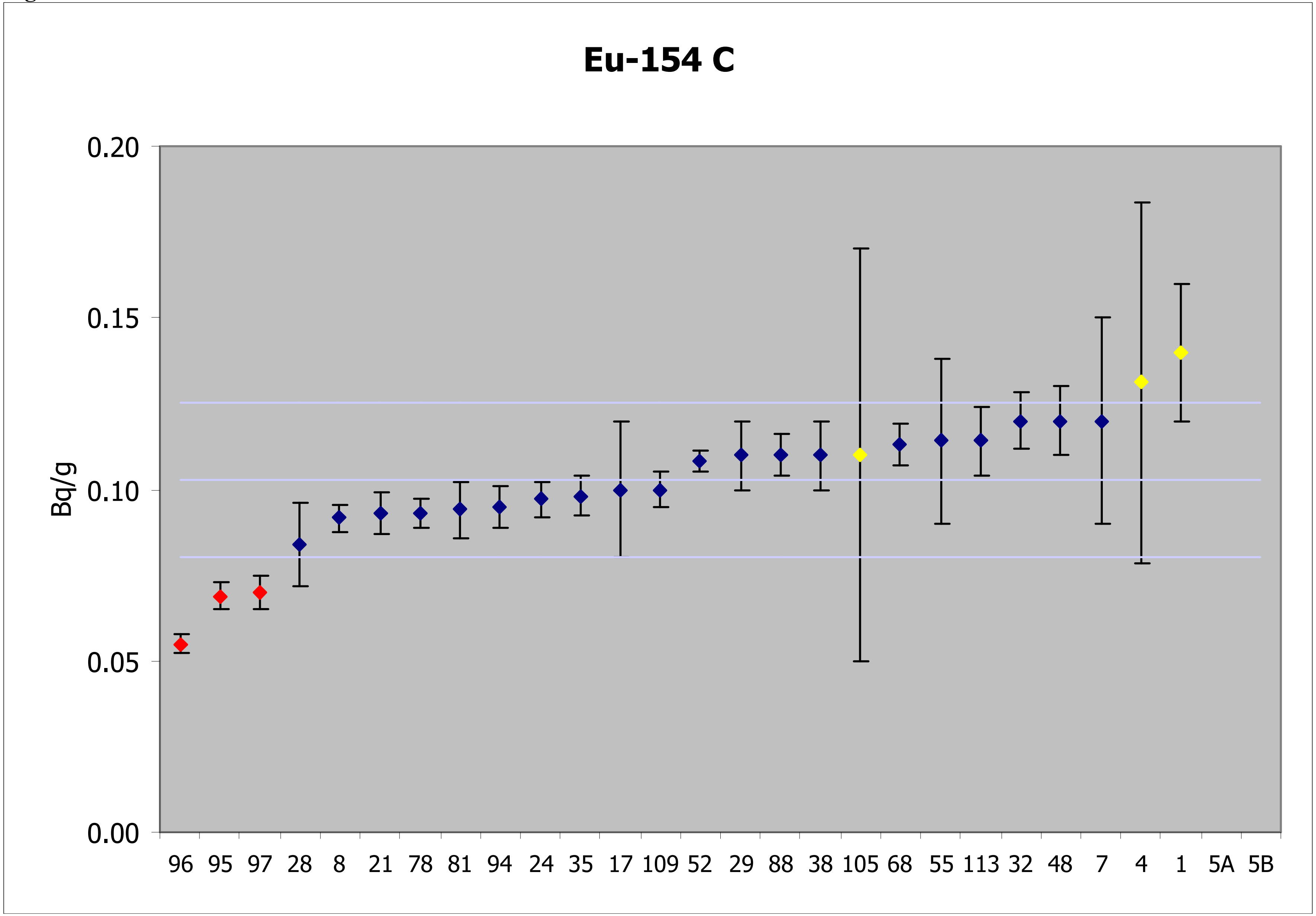


**Figure 54B – Relative uncertainty Eu-154 C**

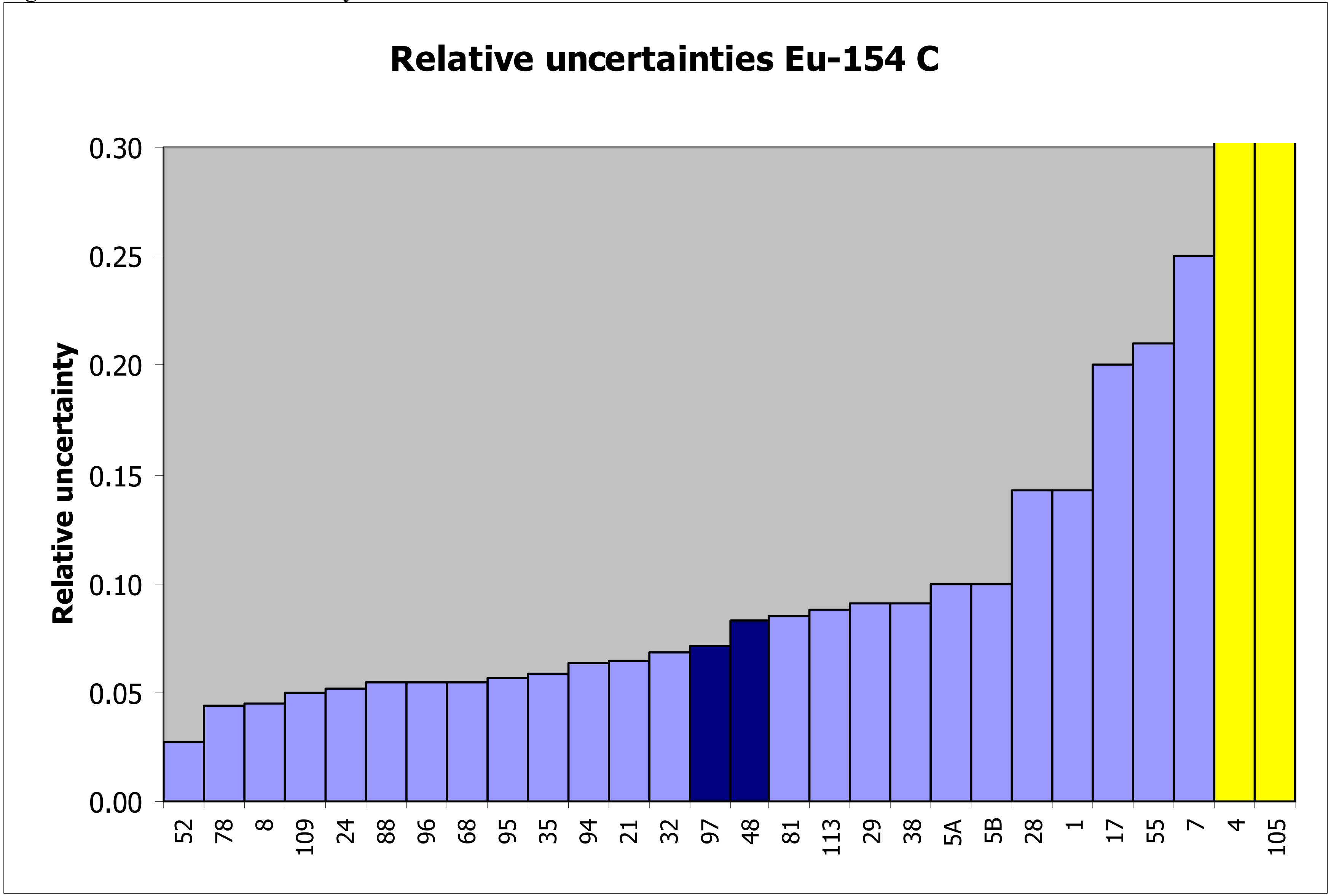


**Figure 54C – Kiri plot Eu-154 C**

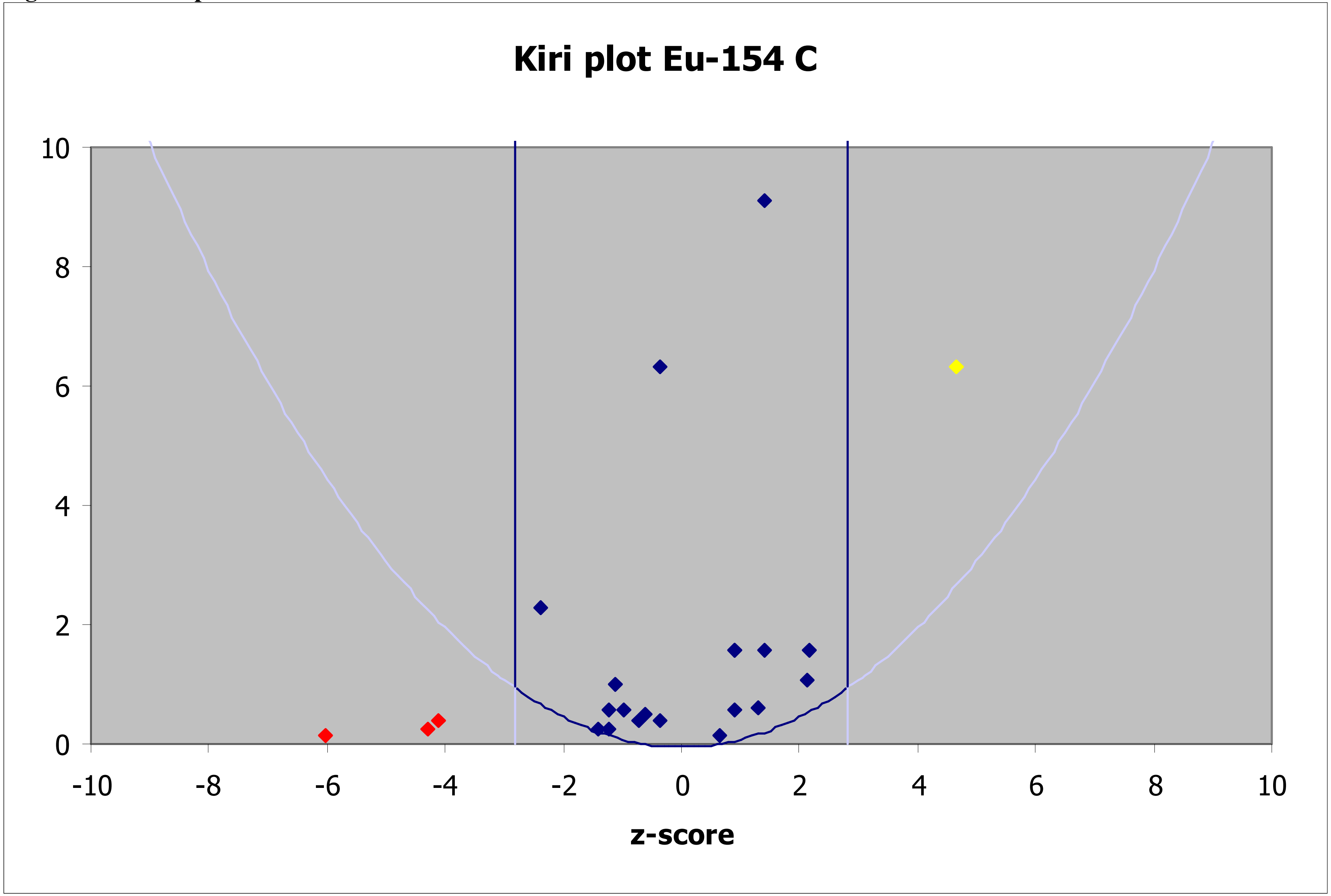


**Figure 54D – Truncated sum of squares (TSS) function $F_r$ plot Eu-154 C**

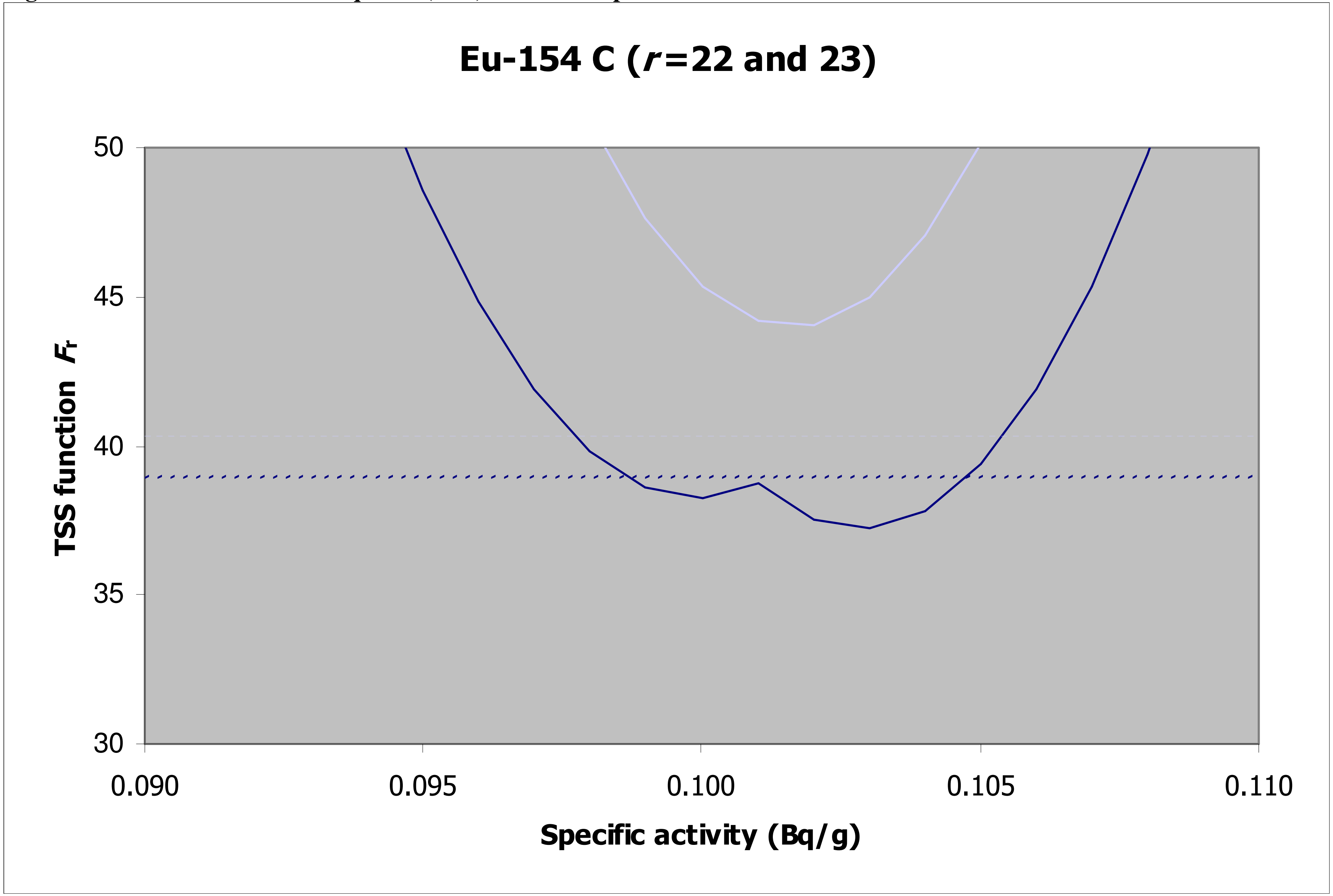


**Figure 54E – MM-PDF plot Eu-154 C**

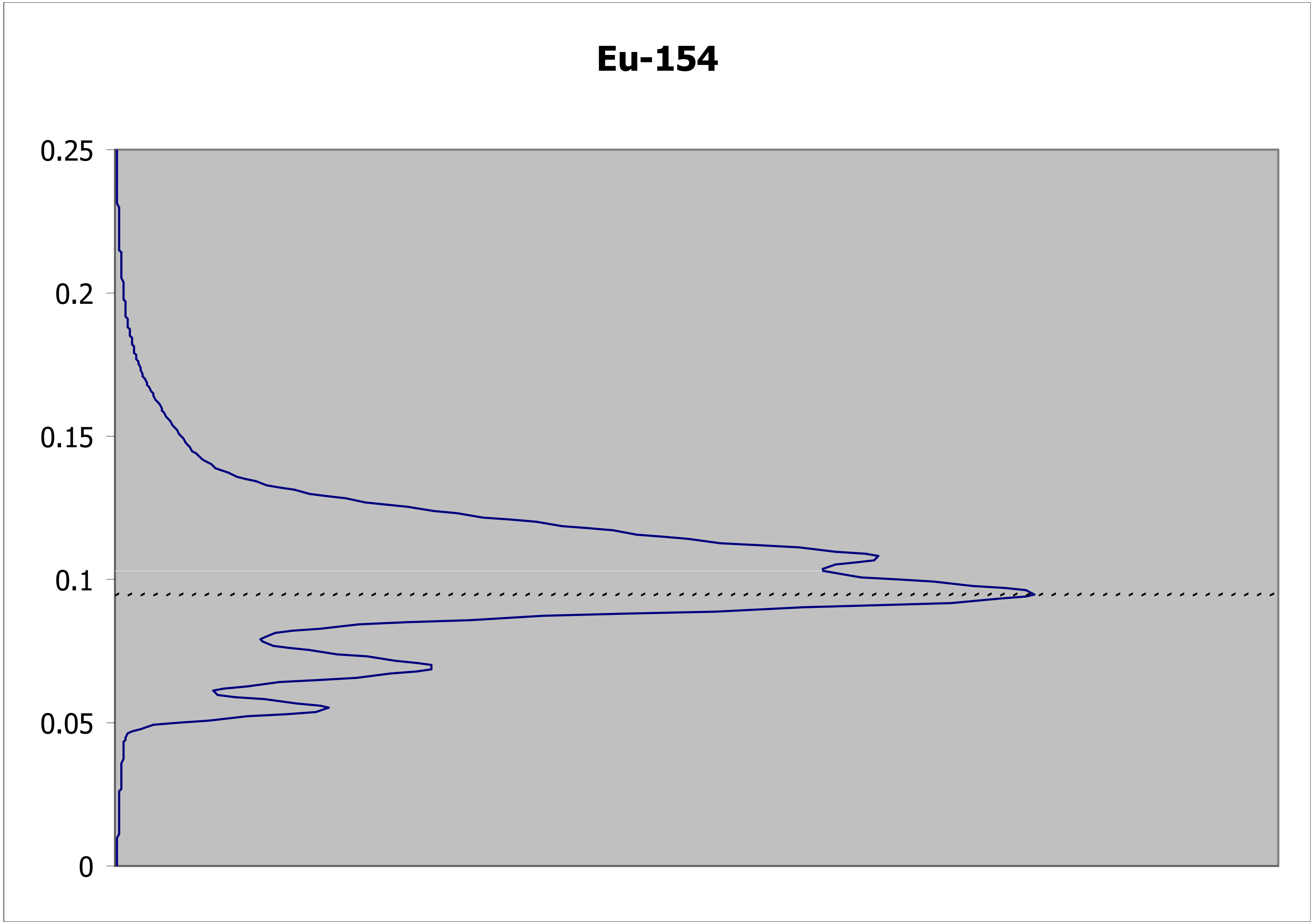


**Figure 55 – Gross beta C**

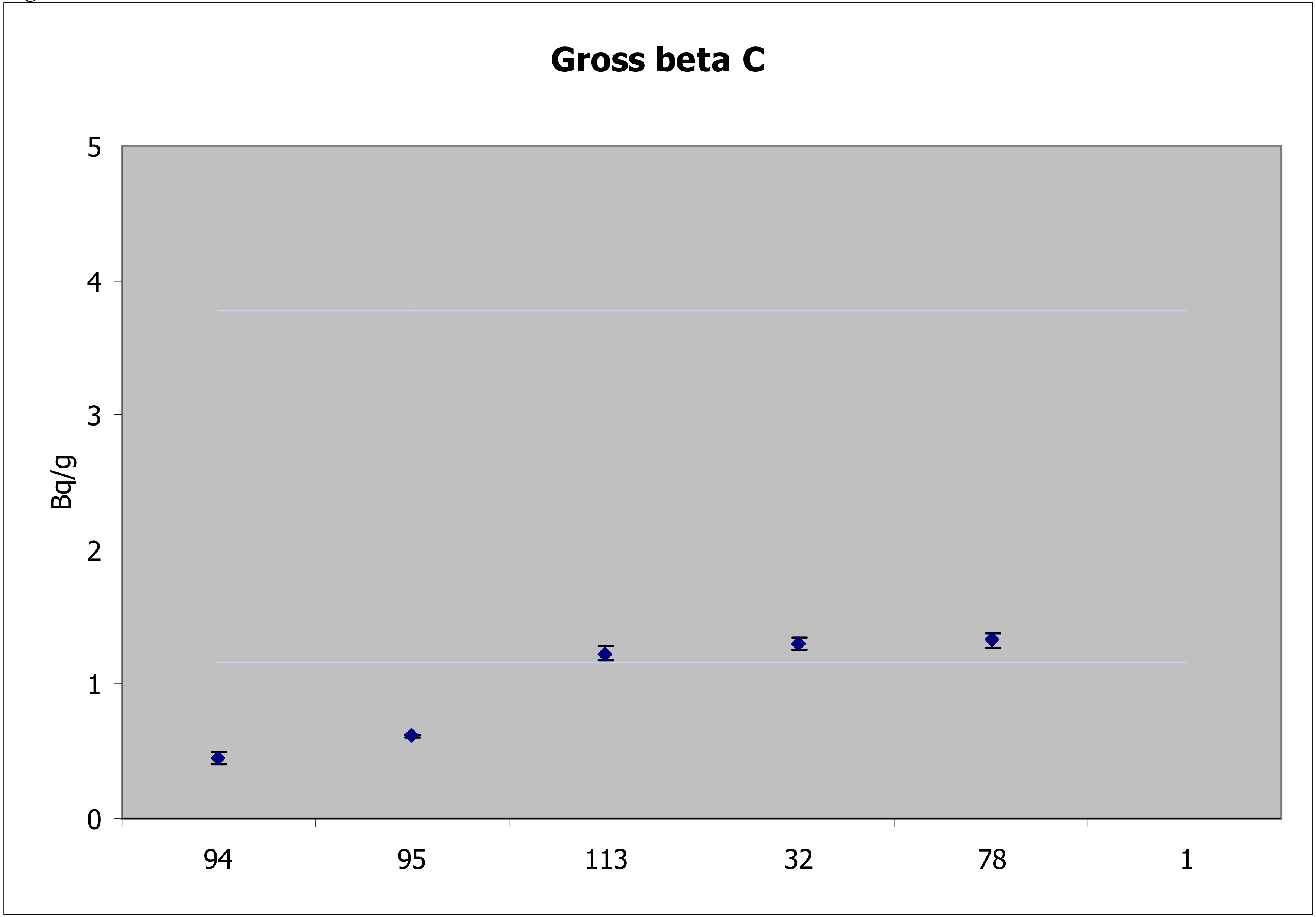


**Figure 56A – Homogeneity test Co-60 C**

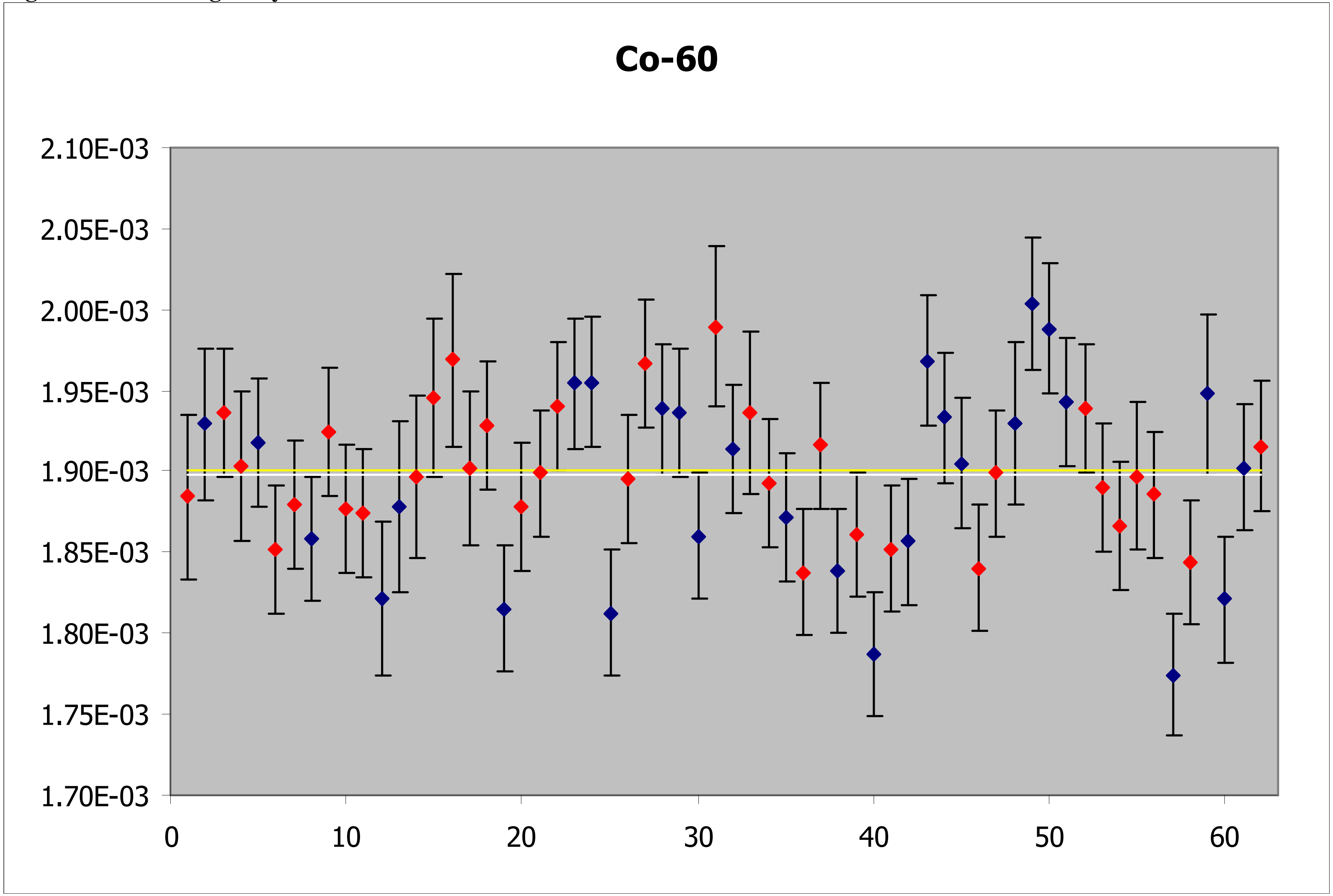


**Figure 56B – Homogeneity test Ba-133 C**

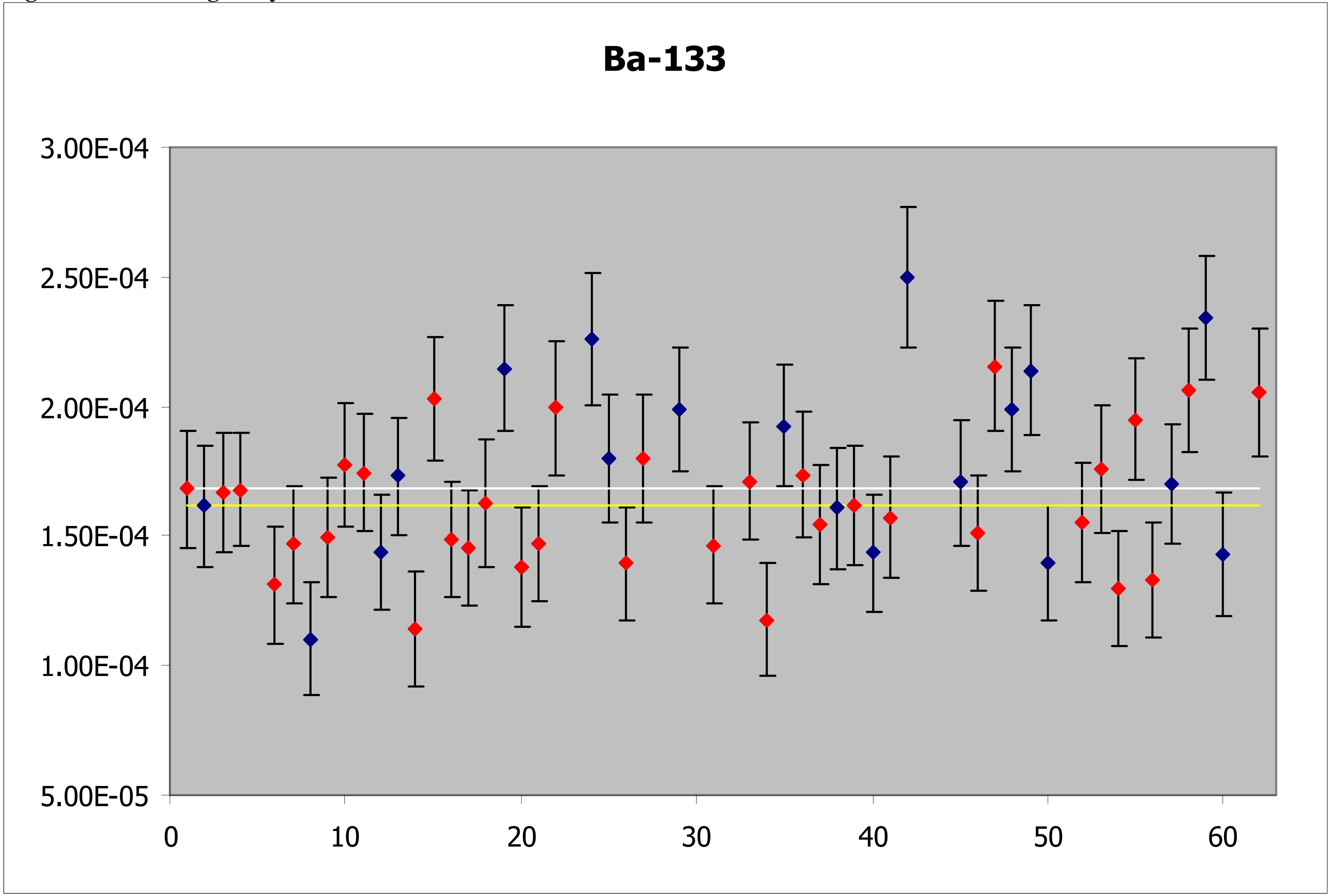


**Figure 56C – Homogeneity test Eu-152 C**

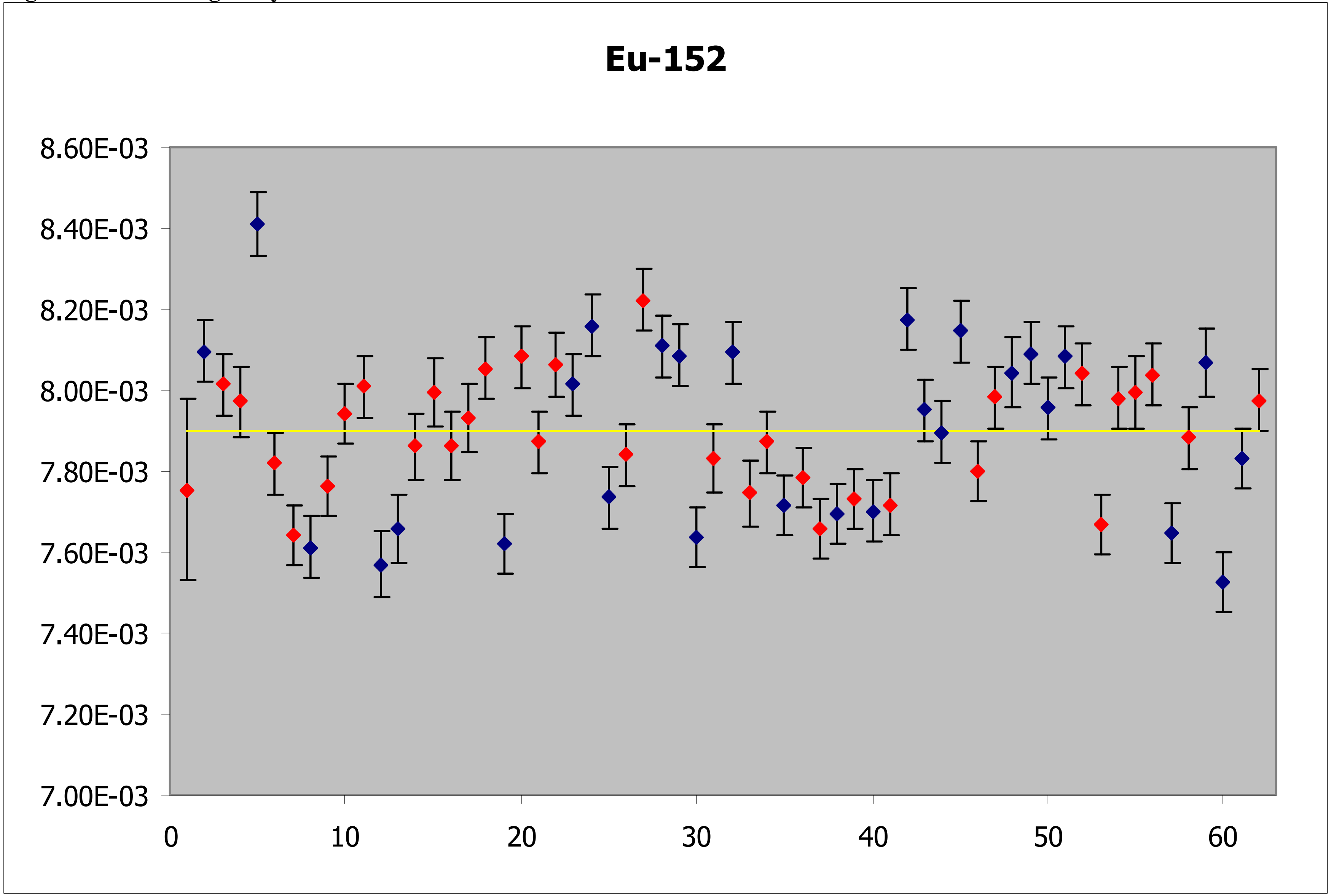


**Figure 56D – Homogeneity test Eu-154 C**

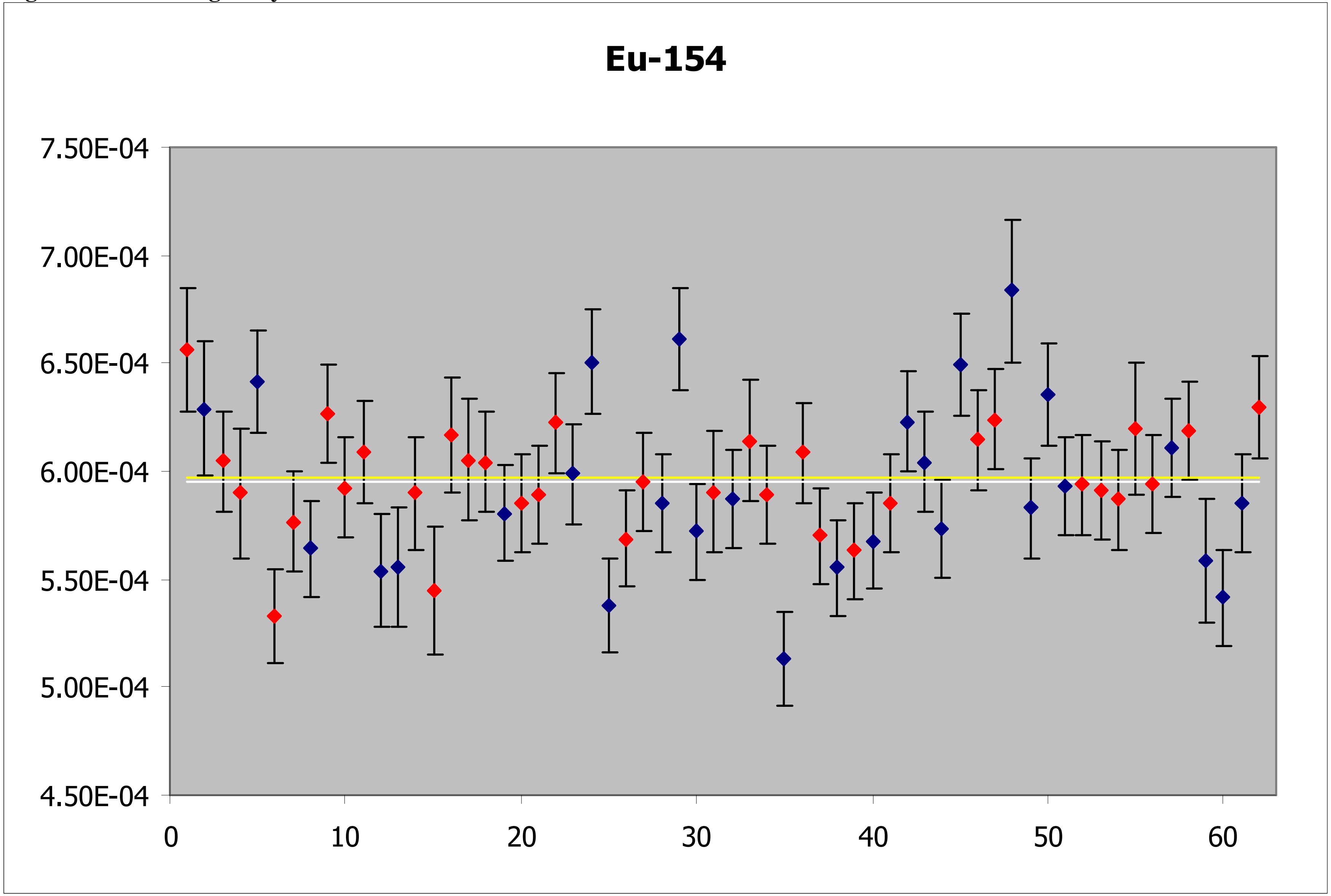


**Figure 57 – Laboratory 1**

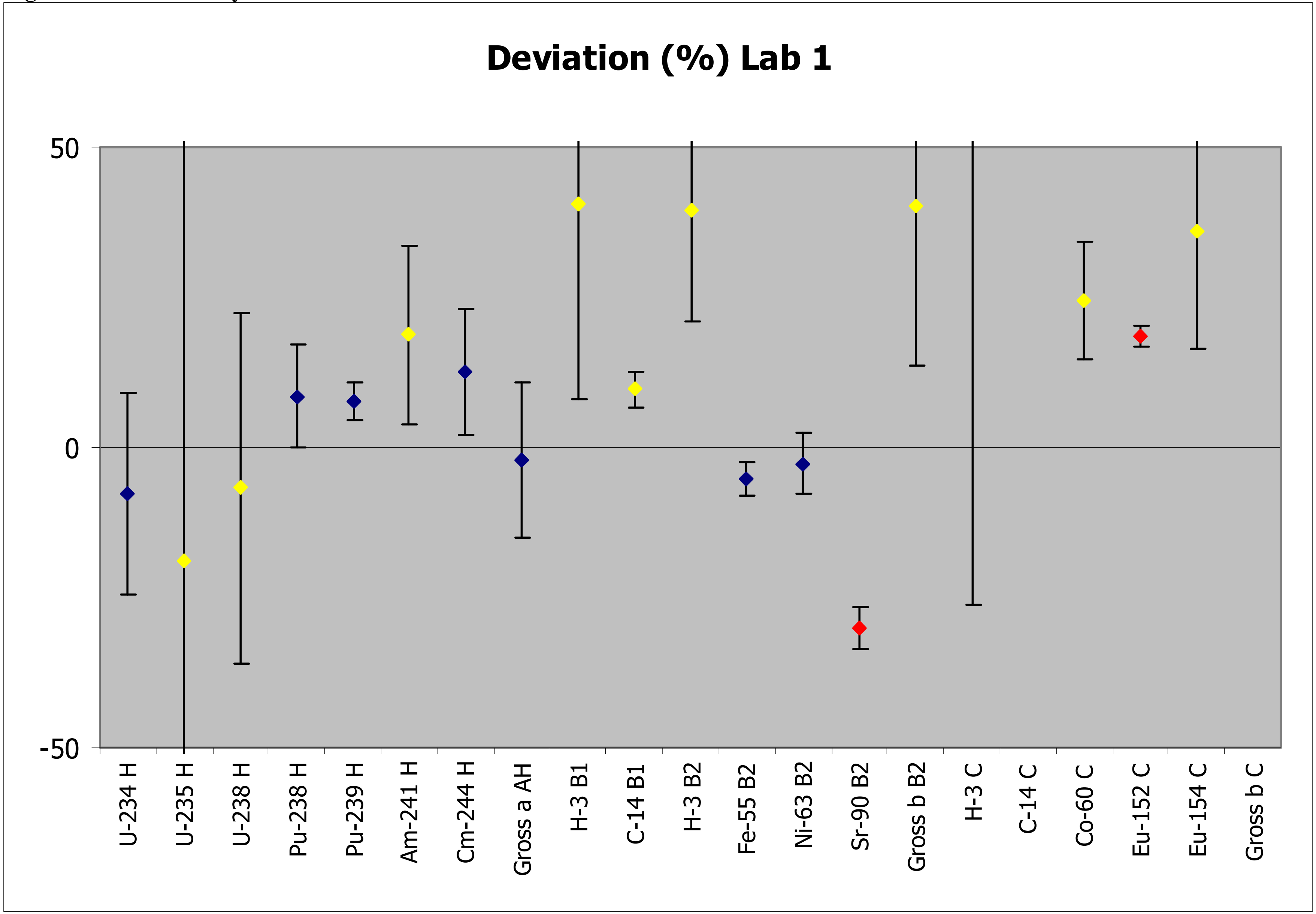


**Figure 58 – Laboratory 4**

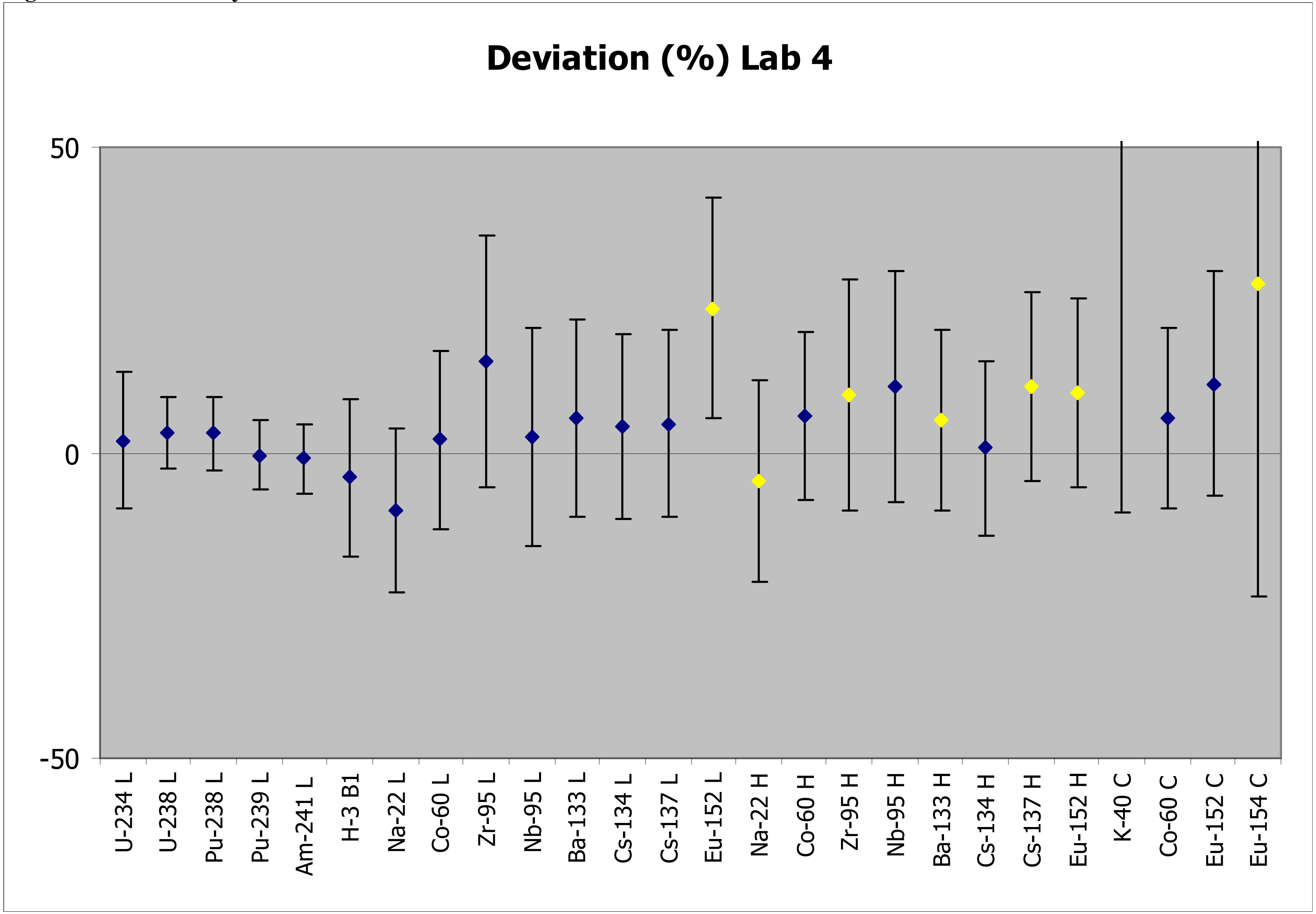


**Figure 59 – Laboratory 5**

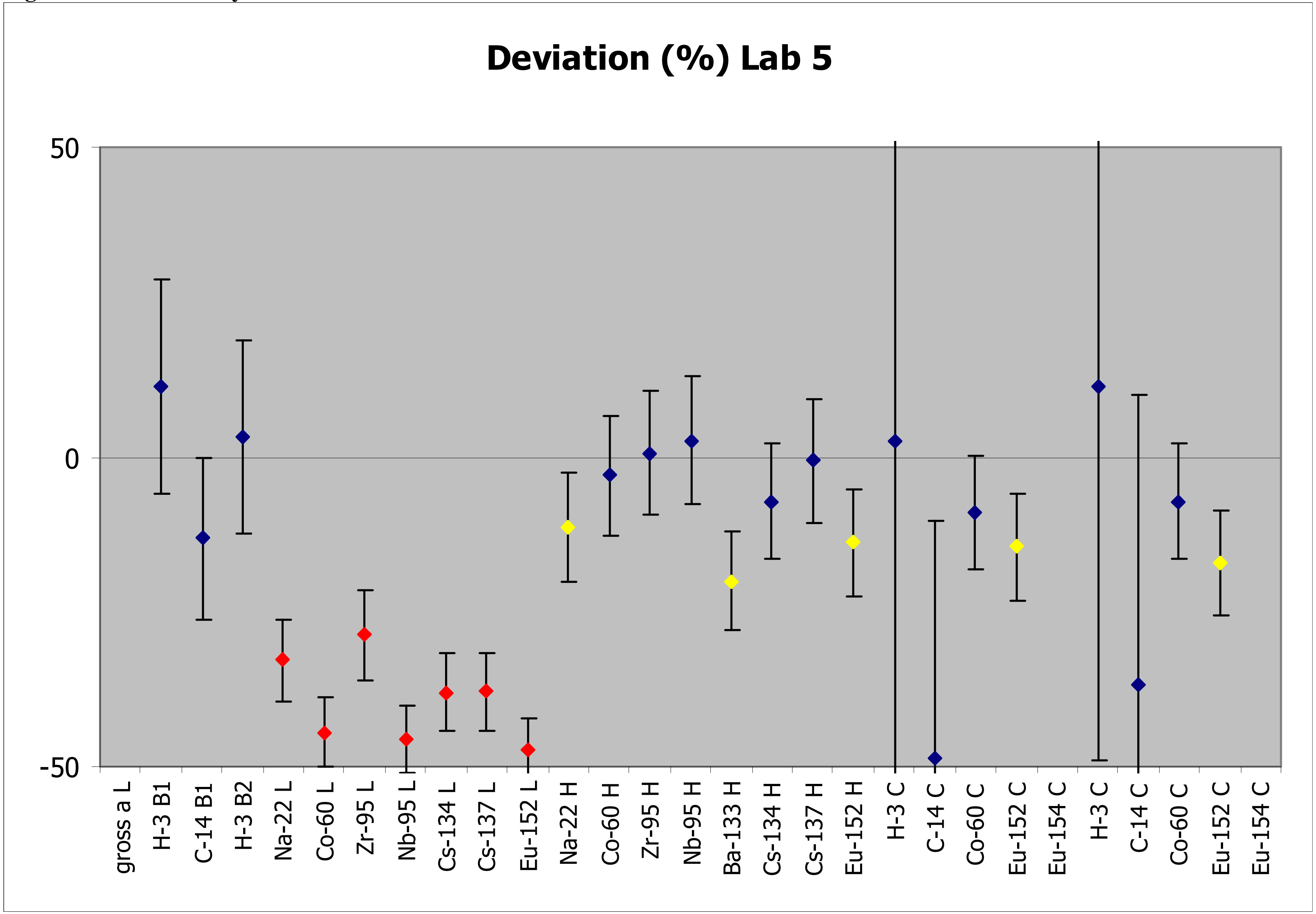


**Figure 60 – Laboratory 7**

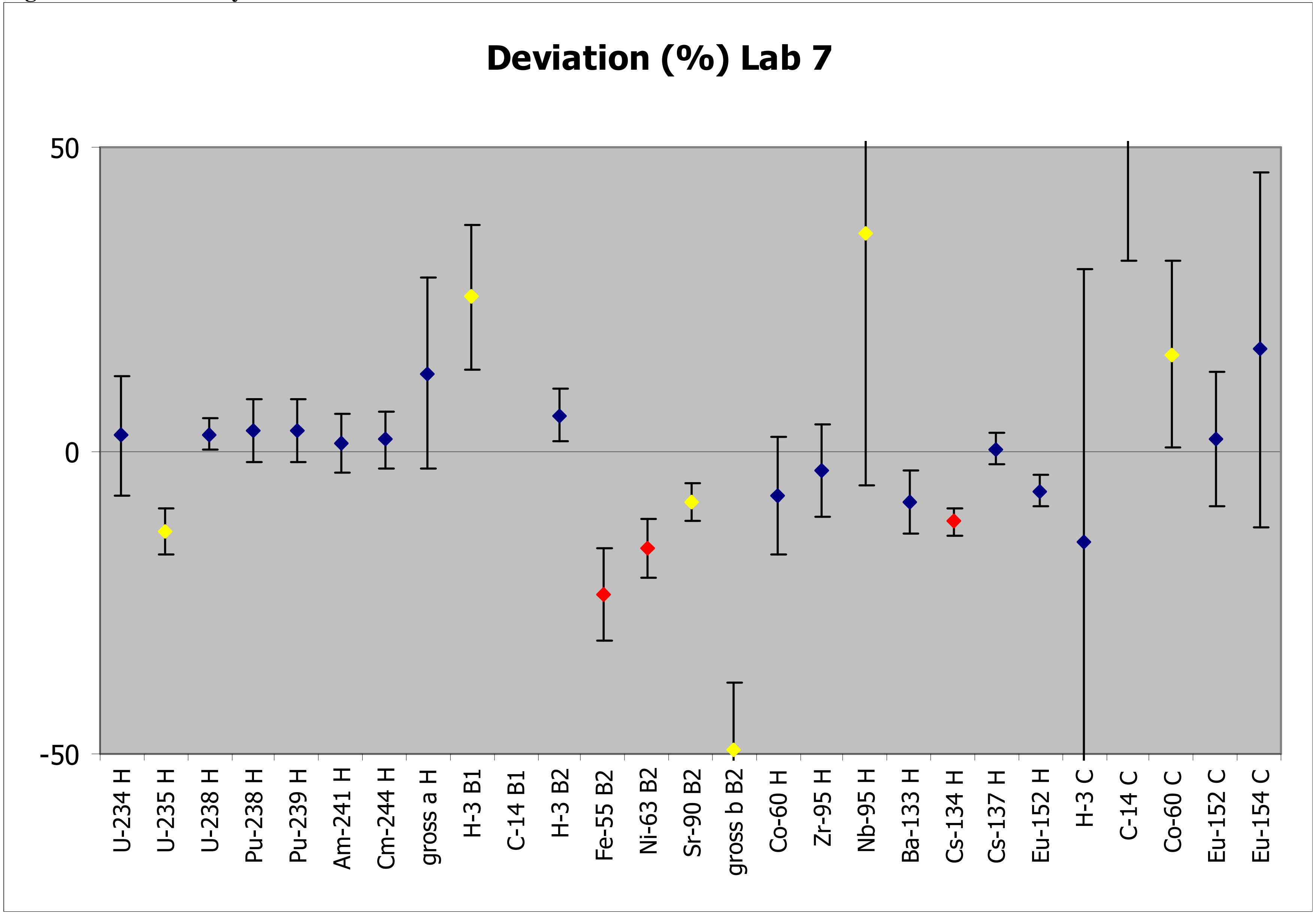


**Figure 61 – Laboratory 8**

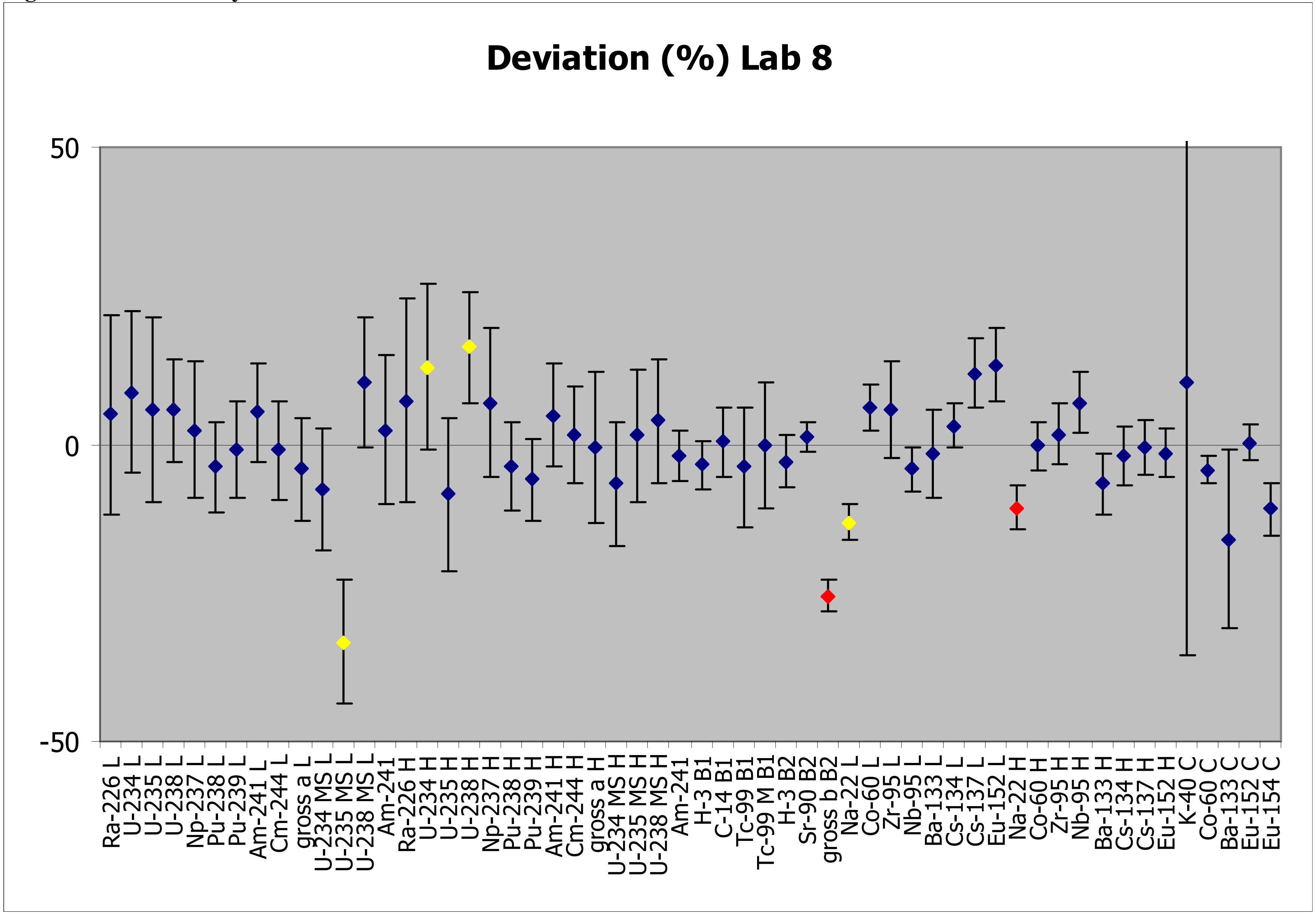


**Figure 62 – Laboratory 11**

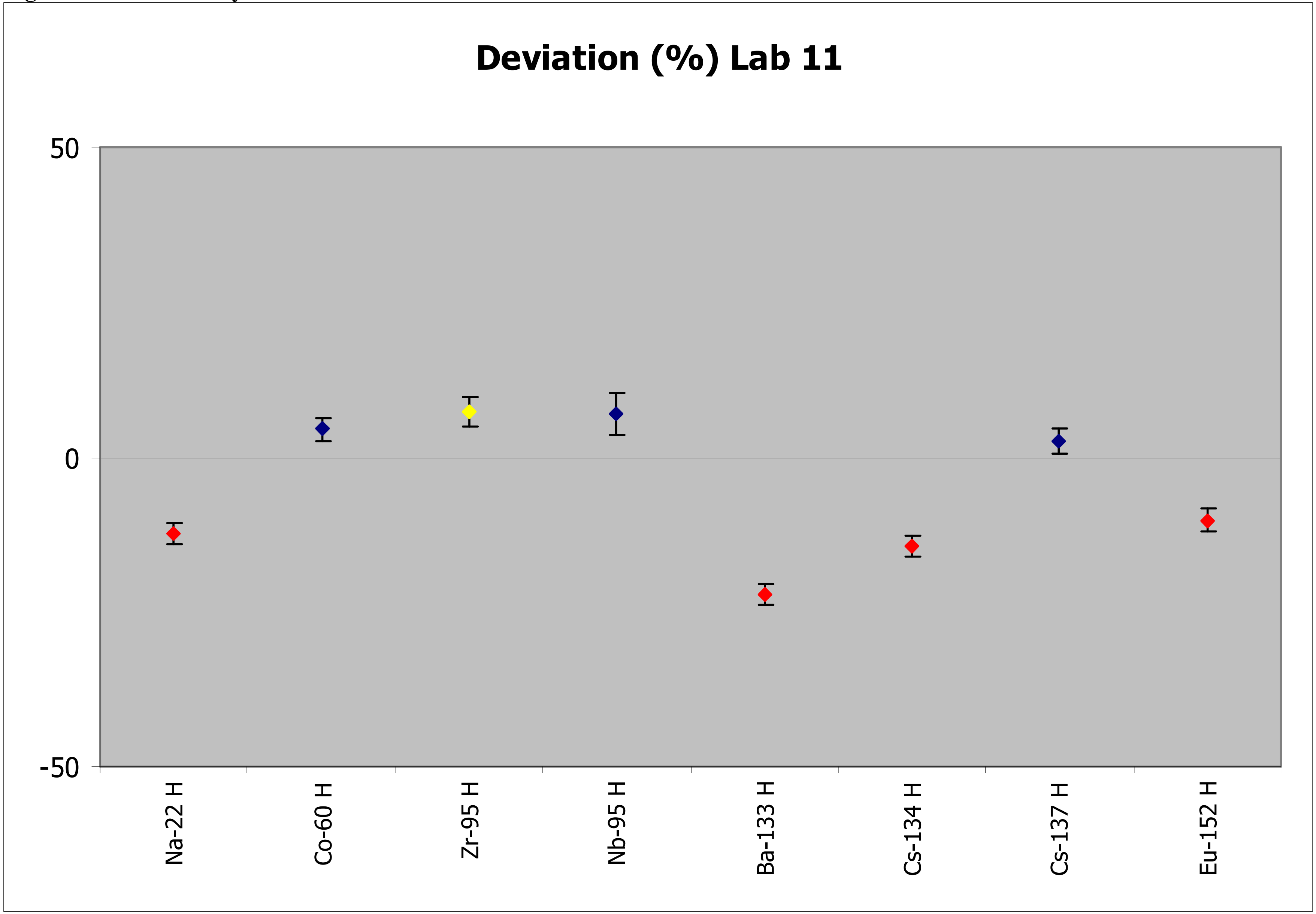


**Figure 63 – Laboratory 13**

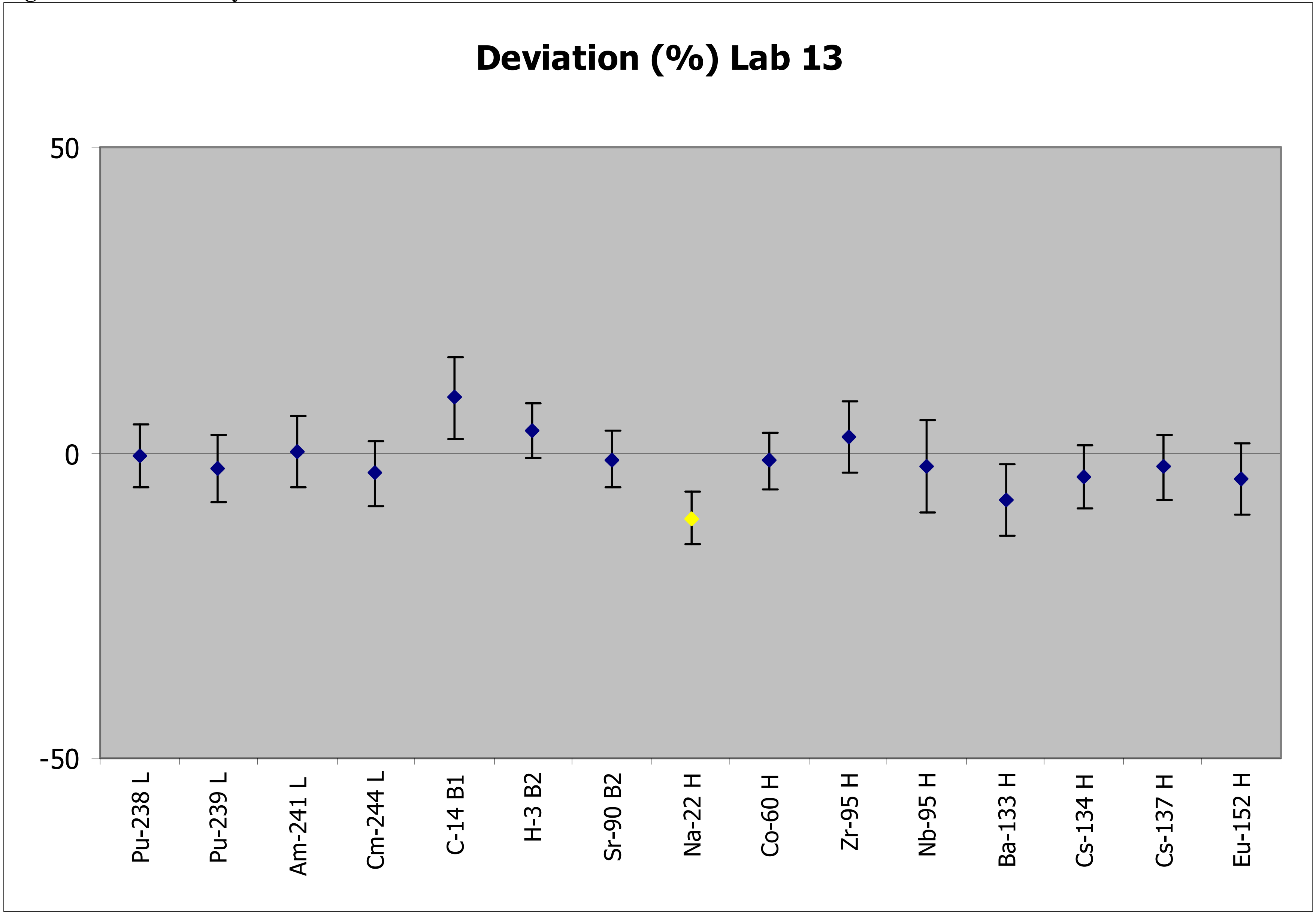


**Figure 64 – Laboratory 14**

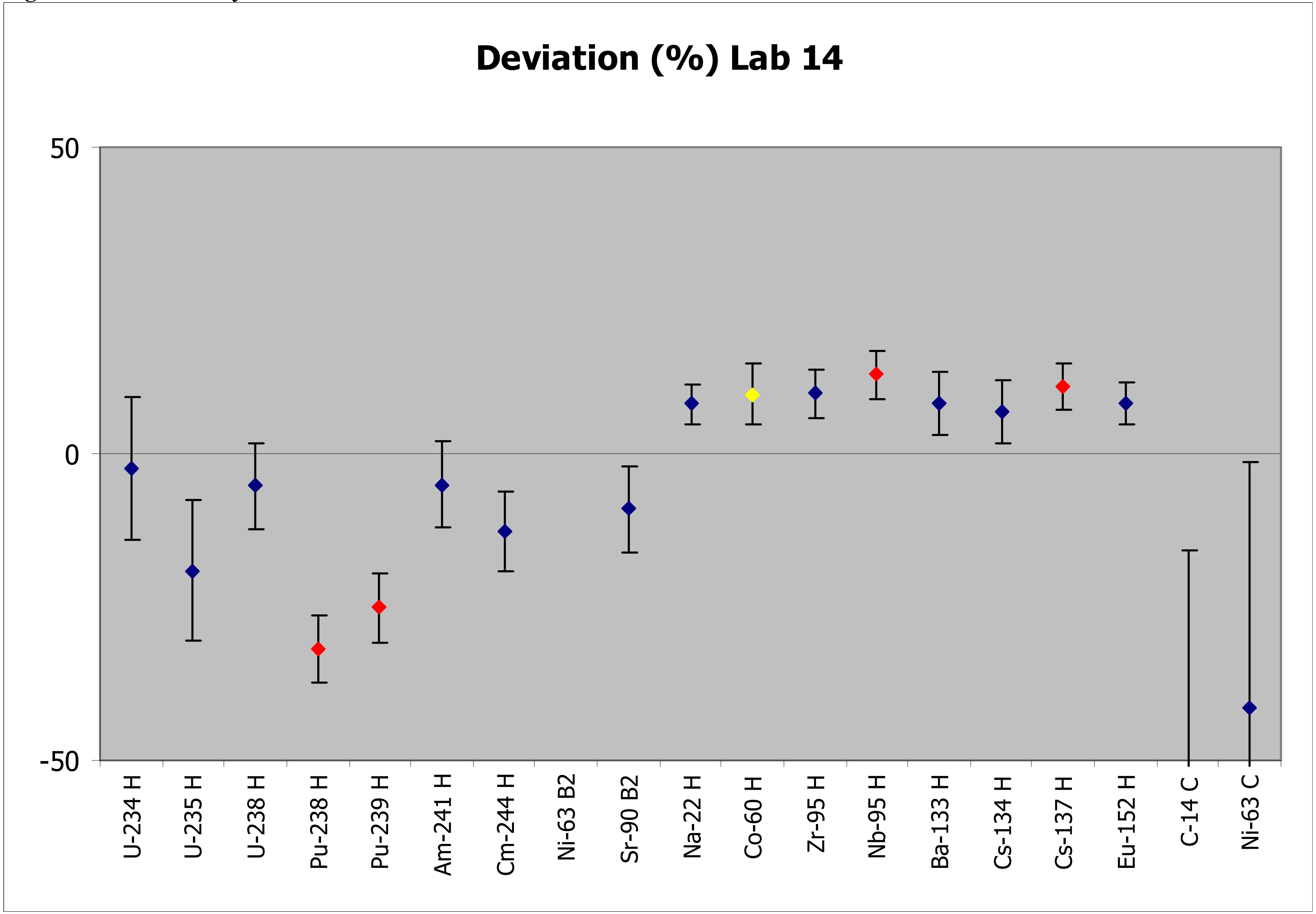


**Figure 65 – Laboratory 15**

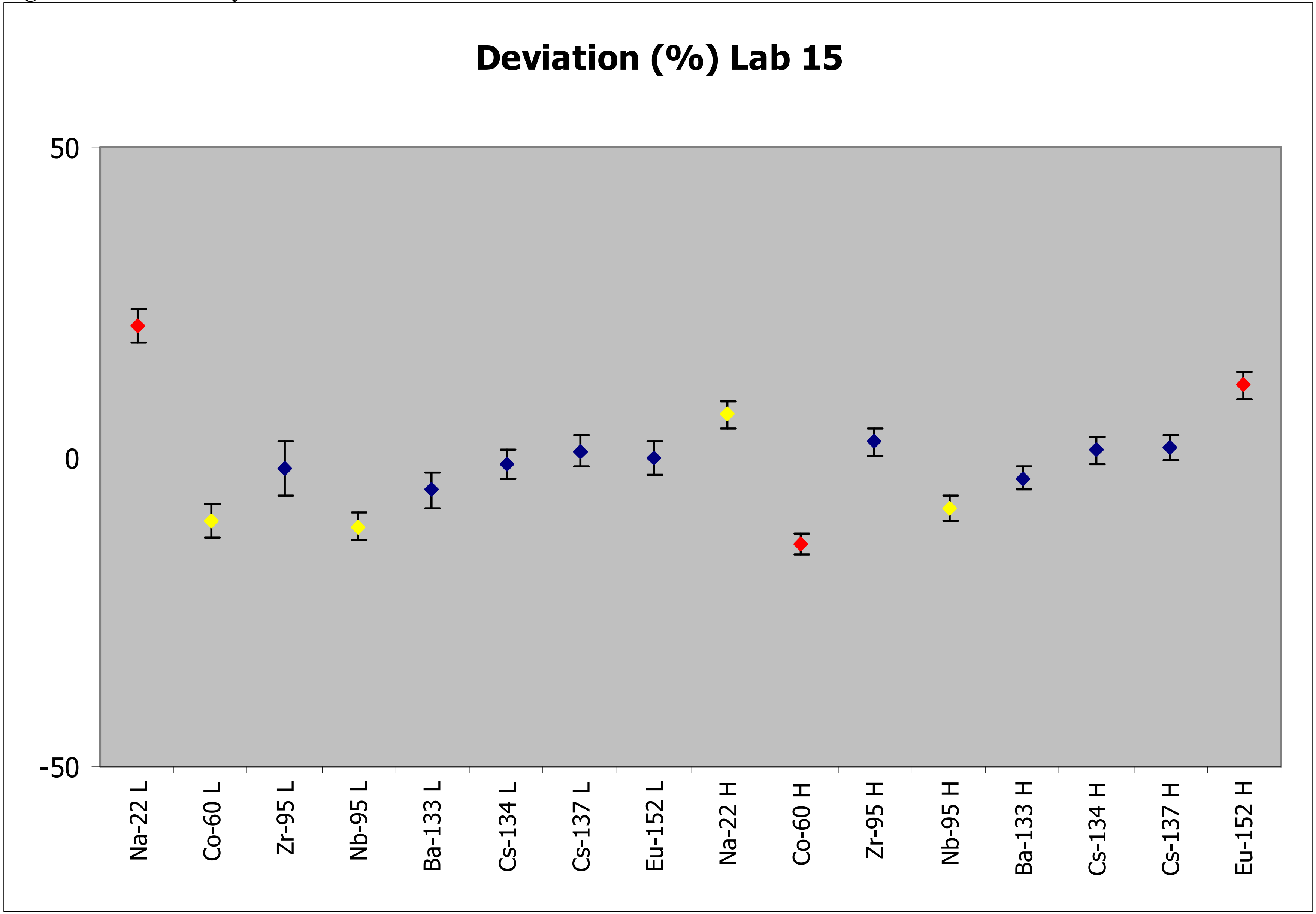


**Figure 66 – Laboratory 16**

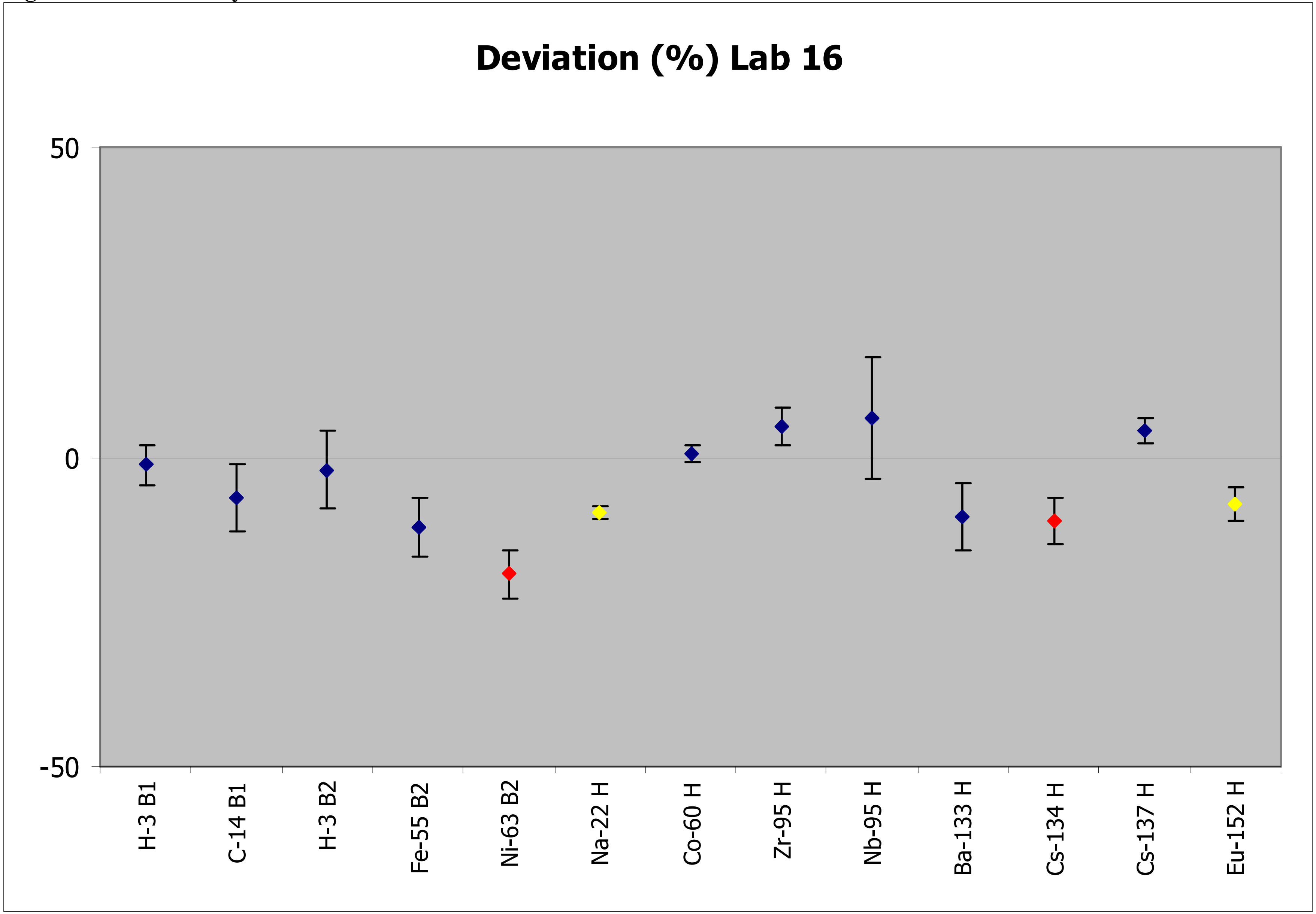


**Figure 67 – Laboratory 17**

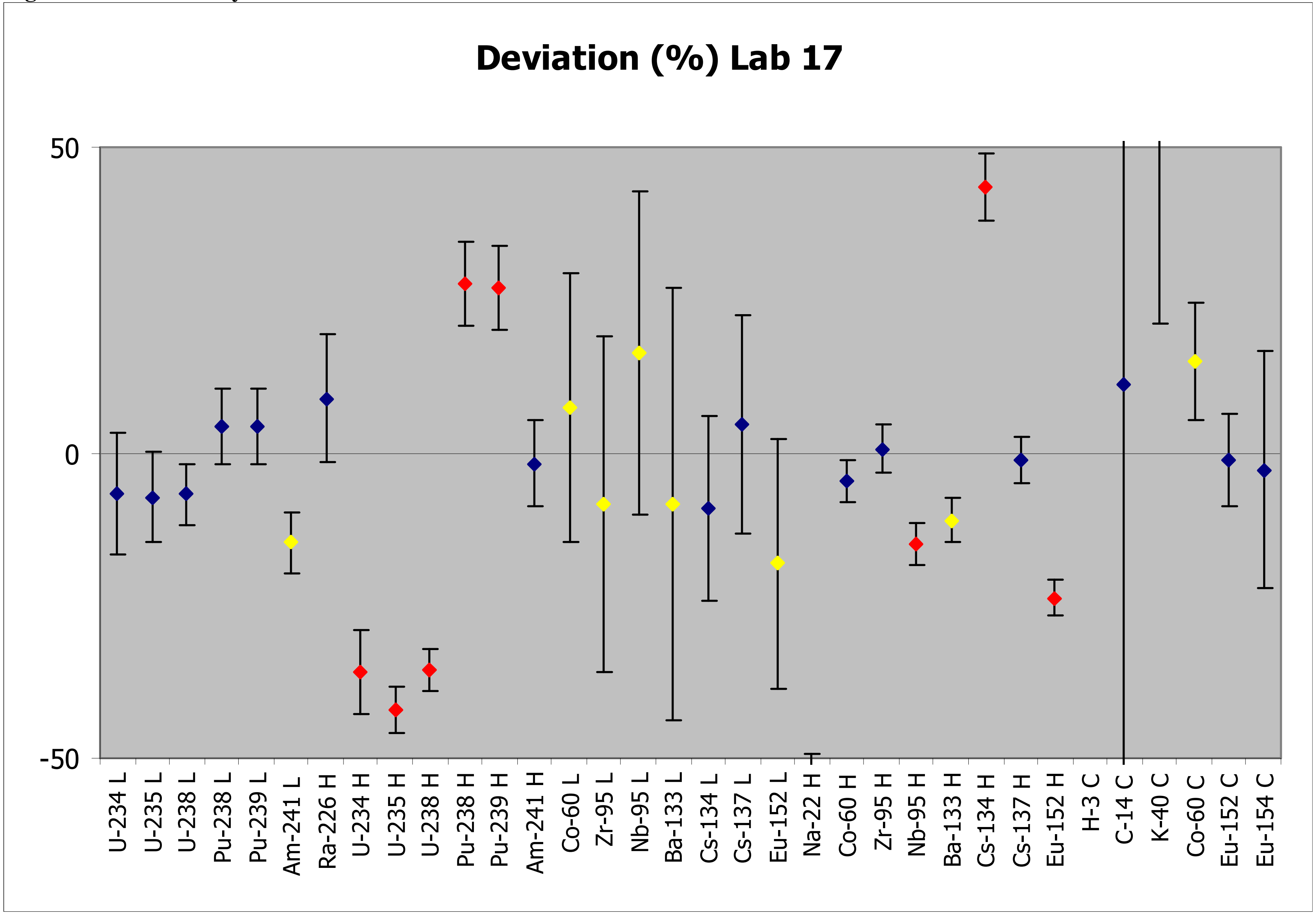


**Figure 68 – Laboratory 18**

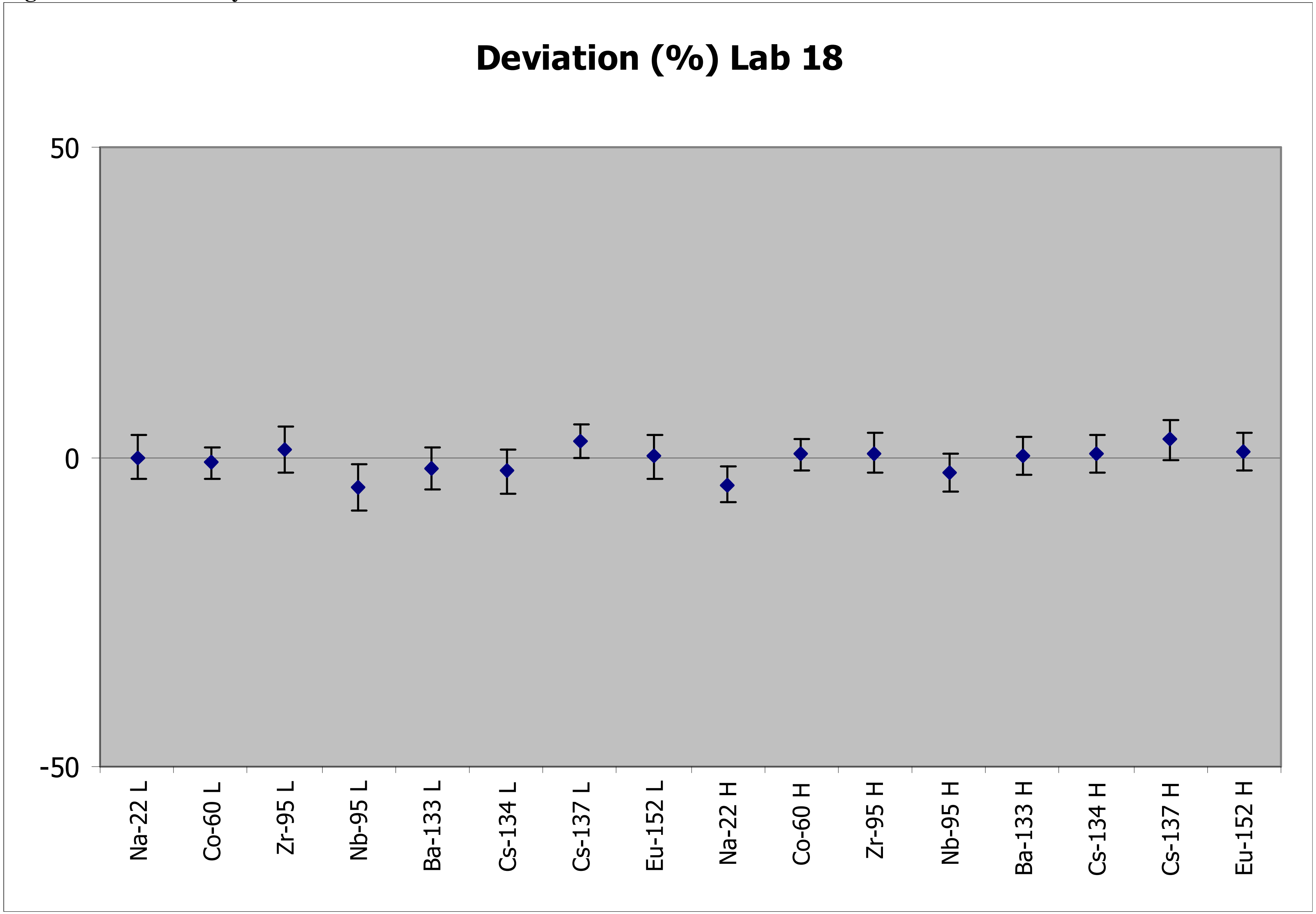


**Figure 69 – Laboratory 19**

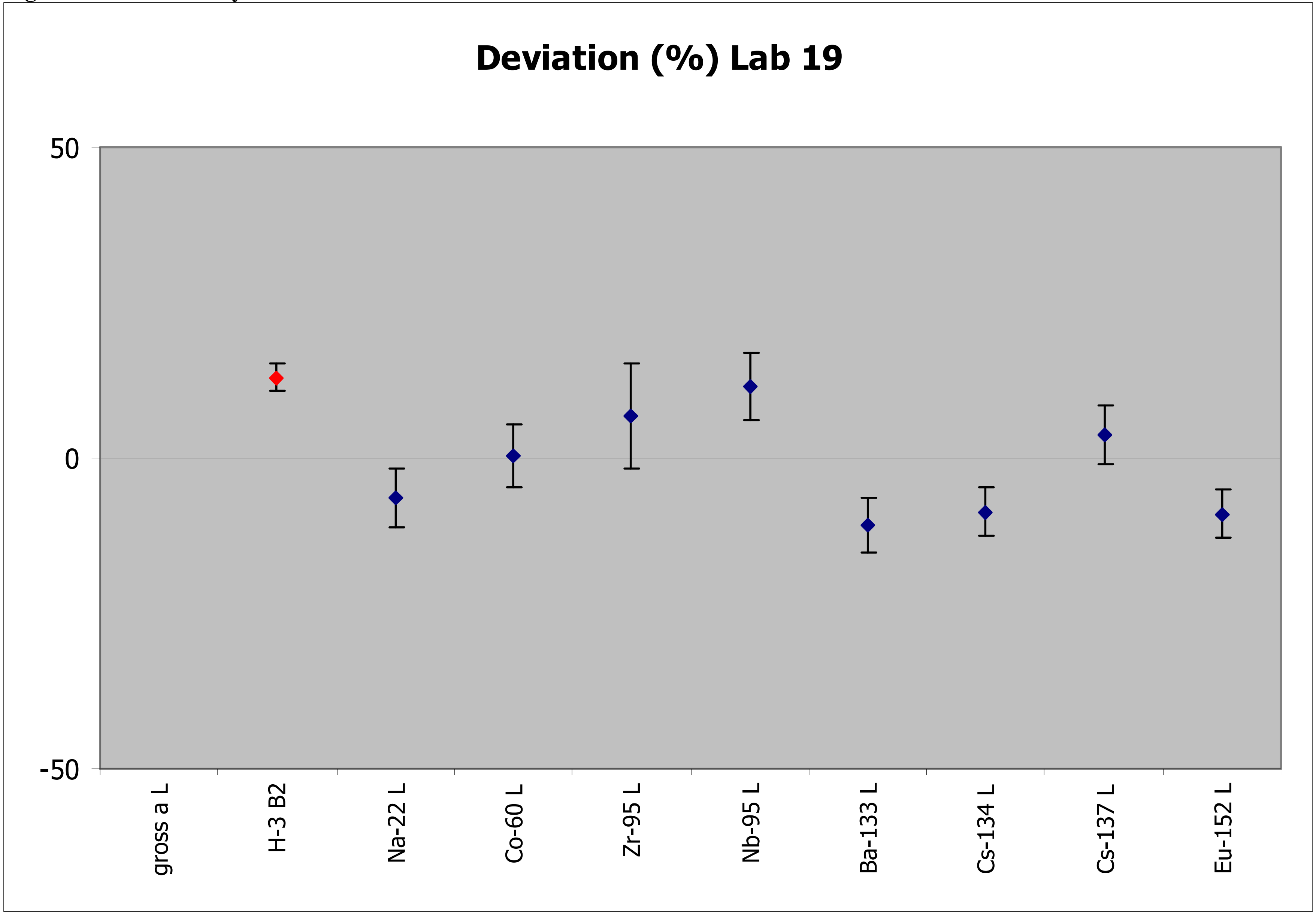


**Figure 70 – Laboratory 20**

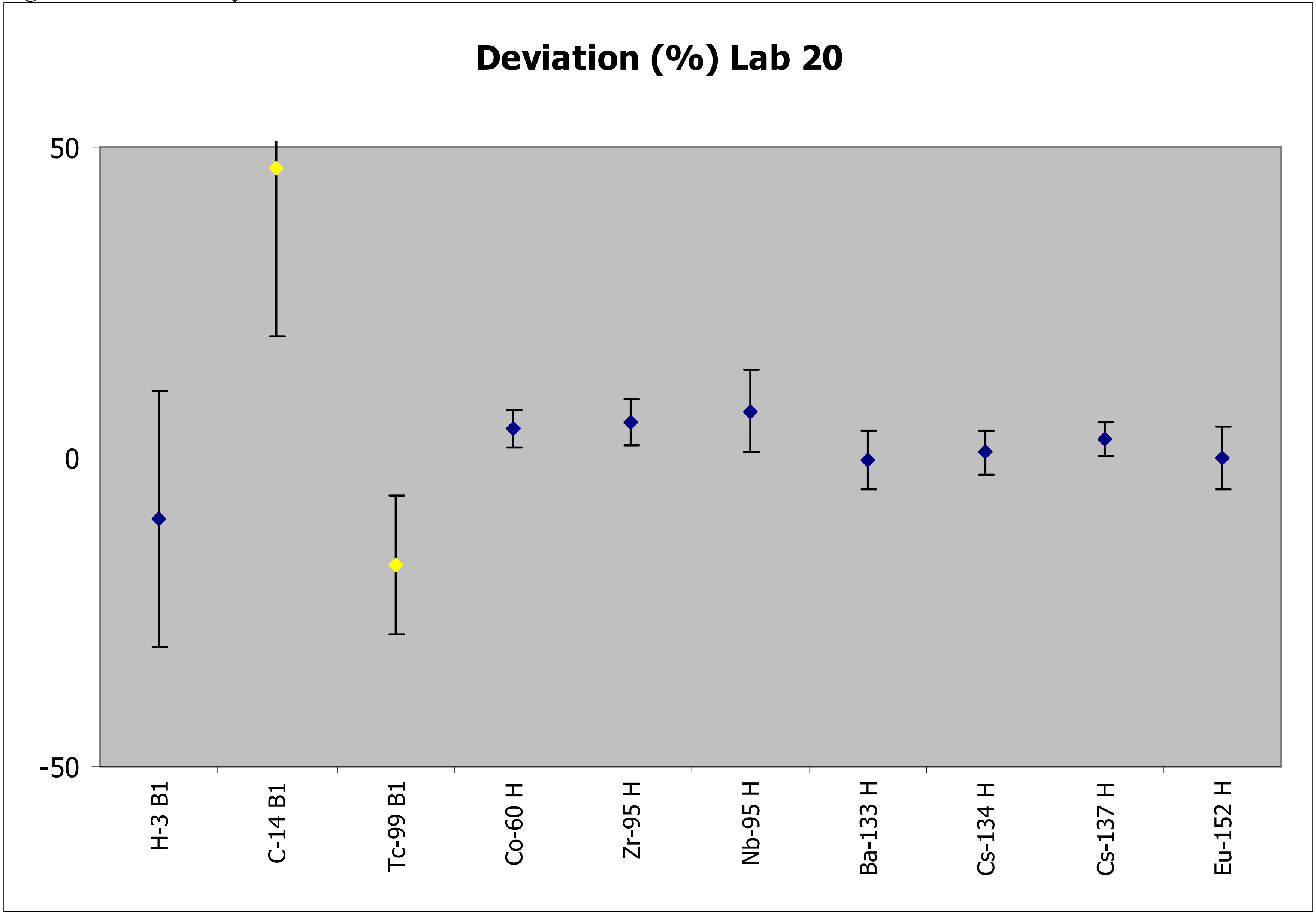


**Figure 71 – Laboratory 21**

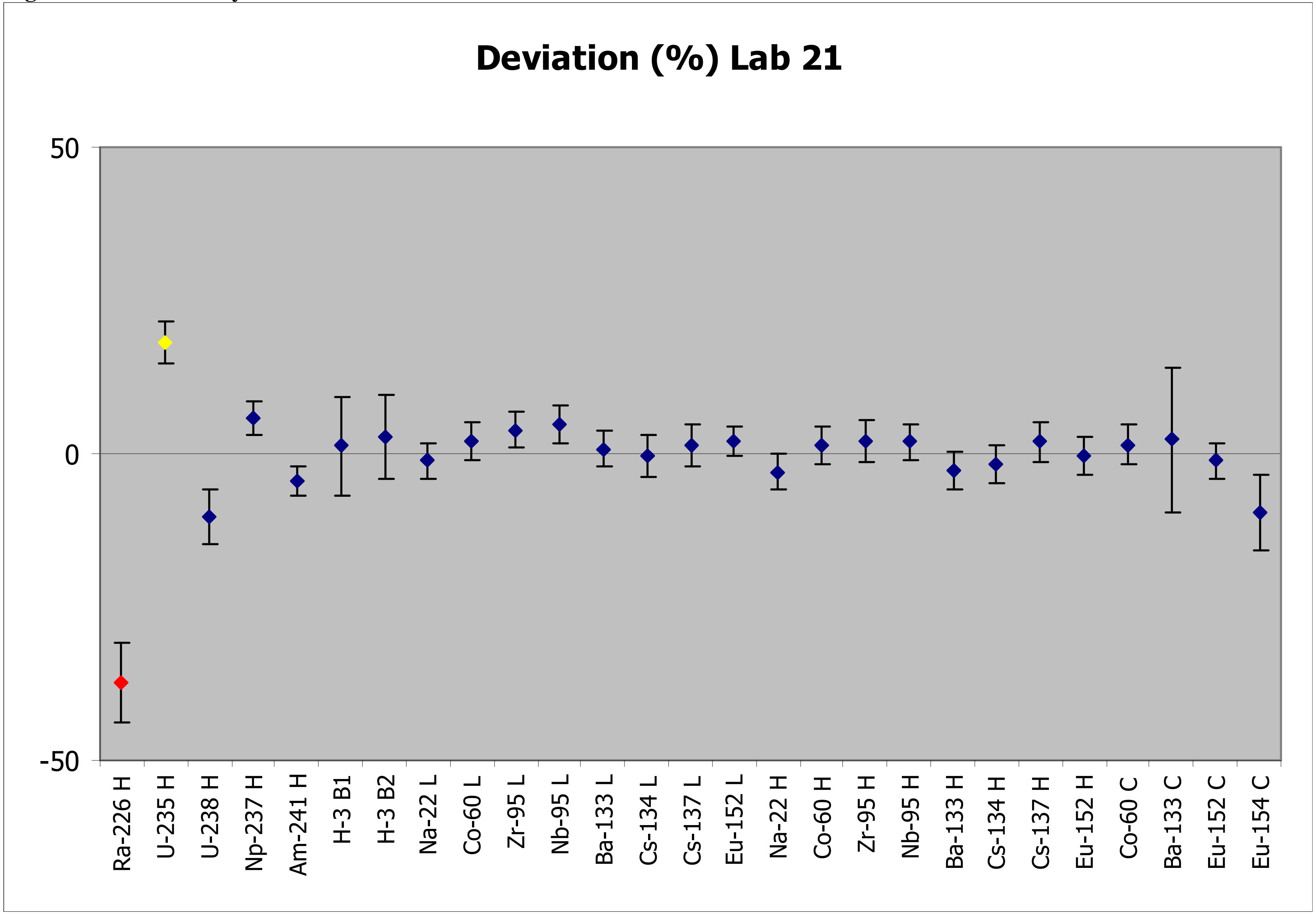


**Figure 72 – Laboratory 23**

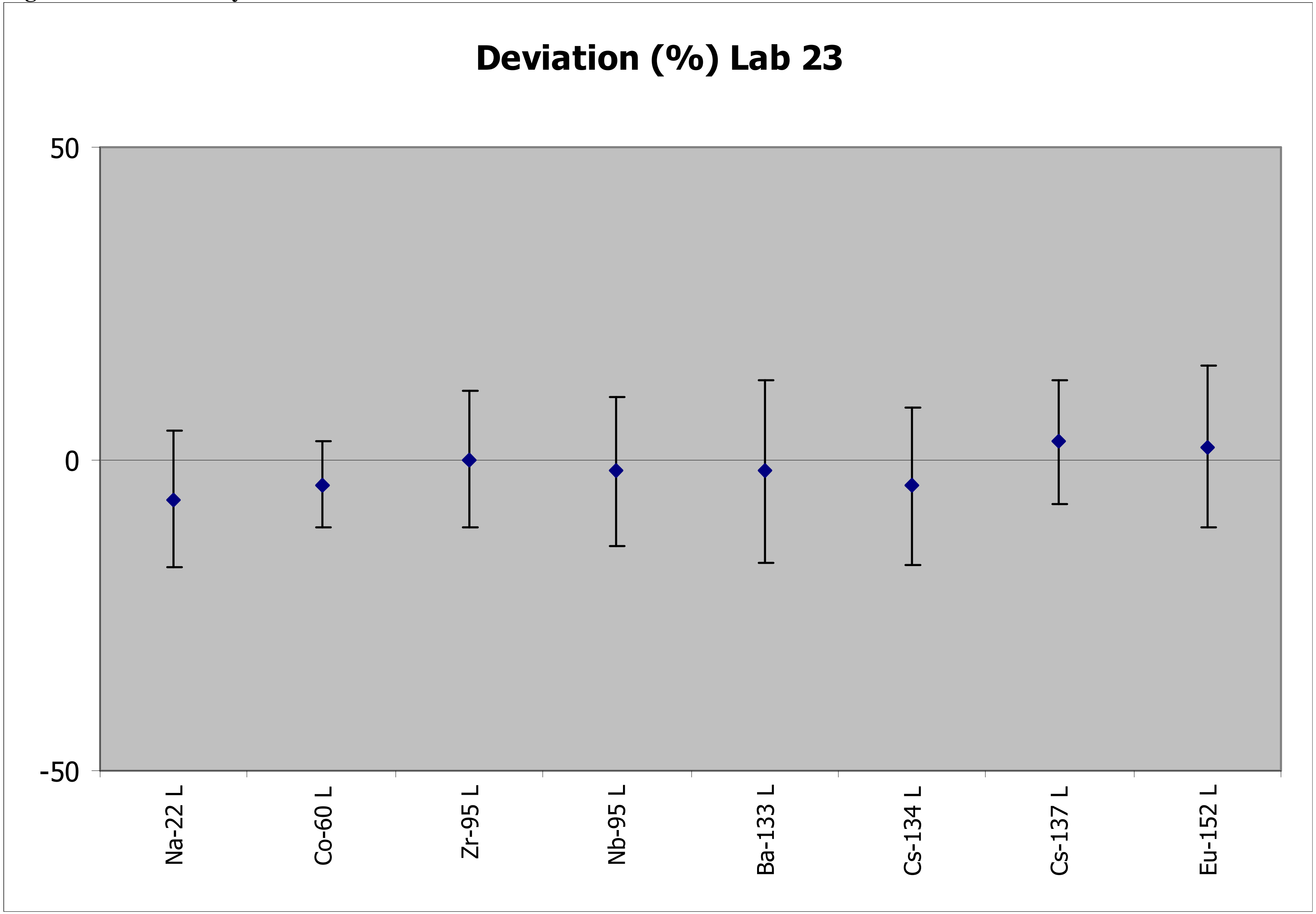


**Figure 73 – Laboratory 24**

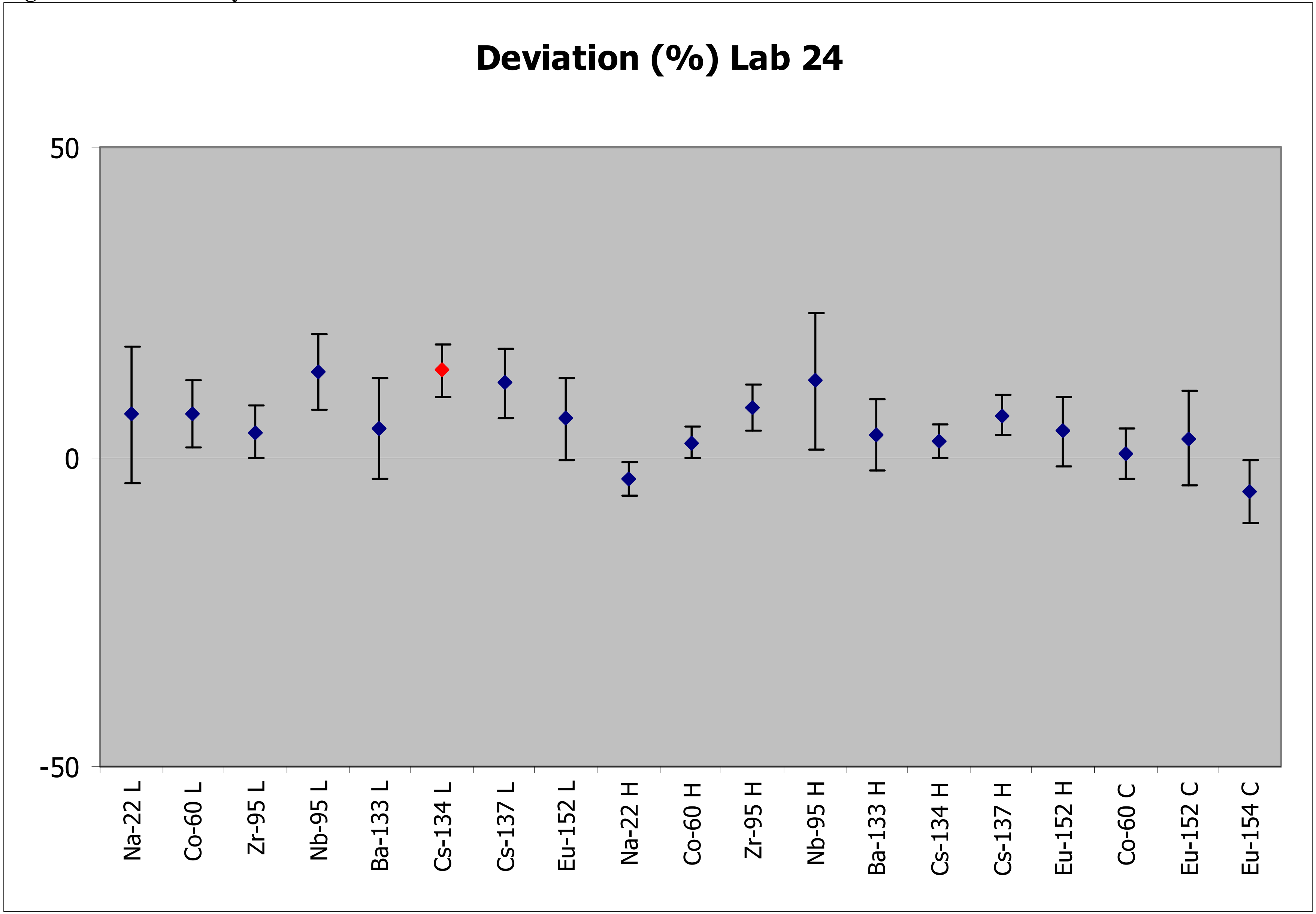


**Figure 74 – Laboratory 25**

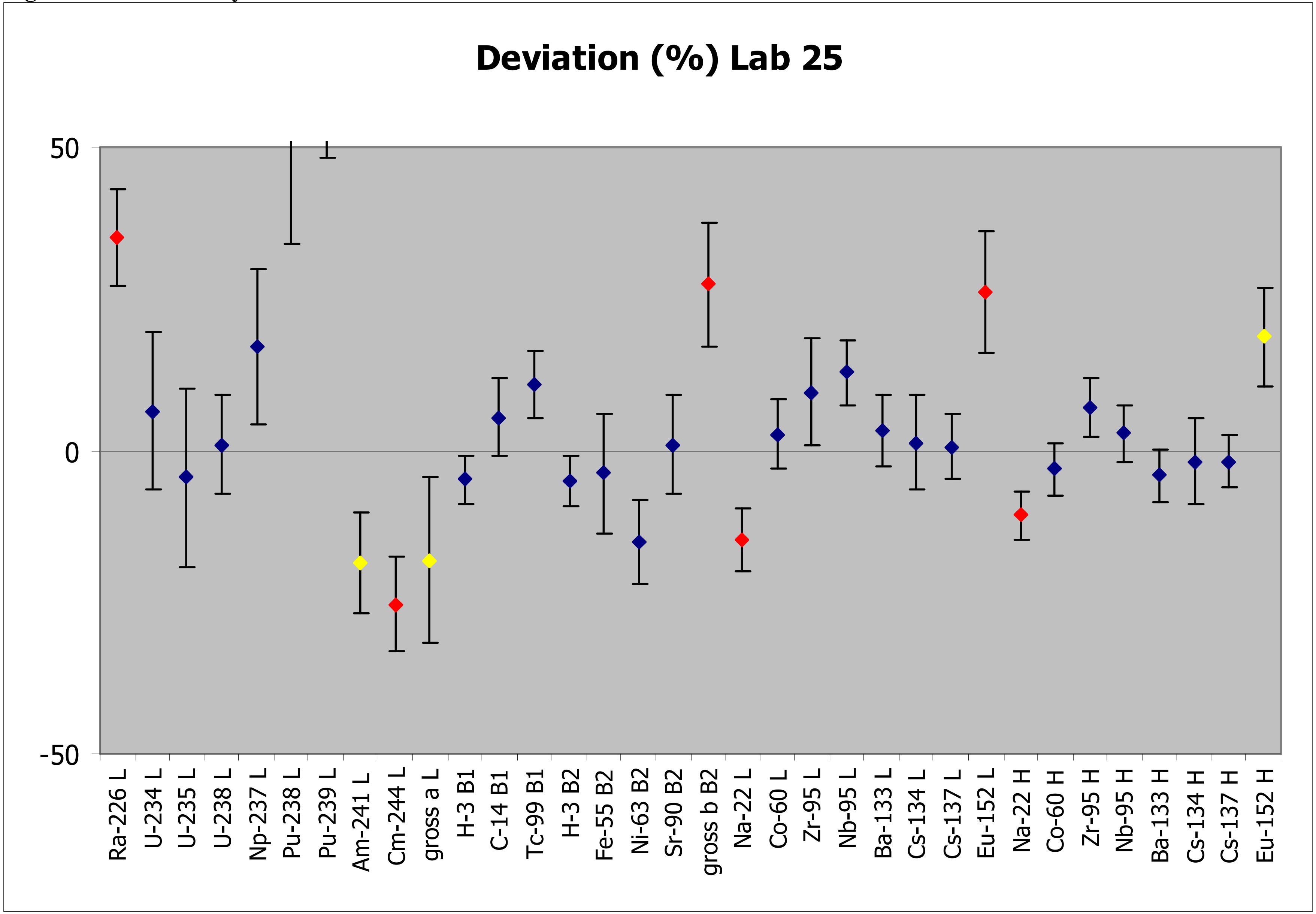


**Figure 75 – Laboratory 26**

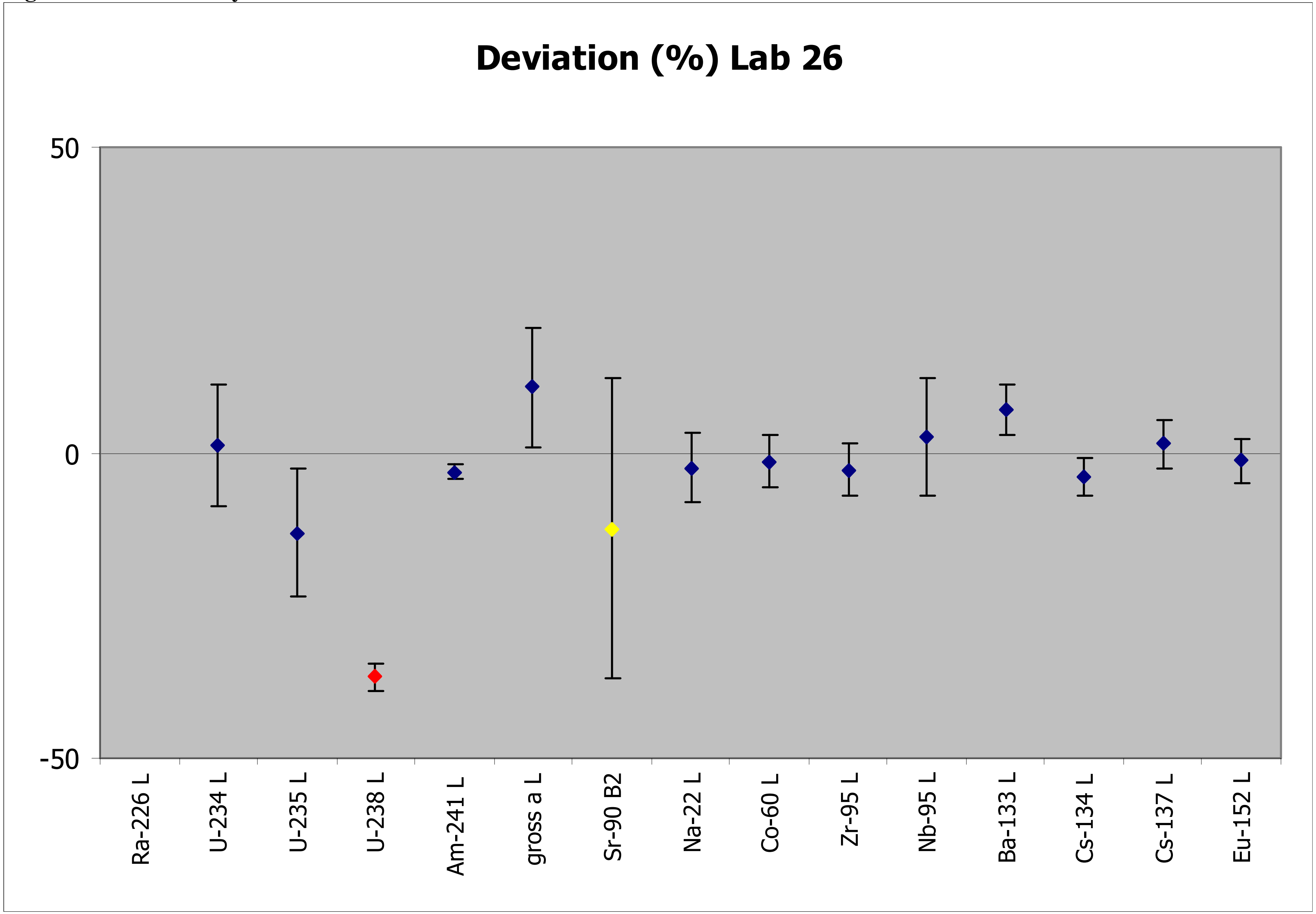


**Figure 76 – Laboratory 27**

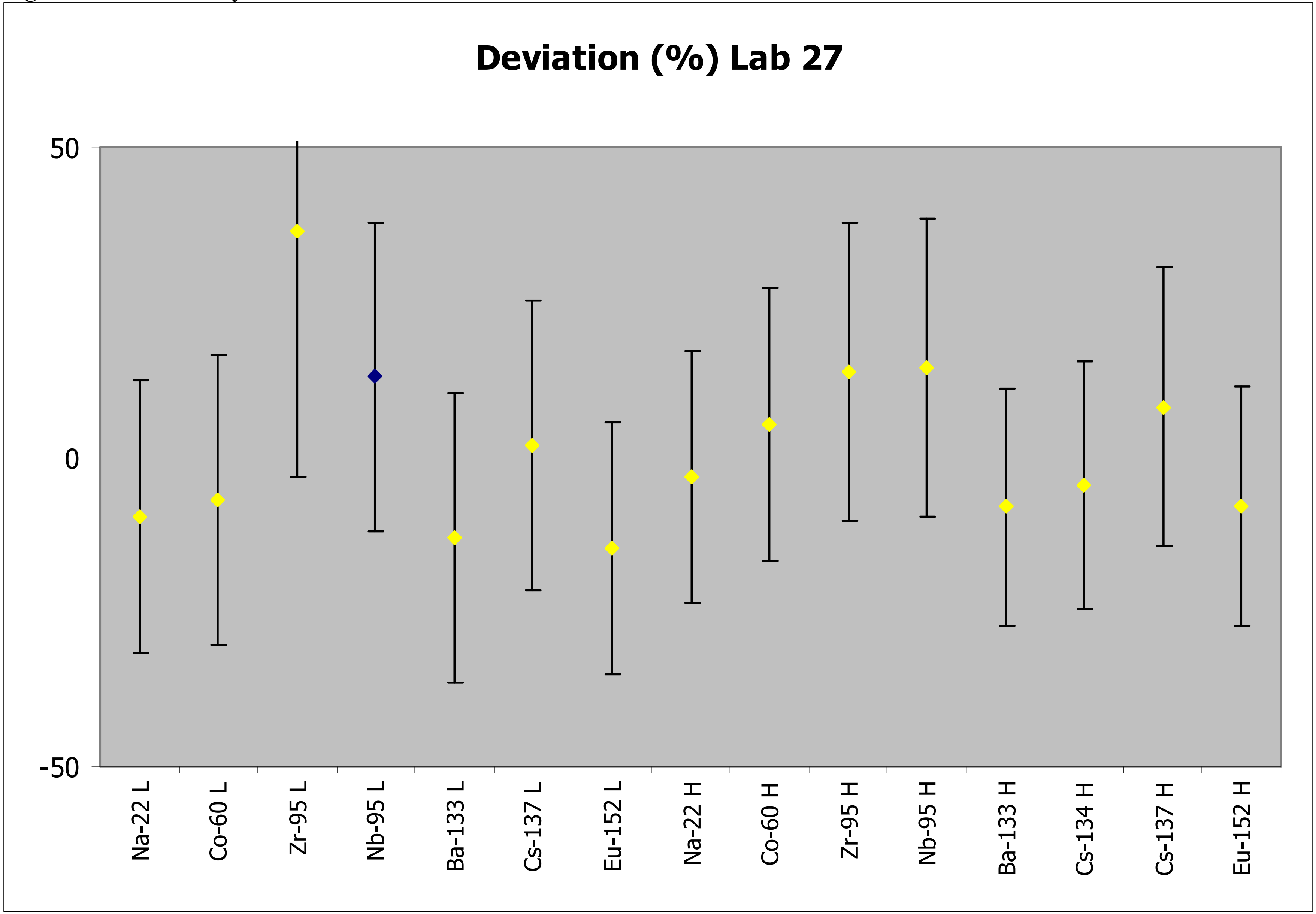


**Figure 77 – Laboratory 28**

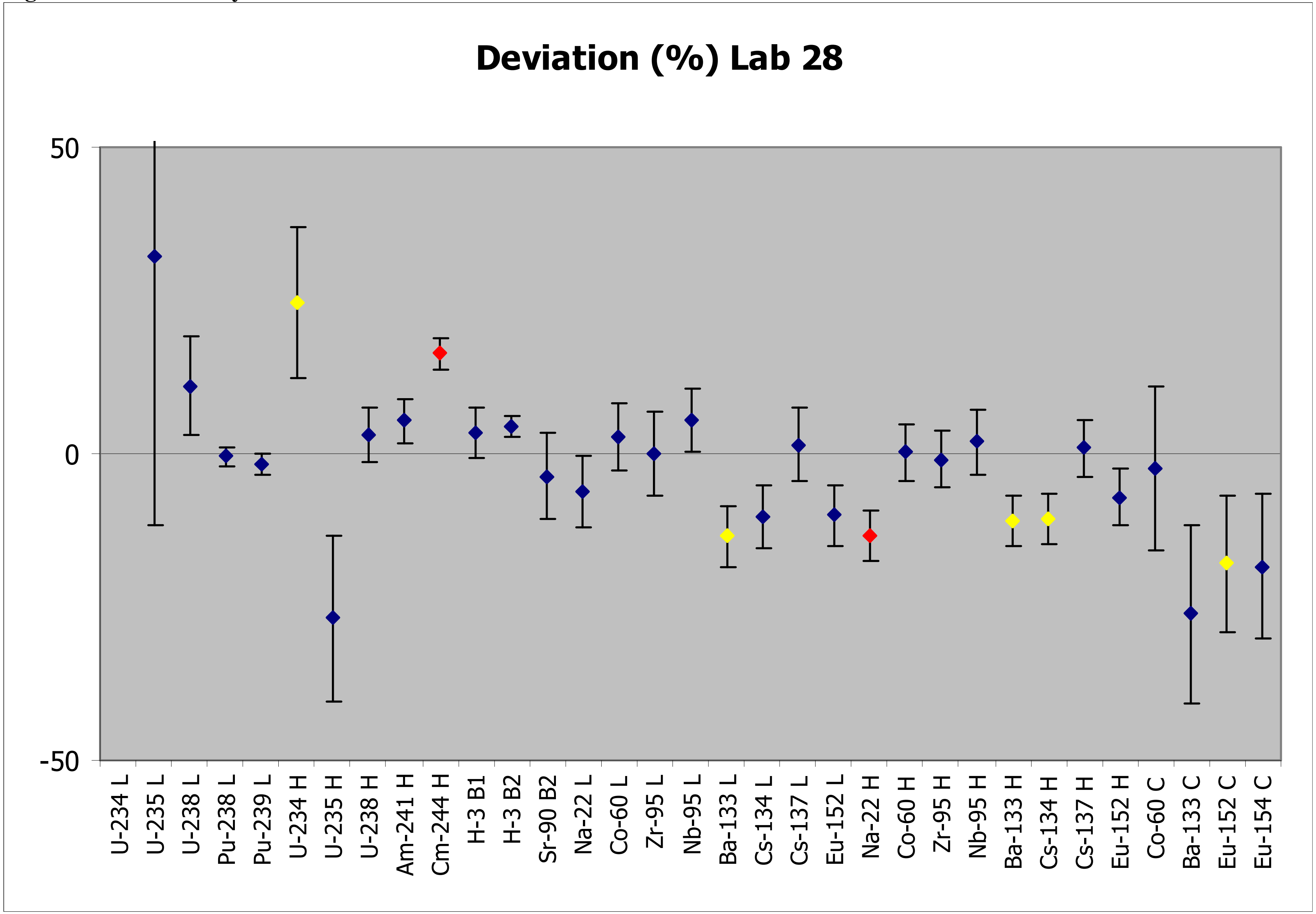


**Figure 78 – Laboratory 29**

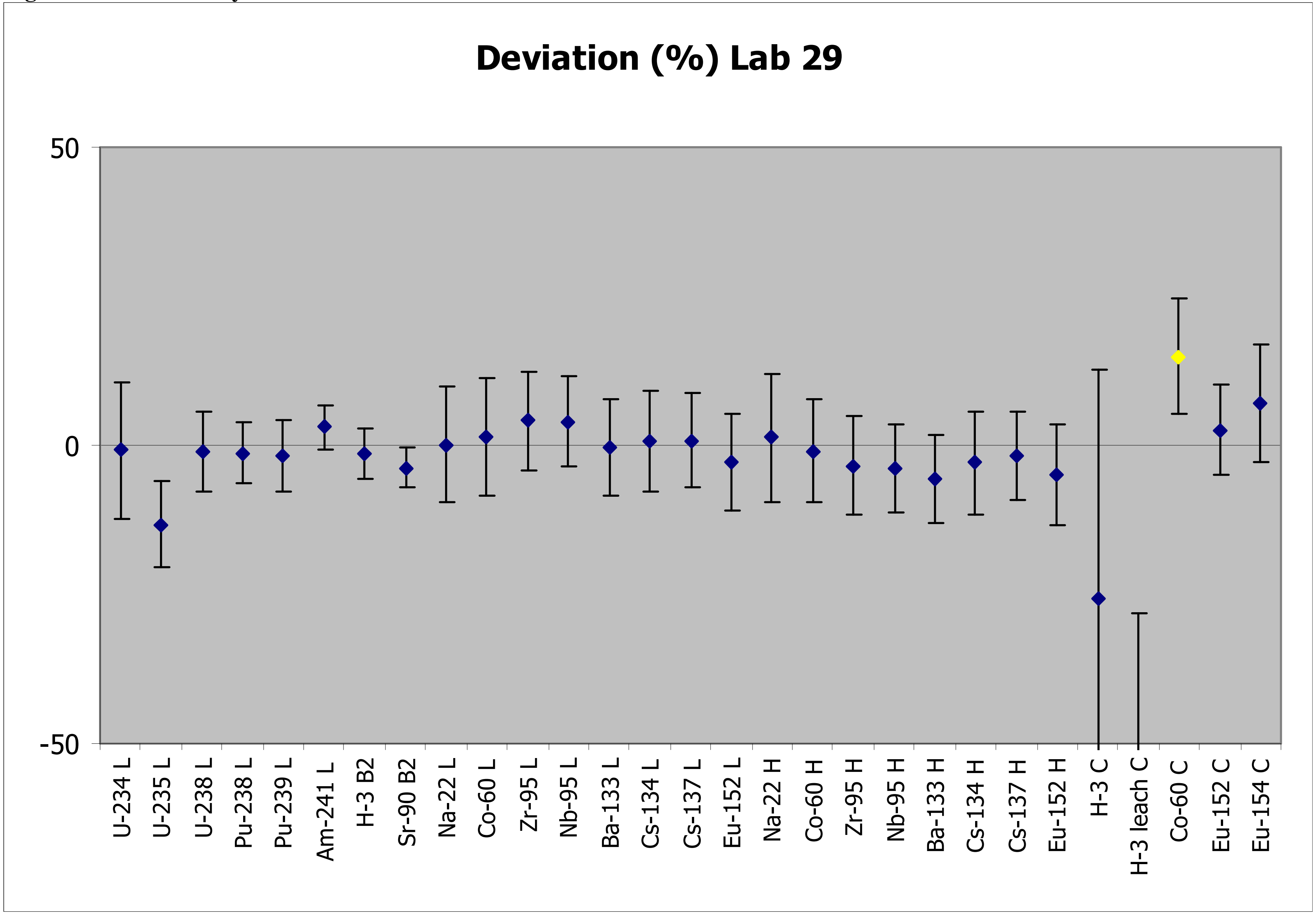


**Figure 79 – Laboratory 31**

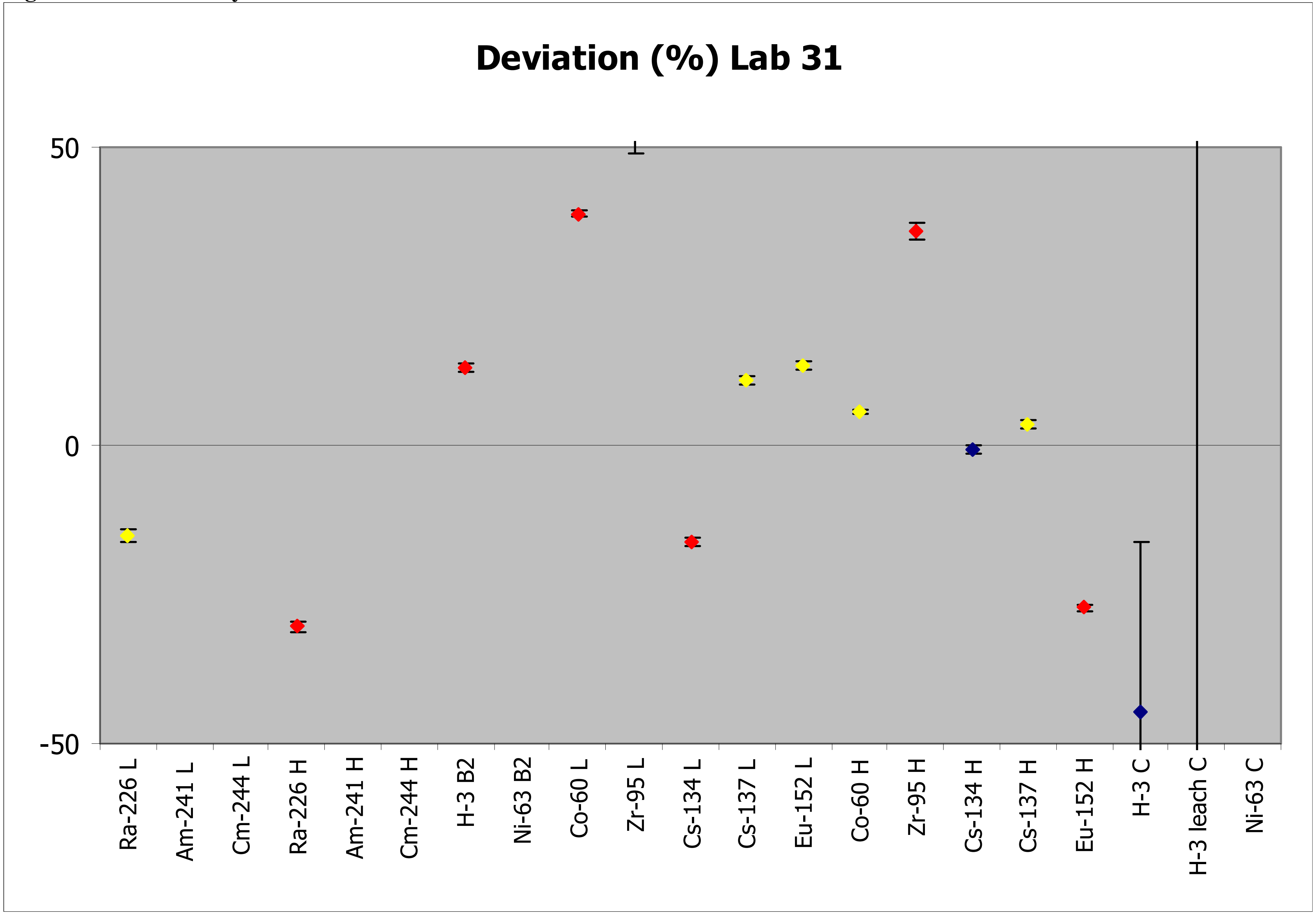


**Figure 80 – Laboratory 32**

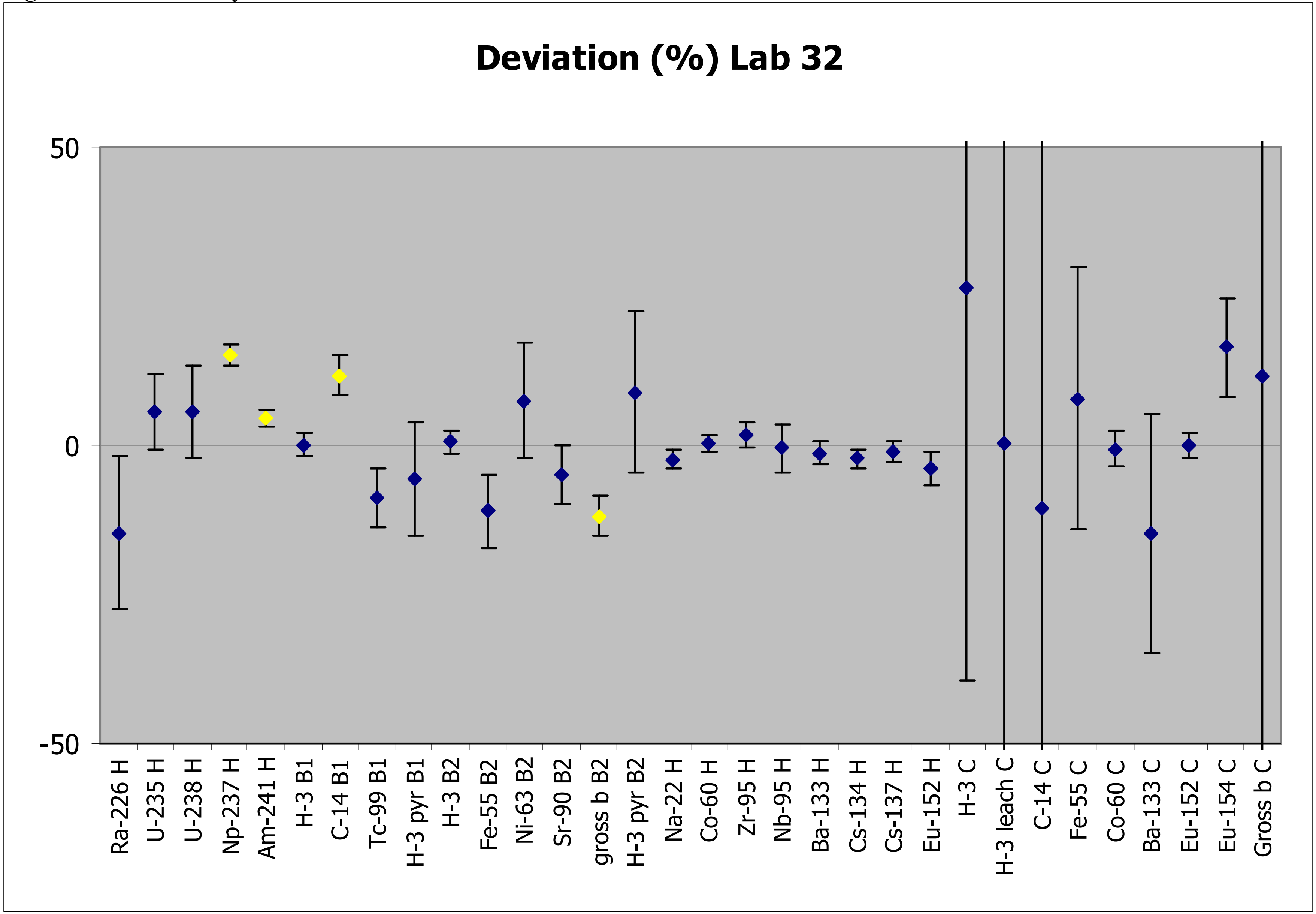


**Figure 81 – Laboratory 33**

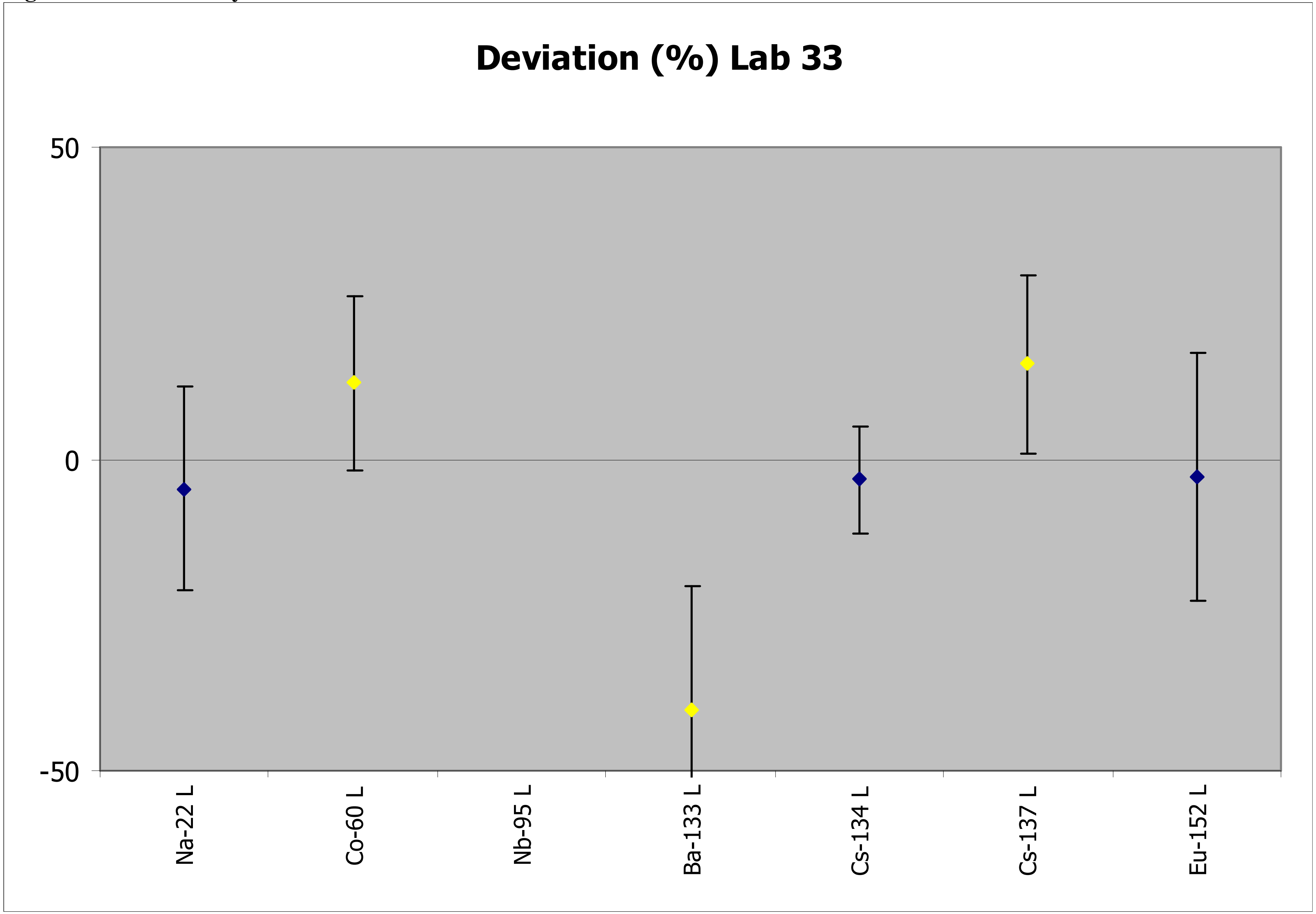


**Figure 82 – Laboratory 35**

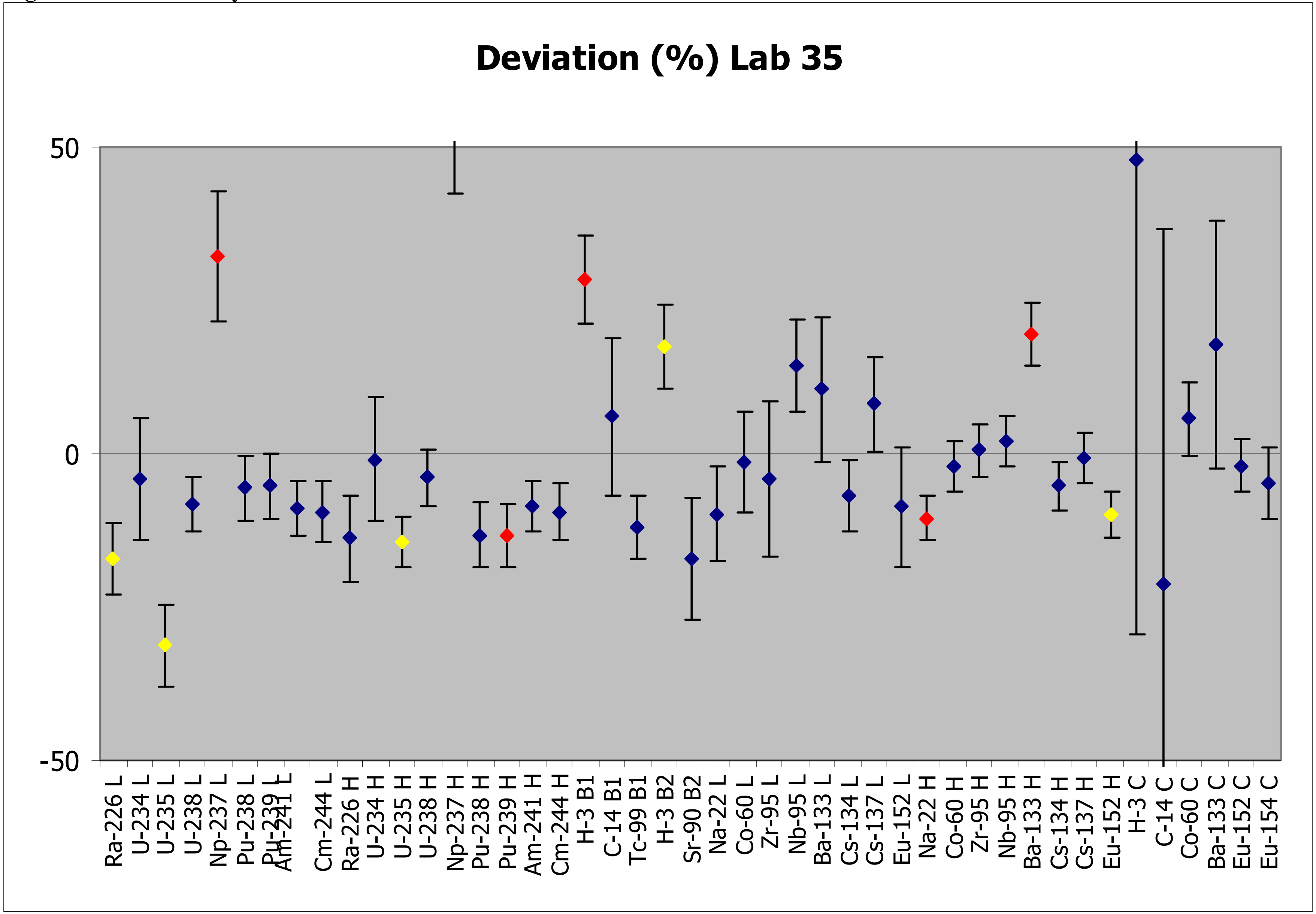
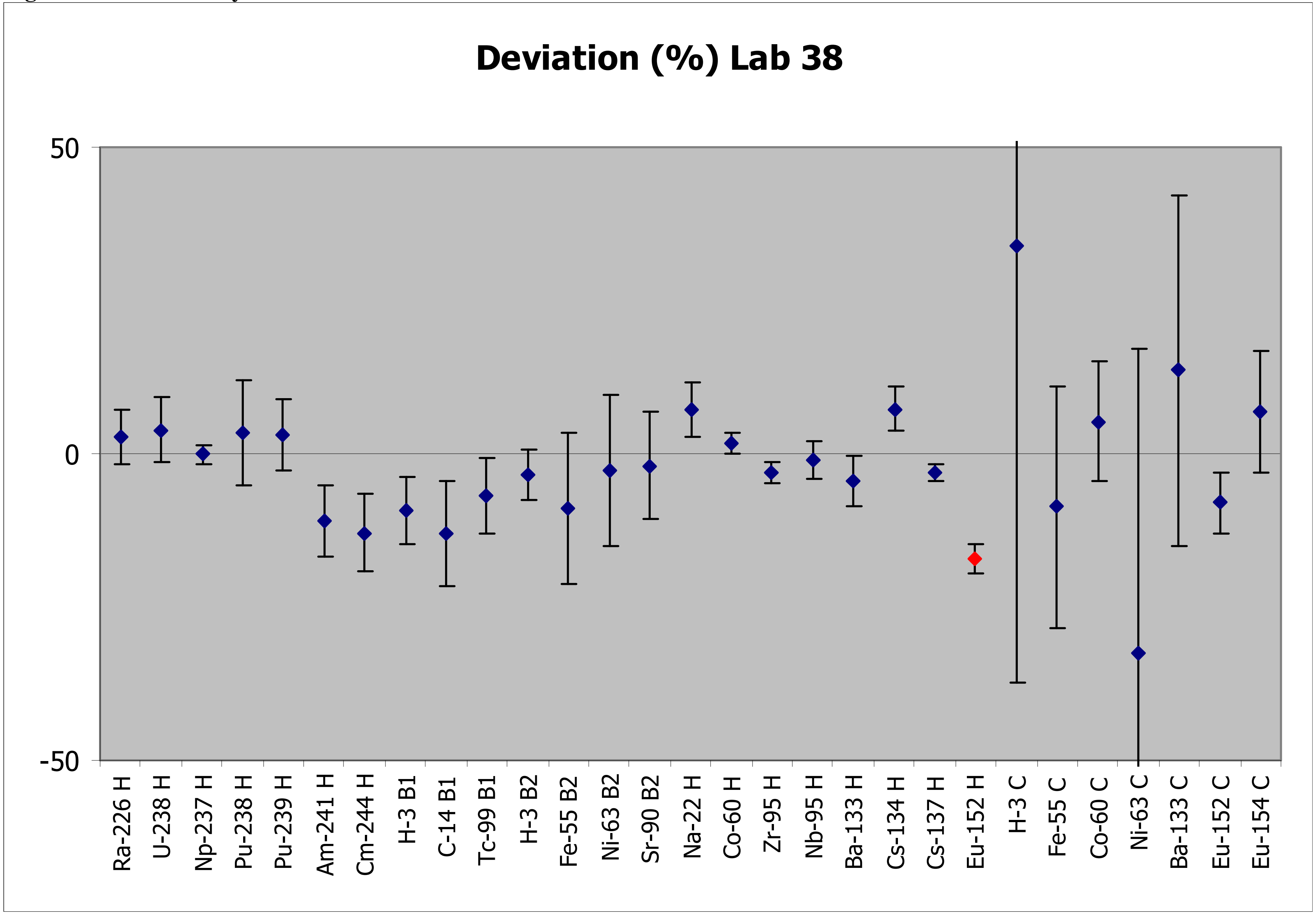


**Figure 83 – Laboratory 38**



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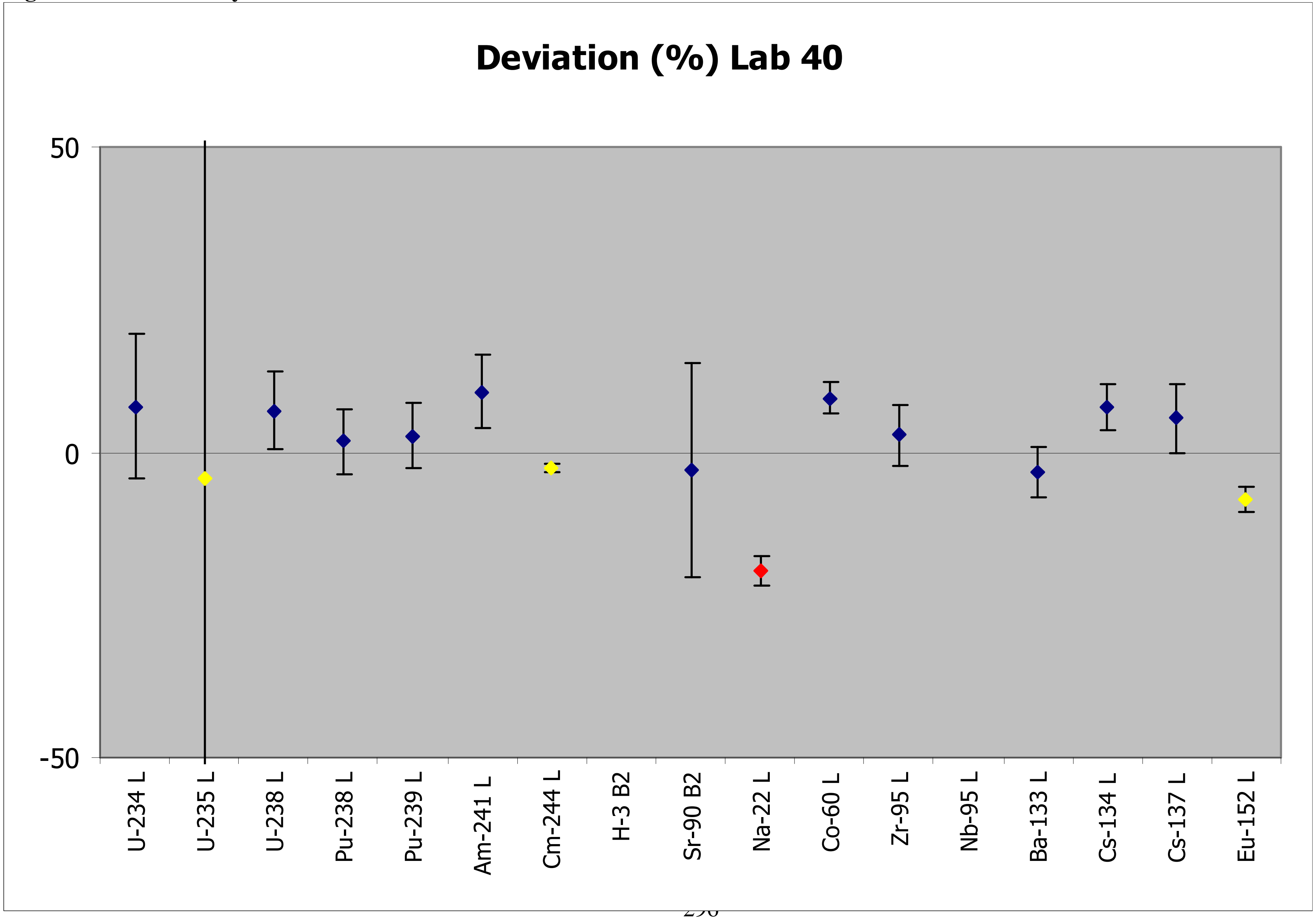
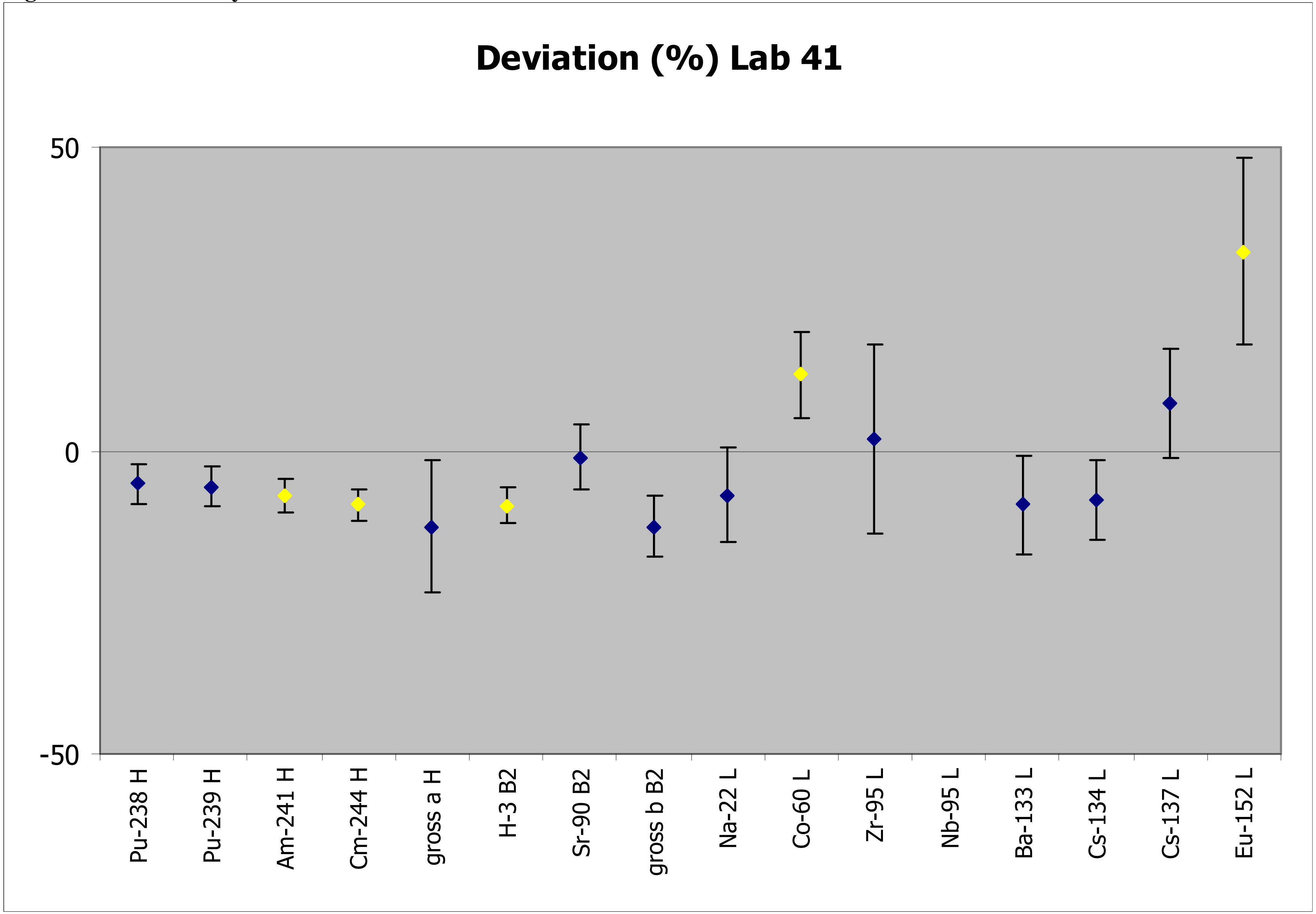


**Figure 85 – Laboratory 41**



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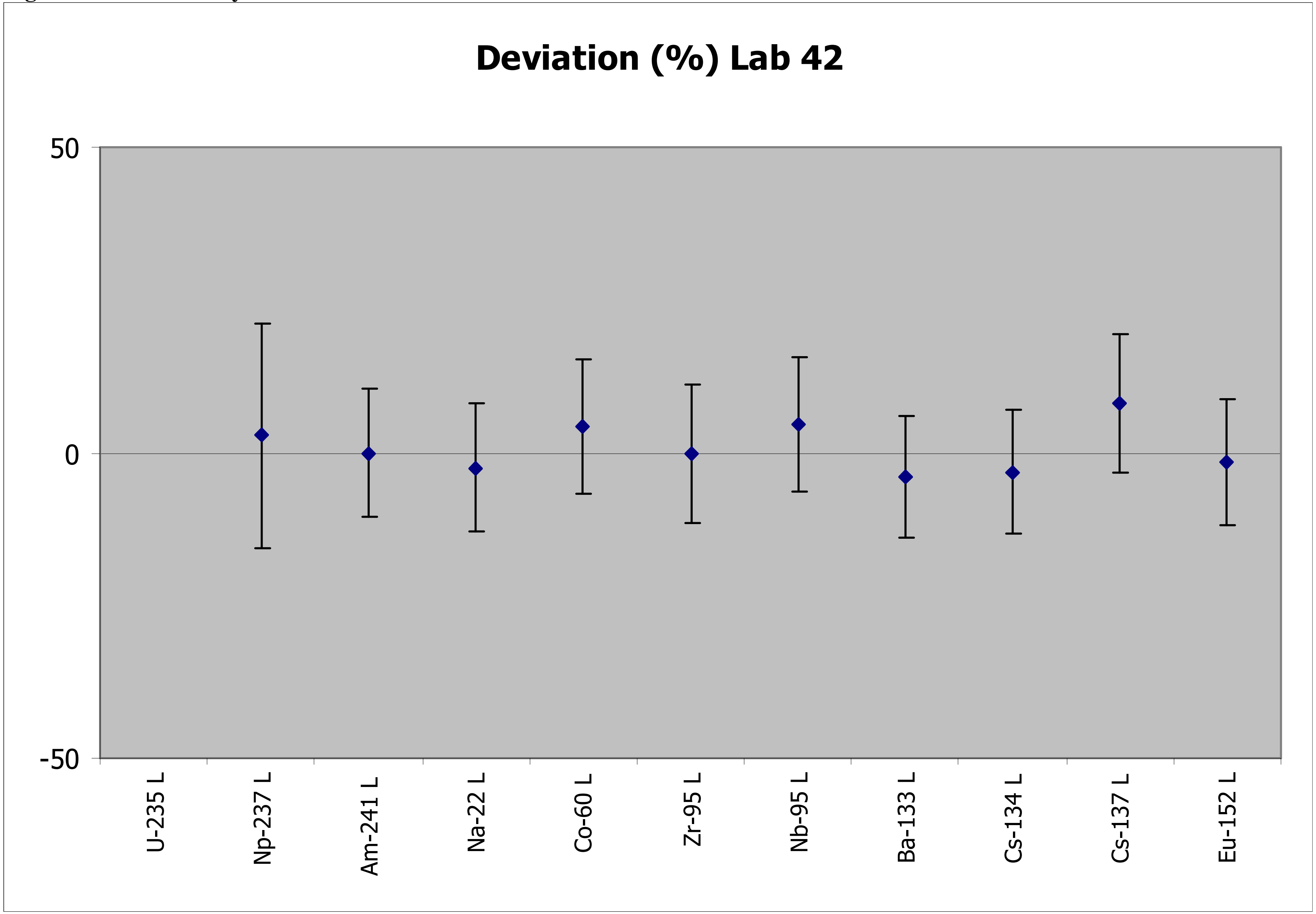

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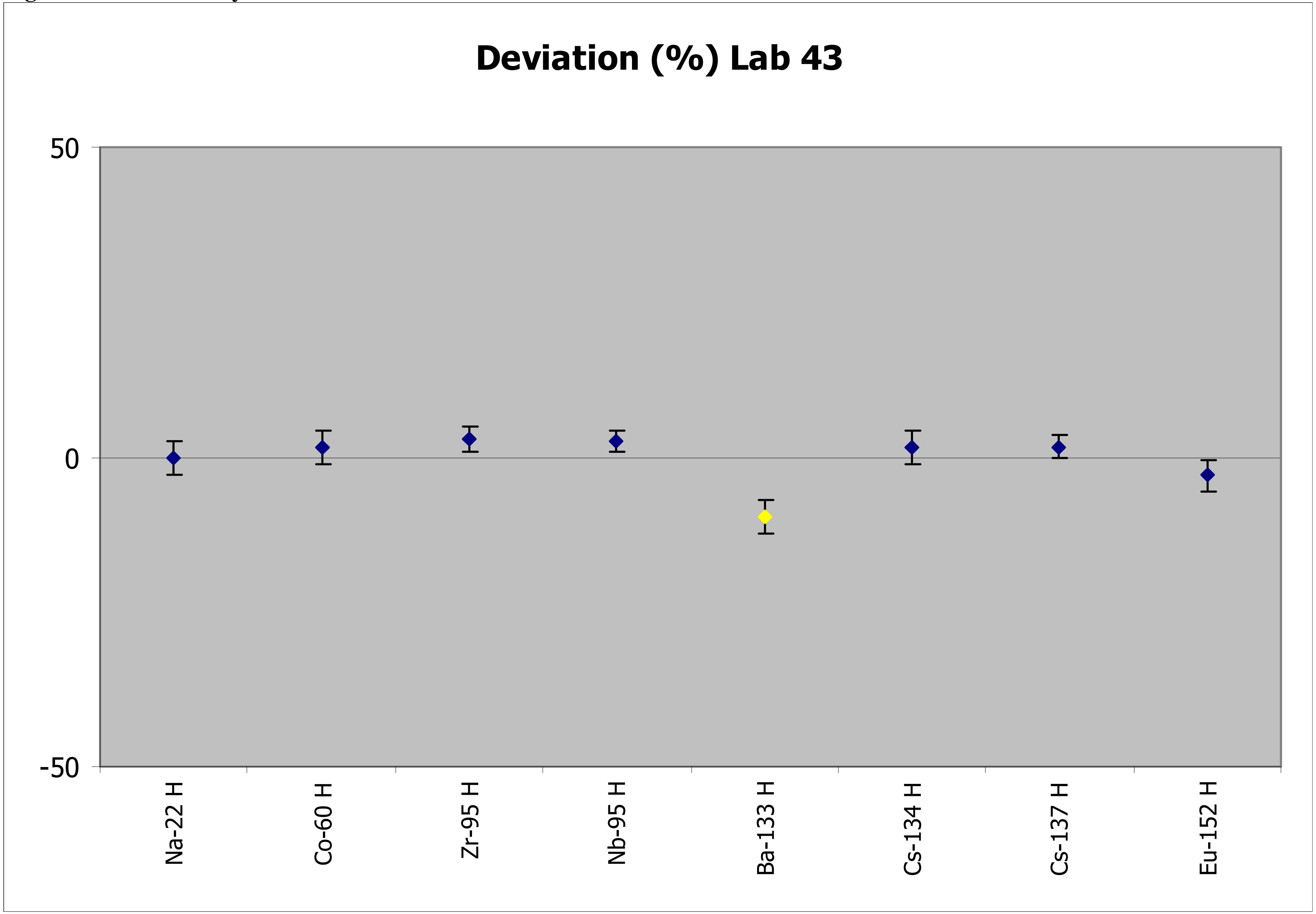

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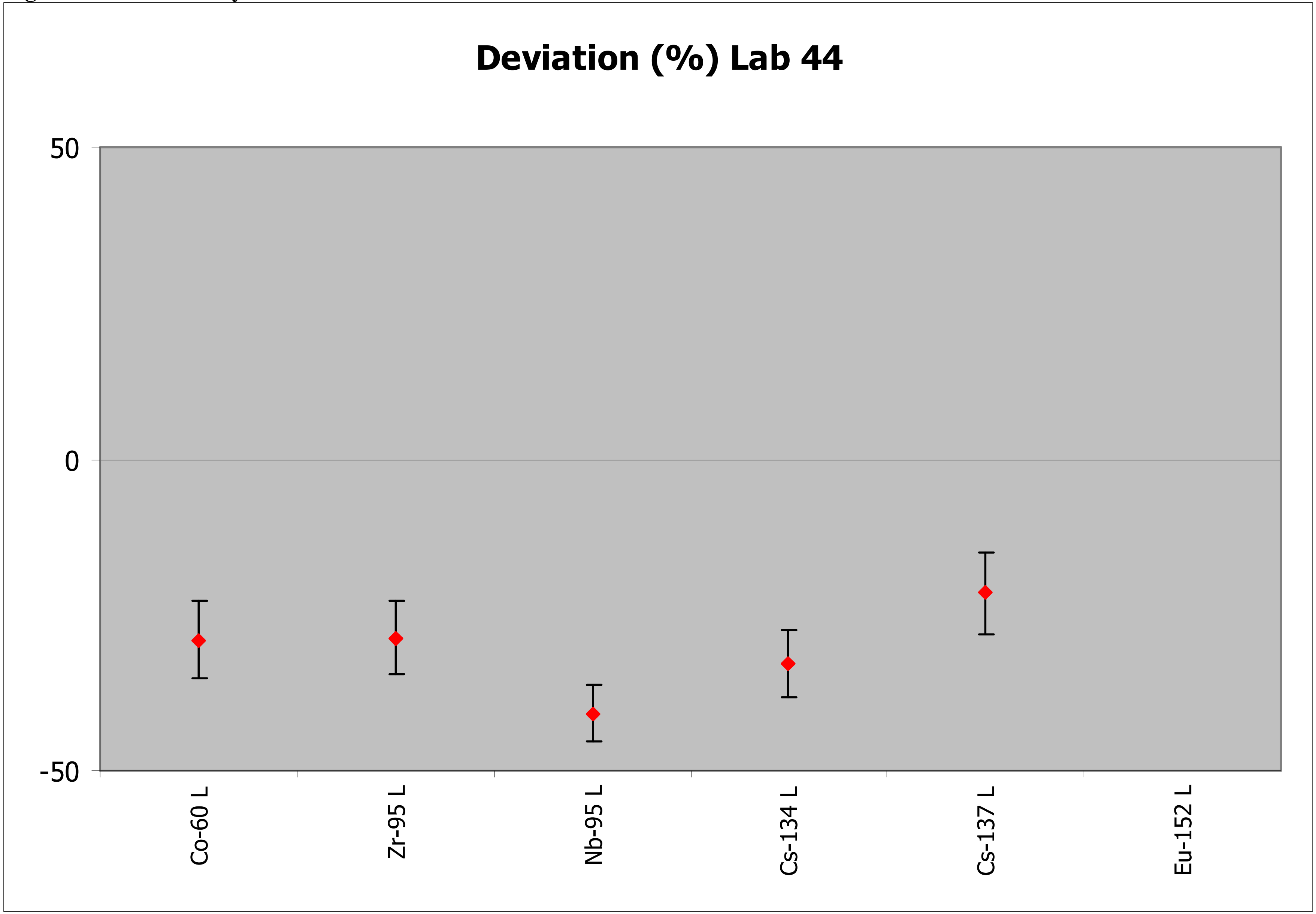

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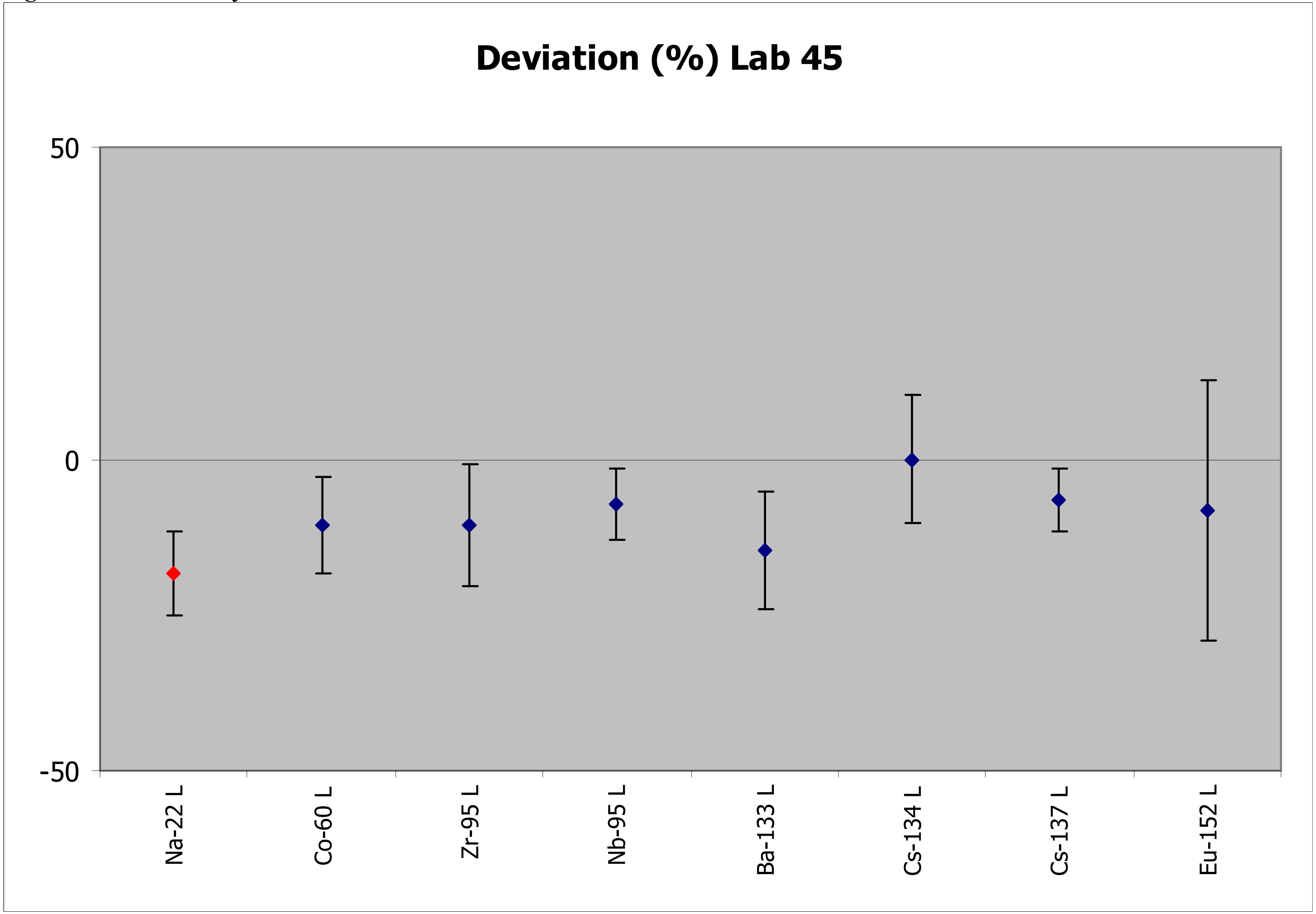

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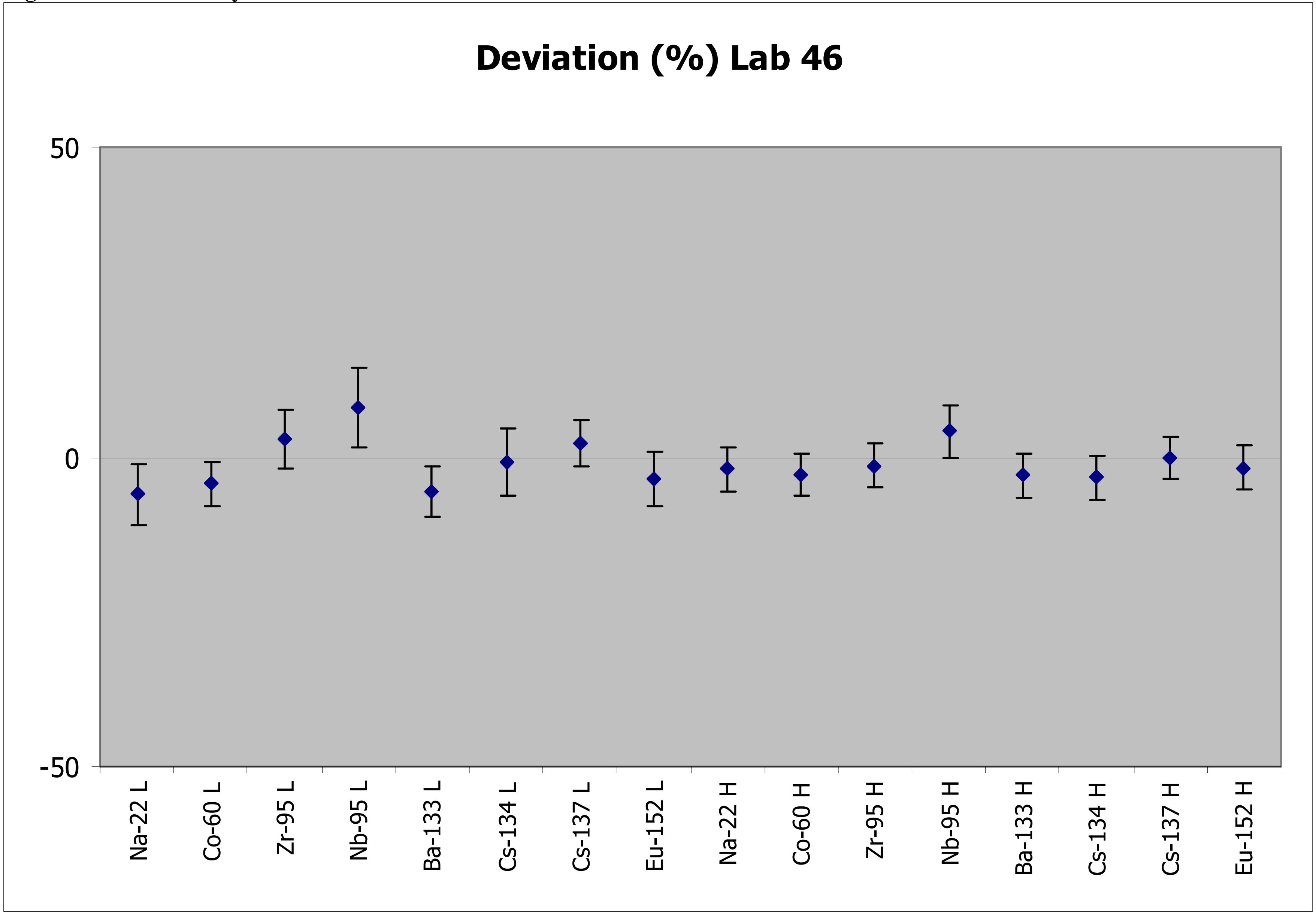


**Figure 91 – Laboratory 47**

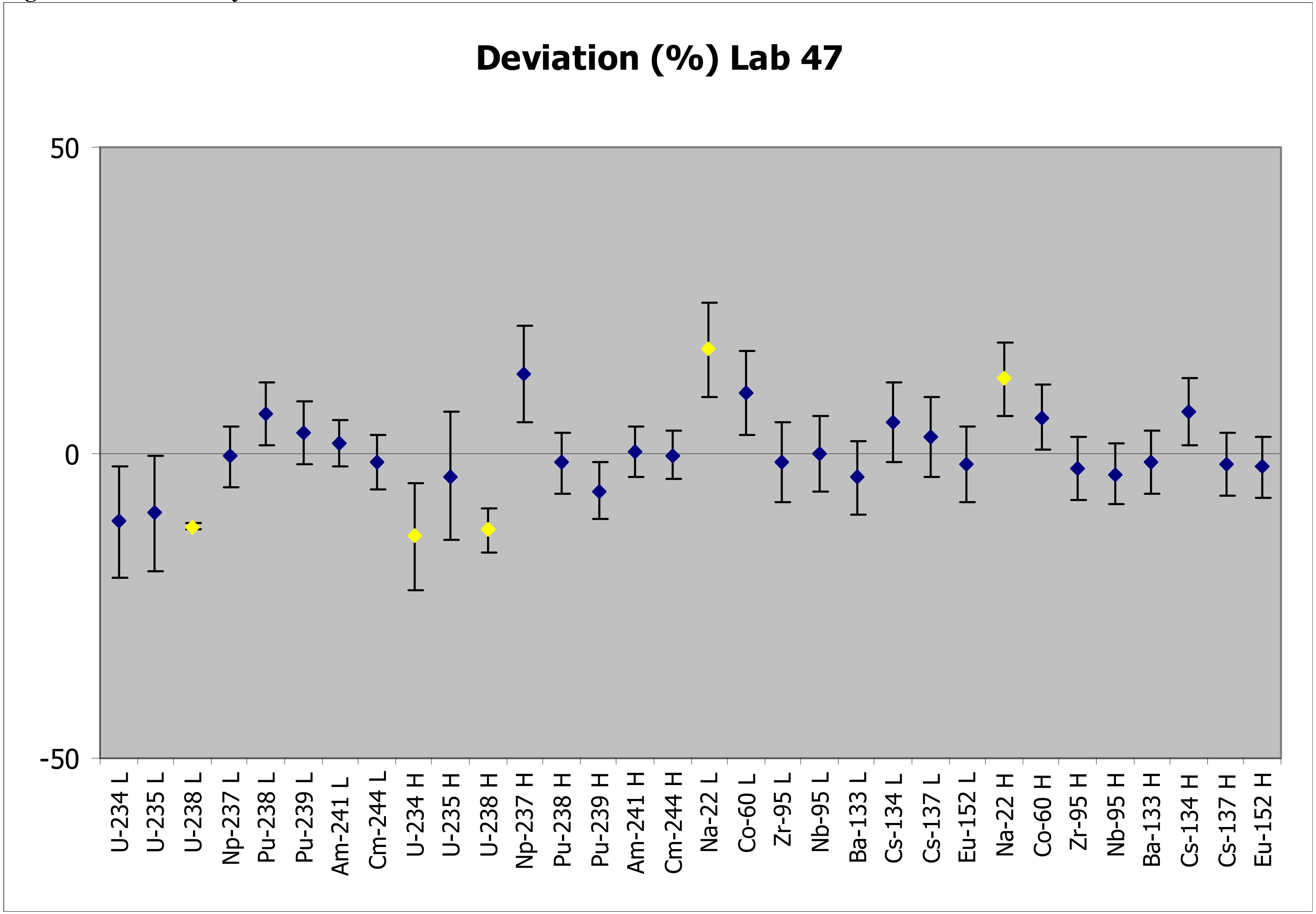


**Figure 92 – Laboratory 48**

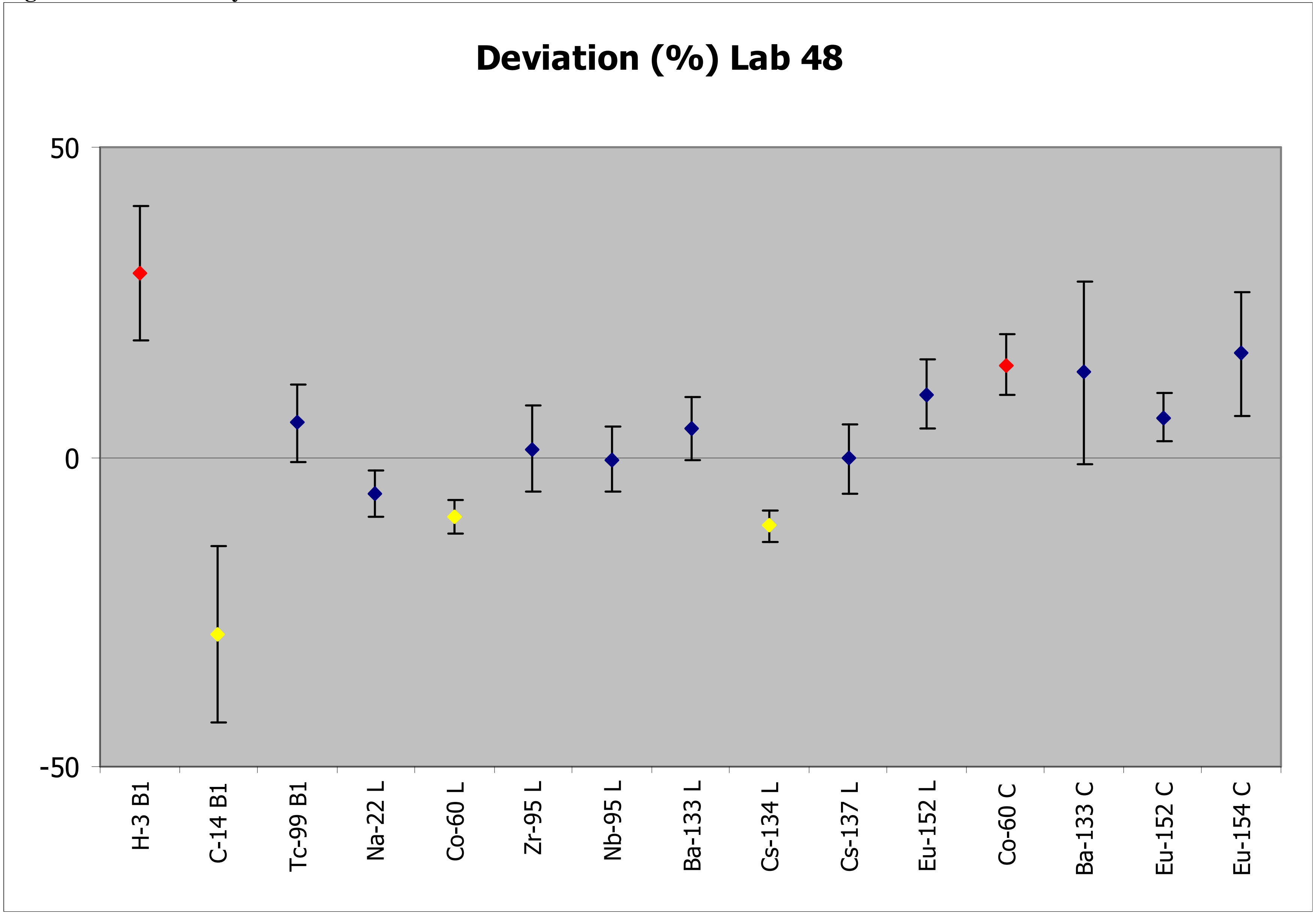


**Figure 93 – Laboratory 51**

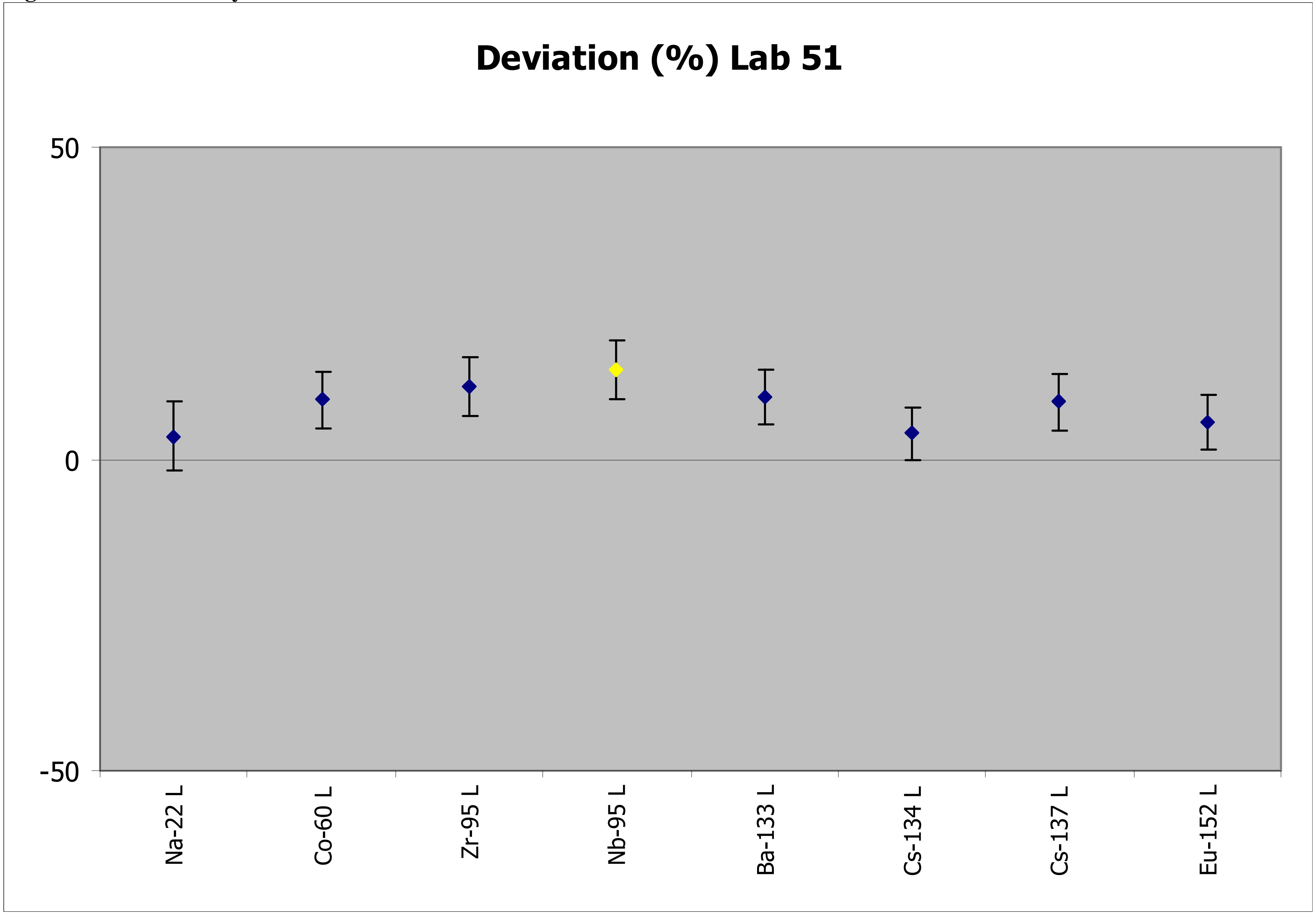


**Figure 94 – Laboratory 52**

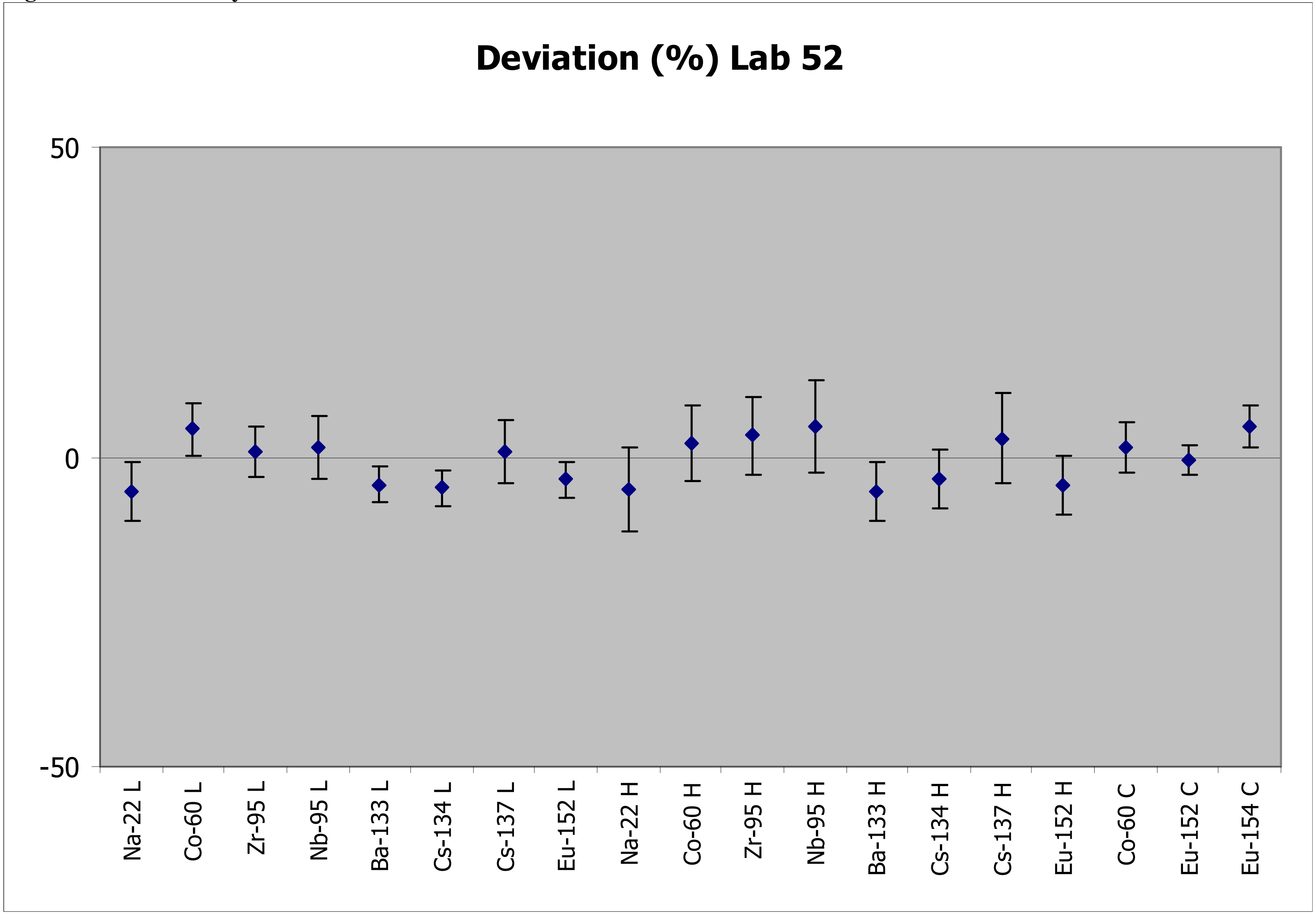


**Figure 95 – Laboratory 53**

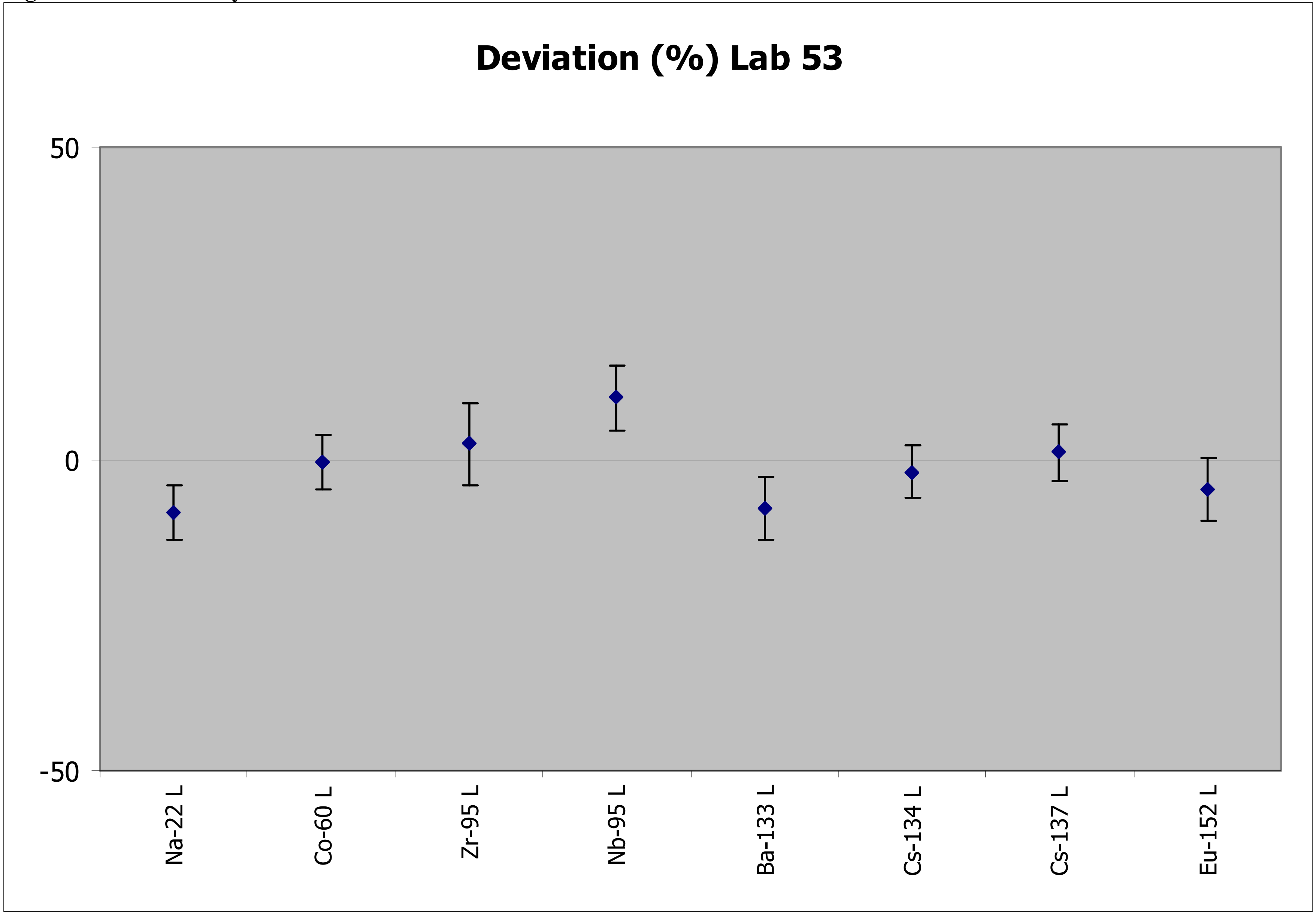


**Figure 96 – Laboratory 54**

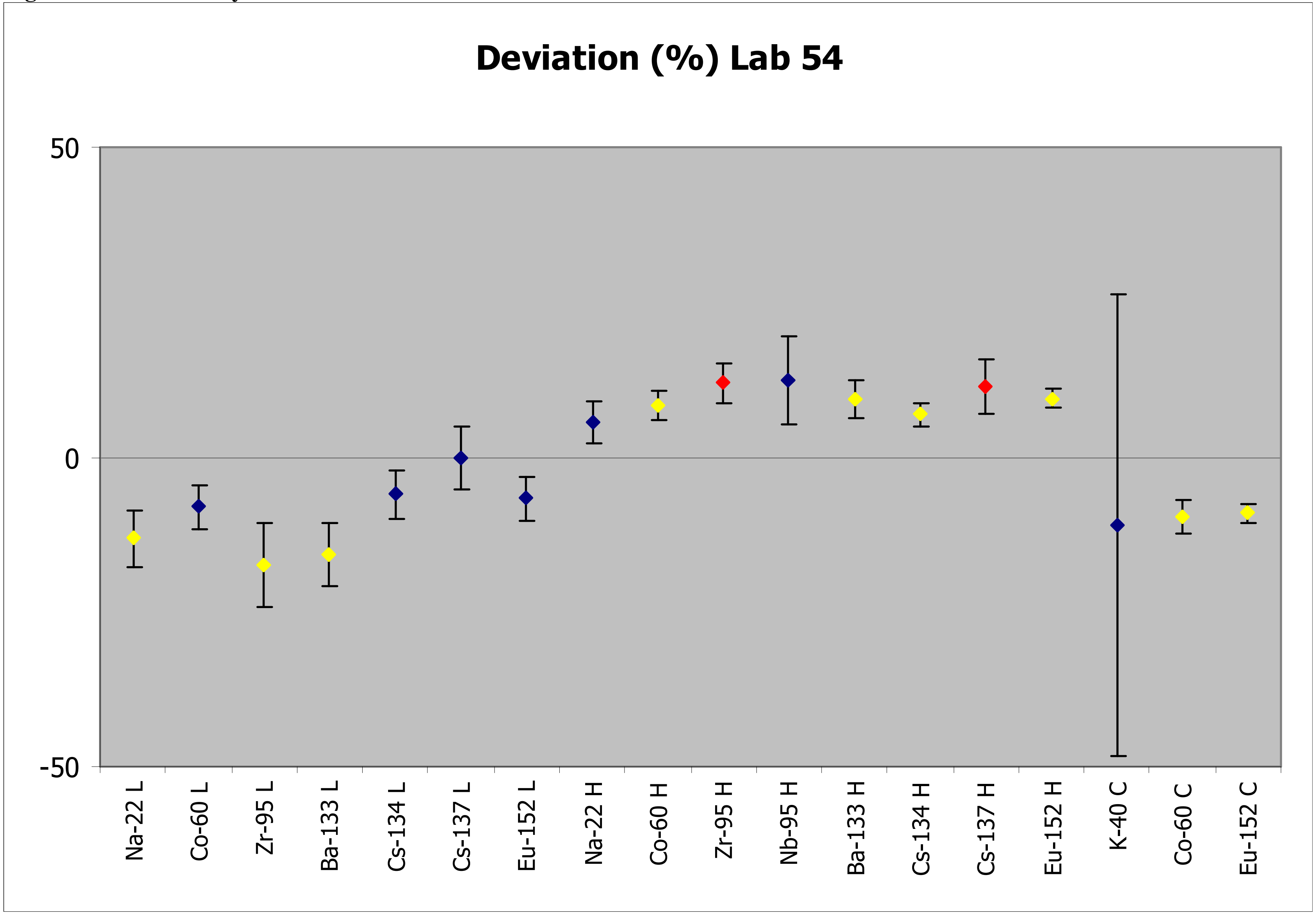


**Figure 97 – Laboratory 55**

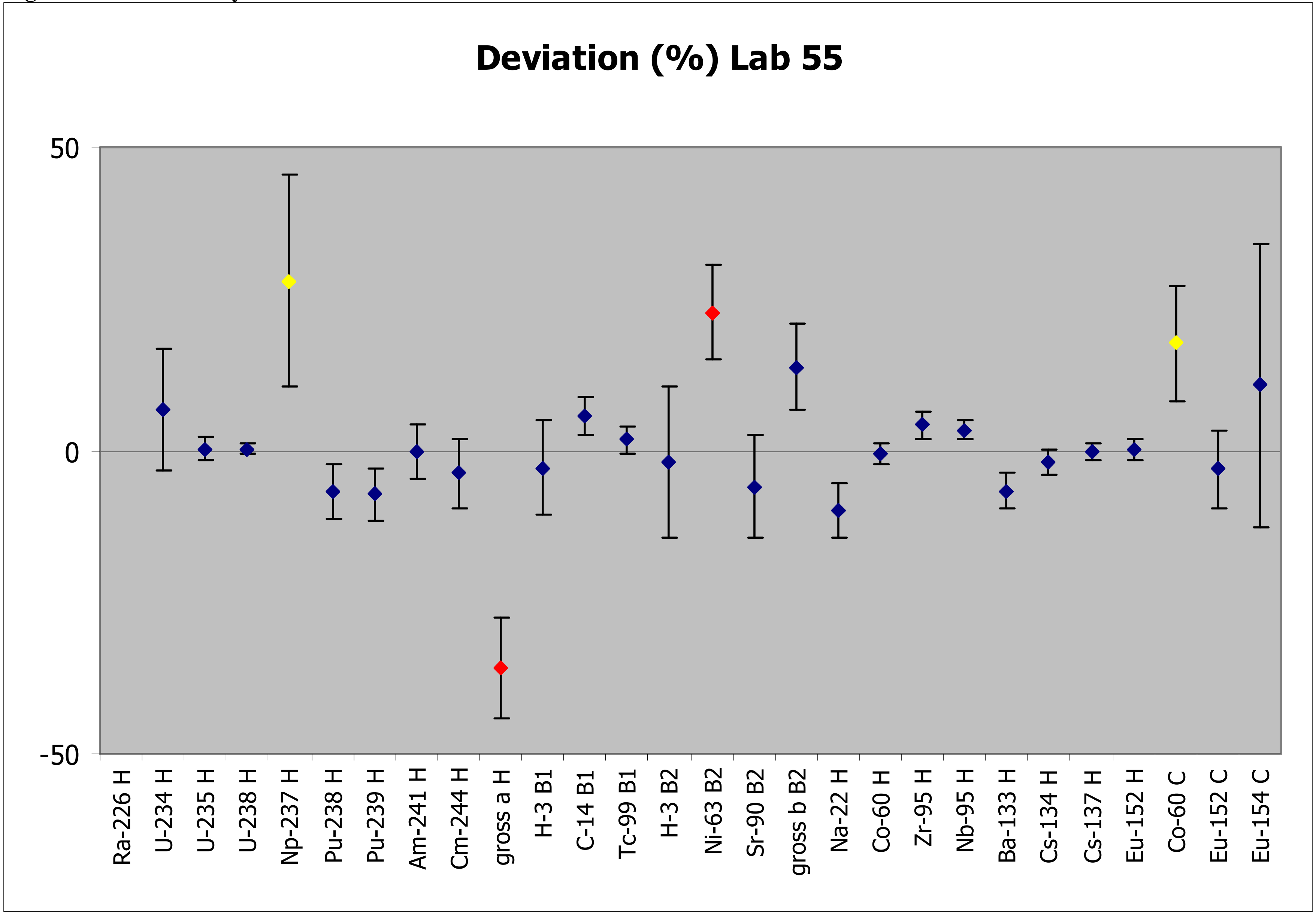


**Figure 98 – Laboratory 56**

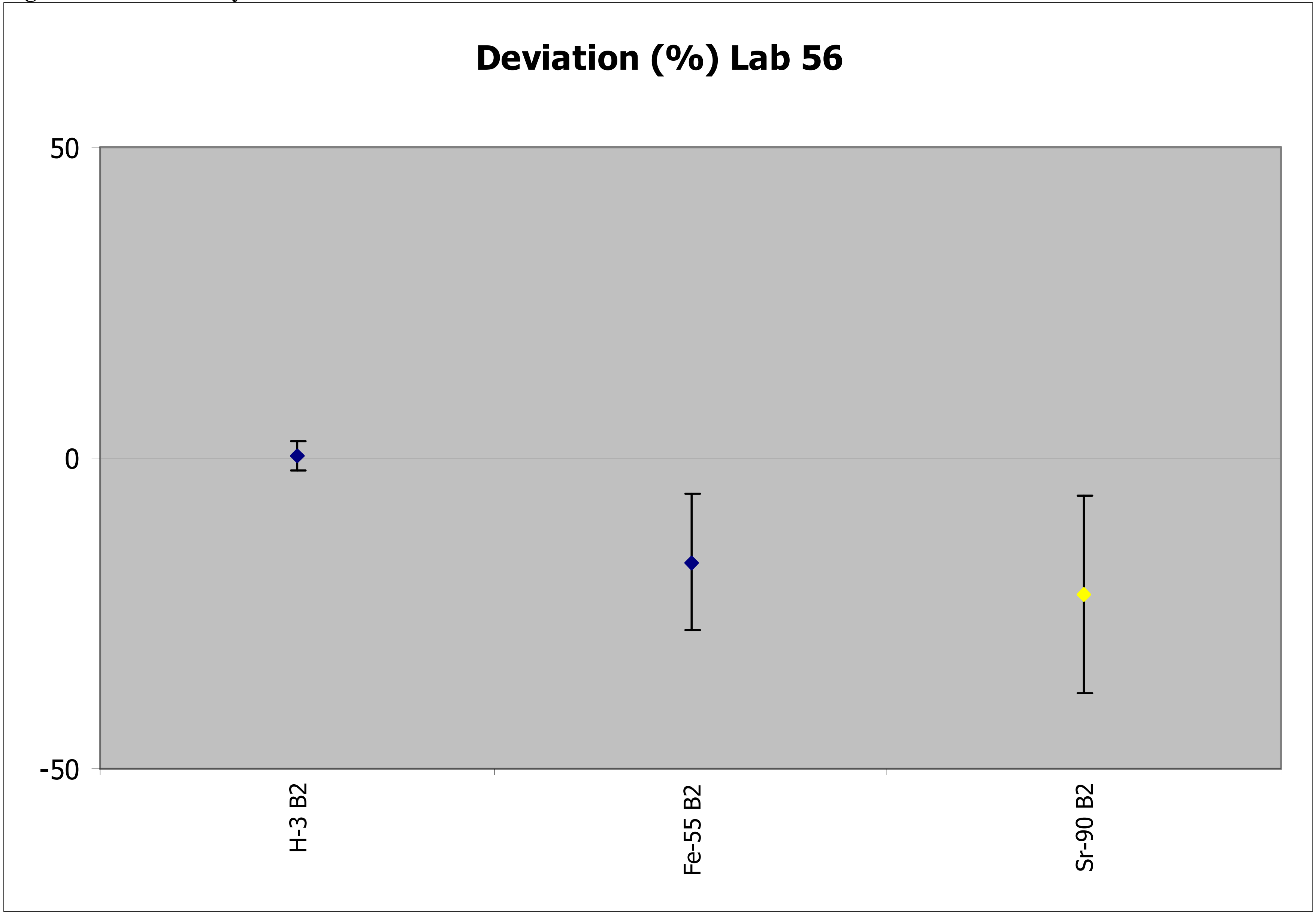


**Figure 99 – Laboratory 59**

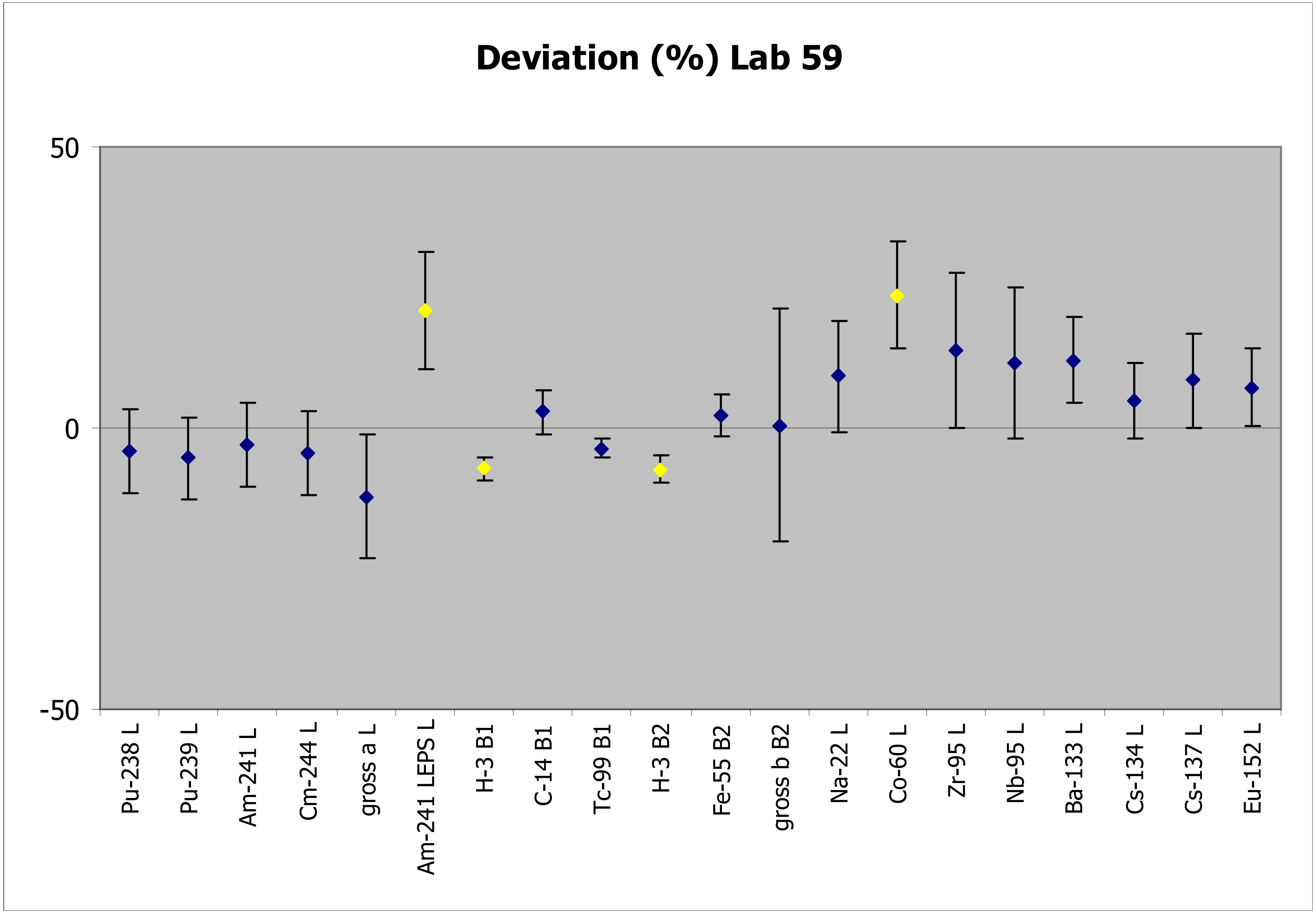


**Figure 100 – Laboratory 62**

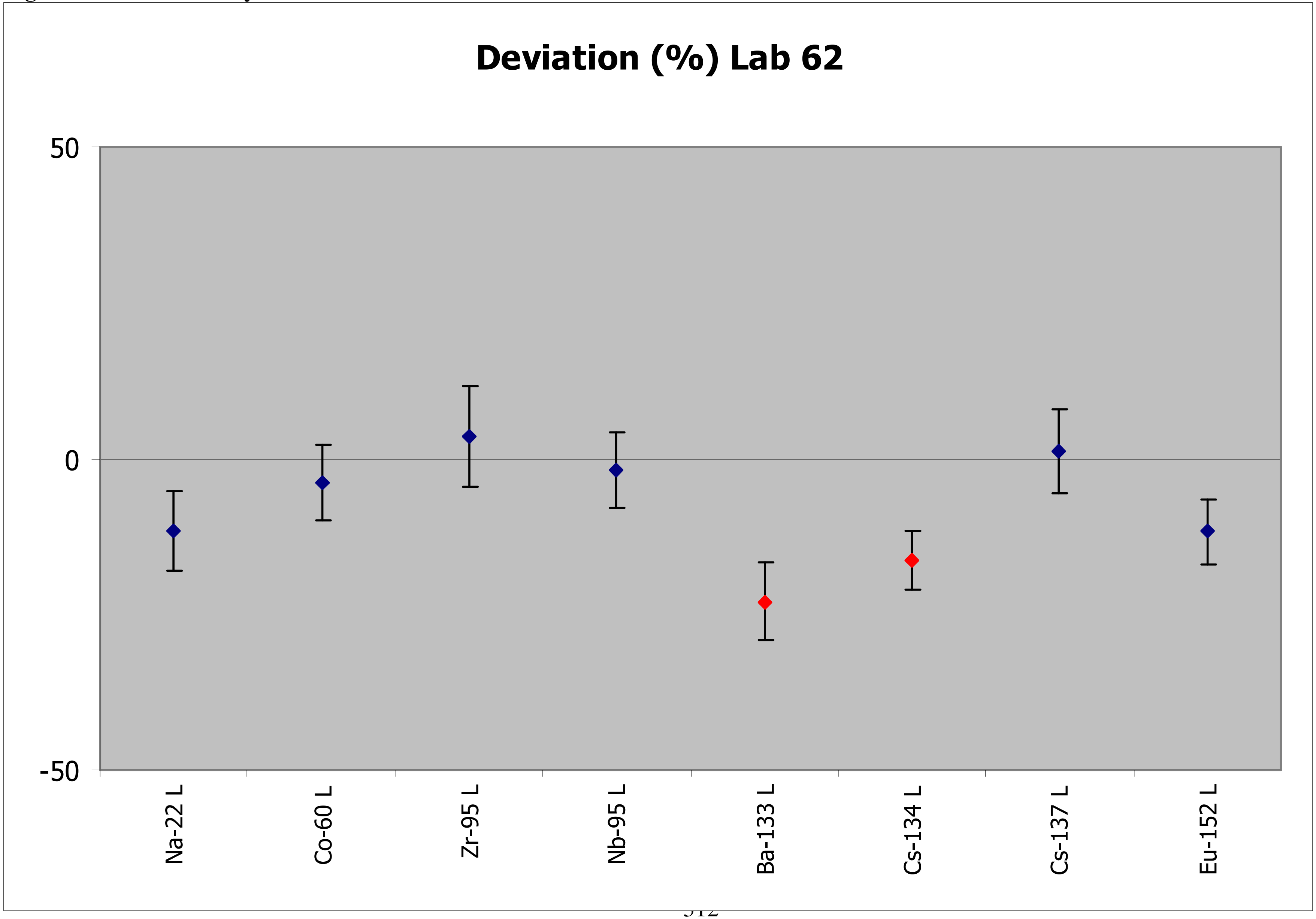


**Figure 101 – Laboratory 65**

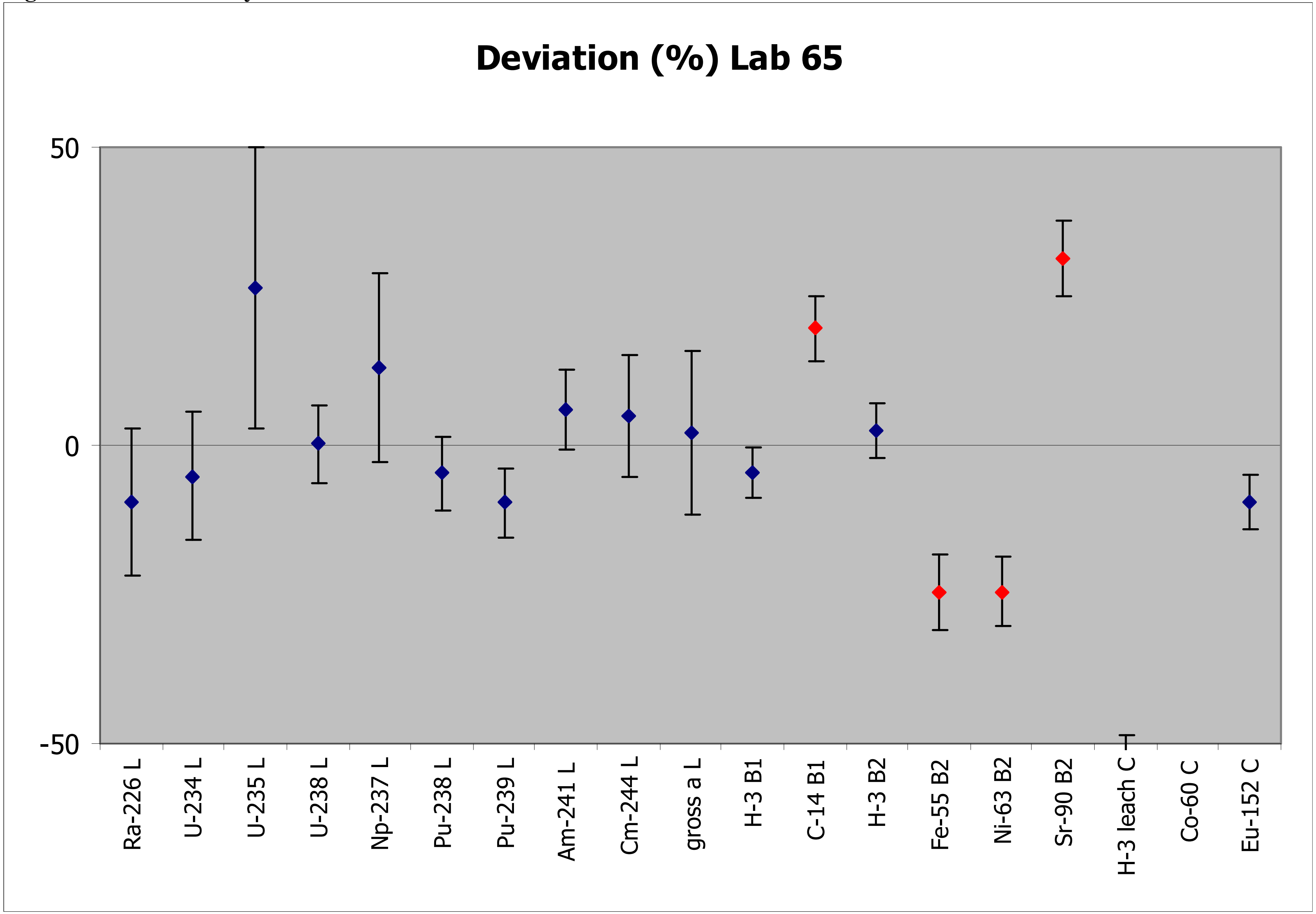


**Figure 102 – Laboratory 68**

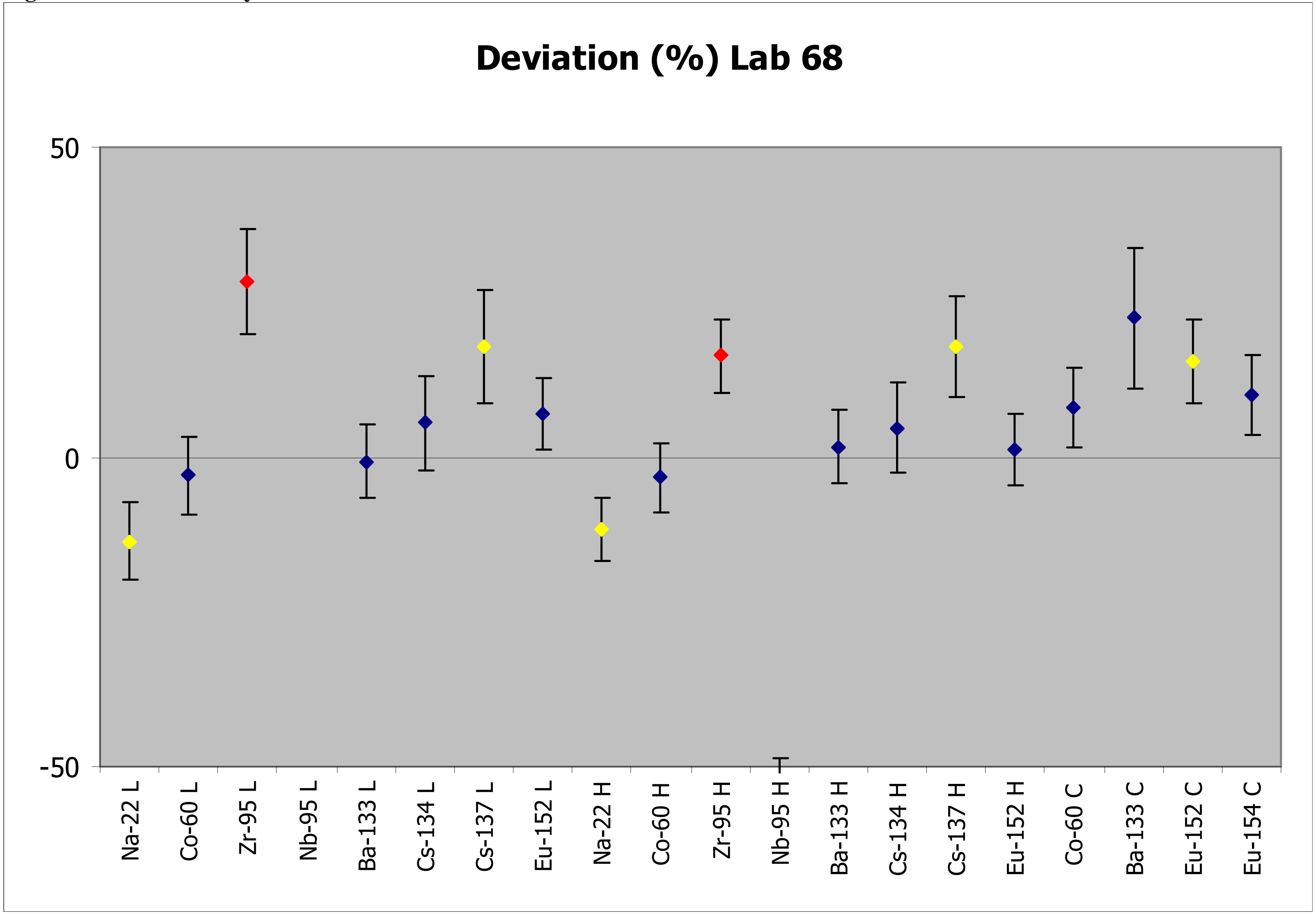


**Figure 103 – Laboratory 72**

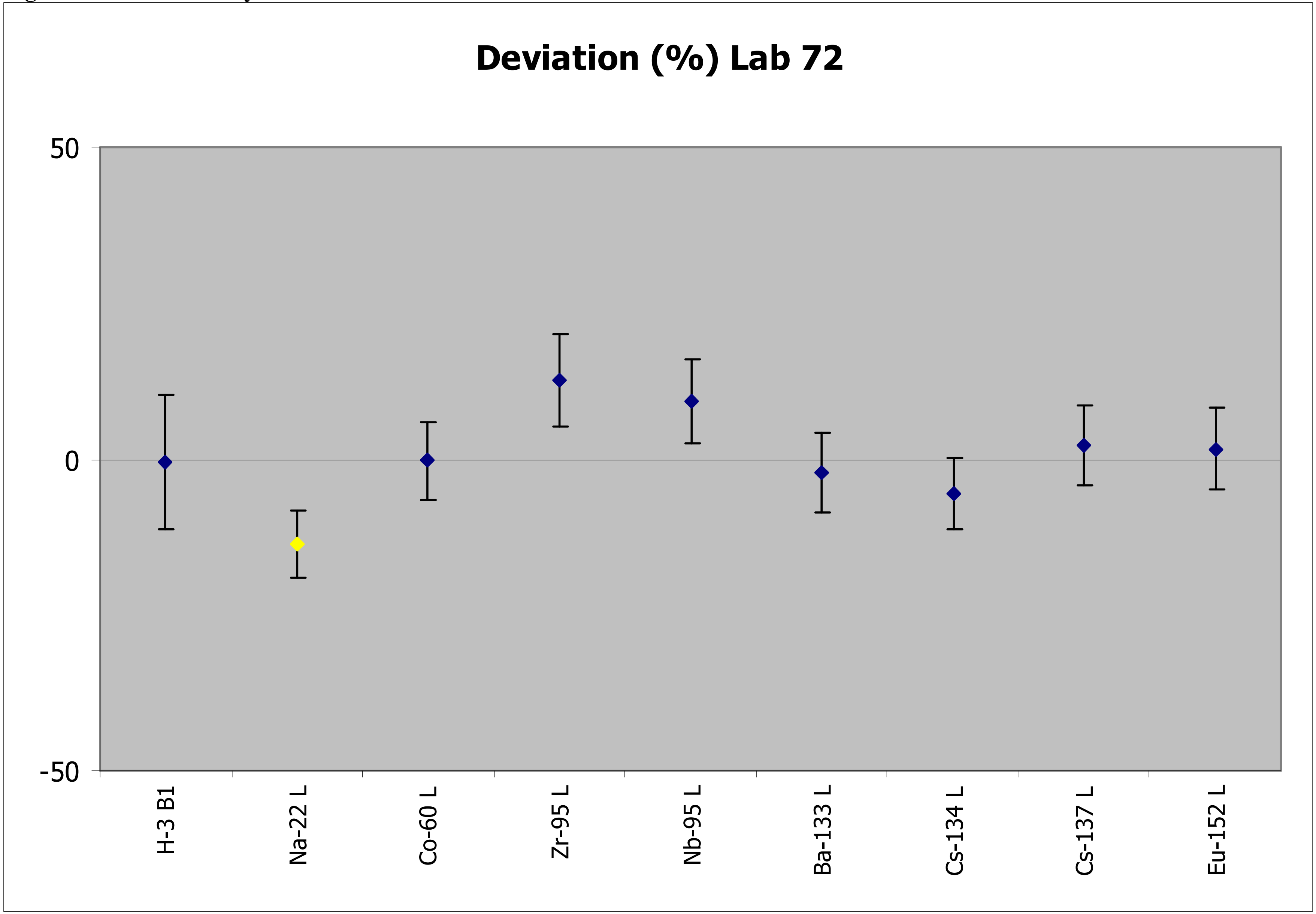
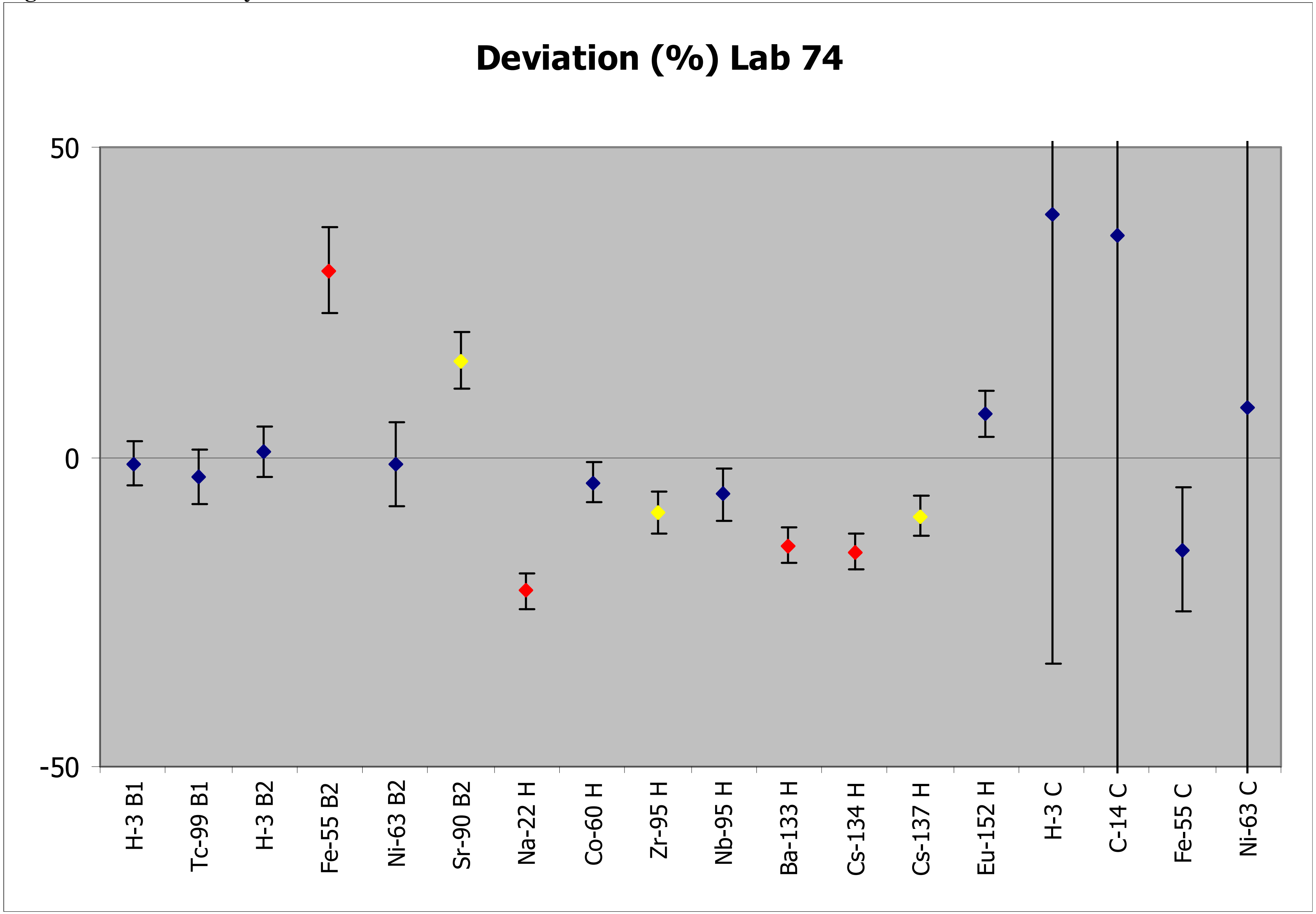


**Figure 104 – Laboratory 74**



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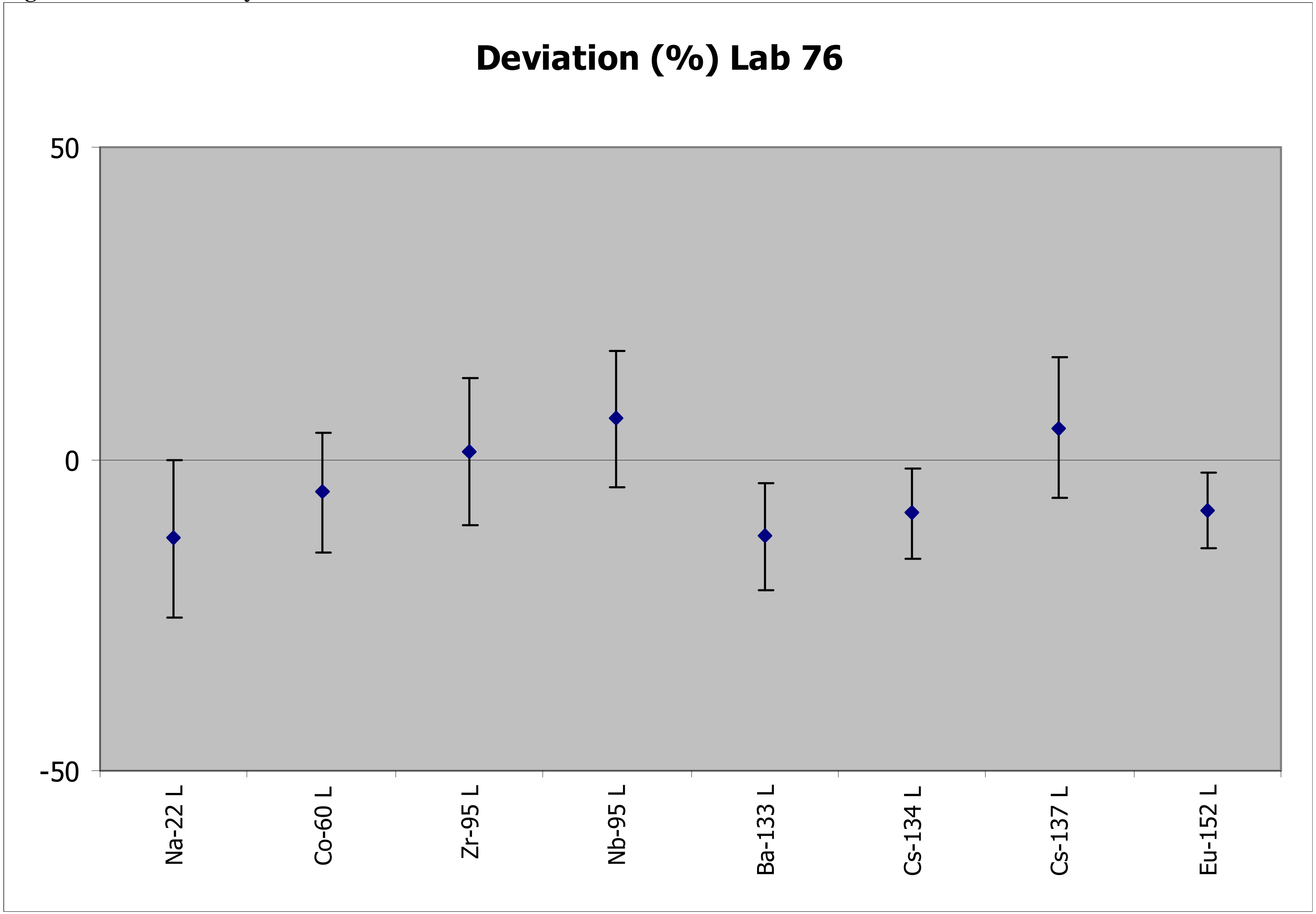


**Figure 106 – Laboratory 77**

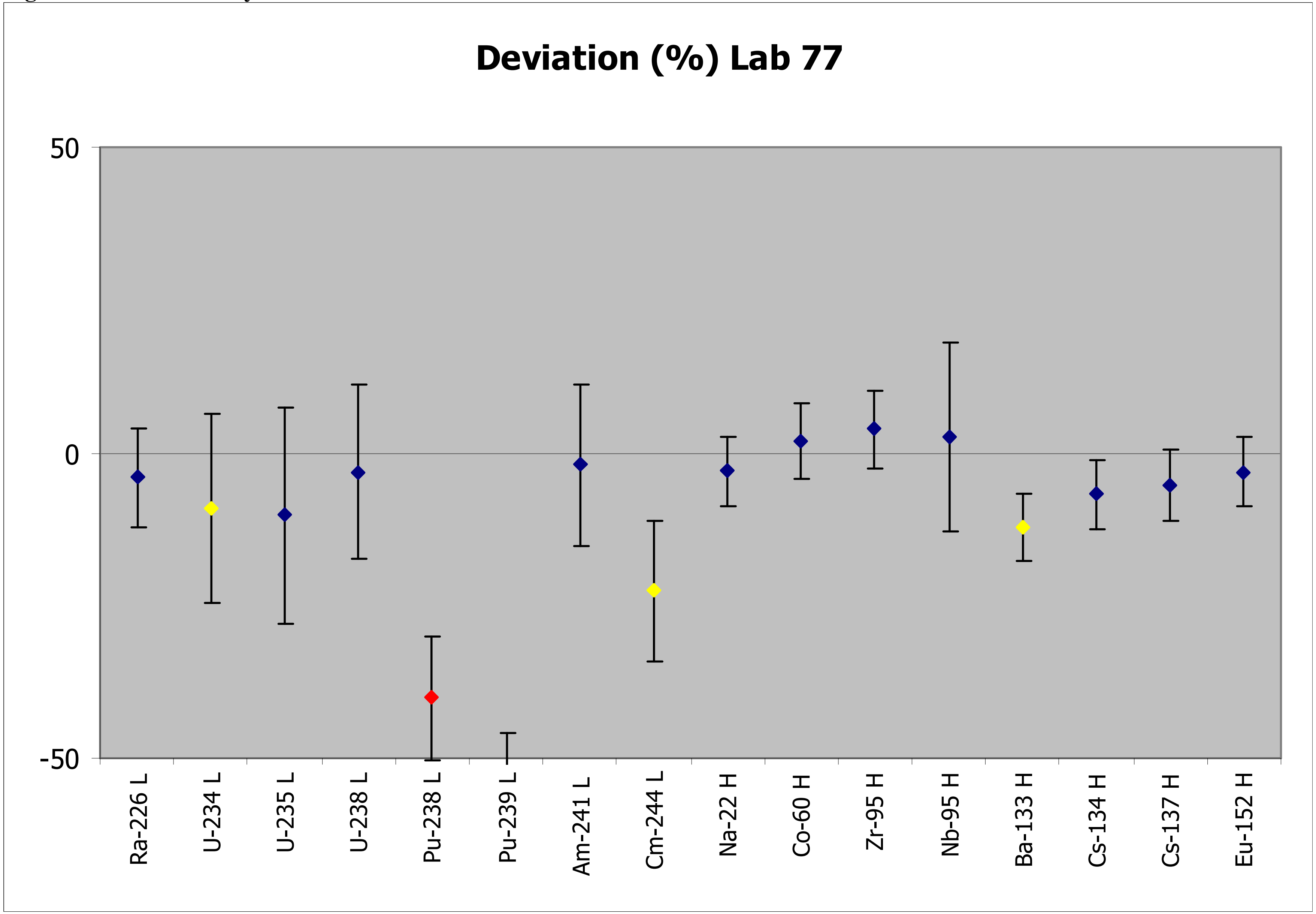


**Figure 107 – Laboratory 78**

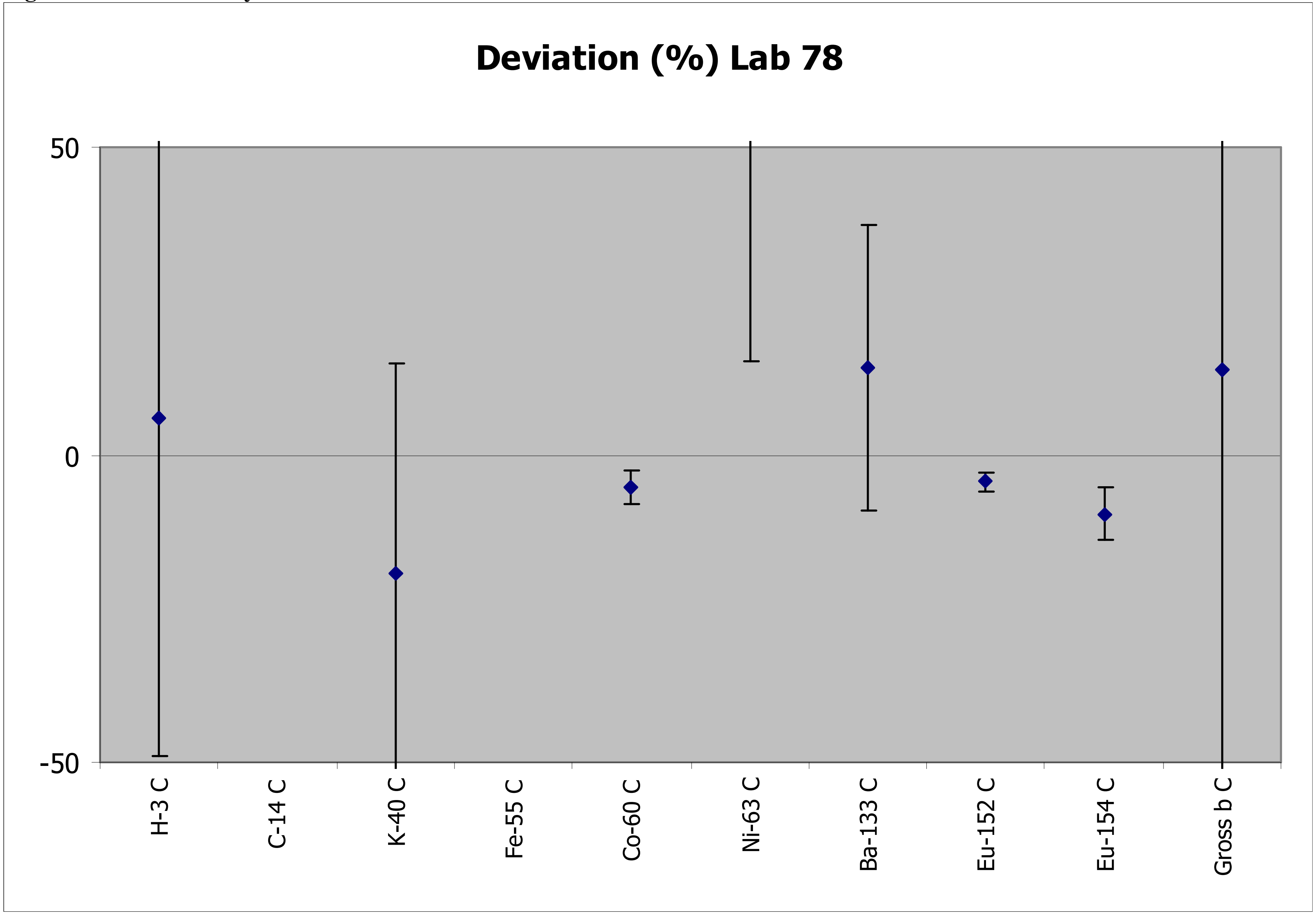


**Figure 108 – Laboratory 81**

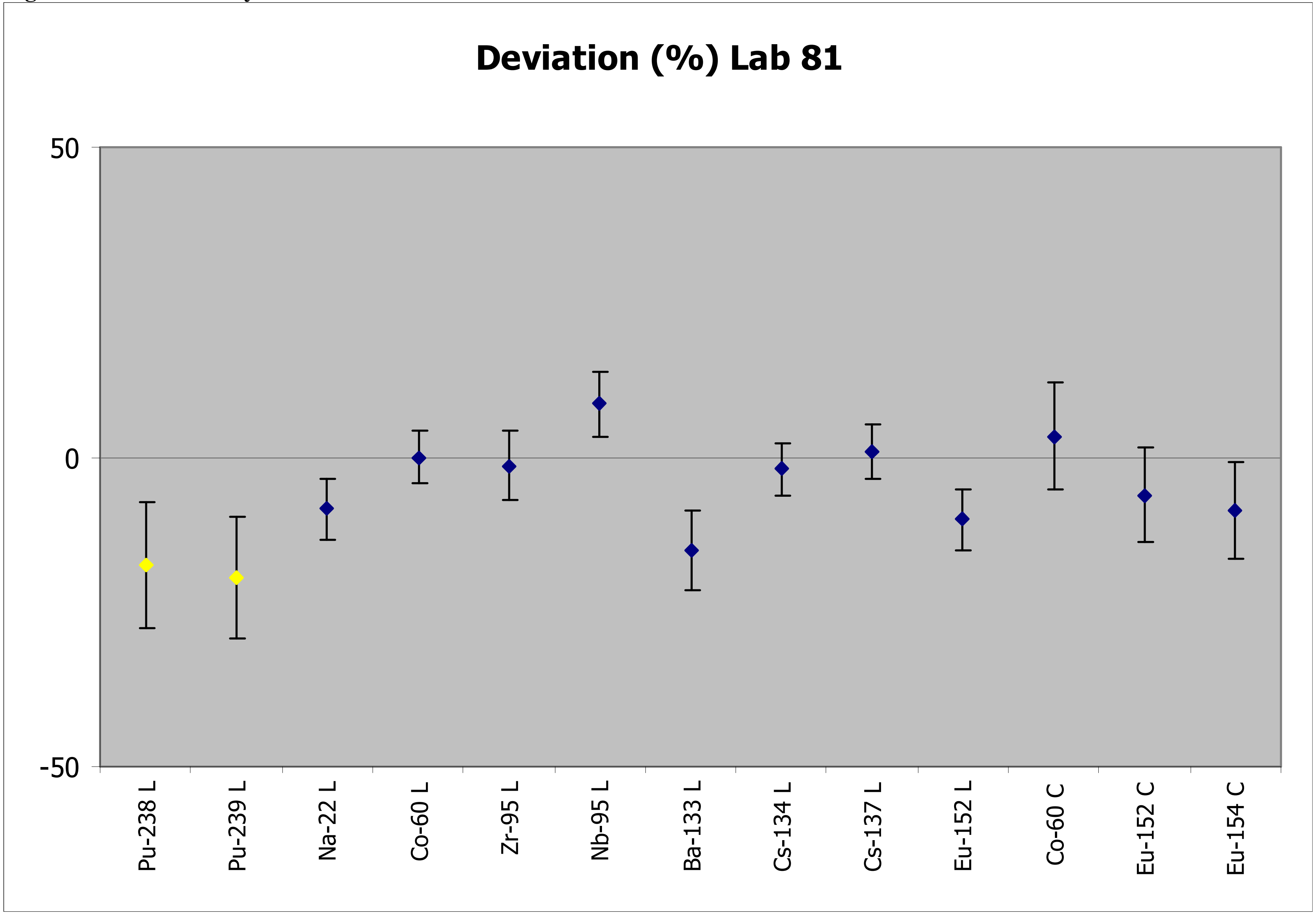


**Figure 109 – Laboratory 82**

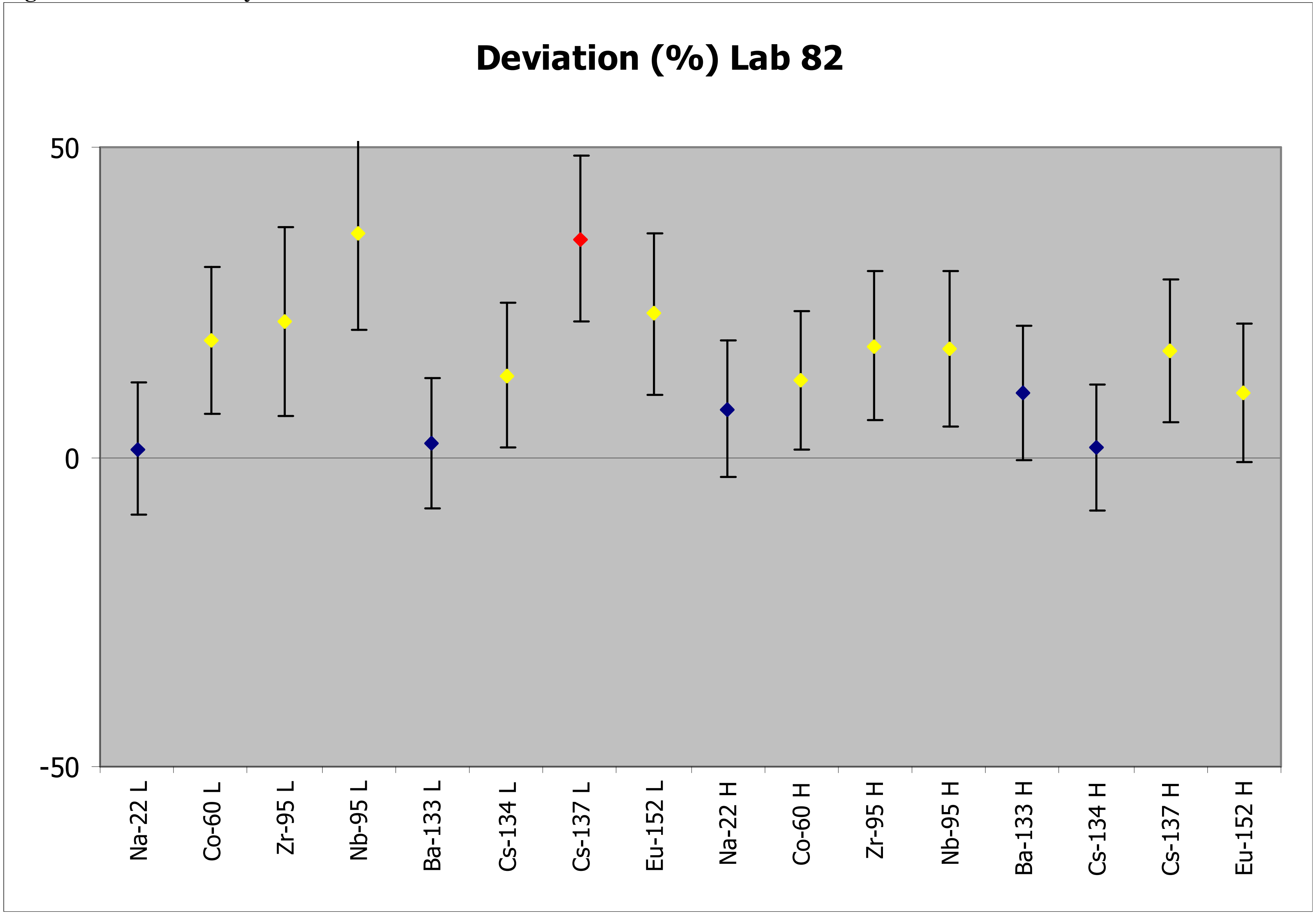


**Figure 110 – Laboratory 83**

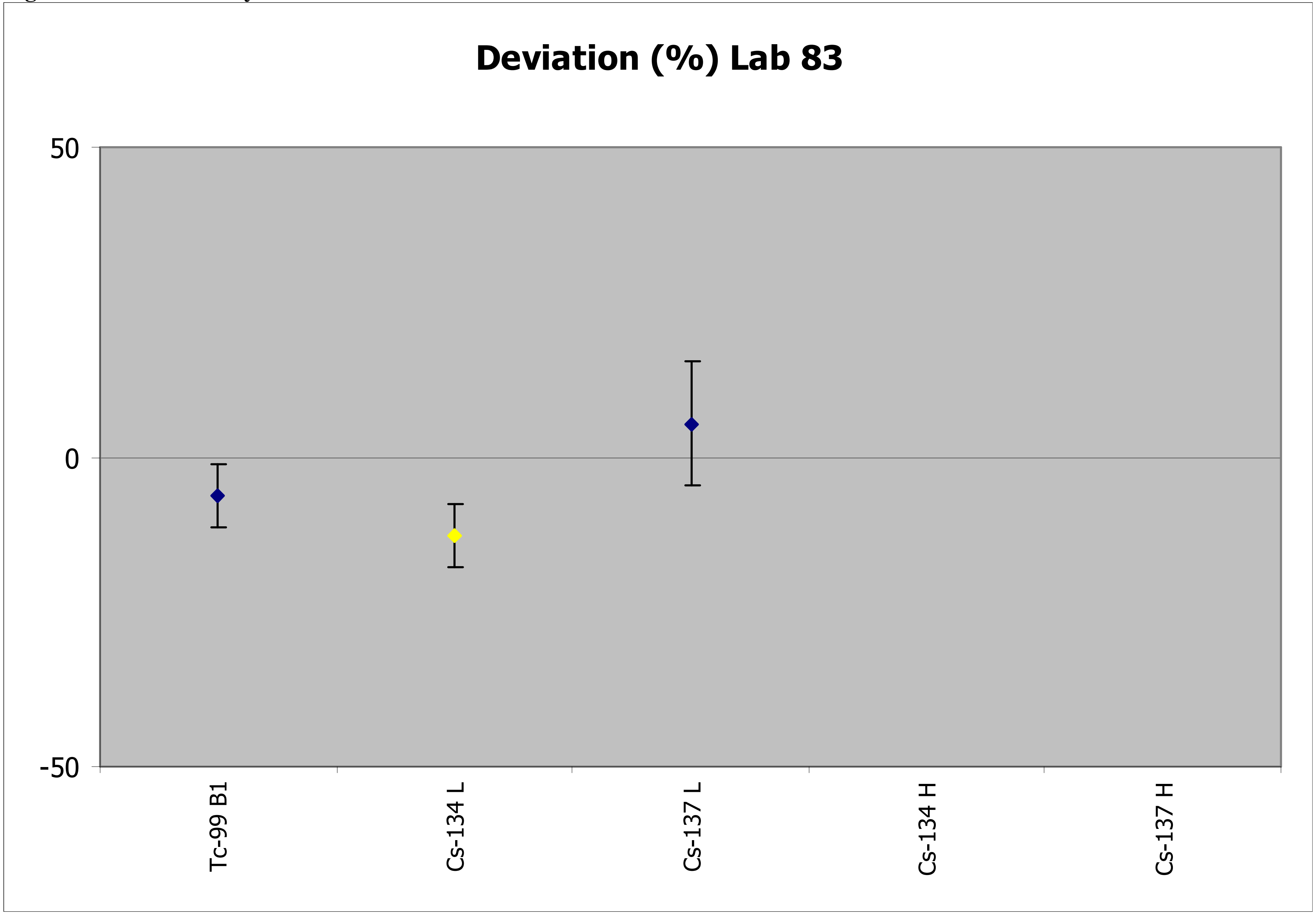


**Figure 111 – Laboratory 88**

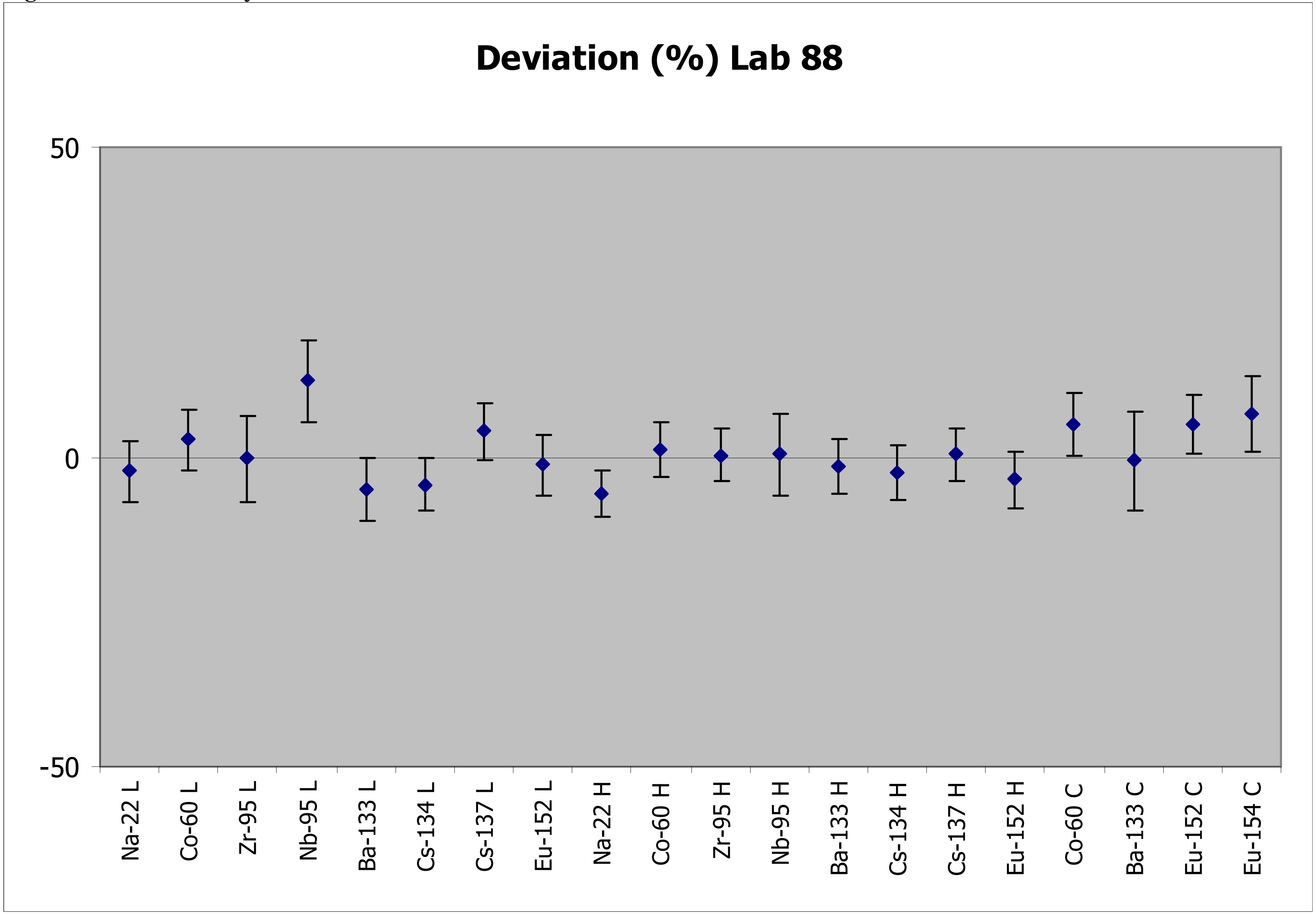


**Figure 112 – Laboratory 89**

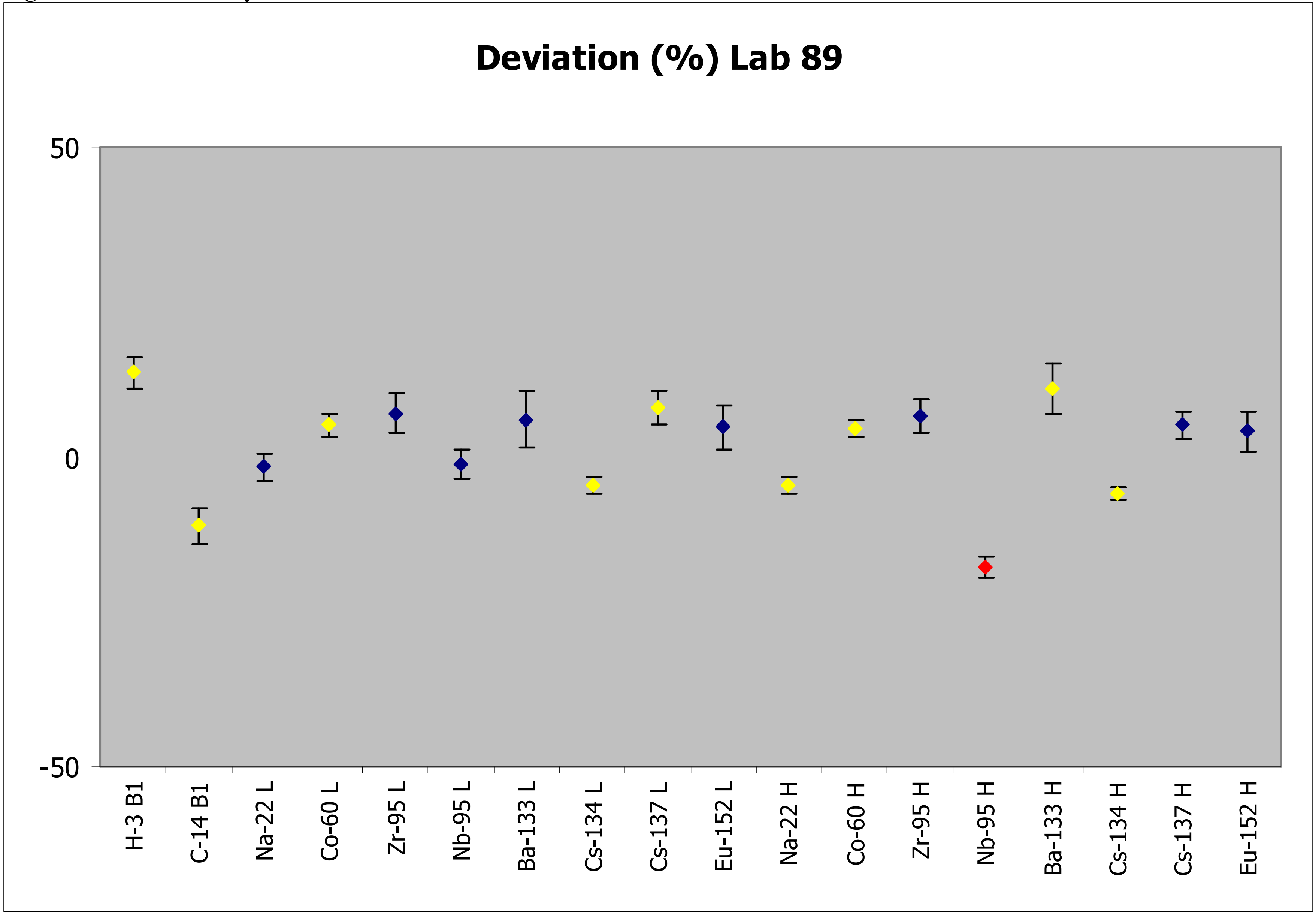


**Figure 113 – Laboratory 90**

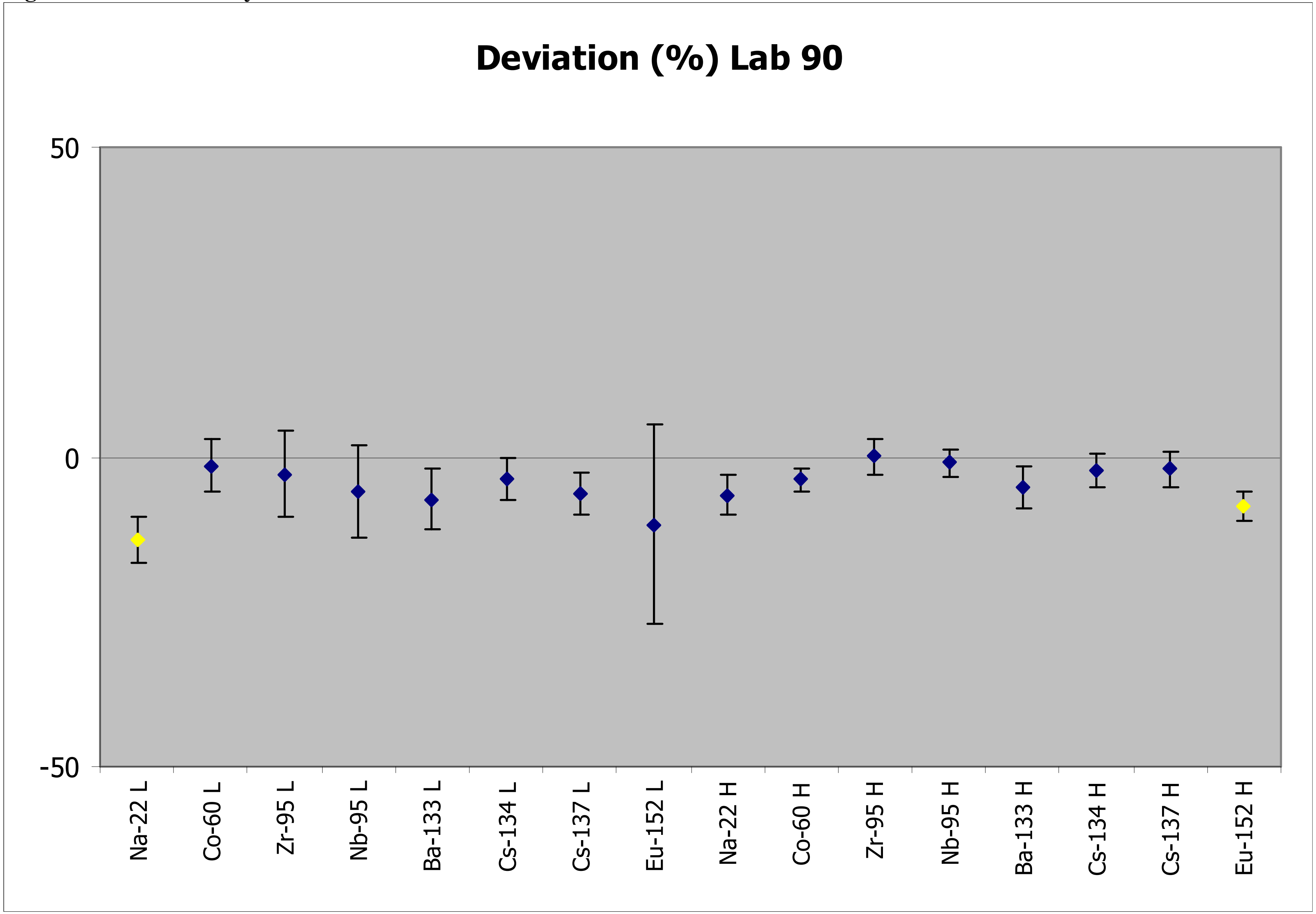


**Figure 114 – Laboratory 91**

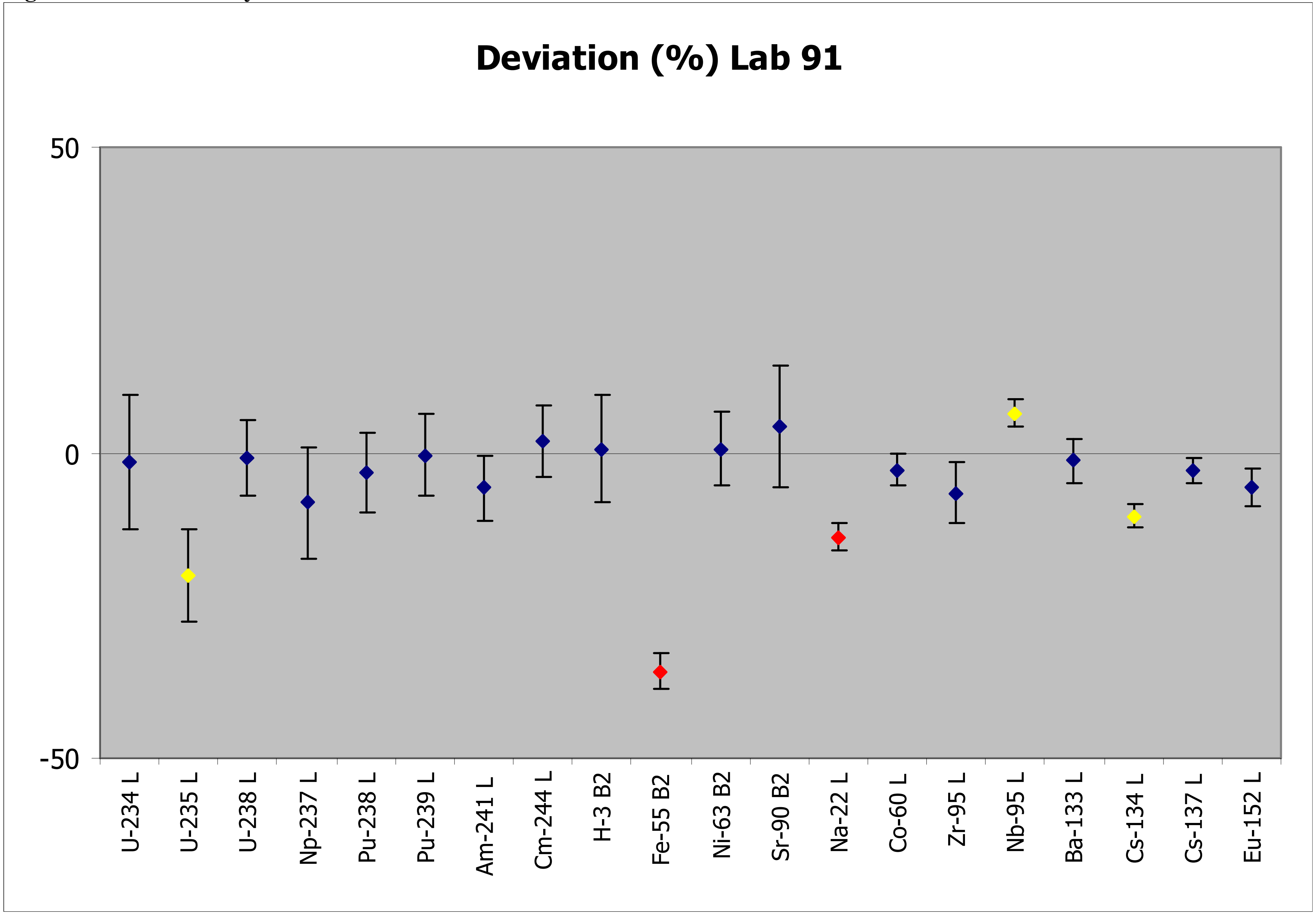


**Figure 115 – Laboratory 92**

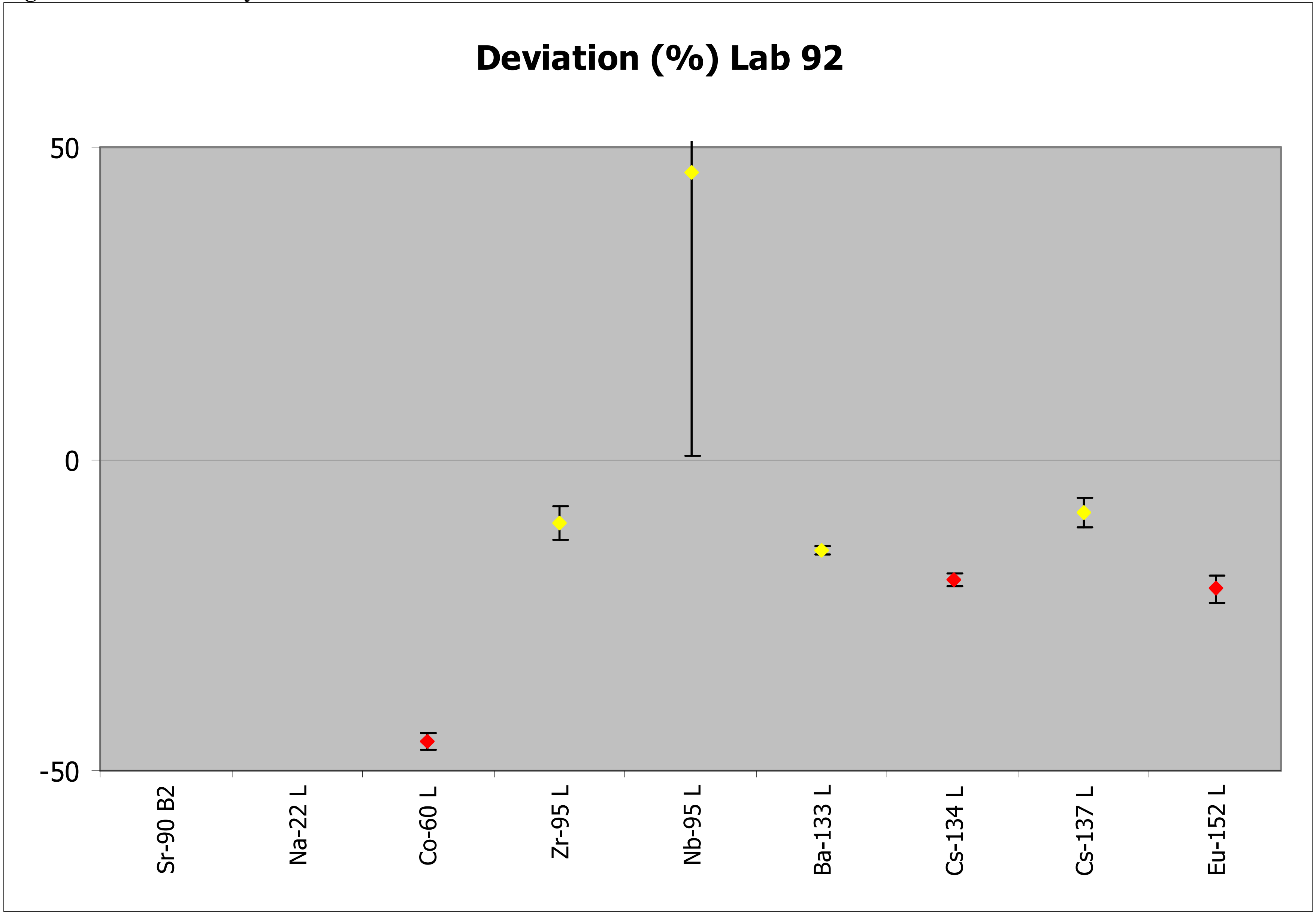


**Figure 116 – Laboratory 93**

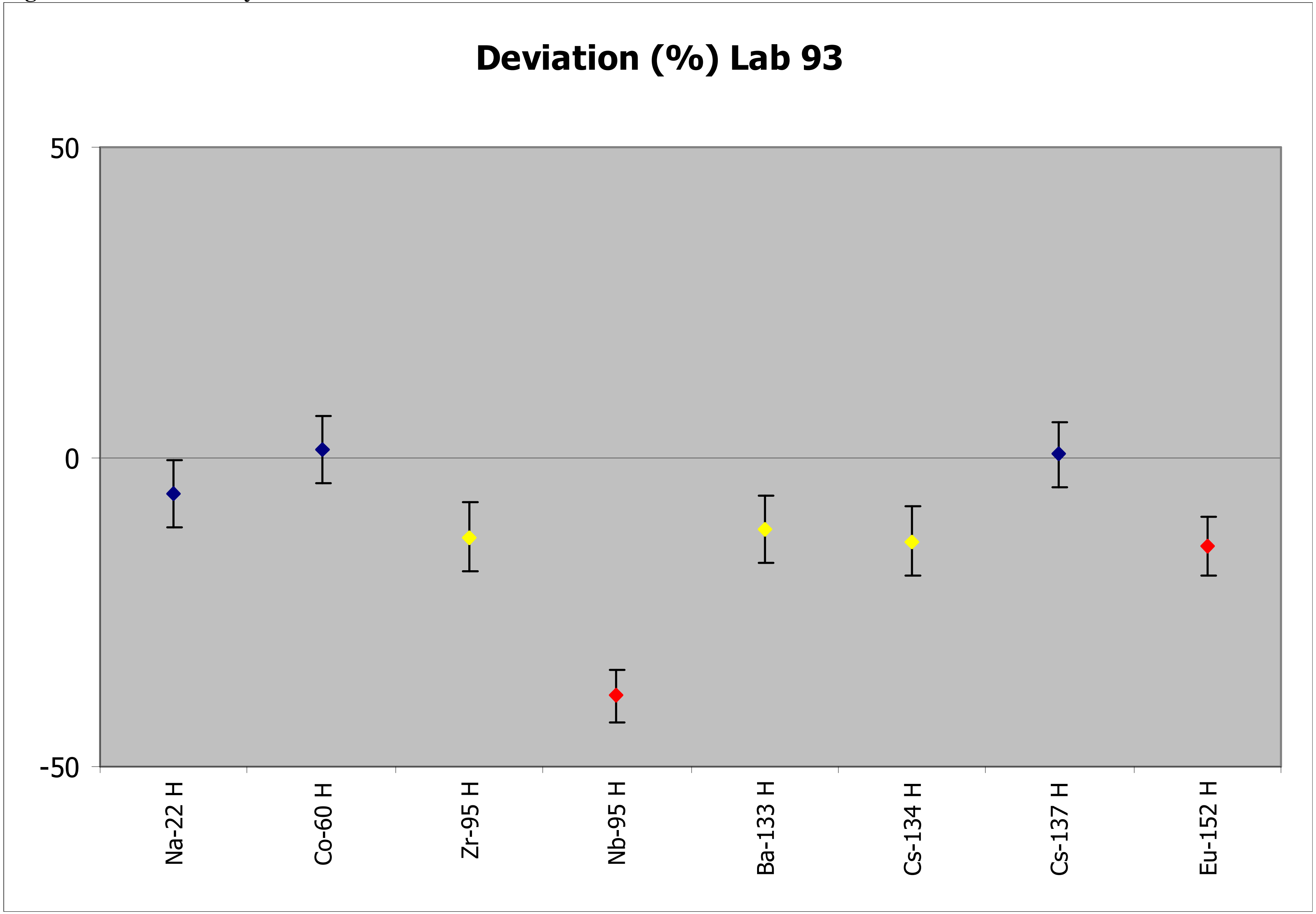


**Figure 117 – Laboratory 94**

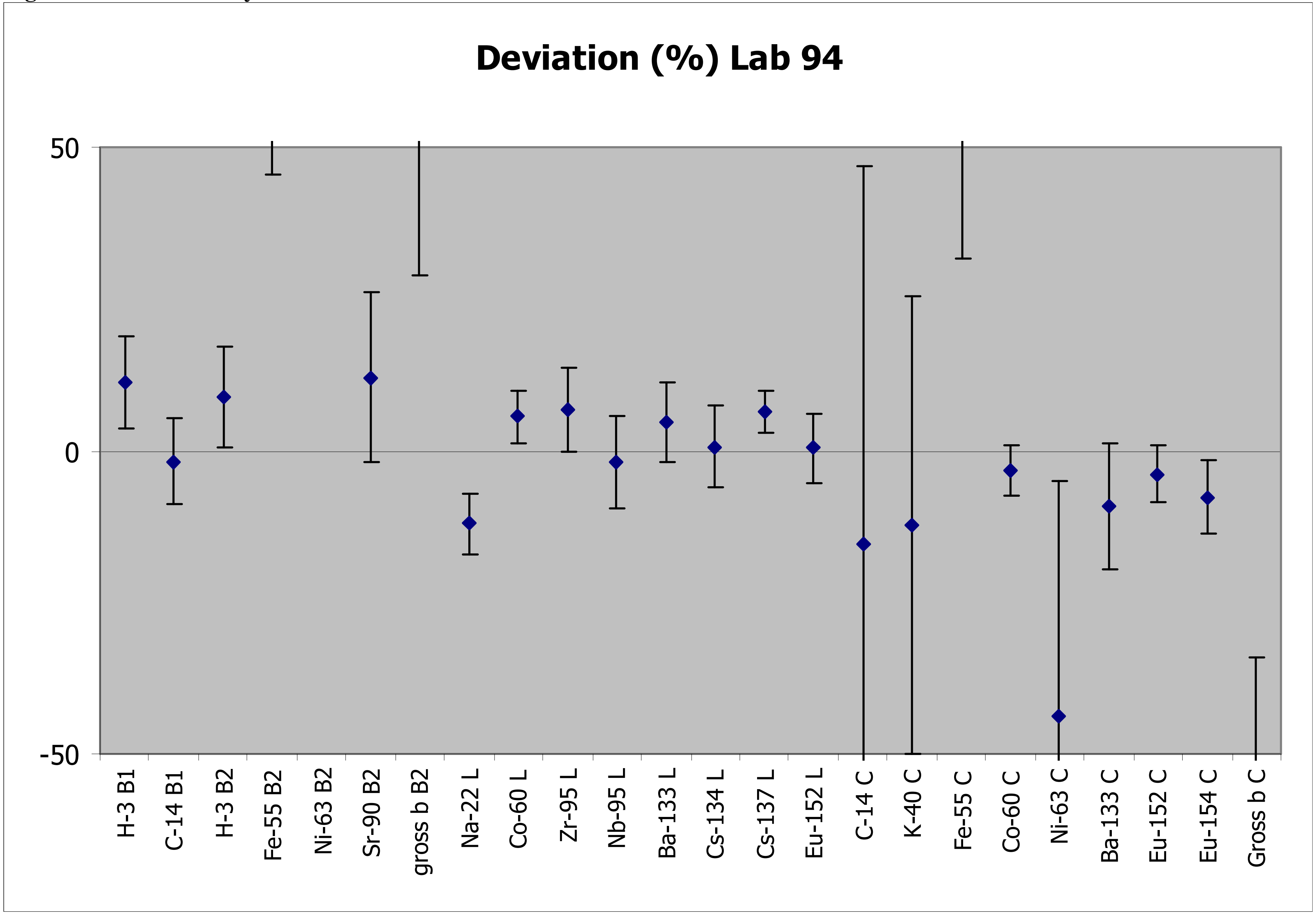


**Figure 118 – Laboratory 95**

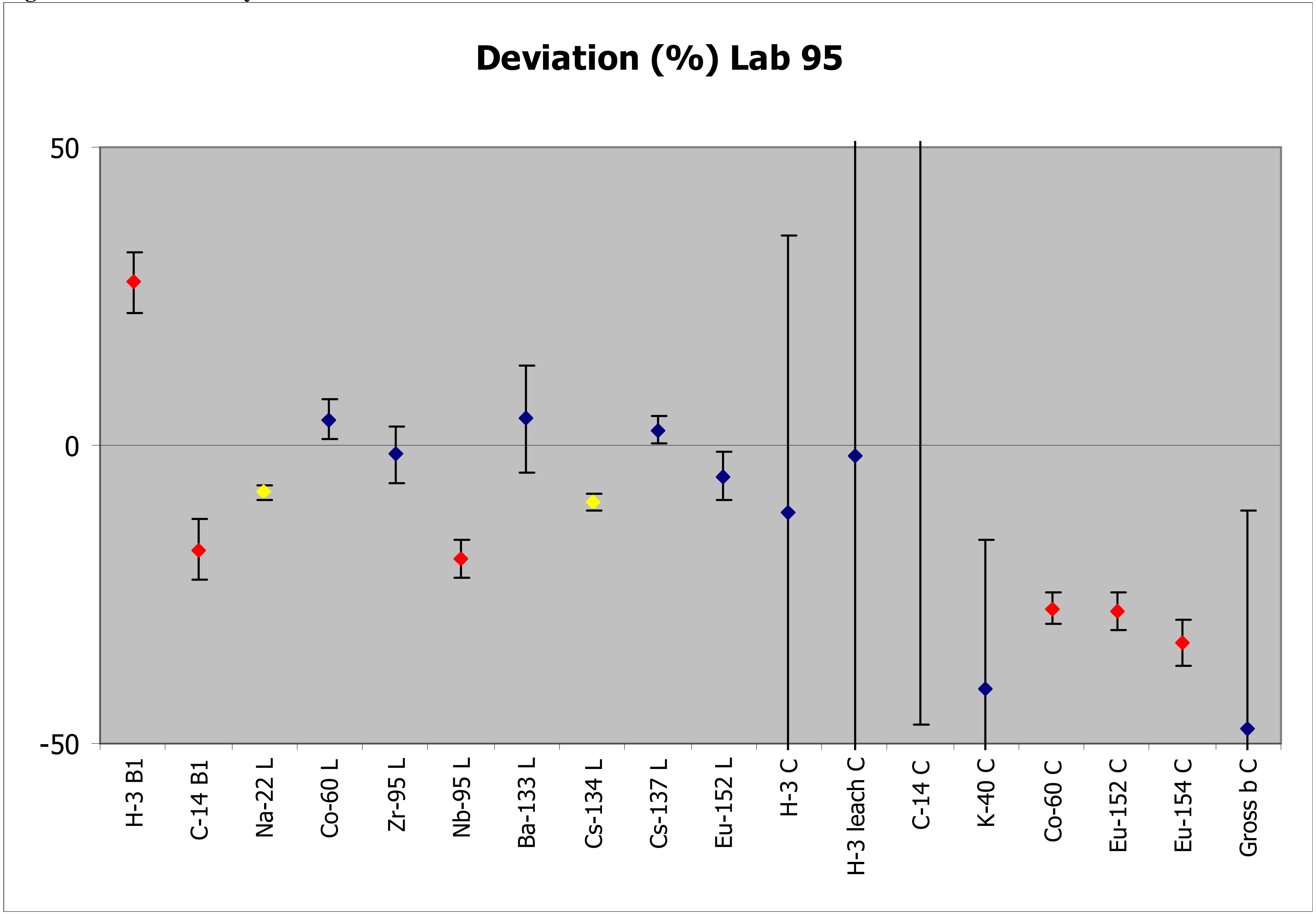


**Figure 119 – Laboratory 96**

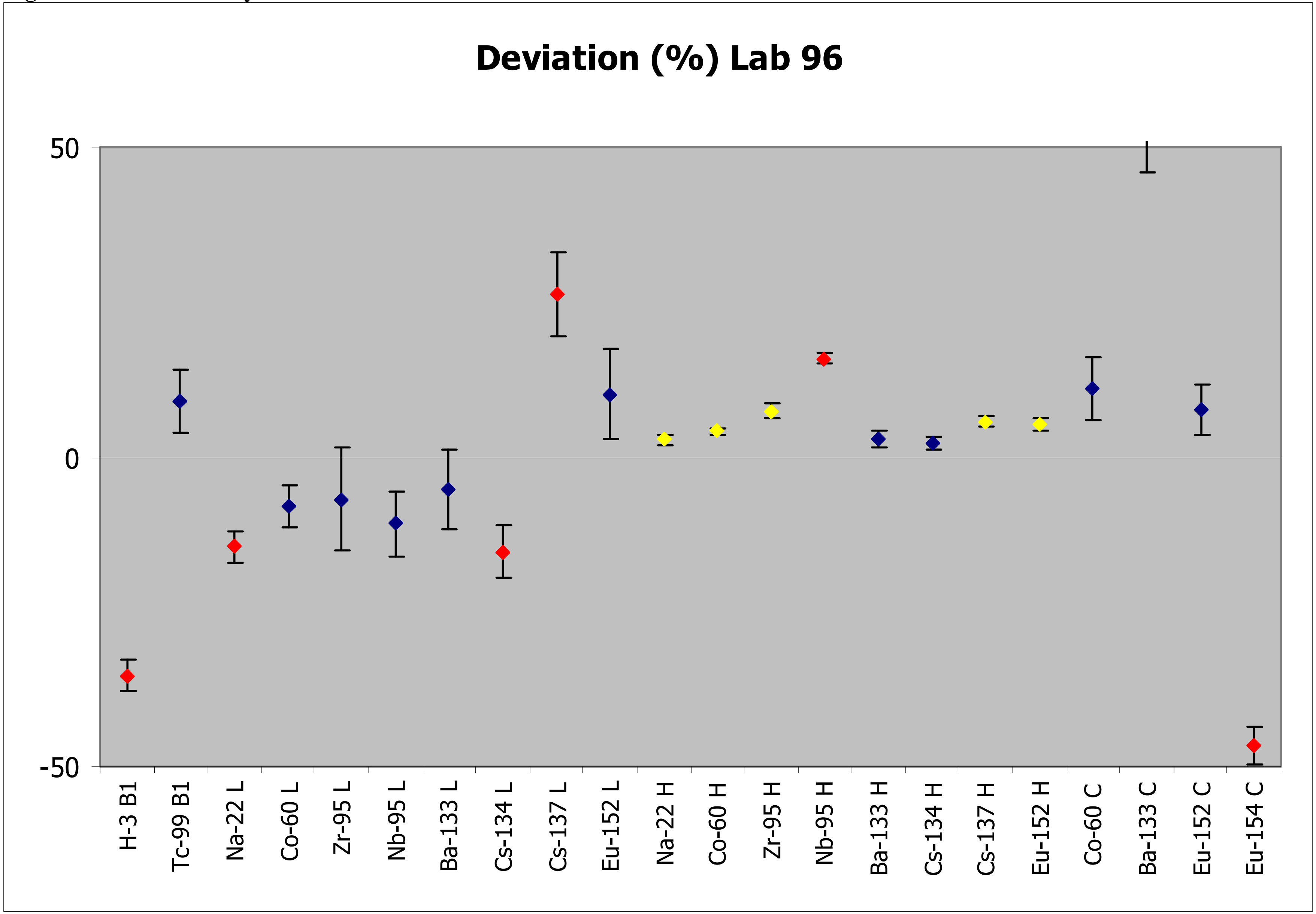


**Figure 120 – Laboratory 97**

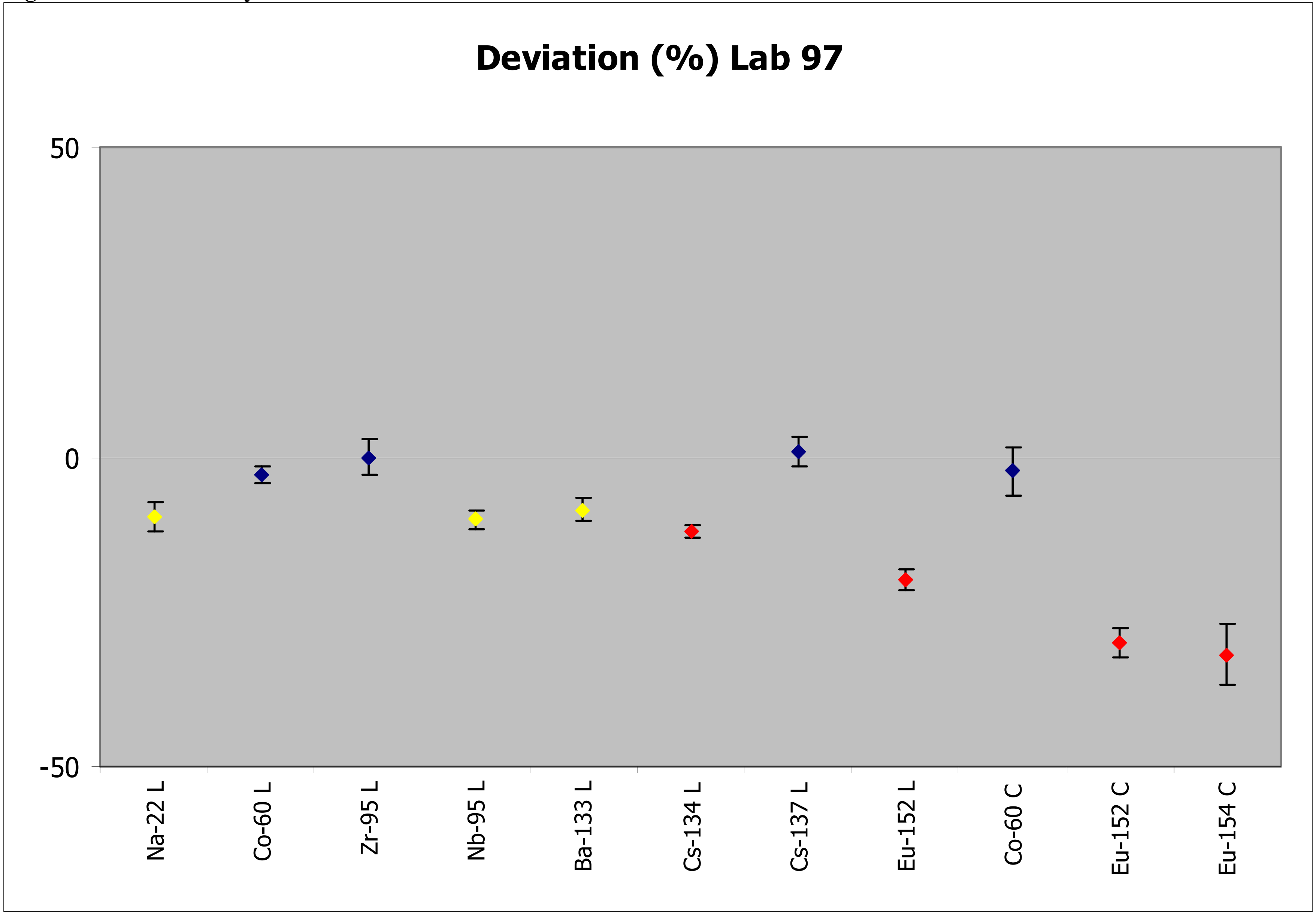


**Figure 121 – Laboratory 98**

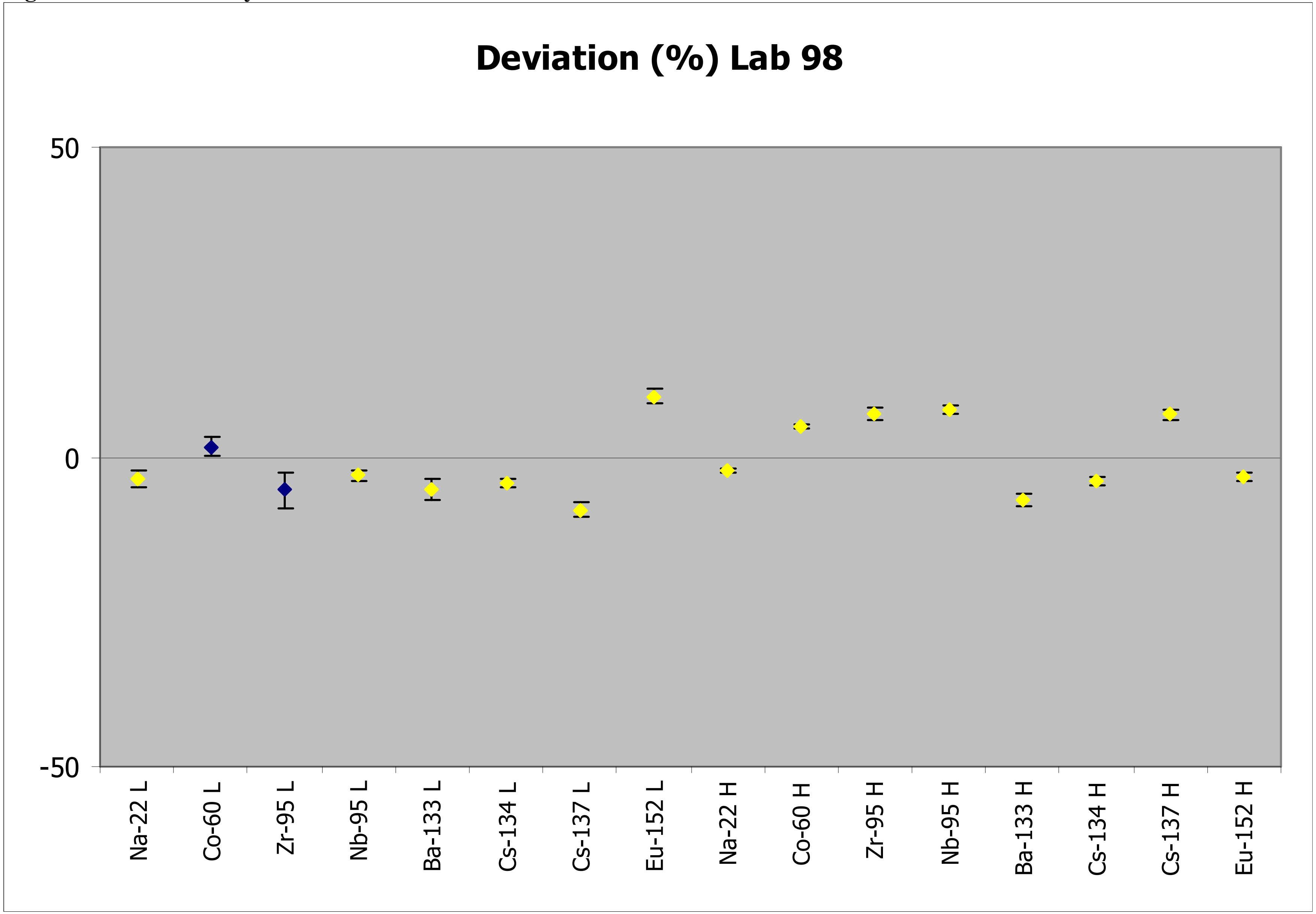


**Figure 122 – Laboratory 101**

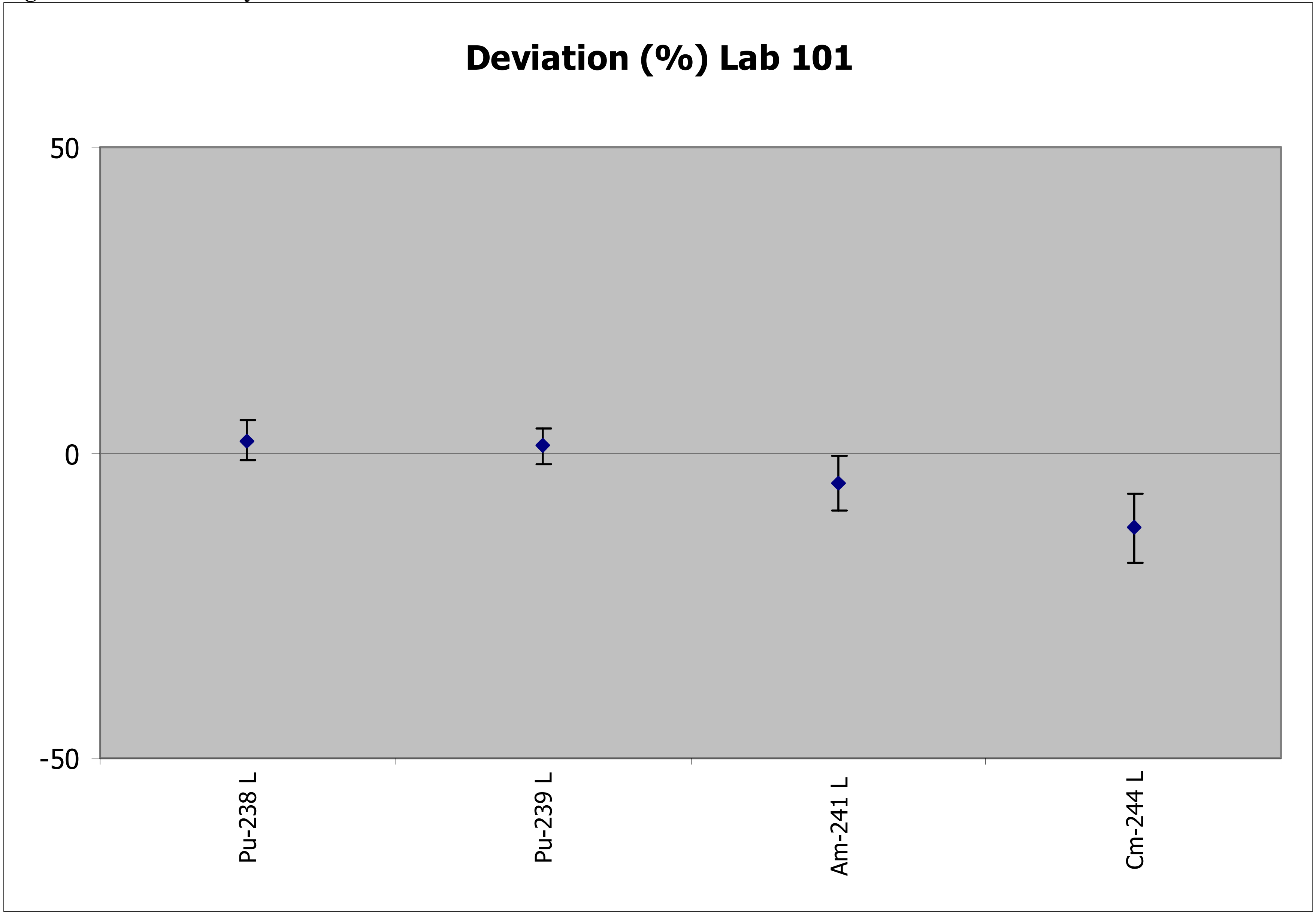


**Figure 123 – Laboratory 102**

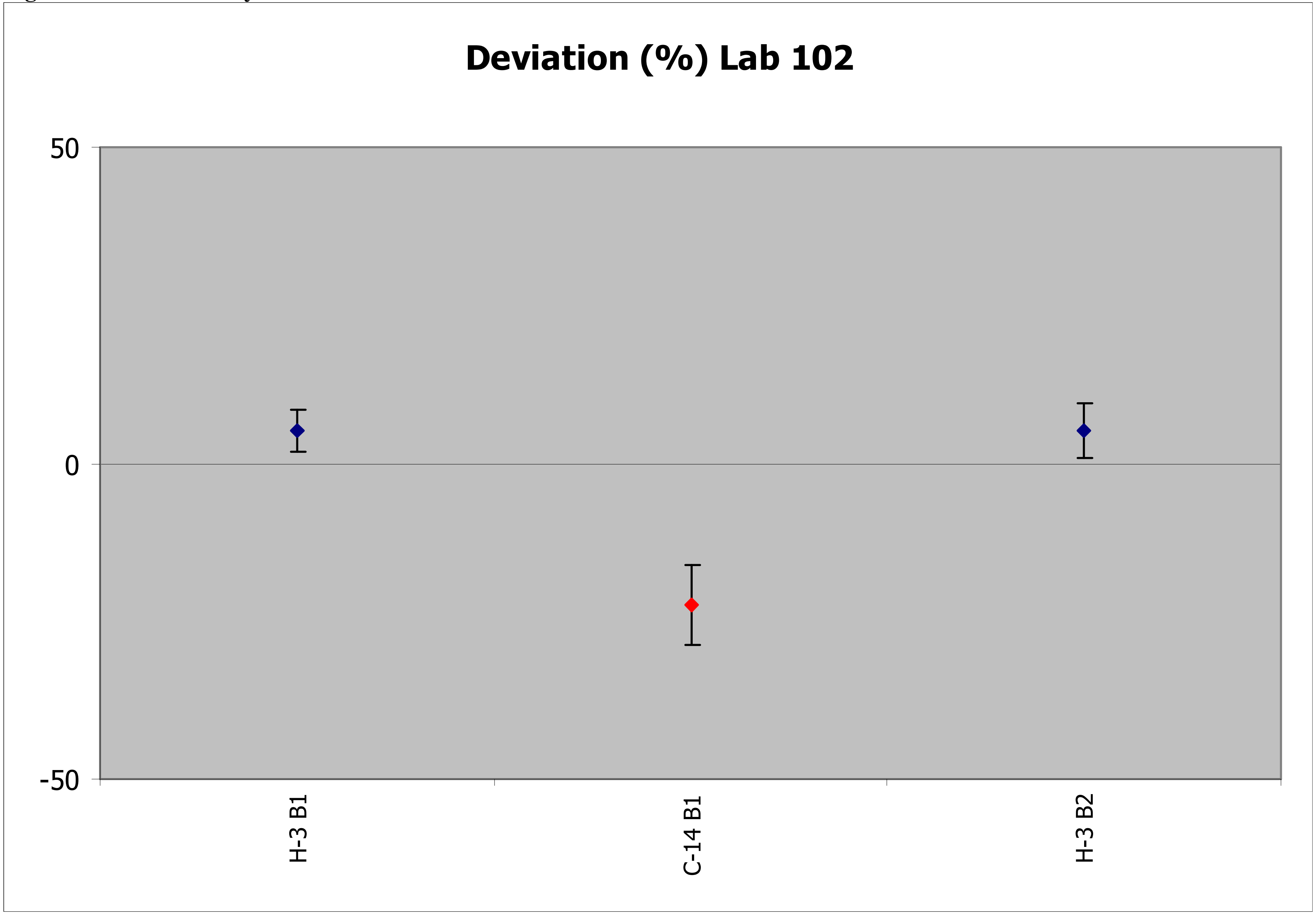


**Figure 124 – Laboratory 103**

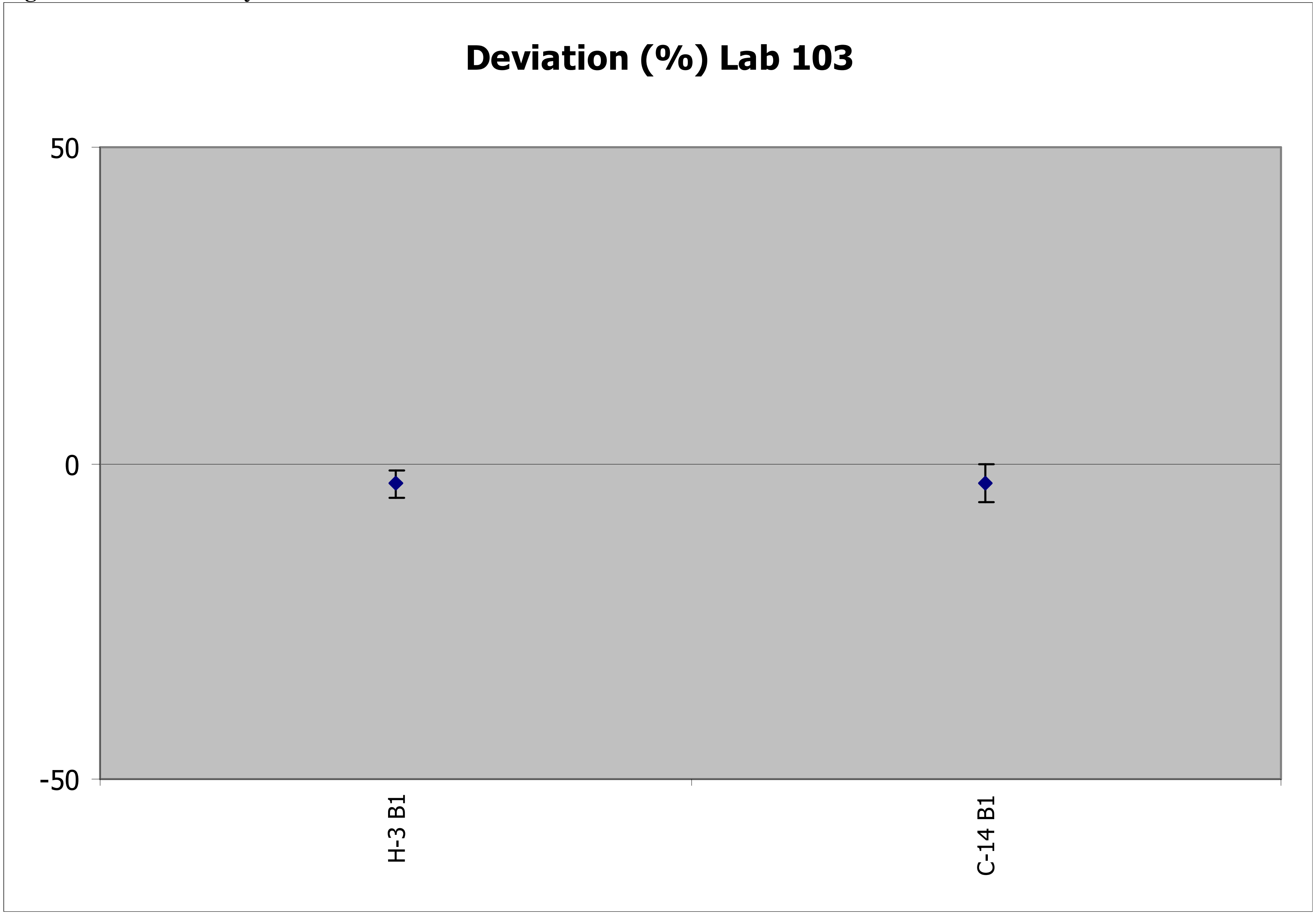


**Figure 125 – Laboratory 104**

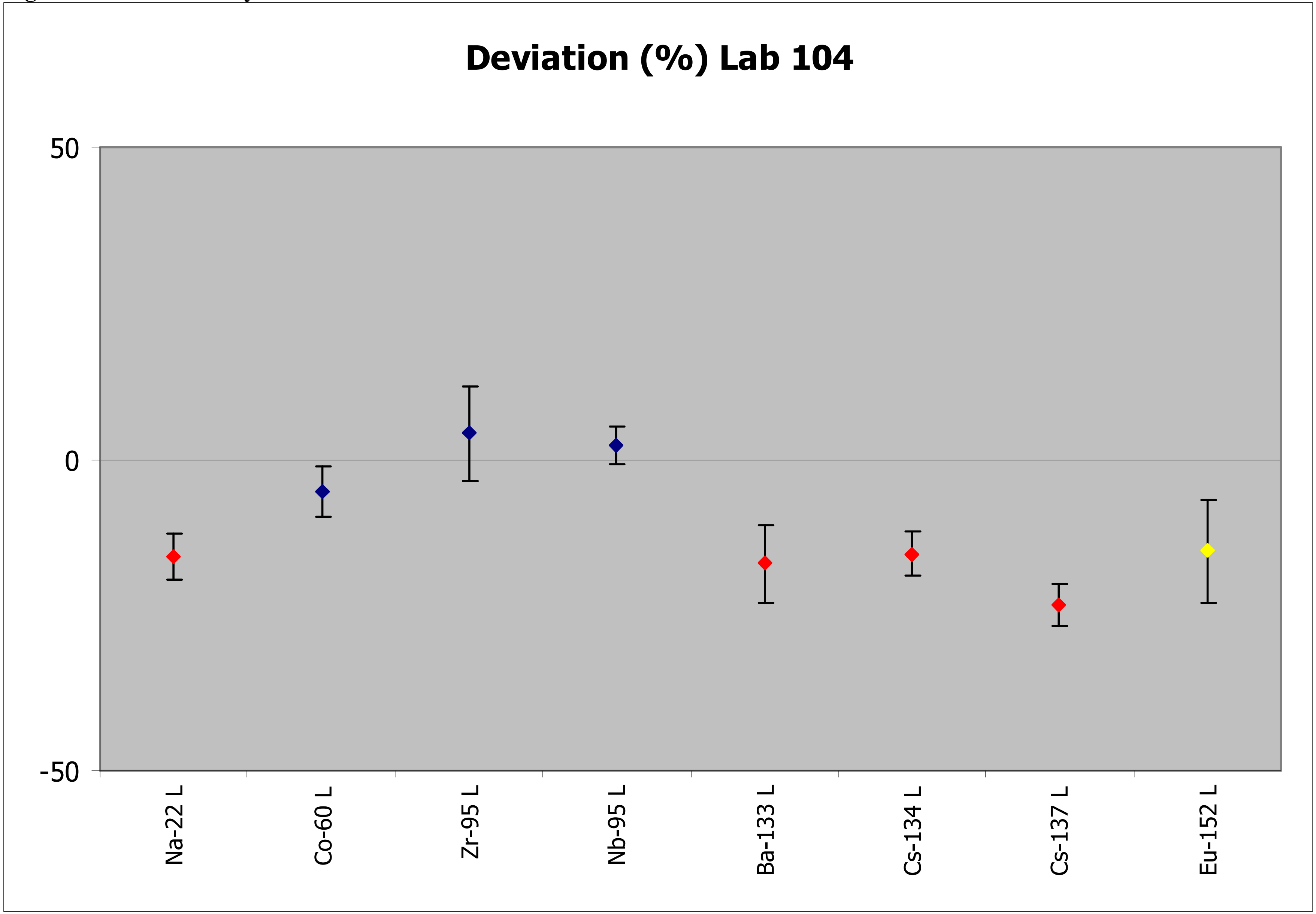


**Figure 126 – Laboratory 105**

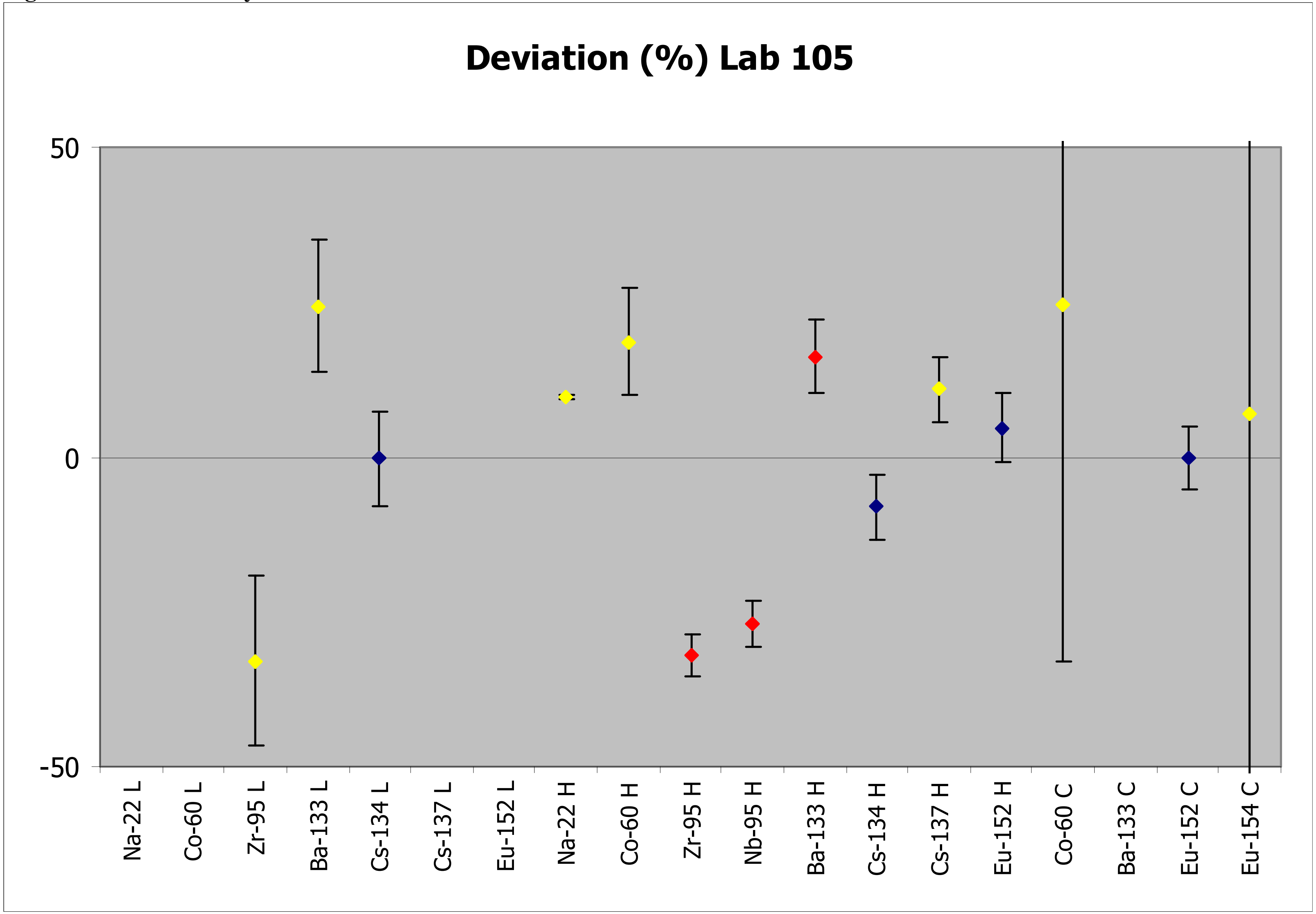


**Figure 127 – Laboratory 106**

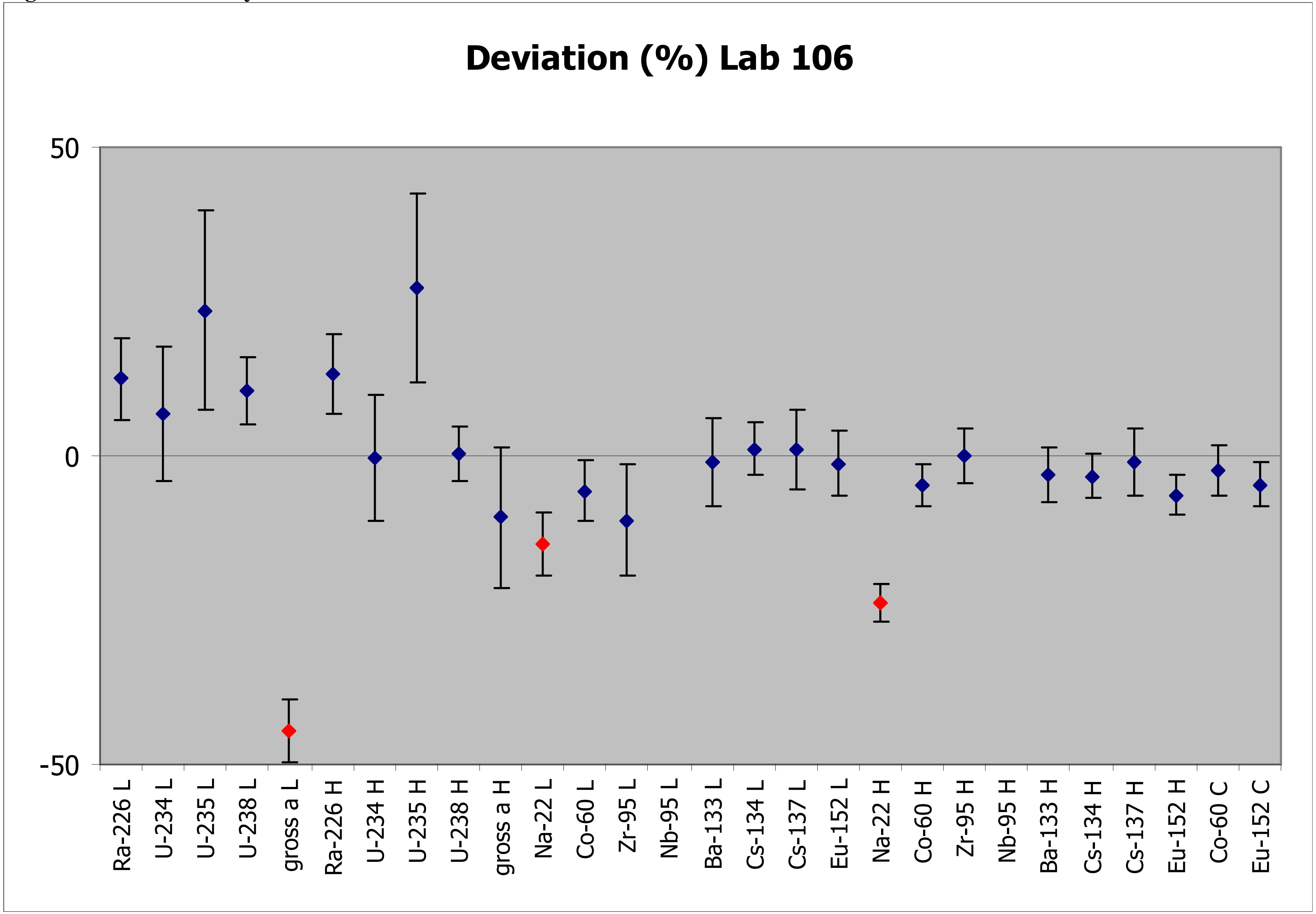


**Figure 128 – Laboratory 107**

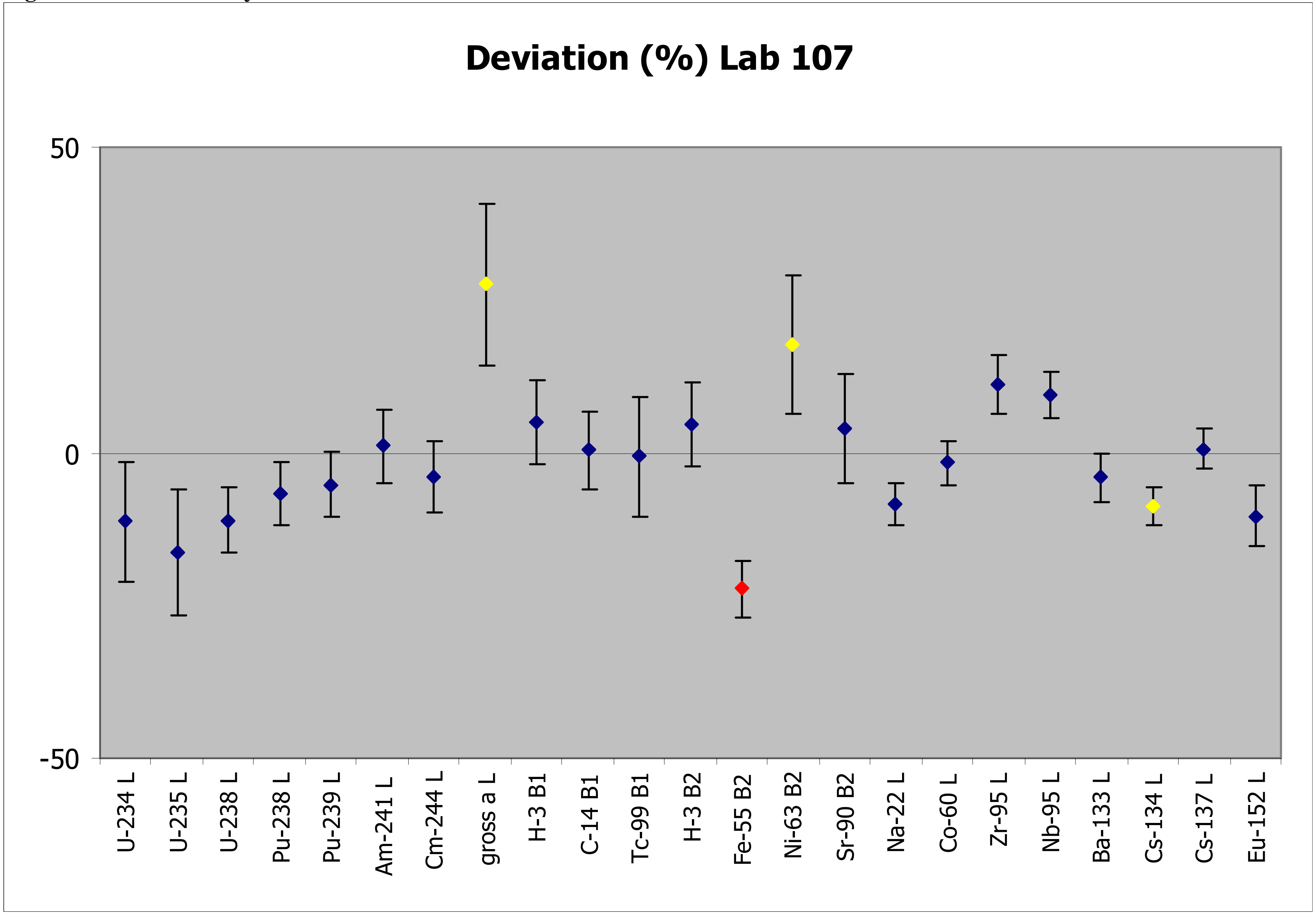


**Figure 129 – Laboratory 108**

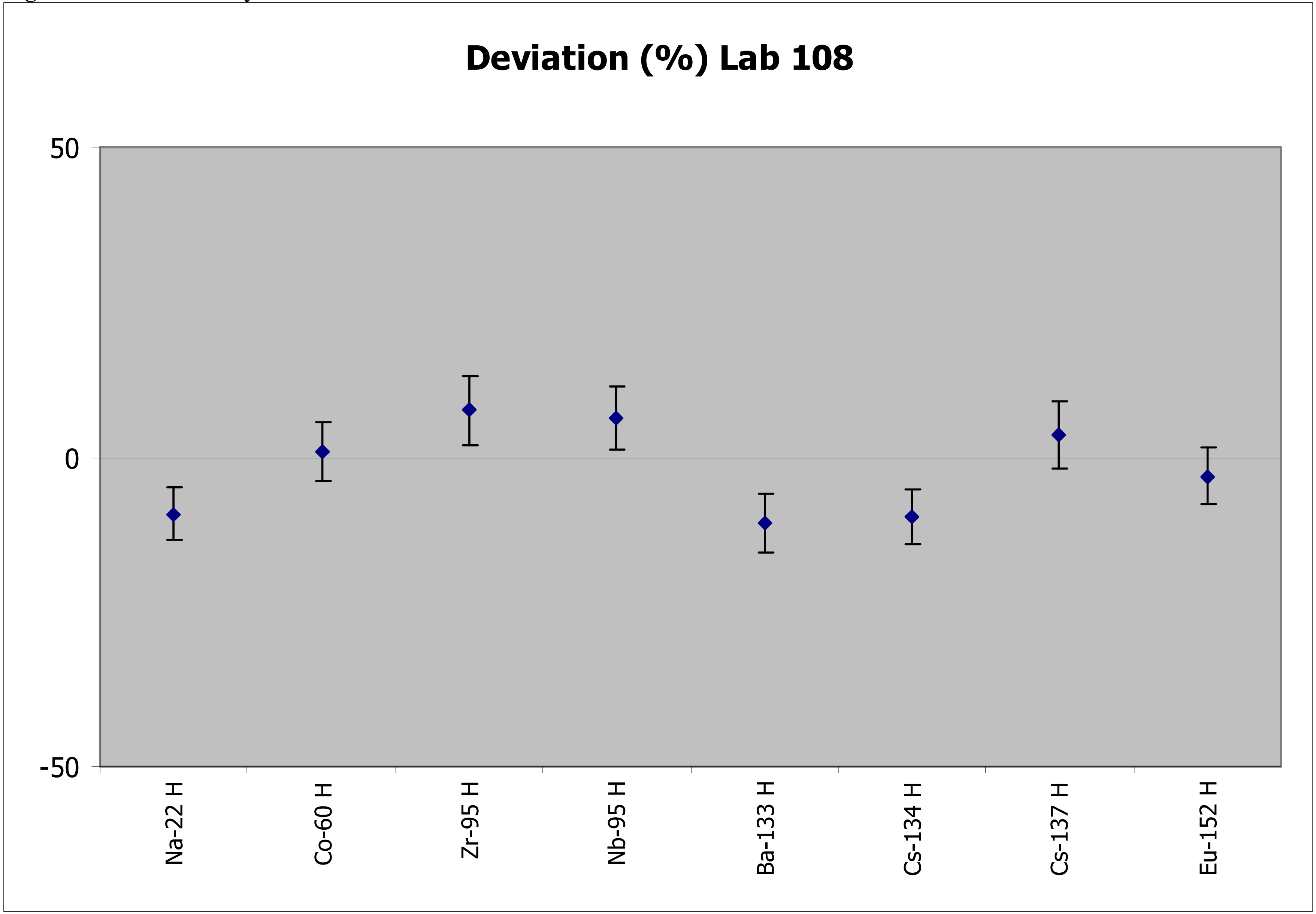


**Figure 130 – Laboratory 109**

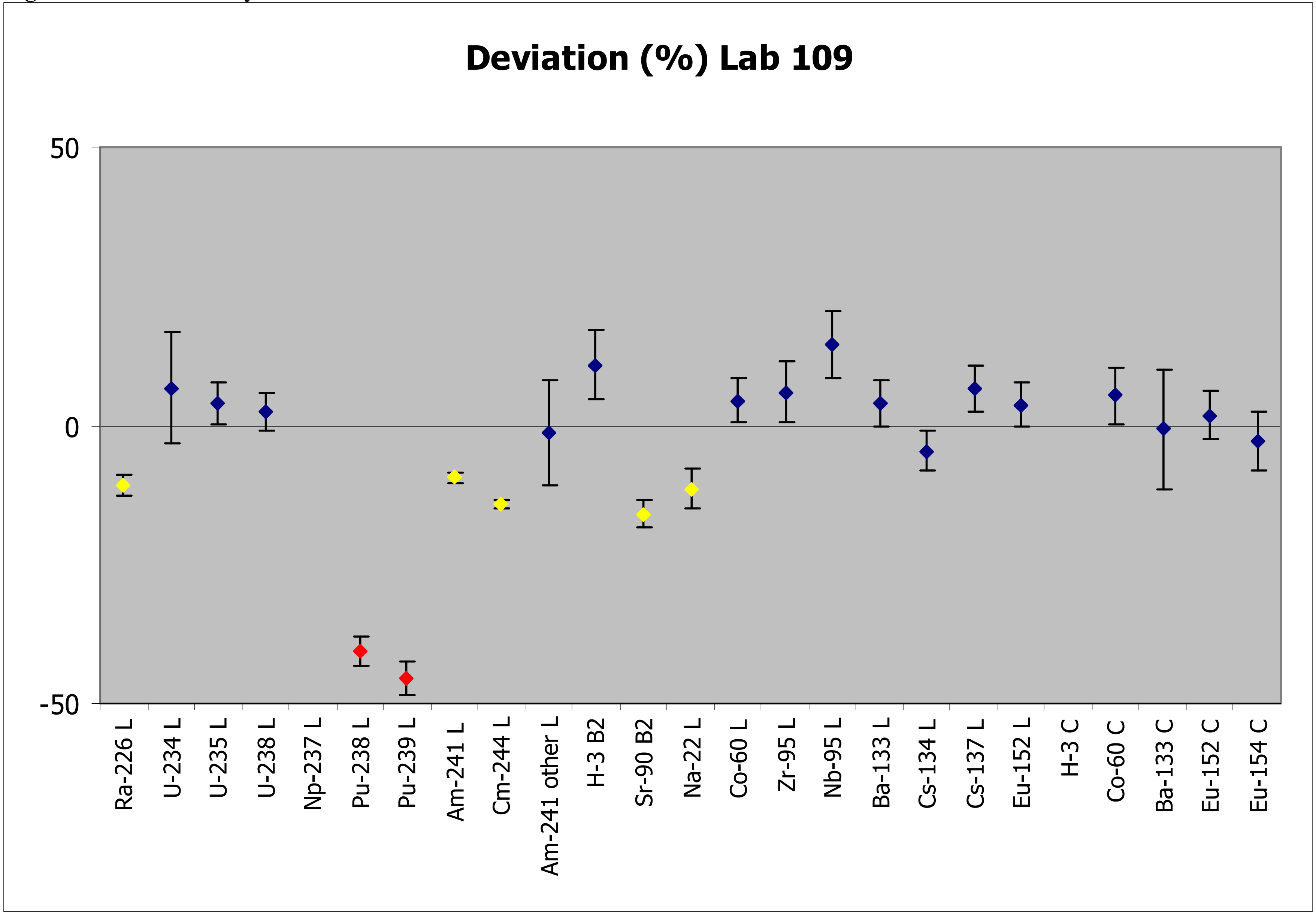


**Figure 131 – Laboratory 110**

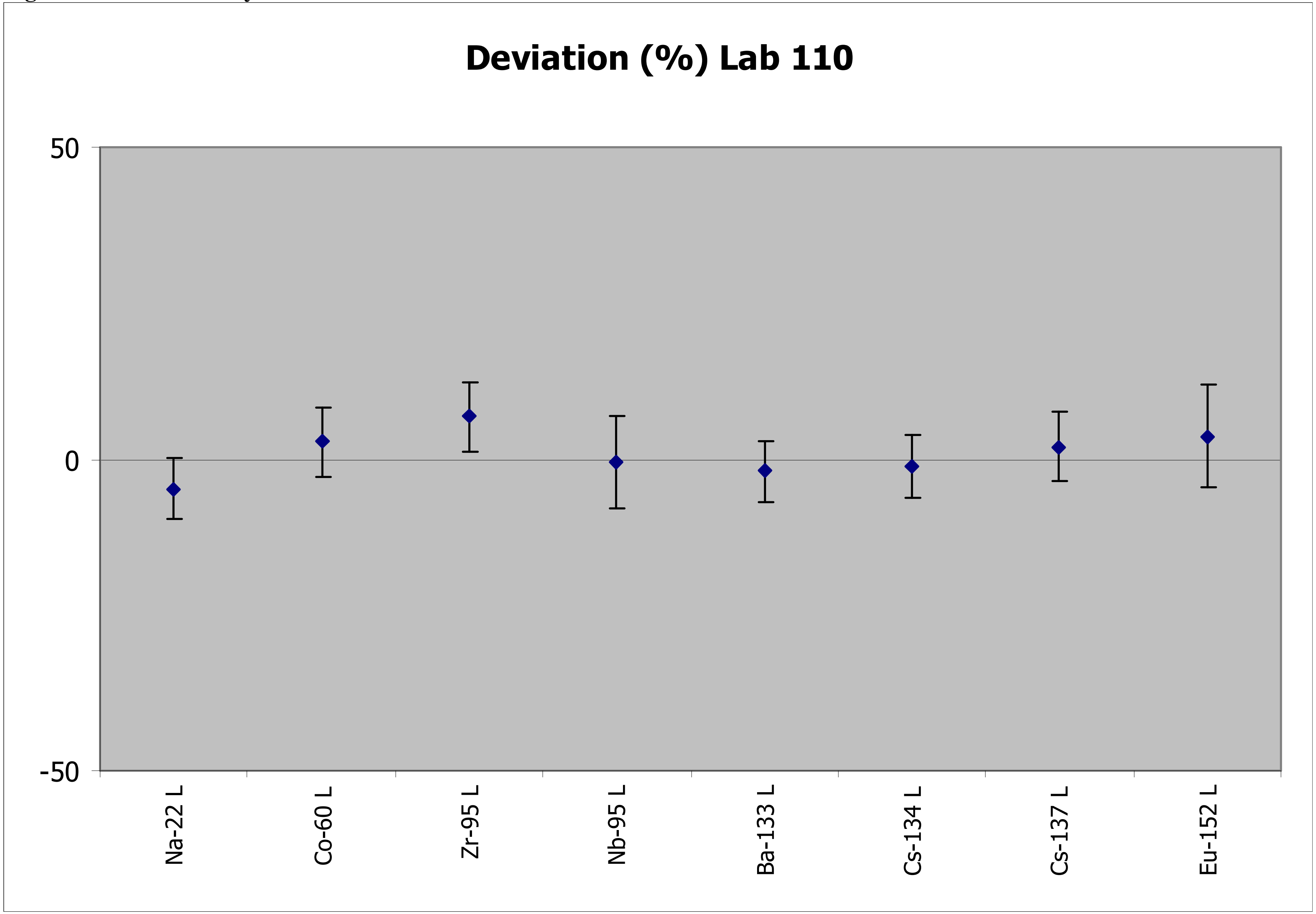


**Figure 132 – Laboratory 111**

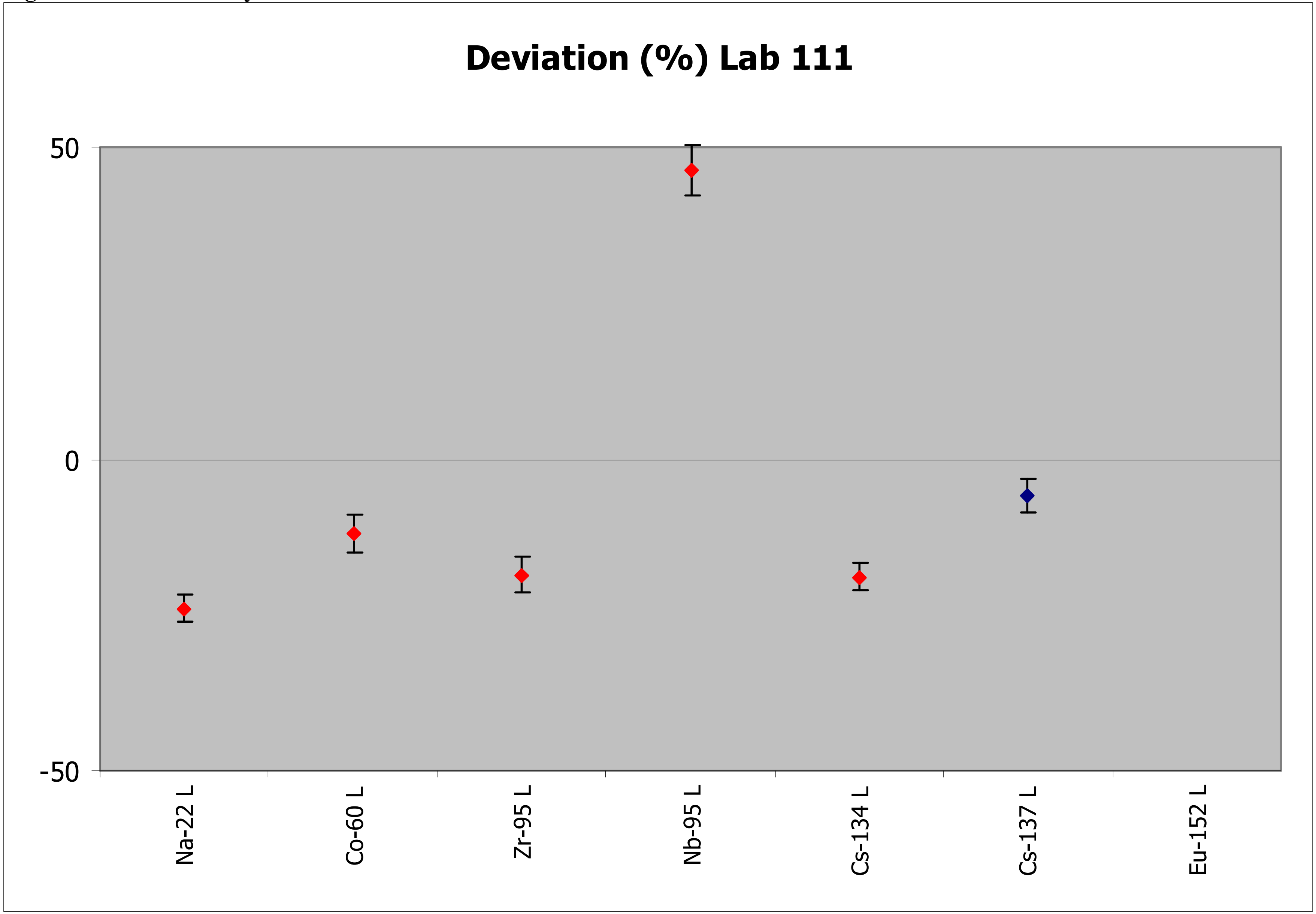


**Figure 133 – Laboratory 112**

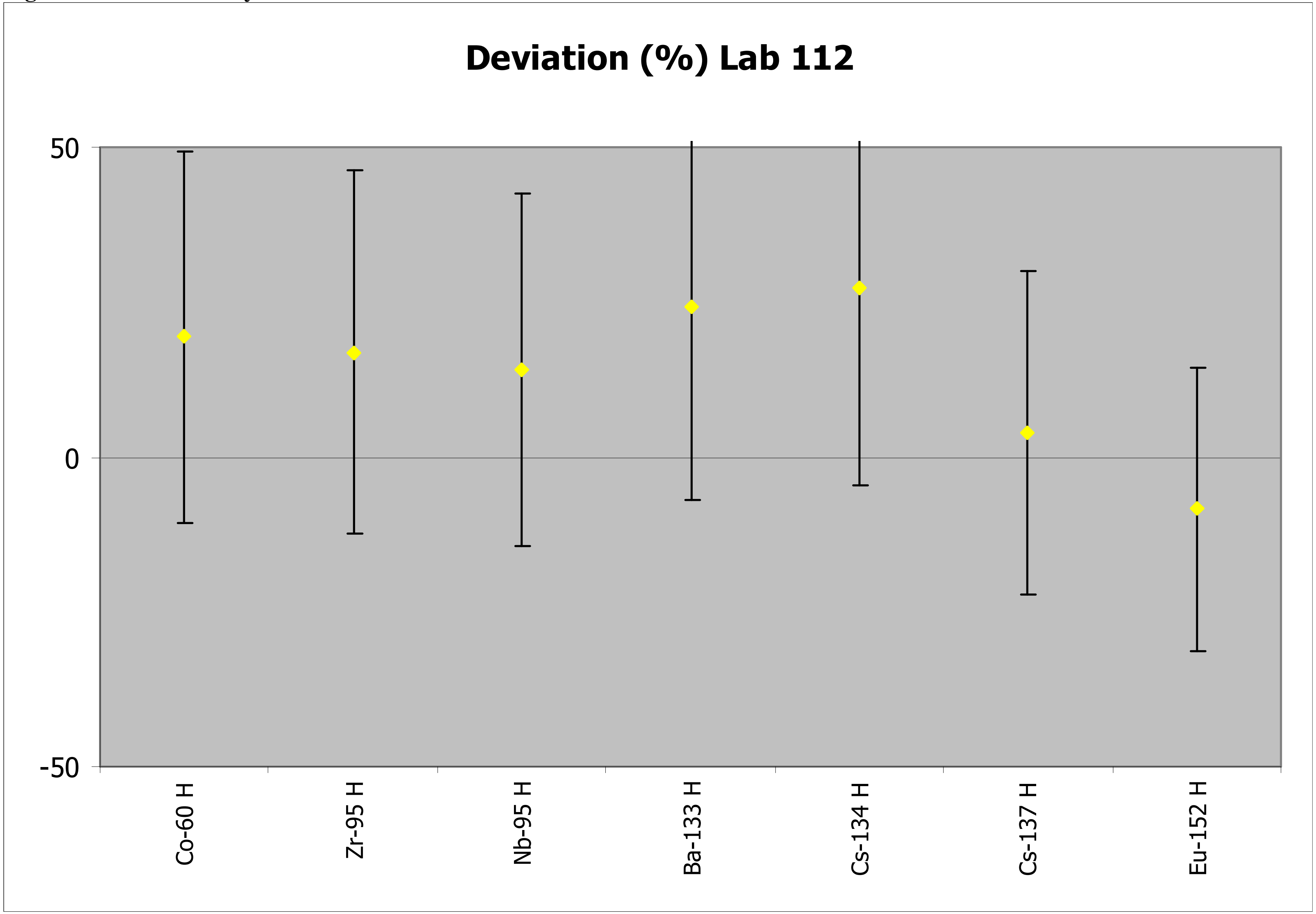


**Figure 134 – Laboratory 113**

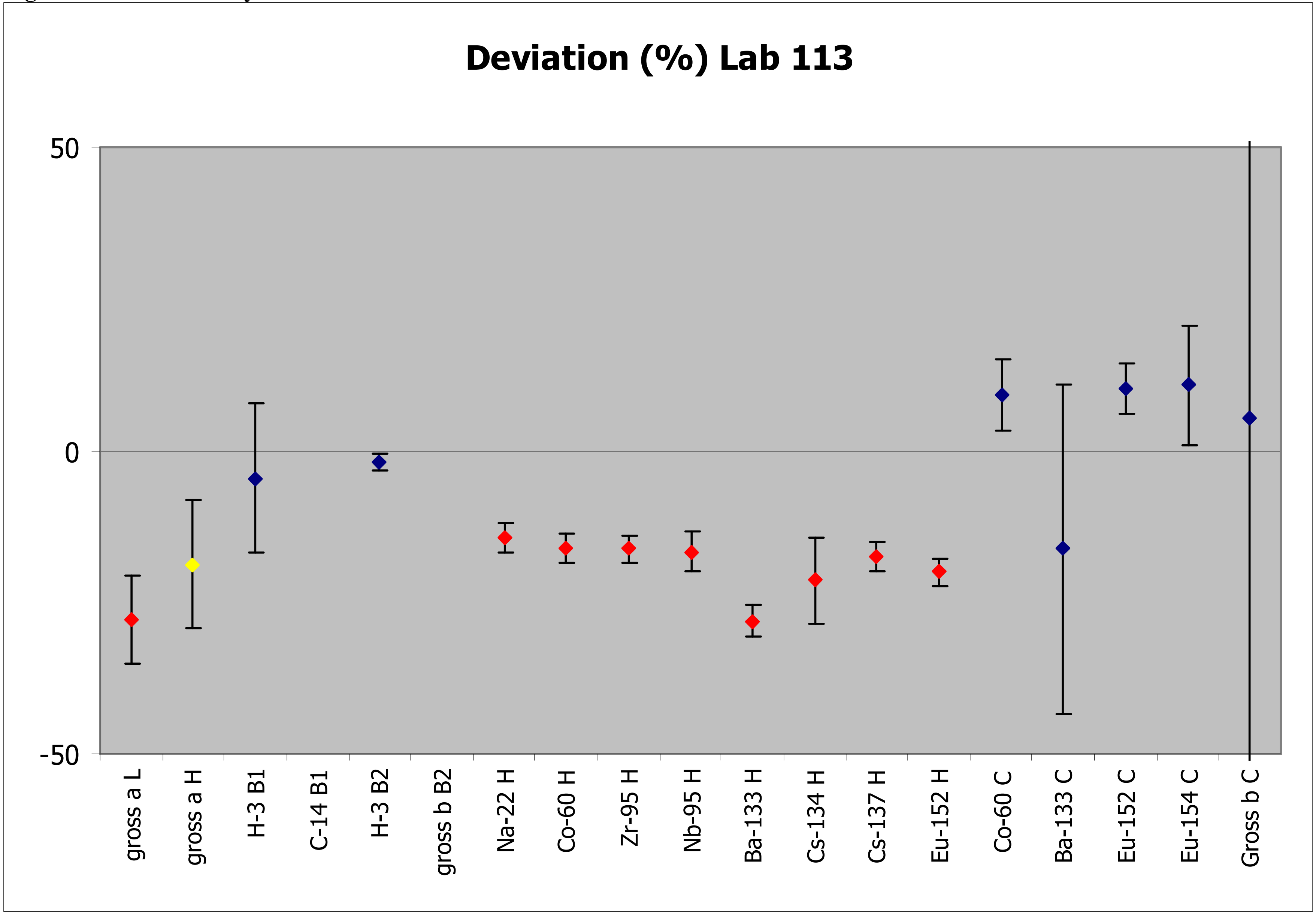


**Figure 135 – Median relative uncertainties**

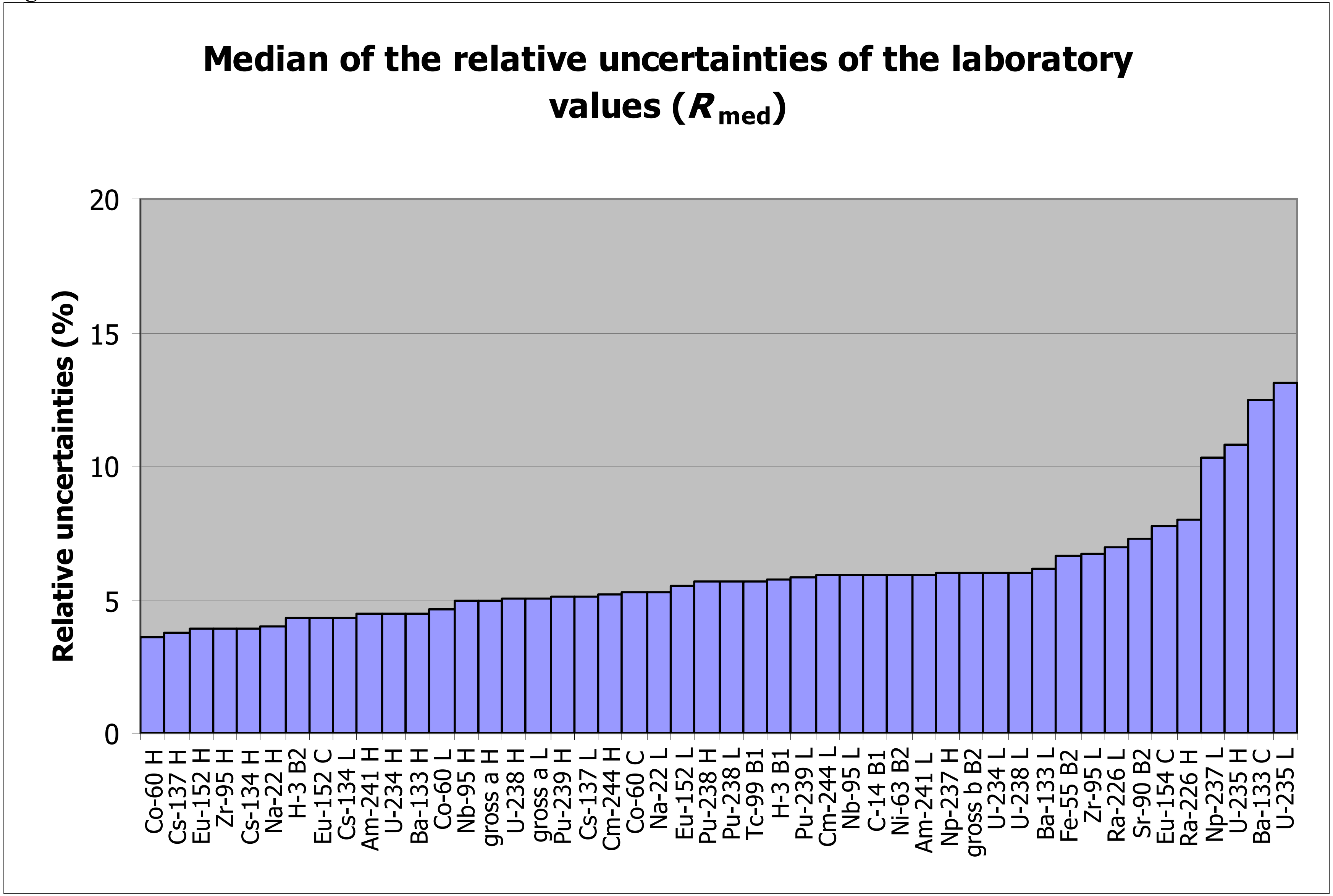


**Figure 136 – Outlier limits relative uncertainties**

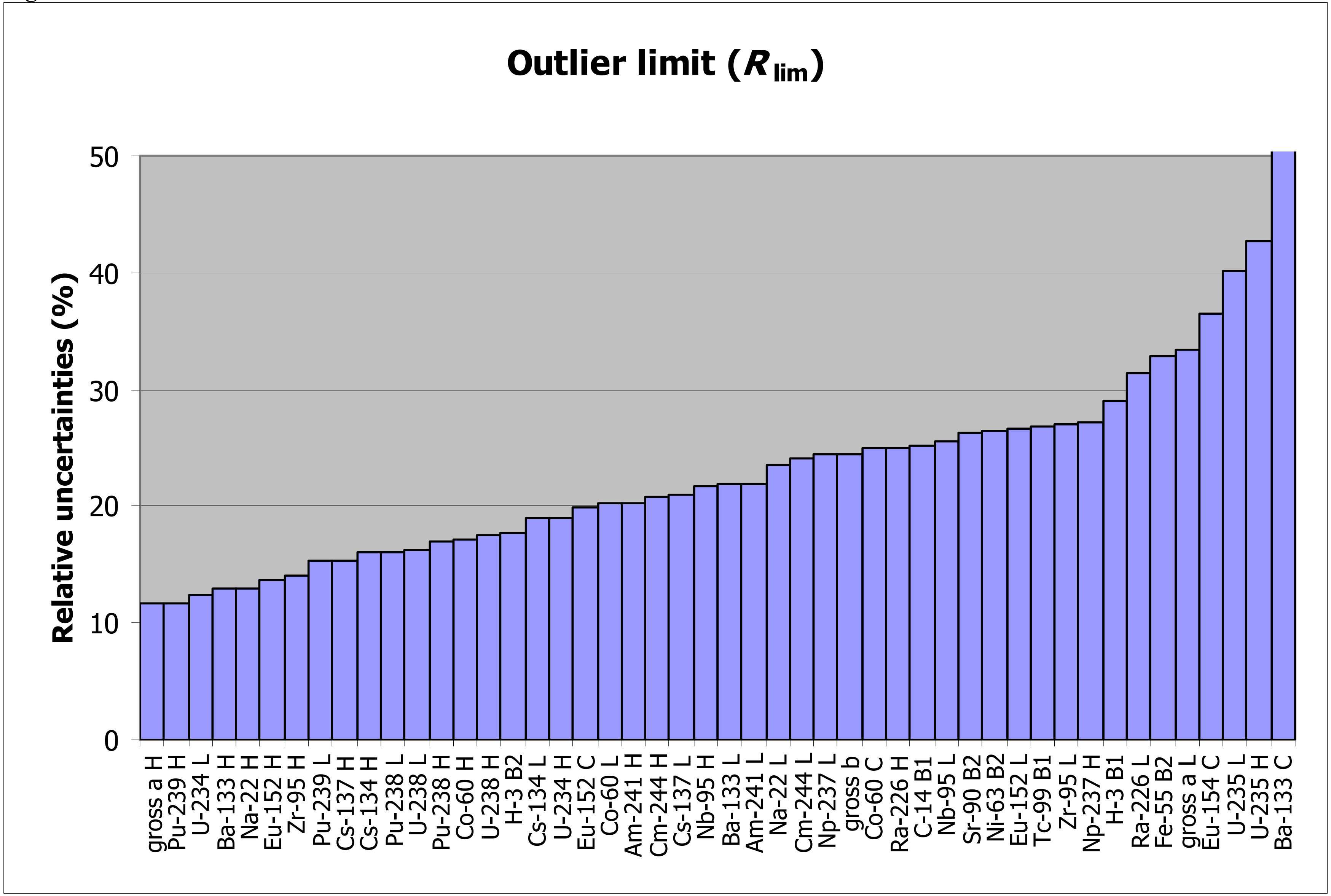


**Figure 137A – Normalised $^{234}U$ / $^{238}U$ ratios AL**

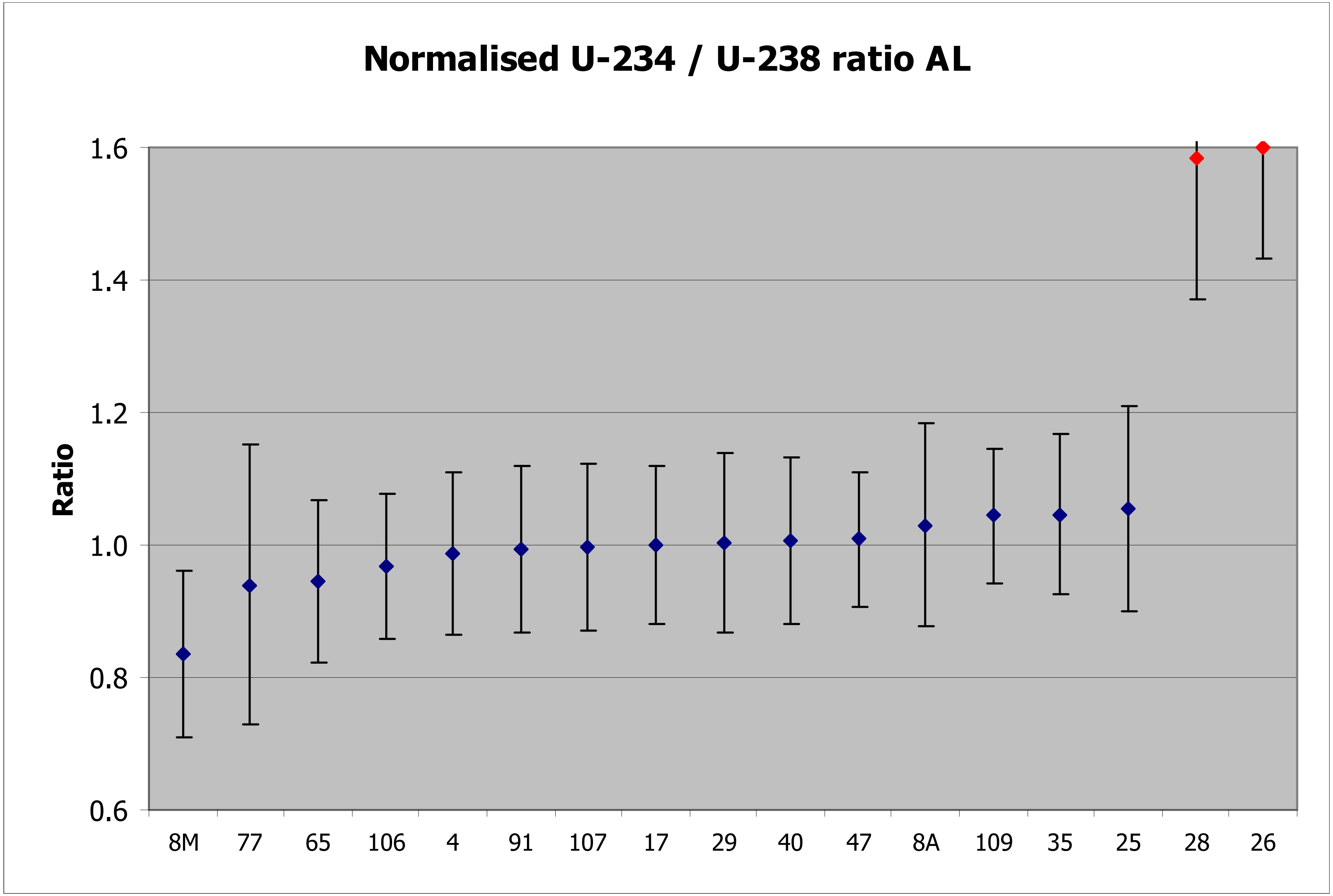


**Figure 137B – Normalised $^{234}U$ / $^{238}U$ ratios AH**

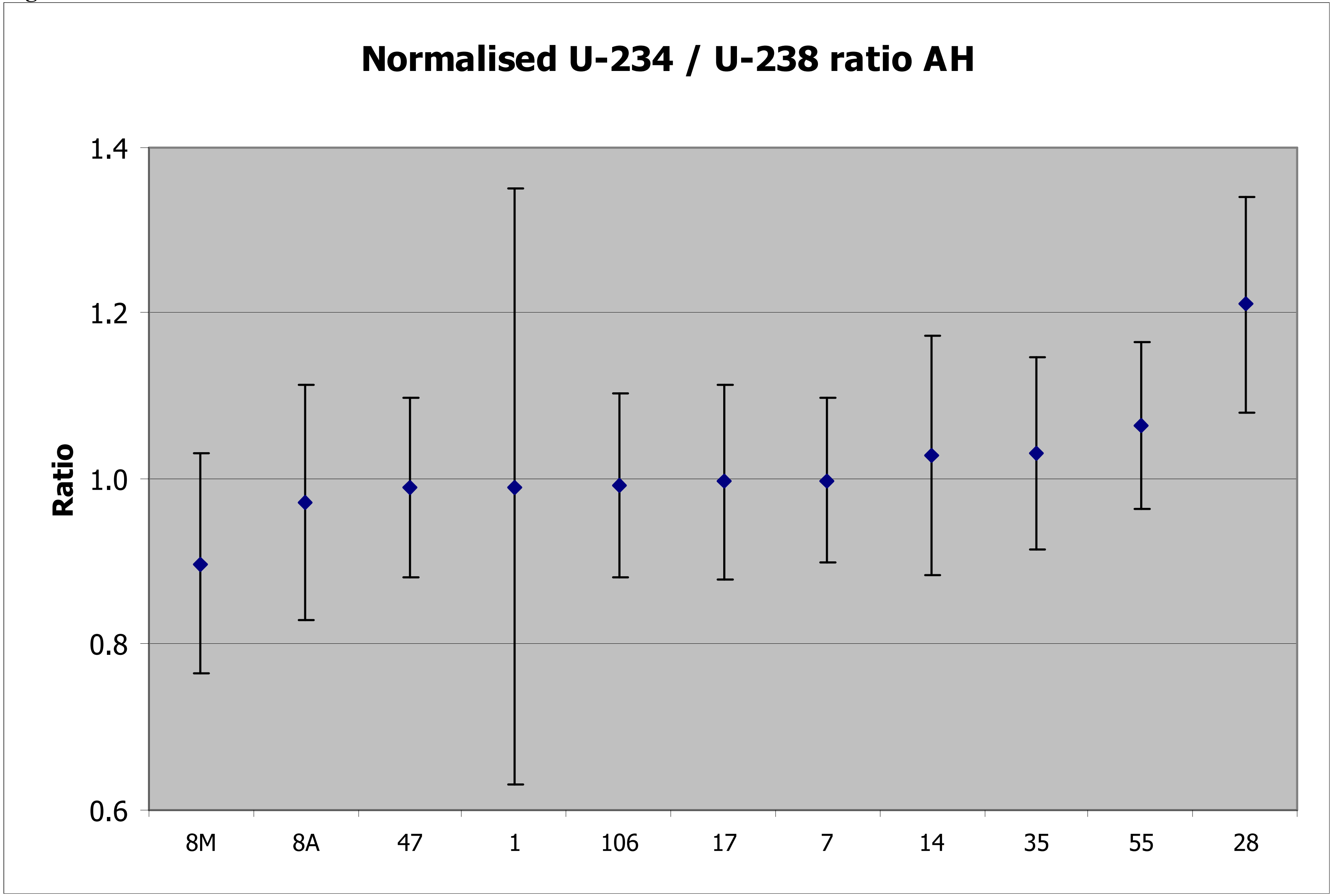


**Figure 138A – Normalised $^{235}U$ / $^{238}U$ ratios AL**

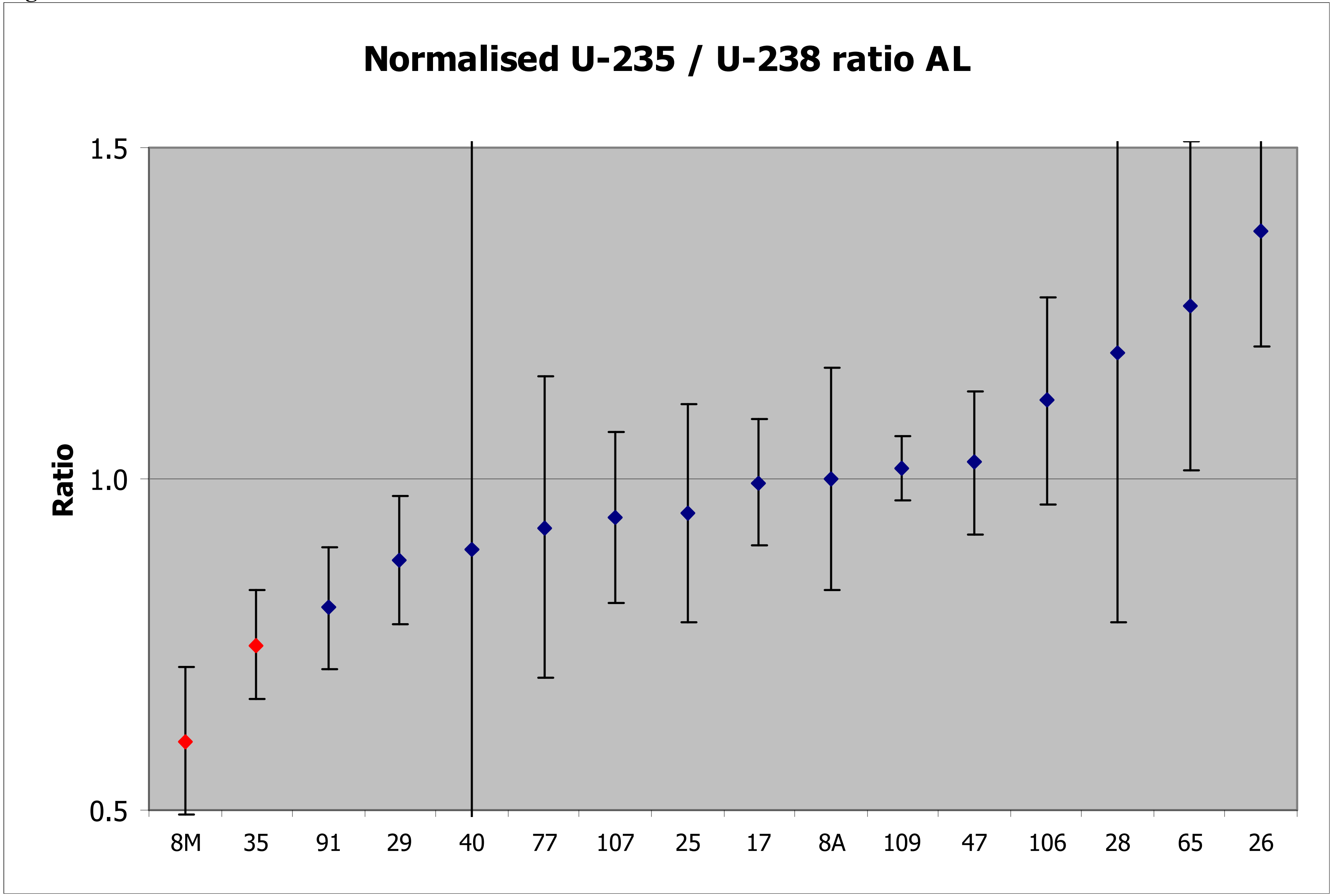


**Figure 138B – Normalised $^{235}U$ / $^{238}U$ ratios AH**

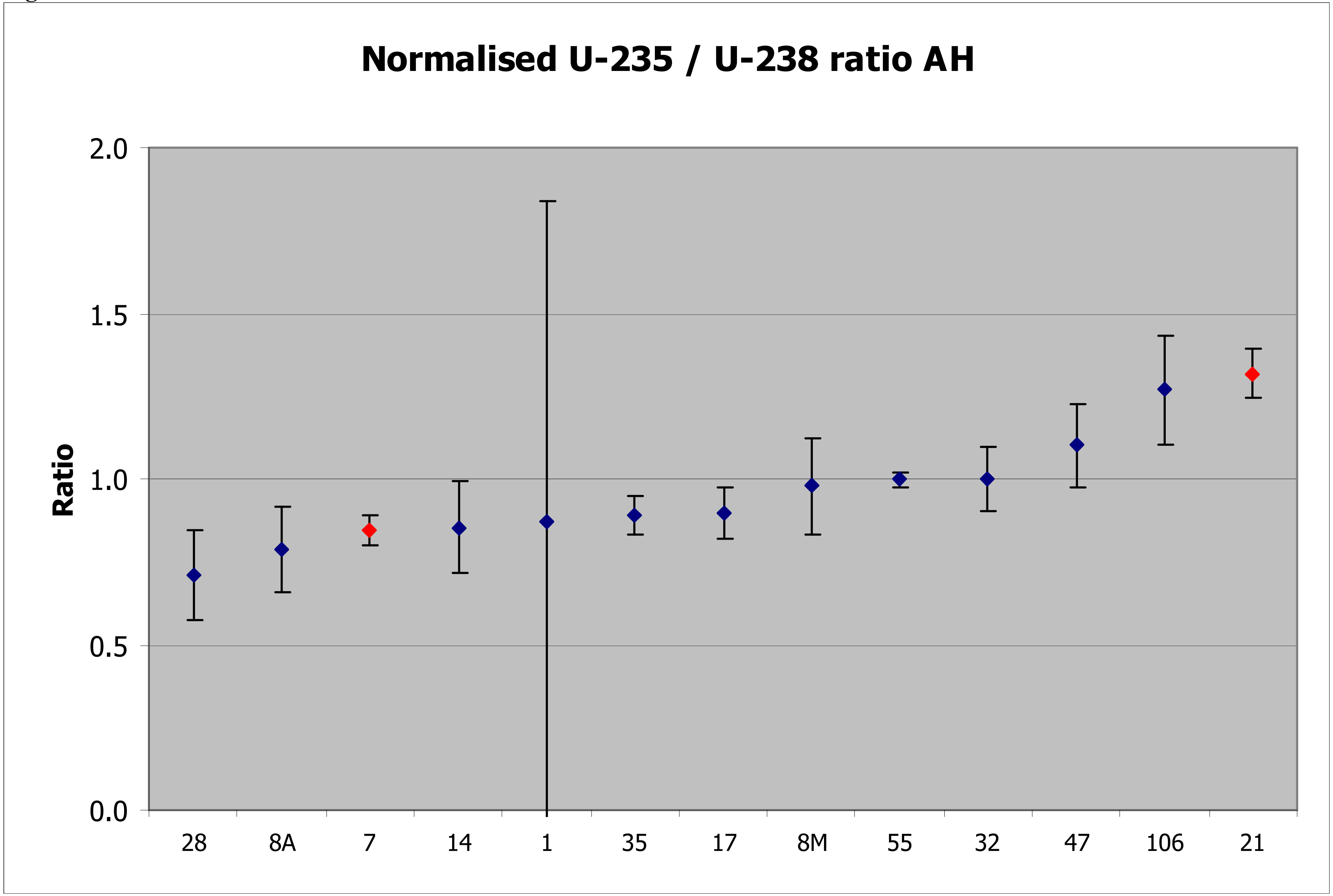


**Figure 139A – Normalised $^{244}Cm$ / $^{241}Am$ ratios AL**

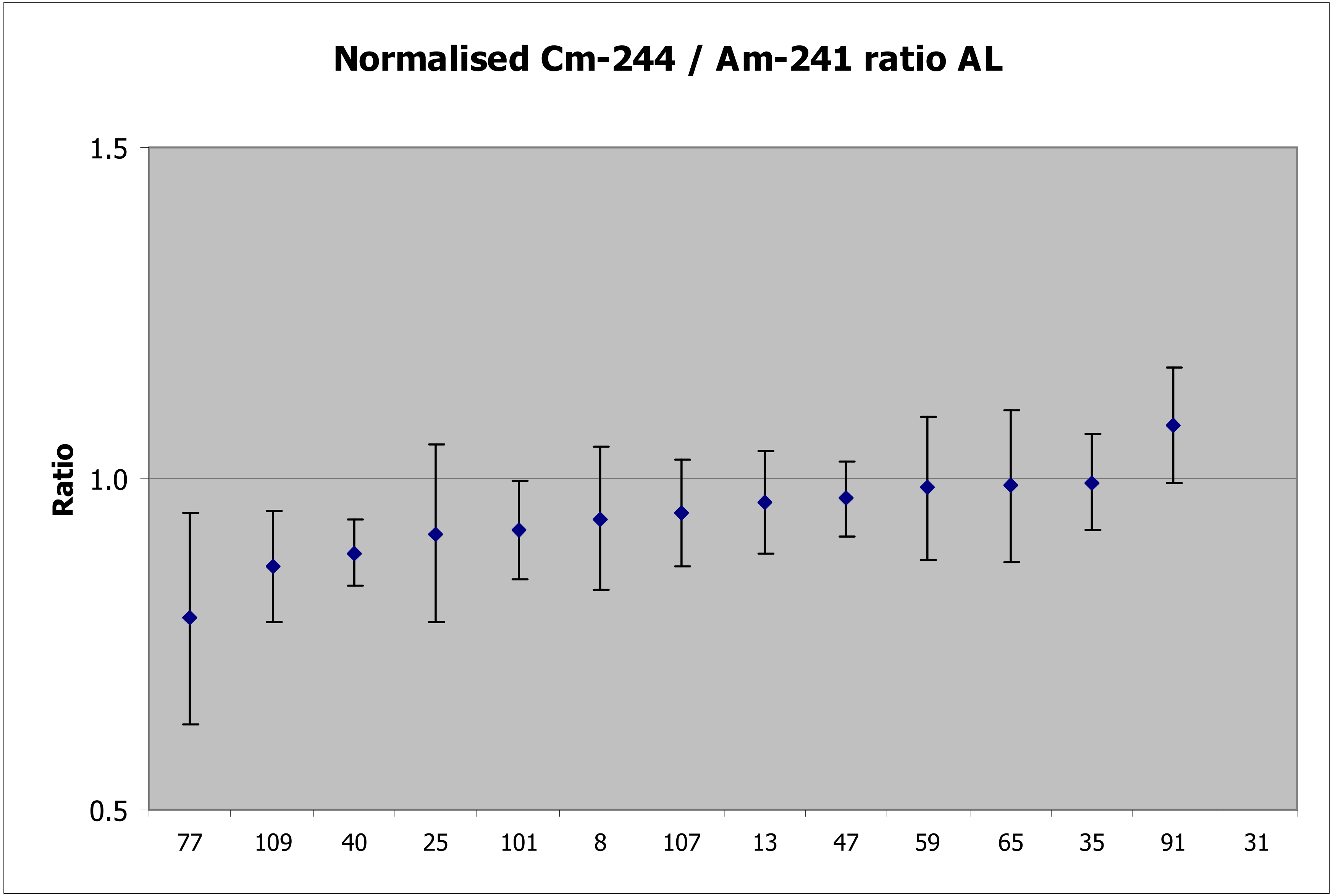
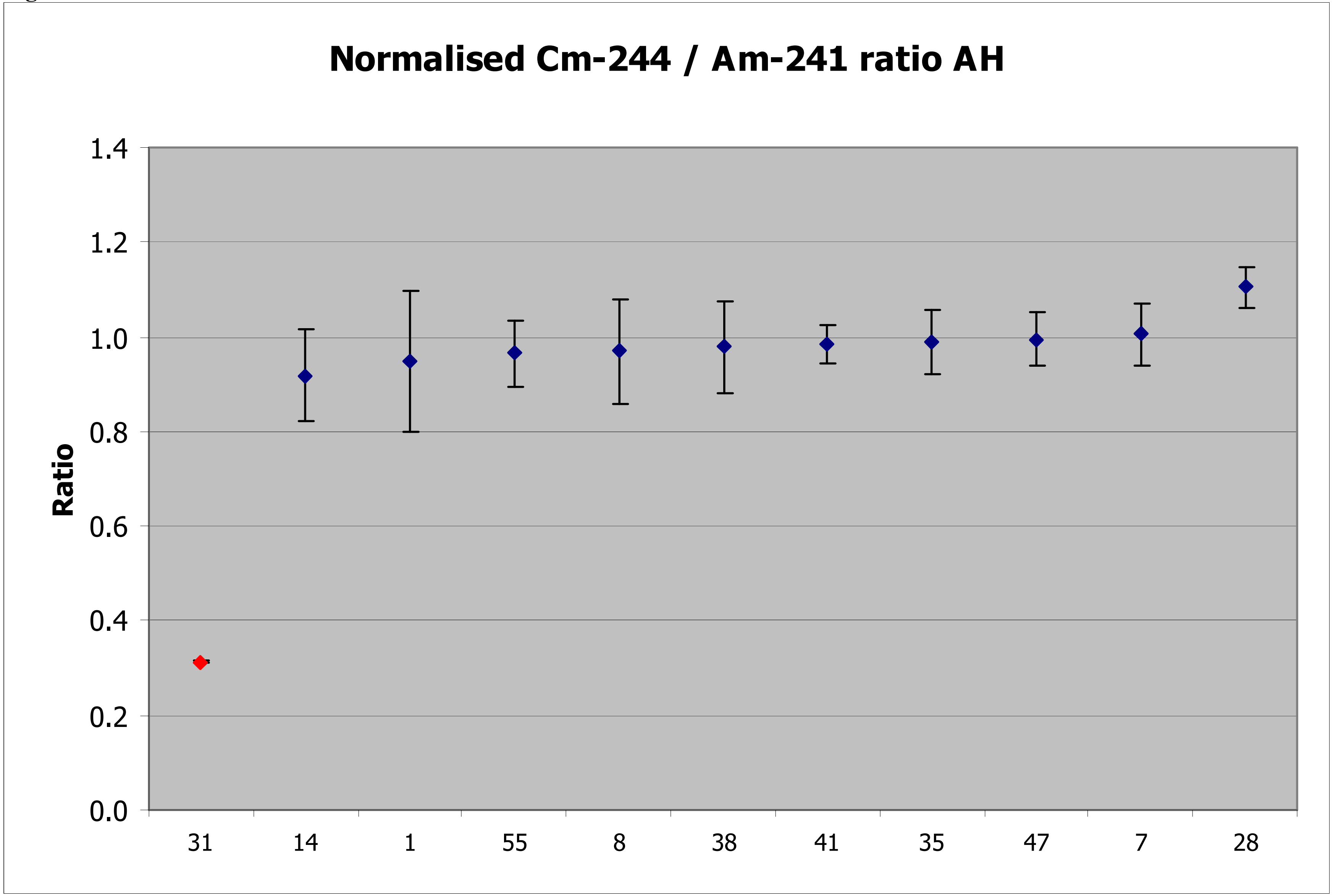


**Figure 139B – Normalised $^{244}Cm$ / $^{241}Am$ ratios AH**



## Appendix A. Results sorted by nuclide

***Table A1 – Ra-226 AL*** **assigned result 4.71(6) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 26 | 0.99(24) | –15.02 D | –11.41 D | –79(5) |
| 35 | 3.9(3) | –2.94 Q | –2.49 | –17(6) |
| 31 | 4(0) | –11.54 Q | –2.19 | –15.1(11) |
| 109 | 4.20(7) | –5.47 Q | –1.57 | –10.9(19) |
| 65 | 4.3(6) | –0.78 | –1.39 | –10(12) |
| 77 | 4.5(4) | –0.50 | –0.59 | –4(8) |
| 8 | 5.0(8) | 0.30 | 0.73 | 5(17) |
| 106 | 5.3(3) | 1.92 | 1.80 | 12(7) |
| 25 | 6.4(4) | 4.54 D | 5.08 D | 35(8) |

***Table A2 – U-234 AL*** **assigned result 14.6(14) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 47 | 13.0(6) | –1.14 | –1.88 | –11(9) |
| 107 | 13.0(8) | –1.05 | –1.87 | –11(10) |
| 77 | 13.3(19) Q | –0.56 | –1.49 | –9(15) |
| 8M | 13.5(9) | –0.69 | –1.26 | –8(10) |
| 17 | 13.6(7) | –0.65 | –1.14 | –7(10) |
| 65 | 13.9(9) | –0.47 | –0.87 | –5(11) |
| 35 | 14.0(7) | –0.39 | –0.68 | –4(10) |
| 91 | 14.4(9) | –0.13 | –0.24 | –1(11) |
| 29 | 14.5(10) | –0.07 | –0.13 | –1(11) |
| 26 | 14.8(5) | 0.12 | 0.20 | 1(10) |
| 4 | 14.9(9) | 0.18 | 0.33 | 2(11) |
| 25 | 15.6(13) | 0.51 | 1.08 | 6(13) |
| 106 | 15.6(7) | 0.65 | 1.12 | 7(11) |
| 109 | 15.60(6) | 0.73 | 1.12 | 7(10) |
| 40 | 15.7(9) | 0.67 | 1.25 | 8(12) |
| 8A | 15.9(13) | 0.69 | 1.47 | 9(13) |
| 28 | 25.7(16) | 5.29 D | 12.62 D | 76(20) |

***Table A3 – U-235 AL*** **assigned result 0.680(3) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 8M | 0.45(7) | –3.21 Q | –2.54 | –33(10) |
| 35 | 0.47(5) | –4.62 Q | –2.39 | –31(7) |
| 91 | 0.54(5) | –2.63 Q | –1.54 | –20(8) |
| 107 | 0.57(7) | –1.57 | –1.23 | –16(10) |
| 29 | 0.59(5) | –1.80 | –1.01 | –13(8) |
| 26 | 0.59(7) | –1.23 | –1.00 | –13(11) |
| 77 | 0.61(12) | –0.58 | –0.79 | –10(18) |
| 47 | 0.61(7) | –1.05 | –0.75 | –10(9) |
| 17 | 0.63(5) | –1.00 | –0.56 | –7(8) |
| 25 | 0.65(10) | –0.30 | –0.34 | –4(15) |
| 40 | 0.7(8) Q | –0.04 | –0.34 | 0(12) × 10$^{1}$ |
| 109 | 0.707(25) | 1.07 | 0.30 | 4(4) |
| 8A | 0.72(11) | 0.37 | 0.44 | 6(16) |
| 106 | 0.84(11) | 1.45 | 1.80 | 24(16) |
| 65 | 0.86(16) | 1.13 | 2.02 | 26(24) |
| 28 | 0.9(3) | 0.73 | 2.47 | 3(5) × 10$^{1}$ |
| 42 | 1.35(22) | 3.10 D | 7.52 D | 10(4) × 10$^{1}$ |

***Table A4 – U-238 AL*** **assigned result 14.76(4) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 26 | 9.3(4) | –15.87 D | –6.10 D | –36.7(23) |
| 47 | 12.98(6) | –27.68 Q | –2.00 | –12.0(5) |
| 107 | 13.1(8) | –2.06 | –1.84 | –11(6) |
| 35 | 13.5(7) | –1.87 | –1.37 | –8(5) |
| 17 | 13.8(7) | –1.38 | –1.14 | –7(5) |
| 77 | 14.3(21) | –0.22 | –0.52 | –3(14) |
| 29 | 14.6(10) | –0.16 | –0.18 | –1(7) |
| 91 | 14.6(9) | –0.13 | –0.14 | –1(6) |
| 65 | 14.8(10) | 0.03 | 0.03 | 0(7) |
| 25 | 14.9(12) | 0.12 | 0.16 | 1(8) |
| 109 | 15.1(5) | 0.67 | 0.38 | 2(4) |
| 4 | 15.2(9) | 0.54 | 0.54 | 3(6) |
| 8A | 15.6(13) | 0.66 | 0.95 | 6(9) |
| 40 | 15.8(9) | 1.09 | 1.14 | 7(6) |
| 106 | 16.3(8) | 1.92 | 1.73 | 10(6) |
| 8M | 16.3(16) | 0.94 | 1.73 | 10(11) |
| 28 | 16.4(12) | 1.37 | 1.85 | 11(8) |

***Table A5 – Np-237 AL*** **assigned result 9.38(10) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 91 | 8.6(9) | –0.89 | –0.78 | –8(9) |
| 47 | 9.3(5) | –0.13 | –0.06 | –1(5) |
| 8 | 9.6(11) | 0.21 | 0.24 | 2(11) |
| 42 | 9.6(17) | 0.15 | 0.27 | 3(18) |
| 65 | 10.6(15) | 0.82 | 1.26 | 13(16) |
| 25 | 11.0(12) | 1.35 | 1.66 | 17(13) |
| 35 | 12.4(10) | 3.01 D | 3.11 D | 32(11) |
| 109 | 91.0(5) | 168.83 D | 84.10 D | 870(11) |

***Table A6 – Pu-238 AL*** **assigned result 11.86(4) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 109 | 7.1(4) | –15.14 D | –7.14 D | –41(3) |
| 77 | 7.1(12) | –3.96 D | –7.07 D | –40(10) |
| 81 | 9.8(12) | –1.71 | –3.06 Q | –17(10) |
| 107 | 11.1(6) | –1.27 | –1.16 | –7(5) |
| 35 | 11.2(6) | –1.06 | –0.99 | –6(6) |
| 65 | 11.3(8) | –0.76 | –0.83 | –5(6) |
| 59 | 11.4(9) | –0.54 | –0.71 | –4(8) |
| 8 | 11.4(9) | –0.50 | –0.68 | –4(8) |
| 91 | 11.5(8) | –0.49 | –0.56 | –3(7) |
| 29 | 11.7(6) | –0.26 | –0.24 | –1(5) |
| 13 | 11.8(6) | –0.09 | –0.09 | 0(5) |
| 28 | 11.80(19) | –0.30 | –0.09 | –0.5(16) |
| 40 | 12.1(6) | 0.35 | 0.33 | 2(6) |
| 101 | 12.1(4) | 0.60 | 0.36 | 2(4) |
| 4 | 12.2(7) | 0.53 | 0.55 | 3(6) |
| 17 | 12.4(7) | 0.70 | 0.76 | 4(6) |
| 47 | 12.6(6) | 1.27 | 1.13 | 6(5) |
| 25 | 17.9(20) | 3.04 D | 8.97 D | 51(17) |

***Table A7 – Pu-239 AL*** **assigned result 10.19(5) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 77 | 4.7(8) | –6.68 D | –9.24 D | –54(8) |
| 109 | 5.6(3) | –15.62 D | –7.81 D | –46(3) |
| 81 | 8.2(10) | –1.98 | –3.35 Q | –19(10) |
| 65 | 9.2(6) | –1.64 | –1.66 | –10(6) |
| 35 | 9.7(6) | –0.99 | –0.90 | –5(6) |
| 59 | 9.7(8) | –0.72 | –0.90 | –5(7) |
| 107 | 9.7(6) | –0.97 | –0.89 | –5(6) |
| 13 | 9.9(6) | –0.49 | –0.46 | –3(6) |
| 29 | 10.0(6) | –0.31 | –0.31 | –2(6) |
| 28 | 10.01(16) | –1.05 | –0.30 | –1.7(16) |
| 8 | 10.1(8) | –0.10 | –0.14 | –1(8) |
| 4 | 10.1(6) | –0.08 | –0.08 | 0(6) |
| 91 | 10.1(7) | –0.07 | –0.08 | 0(7) |
| 101 | 10.3(3) | 0.38 | 0.19 | 1(3) |
| 40 | 10.5(6) | 0.50 | 0.47 | 3(6) |
| 47 | 10.5(6) | 0.63 | 0.56 | 3(5) |
| 17 | 10.6(6) | 0.69 | 0.73 | 4(6) |
| 25 | 17.0(19) | 3.61 D | 11.50 D | 67(19) |

***Table A8 – Am-241 AL*** **assigned result 13.57(4) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 25 | 11.1(11) | –2.24 | –3.11 Q | –19(8) |
| 17 | 11.6(7) | –2.90 Q | –2.47 | –15(5) |
| 109 X | 12.30(12) | –10.06 Q | –1.57 | –9.4(9) |
| 35 | 12.4(6) | –2.03 | –1.51 | –9(5) |
| 91 | 12.8(7) | –1.08 | –0.98 | –6(6) |
| 101 | 12.9(6) | –1.12 | –0.83 | –5(5) |
| 26 | 13.15(18) | –2.30 | –0.52 | –3.1(13) |
| 59A | 13.2(10) | –0.41 | –0.52 | –3(8) |
| 77 | 13.3(18) | –0.15 | –0.34 | –2(13) |
| 109 A | 13.4(13) | –0.13 | –0.21 | –1(10) |
| 4 | 13.4(8) | –0.17 | –0.16 | –1(6) |
| 42 | 13.6(14) | 0.00 | 0.00 | 0(10) |
| 13 | 13.6(8) | 0.03 | 0.04 | 0(6) |
| 107 | 13.7(8) | 0.19 | 0.20 | 1(6) |
| 47 | 13.8(5) | 0.40 | 0.26 | 2(4) |
| 8L | 13.9(17) | 0.19 | 0.41 | 2(13) |
| 29 | 14.0(5) | 0.85 | 0.53 | 3(4) |
| 8A | 14.3(11) | 0.64 | 0.90 | 5(8) |
| 65 | 14.4(9) | 0.92 | 1.02 | 6(7) |
| 40 | 14.9(8) | 1.63 | 1.65 | 10(6) |
| 59G | 16.4(14) | 2.02 | 3.50 Q | 21(10) |
| 31 | 300(0) | 8620.51 D | 354.12 D | 2110(6) |

***Table A9 – Cm-244 AL*** **assigned result 6.96(3) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 25 | 5.2(6) | –3.19 D | –4.29 D | –25(8) |
| 77 | 5.4(8) | –1.95 | –3.85 Q | –23(12) |
| 109 | 5.97(6) | –16.79 Q | –2.41 | –14.2(8) |
| 101 | 6.1(4) | –2.14 | –2.09 | –12(6) |
| 35 | 6.3(4) | –1.87 | –1.61 | –9(5) |
| 59 | 6.7(5) | –0.59 | –0.75 | –4(8) |
| 107 | 6.7(4) | –0.68 | –0.68 | –4(6) |
| 13 | 6.7(4) | –0.66 | –0.58 | –3(5) |
| 40 | 6.79(4) | –3.69 Q | –0.42 | –2.5(7) |
| 47 | 6.9(3) | –0.36 | –0.26 | –2(5) |
| 8 | 6.9(6) | –0.12 | –0.17 | –1(8) |
| 91 | 7.1(4) | 0.33 | 0.32 | 2(6) |
| 65 | 7.3(7) | 0.49 | 0.83 | 5(10) |
| 31 | 350(0) | 13427.11 D | 837.10 D | 4930(18) |

***Table A10 – Gross alpha AL*** **assigned result 92(8) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 5 | 9.3(9) | –10.17 D | –17.75 D | –89.9(13) |
| 106 | 51.0(14) | –4.99 D | –8.78 D | –44(5) |
| 113 | 66(3) | –2.96 D | –5.49 D | –28(7) |
| 25 | 75(11) | –1.24 | –3.57 Q | –18(14) |
| 59 | 81(7) | –1.04 | –2.42 | –12(11) |
| 8 | 88.0(20) | –0.46 | –0.82 | –4(9) |
| 65 | 94(9) | 0.16 | 0.42 | 2(14) |
| 26 | 101.6(19) | 1.18 | 2.11 | 11(10) |
| 107 | 117(7) | 2.45 | 5.44 Q | 28(13) |
| 19 | 173.4(11) | 10.02 D | 17.55 D | 89(17) |

***Table A11 – Ra-226 AH*** **assigned result 4.77(6) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 21 | 3.0(3) | –5.62 D | –4.64 D | –37(7) |
| 31 | 3.32(0) | –23.34 D | –3.78 D | –30.3(9) |
| 32 | 4.1(6) | –1.14 | –1.82 | –15(13) |
| 35 | 4.1(4) | –1.96 | –1.72 | –14(7) |
| 38 | 4.9(2) | 0.64 | 0.35 | 3(5) |
| 8 | 5.1(8) | 0.43 | 0.92 | 7(17) |
| 17 | 5.2(5) | 0.86 | 1.11 | 9(10) |
| 106 | 5.4(3) | 2.07 | 1.66 | 13(7) |
| 55 | 15.0(7) | 14.06 D | 26.74 D | 215(16) |

***Table A12 – U-234 AH*** **assigned result 11.1(10) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 17 | 7.2(4) | –3.66 D | –7.96 D | –36(7) |
| 47 | 9.6(4) | –1.38 | –3.02 Q | –14(9) |
| 1 | 10.3(16) | –0.45 | –1.69 | –8(17) |
| 8M | 10.4(6) | –0.62 | –1.49 | –7(10) |
| 14 | 10.9(8) | –0.21 | –0.55 | –2(12) |
| 35 | 11.0(5) | –0.10 | –0.22 | –1(10) |
| 106 | 11.1(5) | –0.04 | –0.10 | 0(10) |
| 7 | 11.4(3) | 0.26 | 0.56 | 3(10) |
| 55 | 11.9(2) | 0.71 | 1.50 | 7(10) |
| 8A | 12.6(10) | 1.00 | 2.89 Q | 13(14) |
| 28 | 13.9(5) | 2.40 | 5.48 Q | 25(12) |

***Table A13 – U-235 AH*** **assigned result 0.5188(19) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 17 | 0.30(2) | –10.89 D | –3.90 D | –42(4) |
| 28 | 0.38(7) | –1.98 | –2.47 | –27(13) |
| 14 | 0.42(6) | –1.65 | –1.76 | –19(12) |
| 1 | 0.4(5) Q | –0.22 | –1.76 | –2(9) × 10$^{1}$ |
| 35 | 0.444(21) | –3.55 Q | –1.33 | –14(4) |
| 7 | 0.45(2) | –3.42 Q | –1.23 | –13(4) |
| 8A | 0.48(7) | –0.66 | –0.78 | –8(13) |
| 47 | 0.50(6) | –0.37 | –0.35 | –4(10) |
| 55 | 0.52(1) | 0.12 | 0.02 | 0.2(20) |
| 8M | 0.53(6) | 0.14 | 0.15 | 2(11) |
| 32 | 0.55(4) | 0.88 | 0.52 | 6(7) |
| 21 | 0.613(17) | 5.51 Q | 1.68 | 18(4) |
| 106 | 0.66(8) | 1.76 | 2.52 | 27(15) |

***Table A14 – U-238 AH*** **assigned result 11.262(17) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 17 | 7.3(4) | –10.55 D | –7.07 D | –36(4) |
| 47 | 9.8(4) | –3.67 Q | –2.52 | –13(4) |
| 21 | 10.1(5) | –2.32 | –2.05 | –10(5) |
| 1 | 11(4) Q | –0.23 | –1.34 | –1(3) × 10$^{1}$ |
| 14 | 10.7(8) | –0.74 | –1.02 | –5(7) |
| 35 | 10.8(6) | –0.83 | –0.78 | –4(5) |
| 106 | 11.3(5) | 0.08 | 0.07 | 0(5) |
| 55 | 11.30(10) | 0.38 | 0.07 | 0.3(9) |
| 7 | 11.6(3) | 1.06 | 0.54 | 3(3) |
| 28 | 11.6(5) | 0.68 | 0.60 | 3(5) |
| 8M | 11.7(12) | 0.37 | 0.77 | 4(10) |
| 38 | 11.7(6) | 0.73 | 0.77 | 4(6) |
| 32 | 11.9(9) | 0.71 | 1.09 | 5(8) |
| 8A | 13.1(11) | 1.73 | 3.24 Q | 16(9) |

***Table A15 – Np-237 AH*** **assigned result 3.20(4) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 38 | 3.19(4) | –0.10 | –0.03 | –0.2(16) |
| 21 | 3.38(8) | 2.15 | 0.97 | 6(3) |
| 8 | 3.4(4) | 0.56 | 1.18 | 7(13) |
| 47 | 3.61(25) | 1.65 | 2.17 | 13(8) |
| 32 | 3.68(5) | 8.75 Q | 2.53 | 15.1(18) |
| 55 | 4.1(6) | 1.62 | 4.68 Q | 28(17) |
| 35 | 4.9(3) | 5.67 D | 8.66 D | 52(9) |

***Table A16 – Pu-238 AH*** **assigned result 5.807(18) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 14 | 4.0(4) | –5.76 D | –5.61 D | –32(6) |
| 35 | 5.0(3) | –2.55 | –2.33 | –13(5) |
| 55 | 5.4(3) | –1.48 | –1.18 | –7(5) |
| 41 | 5.49(19) | –1.63 | –0.96 | –5(4) |
| 8 | 5.6(5) | –0.50 | –0.66 | –4(8) |
| 47 | 5.7(3) | –0.32 | –0.28 | –2(5) |
| 7 | 6.0(3) | 0.64 | 0.58 | 3(5) |
| 38 | 6.0(5) | 0.39 | 0.58 | 3(9) |
| 1 | 6.3(5) | 0.98 | 1.49 | 8(9) |
| 17 | 7.4(4) | 4.00 D | 4.86 D | 28(7) |

***Table A17 – Pu-239 AH*** **assigned result 15.42(7) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 14 | 11.6(9) | –4.48 D | –4.88 D | –25(6) |
| 35 | 13.4(8) | –2.61 D | –2.61 D | –13(5) |
| 55 | 14.3(7) | –1.62 | –1.41 | –7(5) |
| 47 | 14.5(7) | –1.36 | –1.22 | –6(5) |
| 41 | 14.5(5) | –1.83 | –1.16 | –6(4) |
| 8 | 14.5(11) | –0.86 | –1.16 | –6(7) |
| 38 | 15.9(9) | 0.53 | 0.61 | 3(6) |
| 7 | 15.9(8) | 0.65 | 0.65 | 3(5) |
| 1 | 16.6(5) | 2.34 | 1.49 | 8(4) |
| 17 | 19.6(11) | 3.96 D | 5.25 D | 27(7) |

***Table A18 – Am-241 AH*** **assigned result 3.369(7) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 31 | 0.16(0) | –471.47 D | –21.19 D | –95.250(10) |
| 38 | 3.0(2) | –1.84 | –2.44 | –11(6) |
| 35 | 3.08(14) | –2.06 | –1.91 | –9(4) |
| 41 | 3.12(9) | –2.73 Q | –1.64 | –7(3) |
| 14 | 3.20(24) | –0.70 | –1.11 | –5(7) |
| 21 | 3.22(8) | –1.85 | –0.98 | –4.4(24) |
| 8L | 3.30(14) | –0.49 | –0.45 | –2(4) |
| 17 | 3.31(24) | –0.24 | –0.39 | –2(7) |
| 55 | 3.36(15) | –0.06 | –0.06 | 0(5) |
| 47 | 3.37(14) | 0.01 | 0.01 | 0(4) |
| 7 | 3.41(16) | 0.26 | 0.27 | 1(5) |
| 32 | 3.52(5) | 3.08 Q | 1.03 | 4.6(15) |
| 8A | 3.5(3) | 0.55 | 1.07 | 5(9) |
| 28 | 3.55(12) | 1.51 | 1.20 | 5(4) |
| 1 | 4.0(5) | 1.26 | 4.17 Q | 19(15) |

***Table A19 – Cm-244 AH*** **assigned result 4.708(14) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 31 | 0.07(0) | –319.94 D | –19.08 D | –98.513(5) |
| 38 | 4.1(3) | –2.02 | –2.50 | –13(7) |
| 14 | 4.1(3) | –1.99 | –2.46 | –13(7) |
| 35 | 4.26(22) | –2.03 | –1.84 | –10(5) |
| 41 | 4.29(12) | –3.46 Q | –1.72 | –9(3) |
| 55 | 4.5(3) | –0.67 | –0.73 | –4(6) |
| 47 | 4.69(19) | –0.09 | –0.07 | 0(4) |
| 8 | 4.8(4) | 0.19 | 0.30 | 2(8) |
| 7 | 4.79(22) | 0.37 | 0.34 | 2(5) |
| 1 | 5.3(5) | 1.18 | 2.43 | 13(11) |
| 28 | 5.48(12) | 6.39 D | 3.17 D | 16(3) |

***Table A20 – Gross alpha AH*** **assigned result 65(8) Bq $g^{-1}$**

| | Result (Bq $g^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 55 | 41.9(13) | –2.86 D | –7.17 D | –36(8) |
| 113 | 53.0(21) | –1.47 | –3.76 Q | –19(11) |
| 41 | 57.2(12) | –0.99 | –2.49 | –12(11) |
| 106 | 58.8(14) | –0.80 | –2.00 | –10(11) |
| 1 | 64(3) | –0.16 | –0.41 | –2(13) |
| 8 | 65.0(20) | –0.04 | –0.10 | –1(13) |
| 7 | 74(5) | 0.90 | 2.56 | 13(16) |

***Table A21 – H-3 B1*** **assigned result 0.925(7) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 96 | 0.599(22) | –14.29 D | –6.14 D | –35.3(24) |
| 20 | 0.83(19) | –0.49 | –1.74 | –10(21) |
| 38 | 0.84(5) | –1.70 | –1.61 | –9(6) |
| 58 | 0.859(18) | –3.47 Q | –1.25 | –7.2(21) |
| 32 Pyr | 0.87(9) | –0.59 | –0.99 | –6(10) |
| 25 | 0.88(4) | –1.18 | –0.84 | –5(4) |
| 113 | 0.88(11) | –0.38 | –0.80 | –5(12) |
| 65 | 0.88(4) | –1.05 | –0.78 | –4(5) |
| 4 | 0.89(12) | –0.31 | –0.70 | –4(13) |
| 8 | 0.89(4) | –0.84 | –0.59 | –3(4) |
| 103 | 0.895(19) | –1.52 | –0.57 | –3.3(22) |
| 55 | 0.90(7) | –0.37 | –0.50 | –3(8) |
| 16 | 0.91(3) | –0.42 | –0.23 | –1(4) |
| 74 | 0.92(4) | –0.29 | –0.18 | –1(4) |
| 72 | 0.92(10) | –0.05 | –0.10 | –1(11) |
| 32 Dis | 0.927(16) | 0.09 | 0.03 | 0.2(19) |
| 21 | 0.94(8) | 0.16 | 0.22 | 1(8) |
| 28 | 0.96(4) | 0.86 | 0.59 | 3(4) |
| 107 | 0.97(6) | 0.73 | 0.87 | 5(7) |
| 102 | 0.97(3) | 1.60 | 0.89 | 5(4) |
| 5 | 1.03(16) | 0.65 | 1.96 | 11(17) |
| 94 | 1.03(7) | 1.49 | 1.96 | 11(8) |
| 89 | 1.052(22) | 5.52 Q | 2.38 | 13.7(25) |
| 7 | 1.16(11) | 2.13 | 4.41 Q | 25(12) |
| 95 | 1.18(5) | 5.26 D | 4.75 D | 27(5) |
| 35 | 1.19(7) | 3.99 D | 4.97 D | 29(7) |
| 48 | 1.2(1) | 2.74 D | 5.16 D | 30(11) |
| 1 | 1.3(3) | 1.25 | 7.04 Q | 4(4) × 10$^{1}$ |

***Table A22 – C-14 B1*** **assigned result 0.702(5) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 48 | 0.5(1) | –2.02 | –4.84 Q | –29(14) |
| 102 | 0.55(5) | –3.48 D | –3.77 D | –22(7) |
| 95 | 0.58(4) | –3.44 D | –2.94 D | –17(5) |
| 5 | 0.61(9) | –1.00 | –2.21 | –13(13) |
| 38 | 0.61(6) | –1.53 | –2.21 | –13(9) |
| 89 | 0.624(20) | –3.83 Q | –1.87 | –11(3) |
| 16 | 0.66(4) | –1.24 | –1.11 | –7(6) |
| 103 | 0.68(2) | –1.09 | –0.53 | –3(3) |
| 94 | 0.69(5) | –0.24 | –0.29 | –2(7) |
| 107 | 0.71(5) | 0.06 | 0.07 | 0(7) |
| 8 | 0.71(4) | 0.07 | 0.07 | 0(6) |
| 58 | 0.72(3) | 0.75 | 0.47 | 3(4) |
| 25 | 0.74(5) | 0.86 | 0.93 | 6(7) |
| 55 | 0.742(21) | 1.87 | 0.95 | 6(3) |
| 35 | 0.75(9) | 0.47 | 1.02 | 6(13) |
| 13 | 0.77(5) | 1.30 | 1.50 | 9(7) |
| 1 | 0.77(2) | 3.32 Q | 1.62 | 10(3) |
| 32 | 0.784(23) | 3.50 Q | 1.96 | 12(4) |
| 65 | 0.84(4) | 3.60 D | 3.30 D | 20(6) |
| 20 | 1.03(19) | 1.72 | 7.83 Q | $5(3) \times 10^{1}$ |
| 7 | 1.42(2) | 35.12 D | 17.20 D | 102(3) |
| 113 | 1.60(8) | 11.63 D | 21.48 D | 128(11) |

***Table A23 – Tc-99 B1*** **assigned result 1.612(4) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 20 | 1.33(18) | –1.57 | –3.08 Q | –18(11) |
| 35 | 1.42(9) | –2.27 | –2.11 | –12(6) |
| 32 | 1.47(8) | –1.76 | –1.55 | –9(5) |
| 38 | 1.5(1) | –1.11 | –1.21 | –7(6) |
| 83 | 1.51(8) | –1.27 | –1.11 | –6(5) |
| 8 P | 1.55(16) | –0.38 | –0.67 | –4(10) |
| 58 | 1.55(3) | –2.04 | –0.63 | –3.6(17) |
| 74 | 1.56(7) | –0.75 | –0.56 | –3(5) |
| 107 | 1.60(16) | –0.07 | –0.11 | –1(10) |
| 8 M | 1.61(17) | –0.01 | –0.02 | 0(11) |
| 55 | 1.64(4) | 0.79 | 0.31 | 1.8(22) |
| 48 | 1.7(1) | 0.88 | 0.96 | 5(6) |
| 96 | 1.76(8) | 1.76 | 1.56 | 9(5) |
| 25 | 1.79(9) | 1.98 | 1.92 | 11(6) |

***Table A24 – H-3 B2*** **assigned result 0.487(4) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 41 | 0.443(14) | –2.97 Q | –2.10 | –9(3) |
| 59 | 0.451(11) | –3.12 Q | –1.72 | –7.4(24) |
| 25 | 0.463(20) | –1.18 | –1.15 | –5(4) |
| 38 | 0.47(2) | –0.83 | –0.81 | –3(4) |
| 8 | 0.473(21) | –0.65 | –0.67 | –3(5) |
| 16 | 0.48(3) | –0.33 | –0.48 | –2(6) |
| 55 | 0.48(6) | –0.15 | –0.43 | –2(12) |
| 113 | 0.478(6) | –1.29 | –0.43 | –1.8(14) |
| 29 | 0.48(2) | –0.34 | –0.33 | –1(4) |
| 56 | 0.488(11) | 0.09 | 0.05 | 0.2(24) |
| 32 Dis | 0.490(9) | 0.30 | 0.14 | 0.6(20) |
| 91 | 0.49(4) | 0.07 | 0.15 | 1(9) |
| 74 | 0.491(19) | 0.21 | 0.20 | 1(4) |
| 65 | 0.499(22) | 0.54 | 0.58 | 2(5) |
| 21 | 0.50(4) | 0.39 | 0.63 | 3(7) |
| 5 | 0.50(8) | 0.21 | 0.77 | 3(16) |
| 13 | 0.505(21) | 0.82 | 0.86 | 4(5) |
| 107 | 0.51(4) | 0.67 | 1.06 | 5(7) |
| 28 | 0.509(8) | 2.54 | 1.06 | 4.5(18) |
| 102 | 0.512(20) | 1.24 | 1.20 | 5(4) |
| 7 | 0.515(21) | 1.32 | 1.34 | 6(5) |
| 32 Pyr | 0.53(7) | 0.65 | 2.06 | 9(14) |
| 94 | 0.53(4) | 1.07 | 2.06 | 9(8) |
| 109 | 0.54(3) | 1.76 | 2.54 | 11(6) |
| 19 | 0.55(1) | 5.97 D | 3.02 D | 13.0(22) |
| 31 | 0.550(0) | 18.44 D | 3.02 D | 13.0(8) |
| 35 | 0.57(4) | 2.56 | 4.08 Q | 17(7) |
| 1 | 0.68(9) | 2.14 | 9.25 Q | 40(19) |
| 40 | 0.99(6) | 8.83 D | 23.95 D | 103(12) |

***Table A25 – Fe-55 B2*** **assigned result 1.65(4) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 91 | 1.06(5) | –10.19 D | –5.40 D | –36(3) |
| 65 | 1.24(10) | –3.78 D | –3.72 D | –25(7) |
| 7 | 1.26(12) | –3.07 D | –3.57 D | –24(8) |
| 107 | 1.28(7) | –4.58 D | –3.35 D | –22(5) |
| 56 | 1.37(18) | –1.50 | –2.53 | –17(11) |
| 16 | 1.46(7) | –2.32 | –1.70 | –11(5) |
| 32 | 1.46(10) | –1.74 | –1.67 | –11(6) |
| 38 | 1.5(2) | –0.71 | –1.34 | –9(12) |
| 1 | 1.56(3) | –1.75 | –0.79 | –5(3) |
| 25 | 1.58(16) | –0.38 | –0.57 | –4(10) |
| 59 | 1.68(5) | 0.62 | 0.34 | 2(4) |
| 74 | 2.14(10) | 4.50 D | 4.53 D | 30(7) |
| 94 | 2.8(4) | 2.87 D | 10.59 D | 70(25) |

***Table A26 – Ni-63 B2*** **assigned result 0.596(24) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 31 | 0.007(0) | –24.70 D | –16.59 D | –98.83(5) |
| 14 | 0.21(3) | –10.07 D | –10.87 D | –65(5) |
| 65 | 0.45(3) | –3.89 D | –4.11 D | –25(6) |
| 16 | 0.483(13) | –4.16 D | –3.18 D | –19(4) |
| 7 | 0.50(2) | –3.09 D | –2.71 D | –16(5) |
| 25 | 0.51(4) | –2.06 | –2.51 | –15(7) |
| 38 | 0.58(7) | –0.22 | –0.45 | –3(12) |
| 1 | 0.58(2) | –0.52 | –0.45 | –3(5) |
| 74 | 0.59(4) | –0.18 | –0.20 | –1(7) |
| 91 | 0.60(3) | 0.11 | 0.11 | 1(6) |
| 32 | 0.64(5) | 0.80 | 1.27 | 8(10) |
| 107 | 0.70(6) | 1.58 | 2.96 Q | 18(11) |
| 55 | 0.73(4) | 3.17 D | 3.83 D | 23(8) |
| 94 | 1.05(12) | 3.71 D | 12.79 D | 76(21) |

***Table A27 – Sr-90 B2*** **assigned result 0.5712(11) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 92 | 0.1774(2) | –342.20 D | –9.48 D | –68.94(7) |
| 1 | 0.40(2) | –8.54 D | –4.12 D | –30(4) |
| 56 | 0.45(9) | –1.38 | –3.01 Q | –22(16) |
| 35 | 0.47(6) | –1.70 | –2.34 | –17(10) |
| 109 | 0.480(14) | –6.49 Q | –2.19 | –16.0(25) |
| 26 | 0.50(14) Q | –0.51 | –1.71 | –12(25) |
| 14 | 0.52(4) | –1.28 | –1.23 | –9(7) |
| 7 | 0.523(18) | –2.67 Q | –1.16 | –8(4) |
| 55 | 0.54(5) | –0.70 | –0.82 | –6(9) |
| 32 | 0.54(3) | –0.97 | –0.68 | –5(5) |
| 29 | 0.55(2) | –1.06 | –0.51 | –4(4) |
| 28 | 0.55(4) | –0.53 | –0.51 | –4(7) |
| 40 | 0.6(1) | –0.16 | –0.39 | –3(18) |
| 38 | 0.56(5) | –0.22 | –0.27 | –2(9) |
| 13 | 0.57(3) | –0.23 | –0.15 | –1(5) |
| 41 | 0.57(3) | –0.21 | –0.15 | –1(6) |
| 25 | 0.58(5) | 0.12 | 0.14 | 1(8) |
| 8 | 0.578(15) | 0.47 | 0.16 | 1(3) |
| 107 | 0.59(5) | 0.45 | 0.55 | 4(9) |
| 91 | 0.60(6) | 0.42 | 0.57 | 4(10) |
| 94 | 0.64(8) | 0.86 | 1.66 | 12(14) |
| 74 | 0.66(3) | 3.35 Q | 2.14 | 16(5) |
| 65 | 0.75(4) | 4.83 D | 4.31 D | 31(7) |

***Table A28 – Gross beta B2***

| | Result (Bq $g^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 7 LSC | 1.29(8) | –2.36 | –8.23 Q | –49(11) |
| 8 | 0.85(3) | –9.37 D | –4.26 D | –26(3) |
| 41 | 1.00(6) | –2.46 | –2.08 | –12(5) |
| 32 | 1.01(4) | –3.65 Q | –1.98 | –12(4) |
| 59 LSC | 2.56(5) | 0.03 | 0.09 | 1(21) |
| 55 | 1.30(8) | 1.93 | 2.30 | 14(7) |
| 25 | 1.46(12) | 2.70 D | 4.58 D | 27(10) |
| 1 | 1.6(3) | 1.53 | 6.69 Q | $4(3) \times 10^1$ |
| 113 | 1.87(9) | 8.39 D | 10.64 D | 64(8) |
| 94 LSC | 4.3(5) | 2.42 | 11.52 Q | $7(4) \times 10^1$ |

**assigned result 1.1423(23) Bq $g^{-1}$ (ISO 9697) and 2.5(5) Bq $g^{-1}$ (LSC)**

***Table A29 – Na-22 GL*** **assigned result 8.19(3) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 92 | 2.95(8) | –61.41 D | –12.07 D | –64.0(10) |
| 5 | 5.5(6) | –4.88 D | –6.19 D | –33(7) |
| 111 | 6.23(18) | –10.73 D | –4.51 D | –23.9(22) |
| 40 | 6.59(19) | –8.31 D | –3.68 D | –19.5(23) |
| 45 | 6.7(6) | –2.74 D | –3.47 D | –18(7) |
| 104 | 6.9(3) | –4.10 D | –2.94 D | –16(4) |
| 25 | 7.0(5) | –2.80 D | –2.78 D | –15(6) |
| 96 | 7.00(20) | –5.87 D | –2.74 D | –14.5(25) |
| 106 | 7.0(4) | –2.84 D | –2.69 D | –14(5) |
| 91 | 7.05(18) | –6.24 D | –2.62 D | –13.9(22) |
| 72 | 7.1(5) | –2.59 Q | –2.575 | –14(6) |
| 68 | 7.1(5) | –2.19 | –2.575 | –14(6) |
| 90 | 7.1(3) | –3.61 Q | –2.51 | –13(4) |
| 54 | 7.1(4) | –2.90 Q | –2.48 | –13(5) |
| 8 | 7.11(24) | –4.46 Q | –2.48 | –13(3) |
| 76 | 7.1(10) | –1.03 | –2.41 | –13(12) |
| 94 | 7.2(4) | –2.46 | –2.28 | –12(5) |
| 62 | 7.2(5) | –1.82 | –2.18 | –12(7) |
| 109 | 7.3(3) | –3.08 Q | –2.14 | –11(4) |
| 35 | 7.4(6) | –1.28 | –1.86 | –10(8) |
| 27 | 7.4(18) Q | –0.44 | –1.81 | –10(22) |
| 97 | 7.40(20) | –3.90 Q | –1.81 | –9.6(25) |
| 4 | 7.4(11) | –0.70 | –1.77 | –9(13) |
| 53 | 7.5(4) | –1.99 | –1.61 | –9(5) |
| 107 | 7.5(3) | –2.53 | –1.58 | –8(4) |
| 81 | 7.5(4) | –1.71 | –1.58 | –8(5) |
| 95 | 7.54(11) | –5.68 Q | –1.49 | –7.9(14) |
| 41 | 7.6(6) | –0.95 | –1.38 | –7(8) |
| 23 | 7.7(9) | –0.59 | –1.22 | –6(11) |
| 19 | 7.7(4) | –1.35 | –1.22 | –6(5) |
| 46 | 7.7(4) | –1.27 | –1.15 | –6(5) |
| 28 | 7.7(5) | –1.03 | –1.15 | –6(6) |
| 48 | 7.7(3) | –1.62 | –1.12 | –6(4) |

continues

| continued | | | | |
|---|---|---|---|---|
| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
| 52 | 7.7(4) | –1.20 | –1.08 | –6(5) |
| 110 | 7.8(4) | –0.97 | –0.89 | –5(5) |
| 33 | 7.8(13) | –0.29 | –0.89 | –5(16) |
| 98 | 7.89(10) | –2.85 Q | –0.69 | –3.6(13) |
| 42 | 8.0(9) | –0.23 | –0.46 | –2(11) |
| 26 | 8.0(5) | –0.44 | –0.46 | –2(6) |
| 88 | 8.0(4) | –0.47 | –0.43 | –2(5) |
| 89 | 8.05(18) | –0.75 | –0.32 | –1.7(22) |
| 21 | 8.09(25) | –0.39 | –0.22 | –1(3) |
| 18 | 8.2(3) | –0.03 | –0.02 | 0(4) |
| 29 | 8.2(8) | 0.02 | 0.03 | 0(10) |
| 82 | 8.3(9) | 0.12 | 0.24 | 1(11) |
| 51 | 8.5(5) | 0.67 | 0.70 | 4(6) |
| 24 | 8.8(9) | 0.62 | 1.30 | 7(11) |
| 59 | 9.0(8) | 0.94 | 1.76 | 9(10) |
| 47 | 9.6(6) | 2.19 | 3.19 Q | 17(8) |
| 15 | 9.92(23) | 7.47 D | 3.99 D | 21(3) |
| 105 | 27(3) | 6.75 D | 43.58 D | 23(4) × $10^1$ |

***Table A30 – Co-60 GL*** **assigned result 7.201(22) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 92 | 3.94(9) | –35.21 D | –9.81 D | –45.3(13) |
| 5 | 4.0(4) | –7.99 D | –9.63 D | –44(6) |
| 44 | 5.1(5) | –4.64 D | –6.29 D | –29(6) |
| 111 | 6.34(21) | –4.08 D | –2.59 D | –12(3) |
| 45 | 6.4(6) | –1.38 | –2.32 | –11(8) |
| 15 | 6.46(20) | –3.68 Q | –2.23 | –10(3) |
| 48 | 6.50(20) | –3.48 Q | –2.11 | –10(3) |
| 54 | 6.62(25) | –2.32 | –1.75 | –8(4) |
| 96 | 6.62(24) | –2.41 | –1.75 | –8(4) |
| 27 | 6.7(17) Q | –0.30 | –1.51 | –7(23) |
| 106 | 6.8(4) | –1.17 | –1.24 | –6(5) |
| 76 | 6.8(7) | –0.55 | –1.15 | –5(10) |
| 104 | 6.8(3) | –1.28 | –1.12 | –5(4) |
| 46 | 6.9(3) | –1.19 | –0.94 | –4(4) |
| 23 | 6.9(5) | –0.58 | –0.88 | –4(7) |
| 62 | 6.9(5) | –0.62 | –0.82 | –4(6) |
| 68 | 7.0(5) | –0.47 | –0.63 | –3(6) |
| 97 | 7.00(10) | –1.96 | –0.60 | –2.8(14) |
| 91 | 7.00(19) | –1.05 | –0.60 | –3(3) |
| 107 | 7.08(25) | –0.48 | –0.36 | –2(4) |
| 90 | 7.1(3) | –0.34 | –0.30 | –1(4) |
| 35 | 7.1(6) | –0.17 | –0.30 | –1(8) |
| 26 | 7.1(3) | –0.32 | –0.30 | –1(5) |
| 18 | 7.13(18) | –0.39 | –0.21 | –1.0(25) |
| 53 | 7.2(3) | –0.13 | –0.12 | –1(5) |
| 72 | 7.2(5) | –0.05 | –0.06 | 0(6) |
| 81 | 7.2(3) | 0.00 | 0.00 | 0(4) |
| 19 | 7.2(4) | 0.08 | 0.09 | 0(5) |
| 29 | 7.3(7) | 0.14 | 0.30 | 1(10) |
| 98 | 7.32(10) | 1.16 | 0.36 | 1.7(14) |
| 4 | 7.4(11) | 0.14 | 0.45 | 2(15) |
| 21 | 7.36(22) | 0.72 | 0.48 | 2(3) |
| 88 | 7.4(4) | 0.55 | 0.60 | 3(5) |

continues

| continued | | | | |
|---|---|---|---|---|
| | Result (Bq $kg^{-1}$) | Zeta score | *z*-score | Deviation (%) |
| 25 | 7.4(4) | 0.48 | 0.60 | 3(6) |
| 28 | 7.4(4) | 0.50 | 0.60 | 3(6) |
| 110 | 7.4(4) | 0.50 | 0.60 | 3(6) |
| 42 | 7.5(8) | 0.39 | 0.93 | 4(11) |
| 95 | 7.51(24) | 1.28 | 0.93 | 4(4) |
| 52 | 7.5(3) | 1.06 | 0.96 | 4(4) |
| 109 | 7.5(3) | 1.10 | 0.96 | 4(4) |
| 89 | 7.57(13) | 2.80 Q | 1.11 | 5.1(18) |
| 94 | 7.6(3) | 1.33 | 1.20 | 6(4) |
| 8 | 7.7(3) | 1.66 | 1.35 | 6(4) |
| 24 | 7.7(4) | 1.25 | 1.50 | 7(6) |
| 17 | 7.7(16) Q | 0.33 | 1.59 | 7(22) |
| 40 | 7.84(18) | 3.52 Q | 1.92 | 8.9(25) |
| 51 | 7.9(4) | 2.12 | 2.04 | 9(5) |
| 47 | 7.9(5) | 1.42 | 2.13 | 10(7) |
| 33 | 8.1(10) | 0.88 | 2.64 Q | 12(14) |
| 41 | 8.1(5) | 1.76 | 2.70 Q | 12(7) |
| 82 | 8.6(9) | 1.58 | 4.09 Q | 19(12) |
| 59 | 8.9(7) | 2.50 | 5.11 Q | 24(10) |
| 31 | 10(0) | 128.40 D | 8.42 D | 38.9(5) |
| 105 | 16.8(13) | 7.38 D | 28.88 D | 133(18) |

***Table A31 – Zr-95 GL*** **assigned result 7.30(7) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 105 | 4.9(10) | –2.40 | –4.87 Q | –33(14) |
| 5 | 5.2(5) | –4.01 D | –4.26 D | –29(7) |
| 44 | 5.2(4) | –4.80 D | –4.24 D | –29(6) |
| 111 | 5.94(20) | –6.40 D | –2.76 D | –19(3) |
| 54 | 6.0(5) | –2.57 | –2.58 Q | –17(7) |
| 45 | 6.5(7) | –1.10 | –1.59 | –11(10) |
| 106 | 6.5(7) | –1.15 | –1.55 | –10(9) |
| 92 | 6.55(19) | –3.70 Q | –1.53 | –10(3) |
| 17 | 6.7(20) Q | –0.30 | –1.24 | –8(28) |
| 96 | 6.8(6) | –0.83 | –1.02 | –7(8) |
| 91 | 6.8(4) | –1.32 | –0.98 | –7(5) |
| 98 | 6.91(20) | –1.85 | –0.80 | –5(3) |
| 35 | 7.0(9) | –0.33 | –0.61 | –4(13) |
| 90 | 7.1(5) | –0.40 | –0.41 | –3(7) |
| 26 | 7.1(3) | –0.64 | –0.41 | –3(5) |
| 15 | 7.2(3) | –0.45 | –0.29 | –2(5) |
| 47 | 7.2(5) | –0.24 | –0.23 | –2(7) |
| 95 | 7.2(4) | –0.33 | –0.23 | –2(5) |
| 81 | 7.2(4) | –0.25 | –0.21 | –1(6) |
| 88 | 7.3(5) | –0.05 | –0.05 | 0(7) |
| 42 | 7.3(8) | –0.02 | –0.03 | 0(11) |
| 23 | 7.3(8) | 0.00 | –0.01 | 0(11) |
| 97 | 7.30(20) | –0.01 | –0.01 | 0(3) |
| 28 | 7.3(5) | –0.01 | –0.01 | 0(7) |
| 52 | 7.4(3) | 0.19 | 0.12 | 1(4) |
| 18 | 7.4(3) | 0.28 | 0.16 | 1(4) |
| 76 | 7.4(9) | 0.10 | 0.18 | 1(12) |
| 48 | 7.4(5) | 0.19 | 0.20 | 1(7) |
| 41 | 7.4(11) | 0.12 | 0.28 | 2(16) |
| 53 | 7.5(5) | 0.36 | 0.36 | 2(7) |
| 40 | 7.5(4) | 0.56 | 0.42 | 3(5) |
| 46 | 7.5(4) | 0.62 | 0.44 | 3(5) |
| 62 | 7.6(6) | 0.43 | 0.52 | 4(8) |

continues

| continued | | | | |
|---|---|---|---|---|
| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
| 21 | 7.59(21) | 1.29 | 0.58 | 4(3) |
| 29 | 7.6(6) | 0.49 | 0.60 | 4(8) |
| 104 | 7.6(6) | 0.54 | 0.60 | 4(8) |
| 24 | 7.6(3) | 0.96 | 0.60 | 4(5) |
| 8 | 7.7(6) | 0.73 | 0.87 | 6(8) |
| 109 | 7.7(4) | 1.10 | 0.89 | 6(6) |
| 19 | 7.8(6) | 0.81 | 1.01 | 7(9) |
| 94 | 7.8(5) | 0.98 | 1.01 | 7(7) |
| 110 | 7.8(4) | 1.22 | 1.01 | 7(6) |
| 89 | 7.82(22) | 2.23 | 1.05 | 7(4) |
| 25 | 8.0(7) | 1.08 | 1.41 | 10(9) |
| 107 | 8.1(4) | 2.35 | 1.66 | 11(5) |
| 51 | 8.2(4) | 2.51 | 1.72 | 12(5) |
| 72 | 8.2(6) | 1.68 | 1.86 | 13(8) |
| 59 | 8.3(10) | 1.01 | 2.06 | 14(14) |
| 4 | 8.4(15) | 0.72 | 2.20 | 15(21) |
| 82 | 8.9(11) | 1.45 | 3.24 Q | 22(15) |
| 68 | 9.4(6) | 3.35 D | 4.17 D | 28(9) |
| 27 | 10(3) | 0.92 | 5.38 Q | $4(4) \times 10^{1}$ |
| 31 | 11(0) | 50.57 D | 7.49 D | 50.6(15) |

***Table A32 – Nb-95 GL*** **assigned result 13.46(7) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 68 | 4.9(10) | –8.92 D | –10.78 D | –64(7) |
| 5 | 7.3(7) | –8.40 D | –7.73 D | –46(6) |
| 44 | 8.0(6) | –8.96 D | –6.90 D | –41(5) |
| 95 | 10.9(4) | –6.15 D | –3.21 D | –19(3) |
| 15 | 11.9(3) | –4.93 Q | –1.90 | –11.3(23) |
| 96 | 12.0(7) | –2.07 | –1.83 | –11(5) |
| 97 | 12.10(20) | –6.43 Q | –1.70 | –10.1(16) |
| 45 | 12.5(8) | –1.30 | –1.23 | –7(6) |
| 90 | 12.7(10) | –0.75 | –0.95 | –6(8) |
| 18 | 12.8(5) | –1.30 | –0.82 | –5(4) |
| 8 | 12.9(5) | –1.10 | –0.70 | –4(4) |
| 98 | 13.05(7) | –4.18 Q | –0.51 | –3.0(7) |
| 23 | 13.2(16) | –0.16 | –0.32 | –2(12) |
| 62 | 13.2(8) | –0.32 | –0.32 | –2(6) |
| 94 | 13.2(10) | –0.26 | –0.32 | –2(8) |
| 89 | 13.3(3) | –0.51 | –0.20 | –1.2(23) |
| 48 | 13.4(7) | –0.08 | –0.07 | 0(5) |
| 110 | 13.4(10) | –0.06 | –0.07 | 0(8) |
| 47 | 13.4(8) | –0.02 | –0.02 | 0(6) |
| 52 | 13.7(7) | 0.33 | 0.28 | 2(5) |
| 104 | 13.7(4) | 0.68 | 0.36 | 2(3) |
| 26 | 13.8(13) | 0.26 | 0.43 | 3(10) |
| 4 | 13.8(24) | 0.15 | 0.44 | 3(18) |
| 29 | 14.0(10) | 0.54 | 0.68 | 4(8) |
| 42 | 14.1(15) | 0.43 | 0.81 | 5(11) |
| 21 | 14.1(4) | 1.59 | 0.81 | 5(3) |
| 28 | 14.2(7) | 1.06 | 0.93 | 6(5) |
| 76 | 14.3(15) | 0.59 | 1.08 | 6(11) |
| 91 | 14.3(3) | 2.75 Q | 1.10 | 6.5(24) |
| 46 | 14.5(9) | 1.24 | 1.35 | 8(7) |
| 81 | 14.6(7) | 1.63 | 1.44 | 8(5) |
| 72 | 14.7(9) | 1.40 | 1.59 | 9(7) |
| 107 | 14.7(5) | 2.57 | 1.60 | 9(4) |

continues

| continued | | | | |
|---|---|---|---|---|
| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
| 53 | 14.8(7) | 1.91 | 1.66 | 10(5) |
| 59 | 15.0(18) | 0.86 | 1.94 | 11(13) |
| 19 | 15.0(7) | 2.16 | 1.94 | 11(6) |
| 88 | 15.1(9) | 1.82 | 2.06 | 12(7) |
| 25 | 15.2(7) | 2.35 | 2.16 | 13(6) |
| 27 | 15(4) | 0.52 | 2.18 | 13(25) |
| 24 | 15.3(8) | 2.30 | 2.31 | 14(6) |
| 51 | 15.4(6) | 3.07 Q | 2.40 | 14(5) |
| 35 | 15.4(10) | 1.94 | 2.44 | 14(8) |
| 109 | 15.4(8) | 2.42 | 2.44 | 14(6) |
| 17 | 16(4) | 0.62 | 2.75 Q | 2(3) × 10$^{1}$ |
| 82 | 18.3(21) | 2.31 | 6.08 Q | 36(16) |
| 92 | 20(6) | 1.01 | 7.75 Q | 5(5) × 10$^{1}$ |
| 111 | 19.7(6) | 11.47 D | 7.84 D | 46(4) |
| 40 | 22.3(13) | 7.01 D | 11.10 D | 66(9) |
| 41 | 25.3(14) | 8.28 D | 14.88 D | 88(11) |
| 106 | 25.7(16) | 7.60 D | 15.37 D | 91(12) |
| 33 | 67(15) | 3.51 D | 67.64 D | 40(11) × 10$^{1}$ |

***Table A33 – Ba-133 GL*** **assigned result 6.12(5) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 33 | 3.7(12) | –2.02 | –6.59 Q | –40(20) |
| 62 | 4.7(4) | –3.69 D | –3.76 D | –23(6) |
| 104 | 5.1(4) | –2.67 D | –2.72 D | –17(6) |
| 54 | 5.2(3) | –3.07 Q | –2.56 | –16(5) |
| 81 | 5.2(4) | –2.29 | –2.45 | –15(7) |
| 92 | 5.226(2) | –20.78 Q | –2.38 | –14.6(6) |
| 45 | 5.2(6) | –1.53 | –2.37 | –15(10) |
| 28 | 5.3(3) | –2.71 Q | –2.19 | –13(5) |
| 27 | 5.3(14) Q | –0.55 | –2.11 | –13(23) |
| 76 | 5.4(5) | –1.46 | –2.03 | –12(9) |
| 19 | 5.5(3) | –2.42 | –1.76 | –11(5) |
| 41 | 5.6(5) | –1.12 | –1.47 | –9(8) |
| 97 | 5.60(10) | –4.78 Q | –1.39 | –8.5(18) |
| 17 | 5.6(22) Q | –0.24 | –1.36 | –1(3) × 10$^{1}$ |
| 53 | 5.6(3) | –1.59 | –1.28 | –8(5) |
| 90 | 5.7(3) | –1.39 | –1.12 | –7(5) |
| 46 | 5.78(24) | –1.40 | –0.91 | –6(4) |
| 15 | 5.79(17) | –1.89 | –0.88 | –5(3) |
| 98 | 5.80(10) | –2.94 Q | –0.85 | –5.2(18) |
| 88 | 5.8(3) | –1.06 | –0.85 | –5(5) |
| 96 | 5.8(4) | –0.80 | –0.85 | –5(7) |
| 52 | 5.85(18) | –1.46 | –0.72 | –4(3) |
| 107 | 5.87(24) | –1.03 | –0.67 | –4(4) |
| 42 | 5.9(6) | –0.41 | –0.67 | –4(10) |
| 47 | 5.9(4) | –0.67 | –0.67 | –4(6) |
| 40 | 5.93(25) | –0.75 | –0.51 | –3(4) |
| 72 | 6.0(4) | –0.33 | –0.35 | –2(7) |
| 23 | 6.0(9) | –0.13 | –0.32 | –2(15) |
| 110 | 6.0(3) | –0.40 | –0.32 | –2(5) |
| 18 | 6.01(21) | –0.52 | –0.29 | –2(4) |
| 8 | 6.0(5) | –0.20 | –0.24 | –1(8) |
| 91 | 6.04(21) | –0.38 | –0.21 | –1(4) |
| 106 | 6.1(5) | –0.14 | –0.16 | –1(7) |

continues

| continued | | | | |
|---|---|---|---|---|
| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
| 68 | 6.1(4) | –0.14 | –0.13 | –1(6) |
| 29 | 6.1(5) | –0.04 | –0.05 | 0(8) |
| 21 | 6.17(18) | 0.27 | 0.13 | 1(3) |
| 82 | 6.3(7) | 0.20 | 0.35 | 2(10) |
| 25 | 6.3(4) | 0.55 | 0.53 | 3(6) |
| 109 | 6.37(25) | 0.98 | 0.66 | 4(4) |
| 95 | 6.4(6) | 0.49 | 0.72 | 4(9) |
| 48 | 6.4(3) | 0.92 | 0.74 | 5(5) |
| 94 | 6.4(4) | 0.69 | 0.74 | 5(7) |
| 24 | 6.4(5) | 0.56 | 0.74 | 5(8) |
| 4 | 6.5() | 0.36 | 0.93 | 6(16) |
| 89 | 6.5() | 1.30 | 0.98 | 6(5) |
| 26 | 6.55() | 1.76 | 1.14 | 7(4) |
| 51 | 6.7() | 2.23 | 1.62 | 10(5) |
| 35 | 6.8() | 0.89 | 1.70 | 10(12) |
| 59 | 6.9() | 1.60 | 1.97 | 12(8) |
| 105 | 7.6() | 2.29 | 3.97 Q | 24(11) |

***Table A34 – Cs-134 GL*** **assigned result 11.93(8) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 5 | 7.4(8) | –6.08 D | –8.73 D | –38(6) |
| 44 | 8.0(6) | –6.15 D | –7.54 D | –33(6) |
| 92 | 9.61(10) | –17.79 D | –4.47 D | –19.5(10) |
| 111 | 9.7(3) | –7.96 D | –4.34 D | –18.9(23) |
| 62 | 10.0(6) | –3.51 D | –3.76 D | –16(5) |
| 31 | 10.0(0) | –23.04 D | –3.72 D | –16.2(6) |
| 96 | 10.1(5) | –3.61 D | –3.53 D | –15(5) |
| 104 | 10.1(4) | –4.23 D | –3.49 D | –15(4) |
| 83 | 10.4(6) | –2.53 | –2.95 Q | –13(5) |
| 97 | 10.50(10) | –10.97 D | –2.76 D | –12.0(10) |
| 48 | 10.6(3) | –4.27 Q | –2.57 | –11(3) |
| 91 | 10.70(20) | –5.68 Q | –2.37 | –10.3(18) |
| 28 | 10.7(6) | –2.03 | –2.37 | –10(5) |
| 95 | 10.80(16) | –6.26 Q | –2.18 | –9.5(15) |
| 17 | 10.8(18) | –0.61 | –2.10 | –9(15) |
| 76 | 10.9(9) | –1.19 | –1.99 | –9(7) |
| 107 | 10.9(4) | –2.79 Q | –1.99 | –9(3) |
| 19 | 10.9(5) | –2.16 | –1.99 | –9(4) |
| 41 | 11.0(8) | –1.25 | –1.89 | –8(7) |
| 35 | 11.1(7) | –1.15 | –1.56 | –7(6) |
| 54 | 11.2(5) | –1.52 | –1.37 | –6.0(4) |
| 72 | 11.3(7) | –0.95 | –1.27 | –6(6) |
| 52 | 11.3(4) | –1.72 | –1.16 | –5.0(3) |
| 109 | 11.4(4) | –1.32 | –1.06 | –5(4) |
| 89 | 11.39(13) | –3.50 Q | –1.04 | –4.5(13) |
| 88 | 11.4(5) | –1.05 | –1.02 | –4(5) |
| 23 | 11.4(15) | –0.35 | –1.00 | –4(13) |
| 98 | 11.42(3) | –5.74 Q | –0.98 | –4.3(7) |
| 26 | 11.5(4) | –1.22 | –0.89 | –4(4) |
| 90 | 11.5(4) | –1.05 | –0.83 | –4(4) |
| 33 | 11.5(10) | –0.39 | –0.77 | –3(9) |
| 42 | 11.6(12) | –0.31 | –0.72 | –3(10) |
| 18 | 11.7(4) | –0.67 | –0.54 | –2(4) |

continues

| continued | | | | |
|---|---|---|---|---|
| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
| 53 | 11.7(5) | –0.50 | –0.48 | –2(5) |
| 81 | 11.7(5) | –0.46 | –0.45 | –2(5) |
| 15 | 11.8(3) | –0.52 | –0.29 | –1.3(24) |
| 110 | 11.8(6) | –0.22 | –0.25 | –1(5) |
| 46 | 11.8(6) | –0.16 | –0.19 | –1(6) |
| 21 | 11.9(4) | –0.08 | –0.06 | 0(4) |
| 105 | 11.9(9) | –0.03 | –0.06 | 0(8) |
| 45 | 11.9(12) | 0.00 | 0.00 | 0(10) |
| 29 | 12.0(10) | 0.07 | 0.13 | 1(9) |
| 94 | 12.0(8) | 0.09 | 0.13 | 1(7) |
| 106 | 12.1(5) | 0.27 | 0.27 | 1(5) |
| 25 | 12.1(9) | 0.17 | 0.31 | 1(8) |
| 8 | 12.3(5) | 0.84 | 0.71 | 3(4) |
| 51 | 12.4(5) | 0.96 | 0.94 | 4(5) |
| 4 | 12.5(18) | 0.29 | 1.02 | 4(15) |
| 59 | 12.5(8) | 0.73 | 1.12 | 5(7) |
| 47 | 12.5(8) | 0.78 | 1.15 | 5(7) |
| 68 | 12.6(9) | 0.72 | 1.25 | 5(8) |
| 40 | 12.8(5) | 1.94 | 1.67 | 7(4) |
| 82 | 13.5(14) | 1.12 | 3.02 Q | 13(12) |
| 24 | 13.6(5) | 3.29 D | 3.22 D | 14(5) |

***Table A35 – Cs-137 GL*** **assigned result 9.02(6) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 5 | 5.6(6) | –6.07 D | –7.37 D | –38(6) |
| 104 | 6.9(3) | –6.68 D | –4.55 D | –23(4) |
| 44 | 7.1(6) | –3.27 D | –4.18 D | –22(7) |
| 98 | 8.25(10) | –6.58 Q | –1.66 | –8.6(13) |
| 92 | 8.25(21) | –3.53 Q | –1.66 | –8.6(24) |
| 45 | 8.4(5) | –1.33 | –1.30 | –7(5) |
| 111 | 8.49(24) | –2.15 | –1.14 | –6(3) |
| 90 | 8.5(3) | –1.70 | –1.12 | –6(4) |
| 91 | 8.77(18) | –1.32 | –0.54 | –2.8(21) |
| 48 | 9.0(5) | –0.04 | –0.05 | 0(6) |
| 54 | 9.0(5) | –0.03 | –0.03 | 0(5) |
| 107 | 9.1(3) | 0.20 | 0.13 | 1(4) |
| 25 | 9.1(5) | 0.12 | 0.13 | 1(6) |
| 29 | 9.1(7) | 0.11 | 0.17 | 1(8) |
| 97 | 9.10(20) | 0.37 | 0.17 | 0.9(23) |
| 15 | 9.10(22) | 0.34 | 0.17 | 0.9(25) |
| 52 | 9.1(5) | 0.17 | 0.17 | 1(5) |
| 81 | 9.1(4) | 0.19 | 0.17 | 1(5) |
| 62 | 9.1(6) | 0.16 | 0.21 | 1(7) |
| 53 | 9.1(4) | 0.24 | 0.21 | 1(5) |
| 106 | 9.1(6) | 0.17 | 0.21 | 1(7) |
| 21 | 9.1(3) | 0.39 | 0.25 | 1(4) |
| 26 | 9.2(4) | 0.39 | 0.30 | 2(4) |
| 28 | 9.2(6) | 0.26 | 0.30 | 2(6) |
| 27 | 9.2(21) Q | 0.08 | 0.36 | 2(24) |
| 110 | 9.2(5) | 0.35 | 0.38 | 2(6) |
| 72 | 9.2(6) | 0.34 | 0.43 | 2(7) |
| 46 | 9.2(4) | 0.59 | 0.43 | 2(4) |
| 47 | 9.3(6) | 0.41 | 0.51 | 3(7) |
| 18 | 9.26(23) | 1.00 | 0.51 | 3(3) |
| 95 | 9.26(20) | 1.14 | 0.51 | 2.6(23) |
| 23 | 9.3(9) | 0.28 | 0.53 | 3(10) |
| 19 | 9.4(4) | 0.77 | 0.71 | 4(5) |

continues

| continued | | | | |
|---|---|---|---|---|
| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
| 88 | 9.4(4) | 0.91 | 0.81 | 4(5) |
| 17 | 9.4(16) | 0.25 | 0.88 | 5(18) |
| 4 | 9.5(14) | 0.31 | 0.92 | 5(15) |
| 76 | 9.5(10) | 0.44 | 0.96 | 5(11) |
| 83 | 9.5(9) | 0.53 | 1.03 | 5(10) |
| 40 | 9.5(5) | 0.99 | 1.09 | 6(6) |
| 94 | 9.6(3) | 1.89 | 1.24 | 6(4) |
| 109 | 9.6(4) | 1.62 | 1.31 | 7(4) |
| 41 | 9.7(8) | 0.87 | 1.50 | 8(9) |
| 89 | 9.75(24) | 2.94 Q | 1.57 | 8(3) |
| 42 | 9.8(10) | 0.71 | 1.57 | 8(11) |
| 35 | 9.8(7) | 1.05 | 1.57 | 8(8) |
| 59 | 9.8(8) | 0.99 | 1.63 | 8(9) |
| 51 | 9.9(4) | 2.05 | 1.78 | 9(5) |
| 31 | 10.0(0) | 15.92 Q | 2.11 | 10.8(8) |
| 8 | 10.1(5) | 2.06 | 2.32 | 12(6) |
| 24 | 10.1(5) | 2.14 | 2.32 | 12(6) |
| 33 | 10.4(13) | 1.06 | 2.95 Q | 15(14) |
| 68 | 10.6(8) | 1.96 | 3.46 Q | 18(9) |
| 96 | 11.4(6) | 3.94 D | 5.12 D | 26(7) |
| 82 | 12.2(12) | 2.65 D | 6.84 D | 35(13) |
| 105 | 13.8(0) | 77.77 D | 10.29 D | 53.0(10) |

***Table A36 – Eu-152 GL*** **assigned result 12.35(9) Bq kg$^{-1}$**

| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 44 | 4.1(4) | –23.51 D | –12.11 D | –67(3) |
| 111 | 4.60(13) | –50.01 D | –11.39 D | –62.7(11) |
| 5 | 6.5(7) | –8.92 D | –8.60 D | –47(6) |
| 92 | 9.8(3) | –9.42 D | –3.79 D | –20.9(22) |
| 97 | 9.90(20) | –11.27 D | –3.60 D | –19.8(17) |
| 17 | 10.1(25) | –0.88 | –3.29 Q | –18(21) |
| 104 | 10.5(10) | –1.78 | –2.68 Q | –15(8) |
| 27 | 10.5(25) | –0.72 | –2.67 Q | –15(20) |
| 62 | 10.9(6) | –2.27 | –2.13 | –12(5) |
| 90 | 11.0(20) | –0.67 | –1.98 | –11(16) |
| 107 | 11.1(6) | –2.09 | –1.89 | –10(5) |
| 81 | 11.1(6) | –2.06 | –1.83 | –10(5) |
| 28 | 11.1(6) | –2.06 | –1.83 | –10(5) |
| 19 | 11.2(5) | –2.22 | –1.63 | –9(4) |
| 35 | 11.3(12) | –0.89 | –1.57 | –9(10) |
| 45 | 11(3) | –0.39 | –1.49 | –8(21) |
| 76 | 11.3(8) | –1.33 | –1.48 | –8(6) |
| 40 | 11.40(25) | –3.55 Q | –1.39 | –7.7(21) |
| 54 | 11.5(5) | –1.83 | –1.23 | –7(4) |
| 91 | 11.6(4) | –1.91 | –1.04 | –6(3) |
| 95 | 11.7(5) | –1.30 | –0.95 | –5(4) |
| 53 | 11.7(6) | –0.98 | –0.89 | –5(5) |
| 52 | 11.9(4) | –1.23 | –0.67 | –4(3) |
| 46 | 11.9(6) | –0.81 | –0.64 | –4(5) |
| 29 | 12.0(10) | –0.34 | –0.51 | –3(8) |
| 33 | 12.0(24) | –0.14 | –0.51 | –3(20) |
| 47 | 12.1(8) | –0.30 | –0.33 | –2(6) |
| 42 | 12.2(13) | –0.15 | –0.27 | –2(10) |
| 88 | 12.2(6) | –0.27 | –0.24 | –1(5) |
| 26 | 12.2(5) | –0.37 | –0.24 | –1(4) |
| 106 | 12.2(7) | –0.24 | –0.23 | –1(5) |
| 15 | 12.3(4) | –0.07 | –0.04 | 0(3) |
| 18 | 12.4(5) | 0.01 | 0.01 | 0(4) |

continues

| continued | | | | |
|---|---|---|---|---|
| | Result (Bq kg$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
| 94 | 12.4(7) | 0.08 | 0.08 | 0(6) |
| 72 | 12.6(8) | 0.26 | 0.30 | 2(7) |
| 23 | 12.6(16) | 0.15 | 0.36 | 2(13) |
| 21 | 12.6(3) | 0.82 | 0.37 | 2.1(25) |
| 110 | 12.8(10) | 0.45 | 0.67 | 4(8) |
| 109 | 12.8(5) | 0.95 | 0.67 | 4(4) |
| 89 | 12.9(4) | 1.39 | 0.87 | 5(4) |
| 51 | 13.1(5) | 1.38 | 1.07 | 6(5) |
| 24 | 13.1(8) | 0.94 | 1.11 | 6(7) |
| 68 | 13.2(7) | 1.21 | 1.26 | 7(6) |
| 59 | 13.2(8) | 1.07 | 1.32 | 7(7) |
| 98 | 13.55(10) | 9.21 Q | 1.77 | 9.8(11) |
| 48 | 13.6(7) | 1.78 | 1.84 | 10(6) |
| 96 | 13.6(9) | 1.39 | 1.84 | 10(8) |
| 8 | 14.0(8) | 2.14 | 2.43 | 13(6) |
| 31 | 14(0) | 19.65 Q | 2.43 | 13.4(8) |
| 82 | 15.2(16) | 1.78 | 4.20 Q | 23(13) |
| 4 | 15.3(22) | 1.32 | 4.30 Q | 24(18) |
| 25 | 15.6(12) | 2.60 D | 4.76 | 26(10) |
| 41 | 16.4(19) | 2.13 | 5.96 Q | 33(15) |
| 105 | 26.9(25) | 5.82 D | 21.40 D | 118(20) |

***Table A37 – Na-22 GH*** **assigned result 5.529(20) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 17 | 2.69(11) | –25.39 D | –12.72 D | –51.3(20) |
| 106 | 4.21(17) | –7.71 D | –5.91 D | –24(3) |
| 74 | 4.33(15) | –7.92 D | –5.37 D | –22(3) |
| 113 | 4.73(13) | –6.08 D | –3.58 D | –14.5(24) |
| 28 | 4.79(22) | –3.35 D | –3.31 D | –13(4) |
| 11 | 4.84(9) | –7.35 D | –3.10 D | –12.5(17) |
| 68 | 4.9(3) | –2.28 | –2.86 Q | –12(5) |
| 5 | 4.9(5) | –1.28 | –2.82 Q | –11(9) |
| 13 | 4.94(24) | –2.45 | –2.64 Q | –11(5) |
| 25 | 4.94(22) | –2.67 D | –2.64 D | –11(4) |
| 8 | 4.94(20) | –2.93 D | –2.64 D | –11(4) |
| 35 | 4.95(20) | –2.88 D | –2.59 D | –10(4) |
| 55 | 4.99(25) | –2.15 | –2.42 | –10(5) |
| 108 | 5.02(23) | –2.21 | –2.28 | –9(4) |
| 16 | 5.03(6) | –7.89 Q | –2.24 | –9.0(11) |
| 90 | 5.19(17) | –1.98 | –1.52 | –6(3) |
| 88 | 5.20(20) | –1.64 | –1.47 | –6(4) |
| 93 | 5.2(3) | –1.10 | –1.47 | –6(6) |
| 52 | 5.2(4) | –0.78 | –1.30 | –5(7) |
| 89 | 5.27(7) | –3.56 Q | –1.16 | –4.7(13) |
| 4 | 5.3(9) Q | –0.27 | –1.12 | –5(16) |
| 18 | 5.28(16) | –1.55 | –1.12 | –5(3) |
| 24 | 5.34(15) | –1.25 | –0.85 | –3(3) |
| 27 | 5.4(11) Q | –0.16 | –0.80 | –3(20) |
| 21 | 5.36(16) | –1.05 | –0.76 | –3(3) |
| 77 | 5.4(4) | –0.53 | –0.76 | –3(6) |
| 32 | 5.40(8) | –1.57 | –0.58 | –2.3(15) |
| 98 | 5.41(1) | –5.33 Q | –0.53 | –2.2(4) |
| 46 | 5.42(19) | –0.57 | –0.49 | –2(4) |
| 43 | 5.52(14) | –0.07 | –0.04 | 0(3) |
| 29 | 5.6(6) | 0.12 | 0.32 | 1(11) |
| 96 | 5.68(4) | 3.37 Q | 0.68 | 2.7(8) |
| 54 | 5.84(19) | 1.63 | 1.39 | 6(4) |

continues

| continued | | | | |
|---|---|---|---|---|
| | Result (Bq $g^{-1}$) | Zeta score | $z$-score | Deviation (%) |
| 15 | 5.91(12) | 3.13 Q | 1.71 | 6.9(22) |
| 38 | 5.93(24) | 1.66 | 1.79 | 7(5) |
| 82 | 6.0(6) | 0.72 | 1.93 | 8(11) |
| 14 | 5.98(18) | 2.49 | 2.02 | 8(4) |
| 105 | 6.06(0) | 26.50 Q | 2.38 | 9.6(4) |
| 47 | 6.2(4) | 2.03 | 3.00 Q | 12(6) |

***Table A38 – Co-60 GH*** **assigned result 4.641(14) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 113 | 3.90(11) | –6.68 D | –4.41 D | –16.0(24) |
| 15 | 3.99(8) | –8.02 D | –3.88 D | –14.0(17) |
| 7 | 4.3(5) | –0.78 | –2.09 | –8(10) |
| 106 | 4.42(16) | –1.38 | –1.32 | –5(4) |
| 17 | 4.43(16) | –1.31 | –1.26 | –5(4) |
| 74 | 4.45(15) | –1.27 | –1.14 | –4(4) |
| 90 | 4.47(9) | –1.88 | –1.02 | –3.7(20) |
| 68 | 4.5(3) | –0.58 | –0.90 | –3(6) |
| 25 | 4.50(20) | –0.70 | –0.84 | –3(5) |
| 5 | 4.5(5) | –0.31 | –0.84 | –3(10) |
| 46 | 4.51(16) | –0.82 | –0.78 | –3(4) |
| 35 | 4.55(19) | –0.48 | –0.54 | –2(4) |
| 13 | 4.58(22) | –0.28 | –0.36 | –1(5) |
| 29 | 4.6(4) | –0.10 | –0.24 | –1(9) |
| 55 | 4.62(8) | –0.26 | –0.13 | –0.5(17) |
| 8 | 4.63(19) | –0.06 | –0.07 | 0(4) |
| 28 | 4.65(21) | 0.04 | 0.05 | 0(5) |
| 18 | 4.66(12) | 0.16 | 0.11 | 0(3) |
| 32 | 4.66(6) | 0.31 | 0.11 | 0.4(13) |
| 16 | 4.67(6) | 0.47 | 0.17 | 0.6(13) |
| 108 | 4.68(22) | 0.18 | 0.23 | 1(5) |
| 88 | 4.70(20) | 0.29 | 0.35 | 1(5) |
| 93 | 4.70(25) | 0.24 | 0.35 | 1(6) |
| 43 | 4.71(12) | 0.57 | 0.41 | 1(3) |
| 21 | 4.71(14) | 0.49 | 0.41 | 1(3) |
| 38 | 4.72(8) | 0.97 | 0.47 | 1.7(18) |
| 77 | 4.7(3) | 0.32 | 0.53 | 2(6) |
| 52 | 4.7(3) | 0.35 | 0.59 | 2(6) |
| 24 | 4.75(12) | 0.90 | 0.65 | 2(3) |
| 96 | 4.83(2) | 7.72 Q | 1.12 | 4.1(6) |
| 11 | 4.85(9) | 2.20 | 1.22 | 4.4(20) |
| 89 | 4.85(6) | 3.39 Q | 1.24 | 4.5(13) |
| 20 | 4.85(14) | 1.48 | 1.24 | 5(3) |
| 98 | 4.87(1) | 13.26 Q | 1.36 | 4.9(4) |

continues

| continued | | | | |
|---|---|---|---|---|
| | Result (Bq $g^{-1}$) | Zeta score | *z*-score | Deviation (%) |
| 27 | 4.9(10) Q | 0.24 | 1.48 | 5(22) |
| 31 | 4.9(0) | 18.40 Q | 1.54 | 5.6(4) |
| 47 | 4.91(25) | 1.07 | 1.60 | 6(6) |
| 4 | 4.9(7) | 0.44 | 1.66 | 6(14) |
| 54 | 5.02(11) | 3.42 Q | 2.26 | 8.2(24) |
| 14 | 5.09(23) | 1.95 | 2.67 Q | 10(5) |
| 82 | 5.2(5) | 1.11 | 3.45 Q | 12(11) |
| 105 | 5.5(4) | 2.15 | 5.11 Q | 19(9) |
| 112 | 5.5(14) | 0.65 | 5.35 Q | $2(3) \times 10^1$ |

***Table A39 – Zr-95 GH*** **assigned result 7.35(8) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 105 | 5.00(25) | –9.02 D | –8.16 D | –32(4) |
| 113 | 6.16(16) | –6.76 D | –4.13 D | –16.2(23) |
| 93 | 6.4(4) | –2.34 | –3.30 Q | –13(6) |
| 74 | 6.69(23) | –2.74 Q | –2.29 | –9(4) |
| 29 | 7.1(6) | –0.41 | –0.87 | –3(8) |
| 7 | 7.1(6) | –0.43 | –0.84 | –3(8) |
| 38 | 7.12(10) | –1.86 | –0.80 | –3.1(17) |
| 47 | 7.2(4) | –0.51 | –0.66 | –3(5) |
| 46 | 7.25(25) | –0.39 | –0.35 | –1(4) |
| 28 | 7.3(4) | –0.21 | –0.25 | –1(5) |
| 106 | 7.4(3) | 0.00 | 0.00 | 0(5) |
| 90 | 7.36(20) | 0.04 | 0.03 | 0(3) |
| 88 | 7.4(3) | 0.06 | 0.07 | 0(5) |
| 35 | 7.4(3) | 0.13 | 0.14 | 1(5) |
| 18 | 7.40(22) | 0.21 | 0.17 | 1(4) |
| 17 | 7.4(3) | 0.17 | 0.17 | 1(4) |
| 5 | 7.4(8) | 0.07 | 0.17 | 1(10) |
| 8 | 7.5(4) | 0.32 | 0.41 | 2(5) |
| 32 | 7.48(15) | 0.77 | 0.45 | 1.8(23) |
| 21 | 7.50(23) | 0.62 | 0.52 | 2(4) |
| 15 | 7.53(15) | 1.07 | 0.62 | 2.4(23) |
| 13 | 7.5(4) | 0.45 | 0.66 | 3(6) |
| 43 | 7.56(12) | 1.49 | 0.73 | 2.8(19) |
| 52 | 7.6(5) | 0.54 | 0.87 | 3(7) |
| 77 | 7.6(5) | 0.62 | 1.00 | 4(7) |
| 55 | 7.66(15) | 1.85 | 1.07 | 4.2(23) |
| 16 | 7.71(20) | 1.69 | 1.25 | 5(3) |
| 20 | 7.8(3) | 1.55 | 1.46 | 6(4) |
| 89 | 7.84(19) | 2.40 | 1.70 | 7(3) |
| 98 | 7.86(1) | 6.86 Q | 1.77 | 6.9(11) |
| 25 | 7.9(4) | 1.48 | 1.84 | 7(5) |
| 11 | 7.88(15) | 3.11 Q | 1.84 | 7.2(24) |
| 96 | 7.89(3) | 6.79 Q | 1.87 | 7.3(11) |

continues

| continued | | | | |
|---|---|---|---|---|
| | Result (Bq $g^{-1}$) | Zeta score | *z*-score | Deviation (%) |
| 108 | 7.9(4) | 1.35 | 1.91 | 7(6) |
| 24 | 7.9(3) | 2.14 | 2.01 | 8(4) |
| 4 | 8.1(14) Q | 0.50 | 2.43 | 10(19) |
| 14 | 8.1(3) | 2.48 | 2.50 | 10(4) |
| 54 | 8.23(22) | 3.79 D | 3.05 D | 12(4) |
| 27 | 8.4(18) | 0.57 | 3.50 Q | 14(24) |
| 68 | 8.6(4) | 2.81 D | 4.16 D | 16(6) |
| 112 | 8.6(22) | 0.58 | 4.30 Q | $2(3) \times 10^{1}$ |
| 82 | 8.7(9) | 1.49 | 4.58 Q | 18(12) |
| 31 | 10(0) | 36.01 D | 9.20 D | 36.0(14) |

***Table A40 – Nb-95 GH*** **assigned result 13.54(7) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 68 | 6.0(9) | –8.05 D | –11.25 D | –55(7) |
| 93 | 8.3(6) | –9.08 D | –7.81 D | –38(5) |
| 105 | 9.9(5) | –7.22 D | –5.46 D | –27(4) |
| 89 | 11.13(22) | –10.48 D | –3.62 D | –17.8(17) |
| 113 | 11.3(5) | –5.09 D | –3.39 D | –17(4) |
| 17 | 11.5(5) | –4.43 D | –3.02 D | –15(4) |
| 15 | 12.42(25) | –4.34 Q | –1.68 | –8.3(19) |
| 74 | 12.7(6) | –1.40 | –1.20 | –6(5) |
| 29 | 13.0(10) | –0.54 | –0.82 | –4(8) |
| 47 | 13.1(7) | –0.69 | –0.71 | –3(5) |
| 18 | 13.2(4) | –0.85 | –0.52 | –3(3) |
| 13 | 13.2(10) | –0.32 | –0.49 | –2(8) |
| 38 | 13.4(4) | –0.35 | –0.22 | –1(3) |
| 90 | 13.4(3) | –0.46 | –0.20 | –1.0(21) |
| 32 | 13.5(6) | –0.10 | –0.08 | 0(4) |
| 88 | 13.6(9) | 0.06 | 0.08 | 0(7) |
| 21 | 13.8(4) | 0.63 | 0.38 | 2(3) |
| 28 | 13.8(7) | 0.36 | 0.38 | 2(5) |
| 35 | 13.8(6) | 0.52 | 0.43 | 2(4) |
| 43 | 13.90(23) | 1.48 | 0.53 | 2.6(18) |
| 5 | 13.9(14) | 0.26 | 0.53 | 3(10) |
| 77 | 13.9(21) | 0.17 | 0.53 | 3(16) |
| 25 | 13.9(6) | 0.61 | 0.56 | 3(5) |
| 55 | 14.00(19) | 2.26 | 0.68 | 3.4(15) |
| 46 | 14.1(6) | 0.99 | 0.83 | 4(4) |
| 52 | 14.2(10) | 0.66 | 1.00 | 5(8) |
| 16 | 14.4(13) | 0.65 | 1.28 | 6(10) |
| 108 | 14.4(7) | 1.22 | 1.28 | 6(5) |
| 11 | 14.5(5) | 2.08 | 1.40 | 7(4) |
| 8 | 14.5(7) | 1.36 | 1.43 | 7(5) |
| 20 | 14.6(9) | 1.13 | 1.51 | 7(7) |
| 98 | 14.580(4) | 15.21 Q | 1.55 | 7.6(6) |
| 4 | 15(3) | 0.57 | 2.20 | 11(19) |

continues

| continued | | | | |
|---|---|---|---|---|
| | Result (Bq $g^{-1}$) | Zeta score | *z*-score | Deviation (%) |
| 24 | 15.2(15) | 1.10 | 2.48 | 12(11) |
| 54 | 15.2(10) | 1.72 | 2.48 | 12(7) |
| 14 | 15.3(6) | 3.29 D | 2.63 D | 13(4) |
| 112 | 15(4) | 0.49 | 2.84 Q | $1(3) \times 10^1$ |
| 27 | 16(4) | 0.60 | 2.93 Q | 14(24) |
| 96 | 15.70(9) | 19.11 D | 3.23 D | 15.9(9) |
| 82 | 15.9(17) | 1.38 | 3.53 Q | 17(13) |
| 7 | 18(6) | 0.86 | 7.28 Q | $4(4) \times 10^1$ |
| 106 | 27.6(14) | 10.20 D | 21.12 D | 104(10) |

***Table A41 – Ba-133 GH*** **assigned result 2.754(19) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 113 | 1.98(7) | –10.66 D | –6.22 D | –28(3) |
| 11 | 2.14(4) | –13.47 D | –4.91 D | –22.2(16) |
| 5 | 2.20(22) | –2.51 | –4.45 Q | –20(8) |
| 74 | 2.36(8) | –4.79 D | –3.16 D | –14(3) |
| 77 | 2.42(15) | –2.21 | –2.68 Q | –12(6) |
| 93 | 2.43(15) | –2.14 | –2.60 Q | –12(6) |
| 17 | 2.45(10) | –2.98 Q | –2.44 | –11(4) |
| 28 | 2.45(11) | –2.72 Q | –2.44 | –11(4) |
| 108 | 2.46(13) | –2.24 | –2.36 | –11(5) |
| 43 | 2.49(7) | –3.63 Q | –2.12 | –10(3) |
| 16 | 2.49(15) | –1.75 | –2.12 | –10(6) |
| 7 | 2.52(14) | –1.66 | –1.88 | –8(5) |
| 27 | 2.5(6) Q | –0.42 | –1.80 | –8(19) |
| 13 | 2.54(16) | –1.33 | –1.72 | –8(6) |
| 98 | 2.56(2) | –6.97 Q | –1.56 | –7.0(10) |
| 8 | 2.57(14) | –1.30 | –1.48 | –7(5) |
| 55 | 2.57(8) | –2.23 | –1.48 | –7(3) |
| 29 | 2.60(20) | –0.77 | –1.24 | –6(7) |
| 52 | 2.60(13) | –1.17 | –1.24 | –6(5) |
| 90 | 2.62(9) | –1.45 | –1.08 | –5(4) |
| 38 | 2.63(11) | –1.11 | –1.00 | –5(4) |
| 25 | 2.64(12) | –0.94 | –0.92 | –4(5) |
| 15 | 2.66(5) | –1.75 | –0.75 | –3.4(19) |
| 46 | 2.67(10) | –0.82 | –0.67 | –3(4) |
| 106 | 2.67(12) | –0.69 | –0.67 | –3(5) |
| 21 | 2.68(8) | –0.90 | –0.59 | –3(3) |
| 47 | 2.71(14) | –0.31 | –0.35 | –2(5) |
| 88 | 2.71(12) | –0.36 | –0.35 | –2(5) |
| 32 | 2.72(5) | –0.63 | –0.27 | –1.2(19) |
| 20 | 2.74(13) | –0.11 | –0.11 | –1(5) |
| 18 | 2.76(8) | 0.07 | 0.05 | 0(3) |
| 68 | 2.80(16) | 0.29 | 0.37 | 2(6) |
| 96 | 2.83(3) | 2.13 | 0.61 | 2.8(13) |
| 24 | 2.85(16) | 0.60 | 0.77 | 3(6) |
| 4 | 2.9(4) Q | 0.36 | 1.17 | 5(15) |

continues

| continued | | | | |
|---|---|---|---|---|
| | Result (Bq $g^{-1}$) | Zeta score | $z$-score | Deviation (%) |
| 14 | 2.98(14) | 1.60 | 1.82 | 8(5) |
| 54 | 3.01(8) | 3.11 Q | 2.06 | 9(3) |
| 82 | 3.0(3) | 0.95 | 2.30 | 10(11) |
| 89 | 3.06(11) | 2.74 Q | 2.46 | 11(4) |
| 105 | 3.20(16) | 2.77 D | 3.58 D | 16(6) |
| 35 | 3.29(14) | 3.79 D | 4.31 D | 19(5) |
| 112 | 3.4(9) | 0.77 | 5.35 Q | $2(3) \times 10^1$ |

***Table A42 – Cs-134 GH*** **assigned result 4.63(4) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 113 | 3.6(4) | –2.99 D | –5.46 D | –21(7) |
| 74 | 3.92(13) | –5.32 D | –3.92 D | –15(3) |
| 11 | 3.97(8) | –8.15 D | –3.67 D | –14.4(17) |
| 93 | 4.0(3) | –2.41 | –3.48 Q | –14(6) |
| 7 | 4.09(10) | –5.16 D | –2.99 D | –11.7(22) |
| 28 | 4.14(19) | –2.56 | –2.71 Q | –11(4) |
| 16 | 4.16(17) | –2.73 D | –2.60 D | –10(4) |
| 108 | 4.19(20) | –2.18 | –2.44 | –10(5) |
| 105 | 4.26(24) | –1.54 | –2.05 | –8(5) |
| 5 | 4.3(5) | –0.77 | –1.83 | –7(9) |
| 77 | 4.3(3) | –1.19 | –1.72 | –7(6) |
| 89 | 4.36(4) | –5.28 Q | –1.50 | –5.9(11) |
| 35 | 4.39(18) | –1.33 | –1.34 | –5(4) |
| 27 | 4.4(9) Q | –0.23 | –1.17 | –5(20) |
| 13 | 4.45(24) | –0.75 | –1.01 | –4(5) |
| 98 | 4.45(1) | –5.36 Q | –1.01 | –3.9(7) |
| 52 | 4.47(22) | –0.73 | –0.89 | –4(5) |
| 46 | 4.48(16) | –0.93 | –0.84 | –3(4) |
| 106 | 4.48(16) | –0.93 | –0.84 | –3(4) |
| 29 | 4.5(4) | –0.33 | –0.73 | –3(9) |
| 88 | 4.52(20) | –0.56 | –0.62 | –2(5) |
| 90 | 4.53(12) | –0.83 | –0.56 | –2(3) |
| 32 | 4.53(7) | –1.33 | –0.56 | –2.2(17) |
| 8 | 4.54(23) | –0.40 | –0.51 | –2(5) |
| 25 | 4.6(4) | –0.25 | –0.45 | –2(7) |
| 55 | 4.55(9) | –0.86 | –0.45 | –1.8(21) |
| 21 | 4.56(14) | –0.51 | –0.40 | –2(3) |
| 31 | 4.6(0) | –1.00 | –0.18 | –0.7(7) |
| 18 | 4.66(14) | 0.19 | 0.15 | 1(3) |
| 20 | 4.67(16) | 0.23 | 0.21 | 1(4) |
| 4 | 4.7(7) | 0.06 | 0.21 | 1(14) |
| 15 | 4.68(9) | 0.49 | 0.26 | 1.0(21) |
| 82 | 4.7(5) | 0.14 | 0.37 | 1(10) |
| 43 | 4.71(12) | 0.62 | 0.43 | 2(3) |
| 96 | 4.73(3) | 2.20 | 0.54 | 2.1(10) |
| 24 | 4.75(12) | 0.94 | 0.65 | 3(3) |

continues

| continued | | | | |
|---|---|---|---|---|
| | Result (Bq $g^{-1}$) | Zeta score | $z$-score | Deviation (%) |
| 68 | 4.9(4) | 0.64 | 1.20 | 5(8) |
| 47 | 4.94(25) | 1.22 | 1.69 | 7(6) |
| 14 | 4.95(23) | 1.37 | 1.75 | 7(5) |
| 54 | 4.95(8) | 3.67 Q | 1.75 | 6.9(19) |
| 38 | 4.97(16) | 2.07 | 1.86 | 7(4) |
| 112 | 5.9(15) | 0.86 | 6.97 Q | $3(4) \times 10^1$ |
| 17 | 6.65(25) | 8.00 D | 11.10 D | 44(6) |
| 83 | 9.6(3) | 16.46 D | 27.33 D | 107(7) |

***Table A43 – Cs-137 GH*** **assigned result 9.56(7) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 113 | 7.90(22) | –7.23 D | –4.59 D | –17.4(24) |
| 74 | 8.7(3) | –2.96 Q | –2.52 | –10(4) |
| 77 | 9.1(6) | –0.94 | –1.41 | –5(6) |
| 38 | 9.27(11) | –2.26 | –0.80 | –3.0(13) |
| 13 | 9.3(5) | –0.43 | –0.61 | –2(6) |
| 90 | 9.4(3) | –0.71 | –0.52 | –2(3) |
| 47 | 9.4(5) | –0.37 | –0.50 | –2(5) |
| 25 | 9.4(4) | –0.41 | –0.47 | –2(5) |
| 29 | 9.4(7) | –0.23 | –0.44 | –2(8) |
| 17 | 9.4(4) | –0.33 | –0.33 | –1(4) |
| 32 | 9.46(14) | –0.64 | –0.27 | –1.0(16) |
| 106 | 9.5(5) | –0.19 | –0.27 | –1(6) |
| 35 | 9.5(4) | –0.18 | –0.19 | –1(4) |
| 5 | 9.5(10) | –0.06 | –0.16 | –1(10) |
| 8 | 9.5(5) | –0.11 | –0.14 | –1(5) |
| 46 | 9.5(4) | –0.06 | –0.05 | 0(4) |
| 55 | 9.55(12) | –0.07 | –0.02 | –0.1(14) |
| 7 | 9.59(24) | 0.12 | 0.09 | 0(3) |
| 88 | 9.6(4) | 0.10 | 0.11 | 0(5) |
| 93 | 9.6(5) | 0.08 | 0.11 | 0(6) |
| 28 | 9.7(5) | 0.20 | 0.25 | 1(5) |
| 15 | 9.70(19) | 0.70 | 0.39 | 1.5(21) |
| 43 | 9.72(16) | 0.93 | 0.45 | 1.7(18) |
| 21 | 9.7(3) | 0.61 | 0.50 | 2(3) |
| 11 | 9.79(18) | 1.18 | 0.63 | 2.4(20) |
| 20 | 9.83(24) | 1.09 | 0.75 | 3(3) |
| 18 | 9.8(3) | 0.88 | 0.75 | 3(4) |
| 52 | 9.9(7) | 0.42 | 0.81 | 3(7) |
| 108 | 9.9(5) | 0.68 | 0.94 | 4(6) |
| 31 | 9.9(0) | 5.24 Q | 0.94 | 3.6(7) |
| 112 | 9.9(25) Q | 0.15 | 1.03 | 0(3) × 10$^{1}$ |
| 16 | 9.95(18) | 2.04 | 1.08 | 4.1(20) |
| 89 | 10.06(20) | 2.38 | 1.39 | 5.2(22) |

continues

| continued | | | | |
|---|---|---|---|---|
| | Result (Bq g$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
| 96 | 10.10(4) | 7.08 Q | 1.50 | 5.7(8) |
| 24 | 10.2(3) | 2.09 | 1.77 | 7(4) |
| 98 | 10.21(1) | 9.88 Q | 1.80 | 6.8(8) |
| 27 | 10.3(22) Q | 0.36 | 2.13 | 8(23) |
| 4 | 10.6(15) | 0.70 | 2.88 Q | 11(16) |
| 105 | 10.6(5) | 2.06 | 2.88 Q | 11(6) |
| 14 | 10.6(4) | 2.87 D | 2.91 D | 11(4) |
| 54 | 10.7(4) | 2.63 D | 3.02 D | 11(5) |
| 82 | 11.2(11) | 1.49 | 4.54 Q | 17(12) |
| 68 | 11.3(8) | 2.17 | 4.71 Q | 18(8) |
| 83 | 23.7(10) | 14.11 D | 39.15 D | 148(11) |

***Table A44 – Eu-152 GH*** **assigned result 17.86(12) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 31 | 13(0) | –39.88 D | –6.99 D | –27.2(5) |
| 17 | 13.6(6) | –7.79 D | –6.10 D | –24(3) |
| 113 | 14.3(4) | –8.76 D | –5.15 D | –20.0(23) |
| 38 | 14.8(4) | –6.97 D | –4.39 D | –17.1(24) |
| 93 | 15.3(8) | –3.01 D | –3.68 D | –14(5) |
| 5 | 15.4(15) | –1.59 | –3.54 Q | –14(9) |
| 11 | 16.0(3) | –5.65 D | –2.63 D | –10.2(18) |
| 35 | 16.1(7) | –2.67 Q | –2.57 | –10(4) |
| 112 | 16(4) Q | –0.37 | –2.16 | –8(23) |
| 27 | 16(4) Q | –0.42 | –2.07 | –8(19) |
| 90 | 16.45(4) | –3.22 Q | –2.03 | –7.9(24) |
| 16 | 16.5(5) | –2.83 Q | –1.94 | –8(3) |
| 28 | 16.6(8) | –1.56 | –1.81 | –7(5) |
| 7 | 16.7(5) | –2.55 | –1.71 | –7(3) |
| 106 | 16.7(6) | –1.95 | –1.64 | –6(4) |
| 29 | 17.0(15) | –0.57 | –1.24 | –5(9) |
| 52 | 17.0(9) | –0.95 | –1.18 | –5(5) |
| 13 | 17.1(10) | –0.75 | –1.14 | –4(6) |
| 32 | 17.2(5) | –1.31 | –0.99 | –4(3) |
| 88 | 17.2(8) | –0.81 | –0.95 | –4(5) |
| 98 | 17.29(1) | –4.65 Q | –0.82 | –3.2(7) |
| 77 | 17.3(10) | –0.55 | –0.80 | –3(6) |
| 108 | 17.3(8) | –0.69 | –0.80 | –3(5) |
| 43 | 17.3(5) | –1.16 | –0.78 | –3(3) |
| 47 | 17.5(9) | –0.46 | –0.59 | –2(5) |
| 46 | 17.6(6) | –0.50 | –0.44 | –2(4) |
| 8 | 17.6(8) | –0.35 | –0.37 | –1(4) |
| 21 | 17.8(6) | –0.11 | –0.08 | 0(3) |
| 20 | 17.8(9) | –0.03 | –0.04 | 0(5) |
| 55 | 17.9(3) | 0.13 | 0.06 | 0.2(17) |
| 18 | 18.0(6) | 0.27 | 0.22 | 1(3) |
| 68 | 18.1(10) | 0.22 | 0.32 | 1(6) |
| 89 | 18.6(6) | 1.29 | 1.07 | 4(4) |
| 24 | 18.6(10) | 0.74 | 1.07 | 4(6) |
| 105 | 18.7(10) | 0.83 | 1.21 | 5(6) |

continues

| continued | | | | |
|---|---|---|---|---|
| | Result (Bq $g^{-1}$) | Zeta score | *z*-score | Deviation (%) |
| 96 | 18.80(11) | 5.73 Q | 1.35 | 5.3(10) |
| 74 | 19.1(7) | 1.88 | 1.79 | 7(4) |
| 14 | 19.3(6) | 2.35 | 2.07 | 8(4) |
| 54 | 19.55(23) | 6.50 Q | 2.43 | 9.5(15) |
| 4 | 20(3) | 0.64 | 2.53 | 10(15) |
| 82 | 19.7(20) | 0.92 | 2.65 Q | 10(11) |
| 15 | 19.9(4) | 5.42 D | 2.97 D | 11.5(22) |
| 25 | 21.2(15) | 2.30 | 4.81 Q | 19(8) |

***Table A45 – Total H-3 C*** **assigned result 18(10) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 109 | 0.526(13) | –1.87 | –2.34 | –97.1(15) |
| 17 | 5.8(8) | –1.32 | –1.65 | –68(17) |
| 31 | 10.2(0) | –0.86 | –1.08 | –4(3) × 10$^{1}$ |
| 29 | 13.7(4) | –0.50 | –0.62 | –3(4) × 10$^{1}$ |
| 7 | 15.7(16) | –0.28 | –0.36 | –1(5) × 10$^{1}$ |
| 95 | 16.4(9) | –0.22 | –0.27 | –1(5) × 10$^{1}$ |
| 5A | 19(3) | 0.05 | 0.06 | 0(6) × 10$^{1}$ |
| 78 | 19.6(3) | 0.12 | 0.15 | 1(6) × 10$^{1}$ |
| 5B | 21(3) | 0.21 | 0.27 | 1(6) × 10$^{1}$ |
| 32 | 23.3(13) | 0.50 | 0.63 | 3(7) × 10$^{1}$ |
| 38 | 25(3) | 0.63 | 0.82 | 3(7) × 10$^{1}$ |
| 74 | 25.7(15) | 0.75 | 0.95 | 4(7) × 10$^{1}$ |
| 35 | 27.3(18) | 0.91 | 1.16 | 5(8) × 10$^{1}$ |
| 1 | 28.3(4) | 1.03 | 1.29 | 5(8) × 10$^{1}$ |

Critical value = **3.012**

***Table A46 – Leachable H-3 C*** **assigned result 3(4) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 65 | 0.65(3) | –0.61 | –0.76 | –8(3) × 10$^{1}$ |
| 29 | 0.9(2) | –0.54 | –0.67 | –7(4) × 10$^{1}$ |
| 95 | 2.82(16) | –0.01 | –0.02 | 0(13) × 10$^{1}$ |
| 32 | 2.89(8) | 0.00 | 0.01 | 0(13) × 10$^{1}$ |
| 31 | 8.5(0) | 1.54 | 1.92 | 2(4) × 10$^{2}$ |

Critical value = **4.604**

***Table A47 – C-14 C*** **assigned result 0.06(5) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 1 | 0.016(5) | –1.01 | –1.27 | –73(21) |
| 14 | 0.029(5) | –0.71 | –0.89 | –5(4) × 10$^1$ |
| 5A | 0.031(5) | –0.67 | –0.84 | –5(4) × 10$^1$ |
| 5B | 0.038(6) | –0.50 | –0.64 | –4(5) × 10$^1$ |
| 35 | 0.047(6) | –0.29 | –0.37 | –2(6) × 10$^1$ |
| 94 | 0.051(6) | –0.21 | –0.26 | –2(6) × 10$^1$ |
| 32 | 0.054(4) | –0.14 | –0.18 | –1(7) × 10$^1$ |
| 17 | 0.067(16) | 0.15 | 0.20 | 1(9) × 10$^1$ |
| 74 | 0.082(10) | 0.48 | 0.62 | 4(10) × 10$^1$ |
| 95 | 0.117(7) | 1.29 | 1.63 | 9(14) × 10$^1$ |
| 7 | 0.33(8) | 3.01 | 7.85 Q | 5(5) × 10$^2$ |
| 78 | 0.61(8) | 5.80 D | 15.70 D | 9(8) × 10$^2$ |

Critical value = **3.106**

***Table A48 – K-40 C*** **assigned result 0.18(8) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 95 | 0.108(8) | –0.98 | –1.24 | –41(25) |
| 78 | 0.147(13) | –0.46 | –0.58 | –2(4) × 10$^1$ |
| 94 | 0.16(2) | –0.29 | –0.37 | –1(4) × 10$^1$ |
| 54 | 0.162(13) | –0.27 | –0.34 | –1(4) × 10$^1$ |
| 8 | 0.201(12) | 0.25 | 0.31 | 1(5) × 10$^1$ |
| 4 | 0.29(5) | 1.27 | 1.85 | 6(7) × 10$^1$ |
| 17 | 0.40(7) | 2.12 | 3.62 | 12(10) × 10$^1$ |

Critical value = **3.707**

***Table A49 – Fe-55 C*** **assigned result 0.055(5) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 74 | 0.047(4) | –1.38 | –0.92 | –15(10) |
| 38 | 0.05(1) | –0.43 | –0.53 | –9(20) |
| 32 | 0.059(11) | 0.36 | 0.48 | 8(22) |
| 94 | 0.086(12) | 2.44 | 3.51 | 57(25) |
| 78 | 0.236(21) | 8.30 D | 20.30 D | 33(6) × 10$^1$ |

Critical value = **5.841**

***Table A50 – Co-60 C*** **assigned result 0.1045(14) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 65* | 0.011(6) | –17.16 D | –17.08 D | –90(5) |
| 95* | 0.0759(25) | –10.01 D | –5.20 D | –27(3) |
| 54* | 0.0943(25) | –3.56 Q | –1.85 | –10(3) |
| 5A | 0.095(10) | –0.99 | –1.72 | –9(9) |
| 5B | 0.097(10) | –0.76 | –1.36 | –7(9) |
| 78 | 0.0991(25) | –1.90 | –0.98 | –5(3) |
| 8 | 0.1000(20) | –1.84 | –0.81 | –4.3(23) |
| 94 | 0.101(4) | –0.82 | –0.63 | –3(4) |
| 97 | 0.102(4) | –0.58 | –0.45 | –2(4) |
| 28 | 0.102(14) | –0.18 | –0.45 | –2(13) |
| 106 | 0.102(4) | –0.58 | –0.45 | –2(4) |
| 32 | 0.104(3) | –0.18 | –0.10 | –1(3) |
| 24 | 0.105(4) | 0.12 | 0.10 | 1(4) |
| 52 | 0.106(4) | 0.36 | 0.28 | 1(4) |
| 21 | 0.106(3) | 0.46 | 0.28 | 1(4) |
| 81 | 0.108(9) | 0.39 | 0.64 | 3(9) |
| 88 | 0.110(5) | 1.07 | 1.01 | 5(5) |
| 38 | 0.110(10) | 0.55 | 1.01 | 5(10) |
| 109 | 0.110(5) | 1.07 | 1.01 | 5(5) |
| 4 | 0.110(15) | 0.38 | 1.06 | 6(15) |
| 35 | 0.110(6) | 0.95 | 1.08 | 6(6) |
| 68 | 0.113(7) | 1.27 | 1.53 | 8(7) |
| 113 | 0.114(6) | 1.55 | 1.73 | 9(6) |
| 96 | 0.116(5) | 2.22 | 2.10 | 11(5) |
| 48* | 0.120(5) | 2.99 D | 2.82 D | 15(5) |
| 29 | 0.120(10) | 1.54 | 2.82 Q | 15(10) |
| 17 | 0.120(10) | 1.54 | 2.82 Q | 15(10) |
| 7 | 0.121(16) | 1.03 | 3.01 Q | 16(15) |
| 55 | 0.123(10) | 1.88 | 3.37 Q | 18(10) |
| 105 | 0.13(6) | 0.43 | 4.64 Q | 2(6) × 10$^{1}$ |
| 1 | 0.130(10) | 2.53 | 4.64 Q | 24(10) |

Critical value = **2.779**

***Table A51 – Ni-63 C*** **assigned result 0.04(3) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 94 | 0.025(5) | –0.65 | –0.83 | –4(4) × 10$^{1}$ |
| 14 | 0.026(5) | –0.62 | –0.79 | –4(4) × 10$^{1}$ |
| 38 | 0.03(1) | –0.47 | –0.62 | –3(5) × 10$^{1}$ |
| 74 | 0.048(5) | 0.12 | 0.15 | 1(7) × 10$^{1}$ |
| 78 | 0.1508(25) | 3.60 | 4.52 Q | 24(22) × 10$^{1}$ |
| 31 | 1.4(0) | 46.13 D | 57.66 D | 30(21) × 10$^{2}$ |

Critical value = **4.032**

***Table A52 – Ba-133 C*** **assigned result 0.0070(3) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 28 | 0.0052(10) | –1.78 | –2.09 | –26(14) |
| 113 | 0.0059(19) | –0.60 | –1.30 | –2(3) × 10$^{1}$ |
| 8 | 0.0059(10) | –1.06 | –1.28 | –16(15) |
| 32 | 0.0060(14) | –0.73 | –1.18 | –15(20) |
| 94 | 0.0064(7) | –0.86 | –0.73 | –9(10) |
| 109 | 0.0070(7) | –0.07 | –0.06 | –1(11) |
| 88 | 0.0070(5) | –0.08 | –0.05 | –1(8) |
| 21 | 0.0072(8) | 0.19 | 0.18 | 2(12) |
| 48 | 0.0080(10) | 0.93 | 1.09 | 14(15) |
| 38 | 0.0080(20) | 0.47 | 1.09 | 1(3) × 10$^{1}$ |
| 78 | 0.0080(16) | 0.61 | 1.13 | 14(23) |
| 35 | 0.0083(14) | 0.88 | 1.43 | 18(20) |
| 68 | 0.0086(8) | 2.01 | 1.79 | 22(11) |
| 96* | 0.0110(6) | 6.06 D | 4.49 D | 56(10) |
| 105* | 0.074(6) | 11.15 D | 76.05 D | 95(9) × 10$^{1}$ |

Critical value = **3.055**

***Table A53 – Eu-152 C*** **assigned result 2.63(4) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|
| 97* | 1.84(6) | –11.56 D | –6.94 D | –30.0(24) |
| 95* | 1.90(8) | –8.72 D | –6.42 D | –28(3) |
| 28 | 2.2(3) | –1.62 | –4.14 Q | –18(11) |
| 5B | 2.18(22) | –2.05 | –3.96 Q | –17(8) |
| 5A | 2.25(23) | –1.68 | –3.35 Q | –14(9) |
| 65 | 2.38(12) | –2.02 | –2.21 | –10(5) |
| 54* | 2.39(3) | –5.47 Q | –2.11 | –9.1(16) |
| 38 | 2.42(13) | –1.58 | –1.85 | –8(5) |
| 81 | 2.47(20) | –0.80 | –1.42 | –6(8) |
| 106 | 2.51(9) | –1.27 | –1.07 | –5(4) |
| 78* | 2.517(25) | –2.75 | –1.00 | –4.3(15) |
| 94 | 2.53(12) | –0.82 | –0.89 | –4(5) |
| 55 | 2.55(16) | –0.49 | –0.71 | –3(7) |
| 35 | 2.58(11) | –0.45 | –0.45 | –2(5) |
| 17 | 2.60(20) | –0.16 | –0.28 | –1(8) |
| 21 | 2.60(7) | –0.41 | –0.28 | –1(3) |
| 52 | 2.62(5) | –0.23 | –0.13 | –0.5(23) |
| 105 | 2.63(13) | –0.01 | –0.01 | 0(5) |
| 32 | 2.63(4) | 0.03 | 0.01 | 0.1(20) |
| 8 | 2.64(7) | 0.11 | 0.08 | 0(3) |
| 7 | 2.7(3) | 0.17 | 0.43 | 2(11) |
| 109 | 2.68(11) | 0.42 | 0.43 | 2(5) |
| 29 | 2.70(20) | 0.34 | 0.60 | 3(8) |
| 24 | 2.71(20) | 0.39 | 0.69 | 3(8) |
| 88 | 2.77(12) | 1.11 | 1.22 | 5(5) |
| 48 | 2.80(10) | 1.60 | 1.48 | 6(4) |
| 96 | 2.83(10) | 1.89 | 1.74 | 8(4) |
| 113 | 2.90(10) | 2.55 | 2.36 | 10(4) |
| 4 | 2.9(5) | 0.62 | 2.60 | 11(18) |
| 68 | 3.04(18) | 2.28 | 3.56 Q | 15(7) |
| 1* | 3.120(20) | 12.66 D | 4.29 D | 18.6(17) |

Critical value = **2.787**

***Table A54 – Eu-154 C*** **assigned result 0.1029(18) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 96* | 0.055(3) | –13.73 D | –6.01 D | –47(3) |
| 95* | 0.069(4) | –7.95 D | –4.28 D | –33(4) |
| 97* | 0.070(5) | –6.19 D | –4.13 D | –32(5) |
| 28 | 0.084(12) | –1.55 | –2.37 | –18(12) |
| 8* | 0.092(4) | –2.53 | –1.41 | –11(5) |
| 21 | 0.093(6) | –1.58 | –1.24 | –10(6) |
| 78 | 0.093(4) | –2.21 | –1.24 | –10(5) |
| 81 | 0.094(8) | –1.08 | –1.11 | –9(8) |
| 94 | 0.095(6) | –1.26 | –0.99 | –8(6) |
| 24 | 0.097(5) | –1.10 | –0.74 | –6(5) |
| 35 | 0.098(6) | –0.81 | –0.61 | –5(6) |
| 17 | 0.100(20) | –0.14 | –0.36 | –3(20) |
| 109 | 0.100(5) | –0.54 | –0.36 | –3(5) |
| 52 | 0.108(3) | 1.47 | 0.65 | 5(4) |
| 29 | 0.110(10) | 0.70 | 0.90 | 7(10) |
| 88 | 0.110(6) | 1.14 | 0.90 | 7(6) |
| 38 | 0.110(10) | 0.70 | 0.90 | 7(10) |
| 105 | 0.11(6) Q | 0.12 | 0.90 | 1(6) × 10$^{1}$ |
| 68 | 0.113(6) | 1.59 | 1.29 | 10(7) |
| 55 | 0.114(24) | 0.46 | 1.40 | 11(23) |
| 113 | 0.114(10) | 1.10 | 1.40 | 11(10) |
| 32 | 0.120(8) | 2.02 | 2.13 | 16(8) |
| 48 | 0.120(10) | 1.69 | 2.15 | 17(10) |
| 7 | 0.12(3) | 0.57 | 2.15 | 2(3) × 10$^{1}$ |
| 4* | 0.13(5) | 0.54 | 3.56 Q | 3(5) × 10$^{1}$ |
| 1* | 0.140(20) | 1.85 | 4.67 Q | 36(20) |
| 5A | 1.08(11) | 9.05 D | 122.76 D | 95(11) × 10$^{1}$ |
| 5B | 1.08(11) | 9.05 D | 122.76 D | 95(11) × 10$^{1}$ |

Critical value = **2.831**

***Table A55 – Gross beta C*** **assigned result 1.2(8) Bq g$^{-1}$**

| | Result (Bq g$^{-1}$) | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|
| 94 | 0.45(5) | –0.88 | –1.10 | –6(3) × 10$^{1}$ |
| 95 | 0.612(10) | –0.68 | –0.85 | –5(4) × 10$^{1}$ |
| 113 | 1.23(6) | 0.08 | 0.10 | 1(8) × 10$^{1}$ |
| 32 | 1.30(6) | 0.16 | 0.21 | 1(8) × 10$^{1}$ |
| 78 | 1.33(5) | 0.20 | 0.25 | 1(8) × 10$^{1}$ |
| 1 | 13(5) | 2.34 | 18.22 Q | 10(9) × 10$^{2}$ |

Critical value = **4.032**

## Appendix B. Results sorted by laboratory

***Table B1 – Laboratory 1***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{234}$U AH | 10.3(16) | 11.1(10) | –0.45 | –1.69 | –8(17) |
| $^{235}$U AH | 0.4(5) Q | 0.5188(19) | –0.22 | –1.76 | –2(9) × 10$^{1}$ |
| $^{238}$U AH | 11(4) Q | 11.262(17) | –0.23 | –1.34 | –1(3) × 10$^{1}$ |
| $^{238}$Pu AH | 6.3(5) | 5.807(18) | 0.98 | 1.49 | 8(9) |
| $^{239}$Pu AH | 16.6(5) | 15.42(7) | 2.34 | 1.49 | 8(4) |
| $^{241}$Am AH | 4.0(5) | 3.369(7) | 1.26 | 4.17 Q | 19(15) |
| $^{244}$Cm AH | 5.3(5) | 4.708(14) | 1.18 | 2.43 | 13(11) |
| Gross a AH | 64(3) | 65(8) | –0.16 | –0.41 | –2(13) |
| $^{3}$H B1 | 1.3(3) | 0.925(7) | 1.25 | 7.04 Q | 4(4) × 10$^{1}$ |
| $^{14}$C B1 | 0.77(2) | 0.702(4) | 3.32 Q | 1.62 | 10(3) |
| $^{3}$H B2 | 0.68(9) | 0.487(4) | 2.14 | 9.25 Q | 40(19) |
| $^{55}$Fe B2 | 1.56(3) | 1.65(4) | –1.75 | –0.79 | –5(3) |
| $^{63}$Ni B2 | 0.58(2) | 0.596(24) | –0.52 | –0.45 | –3(5) |
| $^{90}$Sr B2 | 0.40(2) | 0.5712(11) | –8.54 D | –4.12 D | –30(4) |
| Gross b B2 | 1.6(3) | 1.1423(23) | 1.53 | 6.69 Q | 4(3) × 10$^{1}$ |
| $^{3}$H tot C | 28.3(4) | 18(10) | 1.03 | 1.29 | 5(8) × 10$^{1}$ |
| $^{14}$C C | 0.016(5) | 0.06(5) | –1.01 | –1.27 | –73(21) |
| $^{60}$Co C | 0.13(1) | 0.1045(14) | 2.53 | 4.64 Q | 24(10) |
| $^{152}$Eu C | 3.12(2) | 2.63(4) | 12.66 D | 4.29 D | 18.6(17) |
| $^{154}$Eu C | 0.14(2) | 0.1029(18) | 1.85 | 4.67 Q | 36(20) |
| Gross b C | 13(5) | 1.2(8) | 2.34 | 18.22 Q | 10(9) × 10$^{2}$ |

***Table B2 – Laboratory 4***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{234}$U AL | 14.9(9) | 14.6(14) | 0.18 | 0.33 | 2(11) |
| $^{238}$U AL | 15.2(9) | 14.76(4) | 0.54 | 0.54 | 3(6) |
| $^{238}$Pu AL | 12.2(7) | 11.86(4) | 0.53 | 0.55 | 3(6) |
| $^{239}$Pu AL | 10.1(6) | 10.19(5) | –0.08 | –0.08 | 0(6) |
| $^{241}$Am AL | 13.4(8) | 13.57(4) | –0.17 | –0.16 | –1(6) |
| $^{22}$Na GL | 7.4(11) | 8.19(3) | –0.70 | –1.77 | –9(13) |
| $^{60}$Co GL | 7.4(11) | 7.201(22) | 0.14 | 0.45 | 2(15) |
| $^{95}$Zr GL | 8.4(15) | 7.30(7) | 0.72 | 2.20 | 15(21) |
| $^{95}$Nb GL | 13.8(24) | 13.46(7) | 0.15 | 0.44 | 3(18) |
| $^{133}$Ba GL | 6.5(10) | 6.12(5) | 0.36 | 0.93 | 6(16) |
| $^{134}$Cs GL | 12.5(18) | 11.93(8) | 0.29 | 1.02 | 4(15) |
| $^{137}$Cs GL | 9.5(14) | 9.02(6) | 0.31 | 0.92 | 5(15) |
| $^{152}$Eu GL | 15.3(22) | 12.35(9) | 1.32 | 4.30 Q | 24(18) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B1 | 0.89(12) | 0.925(7) | –0.31 | –0.70 | –4(13) |
| $^{22}$Na GH | 5.3(9) Q | 5.529(20) | –0.27 | –1.12 | –5(16) |
| $^{60}$Co GH | 4.9(7) | 4.641(14) | 0.44 | 1.66 | 6(14) |
| $^{95}$Zr GH | 8.1(14) Q | 7.35(8) | 0.50 | 2.43 | 10(19) |
| $^{95}$Nb GH | 15(3) | 13.54(7) | 0.57 | 2.20 | 11(19) |
| $^{133}$Ba GH | 2.9(4) Q | 2.754(19) | 0.36 | 1.17 | 5(15) |
| $^{134}$Cs GH | 4.7(7) | 4.63(4) | 0.06 | 0.21 | 1(14) |
| $^{137}$Cs GH | 10.6(15) | 9.56(7) | 0.70 | 2.88 Q | 11(16) |
| $^{152}$Eu GH | 20(3) Q | 17.86(12) | 0.64 | 2.53 | 10(15) |
| $^{40}$K C | 0.29(5) | 0.18(8) | 1.27 | 1.85 | 6(7) × 10$^{1}$ |
| $^{60}$Co C | 0.110(15) | 0.1045(14) | 0.38 | 1.06 | 6(15) |
| $^{152}$Eu C | 2.9(5) | 2.63(4) | 0.62 | 2.60 | 11(18) |
| $^{154}$Eu C | 0.13(5) | 0.1029(18) | 0.54 | 3.56 Q | 3(5) × 10$^{1}$ |

***Table B3 – Laboratory 5***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq $kg^{-1}$) | (Bq $kg^{-1}$) | | | |
| Gross a AL | 9.3(9) | 92(8) | –10.17 D | – 17.75 D | –89.9(13) |
| $^{22}$Na GL | 5.5(6) | 8.19(3) | –4.88 D | – 6.19 D | –33(7) |
| $^{60}$Co GL | 4.0(4) | 7.201(22) | –7.99 D | – 9.63 D | –44(6) |
| $^{95}$Zr GL | 5.2(5) | 7.30(7) | –4.01 D | – 4.26 D | –29(7) |
| $^{95}$Nb GL | 7.3(7) | 13.46(7) | –8.40 D | – 7.73 D | –46(6) |
| $^{133}$Ba GL | – | 6.12(5) | – | – | – |
| $^{134}$Cs GL | 7.4(8) | 11.93(8) | –6.08 D | – 8.73 D | –38(6) |
| $^{137}$Cs GL | 5.6(6) | 9.02(6) | –6.07 D | – 7.37 D | –38(6) |
| $^{152}$Eu GL | 6.5(7) | 12.35(9) | –8.92 D | – 8.60 D | –47(6) |
| $^{40}$K GL | 12.1(12) | – | – | – | – |
| | (Bq $g^{-1}$) | (Bq $g^{-1}$) | | | |
| $^{3}$H B1 | 1.03(16) | 0.925(7) | 0.65 | 1.96 | 11(17) |
| $^{14}$C B1 | 0.61(9) | 0.702(5) | –1.00 | –2.21 | –13(13) |
| $^{3}$H B2 | 0.50(8) | 0.487(4) | 0.21 | 0.77 | 3(16) |
| $^{22}$Na GH | 4.9(5) | 5.529(20) | –1.28 | –2.82 Q | –11(9) |
| $^{60}$Co GH | 4.5(5) | 4.641(14) | –0.31 | –0.84 | –3(10) |
| $^{95}$Zr GH | 7.4(8) | 7.35(8) | 0.07 | 0.17 | 1(10) |
| $^{95}$Nb GH | 13.9(14) | 13.54(7) | 0.26 | 0.53 | 3(10) |
| $^{133}$Ba GH | 2.20(22) | 2.754(19) | –2.51 | –4.45 Q | –20(8) |
| $^{134}$Cs GH | 4.3(5) | 4.63(4) | –0.77 | –1.83 | –7(9) |
| $^{137}$Cs GH | 9.5(10) | 9.56(7) | –0.06 | –0.16 | –1(10) |
| $^{152}$Eu GH | 15.4(15) | 17.86(12) | –1.59 | –3.54 Q | –14(9) |
| $^{3}$H total C A | 19(3) | 18(10) | 0.05 | 0.06 | $0(6) \times 10^1$ |
| $^{3}$H total C B | 21(3) | 18(10) | 0.21 | 0.27 | $1(6) \times 10^1$ |
| $^{14}$C C A | 0.031(5) | 0.06(5) | –0.67 | –0.84 | $–5(4) \times 10^1$ |
| $^{14}$C C B | 0.038(6) | 0.06(5) | –0.50 | –0.64 | $–4(5) \times 10^1$ |
| $^{60}$Co C A | 0.095(10) | 0.1045(14) | –0.99 | –1.72 | –9(9) |
| $^{60}$Co C B | 0.097(10) | 0.1045(14) | –0.76 | –1.36 | –7(9) |
| $^{152}$Eu C A | 2.25(23) | 2.63(4) | –1.68 | –3.35 Q | –14(9) |
| $^{152}$Eu C B | 2.18(22) | 2.63(4) | –2.05 | –3.96 Q | –17(8) |
| $^{154}$Eu C A | 1.08(11) | 0.1029(18) | 9.05 D | 122.76 D | $95(11) \times 10^1$ |
| $^{154}$Eu C B | 1.08(11) | 0.1029(18) | 9.05 D | 122.76 D | $95(11) \times 10^1$ |

***Table B4 − Laboratory 7***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{234}$U AH | 11.4(3) | 11.1(10) | 0.26 | 0.56 | 3(10) |
| $^{235}$U AH | 0.45(2) | 0.5188(19) | –3.42 Q | –1.23 | –13(4) |
| $^{238}$U AH | 11.6(3) | 11.262(17) | 1.06 | 0.54 | 3(3) |
| $^{238}$Pu AH | 6.0(3) | 5.807(18) | 0.64 | 0.58 | 3(5) |
| $^{239}$Pu AH | 15.9(8) | 15.42(7) | 0.65 | 0.65 | 3(5) |
| $^{241}$Am AH | 3.41(16) | 3.369(7) | 0.26 | 0.27 | 1(5) |
| $^{244}$Cm AH | 4.79(22) | 4.708(14) | 0.37 | 0.34 | 2(5) |
| Gross a AH | 74(5) | 65(8) | 0.90 | 2.56 | 13(16) |
| $^{3}$H B1 | 1.16(11) | 0.925(7) | 2.13 | 4.41 Q | 25(12) |
| $^{14}$C B1 | 1.42(2) | 0.702(4) | 35.12 D | 17.20 D | 102(3) |
| $^{3}$H B2 | 0.515(21) | 0.487(4) | 1.32 | 1.34 | 6(5) |
| $^{55}$Fe B2 | 1.26(12) | 1.65(4) | –3.07 D | –3.57 D | –24(8) |
| $^{63}$Ni B2 | 0.50(2) | 0.596(24) | –3.09 D | –2.71 D | –16(5) |
| $^{90}$Sr B2 | 0.523(18) | 0.5712(11) | –2.67 Q | –1.16 | –8(4) |
| Gross b B2 | 1.29(8) | 2.5(5) | –2.36 | –8.23 Q | –49(11) |
| $^{22}$Na GH | – | 5.529(20) | – | – | – |
| $^{60}$Co GH | 4.3(5) | 4.641(14) | –0.78 | –2.09 | –8(10) |
| $^{95}$Zr GH | 7.1(6) | 7.35(8) | –0.43 | –0.84 | –3(8) |
| $^{95}$Nb GH | 18(6) | 13.54(7) | 0.86 | 7.28 Q | $4(4) \times 10^{1}$ |
| $^{133}$Ba GH | 2.52(14) | 2.754(19) | –1.66 | –1.88 | –8(5) |
| $^{134}$Cs GH | 4.09(10) | 4.63(4) | –5.16 D | –2.99 D | –11.7(22) |
| $^{137}$Cs GH | 9.59(24) | 9.56(7) | 0.12 | 0.09 | 0(3) |
| $^{152}$Eu GH | 16.7(5) | 17.86(12) | –2.55 | –1.71 | –7(3) |
| $^{58}$Co GH | 0.07(1) | – | – | – | – |
| $^{65}$Zn GH | 0.07(2) | – | – | – | – |
| $^{154}$Eu GH | 12.9(12) | – | – | – | – |
| $^{3}$H total C | 15.7(16) | 18(10) | –0.28 | –0.36 | $1(5) \times 10^{1}$ |
| $^{14}$C C | 0.33(8) | 0.06(5) | 3.01 | 7.85 Q | $5(5) \times 10^{2}$ |
| $^{60}$Co C | 0.121(16) | 0.1045(14) | 1.03 | 3.01 Q | 16(15) |
| $^{152}$Eu C | 2.7(3) | 2.63(4) | 0.17 | 0.43 | 2(11) |
| $^{154}$Eu C | 0.12(3) | 0.1029(18) | 0.57 | 2.15 | $2(3) \times 10^{1}$ |

***Table B5 − Laboratory 8***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{226}$Ra AL | 5.0(8) | 4.71(6) | 0.30 | 0.73 | 5(17) |
| $^{234}$U AL A | 15.9(13) | 14.6(14) | 0.69 | 1.47 | 9(13) |
| $^{234}$U AL M | 13.5(9) | 14.6(14) | –0.69 | –1.26 | –8(10) |
| $^{235}$U AL A | 0.72(11) | 0.680(3) | 0.37 | 0.44 | 6(16) |
| $^{235}$U AL M | 0.45(7) | 0.680(3) | –3.21 Q | –2.54 | –33(10) |
| $^{238}$U AL A | 15.6(13) | 14.76(4) | 0.66 | 0.95 | 6(9) |
| $^{238}$U AL M | 16.3(16) | 14.76(4) | 0.94 | 1.73 | 10(11) |
| $^{237}$Np AL | 9.6(11) | 9.38(10) | 0.21 | 0.24 | 2(11) |
| $^{238}$Pu AL | 11.4(9) | 11.86(4) | –0.50 | –0.68 | –4(8) |
| $^{239}$Pu AL | 10.1(8) | 10.19(5) | –0.10 | –0.14 | –1(8) |
| $^{241}$Am AL A | 14.3(11) | 13.57(4) | 0.64 | 0.90 | 5(8) |
| $^{241}$Am AL G | 13.9(17) | 13.57(4) | 0.19 | 0.41 | 2(13) |
| $^{244}$Cm AL | 6.9(6) | 6.96(3) | –0.12 | –0.17 | –1(8) |
| Gross a AL | 88.0(20) | 92(8) | –0.46 | –0.82 | –4(9) |
| $^{22}$Na GL | 7.11(24) | 8.19(3) | –4.46 Q | –2.48 | –13(3) |
| $^{60}$Co GL | 7.7(3) | 7.201(22) | 1.66 | 1.35 | 6(4) |
| $^{95}$Zr GL | 7.7(6) | 7.30(7) | 0.73 | 0.87 | 6(8) |
| $^{95}$Nb GL | 12.9(5) | 13.46(7) | –1.10 | –0.70 | –4(4) |
| $^{133}$Ba GL | 6.0(5) | 6.12(5) | –0.20 | –0.24 | –1(8) |
| $^{134}$Cs GL | 12.3(5) | 11.93(8) | 0.84 | 0.71 | 3(4) |
| $^{137}$Cs GL | 10.1(5) | 9.02(6) | 2.06 | 2.32 | 12(6) |
| $^{152}$Eu GL | 14.0(8) | 12.35(9) | 2.14 | 2.43 | 13(6) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{226}$Ra AH | 5.1(8) | 4.77(6) | 0.43 | 0.92 | 7(17) |
| $^{234}$U AH A | 12.6(10) | 11.1(10) | 1.00 | 2.89 Q | 13(14) |
| $^{234}$U AH M | 10.4(6) | 11.1(10) | –0.62 | –1.49 | –7(10) |
| $^{235}$U AH A | 0.48(7) | 0.5188(19) | –0.66 | –0.78 | –8(13) |
| $^{235}$U AH M | 0.53(6) | 0.5188(19) | 0.14 | 0.15 | 2(11) |
| $^{238}$U AH A | 13.1(11) | 11.262(17) | 1.73 | 3.24 Q | 16(9) |
| $^{238}$U AH M | 11.7(12) | 11.262(17) | 0.37 | 0.77 | 4(10) |
| $^{237}$Np AH | 3.4(4) | 3.20(4) | 0.56 | 1.18 | 7(13) |
| $^{238}$Pu AH | 5.6(5) | 5.807(18) | –0.50 | –0.66 | –4(8) |

continues

| continued | | | | | |
|---|---|---|---|---|---|
| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
| $^{239}$Pu AH | 14.5(11) | 15.42(7) | –0.86 | –1.16 | –6(7) |
| $^{241}$Am AH A | 3.5(3) | 3.369(7) | 0.55 | 1.07 | 5(9) |
| $^{241}$Am AH G | 3.30(14) | 3.369(7) | –0.49 | –0.45 | –2(4) |
| $^{244}$Cm AH | 4.8(4) | 4.708(14) | 0.19 | 0.30 | 2(8) |
| Gross a AH | 65.0(20) | 65(8) | –0.04 | –0.10 | –1(13) |
| $^{3}$H B1 | 0.89(4) | 0.925(7) | –0.84 | –0.59 | –3(4) |
| $^{14}$C B1 | 0.71(4) | 0.702(5) | 0.07 | 0.07 | 0(6) |
| $^{99}$Tc B1 GFP | 1.55(16) | 1.612(4) | –0.38 | –0.67 | –4(10) |
| $^{99}$Tc B1 MS | 1.61(17) | 1.612(4) | –0.01 | –0.02 | 0(11) |
| $^{3}$H B2 | 0.473(21) | 0.487(4) | –0.65 | –0.67 | –3(5) |
| $^{90}$Sr B2 | 0.578(15) | 0.5712(11) | 0.47 | 0.16 | 1(3) |
| Gross b B2 | 0.85(3) | 1.1423(23) | –9.37 D | –4.26 D | –26(3) |
| $^{22}$Na GH | 4.94(20) | 5.529(20) | –2.93 D | –2.64 D | –11(4) |
| $^{60}$Co GH | 4.63(19) | 4.641(14) | –0.06 | –0.07 | 0(4) |
| $^{95}$Zr GH | 7.5(4) | 7.35(8) | 0.32 | 0.41 | 2(5) |
| $^{95}$Nb GH | 14.5(7) | 13.54(7) | 1.36 | 1.43 | 7(5) |
| $^{133}$Ba GH | 2.57(14) | 2.754(19) | –1.30 | –1.48 | –7(5) |
| $^{134}$Cs GH | 4.54(23) | 4.63(4) | –0.40 | –0.51 | –2(5) |
| $^{137}$Cs GH | 9.5(5) | 9.56(7) | –0.11 | –0.14 | –1(5) |
| $^{152}$Eu GH | 17.6(8) | 17.86(12) | –0.35 | –0.37 | –1(4) |
| $^{40}$K C | 0.201(12) | 0.18(8) | 0.25 | 0.31 | $1(5) \times 10^{1}$ |
| $^{60}$Co C | 0.100(2) | 0.1045(14) | –1.84 | –0.81 | –4.3(23) |
| $^{133}$Ba C | 0.0059(10) | 0.0070(3) | –1.06 | –1.28 | –16(15) |
| $^{152}$Eu C | 2.64(7) | 2.63(4) | 0.11 | 0.08 | 0(3) |
| $^{154}$Eu C | 0.092(4) | 0.1029() | –2.53 | –1.41 | –11(5) |

***Table B6 – Laboratory 11***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | 4.84(9) | 5.529(20) | –7.35 D | –3.10 D | –12.5(17) |
| $^{60}$Co GH | 4.85(9) | 4.641(14) | 2.20 | 1.22 | 4.4(20) |
| $^{95}$Zr GH | 7.88(15) | 7.35(8) | 3.11 Q | 1.84 | 7.2(24) |
| $^{95}$Nb GH | 14.5(5) | 13.54(7) | 2.08 | 1.40 | 7(4) |
| $^{133}$Ba GH | 2.14(4) | 2.754(19) | –13.47 D | –4.91 D | –22.2(16) |
| $^{134}$Cs GH | 3.97(8) | 4.63(4) | –8.15 D | –3.67 D | –14.4(17) |
| $^{137}$Cs GH | 9.79(18) | 9.56(7) | 1.18 | 0.63 | 2.4(20) |
| $^{152}$Eu GH | 16.0(3) | 17.86(12) | –5.65 D | –2.63 D | –10.2(18) |

***Table B7 – Laboratory 13***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{238}$Pu AL | 11.8(6) | 11.86(4) | –0.09 | –0.09 | 0(5) |
| $^{239}$Pu AL | 9.9(6) | 10.19(5) | –0.49 | –0.48 | –3(6) |
| $^{241}$Am AL | 13.6(8) | 13.57(4) | 0.03 | 0.04 | 0(6) |
| $^{244}$Cm AL | 6.7(4) | 6.96(3) | –0.66 | –0.58 | –3(5) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{14}$C B1 | 0.77(5) | 0.702(5) | 1.30 | 1.50 | 9(7) |
| $^{3}$H B2 | 0.505(21) | 0.487(4) | 0.82 | 0.86 | 4(5) |
| $^{90}$Sr B2 | 0.57(3) | 0.5712(11) | –0.23 | –0.15 | –1(5) |
| $^{22}$Na GH | 4.94(24) | 5.529(20) | –2.45 | –2.64 Q | –11(5) |
| $^{60}$Co GH | 4.58(22) | 4.641(14) | –0.28 | –0.36 | –1(5) |
| $^{95}$Zr GH | 7.5(4) | 7.35(8) | 0.45 | 0.66 | 3(6) |
| $^{95}$Nb GH | 13.2(10) | 13.54(7) | –0.32 | –0.49 | –2(8) |
| $^{133}$Ba GH | 2.54(16) | 2.754(19) | –1.33 | –1.72 | –8(6) |
| $^{134}$Cs GH | 4.45(24) | 4.63(4) | –0.75 | –1.01 | –4(5) |
| $^{137}$Cs GH | 9.3(5) | 9.56(7) | –0.43 | –0.61 | –2(6) |
| $^{152}$Eu GH | 17.1(10) | 17.86(12) | –0.75 | –1.14 | –4(6) |

***Table B8 – Laboratory 14***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{234}$U AH | 10.9(8) | 11.1(10) | –0.21 | –0.55 | –2(12) |
| $^{235}$U AH | 0.42(6) | 0.5188(19) | –1.65 | –1.76 | –19(12) |
| $^{238}$U AH | 10.7(8) | 11.262(17) | –0.74 | –1.02 | –5(7) |
| $^{238}$Pu AH | 4.0(4) | 5.807(18) | –5.76 D | –5.61 D | –32(6) |
| $^{239}$Pu AH | 11.6(9) | 15.42(7) | –4.48 D | –4.88 D | –25(6) |
| $^{241}$Am AH | 3.20(24) | 3.369(7) | –0.70 | –1.11 | –5(7) |
| $^{244}$Cm AH | 4.1(3) | 4.708(14) | –1.99 | –2.46 | –13(7) |
| $^{63}$Ni B2 | 0.21(3) | 0.596(24) | –10.07 D | –10.87 D | –65(5) |
| $^{90}$Sr B2 | 0.52(4) | 0.5712(11) | –1.28 | –1.23 | –9(7) |
| $^{22}$Na GH | 5.98(18) | 5.529(20) | 2.49 | 2.02 | 8(4) |
| $^{60}$Co GH | 5.09(23) | 4.641(14) | 1.95 | 2.67 Q | 10(5) |
| $^{95}$Zr GH | 8.1(3) | 7.35(8) | 2.48 | 2.50 | 10(4) |
| $^{95}$Nb GH | 15.3(6) | 13.54(7) | 3.29 D | 2.63 D | 13(4) |
| $^{133}$Ba GH | 2.98(14) | 2.754(19) | 1.60 | 1.82 | 8(5) |
| $^{134}$Cs GH | 4.95(23) | 4.63(4) | 1.37 | 1.75 | 7(5) |
| $^{137}$Cs GH | 10.6(4) | 9.56(7) | 2.87 D | 2.91 D | 11(4) |
| $^{152}$Eu GH | 19.3(6) | 17.86(12) | 2.35 | 2.07 | 8(4) |
| $^{14}$C C | 0.029(5) | 0.06(5) | –0.71 | –0.89 | $-5(4) \times 10^1$ |
| $^{63}$Ni C | 0.026(5) | 0.04(3) | –0.62 | –0.79 | $-4(4) \times 10^1$ |

***Table B9 – Laboratory 15***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 9.92(23) | 8.19(3) | 7.47 D | 3.99 D | 21(3) |
| $^{60}$Co GL | 6.46(20) | 7.201(22) | –3.68 Q | –2.23 | –10(3) |
| $^{95}$Zr GL | 7.2(3) | 7.30(7) | –0.45 | –0.29 | –2(5) |
| $^{95}$Nb GL | 11.9(3) | 13.46(7) | –4.93 Q | –1.90 | –11.3(23) |
| $^{133}$Ba GL | 5.79(17) | 6.12(5) | –1.89 | –0.88 | –5(3) |
| $^{134}$Cs GL | 11.8(3) | 11.93(8) | –0.52 | –0.29 | –1.3(24) |
| $^{137}$Cs GL | 9.10(22) | 9.02(6) | 0.34 | 0.17 | 0.9(25) |
| $^{152}$Eu GL | 12.3(4) | 12.35(9) | –0.07 | –0.04 | 0(3) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | 5.91(12) | 5.529(20) | 3.13 Q | 1.71 | 6.9(22) |
| $^{60}$Co GH | 3.99(8) | 4.641(14) | –8.02 D | –3.88 D | –14.0(17) |
| $^{95}$Zr GH | 7.53(15) | 7.35(8) | 1.07 | 0.62 | 2.4(23) |
| $^{95}$Nb GH | 12.42(25) | 13.54(7) | –4.34 Q | –1.68 | –8.3(19) |
| $^{133}$Ba GH | 2.66(5) | 2.754(19) | –1.75 | –0.75 | –3.4(19) |
| $^{134}$Cs GH | 4.68(9) | 4.63(4) | 0.49 | 0.26 | 1.0(21) |
| $^{137}$Cs GH | 9.70(19) | 9.56(7) | 0.70 | 0.39 | 1.5(21) |
| $^{152}$Eu GH | 19.9(4) | 17.86(12) | 5.42 D | 2.97 D | 11.5(22) |

***Table B10 – Laboratory 16***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B1 | 0.91(3) | 0.925(7) | –0.42 | –0.23 | –1(4) |
| $^{14}$C B1 | 0.66(4) | 0.702(4) | –1.24 | –1.11 | –7(6) |
| $^{3}$H B2 | 0.48(3) | 0.487(4) | –0.33 | –0.48 | –2(6) |
| $^{55}$Fe B2 | 1.46(7) | 1.65(4) | –2.32 | –1.70 | –11(5) |
| $^{63}$Ni B2 | 0.483(13) | 0.596(24) | –4.16 D | –3.18 D | –19(4) |
| $^{22}$Na GH | 5.03(6) | 5.529(20) | –7.89 Q | –2.24 | –9.0(11) |
| $^{60}$Co GH | 4.67(6) | 4.641(14) | 0.47 | 0.17 | 0.6(13) |
| $^{95}$Zr GH | 7.71(20) | 7.35(8) | 1.69 | 1.25 | 5(3) |
| $^{95}$Nb GH | 14.4(13) | 13.54(7) | 0.65 | 1.28 | 6(10) |
| $^{133}$Ba GH | 2.49(15) | 2.754(19) | –1.75 | –2.12 | –10(6) |
| $^{134}$Cs GH | 4.16(17) | 4.63(4) | –2.73 D | –2.60 D | –10(4) |
| $^{137}$Cs GH | 9.95(18) | 9.56(7) | 2.04 | 1.08 | 4.1(20) |
| $^{152}$Eu GH | 16.5(5) | 17.86(12) | –2.83 Q | –1.94 | –8(3) |

***Table B11 – Laboratory 17***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{234}$U AL | 13.6(7) | 14.6(14) | –0.65 | –1.14 | –7(10) |
| $^{235}$U AL | 0.63(5) | 0.680(3) | –1.00 | –0.56 | –7(8) |
| $^{238}$U AL | 13.8(7) | 14.76(4) | –1.38 | –1.14 | –7(5) |
| $^{238}$Pu AL | 12.4(7) | 11.86(4) | 0.70 | 0.76 | 4(6) |
| $^{239}$Pu AL | 10.6(6) | 10.19(5) | 0.69 | 0.73 | 4(6) |
| $^{241}$Am AL | 11.6(7) | 13.57(4) | –2.90 Q | –2.47 | –15(5) |
| $^{22}$Na GL | – | 8.19(3) | – | – | – |
| $^{60}$Co GL | 7.7(16) Q | 7.201(22) | 0.33 | 1.59 | 7(22) |
| $^{95}$Zr GL | 6.7(20) Q | 7.30(7) | –0.30 | –1.24 | –1(3) × 10$^{1}$ |
| $^{95}$Nb GL | 16(4) | 13.46(7) | 0.62 | 2.75 Q | 2(3) × 10$^{1}$ |
| $^{133}$Ba GL | 5.6(22) Q | 6.12(5) | –0.24 | –1.36 | –1(4) × 10$^{1}$ |
| $^{134}$Cs GL | 10.8(18) | 11.93(8) | –0.61 | –2.10 | –9(15) |
| $^{137}$Cs GL | 9.4(16) | 9.02(6) | 0.25 | 0.88 | 5(18) |
| $^{152}$Eu GL | 10.1(25) | 12.35(9) | –0.88 | –3.29 Q | –18(21) |
| $^{207}$Bi GL | 2.4(12) | – | – | – | – |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{226}$Ra AH | 5.2(5) | 4.77(6) | 0.86 | 1.11 | 9(10) |
| $^{234}$U AH | 7.2(4) | 11.1(10) | –3.66 D | –7.96 D | –36(7) |
| $^{235}$U AH | 0.30(2) | 0.5188(19) | –10.89 D | –3.90 D | –42(4) |
| $^{238}$U AH | 7.3(4) | 11.262(17) | –10.55 D | –7.07 D | –36(4) |
| $^{238}$Pu AH | 7.4(4) | 5.807(18) | 4.00 D | 4.86 D | 28(7) |
| $^{239}$Pu AH | 19.6(11) | 15.42(7) | 3.96 D | 5.25 D | 27(7) |
| $^{241}$Am AH | 3.31(24) | 3.369(7) | –0.24 | –0.39 | –2(7) |
| $^{22}$Na GH | 2.69(11) | 5.529(20) | –25.39 D | –12.72 D | –51.3(20) |
| $^{60}$Co GH | 4.43(16) | 4.641(14) | –1.31 | –1.26 | –5(4) |
| $^{95}$Zr GH | 7.4(3) | 7.35(8) | 0.17 | 0.17 | 1(4) |
| $^{95}$Nb GH | 11.5(5) | 13.54(7) | –4.43 D | –3.02 D | –15(4) |
| $^{133}$Ba GH | 2.45(10) | 2.754(19) | –2.98 Q | –2.44 | –11(4) |
| $^{134}$Cs GH | 6.65(25) | 4.63(4) | 8.00 D | 11.10 D | 44(6) |
| $^{137}$Cs GH | 9.4(4) | 9.56(7) | –0.33 | –0.33 | –1(4) |
| $^{152}$Eu GH | 13.6(6) | 17.86(12) | –7.79 D | –6.10 D | –24(3) |
| $^{3}$H tot C | 5.8(8) | 18(10) | –1.32 | –1.65 | –68(17) |
| $^{14}$C C | 0.067(16) | 0.06(5) | 0.15 | 0.20 | 1(9)× 10$^{1}$ |

| | | | | | |
|---|---|---|---|---|---|
| $^{40}$K C | 0.40(7) | 0.18(8) | 2.12 | 3.62 | 12(10) × 10$^{1}$ |
| $^{60}$Co C | 0.12(1) | 0.1045(14) | 1.54 | 2.82 Q | 15(10) |
| $^{152}$Eu C | 2.6(2) | 2.63(4) | –0.16 | –0.28 | –1(8) |
| $^{154}$Eu C | 0.10(2) | 0.1029(18) | –0.14 | –0.36 | –3(20) |

***Table B12 – Laboratory 18***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 8.2(3) | 8.19(3) | –0.03 | –0.02 | 0(4) |
| $^{60}$Co GL | 7.13(18) | 7.201(22) | –0.39 | –0.21 | –1.0(25) |
| $^{95}$Zr GL | 7.4(3) | 7.30(7) | 0.28 | 0.16 | 1(4) |
| $^{95}$Nb GL | 12.8(5) | 13.46(7) | –1.30 | –0.82 | –5(4) |
| $^{133}$Ba GL | 6.01(21) | 6.12(5) | –0.52 | –0.29 | –2(4) |
| $^{134}$Cs GL | 11.7(4) | 11.93(8) | –0.67 | –0.54 | –2(4) |
| $^{137}$Cs GL | 9.26(23) | 9.02(6) | 1.00 | 0.51 | 3(3) |
| $^{152}$Eu GL | 12.4(5) | 12.35(9) | 0.01 | 0.01 | 0(4) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | 5.28(16) | 5.529(20) | –1.55 | –1.12 | –5(3) |
| $^{60}$Co GH | 4.66(12) | 4.641(14) | 0.16 | 0.11 | 0(3) |
| $^{95}$Zr GH | 7.40(22) | 7.35(8) | 0.21 | 0.17 | 1(4) |
| $^{95}$Nb GH | 13.2(4) | 13.54(7) | –0.85 | –0.52 | –3(3) |
| $^{133}$Ba GH | 2.76(8) | 2.754(19) | 0.07 | 0.05 | 0(3) |
| $^{134}$Cs GH | 4.66(14) | 4.63(4) | 0.19 | 0.15 | 1(3) |
| $^{137}$Cs GH | 9.8(3) | 9.56(7) | 0.88 | 0.75 | 3(4) |
| $^{152}$Eu GH | 18.0(6) | 17.86(12) | 0.27 | 0.22 | 1(3) |

***Table B13 – Laboratory 19***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| Gross a AL | 173.4(11) | 92(8) | 10.02 D | 17.55 D | 89(17) |
| $^{22}$Na GL | 7.7(4) | 8.19(3) | –1.35 | –1.22 | –6(5) |
| $^{60}$Co GL | 7.2(4) | 7.201(22) | 0.08 | 0.09 | 0(5) |
| $^{95}$Zr GL | 7.8(6) | 7.30(7) | 0.81 | 1.01 | 7(9) |
| $^{95}$Nb GL | 15.0(7) | 13.46(7) | 2.16 | 1.94 | 11(6) |
| $^{133}$Ba GL | 5.5(3) | 6.12(5) | –2.42 | –1.76 | –11(5) |
| $^{134}$Cs GL | 10.9(5) | 11.93(8) | –2.16 | –1.99 | –9(4) |
| $^{137}$Cs GL | 9.4(4) | 9.02(6) | 0.77 | 0.71 | 4(5) |
| $^{152}$Eu GL | 11.2(5) | 12.35(9) | –2.22 | –1.63 | –9(4) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B2 | 0.55(1) | 0.487(4) | 5.97 D | 3.02 D | 13.0(22) |

***Table B14 – Laboratory 20***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B1 | 0.83(19) | 0.925(7) | –0.49 | –1.74 | –10(21) |
| $^{14}$C B1 | 1.03(19) | 0.702(5) | 1.72 | 7.83 Q | 5(3) × 10$^{1}$ |
| $^{99}$Tc B1 | 1.33(18) | 1.612(4) | –1.57 | –3.08 Q | –18(11) |
| $^{22}$Na GH | – | 5.529(20) | – | – | – |
| $^{60}$Co GH | 4.85(14) | 4.641(14) | 1.48 | 1.24 | 5(3) |
| $^{95}$Zr GH | 7.8(3) | 7.35(8) | 1.55 | 1.46 | 6(4) |
| $^{95}$Nb GH | 14.6(9) | 13.54(7) | 1.13 | 1.51 | 7(7) |
| $^{133}$Ba GH | 2.74(13) | 2.754(19) | –0.11 | –0.11 | –1(5) |
| $^{134}$Cs GH | 4.67(16) | 4.63(4) | 0.23 | 0.21 | 1(4) |
| $^{137}$Cs GH | 9.83(24) | 9.56(7) | 1.09 | 0.75 | 3(3) |
| $^{152}$Eu GH | 17.8(9) | 17.86(12) | –0.03 | –0.04 | 0(5) |
| $^{154}$Eu GH | 14.9(8) | – | – | – | – |

***Table B15 – Laboratory 21***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 8.09(25) | 8.19(3) | –0.39 | –0.22 | –1(3) |
| $^{60}$Co GL | 7.36(22) | 7.201(22) | 0.72 | 0.48 | 2(3) |
| $^{95}$Zr GL | 7.59(21) | 7.30(7) | 1.29 | 0.58 | 4(3) |
| $^{95}$Nb GL | 14.1(4) | 13.46(7) | 1.59 | 0.81 | 5(3) |
| $^{133}$Ba GL | 6.17(18) | 6.12(5) | 0.27 | 0.13 | 1(3) |
| $^{134}$Cs GL | 11.9(4) | 11.93(8) | –0.08 | –0.06 | 0(4) |
| $^{137}$Cs GL | 9.1(3) | 9.02(6) | 0.39 | 0.25 | 1(4) |
| $^{152}$Eu GL | 12.6(3) | 12.35(9) | 0.82 | 0.37 | 2.1(25) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{226}$Ra AH | 3.0(3) | 4.77(6) | –5.62 D | –4.64 D | –37(7) |
| $^{235}$U AH | 0.613(17) | 0.5188(19) | 5.51 Q | 1.68 | 18(4) |
| $^{238}$U AH | 10.1(5) | 11.262(17) | –2.32 | –2.05 | –10(5) |
| $^{237}$Np AH | 3.38(8) | 3.20(4) | 2.15 | 0.97 | 6(3) |
| $^{241}$Am AH | 3.22(8) | 3.369(7) | –1.85 | –0.98 | –4.4(24) |
| 3H B1 | 0.94(8) | 0.925(7) | 0.16 | 0.22 | 1(8) |
| $^{3}$H B2 | 0.50(4) | 0.487(4) | 0.39 | 0.63 | 3(7) |
| $^{22}$Na GH | 5.36(16) | 5.529(20) | –1.05 | –0.76 | –3(3) |
| $^{60}$Co GH | 4.71(14) | 4.641(14) | 0.49 | 0.41 | 1(3) |
| $^{95}$Zr GH | 7.50(23) | 7.35(8) | 0.62 | 0.52 | 2(4) |
| $^{95}$Nb GH | 13.8(4) | 13.54(7) | 0.63 | 0.38 | 2(3) |
| $^{133}$Ba GH | 2.68(8) | 2.754(19) | –0.90 | –0.59 | –3(3) |
| $^{134}$Cs GH | 4.56(14) | 4.63(4) | –0.51 | –0.40 | –2(3) |
| $^{137}$Cs GH | 9.7(3) | 9.56(7) | 0.61 | 0.50 | 2(3) |
| $^{152}$Eu GH | 17.8(6) | 17.86(12) | –0.11 | –0.08 | 0(3) |
| $^{22}$Na C | 0.030(2) | – | – | – | – |
| $^{60}$Co C | 0.106(3) | 0.1045(14) | 0.46 | 0.28 | 1(4) |
| $^{133}$Ba C | 0.0072(8) | 0.0070(3) | 0.19 | 0.18 | 2(12) |
| $^{137}$Cs C | 0.0026(4) | – | – | – | – |
| $^{152}$Eu C | 2.60(7) | 2.63(4) | –0.41 | –0.28 | –1(3) |
| $^{154}$Eu C | 0.093(6) | 0.1029(18) | –1.58 | –1.24 | –10(6) |
| $^{226}$Ra C | 0.033(4) | – | – | – | – |
| $^{228}$Ra C | 0.0076(20) | – | – | – | – |
| $^{228Th}$ C | 0.0062(7) | – | – | – | – |

| | | | | | |
|---|---|---|---|---|---|
| $^{238}$U C | 0.014(5) | – | – | – | – |

***Table B16 – Laboratory 23***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.7(9) | 8.19(3) | –0.59 | –1.22 | –6(11) |
| $^{60}$Co GL | 6.9(5) | 7.201(22) | –0.58 | –0.88 | –4(7) |
| $^{95}$Zr GL | 7.3(8) | 7.30(7) | 0.00 | –0.01 | 0(11) |
| $^{95}$Nb GL | 13.2(16) | 13.46(7) | –0.16 | –0.32 | –2(12) |
| $^{133}$Ba GL | 6.0(9) | 6.12(5) | –0.13 | –0.32 | –2(15) |
| $^{134}$Cs GL | 11.4(15) | 11.93(8) | –0.35 | –1.00 | –4(13) |
| $^{137}$Cs GL | 9.3(9) | 9.02(6) | 0.28 | 0.53 | 3(10) |
| $^{152}$Eu GL | 12.6(16) | 12.35(9) | 0.15 | 0.36 | 2(13) |

***Table B17 – Laboratory 24***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 8.8(9) | 8.19(3) | 0.62 | 1.30 | 7(11) |
| $^{60}$Co GL | 7.7(4) | 7.201(22) | 1.25 | 1.50 | 7(6) |
| $^{95}$Zr GL | 7.6(3) | 7.30(7) | 0.96 | 0.60 | 4(5) |
| $^{95}$Nb GL | 15.3(8) | 13.46(7) | 2.30 | 2.31 | 14(6) |
| $^{133}$Ba GL | 6.4(5) | 6.12(5) | 0.56 | 0.74 | 5(8) |
| $^{134}$Cs GL | 13.6(5) | 11.93(8) | 3.29 D | 3.22 D | 14(5) |
| $^{137}$Cs GL | 10.1(5) | 9.02(6) | 2.14 | 2.32 | 12(6) |
| $^{152}$Eu GL | 13.1(8) | 12.35(9) | 0.94 | 1.11 | 6(7) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | 5.34(15) | 5.529(20) | –1.25 | –0.85 | –3(3) |
| $^{60}$Co GH | 4.75(12) | 4.641(14) | 0.90 | 0.65 | 2(3) |
| $^{95}$Zr GH | 7.9(3) | 7.35(8) | 2.14 | 2.01 | 8(4) |
| $^{95}$Nb GH | 15.2(15) | 13.54(7) | 1.10 | 2.48 | 12(11) |
| $^{133}$Ba GH | 2.85(16) | 2.754(19) | 0.60 | 0.77 | 3(6) |
| $^{134}$Cs GH | 4.75(12) | 4.63(4) | 0.94 | 0.65 | 3(3) |
| $^{137}$Cs GH | 10.2(3) | 9.56(7) | 2.09 | 1.77 | 7(4) |
| $^{152}$Eu GH | 18.6(10) | 17.86(12) | 0.74 | 1.07 | 4(6) |
| $^{60}$Co C | 0.105(4) | 0.1045(14) | 0.12 | 0.10 | 1(4) |
| $^{152}$Eu C | 2.71(2) | 2.63(4) | 0.39 | 0.69 | 3(8) |
| $^{154}$Eu C | 0.097(5) | 0.1029(18) | –1.10 | –0.74 | –6(5) |

***Table B18 – Laboratory 25***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{226}$Ra AL | 6.4(4) | 4.71(6) | 4.54 D | 5.08 D | 35(8) |
| $^{234}$U AL | 15.6(13) | 14.6(14) | 0.51 | 1.08 | 6(13) |
| $^{235}$U AL | 0.65(10) | 0.680(3) | –0.30 | –0.34 | –4(15) |
| $^{238}$U AL | 14.9(12) | 14.76(4) | 0.12 | 0.16 | 1(8) |
| $^{237}$Np AL | 11.0(12) | 9.38(10) | 1.35 | 1.66 | 17(13) |
| $^{238}$Pu AL | 17.9(20) | 11.86(4) | 3.04 D | 8.97 D | 51(17) |
| $^{239}$Pu AL | 17.0(19) | 10.19(5) | 3.61 D | 11.50 D | 67(19) |
| $^{241}$Am AL | 11.1(11) | 13.57(4) | –2.24 | –3.11 Q | –19(8) |
| $^{244}$Cm AL | 5.2(6) | 6.96(3) | –3.19 D | –4.29 D | –25(8) |
| gross α AL | 75(11) | 92(8) | –1.24 | –3.57 Q | –18(14) |
| $^{22}$Na GL | 7.0(5) | 8.19(3) | –2.80 D | –2.78 D | –15(6) |
| $^{60}$Co GL | 7.4(4) | 7.201(22) | 0.48 | 0.60 | 3(6) |
| $^{95}$Zr GL | 8.0(7) | 7.30(7) | 1.08 | 1.41 | 10(9) |
| $^{95}$Nb GL | 15.2(7) | 13.46(7) | 2.35 | 2.16 | 13(6) |
| $^{133}$Ba GL | 6.3(4) | 6.12(5) | 0.55 | 0.53 | 3(6) |
| $^{134}$Cs GL | 12.1(9) | 11.93(8) | 0.17 | 0.31 | 1(8) |
| $^{137}$Cs GL | 9.1(5) | 9.02(6) | 0.12 | 0.13 | 1(6) |
| $^{152}$Eu GL | 15.6(12) | 12.35(9) | 2.60 D | 4.76 D | 26(10) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B1 | 0.88(4) | 0.925(7) | –1.18 | –0.84 | –5(4) |
| $^{14}$C B1 | 0.74(5) | 0.702(4) | 0.86 | 0.93 | 6(7) |
| $^{99}$Tc B1 | 1.79(9) | 1.612(4) | 1.98 | 1.92 | 11(6) |
| $^{3}$H B2 | 0.463(2) | 0.487(4) | –1.18 | –1.15 | –5(4) |
| $^{55}$Fe B2 | 1.58(16) | 1.65(4) | –0.38 | –0.57 | –4(10) |
| $^{63}$Ni B2 | 0.51(4) | 0.596(24) | –2.06 | –2.51 | –15(7) |
| $^{90}$Sr B2 | 0.58(5) | 0.5712(11) | 0.12 | 0.14 | 1(8) |
| Gross b B2 | 1.46(12) | 1.1423(23) | 2.70 D | 4.58 D | 27(10) |
| $^{22}$Na GH | 4.94(22) | 5.529(20) | –2.67 D | –2.64 D | –11(4) |
| $^{60}$Co GH | 4.50(20) | 4.641(14) | –0.70 | –0.84 | –3(5) |
| $^{95}$Zr GH | 7.9(4) | 7.35(8) | 1.48 | 1.84 | 7(5) |
| $^{95}$Nb GH | 13.9(6) | 13.54(7) | 0.61 | 0.56 | 3(5) |

continues

| continued | | | | | |
|---|---|---|---|---|---|
| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
| $^{133}$Ba GH | 2.64(12) | 2.754(19) | –0.94 | –0.92 | –4(5) |
| $^{134}$Cs GH | 4.6(4) | 4.63(4) | –0.25 | –0.45 | –2(7) |
| $^{137}$Cs GH | 9.4(4) | 9.56(7) | –0.41 | –0.47 | –2(5) |
| $^{152}$Eu GH | 21.2(15) | 17.86(12) | 2.30 | 4.81 Q | 19(8) |

***Table B19 – Laboratory 26***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{226}$Ra AL | 0.99(24) | 4.71(6) | –15.02 D | –11.41 D | –79(5) |
| $^{234}$U AL | 14.8(5) | 14.6(14) | 0.12 | 0.20 | 1(10) |
| $^{235}$U AL | 0.59(7) | 0.680(3) | –1.23 | –1.00 | –13(11) |
| $^{238}$U AL | 9.3(4) | 14.76(4) | –15.87 D | –6.10 D | –36.7(23) |
| $^{241}$Am AL | 13.15(18) | 13.57(4) | –2.30 | –0.52 | –3.1(13) |
| gross α AL | 101.6(19) | 92(8) | 1.18 | 2.11 | 11(10) |
| $^{22}$Na GL | 8.0(5) | 8.19(3) | –0.44 | –0.46 | –2(6) |
| $^{60}$Co GL | 7.1(3) | 7.201(22) | –0.32 | –0.30 | –1(5) |
| $^{95}$Zr GL | 7.1(3) | 7.30(7) | –0.64 | –0.41 | –3(5) |
| $^{95}$Nb GL | 13.8(13) | 13.46(7) | 0.26 | 0.43 | 3(10) |
| $^{133}$Ba GL | 6.55(24) | 6.12(5) | 1.76 | 1.14 | 7(4) |
| $^{134}$Cs GL | 11.5(4) | 11.93(8) | –1.22 | –0.89 | –4(4) |
| $^{137}$Cs GL | 9.2(4) | 9.02(6) | 0.39 | 0.30 | 2(4) |
| $^{152}$Eu GL | 12.2(5) | 12.35(9) | –0.37 | –0.24 | –1(4) |
| $^{57}$Co GL | 0.29(14) | – | – | – | – |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{90}$Sr B2 | 0.50(14) Q | 0.5712(11) | –0.51 | –1.71 | –12(25) |

***Table B20 – Laboratory 27***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq $kg^{-1}$) | (Bq $kg^{-1}$) | | | |
| $^{22}$Na GL | 7.4(18) Q | 8.19(3) | –0.44 | –1.81 | –10(22) |
| $^{60}$Co GL | 6.7(17) Q | 7.201(22) | –0.30 | –1.51 | –7(23) |
| $^{95}$Zr GL | 10(3) | 7.30(7) | 0.92 | 5.38 Q | 4(4) × $10^1$ |
| $^{95}$Nb GL | 15(4) | 13.46(7) | 0.52 | 2.18 | 13(25) |
| $^{133}$Ba GL | 5.3(14) Q | 6.12(5) | –0.55 | –2.11 | –13(23) |
| $^{134}$Cs GL | – | 11.93(8) | – | – | – |
| $^{137}$Cs GL | 9.2(21) Q | 9.02(6) | 0.08 | 0.36 | 2(24) |
| $^{152}$Eu GL | 10.5(25) | 12.35(9) | –0.72 | –2.67 Q | –15(20) |
| $^{109}$Cd GL | 6.7(18) | – | – | – | – |
| | (Bq $g^{-1}$) | (Bq $g^{-1}$) | | | |
| $^{22}$Na GH | 5.4(11) Q | 5.529(20) | –0.16 | –0.80 | –3(20) |
| $^{60}$Co GH | 4.9(10) Q | 4.641(14) | 0.24 | 1.48 | 5(22) |
| $^{95}$Zr GH | 8.4(18) | 7.35(8) | 0.57 | 3.50 Q | 14(24) |
| $^{95}$Nb GH | 16(4) | 13.54(7) | 0.60 | 2.93 Q | 14(24) |
| $^{133}$Ba GH | 2.5(6) Q | 2.754(19) | –0.42 | –1.80 | –8(19) |
| $^{134}$Cs GH | 4.4(9) Q | 4.63(4) | –0.23 | –1.17 | –5(20) |
| $^{137}$Cs GH | 10.3(22) Q | 9.56(7) | 0.36 | 2.13 | 8(23) |
| $^{152}$Eu GH | 16(4) Q | 17.86(12) | –0.42 | –2.07 | –8(19) |

***Table B21 – Laboratory 28***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{234}$U AL | 25.7(16) | 14.6(14) | 5.29 D | 12.62 D | 76(20) |
| $^{235}$U AL | 0.9(3) | 0.680(3) | 0.73 | 2.47 | 3(4) × 10$^{1}$ |
| $^{238}$U AL | 16.4(12) | 14.76(4) | 1.37 | 1.85 | 11(8) |
| $^{238}$Pu AL | 11.80(19) | 11.86(4) | –0.30 | –0.09 | –0.5(16) |
| $^{239}$Pu AL | 10.01(16) | 10.19(5) | –1.05 | –0.30 | –1.7(16) |
| $^{22}$Na GL | 7.7(5) | 8.19(3) | –1.03 | –1.15 | –6(6) |
| $^{60}$Co GL | 7.4(4) | 7.201(22) | 0.50 | 0.60 | 3(6) |
| $^{95}$Zr GL | 7.3(5) | 7.30(7) | –0.01 | –0.01 | 0(7) |
| $^{95}$Nb GL | 14.2(7) | 13.46(7) | 1.06 | 0.93 | 6(5) |
| $^{133}$Ba GL | 5.3(3) | 6.12(5) | –2.71 Q | –2.19 | –13(5) |
| $^{134}$Cs GL | 10.7(6) | 11.93(8) | –2.03 | –2.37 | –10(5) |
| $^{137}$Cs GL | 9.2(6) | 9.02(6) | 0.26 | 0.30 | 2(6) |
| $^{152}$Eu GL | 11.1(6) | 12.35(9) | –2.06 | –1.83 | –10(5) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{234}$U AH | 13.9(5) | 11.1(10) | 2.40 | 5.48 Q | 25(12) |
| $^{235}$U AH | 0.38(7) | 0.5188(19) | –1.98 | –2.47 | –27(13) |
| $^{238}$U AH | 11.6(5) | 11.262(17) | 0.68 | 0.60 | 3(5) |
| $^{241}$Am AH | 3.55(12) | 3.369(7) | 1.51 | 1.20 | 5(4) |
| $^{244}$Cm AH | 5.48(12) | 4.708(14) | 6.39 D | 3.17 D | 16(3) |
| $^{3}$H B1 | 0.96(4) | 0.925(7) | 0.86 | 0.59 | 3(4) |
| $^{3}$H B2 | 0.509(8) | 0.487(4) | 2.54 | 1.06 | 4.5(18) |
| $^{90}$Sr B2 | 0.55(4) | 0.5712(11) | –0.53 | –0.51 | –4(7) |
| $^{22}$Na GH | 4.79(22) | 5.529(20) | –3.35 D | –3.31 D | –13(4) |
| $^{60}$Co GH | 4.65(21) | 4.641(14) | 0.04 | 0.05 | 0(5) |
| $^{95}$Zr GH | 7.3(4) | 7.35(8) | –0.21 | –0.25 | –1(5) |
| $^{95}$Nb GH | 13.8(7) | 13.54(7) | 0.36 | 0.38 | 2(5) |
| $^{133}$Ba GH | 2.45(11) | 2.754(19) | –2.72 Q | –2.44 | –11(4) |
| $^{134}$Cs GH | 4.14(19) | 4.63(4) | –2.56 | –2.71 Q | –11(4) |
| $^{137}$Cs GH | 9.7(5) | 9.56(7) | 0.20 | 0.25 | 1(5) |
| $^{152}$Eu GH | 16.6(8) | 17.86(12) | –1.56 | –1.81 | –7(5) |
| $^{154}$Eu GH | 0.65(6) | – | – | – | – |
| $^{60}$Co C | 0.102(14) | 0.1045(14) | –0.18 | –0.45 | –2(13) |

continues

| continued | | | | | |
|---|---|---|---|---|---|
| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
| $^{133}$Ba C | 0.0052(10) | 0.0070(3) | –1.78 | –2.09 | –26(14) |
| $^{152}$Eu C | 2.2(3) | 2.63(4) | –1.62 | –4.14 Q | –18(11) |
| $^{154}$Eu C | 0.084(12) | 0.1029(18) | –1.55 | –2.37 | –18(12) |

***Table B22 − Laboratory 29***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{234}$U AL | 14.5(10) | 14.6(14) | –0.07 | –0.13 | –1(11) |
| $^{235}$U AL | 0.59(5) | 0.680(3) | –1.80 | –1.01 | –13(8) |
| $^{238}$U AL | 14.6(10) | 14.76(4) | –0.16 | –0.18 | –1(7) |
| $^{238}$Pu AL | 11.7(6) | 11.86(4) | –0.26 | –0.24 | –1(5) |
| $^{239}$Pu AL | 10.0(6) | 10.19(5) | –0.31 | –0.31 | –2(6) |
| $^{241}$Am AL | 14.0(5) | 13.57(4) | 0.85 | 0.53 | 3(4) |
| $^{22}$Na GL | 8.2(8) | 8.19(3) | 0.02 | 0.03 | 0(10) |
| $^{60}$Co GL | 7.3(7) | 7.201(22) | 0.14 | 0.30 | 1(10) |
| $^{95}$Zr GL | 7.6(6) | 7.30(7) | 0.49 | 0.60 | 4(8) |
| $^{95}$Nb GL | 14.0(10) | 13.46(7) | 0.54 | 0.68 | 4(8) |
| $^{133}$Ba GL | 6.1(5) | 6.12(5) | –0.04 | –0.05 | 0(8) |
| $^{134}$Cs GL | 12.0(10) | 11.93(8) | 0.07 | 0.13 | 1(9) |
| $^{137}$Cs GL | 9.1(7) | 9.02(6) | 0.11 | 0.17 | 1(8) |
| $^{152}$Eu GL | 12.0(10) | 12.35(9) | –0.34 | –0.51 | –3(8) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B2 | 0.48(2) | 0.487(4) | –0.34 | –0.33 | –1(4) |
| $^{90}$Sr B2 | 0.55(2) | 0.5712(11) | –1.06 | –0.51 | –4(4) |
| $^{22}$Na GH | 5.6(6) | 5.529(20) | 0.12 | 0.32 | 1(11) |
| $^{60}$Co GH | 4.6(4) | 4.641(14) | –0.10 | –0.24 | –1(9) |
| $^{95}$Zr GH | 7.1(6) | 7.35(8) | –0.41 | –0.87 | –3(8) |
| $^{95}$Nb GH | 13.0(10) | 13.54(7) | –0.54 | –0.82 | –4(8) |
| $^{133}$Ba GH | 2.60(20) | 2.754(19) | –0.77 | –1.24 | –6(7) |
| $^{134}$Cs GH | 4.5(4) | 4.63(4) | –0.33 | –0.73 | –3(9) |
| $^{137}$Cs GH | 9.4(7) | 9.56(7) | –0.23 | –0.44 | –2(8) |
| $^{152}$Eu GH | 17.0(15) | 17.86(12) | –0.57 | –1.24 | –5(9) |
| $^{3}$H tot C | 13.7(4) | 18(10) | –0.50 | –0.62 | $–3(4) \times 10^{1}$ |
| $^{3}$H leach C | 0.9(2) | 3(4) | –0.54 | –0.67 | $–7(4) \times 10^{1}$ |
| $^{3}$H fixed C | 12.7(3) | – | – | – | – |
| $^{58}$Co C | 0.0086(18) | – | – | – | – |
| $^{60}$Co C | 0.120(10) | 0.1045(14) | 1.54 | 2.82 Q | 15(10) |
| $^{152}$Eu C | 2.70(20) | 2.63(4) | 0.34 | 0.60 | 3(8) |
| $^{154}$Eu C | 0.110(10) | 0.1029(18) | 0.70 | 0.90 | 7(10) |

***Table B23 – Laboratory 31***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{226}$Ra AL | 4(0) | 4.71(6) | –11.54 Q | –2.19 | –15.1(11) |
| $^{241}$Am AL | 300(0) | 13.57(4) | 8620.51 D | 354.12 D | 2110(6) |
| $^{244}$Cm AL | 350(0) | 6.96(3) | 13427.11 D | 837.10 D | 4930(18) |
| $^{22}$Na GL | – | 8.19(3) | – | – | – |
| $^{60}$Co GL | 10(0) | 7.201(22) | 128.40 D | 8.42 D | 38.9(5) |
| $^{95}$Zr GL | 11(0) | 7.30(7) | 50.57 D | 7.49 D | 50.6(15) |
| $^{95}$Nb GL | – | 13.46(7) | – | – | – |
| $^{133}$Ba GL | – | 6.12(5) | – | – | – |
| $^{134}$Cs GL | 10(0) | 11.93(8) | –23.04 D | –3.72 D | –16.2(6) |
| $^{137}$Cs GL | 10(0) | 9.02(6) | 15.92 Q | 2.11 | 10.8(8) |
| $^{152}$Eu GL | 14(0) | 12.35(9) | 19.65 Q | 2.43 | 13.4(8) |
| $^{54}$Mn GL | 2(0) | – | – | – | – |
| $^{155}$Eu GL | 4(0) | – | – | – | – |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{226}$Ra AH | 3.32(0) | 4.77(6) | –23.34 D | –3.78 D | –30.3(9) |
| $^{241}$Am AH | 0.16(0) | 3.369(7) | –471.47 D | –21.19 D | –95.250(10) |
| $^{244}$Cm AH | 0.07(0) | 4.708(14) | –319.94 D | –19.08 D | –98.513(5) |
| $^{3}$H B2 | 0.55(0) | 0.487(4) | 18.44 D | 3.02 D | 13.0(8) |
| $^{63}$Ni B2 | 0.007(0) | 0.596(24) | –24.70 D | –16.59 D | –98.83(5) |
| $^{22}$Na GH | – | 5.529(20) | – | – | – |
| $^{60}$Co GH | 4.9(0) | 4.641(14) | 18.40 Q | 1.54 | 5.6(4) |
| $^{95}$Zr GH | 10(0) | 7.35(8) | 36.01 D | 9.20 D | 36.0(14) |
| $^{95}$Nb GH | – | 13.54(7) | – | – | – |
| $^{133}$Ba GH | – | 2.754(19) | – | – | – |
| $^{134}$Cs GH | 4.6(0) | 4.63(4) | –1.00 | –0.18 | –0.7(7) |
| $^{137}$Cs GH | 9.9(0) | 9.56(7) | 5.24 Q | 0.94 | 3.6(7) |
| $^{152}$Eu GH | 13(0) | 17.86(12) | –39.88 D | –6.99 D | –27.2(5) |
| $^{58}$Co GH | 0.12(0) | – | – | – | – |
| $^{155}$Eu GH | 0.06(0) | – | – | – | – |
| $^{3}$H C | 10.2(0) | 18(10) | –0.86 | –1.08 | $-5(3) \times 10^{1}$ |
| $^{3}$H leach C | 8.5(0) | 3(4) | 1.54 | 1.92 | $2(4) \times 10^{2}$ |
| $^{63}$Ni C | 1.4(0) | 0.04(3) | 46.13 D | 57.66 D | $30(21) \times 10^{2}$ |

***Table B24 – Laboratory 32***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{226}$Ra AH | 4.1(6) | 4.77(6) | –1.14 | –1.82 | –15(13) |
| $^{235}$U AH | 0.55(4) | 0.5188(19) | 0.88 | 0.52 | 6(7) |
| $^{238}$U AH | 11.9(9) | 11.262(17) | 0.71 | 1.09 | 5(8) |
| $^{237}$Np AH | 3.68(5) | 3.20(4) | 8.75 Q | 2.53 | 15.1(18) |
| $^{241}$Am AH | 3.52(5) | 3.369(7) | 3.08 Q | 1.03 | 4.6(15) |
| $^{3}$H (dis) B1 | 0.927(16) | 0.925(7) | 0.09 | 0.03 | 0.2(19) |
| $^{3}$H (pyr) B1 | 0.87(9) | 0.925(7) | –0.59 | –0.99 | –6(10) |
| $^{14}$C B1 | 0.784(23) | 0.702(5) | 3.50 Q | 1.96 | 12(4) |
| $^{99}$Tc B1 | 1.47(8) | 1.612(4) | –1.76 | –1.55 | –9(5) |
| $^{3}$H B2 dis | 0.490(9) | 0.487(4) | 0.30 | 0.14 | 0.6(20) |
| $^{3}$H B2 pyr | 0.53(7) | 0.487(4) | 0.65 | 2.06 | 9(14) |
| $^{55}$Fe B2 | 1.46(10) | 1.65(4) | –1.74 | –1.67 | –11(6) |
| $^{63}$Ni B2 | 0.64(5) | 0.596(24) | 0.80 | 1.27 | 8(10) |
| $^{90}$Sr B2 | 0.54(3) | 0.5712(11) | –0.97 | –0.68 | –5(5) |
| Gross b B2 | 1.01(4) | 1.1423(23) | –3.65 Q | –1.98 | –12(4) |
| $^{22}$Na GH | 5.40(8) | 5.529(20) | –1.57 | –0.58 | –2.3(15) |
| $^{60}$Co GH | 4.66(6) | 4.641(14) | 0.31 | 0.11 | 0.4(13) |
| $^{95}$Zr GH | 7.48(15) | 7.35(8) | 0.77 | 0.45 | 1.8(23) |
| $^{95}$Nb GH | 13.5(6) | 13.54(7) | –0.10 | –0.08 | 0(4) |
| $^{133}$Ba GH | 2.72(5) | 2.754(19) | –0.63 | –0.27 | –1.2(19) |
| $^{134}$Cs GH | 4.53(7) | 4.63(4) | –1.33 | –0.56 | –2.2(17) |
| $^{137}$Cs GH | 9.46(14) | 9.56(7) | –0.64 | –0.27 | –1.0(16) |
| $^{152}$Eu GH | 17.2(5) | 17.86(12) | –1.31 | –0.99 | –4(3) |
| $^{3}$H tot C | 23.3(13) | 18(10) | 0.50 | 0.63 | $3(7) \times 10^1$ |
| $^{3}$H leach C | 2.89(8) | 3(4) | 0.00 | 0.01 | $0(13) \times 10^1$ |
| $^{3}$H fixed C | 20.5(13) | – | – | – | – |
| $^{14}$C C | 0.054(4) | 0.06(5) | –0.14 | –0.18 | $–1(7) \times 10^1$ |
| $^{36}$Cl C | 0.017(3) | – | – | – | – |
| $^{55}$Fe C | 0.059(11) | 0.055(5) | 0.36 | 0.48 | 8(22) |
| $^{60}$Co C | 0.0104(3) | 0.1045() | –0.18 | –0.10 | –1(3) |
| $^{133}$Ba C | 0.0060(14) | 0.0070(3) | –0.73 | –1.18 | –15(20) |
| $^{152}$Eu C | 2.63(4) | 2.63(4) | 0.03 | 0.01 | 0.1(20) |
| continues | | | | | |

| continued | | | | | |
|---|---|---|---|---|---|
| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
| $^{154}$Eu C | 0.120(8) | 0.1029(18) | 2.02 | 2.13 | 16(8) |
| Gross b C | 1.30(6) | 1.2(8) | 0.16 | 0.21 | 1(8) × $10^{1}$ |

***Table B25 – Laboratory 33***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.8(13) | 8.19(3) | –0.29 | –0.89 | –5(16) |
| $^{60}$Co GL | 8.1(10) | 7.201(22) | 0.88 | 2.64 Q | 12(14) |
| $^{95}$Zr GL | – | 7.30(7) | – | – | – |
| $^{95}$Nb GL | 67(15) | 13.46(7) | 3.51 D | 67.64 D | 40(11) × $10^{1}$ |
| $^{133}$Ba GL | 3.7(12) | 6.12(5) | –2.02 | –6.59 Q | –40(20) |
| $^{134}$Cs GL | 11.5(10) | 11.93(8) | –0.39 | –0.77 | –3(9) |
| $^{137}$Cs GL | 10.4(13) | 9.02(6) | 1.06 | 2.95 Q | 15(14) |
| $^{152}$Eu GL | 12.0(24) | 12.35(9) | –0.14 | –0.51 | –3(20) |
| $^{40}$K GL | 57(3) × $10^{1}$ | – | – | – | – |
| $^{46}$Sc GL | 46(7) | – | – | – | – |
| $^{57}$Co GL | 5.0(11) | – | – | – | – |

***Table B26 – Laboratory 35***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{226}$Ra AL | 3.9(3) | 4.71(6) | –2.94 Q | –2.49 | –17(6) |
| $^{234}$U AL | 14.0(7) | 14.6(14) | –0.39 | –0.68 | –4(10) |
| $^{235}$U AL | 0.47(5) | 0.680(3) | –4.62 Q | –2.39 | –31(7) |
| $^{238}$U AL | 13.5(7) | 14.76(4) | –1.87 | –1.37 | –8(5) |
| $^{237}$Np AL | 12.4(10) | 9.38(10) | 3.01 D | 3.11 D | 32(11) |
| $^{238}$Pu AL | 11.2(6) | 11.86(4) | –1.06 | –0.99 | –6(6) |
| $^{239}$Pu AL | 9.7(6) | 10.19(5) | –0.99 | –0.90 | –5(6) |
| $^{241}$Am AL | 12.4(6) | 13.57(4) | –2.03 | –1.51 | –9(5) |
| $^{244}$Cm AL | 6.3(4) | 6.96(3) | –1.87 | –1.61 | –9(5) |
| $^{22}$Na GL | 7.4(6) | 8.19(3) | –1.28 | –1.86 | –10(8) |
| $^{60}$Co GL | 7.1(6) | 7.201(22) | –0.17 | –0.30 | –1(8) |
| $^{95}$Zr GL | 7.0(9) | 7.30(7) | –0.33 | –0.61 | –4(13) |
| $^{95}$Nb GL | 15.4(10) | 13.46(7) | 1.94 | 2.44 | 14(8) |
| $^{133}$Ba GL | 6.8(7) | 6.12(5) | 0.89 | 1.70 | 10(12) |
| $^{134}$Cs GL | 11.1(7) | 11.93(8) | –1.15 | –1.56 | –7(6) |
| $^{137}$Cs GL | 9.8(7) | 9.02(6) | 1.05 | 1.57 | 8(8) |
| $^{152}$Eu GL | 11.3(12) | 12.35(9) | –0.89 | –1.57 | –9(10) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{226}$Ra AH | 4.1(4) | 4.77(6) | –1.96 | –1.72 | –14(7) |
| $^{234}$U AH | 11.0(5) | 11.1(10) | –0.10 | –0.22 | –1(10) |
| $^{235}$U AH | 0.444(21) | 0.5188(19) | –3.55 Q | –1.33 | –14(4) |
| $^{238}$U AH | 10.8(6) | 11.262(17) | –0.83 | –0.78 | –4(5) |
| $^{237}$Np AH | 4.9(3) | 3.20(4) | 5.67 D | 8.66 D | 52(9) |
| $^{238}$Pu AH | 5.0(3) | 5.807(18) | –2.55 | –2.33 | –13(5) |
| $^{239}$Pu AH | 13.4(8) | 15.42(7) | –2.61 D | –2.61 D | –13(5) |
| $^{241}$Am AH | 3.08(14) | 3.369(7) | –2.06 | –1.91 | –9(4) |
| $^{244}$Cm AH | 4.26(22) | 4.708(14) | –2.03 | –1.84 | –10(5) |
| $^{3}$H B1 | 1.19(7) | 0.925(7) | 3.99 D | 4.97 D | 29(7) |
| $^{14}$C B1 | 0.75(9) | 0.702(5) | 0.47 | 1.02 | 6(13) |
| $^{99}$Tc B1 | 1.42(9) | 1.612(4) | –2.27 | –2.11 | –12(6) |
| $^{3}$H B2 | 0.57(4) | 0.487(4) | 2.56 | 4.08 Q | 17(7) |
| $^{90}$Sr B2 | 0.47(6) | 0.5712(11) | –1.70 | –2.34 | –17(10) |

continues

| continued | | | | | |
|---|---|---|---|---|---|
| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
| $^{22}$Na GH | 4.95(20) | 5.529(20) | –2.88 D | –2.59 D | –10(4) |
| $^{60}$Co GH | 4.55(19) | 4.641(14) | –0.48 | –0.54 | –2(4) |
| $^{95}$Zr GH | 7.4(3) | 7.35(8) | 0.13 | 0.14 | 1(5) |
| $^{95}$Nb GH | 13.8(6) | 13.54(7) | 0.52 | 0.43 | 2(4) |
| $^{133}$Ba GH | 3.29(14) | 2.754(19) | 3.79 D | 4.31 D | 19(5) |
| $^{134}$Cs GH | 4.39(18) | 4.63(4) | –1.33 | –1.34 | –5(4) |
| $^{137}$Cs GH | 9.5(4) | 9.56(7) | –0.18 | –0.19 | –1(4) |
| $^{152}$Eu GH | 16.1(7) | 17.86(12) | –2.67 Q | –2.57 | –10(4) |
| $^{3}$H tot C | 27.3(18) | 18(10) | 0.91 | 1.16 | $5(8) \times 10^1$ |
| $^{14}$C C | 0.047(6) | 0.06(5) | –0.29 | –0.37 | $-2(6) \times 10^1$ |
| $^{60}$Co C | 0.110(6) | 0.1045(14) | 0.95 | 1.08 | 6(6) |
| $^{133}$Ba C | 0.0083(14) | 0.0070(3) | 0.88 | 1.43 | 18(20) |
| $^{152}$Eu C | 2.58(11) | 2.63(4) | –0.45 | –0.45 | –2(5) |
| $^{154}$Eu C | 0.098(6) | 0.1029(18) | –0.81 | –0.61 | –5(6) |

***Table B27 – Laboratory 38***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{226}$Ra AH | 4.9(2) | 4.77(6) | 0.64 | 0.35 | 3(5) |
| $^{238}$U AH | 11.7(6) | 11.262(17) | 0.73 | 0.77 | 4(6) |
| $^{237}$Np AH | 3.19(4) | 3.20(4) | –0.10 | –0.03 | –0.2(16) |
| $^{238}$Pu AH | 6.0(5) | 5.807(18) | 0.39 | 0.58 | 3(9) |
| $^{239}$Pu AH | 15.9(9) | 15.42(7) | 0.53 | 0.61 | 3(6) |
| $^{241}$Am AH | 3.0(2) | 3.369(7) | –1.84 | –2.44 | –11(6) |
| $^{244}$Cm AH | 4.1(3) | 4.708(14) | –2.02 | –2.50 | –13(7) |
| $^{3}$H B1 | 0.84(5) | 0.925(7) | –1.70 | –1.61 | –9(6) |
| $^{14}$C B1 | 0.61(6) | 0.702(5) | –1.53 | –2.21 | –13(9) |
| $^{99}$Tc B1 | 1.5(1) | 1.612(4) | –1.11 | –1.21 | –7(6) |
| $^{3}$H B2 | 0.47(2) | 0.487(4) | –0.83 | –0.81 | –3(4) |
| $^{55}$Fe B2 | 1.5(2) | 1.65(4) | –0.71 | –1.34 | –9(12) |
| $^{63}$Ni B2 | 0.58(7) | 0.596(24) | –0.22 | –0.45 | –3(12) |
| $^{90}$Sr B2 | 0.56(5) | 0.5712(11) | –0.22 | –0.27 | –2(9) |
| $^{22}$Na GH | 5.93(24) | 5.529(20) | 1.66 | 1.79 | 7(5) |
| $^{60}$Co GH | 4.72(8) | 4.641(14) | 0.97 | 0.47 | 1.7(18) |
| $^{95}$Zr GH | 7.12(10) | 7.35(8) | –1.86 | –0.80 | –3.1(17) |
| $^{95}$Nb GH | 13.4(4) | 13.54(7) | –0.35 | –0.22 | –1(3) |
| $^{133}$Ba GH | 2.63(11) | 2.754(19) | –1.11 | –1.00 | –5(4) |
| $^{134}$Cs GH | 4.97(16) | 4.63(4) | 2.07 | 1.86 | 7(4) |
| $^{137}$Cs GH | 9.27(11) | 9.56(7) | –2.26 | –0.80 | –3.0(13) |
| $^{152}$Eu GH | 14.8(4) | 17.86(12) | –6.97 D | –4.39 D | –17.1(24) |
| $^{3}$H tot C | 25(3) | 18(10) | 0.63 | 0.82 | $3(7) \times 10^{1}$ |
| $^{55}$Fe C | 0.05(1) | 0.055(5) | –0.43 | –0.53 | –9(20) |
| $^{60}$Co C | 0.11(1) | 0.1045(14) | 0.55 | 1.01 | 5(10) |
| $^{63}$Ni C | 0.03(1) | 0.04(3) | –0.47 | –0.62 | $–3(5) \times 10^{1}$ |
| $^{133}$Ba C | 0.008(2) | 0.0070(3) | 0.47 | 1.09 | $1(3) \times 10^{1}$ |
| $^{152}$Eu C | 2.42(13) | 2.63(4) | –1.58 | –1.58 | –8(5) |
| $^{154}$Eu C | 0.11(1) | 0.1029(18) | 0.70 | 0.90 | 7(10) |

***Table B28 – Laboratory 40***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{234}$U AL | 15.7(9) | 14.6(14) | 0.67 | 1.25 | 8(12) |
| $^{235}$U AL | 0.7(8) Q | 0.680(3) | –0.04 | –0.34 | 0(12) × 10$^{1}$ |
| $^{238}$U AL | 15.8(9) | 14.76(4) | 1.09 | 1.14 | 7(6) |
| $^{238}$Pu AL | 12.1(6) | 11.86(4) | 0.35 | 0.33 | 2(6) |
| $^{239}$Pu AL | 10.5(6) | 10.19(5) | 0.50 | 0.47 | 3(6) |
| $^{241}$Am AL | 14.9(8) | 13.57(4) | 1.63 | 1.65 | 10(6) |
| $^{244}$Cm AL | 6.79(4) | 6.96(3) | –3.69 Q | –0.42 | –2.5(7) |
| $^{22}$Na GL | 6.59(19) | 8.19(3) | –8.31 D | –3.68 D | –19.5(23) |
| $^{60}$Co GL | 7.84(18) | 7.201(22) | 3.52 Q | 1.92 | 8.9(25) |
| $^{95}$Zr GL | 7.5(4) | 7.30(7) | 0.56 | 0.42 | 3(5) |
| $^{95}$Nb GL | 22.3(13) | 13.46(7) | 7.01 D | 11.10 D | 66(9) |
| $^{133}$Ba GL | 5.93(25) | 6.12(5) | –0.75 | –0.51 | –3(4) |
| $^{134}$Cs GL | 12.8(5) | 11.93(8) | 1.94 | 1.67 | 7(4) |
| $^{137}$Cs GL | 9.5(5) | 9.02(6) | 0.99 | 1.09 | 6(6) |
| $^{152}$Eu GL | 11.40(25) | 12.35(9) | –3.55 Q | –1.39 | –7.7(21) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B2 | 0.99(6) | 0.487(4) | 8.83 D | 23.95 D | 103(12) |
| $^{90}$Sr B2 | 0.6(1) | 0.5712(11) | –0.16 | –0.39 | –3(18) |

***Table B29 – Laboratory 41***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.6(6) | 8.19(3) | –0.95 | –1.38 | –7(8) |
| $^{60}$Co GL | 8.1(5) | 7.201(22) | 1.76 | 2.70 Q | 12(7) |
| $^{95}$Zr GL | 7.4(11) | 7.30(7) | 0.12 | 0.28 | 2(16) |
| $^{95}$Nb GL | 25.3(14) | 13.46(7) | 8.28 D | 14.88 D | 88(11) |
| $^{133}$Ba GL | 5.6(5) | 6.12(5) | –1.12 | –1.47 | –9(8) |
| $^{134}$Cs GL | 11.0(8) | 11.93(8) | –1.25 | –1.89 | –8(7) |
| $^{137}$Cs GL | 9.7(8) | 9.02(6) | 0.87 | 1.50 | 8(9) |
| $^{152}$Eu GL | 16.4(19) | 12.35(9) | 2.13 | 5.96 Q | 33(15) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{238}$Pu AH | 5.49(19) | 5.807(18) | –1.63 | –0.96 | –5(4) |
| $^{239}$Pu AH | 14.5(5) | 15.42(7) | –1.83 | –1.16 | –6(4) |
| $^{241}$Am AH | 3.12(9) | 3.369(7) | –2.73 Q | –1.64 | –7(3) |
| $^{244}$Cm AH | 4.29(12) | 4.708(14) | –3.46 Q | –1.72 | –9(3) |
| gross α AH | 57.2(12) | 65(8) | –0.99 | –2.49 | –12(11) |
| $^{3}$H B2 | 0.443(14) | 0.487(4) | –2.97 Q | –2.10 | –9(3) |
| $^{90}$Sr B2 | 0.57(3) | 0.5712(11) | –0.21 | –0.15 | –1(6) |
| gross β B2 | 1.00(6) | 1.1423(23) | –2.46 | –2.08 | –12(5) |

***Table B30 – Laboratory 42***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{235}$U AL | 1.35(22) | 0.680(3) | 3.10 D | 7.52 D | 10(3) × 10$^{1}$ |
| $^{237}$Np AL | 9.6(17) | 9.38(10) | 0.15 | 0.27 | 3(18) |
| $^{241}$Am AL | 13.6(14) | 13.57(4) | 0.00 | 0.00 | 0(10) |
| $^{22}$Na GL | 8.0(9) | 8.19(3) | –0.23 | –0.46 | –2(11) |
| $^{60}$Co GL | 7.5(8) | 7.201(22) | 0.39 | 0.93 | 4(11) |
| $^{95}$Zr GL | 7.3(8) | 7.30(7) | –0.02 | –0.03 | 0(11) |
| $^{95}$Nb GL | 14.1(15) | 13.46(7) | 0.43 | 0.81 | 5(11) |
| $^{133}$Ba GL | 5.9(6) | 6.12(5) | –0.41 | –0.67 | –4(10) |
| $^{134}$Cs GL | 11.6(12) | 11.93(8) | –0.31 | –0.72 | –3(10) |
| $^{137}$Cs GL | 9.8(10) | 9.02(6) | 0.71 | 1.57 | 8(11) |
| $^{152}$Eu GL | 12.2(13) | 12.35(9) | –0.15 | –0.27 | –2(10) |

***Table B31 – Laboratory 43***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | 5.52(14) | 5.529(20) | –0.07 | –0.04 | 0(3) |
| $^{60}$Co GH | 4.71(12) | 4.641(14) | 0.57 | 0.41 | 1(3) |
| $^{95}$Zr GH | 7.56(12) | 7.35(8) | 1.49 | 0.73 | 2.8(19) |
| $^{95}$Nb GH | 13.90(23) | 13.54(7) | 1.48 | 0.53 | 2.6(18) |
| $^{133}$Ba GH | 2.49(7) | 2.754(19) | –3.63 Q | –2.12 | –10(3) |
| $^{134}$Cs GH | 4.71(12) | 4.63(4) | 0.62 | 0.43 | 2(3) |
| $^{137}$Cs GH | 9.72(16) | 9.56(7) | 0.93 | 0.45 | 1.7(18) |
| $^{152}$Eu GH | 17.3(5) | 17.86(12) | –1.16 | –0.78 | –3(3) |

***Table B32 – Laboratory 44***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | – | 8.19(3) | – | – | – |
| $^{60}$Co GL | 5.1(5) | 7.201(22) | –4.64 D | –6.29 D | –29(6) |
| $^{95}$Zr GL | 5.2(5) | 7.30(7) | –4.80 D | –4.24 D | –29(6) |
| $^{95}$Nb GL | 8.0(6) | 13.46(7) | –8.96 D | –6.90 D | –41(5) |
| $^{133}$Ba GL | – | 6.12(5) | – | – | – |
| $^{134}$Cs GL | 8.0(6) | 11.93(8) | –6.15 D | –7.54 D | –33(6) |
| $^{137}$Cs GL | 7.1(6) | 9.02(6) | –3.27 D | –4.18 D | –22(7) |
| $^{152}$Eu GL | 4.1(4) | 12.35(9) | –23.51 D | –12.11 D | –67(3) |

***Table B33 – Laboratory 45***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 6.7(6) | 8.19(3) | –2.74 D | –3.47 D | –18(7) |
| $^{60}$Co GL | 6.4(6) | 7.201(22) | –1.38 | –2.32 | –11(8) |
| $^{95}$Zr GL | 6.5(7) | 7.30(7) | –1.10 | –1.59 | –11(10) |
| $^{95}$Nb GL | 12.5(8) | 13.46(7) | –1.30 | –1.23 | –7(6) |
| $^{133}$Ba GL | 5.2(6) | 6.12(5) | –1.53 | –2.37 | –15(10) |
| $^{134}$Cs GL | 11.9(12) | 11.93(8) | 0.00 | 0.00 | 0(10) |
| $^{137}$Cs GL | 8.4(5) | 9.02(6) | –1.33 | –1.30 | –7(5) |
| $^{152}$Eu GL | 11(3) | 12.35(9) | –0.39 | –1.49 | –8(21) |

***Table B34 – Laboratory 46***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.7(4) | 8.19(3) | –1.27 | –1.15 | –6(5) |
| $^{60}$Co GL | 6.9(3) | 7.201(22) | –1.19 | –0.94 | –4(4) |
| $^{95}$Zr GL | 7.5(4) | 7.30(7) | 0.62 | 0.44 | 3(5) |
| $^{95}$Nb GL | 14.5(9) | 13.46(7) | 1.24 | 1.35 | 8(7) |
| $^{133}$Ba GL | 5.78(24) | 6.12(5) | –1.40 | –0.91 | –6(4) |
| $^{134}$Cs GL | 11.8(6) | 11.93(8) | –0.16 | –0.19 | –1(6) |
| $^{137}$Cs GL | 9.2(4) | 9.02(6) | 0.59 | 0.43 | 2(4) |
| $^{152}$Eu GL | 11.9(6) | 12.35(9) | –0.81 | –0.64 | –4(5) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | 5.42(19) | 5.529(20) | –0.57 | –0.49 | –2(4) |
| $^{60}$Co GH | 4.51(16) | 4.641(14) | –0.82 | –0.78 | –3(4) |
| $^{95}$Zr GH | 7.25(25) | 7.35(8) | –0.39 | –0.35 | –1(4) |
| $^{95}$Nb GH | 14.1(6) | 13.54(7) | 0.99 | 0.83 | 4(4) |
| $^{133}$Ba GH | 2.67(10) | 2.754(19) | –0.82 | –0.67 | –3(4) |
| $^{134}$Cs GH | 4.48(16) | 4.63(4) | –0.93 | –0.84 | –3(4) |
| $^{137}$Cs GH | 9.5(4) | 9.56(7) | –0.06 | –0.05 | 0(4) |
| $^{152}$Eu GH | 17.6(6) | 17.86(12) | –0.50 | –0.44 | –2(4) |

***Table B35 – Laboratory 47***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{234}$U AL | 13.0(6) | 14.6(14) | –1.14 | –1.88 | –11(9) |
| $^{235}$U AL | 0.61(7) | 0.680(3) | –1.05 | –0.75 | –10(9) |
| $^{238}$U AL | 12.98(6) | 14.76(4) | –27.68 Q | –2.00 | –12.0(5) |
| $^{237}$Np AL | 9.3(5) | 9.38(10) | –0.13 | –0.06 | –1(5) |
| $^{238}$Pu AL | 12.6(6) | 11.86(4) | 1.27 | 1.13 | 6(5) |
| $^{239}$Pu AL | 10.5(6) | 10.19(5) | 0.63 | 0.56 | 3(5) |
| $^{241}$Am AL | 13.8(5) | 13.57(4) | 0.40 | 0.26 | 2(4) |
| $^{244}$Cm AL | 6.9(3) | 6.96(3) | –0.36 | –0.26 | –2(5) |
| $^{22}$Na GL | 9.6(6) | 8.19(3) | 2.19 | 3.19 Q | 17(8) |
| $^{60}$Co GL | 7.9(5) | 7.201(22) | 1.42 | 2.13 | 10(7) |
| $^{95}$Zr GL | 7.2(5) | 7.30(7) | –0.24 | –0.23 | –2(7) |
| $^{95}$Nb GL | 13.4(8) | 13.46(7) | –0.02 | –0.02 | 0(6) |
| $^{133}$Ba GL | 5.9(4) | 6.12(5) | –0.67 | –0.67 | –4(6) |
| $^{134}$Cs GL | 12.5(8) | 11.93(8) | 0.78 | 1.15 | 5(7) |
| $^{137}$Cs GL | 9.3(6) | 9.02(6) | 0.41 | 0.51 | 3(7) |
| $^{152}$Eu GL | 12.1(8) | 12.35(9) | –0.30 | –0.33 | –2(6) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{234}$U AH | 9.6(4) | 11.1(10) | –1.08 | –3.02 Q | –14(9) |
| $^{235}$U AH | 0.50(6) | 0.5188(19) | –0.37 | –0.35 | –4(10) |
| $^{238}$U AH | 9.8(4) | 11.262(17) | –3.66 Q | –2.52 | –13(4) |
| $^{237}$Np AH | 3.61(25) | 3.20(4) | 1.55 | 2.17 | 13(9) |
| $^{238}$Pu AH | 5.7(3) | 5.807(18) | –0.32 | –0.28 | –2(5) |
| $^{239}$Pu AH | 14.5(7) | 15.42(7) | –1.36 | –1.22 | –6(5) |
| $^{241}$Am AH | 3.37(14) | 3.369(7) | 0.01 | 0.01 | 0(5) |
| $^{244}$Cm AH | 4.69(19) | 4.708(14) | –0.09 | –0.07 | 0(4) |
| $^{22}$Na GH | 6.2(4) | 5.529(20) | 2.03 | 3.00 Q | 12(6) |
| $^{60}$Co GH | 4.91(25) | 4.641(14) | 1.07 | 1.60 | 6(6) |
| $^{95}$Zr GH | 7.2(4) | 7.35(8) | –0.51 | –0.66 | –3(5) |
| $^{95}$Nb GH | 13.1(7) | 13.54(7) | –0.69 | –0.71 | –3(5) |
| $^{133}$Ba GH | 2.71(14) | 2.754(19) | –0.31 | –0.35 | –2(5) |
| $^{134}$Cs GH | 4.94(25) | 4.63(4) | 1.22 | 1.69 | 7(6) |
| $^{137}$Cs GH | 9.4(5) | 9.56(7) | –0.37 | –0.50 | –2(5) |
| $^{152}$Eu GH | 17.5(9) | 17.86(12) | –0.46 | –0.59 | –2(5) |

***Table B36 – Laboratory 48***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.7(3) | 8.19(3) | –1.62 | –1.12 | –6(4) |
| $^{60}$Co GL | 6.5(2) | 7.201(22) | –3.48 Q | –2.11 | –10(3) |
| $^{95}$Zr GL | 7.4(5) | 7.30(7) | 0.19 | 0.20 | 1(7) |
| $^{95}$Nb GL | 13.4(7) | 13.46(7) | –0.08 | –0.07 | 0(5) |
| $^{133}$Ba GL | 6.4(3) | 6.12(5) | 0.92 | 0.74 | 5(5) |
| $^{134}$Cs GL | 10.6(3) | 11.93(8) | –4.27 Q | –2.57 | –11(3) |
| $^{137}$Cs GL | 9.0(5) | 9.02(6) | –0.04 | –0.05 | 0(6) |
| $^{152}$Eu GL | 13.6(7) | 12.35(9) | 1.78 | 1.84 | 10(6) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B1 | 1.2(1) | 0.925(7) | 2.74 D | 5.16 D | 30(11) |
| $^{14}$C B1 | 0.5(1) | 0.702(5) | –2.02 | –4.84 Q | –29(14) |
| $^{99}$Tc B1 | 1.7(1) | 1.612(4) | 0.88 | 0.96 | 5(6) |
| $^{60}$Co C | 0.120(5) | 0.1045(14) | 2.99 D | 2.82 D | 15(5) |
| $^{133}$Ba C | 0.008(1) | 0.0070(3) | 0.93 | 1.09 | 14(15) |
| $^{152}$Eu C | 2.8(1) | 2.63(4) | 1.60 | 1.48 | 6(4) |
| $^{154}$Eu C | 0.12(1) | 0.1029(18) | 1.69 | 2.15 | 17(10) |

***Table B37 – Laboratory 51***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 8.5(5) | 8.19(3) | 0.67 | 0.70 | 4(6) |
| $^{60}$Co GL | 7.9(4) | 7.201(22) | 2.12 | 2.04 | 9(5) |
| $^{95}$Zr GL | 8.2(4) | 7.30(7) | 2.51 | 1.72 | 12(5) |
| $^{95}$Nb GL | 15.4(6) | 13.46(7) | 3.07 Q | 2.40 | 14(5) |
| $^{133}$Ba GL | 6.7(3) | 6.12(5) | 2.23 | 1.62 | 10(5) |
| $^{134}$Cs GL | 12.4(5) | 11.93(8) | 0.96 | 0.94 | 4(5) |
| $^{137}$Cs GL | 9.9(4) | 9.02(6) | 2.05 | 1.78 | 9(5) |
| $^{152}$Eu GL | 13.1(5) | 12.35(9) | 1.38 | 1.07 | 6(5) |

***Table B38 – Laboratory 52***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.7(4) | 8.19(3) | –1.20 | –1.08 | –6(5) |
| $^{60}$Co GL | 7.5(3) | 7.201(22) | 1.06 | 0.96 | 4(4) |
| $^{95}$Zr GL | 7.4(3) | 7.30(7) | 0.19 | 0.12 | 1(4) |
| $^{95}$Nb GL | 13.7(7) | 13.46(7) | 0.33 | 0.28 | 2(5) |
| $^{133}$Ba GL | 5.85(18) | 6.12(5) | –1.46 | –0.72 | –4(3) |
| $^{134}$Cs GL | 11.3(4) | 11.93(8) | –1.72 | –1.16 | –5(3) |
| $^{137}$Cs GL | 9.1(5) | 9.02(6) | 0.17 | 0.17 | 1(5) |
| $^{152}$Eu GL | 11.9(4) | 12.35(9) | –1.23 | –0.67 | –4(3) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | 5.2(4) | 5.529(20) | –0.78 | –1.30 | –5(7) |
| $^{60}$Co GH | 4.7(3) | 4.641(14) | 0.35 | 0.59 | 2(6) |
| $^{95}$Zr GH | 7.6(5) | 7.35(8) | 0.54 | 0.87 | 3(7) |
| $^{95}$Nb GH | 14.2(10) | 13.54(7) | 0.66 | 1.00 | 5(8) |
| $^{133}$Ba GH | 2.60(13) | 2.754(19) | –1.17 | –1.24 | –6(5) |
| $^{134}$Cs GH | 4.47(22) | 4.63(4) | –0.73 | –0.89 | –4(5) |
| $^{137}$Cs GH | 9.9(7) | 9.56(7) | 0.42 | 0.81 | 3(7) |
| $^{152}$Eu GH | 17.0(9) | 17.86(12) | –0.95 | –1.18 | –5(5) |
| $^{60}$Co C | 0.106(4) | 0.1045(14) | 0.36 | 0.28 | 1(4) |
| $^{152}$Eu C | 2.62(5) | 2.63(4) | –0.23 | –0.13 | –0.5(23) |
| $^{154}$Eu C | 0.108(3) | 0.1029(18) | 1.47 | 0.65 | 5(4) |

***Table B39 – Laboratory 53***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.5(4) | 8.19(3) | –1.99 | –1.61 | –9(5) |
| $^{60}$Co GL | 7.2(3) | 7.201(22) | –0.13 | –0.12 | –1(5) |
| $^{95}$Zr GL | 7.5(5) | 7.30(7) | 0.36 | 0.36 | 2(7) |
| $^{95}$Nb GL | 14.8(7) | 13.46(7) | 1.91 | 1.66 | 10(5) |
| $^{133}$Ba GL | 5.6(3) | 6.12(5) | –1.59 | –1.28 | –8(5) |
| $^{134}$Cs GL | 11.7(5) | 11.93(8) | –0.50 | –0.48 | –2(5) |
| $^{137}$Cs GL | 9.1(4) | 9.02(6) | 0.24 | 0.21 | 1(5) |
| $^{152}$Eu GL | 11.7(6) | 12.35(9) | –0.98 | –0.89 | –5(5) |

***Table B40 – Laboratory 54***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.1(4) | 8.19(3) | –2.90 Q | –2.48 | –13(5) |
| $^{60}$Co GL | 6.62(25) | 7.201(22) | –2.32 | –1.75 | –8(4) |
| $^{95}$Zr GL | 6.0(5) | 7.30(7) | –2.57 | –2.58 Q | –17(7) |
| $^{95}$Nb GL | – | 13.46(7) | – | – | – |
| $^{133}$Ba GL | 5.2(3) | 6.12(5) | –3.07 Q | –2.56 | –16(5) |
| $^{134}$Cs GL | 11.2(5) | 11.93(8) | –1.52 | –1.37 | –6(4) |
| $^{137}$Cs GL | 9.0(5) | 9.02(6) | –0.03 | –0.03 | 0(5) |
| $^{152}$Eu GL | 11.5(5) | 12.35(9) | –1.83 | –1.23 | –7(4) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | 5.84(19) | 5.529(20) | 1.63 | 1.39 | 6(4) |
| $^{60}$Co GH | 5.02(11) | 4.641(14) | 3.42 Q | 2.26 | 8.2(24) |
| $^{95}$Zr GH | 8.23(22) | 7.35(8) | 3.79 D | 3.05 D | 12(4) |
| $^{95}$Nb GH | 15.2(10) | 13.54(7) | 1.72 | 2.48 | 12(7) |
| $^{133}$Ba GH | 3.01(8) | 2.754(19) | 3.11 Q | 2.06 | 9(3) |
| $^{134}$Cs GH | 4.95(8) | 4.63(4) | 3.67 Q | 1.75 | 6.9(19) |
| $^{137}$Cs GH | 10.7(4) | 9.56(7) | 2.63 D | 3.02 D | 11(5) |
| $^{152}$Eu GH | 19.55(23) | 17.86(12) | 6.50 Q | 2.43 | 9.5(15) |
| $^{109}$Cd GH | 0.99(12) | – | – | – | – |
| $^{170}$Tm GH | 3.9(5) | – | – | – | – |
| $^{40}$K C | 0.162(13) | 0.18(8) | –0.27 | –0.34 | $-1(4) \times 10^1$ |
| $^{60}$Co C | 0.0943(25) | 0.1045(14) | –3.56 Q | –1.85 | –10(3) |
| $^{152}$Eu C | 2.39(3) | 2.63(4) | –5.47 Q | –2.11 | –9.1(16) |

***Table B41 – Laboratory 55***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{226}$Ra AH | 15.0(7) | 4.77(6) | 14.06 D | 26.74 D | 215(16) |
| $^{234}$U AH | 11.9(2) | 11.1(10) | 0.71 | 1.50 | 7(10) |
| $^{235}$U AH | 0.52(1) | 0.5188(19) | 0.12 | 0.02 | 0.2(20) |
| $^{238}$U AH | 11.3(1) | 11.262(17) | 0.38 | 0.07 | 0.3(9) |
| $^{237}$Np AH | 4.1(6) | 3.20(4) | 1.62 | 4.68 Q | 28(17) |
| $^{238}$Pu AH | 5.4(3) | 5.807(18) | –1.48 | –1.18 | –7(5) |
| $^{239}$Pu AH | 14.3(7) | 15.42(7) | –1.62 | –1.41 | –7(5) |
| $^{241}$Am AH | 3.36(15) | 3.369(7) | –0.06 | –0.06 | 0(5) |
| $^{244}$Cm AH | 4.5(3) | 4.708(14) | –0.67 | –0.73 | –4(6) |
| Gross a AH | 41.9(13) | 65(8) | –2.86 D | –7.17 D | –36(8) |
| $^{3}$H B1 | 0.90(7) | 0.925(7) | –0.37 | –0.50 | –3(8) |
| $^{14}$C B1 | 0.742(21) | 0.702(5) | 1.87 | 0.95 | 6(3) |
| $^{99}$Tc B1 | 1.64(4) | 1.612(4) | 0.79 | 0.31 | 1.8(22) |
| $^{3}$H B2 | 0.48(6) | 0.487(4) | –0.15 | –0.43 | –2(12) |
| $^{63}$Ni B2 | 0.73(4) | 0.596(24) | 3.17 D | 3.83 D | 23(8) |
| $^{90}$Sr B2 | 0.54(5) | 0.5712(11) | –0.70 | –0.82 | –6(9) |
| Gross b B2 | 1.30(8) | 1.1423(23) | 1.93 | 2.30 | 14(7) |
| $^{22}$Na GH | 4.99(25) | 5.529(20) | –2.15 | –2.42 | –10(5) |
| $^{60}$Co GH | 4.62(8) | 4.641(14) | –0.26 | –0.13 | –0.5(17) |
| $^{95}$Zr GH | 7.66(15) | 7.35(8) | 1.85 | 1.07 | 4.2(23) |
| $^{95}$Nb GH | 14.00(19) | 13.54(7) | 2.26 | 0.68 | 3.4(15) |
| $^{133}$Ba GH | 2.57(8) | 2.754(19) | –2.23 | –1.48 | –7(3) |
| $^{134}$Cs GH | 4.55(9) | 4.63(4) | –0.86 | –0.45 | –1.8(21) |
| $^{137}$Cs GH | 9.55(12) | 9.56(7) | –0.07 | –0.02 | –0.1(14) |
| $^{152}$Eu GH | 17.9(3) | 17.86(12) | 0.13 | 0.06 | 0.2(17) |
| $^{60}$Co C | 0.123(10) | 0.1045(14) | 1.88 | 3.37 Q | 18(10) |
| $^{152}$Eu C | 2.55(16) | 2.63(4) | –0.49 | –0.71 | –3(7) |
| $^{154}$Eu C | 0.114(24) | 0.1029(18) | 0.46 | 1.40 | 11(23) |

***Table B42 – Laboratory 56***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B2 | 0.488(11) | 0.487(4) | 0.09 | 0.05 | 0.2(24) |
| $^{55}$Fe B2 | 1.37(18) | 1.65(4) | –1.50 | –2.53 | –17(11) |
| $^{90}$Sr B2 | 0.45(9) | 0.5712(11) | –1.38 | –3.01 Q | –22(16) |

***Table B43 – Laboratory 59***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{238}$Pu AL | 11.4(9) | 11.86(4) | –0.59 | –0.71 | –4(8) |
| $^{239}$Pu AL | 9.7(8) | 10.19(5) | –0.72 | –0.90 | –5(7) |
| $^{241}$Am AL G | 16.4(14) | 13.57(4) | 2.02 | 3.50 Q | 21(10) |
| $^{241}$Am AL A | 13.2(10) | 13.57(4) | –0.41 | –0.52 | –3(8) |
| $^{244}$Cm AL | 6.7(5) | 6.96(3) | –0.59 | –0.75 | –4(8) |
| Gross a AL | 81(7) | 92(8) | –1.04 | –2.42 | –12(11) |
| $^{22}$Na GL | 9.0(8) | 8.19(3) | 0.94 | 1.76 | 9(10) |
| $^{60}$Co GL | 8.9(7) | 7.201(22) | 2.50 | 5.11 Q | 24(10) |
| $^{95}$Zr GL | 8.3(10) | 7.30(7) | 1.01 | 2.06 | 14(14) |
| $^{95}$Nb GL | 15.0(18) | 13.46(7) | 0.86 | 1.94 | 11(13) |
| $^{133}$Ba GL | 6.9(5) | 6.12(5) | 1.60 | 1.97 | 12(8) |
| $^{134}$Cs GL | 12.5(8) | 11.93(8) | 0.73 | 1.12 | 5(7) |
| $^{137}$Cs GL | 9.8(8) | 9.02(6) | 0.99 | 1.63 | 8(9) |
| $^{152}$Eu GL | 13.2(8) | 12.35(9) | 1.07 | 1.32 | 7(7) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B1 | 0.859(18) | 0.925(7) | –3.47 Q | –1.25 | –7.2(21) |
| $^{14}$C B1 | 0.72(3) | 0.702(5) | 0.75 | 0.47 | 3(4) |
| $^{99}$Tc B1 | 1.55(3) | 1.612(4) | –2.04 | –0.63 | –3.6(17) |
| $^{3}$H B2 | 0.451(11) | 0.487(4) | –3.12 Q | –1.72 | –7.4(24) |
| $^{55}$Fe B2 | 1.68(5) | 1.65(4) | 0.62 | 0.34 | 2(4) |
| Gross b B2 | 2.56(5) | 2.5(5) | 0.03 | 0.09 | 1(21) |

***Table B44 – Laboratory 62***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.2(5) | 8.19(3) | –1.82 | –2.18 | –12(7) |
| $^{60}$Co GL | 6.9(5) | 7.201(22) | –0.62 | –0.82 | –4(6) |
| $^{95}$Zr GL | 7.6(6) | 7.30(7) | 0.43 | 0.52 | 4(8) |
| $^{95}$Nb GL | 13.2(8) | 13.46(7) | –0.32 | –0.32 | –2(6) |
| $^{133}$Ba GL | 4.7(4) | 6.12(5) | –3.69 D | –3.76 D | –23(6) |
| $^{134}$Cs GL | 10.0(6) | 11.93(8) | –3.51 D | –3.76 D | –16(5) |
| $^{137}$Cs GL | 9.1(6) | 9.02(6) | 0.16 | 0.21 | 1(7) |
| $^{152}$Eu GL | 10.9(6) | 12.35(9) | –2.27 | –2.13 | –12(5) |

***Table B45 – Laboratory 65***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{226}$Ra AL | 4.3(6) | 4.71(6) | –0.78 | –1.39 | –10(12) |
| $^{234}$U AL | 13.9(9) | 14.6(14) | –0.47 | –0.87 | –5(11) |
| $^{235}$U AL | 0.86(16) | 0.680(3) | 1.13 | 2.02 | 26(24) |
| $^{238}$U AL | 14.8(10) | 14.76(4) | 0.03 | 0.03 | 0(7) |
| $^{237}$Np AL | 10.6(15) | 9.38(10) | 0.82 | 1.26 | 13(16) |
| $^{238}$Pu AL | 11.3(8) | 11.86(4) | –0.76 | –0.83 | –5(6) |
| $^{239}$Pu AL | 9.2(6) | 10.19(5) | –1.64 | –1.66 | –10(6) |
| $^{241}$Am AL | 14.4(9) | 13.57(4) | 0.92 | 1.02 | 6(7) |
| $^{244}$Cm AL | 7.3(7) | 6.96(3) | 0.49 | 0.83 | 5(10) |
| Gross a AL | 94(9) | 92(8) | 0.16 | 0.42 | 2(14) |
| | | | | | |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B1 | 0.88(4) | 0.925(7) | –1.05 | –0.78 | –4(5) |
| $^{14}$C B1 | 0.84(4) | 0.702(5) | 3.60 D | 3.30 D | 20(6) |
| $^{3}$H B2 | 0.499(22) | 0.487(4) | 0.54 | 0.58 | 2(5) |
| $^{55}$Fe B2 | 1.24(10) | 1.65(4) | –3.78 D | –3.72 D | –25(7) |
| $^{63}$Ni B2 | 0.45(3) | 0.596(24) | –3.89 D | –4.11 D | –25(6) |
| $^{90}$Sr B2 | 0.75(4) | 0.5712(11) | 4.83 D | 4.31 D | 31(7) |
| $^{3}$H leach C | 0.65(3) | 3(4) | –0.61 | –0.76 | $-8(3) \times 10^{1}$ |
| $^{60}$Co C | 0.011(6) | 0.1045(14) | –17.16 D | –17.08 D | –90(5) |
| $^{152}$Eu C | 2.38(12) | 2.63(4) | –2.02 | –2.21 | –10(5) |

***Table B46 – Laboratory 68***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.1(5) | 8.19(3) | –2.19 | –2.58 | –14(6) |
| $^{60}$Co GL | 7.0(5) | 7.201(22) | –0.47 | –0.63 | –3(6) |
| $^{95}$Zr GL | 9.4(6) | 7.30(7) | 3.35 D | 4.17 D | 28(9) |
| $^{95}$Nb GL | 4.9(10) Q | 13.46(7) | –8.92 D | –10.78 D | –64(7) |
| $^{133}$Ba GL | 6.1(4) | 6.12(5) | –0.14 | –0.13 | –1(6) |
| $^{134}$Cs GL | 12.6(9) | 11.93(8) | 0.72 | 1.25 | 5(8) |
| $^{137}$Cs GL | 10.6(8) | 9.02(6) | 1.96 | 3.46 Q | 18(9) |
| $^{152}$Eu GL | 13.2(7) | 12.35(9) | 1.21 | 1.26 | 7(6) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | 4.9(3) | 5.529(20) | –2.28 | –2.86 Q | –12(5) |
| $^{60}$Co GH | 4.5(3) | 4.641(14) | –0.58 | –0.90 | –3(6) |
| $^{95}$Zr GH | 8.6(4) | 7.35(8) | –2.81 D | 4.16 D | 16(6) |
| $^{95}$Nb GH | 6.0(9) | 13.54(7) | –8.05 D | –11.25 D | –55(7) |
| $^{133}$Ba GH | 2.80(16) | 2.754(19) | 0.29 | 0.37 | 2(6) |
| $^{134}$Cs GH | 4.9(4) | 4.63(4) | 0.64 | 1.20 | 5(8) |
| $^{137}$Cs GH | 11.3(8) | 9.56(7) | 2.17 | 4.71 Q | 18(8) |
| $^{152}$Eu GH | 18.1(10) | 17.86(12) | 0.22 | 0.32 | 1(6) |
| $^{60}$Co C | 0.113(7) | 0.1045(14) | 1.27 | 1.53 | 8(7) |
| $^{133}$Ba C | 0.0086(8) | 0.0070(3) | 2.01 | 1.79 | 22(11) |
| $^{152}$Eu C | 3.04(18) | 2.63(4) | 2.28 | 3.56 Q | 15(7) |
| $^{154}$Eu C | 0.113(6) | 0.1029(18) | 1.59 | 1.29 | 10(7) |

***Table B47 – Laboratory 72***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.1(5) | 8.19(3) | –2.59 Q | –2.58 | –14(6) |
| $^{60}$Co GL | 7.2(5) | 7.201(22) | –0.05 | –0.06 | 0(6) |
| $^{95}$Zr GL | 8.2(6) | 7.30(7) | 1.68 | 1.86 | 13(8) |
| $^{95}$Nb GL | 14.7(9) | 13.46(7) | 1.40 | 1.59 | 9(7) |
| $^{133}$Ba GL | 6.0(4) | 6.12(5) | –0.33 | –0.35 | –2(7) |
| $^{134}$Cs GL | 11.3(7) | 11.93(8) | –0.95 | –1.27 | –6(6) |
| $^{137}$Cs GL | 9.2(6) | 9.02(6) | 0.34 | 0.43 | 2(7) |
| $^{152}$Eu GL | 12.6(8) | 12.35(9) | 0.26 | 0.30 | 2(7) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B1 | 0.92(10) | 0.925(7) | –0.05 | –0.10 | –1(11) |

***Table B48 – Laboratory 74***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq $g^{-1}$) | (Bq $g^{-1}$) | | | |
| $^{3}$H B1 | 0.92(4) | 0.925(7) | –0.29 | –0.18 | –1(4) |
| $^{99}$Tc B1 | 1.56(7) | 1.612(4) | –0.75 | –0.56 | –3(5) |
| $^{3}$H B2 | 0.491(19) | 0.487(4) | 0.21 | 0.20 | 1(4) |
| $^{55}$Fe B2 | 2.14(10) | 1.65(4) | 4.50 D | 4.53 D | 30(7) |
| $^{63}$Ni B2 | 0.59(4) | 0.596(24) | –0.18 | –0.20 | –1(7) |
| $^{90}$Sr B2 | 0.66(3) | 0.5712(11) | 3.35 Q | 2.14 | 16(5) |
| $^{22}$Na GH | 4.33(15) | 5.529(20) | –7.92 D | –5.37 D | –22(3) |
| $^{60}$Co GH | 4.45(15) | 4.641(14) | –1.27 | –1.14 | –4(4) |
| $^{95}$Zr GH | 6.69(23) | 7.35(8) | –2.74 Q | –2.29 | –9(4) |
| $^{95}$Nb GH | 12.7(6) | 13.54(7) | –1.40 | –1.20 | –6(5) |
| $^{133}$Ba GH | 2.36(8) | 2.754(19) | –4.79 D | –3.16 D | –14(3) |
| $^{134}$Cs GH | 3.92(13) | 4.63(4) | –5.32 D | –3.92 D | –15(3) |
| $^{137}$Cs GH | 8.7(3) | 9.56(7) | –2.96 Q | –2.52 | –10(4) |
| $^{152}$Eu GH | 19.1(7) | 17.86(12) | 1.88 | 1.79 | 7(4) |
| $^{3}$H tot C | 25.7(15) | 18(10) | 0.75 | 0.95 | $4(7) \times 10^1$ |
| $^{14}$C C | 0.082(10) | 0.06(5) | 0.48 | 0.62 | $4(10) \times 10^1$ |
| $^{55}$Fe C | 0.047(4) | 0.055(5) | –1.38 | –0.92 | 15(10) |
| $^{63}$Ni C | 0.048(5) | 0.04(3) | 0.12 | 0.15 | $1(7) \times 10^1$ |

***Table B49 – Laboratory 76***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq $kg^{-1}$) | (Bq $kg^{-1}$) | | | |
| $^{22}$Na GL | 7.1(10) | 8.19(3) | –1.03 | –2.41 | –13(12) |
| $^{60}$Co GL | 6.8(7) | 7.201(22) | –0.55 | –1.15 | –5(10) |
| $^{95}$Zr GL | 7.4(9) | 7.30(7) | 0.10 | 0.18 | 1(12) |
| $^{95}$Nb GL | 14.3(15) | 13.46(7) | 0.59 | 1.08 | 6(11) |
| $^{133}$Ba GL | 5.4(5) | 6.12(5) | –1.46 | –2.03 | –12(9) |
| $^{134}$Cs GL | 10.9(9) | 11.93(8) | –1.19 | –1.99 | –9(7) |
| $^{137}$Cs GL | 9.5(10) | 9.02(6) | 0.44 | 0.96 | 5(11) |
| $^{152}$Eu GL | 11.3(8) | 12.35(9) | –1.33 | –1.48 | –8(6) |
| $^{40}$K GL | 22(4) | – | – | – | – |
| $^{106}$Ru GL | 66(8) | – | – | – | – |

***Table B50 – Laboratory 77***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{226}$Ra AL | 4.5(4) | 4.71(6) | –0.50 | –0.59 | –4(8) |
| $^{234}$U AL | 13.3(19) Q | 14.6(14) | –0.56 | –1.49 | –9(15) |
| $^{235}$U AL | 0.61(12) | 0.680(3) | –0.58 | –0.79 | –10(18) |
| $^{238}$U AL | 14.3(21) | 14.76(4) | –0.22 | –0.52 | –3(14) |
| $^{238}$Pu AL | 7.1(12) | 11.86(4) | –3.96 D | –7.07 D | –40(10) |
| $^{239}$Pu AL | 4.7(8) | 10.19(5) | –6.68 D | –9.24 D | –54(8) |
| $^{241}$Am AL | 13.3(18) | 13.57(4) | –0.15 | –0.34 | –2(13) |
| $^{244}$Cm AL | 5.4(8) | 6.96(3) | –1.95 | –3.85 Q | –23(12) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | 5.4(4) | 5.529(20) | –0.53 | –0.76 | –3(6) |
| $^{60}$Co GH | 4.7(3) | 4.641(14) | 0.32 | 0.53 | 2(6) |
| $^{95}$Zr GH | 7.6(5) | 7.35(8) | 0.62 | 1.00 | 4(7) |
| $^{95}$Nb GH | 13.9(21) | 13.54(7) | 0.17 | 0.53 | 3(16) |
| $^{133}$Ba GH | 2.42(15) | 2.754(19) | –2.21 | –2.68 Q | –12(6) |
| $^{134}$Cs GH | 4.3(3) | 4.63(4) | –1.19 | –1.72 | –7(6) |
| $^{137}$Cs GH | 9.1(6) | 9.56(7) | –0.94 | –1.41 | –5(6) |
| $^{152}$Eu GH | 17.3(10) | 17.86(12) | –0.55 | –0.80 | –3(6) |

***Table B51 – Laboratory 78***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H total C | 19.6(3) | 18(10) | 0.12 | 0.15 | $1(6) \times 10^1$ |
| $^{14}$C C | 0.61(8) | 0.06(5) | 5.80 D | 15.70 D | $9(8) \times 10^2$ |
| $^{40}$K C | 0.147(13) | 0.18(8) | –0.46 | –0.58 | $–2(4) \times 10^1$ |
| $^{55}$Fe C | 0.236(21) | 0.055(5) | 8.30 D | 20.30 D | $33(6) \times 10^1$ |
| $^{60}$Co C | 0.0991(25) | 0.1045(14) | –1.90 | –0.98 | –5(3) |
| $^{63}$Ni C | 0.1508(25) | 0.04(3) | 3.60 | 4.52 Q | $24(22) \times 10^1$ |
| $^{133}$Ba C | 0.0080(16) | 0.0070(3) | 0.61 | 1.13 | 14(23) |
| $^{152}$Eu C | 2.517(25) | 2.63(4) | –2.75 | –1.00 | –4.3(15) |
| $^{154}$Eu C | 0.093(4) | 0.1029(18) | –2.21 | –1.24 | –10(5) |
| Gross b C | 1.33(5) | 1.2(8) | 0.20 | 0.25 | $1(8) \times 10^1$ |

***Table B52 – Laboratory 81***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{238}$Pu AL | 9.8(12) | 11.86(4) | –1.71 | –3.06 Q | –17(10) |
| $^{239}$Pu AL | 8.2(10) | 10.19(5) | –1.98 | –3.35 Q | –19(10) |
| $^{22}$Na GL | 7.5(4) | 8.19(3) | –1.71 | –1.58 | –8(5) |
| $^{60}$Co GL | 7.2(3) | 7.201(22) | 0.00 | 0.00 | 0(4) |
| $^{95}$Zr GL | 7.2(4) | 7.30(7) | –0.25 | –0.21 | –1(6) |
| $^{95}$Nb GL | 14.6(7) | 13.46(7) | 1.63 | 1.44 | 8(5) |
| $^{133}$Ba GL | 5.2(4) | 6.12(5) | –2.29 | –2.45 | –15(7) |
| $^{134}$Cs GL | 11.7(5) | 11.93(8) | –0.46 | –0.45 | –2(5) |
| $^{137}$Cs GL | 9.1(4) | 9.02(6) | 0.19 | 0.17 | 1(5) |
| $^{152}$Eu GL | 11.1(6) | 12.35(9) | –2.06 | –1.83 | –10(5) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{60}$Co C | 0.108(9) | 0.1045(14) | 0.39 | 0.64 | 3(9) |
| $^{152}$Eu C | 2.47(20) | 2.63(4) | –0.80 | –1.42 | –6(8) |
| $^{154}$Eu C | 0.094(8) | 0.1029(18) | –1.08 | –1.11 | –9(8) |

***Table B53 – Laboratory 82***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 8.3(9) | 8.19(3) | 0.12 | 0.24 | 1(11) |
| $^{60}$Co GL | 8.6(9) | 7.201(22) | 1.58 | 4.09 Q | 19(12) |
| $^{95}$Zr GL | 8.9(11) | 7.30(7) | 1.45 | 3.24 Q | 22(15) |
| $^{95}$Nb GL | 18.3(21) | 13.46(7) | 2.31 | 6.08 Q | 36(16) |
| $^{133}$Ba GL | 6.3(7) | 6.12(5) | 0.20 | 0.35 | 2(10) |
| $^{134}$Cs GL | 13.5(14) | 11.93(8) | 1.12 | 3.02 Q | 13(12) |
| $^{137}$Cs GL | 12.2(12) | 9.02(6) | 2.65 D | 6.84 D | 35(13) |
| $^{152}$Eu GL | 15.2(16) | 12.35(9) | 1.78 | 4.20 Q | 23(13) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | 6.0(6) | 5.529(20) | 0.72 | 1.93 | 8(11) |
| $^{60}$Co GH | 5.2(5) | 4.641(14) | 1.11 | 3.45 Q | 12(11) |
| $^{95}$Zr GH | 8.7(9) | 7.35(8) | 1.49 | 4.58 Q | 18(12) |
| $^{95}$Nb GH | 15.9(17) | 13.54(7) | 1.38 | 3.53 Q | 17(13) |
| $^{133}$Ba GH | 3.0(3) | 2.754(19) | 0.95 | 2.30 | 10(11) |
| $^{134}$Cs GH | 4.7(5) | 4.63(4) | 0.14 | 0.37 | 1(10) |
| $^{137}$Cs GH | 11.2(11) | 9.56(7) | 1.49 | 4.54 Q | 17(12) |
| $^{152}$Eu GH | 19.7(20) | 17.86(12) | 0.92 | 2.65 Q | 10(11) |
| $^{170}$Tm GH | 4.9(6) | – | – | – | – |

***Table B54 – Laboratory 83***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | – | 8.19(3) | – | – | – |
| $^{60}$Co GL | – | 7.201(22) | – | – | – |
| $^{95}$Zr GL | – | 7.30(7) | – | – | – |
| $^{95}$Nb GL | – | 13.46(7) | – | – | – |
| $^{133}$Ba GL | – | 6.12(5) | – | – | – |
| $^{134}$Cs GL | 10.4(6) | 11.93(8) | –2.53 | –2.95 Q | –13(5) |
| $^{137}$Cs GL | 9.5(9) | 9.02(6) | 0.53 | 1.03 | 5(10) |
| $^{152}$Eu GL | – | 12.35(9) | – | – | – |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{99}$Tc B2 | 1.51(8) | 1.612(4) | –1.27 | –1.11 | –6(5) |
| $^{22}$Na GH | – | 5.529(20) | – | – | – |
| $^{60}$Co GH | – | 4.641(14) | – | – | – |
| $^{95}$Zr GH | – | 7.35(8) | – | – | – |
| $^{95}$Nb GH | – | 13.54(7) | – | – | – |
| $^{133}$Ba GH | – | 2.754(19) | – | – | – |
| $^{134}$Cs GH | 9.6(3) | 4.63(4) | 16.46 D | 27.33 D | 107(7) |
| $^{137}$Cs GH | 23.7(10) | 9.56(7) | 14.11 D | 39.15 D | 148(11) |
| $^{152}$Eu GH | – | 17.86(12) | – | – | – |

***Table B55 – Laboratory 88***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 8.0(4) | 8.19(3) | –0.47 | –0.43 | –2(5) |
| $^{60}$Co GL | 7.4(4) | 7.201(22) | 0.55 | 0.60 | 3(5) |
| $^{95}$Zr GL | 7.3(5) | 7.30(7) | –0.05 | –0.05 | 0(7) |
| $^{95}$Nb GL | 15.1(9) | 13.46(7) | 1.82 | 2.06 | 12(7) |
| $^{133}$Ba GL | 5.8(3) | 6.12(5) | –1.06 | –0.85 | –5(5) |
| $^{134}$Cs GL | 11.4(5) | 11.93(8) | –1.05 | –1.02 | –4(5) |
| $^{137}$Cs GL | 9.4(4) | 9.02(6) | 0.91 | 0.81 | 4(5) |
| $^{152}$Eu GL | 12.2(6) | 12.35(9) | –0.27 | –0.24 | –1(5) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | 5.20(20) | 5.529(20) | –1.64 | –1.47 | –6(4) |
| $^{60}$Co GH | 4.70(20) | 4.641(14) | 0.29 | 0.35 | 1(5) |
| $^{95}$Zr GH | 7.4(3) | 7.35(8) | 0.06 | 0.07 | 0(5) |
| $^{95}$Nb GH | 13.6(9) | 13.54(7) | 0.06 | 0.08 | 0(7) |
| $^{133}$Ba GH | 2.71(12) | 2.754(19) | –0.36 | –0.35 | –2(5) |
| $^{134}$Cs GH | 4.52(20) | 4.63(4) | –0.56 | –0.62 | –2(5) |
| $^{137}$Cs GH | 9.6(4) | 9.56(7) | 0.10 | 0.11 | 0(5) |
| $^{152}$Eu GH | 17.2(8) | 17.86(12) | –0.81 | –0.95 | –4(5) |
| $^{60}$Co C | 0.110(5) | 0.1045(14) | 1.07 | 1.01 | 5(5) |
| $^{133}$Ba C | 0.0070(5) | 0.0070(3) | –0.08 | –0.05 | –1(8) |
| $^{152}$Eu C | 2.77(12) | 2.63(4) | 1.11 | 1.22 | 5(5) |
| $^{154}$Eu C | 0.110(6) | 0.1029(18) | 1.14 | 0.90 | 7(6) |

***Table B56 – Laboratory 89***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 8.05(18) | 8.19(3) | –0.75 | –0.32 | –1.7(22) |
| $^{60}$Co GL | 7.57(13) | 7.201(22) | 2.80 Q | 1.11 | 5.1(18) |
| $^{95}$Zr GL | 7.82(22) | 7.30(7) | 2.23 | 1.05 | 7(4) |
| $^{95}$Nb GL | 13.3(3) | 13.46(7) | –0.51 | –0.20 | –1.2(23) |
| $^{133}$Ba GL | 6.5(3) | 6.12(5) | 1.30 | 0.98 | 6(5) |
| $^{134}$Cs GL | 11.39(13) | 11.93(8) | –3.50 Q | –1.04 | –4.5(13) |
| $^{137}$Cs GL | 9.75(24) | 9.02(6) | 2.94 Q | 1.57 | 8(3) |
| $^{152}$Eu GL | 12.9(4) | 12.35(9) | 1.39 | 0.87 | 5(4) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B1 | 1.052(22) | 0.925(7) | 5.52 Q | 2.38 | 13.7(25) |
| $^{14}$C B1 | 0.624(20) | 0.702(5) | –3.83 Q | –1.87 | –11(3) |
| $^{22}$Na GH | 5.27(7) | 5.529(20) | –3.56 Q | –1.16 | –4.7(13) |
| $^{60}$Co GH | 4.85(6) | 4.641(14) | 3.39 Q | 1.24 | 4.5(13) |
| $^{95}$Zr GH | 7.84(19) | 7.35(8) | 2.40 | 1.70 | 7(3) |
| $^{95}$Nb GH | 11.13(22) | 13.54(7) | –10.48 D | –3.62 D | –17.8(17) |
| $^{133}$Ba GH | 3.06(11) | 2.754(19) | 2.74 Q | 2.46 | 11(4) |
| $^{134}$Cs GH | 4.36(4) | 4.63(4) | –5.28 Q | –1.50 | –5.9(11) |
| $^{137}$Cs GH | 10.06(20) | 9.56(7) | 2.38 | 1.39 | 5.2(22) |
| $^{152}$Eu GH | 18.6(6) | 17.86(12) | 1.29 | 1.07 | 4(4) |

***Table B57 – Laboratory 90***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.1(3) | 8.19(3) | –3.61 Q | –2.51 | –13(4) |
| $^{60}$Co GL | 7.1(3) | 7.201(22) | –0.34 | –0.30 | –1(4) |
| $^{95}$Zr GL | 7.1(5) | 7.30(7) | –0.40 | –0.41 | –3(7) |
| $^{95}$Nb GL | 12.7(10) | 13.46(7) | –0.75 | –0.95 | –6(8) |
| $^{133}$Ba GL | 5.7(3) | 6.12(5) | –1.39 | –1.12 | –7(5) |
| $^{134}$Cs GL | 11.5(4) | 11.93(8) | –1.05 | –0.83 | –4(4) |
| $^{137}$Cs GL | 8.5(3) | 9.02(6) | –1.70 | –1.12 | –6(4) |
| $^{152}$Eu GL | 11.0(20) | 12.35(9) | –0.67 | –1.98 | –11(16) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | 5.19(17) | 5.529(20) | –1.98 | –1.52 | –6(3) |
| $^{60}$Co GH | 4.47(9) | 4.641(14) | –1.88 | –1.02 | –3.7(20) |
| $^{95}$Zr GH | 7.36(20) | 7.35(8) | 0.04 | 0.03 | 0(3) |
| $^{95}$Nb GH | 13.4(3) | 13.54(7) | –0.46 | –0.20 | –1.0(21) |
| $^{133}$Ba GH | 2.62(9) | 2.754(19) | –1.45 | –1.08 | –5(4) |
| $^{134}$Cs GH | 4.53(12) | 4.63(4) | –0.83 | –0.56 | –2(3) |
| $^{137}$Cs GH | 9.4(3) | 9.56(7) | –0.71 | –0.52 | –2(3) |
| $^{152}$Eu GH | 16.5(4) | 17.86(12) | –3.22 Q | –2.03 | –7.9(24) |

***Table B58 – Laboratory 91***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{234}$U AL | 14.4(9) | 14.6(14) | –0.13 | –0.24 | –1(11) |
| $^{235}$U AL | 0.54(5) | 0.680(3) | –2.63 Q | –1.54 | –20(8) |
| $^{238}$U AL | 14.6(9) | 14.76(4) | –0.13 | –0.14 | –1(6) |
| $^{237}$Np AL | 8.6(9) | 9.38(10) | –0.89 | –0.78 | –8(9) |
| $^{238}$Pu AL | 11.5(8) | 11.86(4) | –0.49 | –0.56 | –3(7) |
| $^{239}$Pu AL | 10.1(7) | 10.19(5) | –0.07 | –0.08 | 0(7) |
| $^{241}$Am AL | 12.8(7) | 13.57(4) | –1.08 | –0.98 | –6(6) |
| $^{244}$Cm AL | 7.1(4) | 6.96(3) | 0.33 | 0.32 | 2(6) |
| $^{22}$Na GL | 7.05(18) | 8.19(3) | –6.24 D | –2.62 D | –13.9(22) |
| $^{60}$Co GL | 7.00(19) | 7.201(22) | –1.05 | –0.60 | –3(3) |
| $^{95}$Zr GL | 6.8(4) | 7.30(7) | –1.32 | –0.98 | –7(5) |
| $^{95}$Nb GL | 14.3(3) | 13.46(7) | 2.75 Q | 1.10 | 6.5(24) |
| $^{133}$Ba GL | 6.04(21) | 6.12(5) | –0.38 | –0.21 | –1(4) |
| $^{134}$Cs GL | 10.70(20) | 11.93(8) | –5.68 Q | –2.37 | –10.3(18) |
| $^{137}$Cs GL | 8.77(18) | 9.02(6) | –1.32 | –0.54 | –2.8(21) |
| $^{152}$Eu GL | 11.6(4) | 12.35(9) | –1.91 | –1.04 | –6(3) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B2 | 0.49(4) | 0.487(4) | 0.07 | 0.15 | 1(9) |
| $^{55}$Fe B2 | 1.06(5) | 1.65(4) | –10.19 D | –5.40 D | –36(3) |
| $^{63}$Ni B2 | 0.60(3) | 0.596(24) | 0.11 | 0.11 | 1(6) |
| $^{90}$Sr B2 | 0.60(6) | 0.5712(11) | 0.42 | 0.57 | 4(10) |

***Table B59 – Laboratory 92***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 2.95(8) | 8.19(3) | –61.41 D | –12.07 D | –64.0(10) |
| $^{60}$Co GL | 3.94(9) | 7.201(22) | –35.21 D | –9.81 D | –45.3(13) |
| $^{95}$Zr GL | 6.55(19) | 7.30(7) | –3.70 Q | –1.53 | –10(3) |
| $^{95}$Nb GL | 20(6) | 13.46(7) | 1.01 | 7.75 Q | 5(5) × 10$^{1}$ |
| $^{133}$Ba GL | 5.226(2) | 6.12(5) | –20.78 Q | –2.38 | –14.6(6) |
| $^{134}$Cs GL | 9.61(10) | 11.93(8) | –17.79 D | –4.47 D | –19.5(10) |
| $^{137}$Cs GL | 8.25(21) | 9.02(6) | –3.53 Q | –1.66 | –8.6(24) |
| $^{152}$Eu GL | 9.8(3) | 12.35(9) | –9.42 D | –3.79 D | –20.9(22) |
| $^{40}$K GL | 9.2(5) | – | – | – | – |
| $^{207}$Bi GL | 0.86(3) | – | – | – | – |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{90}$Sr B2 | 0.1774(2) | 0.5712(11) | –342.20 D | –9.48 D | –68.94(7) |

***Table B60 – Laboratory 93***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | 5.2(3) | 5.529(20) | –1.10 | –1.47 | –6(6) |
| $^{60}$Co GH | 4.70(25) | 4.641(14) | 0.24 | 0.35 | 1(6) |
| $^{95}$Zr GH | 6.4(4) | 7.35(8) | –2.34 | –3.30 Q | –13(6) |
| $^{95}$Nb GH | 8.3(6) | 13.54(7) | –9.08 D | –7.81 D | –38(5) |
| $^{133}$Ba GH | 2.43(15) | 2.754(19) | –2.14 | –2.60 Q | –12(6) |
| $^{134}$Cs GH | 4.0(3) | 4.63(4) | –2.41 | –3.48 Q | –14(6) |
| $^{137}$Cs GH | 9.6(5) | 9.56(7) | 0.08 | 0.11 | 0(6) |
| $^{152}$Eu GH | 15.3(8) | 17.86(12) | –3.01 D | –3.68 D | –14(5) |
| $^{40}$K GH | 2.35(15) | – | – | – | – |
| $^{58}$Co GH | 0.08(1) | – | – | – | – |

***Table B61 – Laboratory 94***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.2(4) | 8.19(3) | –2.46 | –2.28 | –12(5) |
| $^{60}$Co GL | 7.6(3) | 7.201(22) | 1.33 | 1.20 | 6(4) |
| $^{95}$Zr GL | 7.8(5) | 7.30(7) | 0.98 | 1.01 | 7(7) |
| $^{95}$Nb GL | 13.2(10) | 13.46(7) | –0.26 | –0.32 | –2(8) |
| $^{133}$Ba GL | 6.4(4) | 6.12(5) | 0.69 | 0.74 | 5(7) |
| $^{134}$Cs GL | 12.0(8) | 11.93(8) | 0.09 | 0.13 | 1(7) |
| $^{137}$Cs GL | 9.6(3) | 9.02(6) | 1.89 | 1.24 | 6(4) |
| $^{152}$Eu GL | 12.4(7) | 12.35(9) | 0.08 | 0.08 | 0(6) |
| $^{40}$K GL | 4.8(3) | – | – | – | – |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B1 | 1.03(7) | 0.925(7) | 1.49 | 1.96 | 11(8) |
| $^{14}$C B1 | 0.69(5) | 0.702(5) | –0.24 | –0.29 | –2(7) |
| $^{3}$H B2 | 0.53(4) | 0.487(4) | 1.07 | 2.06 | 9(8) |
| $^{55}$Fe B2 | 2.8(4) | 1.65(4) | 2.87 D | 10.59 D | 70(25) |
| $^{63}$Ni B2 | 1.05(12) | 0.596(24) | 3.71 D | 12.79 D | 76(21) |
| $^{90}$Sr B2 | 0.64(8) | 0.5712(11) | 0.86 | 1.66 | 12(14) |
| Gross b B2 | 4.3(5) | 2.5(5) | 2.42 | 11.52 Q | $7(4) \times 10^1$ |
| $^{14}$C C | 0.051(6) | 0.06(5) | –0.21 | –0.26 | $-2(6) \times 10^1$ |
| $^{40}$K C | 0.16(2) | 0.18(8) | –0.29 | –0.37 | $-1(4) \times 10^1$ |
| $^{55}$Fe C | 0.086(12) | 0.055(5) | 2.44 | 3.51 | 57(25) |
| $^{60}$Co C | 0.101(4) | 0.1045(14) | –0.82 | –0.63 | –3(4) |
| $^{63}$Ni C | 0.025(5) | 0.04(3) | –0.65 | –0.83 | $-4(4) \times 10^1$ |
| $^{133}$Ba C | 0.0064(7) | 0.0070(3) | –0.86 | –0.73 | –9(10) |
| $^{152}$Eu C | 2.53(12) | 2.63(4) | –0.82 | –0.89 | –4(5) |
| $^{154}$Eu C | 0.095(6) | 0.1029(18) | –1.26 | –0.99 | –8(6) |
| Gross b C | 0.45(5) | 1.2(8) | –0.88 | –1.10 | $-6(3) \times 10^1$ |

***Table B62 – Laboratory 95***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.54(11) | 8.19(3) | –5.68 Q | –1.49 | –7.9(14) |
| $^{60}$Co GL | 7.51(24) | 7.201(22) | 1.28 | 0.93 | 4(4) |
| $^{95}$Zr GL | 7.2(4) | 7.30(7) | –0.33 | –0.23 | –2(5) |
| $^{95}$Nb GL | 10.9(4) | 13.46(7) | –6.15 D | –3.21 D | –19(3) |
| $^{133}$Ba GL | 6.4(6) | 6.12(5) | 0.49 | 0.72 | 4(9) |
| $^{134}$Cs GL | 10.80(16) | 11.93(8) | –6.26 Q | –2.18 | –9.5(15) |
| $^{137}$Cs GL | 9.26(20) | 9.02(6) | 1.14 | 0.51 | 2.6(23) |
| $^{152}$Eu GL | 11.7(5) | 12.35(9) | –1.30 | –0.95 | –5(4) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B1 | 1.18(5) | 0.925(7) | 5.26 D | 4.75 D | 27(5) |
| $^{14}$C B1 | 0.58(4) | 0.702(5) | –3.44 D | –2.94 D | –17(5) |
| $^{3}$H tot C | 16.4(9) | 18(10) | –0.22 | –0.27 | –1(5) × 10$^{1}$ |
| $^{3}$H leach C | 2.82(16) | 3(4) | –0.01 | –0.02 | 0(13) × 10$^{1}$ |
| $^{3}$H fix C | 13.6(11) | – | – | – | – |
| $^{14}$C C | 0.117(7) | 0.06(5) | 1.29 | 1.63 | 9(14) × 10$^{1}$ |
| $^{40}$K C | 0.108(8) | 0.18(8) | –0.98 | –1.24 | –41(25) |
| $^{60}$Co C | 0.0759(25) | 0.1045(14) | –10.01 D | –5.20 D | –27(3) |
| $^{152}$Eu C | 1.90(8) | 2.63(4) | –8.72 D | –6.42 D | –28(3) |
| $^{154}$Eu C | 0.069(4) | 0.1029(18) | –7.95 D | –4.28 D | –33(4) |
| Gross b C | 0.612(10) | 1.2(8) | –0.68 | –0.85 | –5(4) × 10$^{1}$ |

***Table B63 – Laboratory 96***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.00(20) | 8.19(3) | –5.87 D | –2.74 D | –14.5(25) |
| $^{60}$Co GL | 6.62(24) | 7.201(22) | –2.41 | –1.75 | –8(4) |
| $^{95}$Zr GL | 6.8(6) | 7.30(7) | –0.83 | –1.02 | –7(8) |
| $^{95}$Nb GL | 12.0(7) | 13.46(7) | –2.07 | –1.83 | –11(5) |
| $^{133}$Ba GL | 5.8(4) | 6.12(5) | –0.80 | –0.85 | –5(7) |
| $^{134}$Cs GL | 10.1(5) | 11.93(8) | –3.61 D | –3.53 D | –15(5) |
| $^{137}$Cs GL | 11.4(6) | 9.02(6) | 3.94 D | 5.12 D | 26(7) |
| $^{152}$Eu GL | 13.6(9) | 12.35(9) | 1.39 | 1.84 | 10(7) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B1 | 0.599(22) | 0.925(7) | –14.29 D | –6.14 D | –35.3(24) |
| $^{99}$Tc B1 | 1.76(8) | 1.612(4) | 1.76 | 1.56 | 9(5) |
| $^{22}$Na GH | 5.68(4) | 5.529(20) | 3.37 Q | 0.68 | 2.7(8) |
| $^{60}$Co GH | 4.83(2) | 4.641(14) | 7.72 Q | 1.12 | 4.1(6) |
| $^{95}$Zr GH | 7.89(3) | 7.35(8) | 6.79 Q | 1.87 | 7.3(11) |
| $^{95}$Nb GH | 15.70(9) | 13.54(7) | 19.11 D | 3.23 D | 15.9(9) |
| $^{133}$Ba GH | 2.83(3) | 2.754(19) | 2.13 | 0.61 | 2.8(13) |
| $^{134}$Cs GH | 4.73(3) | 4.63(4) | 2.20 | 0.54 | 2.1(10) |
| $^{137}$Cs GH | 10.10(4) | 9.56(7) | 7.08 Q | 1.50 | 5.7(8) |
| $^{152}$Eu GH | 18.80(11) | 17.86(12) | 5.73 Q | 1.35 | 5.3(10) |
| $^{60}$Co C | 0.116(5) | 0.1045(14) | 2.22 | 2.10 | 11(5) |
| $^{133}$Ba C | 0.0110(6) | 0.0070(3) | 6.06 D | 4.49 D | 56(10) |
| $^{152}$Eu C | 2.83(10) | 2.63(4) | 1.89 | 1.74 | 8(4) |
| $^{154}$Eu C | 0.055(3) | 0.1029(18) | –13.73 D | –6.01 D | –47(3) |

***Table B64 – Laboratory 97***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.40(20) | 8.19(3) | –3.90 Q | –1.81 | –9.6(25) |
| $^{60}$Co GL | 7.00(10) | 7.201(22) | –1.96 | –0.60 | –2.8(14) |
| $^{95}$Zr GL | 7.30(20) | 7.30(7) | –0.01 | –0.01 | 0(3) |
| $^{95}$Nb GL | 12.10(20) | 13.46(7) | –6.43 Q | –1.70 | –10.1(16) |
| $^{133}$Ba GL | 5.60(10) | 6.12(5) | –4.78 Q | –1.39 | –8.5(18) |
| $^{134}$Cs GL | 10.50() | 11.93(8) | –10.97 D | –2.76 D | –12.0(10) |
| $^{137}$Cs GL | 9.10(20) | 9.02(6) | 0.37 | 0.17 | 0.9(23) |
| $^{152}$Eu GL | 9.90(20) | 12.35(9) | –11.27 D | –3.60 D | –19.8(17) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{60}$Co C | 0.102(4) | 0.1045(14) | –0.58 | –0.45 | –2(4) |
| $^{152}$Eu C | 1.84(6) | 2.63(4) | –11.56 D | –6.94 D | –30.1(24) |
| $^{154}$Eu C | 0.070(5) | 0.1029(18) | –6.19 D | –4.13 D | –32(5) |

***Table B65 – Laboratory 98***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.89(10) | 8.19(3) | –2.85 Q | –0.69 | –3.6(13) |
| $^{60}$Co GL | 7.32(10) | 7.201(22) | 1.16 | 0.36 | 1.7(14) |
| $^{95}$Zr GL | 6.91(20) | 7.30(7) | –1.85 | –0.80 | –5(3) |
| $^{95}$Nb GL | 13.05(7) | 13.46(7) | –4.18 Q | –0.51 | –3.0(7) |
| $^{133}$Ba GL | 5.80(10) | 6.12(5) | –2.94 Q | –0.85 | –5.2(18) |
| $^{134}$Cs GL | 11.42(3) | 11.93(8) | –5.74 Q | –0.98 | –4.3(7) |
| $^{137}$Cs GL | 8.25(10) | 9.02(6) | –6.58 Q | –1.66 | –8.6(13) |
| $^{152}$Eu GL | 13.55(10) | 12.35(9) | 9.21 Q | 1.77 | 9.8(11) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | 5.41(1) | 5.529(20) | –5.33 Q | –0.53 | –2.2(4) |
| $^{60}$Co GH | 4.87(1) | 4.641(14) | –13.26 Q | 1.36 | 4.9(4) |
| $^{95}$Zr GH | 7.86(1) | 7.35(8) | 6.86 Q | 1.77 | 6.9(11) |
| $^{95}$Nb GH | 14.580(4) | 13.54(7) | 15.21 Q | 1.55 | 7.6(6) |
| $^{133}$Ba GH | 2.56(2) | 2.754(19) | –6.97 Q | –1.56 | –7.0(10) |
| $^{134}$Cs GH | 4.45(1) | 4.63(4) | –5.36 Q | –1.01 | –3.9(7) |
| $^{137}$Cs GH | 10.21(1) | 9.56(7) | 9.88 Q | 1.80 | 6.8(8) |
| $^{152}$Eu GH | 17.29(1) | 17.86(12) | –4.65 Q | –0.82 | –3.2(7) |

***Table B66 – Laboratory 101***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{238}$Pu AL | 12.1(4) | 11.86(4) | 0.60 | 0.36 | 2(4) |
| $^{239}$Pu AL | 10.3(3) | 10.19(5) | 0.38 | 0.19 | 1(3) |
| $^{241}$Am AL | 12.9(6) | 13.57(4) | –1.12 | –0.83 | –5(5) |
| $^{244}$Cm AL | 6.1(4) | 6.96(3) | –2.14 | –2.09 | –12(6) |

***Table B67 – Laboratory 102***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B1 | 0.97(3) | 0.925(7) | 1.60 | 0.89 | 5(4) |
| $^{14}$C B1 | 0.55(5) | 0.702(5) | –3.48 D | –3.77 D | –22(7) |
| $^{3}$H B2 | 0.512(20) | 0.487(4) | 1.24 | 1.20 | 5(4) |

***Table B68 – Laboratory 103***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B1 | 0.895(19) | 0.925(7) | –1.52 | –0.57 | –3.3(22) |
| $^{14}$C B1 | 0.68(2) | 0.702(5) | –1.09 | –0.53 | –3(3) |

***Table B69 – Laboratory 104***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 6.9(3) | 8.19(3) | –4.10 D | –2.94 D | –16(4) |
| $^{60}$Co GL | 6.8(3) | 7.201(22) | –1.28 | –1.12 | –5(4) |
| $^{95}$Zr GL | 7.6(6) | 7.30(7) | 0.54 | 0.60 | 4(8) |
| $^{95}$Nb GL | 13.7(4) | 13.46(7) | 0.68 | 0.36 | 2(3) |
| $^{133}$Ba GL | 5.1(4) | 6.12(5) | –2.67 D | –2.72 D | –17(6) |
| $^{134}$Cs GL | 10.1(4) | 11.93(8) | –4.23 D | –3.49 D | –15(4) |
| $^{137}$Cs GL | 6.9(3) | 9.02(6) | –6.68 D | –4.55 D | –23(4) |
| $^{152}$Eu GL | 10.5(10) | 12.35(9) | –1.78 | –2.68 Q | –15(8) |

***Table B70 – Laboratory 105***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 27(3) | 8.19(3) | 6.75 D | 43.58 D | 23(4) × 10$^{1}$ |
| $^{60}$Co GL | 16.8(13) | 7.201(22) | 7.38 D | 28.88 D | 133(18) |
| $^{95}$Zr GL | 4.9(10) | 7.30(7) | –2.40 | –4.87 Q | –33(14) |
| $^{133}$Ba GL | 7.6(7) | 6.12(5) | 2.29 | 3.97 Q | 24(11) |
| $^{134}$Cs GL | 11.9(9) | 11.93(8) | –0.03 | –0.06 | 0(8) |
| $^{137}$Cs GL | 13.8(0) | 9.02(6) | –77.77 D | 10.29 D | 53.0(10) |
| $^{152}$Eu GL | 26.9(25) | 12.35(9) | 5.82 D | 21.40 D | 118(20) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | 6.06(0) | 5.529(20) | 26.50 Q | 2.38 | 9.6(4) |
| $^{60}$Co GH | 5.5(4) | 4.641(14) | 2.15 | 5.11 Q | 19(9) |
| $^{95}$Zr GH | 5.00(25) | 7.35(8) | –9.02 D | –8.16 D | –32(4) |
| $^{95}$Nb GH | 9.9(5) | 13.54(7) | –7.22 D | –5.46 D | –27(4) |
| $^{133}$Ba GH | 3.20(16) | 2.754(19) | 2.77 D | 3.58 D | 16(6) |
| $^{134}$Cs GH | 4.26(24) | 4.63(4) | –1.54 | –2.05 | –8(5) |
| $^{137}$Cs GH | 10.6(5) | 9.56(7) | 2.06 | 2.88 Q | 11(6) |
| $^{152}$Eu GH | 18.7(10) | 17.86(12) | 0.83 | 1.21 | 5(6) |
| $^{60}$Co C | 0.13(6) | 0.1045(14) | 0.43 | 4.64 Q | 2(6) × 10$^{1}$ |
| $^{133}$Ba C | 0.074(6) | 0.0070(3) | 11.15 D | 76.05 D | 95(9) × 10$^{1}$ |
| $^{152}$Eu C | 2.63(13) | 2.63(4) | –0.01 | –0.01 | 0(5) |
| $^{154}$Eu C | 0.11(6) Q | 0.1029(18) | 0.12 | 0.90 | 1(6) × 10$^{1}$ |

***Table B71 – Laboratory 106***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{226}$Ra AL | 5.3(3) | 4.71(6) | 1.92 | 1.80 | 12(7) |
| $^{234}$U AL | 15.6(7) | 14.6(14) | 0.65 | 1.12 | 7(11) |
| $^{235}$U AL | 0.84(11) | 0.680(3) | 1.45 | 1.80 | 24(16) |
| $^{238}$U AL | 16.3(8) | 14.76(4) | 1.92 | 1.73 | 10(6) |
| gross α AL | 51.0(14) | 92(8) | –4.99 D | –8.78 D | –44(5) |
| $^{22}$Na GL | 7.0(4) | 8.19(3) | –2.84 D | –2.69 D | –14(5) |
| $^{60}$Co GL | 6.8(4) | 7.201(22) | –1.17 | –1.24 | –6(5) |
| $^{95}$Zr GL | 6.5(7) | 7.30(7) | –1.15 | –1.55 | –10(9) |
| $^{95}$Nb GL | 25.7(16) | 13.46(7) | 7.60 D | 15.37 D | 91(12) |
| $^{133}$Ba GL | 6.1(5) | 6.12(5) | –0.14 | –0.16 | –1(7) |
| $^{134}$Cs GL | 12.1(5) | 11.93(8) | 0.27 | 0.27 | 1(5) |
| $^{137}$Cs GL | 9.1(6) | 9.02(6) | 0.17 | 0.21 | 1(7) |
| $^{152}$Eu GL | 12.2(7) | 12.35(9) | –0.24 | –0.23 | –1(5) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{226}$Ra AH | 5.4(3) | 4.77(6) | 2.07 | 1.66 | 13(7) |
| $^{234}$U AH | 11.1(5) | 11.1(10) | –0.04 | –0.10 | 0(10) |
| $^{235}$U AH | 0.66(8) | 0.5188(19) | 1.76 | 2.52 | 27(15) |
| $^{238}$U AH | 11.3(5) | 11.262(17) | 0.08 | 0.07 | 0(5) |
| gross α AH | 58.8(14) | 65(8) | –0.80 | –2.00 | –10(11) |
| $^{22}$Na GH | 4.21(17) | 5.529(20) | –7.71 D | –5.91 D | –24(3) |
| $^{60}$Co GH | 4.42(16) | 4.641(14) | –1.38 | –1.32 | –5(4) |
| $^{95}$Zr GH | 7.4(3) | 7.35(8) | 0.00 | 0.00 | 0(5) |
| $^{95}$Nb GH | 27.6(14) | 13.54(7) | 10.20 D | 21.12 D | 104(10) |
| $^{133}$Ba GH | 2.67(12) | 2.754(19) | –0.69 | –0.67 | –3(5) |
| $^{134}$Cs GH | 4.48(16) | 4.63(4) | –0.93 | –0.84 | –3(4) |
| $^{137}$Cs GH | 9.5(5) | 9.56(7) | –0.19 | –0.27 | –1(6) |
| $^{152}$Eu GH | 16.7(6) | 17.86(12) | –1.95 | –1.64 | –6(4) |
| $^{22}$Na C | 0.030(2) | – | – | – | – |
| $^{60}$Co C | 0.102(4) | 0.1045(14) | –0.58 | –0.45 | –2(4) |
| $^{152}$Eu C | 2.51(9) | 2.63(4) | –1.27 | –1.07 | –5(4) |

***Table B72 – Laboratory 107***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{234}$U AL | 13.0(8) | 14.6(14) | –1.05 | –1.87 | –11(10) |
| $^{235}$U AL | 0.57(7) | 0.680(3) | –1.57 | –1.23 | –16(10) |
| $^{238}$U AL | 13.1(8) | 14.76(4) | –2.06 | –1.84 | –11(6) |
| $^{238}$Pu AL | 11.1(6) | 11.86(4) | –1.27 | –1.16 | –7(5) |
| $^{239}$Pu AL | 9.7(6) | 10.19(5) | –0.97 | –0.89 | –5(6) |
| $^{241}$Am AL | 13.7(8) | 13.57(4) | 0.19 | 0.20 | 1(6) |
| $^{244}$Cm AL | 6.7(4) | 6.96(3) | –0.68 | –0.68 | –4(6) |
| gross α AL | 117(7) | 92(8) | 2.45 | 5.44 Q | 28(13) |
| $^{22}$Na GL | 7.5(3) | 8.19(3) | –2.53 | –1.58 | –8(4) |
| $^{60}$Co GL | 7.08(25) | 7.201(22) | –0.48 | –0.36 | –2(4) |
| $^{95}$Zr GL | 8.1(4) | 7.30(7) | 2.35 | 1.66 | 11(5) |
| $^{95}$Nb GL | 14.7(5) | 13.46(7) | 2.57 | 1.60 | 9(4) |
| $^{133}$Ba GL | 5.87(24) | 6.12(5) | –1.03 | –0.67 | –4(4) |
| $^{134}$Cs GL | 10.9(4) | 11.93(8) | –2.79 Q | –1.99 | –9(3) |
| $^{137}$Cs GL | 9.1(3) | 9.02(6) | 0.20 | 0.13 | 1(4) |
| $^{152}$Eu GL | 11.1(6) | 12.35(9) | –2.09 | –1.89 | –10(5) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B1 | 0.97(6) | 0.925(7) | 0.73 | 0.87 | 5(7) |
| $^{14}$C B1 | 0.71(5) | 0.702(5) | 0.06 | 0.07 | 0(7) |
| $^{99}$Tc B1 | 1.60(16) | 1.612(4) | –0.07 | –0.11 | –1(10) |
| $^{3}$H B2 | 0.51(4) | 0.487(4) | 0.67 | 1.06 | 5(7) |
| $^{55}$Fe B2 | 1.28(7) | 1.65(4) | –4.58 D | –3.35 D | –22(5) |
| $^{63}$Ni B2 | 0.70(6) | 0.596(24) | 1.58 | 2.96 Q | 18(11) |
| $^{90}$Sr B2 | 0.59(5) | 0.5712(11) | 0.45 | 0.55 | 4(9) |

***Table B73 – Laboratory 108***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | 5.02(23) | 5.529(20) | –2.21 | –2.28 | –9(4) |
| $^{60}$Co GH | 4.68(22) | 4.641(14) | 0.18 | 0.23 | 1(5) |
| $^{95}$Zr GH | 7.9(4) | 7.35(8) | 1.35 | 1.91 | 7(6) |
| $^{95}$Nb GH | 14.4(7) | 13.54(7) | 1.22 | 1.28 | 6(5) |
| $^{133}$Ba GH | 2.46(13) | 2.754(19) | –2.24 | –2.36 | –11(5) |
| $^{134}$Cs GH | 4.19(20) | 4.63(4) | –2.18 | –2.44 | –10(5) |
| $^{137}$Cs GH | 9.9(5) | 9.56(7) | 0.68 | 0.94 | 4(6) |
| $^{152}$Eu GH | 17.3(8) | 17.86(12) | –0.69 | –0.80 | –3(5) |

***Table B74 – Laboratory 109***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{226}$Ra AL | 4.20(7) | 4.71(6) | –5.47 Q | –1.57 | –10.9(19) |
| $^{234}$U AL | 15.60(6) | 14.6(14) | 0.73 | 1.12 | 7(10) |
| $^{235}$U AL | 0.707(25) | 0.680(3) | 1.07 | 0.30 | 4(4) |
| $^{238}$U AL | 15.1(5) | 14.76(4) | 0.67 | 0.38 | 2(4) |
| $^{237}$Np AL | 91.0(5) | 9.38(10) | 168.83 D | 84.10 D | 870(11) |
| $^{238}$Pu AL | 7.1(4) | 11.86(4) | –15.14 D | –7.14 D | –41(3) |
| $^{239}$Pu AL | 5.6(3) | 10.19(5) | –15.62 D | –7.81 D | –46(3) |
| $^{241}$Am AL X | 12.30(12) | 13.57(4) | –10.06 Q | –1.57 | –9.4(9) |
| $^{241}$Am AL A | 13.4(13) | 13.57(4) | –0.13 | –0.21 | –1(10) |
| $^{244}$Cm AL | 5.97(6) | 6.96(3) | –16.79 Q | –2.41 | –14.2(8) |
| $^{22}$Na GL | 7.3(3) | 8.19(3) | –3.08 Q | –2.14 | –11(4) |
| $^{60}$Co GL | 7.5(3) | 7.201(22) | 1.10 | 0.96 | 4(4) |
| $^{95}$Zr GL | 7.7(4) | 7.30(7) | 1.10 | 0.89 | 6(6) |
| $^{95}$Nb GL | 15.4(8) | 13.46(7) | 2.42 | 2.44 | 14(6) |
| $^{133}$Ba GL | 6.37(25) | 6.12(5) | 0.98 | 0.66 | 4(4) |
| $^{134}$Cs GL | 11.4(4) | 11.93(8) | –1.32 | –1.06 | –5(4) |
| $^{137}$Cs GL | 9.6(4) | 9.02(6) | 1.62 | 1.31 | 7(4) |
| $^{152}$Eu GL | 12.8(5) | 12.35(9) | 0.95 | 0.67 | 4(4) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{3}$H B2 | 0.54(3) | 0.487(4) | 1.76 | 2.54 | 11(6) |
| $^{90}$Sr B2 | 0.480(14) | 0.5712(11) | –6.49 Q | –2.19 | –16.0(25) |
| $^{3}$H C | 0.526(13) | 18(10) | –1.87 | –2.34 | –97.1(15) |
| $^{60}$Co C | 0.110(5) | 0.1045(14) | 1.07 | 1.01 | 5(5) |
| $^{133}$Ba C | 0.0070(7) | 0.0070(3) | –0.07 | –0.06 | –1(11) |
| $^{152}$Eu C | 2.68(11) | 2.63(4) | 0.42 | 0.43 | 2(5) |
| $^{154}$Eu C | 0.100(5) | 0.1029(18) | –0.54 | –0.36 | –3(5) |

***Table B75 – Laboratory 110***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 7.8(4) | 8.19(3) | –0.97 | –0.89 | –5(5) |
| $^{60}$Co GL | 7.4(4) | 7.201(22) | 0.50 | 0.60 | 3(6) |
| $^{95}$Zr GL | 7.8(4) | 7.30(7) | 1.22 | 1.01 | 7(6) |
| $^{95}$Nb GL | 13.4(10) | 13.46(7) | –0.06 | –0.07 | 0(8) |
| $^{133}$Ba GL | 6.0(3) | 6.12(5) | –0.40 | –0.32 | –2(5) |
| $^{134}$Cs GL | 11.8(6) | 11.93(8) | –0.22 | –0.25 | –1(5) |
| $^{137}$Cs GL | 9.2(5) | 9.02(6) | 0.35 | 0.38 | 2(6) |
| $^{152}$Eu GL | 12.8(10) | 12.35(9) | 0.45 | 0.67 | 4(8) |

***Table B76 – Laboratory 111***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| $^{22}$Na GL | 6.23(18) | 8.19(3) | –10.73 D | –4.51 D | –23.9(22) |
| $^{60}$Co GL | 6.34(21) | 7.201(22) | –4.08 D | –2.59 D | –12(3) |
| $^{95}$Zr GL | 5.94(20) | 7.30(7) | –6.40 D | –2.76 D | –19(3) |
| $^{95}$Nb GL | 19.7(6) | 13.46(7) | 11.47 D | 7.84 D | 46(4) |
| $^{133}$Ba GL | – | 6.12(5) | – | – | – |
| $^{134}$Cs GL | 9.7(3) | 11.93(8) | –7.96 D | –4.34 D | –18.9(23) |
| $^{137}$Cs GL | 8.49(24) | 9.02(6) | –2.15 | –1.14 | –6(3) |
| $^{152}$Eu GL | 4.60(13) | 12.35(9) | –50.01 D | –11.39 D | –62.7(11) |
| $^{210}$Pb GL | 7.3(6) | – | – | – | – |

***Table B77 – Laboratory 112***

| | Result | Assigned result | Zeta score | $z$-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| $^{22}$Na GH | – | 5.529(20) | – | – | – |
| $^{60}$Co GH | 5.5(14) | 4.641(14) | 0.65 | 5.35 Q | 2(3) × 10$^{1}$ |
| $^{95}$Zr GH | 8.6(22) | 7.35(8) | 0.58 | 4.30 Q | 2(3) × 10$^{1}$ |
| $^{95}$Nb GH | 15(4) | 13.54(7) | 0.49 | 2.84 Q | 1(3) × 10$^{1}$ |
| $^{133}$Ba GH | 3.4(9) | 2.754(19) | 0.77 | 5.35 Q | 2(3) × 10$^{1}$ |
| $^{134}$Cs GH | 5.9(15) | 4.63(4) | 0.86 | 6.97 Q | 3(4) × 10$^{1}$ |
| $^{137}$Cs GH | 9.9(25) Q | 9.56(7) | 0.15 | 1.03 | 0(3) × 10$^{1}$ |
| $^{152}$Eu GH | 16(4) Q | 17.86(12) | –0.37 | –2.16 | –8(23) |
| $^{154}$Eu GH | 18(5) | – | – | – | – |

***Table B78 – Laboratory 113***

| | Result | Assigned result | Zeta score | *z*-score | Deviation (%) |
|---|---|---|---|---|---|
| | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | | | |
| Gross a AL | 66(3) | 92(8) | –2.96 D | –5.49 D | –28(7) |
| | (Bq g$^{-1}$) | (Bq g$^{-1}$) | | | |
| Gross a AH | 53.0(21) | 65(8) | –1.47 | –3.76 Q | –19(11) |
| $^{3}$H B1 | 0.88(11) | 0.925(7) | –0.38 | –0.80 | –5(12) |
| $^{14}$C B1 | 1.60(8) | 0.702(5) | 11.63 D | 21.48 D | 128(11) |
| $^{3}$H B2 | 0.478(6) | 0.487(4) | –1.29 | –0.43 | –1.8(14) |
| Gross b B2 | 1.87(9) | 1.1423(23) | 8.39 D | 10.64 D | 64(8) |
| $^{22}$Na GH | 4.73(13) | 5.529(20) | –6.08 D | –3.58 D | –14.5(24) |
| $^{60}$Co GH | 3.90(11) | 4.641(14) | –6.68 D | –4.41 D | –16.0(24) |
| $^{95}$Zr GH | 6.16(16) | 7.35(8) | –6.76 D | –4.13 D | –16.2(23) |
| $^{95}$Nb GH | 11.3(5) | 13.54(7) | –5.09 D | –3.39 D | –17(4) |
| $^{133}$Ba GH | 1.98(7) | 2.754(19) | –10.66 D | –6.22 D | –28(3) |
| $^{134}$Cs GH | 3.6(4) | 4.63(4) | –2.99 D | –5.46 D | –21(7) |
| $^{137}$Cs GH | 7.90(22) | 9.56(7) | –7.23 D | –4.59 D | –17.4(24) |
| $^{152}$Eu GH | 14.3(4) | 17.86(12) | –8.76 D | –5.15 D | –20.0(23) |
| $^{60}$Co C | 0.114(6) | 0.1045(14) | 1.55 | 1.73 | 9(6) |
| $^{133}$Ba C | 0.0059(19) | 0.0070(3) | –0.60 | –1.30 | $-2(3) \times 10^{1}$ |
| $^{152}$Eu C | 2.9(1) | 2.63(4) | 2.55 | 2.36 | 10(4) |
| $^{154}$Eu C | 0.114(1) | 0.1029(18) | 1.10 | 1.40 | 11(10) |
| Gross b C | 1.23(6) | 1.2(8) | 0.08 | 0.10 | $1(8) \times 10^{1}$ |

# Appendix C. Source preparation

## C1 AL samples

A mixed radionuclide solution (B08059) was prepared by mixing standardised solutions of the individual nuclides (Table C1). The chemical form of the AL samples was 2.0 M $HNO_3$.

**Table C1 – Starting material B08059**

| Nuclide | Source identifier | Activity conc. (kBq $g^{-1}$) | Gravimetric Dilution Factor AL GDF1 | B08059 Act. conc. (kBq $g^{-1}$) |
|---|---|---|---|---|
| $^{226}$Ra | A07050 | 10.59(14) | 82.845(25) | 0.1278(17) |
| $^{237}$Np | A07051 | 9.11(9) | 35.805(7) | 0.2544(25) |
| $^{234}$U | X08135 | 0.99(9) | 2.50403(10) | 0.40(4) |
| $^{235}$U | X08135 | 0.04618(17) | 2.50403(10) | 0.01844(7) |
| $^{238}$U | X08135 | 1.0024(15) | 2.50403(10) | 0.4003(6) |
| $^{238}$Pu | A07053 | 17.25(5) | 53.646(17) | 0.3216(10) |
| $^{239}$Pu | A08155 | 19.88(9) | 72.40(3) | 0.2747(12) |
| $^{240}$Pu* | A08155 | 0.087 | 72.40(3) | 0.0012 |
| $^{241}$Pu* | A08155 | 0.11 | 72.40(3) | 0.0015 |
| $^{241}$Am | A07055 | 10.006(18) | 27.1858(22) | 0.3681(7) |
| $^{244}$Cm | A07056 | 13.58(4) | 71.98(8) | 0.1887(6) |
| $^{240}$Pu* | A07056 | 0.028 | 71.98(8) | 0.00039 |

The B08059 solution was diluted three times to produce the AL sample in B08093 (Table C2). All dilutions were validated using liquid scintillation counting counting (see Appendix D). In total, 20.443 kg of AL sample was produced.

**Table C2 – Preparation of solution for AL source B08093**

| Nuclide | Gravimetric Dilution Factor AL GDF2 | Gravimetric Dilution Factor AL GDF3 | Gravimetric Dilution Factor AL GDF4 | B08093 Act. conc. (Bq $kg^{-1}$) |
|---|---|---|---|---|
| $^{226}$Ra | 30.08(5) | 30.009(4) | 30.042(4) | 4.71(6) |
| $^{237}$Np | 30.08(5) | 30.009(4) | 30.042(4) | 9.38(10) |
| $^{234}$U | 30.08(5) | 30.009(4) | 30.042(4) | 14.6(14) |
| $^{235}$U | 30.08(5) | 30.009(4) | 30.042(4) | 0.680(3) |
| $^{238}$U | 30.08(5) | 30.009(4) | 30.042(4) | 14.76(4) |
| $^{238}$Pu | 30.08(5) | 30.009(4) | 30.042(4) | 11.86(4) |
| $^{239}$Pu | 30.08(5) | 30.009(4) | 30.042(4) | 10.13(5) |
| $^{240}$Pu* | 30.08(5) | 30.009(4) | 30.042(4) | 0.059 |
| $^{241}$Pu* | 30.08(5) | 30.009(4) | 30.042(4) | 0.056 |
| $^{241}$Am | 30.08(5) | 30.009(4) | 30.042(4) | 13.57(4) |
| $^{244}$Cm | 30.08(5) | 30.009(4) | 30.042(4) | 6.96(3) |
| gross alpha | – | – | – | 92(8) |

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 33% of the $^{226}$Ra activity concentration, which based on the time elapsed since the last purification of the $^{226}$Ra starting material) and the $^{222}$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.

## C2 AH samples

A mixed radionuclide solution (B08060) was prepared by mixing standardised solutions of the individual nuclides (Table C3). The chemical form of the AH samples was 2.0 M $HNO_3$.

**Table C3 – Starting material B08060**

| Nuclide | Source identifier | Activity conc. (kBq $g^{-1}$) | Gravimetric Dilution Factor AH GDF1 | B08060 Act. conc. (kBq $g^{-1}$) |
|---|---|---|---|---|
| $^{226}$Ra | A07050 | 10.59(14) | 74.017(22) | 0.1431(19) |
| $^{237}$Np | A07051 | 9.11(9) | 94.99(6) | 0.0959(10) |
| $^{234}$U | X08135 | 0.99(9) | 2.96531(25) | 0.33(3) |
| $^{235}$U | X08135 | 0.04618(17) | 2.96531(25) | 0.01557(6) |
| $^{238}$U | X08135 | 1.0024(15) | 2.96531(25) | 0.3380(5) |
| $^{238}$Pu | A07053 | 17.25(5) | 98.98(6) | 0.1743(6) |
| $^{239}$Pu | A08155 | 19.88(9) | 43.182(5) | 0.4605(20) |
| $^{240}$Pu* | A08155 | 0.087 | 43.182(5) | 0.0020 |
| $^{241}$Pu* | A08155 | 0.11 | 43.182(5) | 0.0025 |
| $^{241}$Am | A07055 | 10.006(18) | 98.96(9) | 0.10112(20) |
| $^{244}$Cm | A07056 | 13.58(4) | 96.11(3) | 0.1413(5) |
| $^{240}$Pu* | A07056 | 0.028 | 96.11(3) | 0.00029 |

The B08060 solution was diluted once to produce the AH sample in B08062 (Table C4). The dilution was validated using liquid scintillation counting (see Appendix D). In total, 0.600 kg of AH sample was produced.

**Table C4 – Preparation of solution for AH source B08062**

| Nuclide | Gravimetric Dilution Factor AH GDF2 | B08062 Act. conc. (Bq $g^{-1}$) |
|---|---|---|
| $^{226}$Ra | 30.017(6) | 4.77(6) |
| $^{237}$Np | 30.017(6) | 3.20(4) |
| $^{234}$U | 30.017(6) | 11.1(10) |
| $^{235}$U | 30.017(6) | 0.5188(19) |
| $^{238}$U | 30.017(6) | 11.262(17) |
| $^{238}$Pu | 30.017(6) | 5.807(18) |
| $^{239}$Pu | 30.017(6) | 15.34(7) |
| $^{240}$Pu* | 30.017(6) | 0.077 |
| $^{241}$Pu* | 30.017(6) | 0.084 |
| $^{241}$Am | 30.017(6) | 3.369(7) |
| $^{244}$Cm | 30.017(6) | 4.708(14) |
| gross alpha | – | 65(8) |

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 33% of the $^{226}$Ra activity concentration, which based on the time elapsed since the last purification of the $^{226}$Ra starting material) and the $^{222}$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 (B08135) was prepared by mixing standardised solutions of the individual nuclides (Table C5). The chemical form of the B1 samples was 0.0016 M NaOH containing 0.0066 mg g$^{-1}$ C as carbonate.

**Table C5 – Starting material B08135**

| Nuclide | Source identifier | Activity conc. (kBq g$^{-1}$) | Gravimetric Dilution Factor GDF1 | B08135 Act. conc. (kBq g$^{-1}$) |
|---|---|---|---|---|
| $^{3}$H | A08006 | 4.87(4) | 48.900(16) | 0.0996(7) |
| $^{14}$C | A07200 | 1.898(11) | 25.1482(10) | 0.0755(5) |
| $^{99}$Tc | A08186 | 18.33(4) | 105.8175(18) | 0.1732(4) |

The solution in B08135 was diluted once to produce the B1 sample in B08137 (Table C6). The dilutions were validated using liquid scintillation counting (see Appendix D). In total, 21.010 kg of B1 sample was produced.

**Table C6 – Preparation of solution for B1 source B08137**

| Nuclide | Gravimetric Dilution Factor B1 GDF2 | B08137 Act. conc. (Bq g$^{-1}$) |
|---|---|---|
| $^{3}$H | 107.61(4) | 0.925(7) |
| $^{14}$C | 107.49(4) | 0.702(5) |
| $^{99}$Tc | 107.49(4) | 1.612(4) |

## C4 B2 samples

A mixed radionuclide solution (B08136) was prepared by mixing standardised solutions of the individual nuclides (Table C7). The chemical form of the B2 samples was 0.12 M HCl (containing 0.0134 mg g$^{-1}$ Fe, 0.0150 mg g$^{-1}$ Ni and 0.0135 mg g$^{-1}$ Sr).

**Table C7 – Starting material B08136**

| Nuclide | Source identifier | Activity conc. (kBq g$^{-1}$) | Gravimetric Dilution Factor B2 GDF1 | B08136 Act. conc. (kBq g$^{-1}$) |
|---|---|---|---|---|
| $^{3}$H | A08006 | 4.87(4) | 6.3125(12) | 0.771(6) |
| $^{55}$Fe | A05671 | 252(6) | 96.81(9) | 2.60(6) |
| $^{63}$Ni | A07196 | 38.6(15) | 40.999(9) | 0.94(4) |
| $^{90}$Sr | A07399 | 38.74(8) | 42.919(7) | 0.9027(17) |

The B08136 solution was diluted twice to produce the B2 sample in B08181 (Table C8). All dilutions were validated using Cerenkov counting (see Appendix D). In total, 21.410 kg of BL sample was produced.

**Table C8 – Preparation of solution for B2 source B08181**

| Nuclide | Gravimetric Dilution Factor B2 GDF2 | Gravimetric Dilution Factor B2 GDF3 | B08181 Act. conc. (Bq g$^{-1}$) |
|---|---|---|---|
| $^{3}$H | 23.089(4) | 68.62(4) | 0.487(4) |
| $^{55}$Fe | 23.076(4) | 68.49(4) | 1.65(4) |
| $^{63}$Ni | 23.076(4) | 68.49(4) | 0.596(24) |
| $^{90}$Sr | 23.076(4) | 68.49(4) | 0.5712(11) |
| gross beta ISO 9697 | – | – | 1.1423(23) |
| gross beta LSC | – | – | 2.5(5) |

The gross beta activity concentration for methods following ISO 9697:1992 (gas-flow proportional counting; non-volatile beta emmitters with beta max energies > 0.3 MeV) was calculated by combining of the activity concentrations $^{90}$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 of the activity concentrations $^{90}$Sr plus the $^{90}$Y contribution (estimated as 100% of the $^{90}$Sr activity concentration) and 50% of the $^{3}$H, $^{55}$Fe and $^{63}$Ni activity concentrations. In this case, the activity concentration uncertainty is dominated by the uncertainty of the $^{3}$H, $^{55}$Fe and $^{63}$Ni activity concentrations.

## C6 GL samples

A mixed radionuclide solution (B08224) was prepared by mixing and diluting standardised solutions of the individual nuclides (Table C9). The chemical form of the GL samples was 2.4 M HCl / 0.5 mM oxalic acid containing 0.031 mg g$^{-1}$ Ba, 0.029 mg g$^{-1}$ Co, 0.028 mg g$^{-1}$ Cs, 0.038 mg g$^{-1}$ Eu, 0.030 mg g$^{-1}$ Na and 0.025 mg g$^{-1}$ Zr. The dilutions were validated using gamma-ray spectrometry (see Appendix D).

**Table C9 – Starting material B08224**

| Nuclide | Source identifier | Activity conc. (kBq $g^{-1}$) | Gravimetric Dilution Factor GL GDF1 | B08224 Act. conc. (kBq $g^{-1}$) |
|---|---|---|---|---|
| $^{22}$Na | A08191 | 98.8(4) | 43.252(6) | 2.284(8) |
| $^{60}$Co | A051176 | 161.1(5) | 80.192(22) | 2.008(6) |
| $^{95}$Zr | A08187 | 194.6(19) | 95.52(4) | 2.037(20) |
| $^{95}$Nb | A08187 | 358.5(18) | 95.52(4) | 3.753(19) |
| $^{133}$Ba | A07624 | 24.78(17) | 14.5143(6) | 1.707(12) |
| $^{134}$Cs | A08072 | 314.9(22) | 94.64(3) | 3.328(23) |
| $^{137}$Cs | A08139 | 230.8(16) | 91.739(23) | 2.516(17) |
| $^{152}$Eu | A06413 | 256.0(17) | 74.339(11) | 3.443(23) |

The solution in B08224 was diluted three times to produce the GL sample in B08293 (Table C10). All dilutions were validated using gamma-ray spectrometry (see Appendix D). In total, 33.797 kg of GL sample was produced.

**Table C10 – Preparation of solution for GL source B08293**

| Nuclide | Gravimetric Dilution Factor GL GDF2 | Gravimetric Dilution Factor GL GDF3 | Gravimetric Dilution Factor GL GDF4 | B08293 Act. conc. (Bq $kg^{-1}$) |
|---|---|---|---|---|
| $^{22}$Na | 64.62(7) | 64.823(21) | 66.586(18) | 8.19(3) |
| $^{60}$Co | 64.62(7) | 64.823(21) | 66.586(18) | 7.201(22) |
| $^{95}$Zr | 64.62(7) | 64.823(21) | 66.586(18) | 7.30(7) |
| $^{95}$Nb | 64.62(7) | 64.823(21) | 66.586(18) | 13.46(7) |
| $^{133}$Ba | 64.62(7) | 64.823(21) | 66.586(18) | 6.12(5) |
| $^{134}$Cs | 64.62(7) | 64.823(21) | 66.586(18) | 11.93(8) |
| $^{137}$Cs | 64.62(7) | 64.823(21) | 66.586(18) | 9.02(6) |
| $^{152}$Eu | 64.62(7) | 64.823(21) | 66.586(18) | 12.35(9) |

## C7 GH samples

A mixed radionuclide solution (B08225) was prepared by mixing and diluting standardised solutions of the individual nuclides (Table C11). The chemical form of the GH samples was 2.4 M HCl / 0.5 mM oxalic acid containing 0.031 mg $g^{-1}$ Ba, 0.029 mg $g^{-1}$ Co, 0.028 mg $g^{-1}$ Cs, 0.038 mg $g^{-1}$ Eu, 0.030 mg $g^{-1}$ Na and 0.025 mg $g^{-1}$ Zr. The dilutions were validated using gamma-ray spectrometry (see Appendix D).

**Table C11 – Starting material B08225**

| Nuclide | Source identifier | Activity conc. (kBq $g^{-1}$) | Gravimetric Dilution Factor GDF1 | B08225 Act. conc. (kBq $g^{-1}$) |
|---|---|---|---|---|
| $^{22}$Na | A08191 | 98.8(4) | 19.8125(18) | 4.985(18) |
| $^{60}$Co | A051176 | 161.1(5) | 38.490(6) | 4.184(13) |
| $^{95}$Zr | A08187 | 194.6(19) | 29.357(7) | 6.63(7) |
| $^{95}$Nb | A08187 | 358.5(18) | 29.357(7) | 12.21(6) |
| $^{133}$Ba | A07624 | 24.78(17) | 9.9789(7) | 2.483(17) |
| $^{134}$Cs | A08072 | 314.9(22) | 75.40(3) | 4.18(3) |
| $^{137}$Cs | A08139 | 230.8(16) | 26.785(4) | 8.62(6) |
| $^{152}$Eu | A06413 | 256.0(17) | 15.8974(12) | 16.10(11) |

The solution in B08225 was diluted twice to produce the GH sample in B08227 (Table C12). The dilutions were validated using gamma-ray spectrometry (see Appendix D). In total, 5.425 kg of GH sample was produced.

**Table C12 – Preparation of solution for GH source B08227**

| Nuclide | Gravimetric Dilution Factor GH GDF2 | Gravimetric Dilution Factor GH GDF3 | B08227 Act. conc. (Bq $g^{-1}$) |
|---|---|---|---|
| $^{22}$Na | 30.017(5) | 30.036(12) | 5.529(20) |
| $^{60}$Co | 30.017(5) | 30.036(12) | 4.641(14) |
| $^{95}$Zr | 30.017(5) | 30.036(12) | 7.35(8) |
| $^{95}$Nb | 30.017(5) | 30.036(12) | 13.54(7) |
| $^{133}$Ba | 30.017(5) | 30.036(12) | 2.754(19) |
| $^{134}$Cs | 30.017(5) | 30.036(12) | 4.63(4) |
| $^{137}$Cs | 30.017(5) | 30.036(12) | 9.56(7) |
| $^{152}$Eu | 30.017(5) | 30.036(12) | 17.86(12) |

## C8 C samples

The concrete samples originate from samples taken from a concrete bioshield of a decommissioned nuclear reactor which ceased operation ~25 years ago after ~20 years of operation. The concrete was thought to contain the following nuclides formed by neutron activation of concrete components: $^{3}H$, $^{14}C$, $^{36}Cl$, $^{41}Ca$, $^{55}Fe$, $^{60}Co$, $^{63}Ni$, $^{133}Ba$, $^{152}Eu$ and $^{154}Eu$.

The concrete core samples were crushed, mixed and sieved to <0.25 mm to form a homogeneous sample (~6.3 kg). The resulting powder was then heated overnight to 150 ºC to remove some of the tritium present in the sample as mobile tritiated water. Subsequently, 62 samples (100 g each) were prepared. All samples were tested with gamma spectrometry for homogeneity (see Table C13 and C14 and Figures 70A-D). Stability tests indicated that the concrete powder was slightly hydroscopic (an uncertainty component of 1.0% was included in the relative uncertainty of the assigned value $u_{N,rel}$).

One sample was analysed for its elemental composition with instrumental neutron activation analysis. In total, 36 elements were detected. Three elements (Al, Ca and Si) were found to be present at levels of at least 1% by weight. Eight elements, including Ba [192(12) ppm] and Fe [0.680(8) wt%], were found to be present at levels between 100 ppm and 1% by weight. Seventeen elements, including Co [2.70(6) ppm), were found to be present at levels between 1 ppm and 100 ppm. Eight elements, including Eu [0.372(11) ppm], were found to be present at levels lower than 1 ppm. Nickel was not detected and it is likely to be present at levels below its detection limit (72 ppm). More information can be found in Appendix E.

**Table C13 – Homogeneity tests (samples despatched)**

| Nuclide | $u_{bb}$ (%) | $u_{meas}$ (%) | $u_{int}$ (%) | $u_{hom}$ (%) | $u_{cons}$ (%) | $u_{N,rel}$ (%) |
|---|---|---|---|---|---|---|
| $^{60}Co$ | 1.98 | 2.55* | 2.21 | 0 | 0.86 | 1.32 |
| $^{133}Ba$ | 15.6 | 18.9* | 14.6 | 0 | 3.51 | 3.65 |
| $^{152}Eu$ | 1.77 | 3.17* | 1.04 | 0 | 0.76 | 1.25 |
| $^{154}Eu$ | 4.05 | 2.71 | 4.09* | 0 | 1.41 | 1.73 |

* value used to estimate homogeneity uncertainty (see Section 2.8)

**Table C14 – Assigned values C samples**

| **Nuclide** | ***n*** | **WM LCS** | **LCS (%)** | **Robust mean** | **Assigned value *N*** |
|---|---|---|---|---|---|
| | | Bq $g^{-1}$ | | Bq $g^{-1}$ | Bq $g^{-1}$ |
| $^{3}H$ total **(C)** | 14 | 24.3(8) | 43 | 18(10) | 18(10) |
| $^{3}H$ leachable | 5 | 2.87(7) | 40 | 3(4) | 3(4) |
| $^{14}C$ | 12 | 0.0495(25) | 42 | 0.06(5) | 0.06(5) |
| $^{40}K$ | 7 | 0.160(8) | 57 | 0.18(8) | 0.18(8) |
| $^{55}Fe$ | 5 | 0.055(5) | 80 | 0.066(22) | 0.055(5) |
| $^{60}Co$ | 31 | 0.1045(9) | 87 | 0.108(11) | 0.1045(14) |
| $^{63}Ni$ | 6 | 0.026(4) | 50 | 0.04(3) | 0.04(3) |
| $^{133}Ba$ | 15 | 0.00704(25) | 87 | 0.0074(15) | 0.0070(3) |
| $^{152}Eu$ | 31 | 2.631(20) | 84 | 2.59(21) | 2.63(4) |
| $^{154}Eu$ | 28 | 0.1029(14) | 79 | 0.106(18) | 0.1029(18) |
| gross beta | 6 | 1.29(3) | 60 | 1.2(8) | 1.2(8) |

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**Table C15 – Various estimators based on the participants' results**

| Nuclide | MM-mode | MM-median | Robust mean | WM LCS |
|---|---|---|---|---|
| | Bq g$^{-1}$ | Bq g$^{-1}$ | Bq g$^{-1}$ | Bq g$^{-1}$ |
| $^{60}$Co | 0.10406 | 0.10625 | 0.108(11) | 0.1045(9) |
| $^{133}$Ba | 0.00695 | 0.00724 | 0.0074(15) | 0.00704(25) |
| $^{152}$Eu | 2.6235 | 2.5890 | 2.59(21) | 2.631(20) |
| $^{154}$Eu | 0.0950 | 0.1031 | 0.106(18) | 0.1029(14) |

**Table C16 – Standard deviations for proficiency assessment and relative uncertainty outliers**

| Nuclide | Number of results | Median relative uncertainty $R_{\mathrm{med}}$ (%) | Robust standard deviation (%) | $\sigma_{\mathrm{p}}$ (%) | Number of unc. outliers | Outlier limit $R_{\mathrm{lim}}$ (%) |
|---|---|---|---|---|---|---|
| $^{3}$H total (C) | 14 | 5.6 | 41.5 | 41.5 | 0 | 41.3 |
| $^{3}$H leach | 5 | 4.0 | 102 | 102 | – | – |
| $^{14}$C | 12 | 14.4 | 58.0 | 58.0 | 0 | 53.9 |
| $^{40}$K | 7 | 8.5 | 33.0 | 33.0 | 0 | 39.4 |
| $^{55}$Fe | 5 | 14.0 | 33.6 | 14.0 | – | – |
| $^{60}$Co | 31 | 5.3 | 10.1 | 5.3 | 2 | 24.9 |
| $^{63}$Ni | 6 | 15.0 | 52.8 | 52.8 | – | – |
| $^{133}$Ba | 15 | 12.5 | 21.0 | 12.5 | 0 | 54.5 |
| $^{152}$Eu | 31 | 4.3 | 8.3 | 4.3 | 0 | 19.8 |
| $^{154}$Eu | 28 | 7.7 | 16.9 | 7.7 | 2 | 36.5 |
| gross beta | 6 | 4.4 | 55.7 | 55.7 | – | – |

## Appendix D. Dilution checks

**Table D1 – Dilution checks AL and AH samples**

| | AL | AH |
|---|---|---|
| GDF2 vs. RDF2 | 30.08(5) vs. 30.09(3) | 30.017(6) vs. 29.96(5) |
| zeta score DF2 | **–0.18** | **1.19** |
| GDF3 vs. RDF3 | 30.009(4) vs. 29.99(3) | – |
| zeta score DF3 | **0.71** | **–** |
| GDF4 vs. RDF4 | 30.042(4) vs. 30.0(4) | – |
| zeta score DF4 | **0.21** | **–** |

**Table D2 – Dilution checks B1 and B2 samples**

| | B1 | B2 |
|---|---|---|
| GDF2 vs. RDF2 | 107.49(4) vs. 108.0(4) | 23.076(4) vs. 23.17(9) |
| zeta score DF2 | **–1.49** | **–1.10** |
| GDF2 vs. RDF2 ($^3$H) | 107.61(4) vs. 108.0(4) | 23.089(4) vs. 23.17(9) |
| zeta score DF2 ($^3$H) | **–1.12** | **–0.94** |
| GDF3 vs. RDF3 | – | 68.49(4) vs. 68.8(3) |
| zeta score DF3 | **–** | **–0.90** |
| GDF3 vs. RDF3 ($^3$H) | – | 68.62(4) vs. 68.8(3) |
| zeta score DF3 ($^3$H) | **–** | **–0.48** |

**Table D3 – Dilution checks GL and GH samples**

| | GL | GH |
|---|---|---|
| GDF2 vs. RDF2 | 64.62(7) vs. 64.56(13) | 30.017(5) vs. 30.055(25) |
| zeta score DF2 | **–0.37** | **–1.53** |
| GDF3 vs. RDF3 | 64.823(21) vs. 65.7(8) | 30.036(12) vs. 30.13(10) |
| zeta score DF3 | **1.01** | **–0.92** |
| GDF4 vs. RDF4s | 66.586(18) vs. 63.8(14) to 69(4) | – |
| zeta scores DF4 | **–1.30 < zeta < 0.61** | **–** |

## Appendix E. Elemental Composition of the concrete C samples

| Major components | (% by weight) |
|---|---|
| Al | 1.150(23) |
| Ca | 28.7(4) |
| Si | 11(4) |

| Minor components | (% by weight) |
|---|---|
| Ba | 0.0160(16) |
| Fe | 0.649(7) |
| K | 0.544(6) |
| Mg | 0.44(3) |
| Mn | 0.0546(11) |
| Na | 0.2180(22) |
| Sr | 0.072(7) |
| Ti | 0.061(6) |

| Trace components | (ppm) |
|---|---|
| As | 2.46(8) |
| Br | 1.04(7) |
| Ce | 12.5(5) |
| Co | 2.52(8) |
| Cr | 20.1(6) |
| Cs | 1.19(7) |
| Dy | 1.3(3) |
| Ga | 3.4(4) |
| Hf | 1.21(5) |
| La | 7.62(8) |
| Nd | 7.1(14) |
| Rb | 16.0(14) |
| Sc | 2.090(25) |
| Sm | 1.32(3) |
| Th | 1.40(4) |
| U | 1.70(20) |
| V | 17.7(6) |
| W | 1.18(7) |
| Zn | 17.0(19) |

| Ultra trace components | (ppm) |
|---|---|
| Eu | 0.378(11) |
| Lu | 0.077(7) |
| Sb | 0.52(4) |
| Tb | 0.170(22) |
| Yb | 0.59(3) |

The following elements were not detected and their concentration is likely to be lower than the stated detection limit

| | (ppm) |
|---|---|
| Ag | < 1.3 |
| Au | < 0.0052 |
| Cd | < 4.9 |
| Cl | < 76 |
| Cu | < 49 |
| Er | < 80 |
| In | < 0.089 |
| Ir | < 0.0036 |
| Mo | < 3.9 |
| Ni | < 150 |
| Pd | < 120 |
| Se | < 2.0 |
| Ta | < 0.22 |
| Zr | < 120 |

## Appendix F. Sample details

| Lab code | AL | AH | B1 | B2 | GL | GH | C | Date results received |
|---|---|---|---|---|---|---|---|---|
| 1 | | x | x | x | | | | 1 December 2008 |
| 4 | x | | x | | x | x | x | 28 November 2008 |
| 5 | x | | x | x | x | x | x | 18 December 2008 |
| 7 | | x | x | x | | x | x | 3 December 2008 |
| 8 | x | x | x | x | x | x | x | 1 December 2008 |
| 11 | | | | | | x | | 2 December 2008 |
| 13 | x | | x | x | | x | | 26 November 2008 |
| 14 | | x | | x | | x | x | 15 December 2008 |
| 15 | | | | | x | x | | 1 December 2008 |
| 16 | | | x | x | | x | | 28 November 2008 |
| 17 | x | x | | | x | x | x | 16 December 2008 |
| 18 | | | | | x | x | | 28 November 2008 |
| 19 | x | | | x | x | | | 12 December 2008 |
| 20 | | | x | | | x | | 25 November 2008 |
| 21 | | x | x | x | x | x | x | 2 January 2009 |
| 23 | | | | | x | | | 21 November 2008 |
| 24 | | | | | x | x | x | 30 November 2008 |
| 25 | x | | x | x | x | x | | 1 December 2008 |
| 26 | x | | | x | x | | | 9 December 2008 |
| 27 | | | | | x | x | | 24 November 2008 |
| 28 | x | x | x | x | x | x | x | 1 December 2008 |
| 29 | x | | | x | x | x | x | 25 November 2008 |
| 31 | x | x | | x | x | x | x | 9 January 2009 |
| 32 | | x | x | x | | x | x | 16 December 2008 |
| 33 | | | | | x | | | 14 January 2009 |
| 35 | x | x | x | x | x | x | x | 17 December 2008 |
| 38 | | x | x | x | | x | x | 15 December 2008 |
| 40 | x | | | x | x | | | 27 November 2008 |
| 41 | | x | | x | x | | | 28 November 2008 |
| 42 | x | | | | x | | | 26 November 2008 |
| 43 | | | | | | x | | 24 October 2008 |
| 44 | | | | | x | | | 1 December 2008 |
| 45 | | | | | x | | | 20 November 2008 |
| 46 | | | | | x | x | | 27 November 2008 |
| 47 | x | x | | | x | x | | 28 November 2008 |
| 48 | | | x | | x | | x | 24 November 2008 |
| 51 | | | | | x | | | 1 December 2008 |
| 52 | | | | | x | x | x | 1 December 2008 |
| 53 | | | | | x | | | 26 November 2008 |
| 54 | | | | | x | x | x | 1 December 2008 |
| 55 | | x | x | x | | x | x | 1 December 2008 |
| 56 | | | | x | | | | 1 December 2008 |
| 59 | x | | x | x | x | | | 12 December 2008 |
| 62 | | | | | x | | | 25 November 2008 |
| 65 | x | | x | x | | | x | 11 December 2008 |
| 68 | | | | | x | x | x | 27 November 2008 |
| 72 | | | x | | x | | | 19 November 2008 |
| 74 | | | x | x | | x | x | 2 December 2008 |
| 76 | | | | | x | | | 25 November 2008 |

| Lab code | AL | AH | B1 | B2 | GL | GH | C | Date results received |
|---|---|---|---|---|---|---|---|---|
| 77 | x | | | | | x | | 12 December 2008 |
| 78 | | | | | | | x | 1 December 2008 |
| 81 | x | | | | x | | x | 1 December 2008 |
| 82 | | | | | x | x | | 28 November 2008 |
| 83 | | | x | | x | x | | 1 December 2008 |
| 88 | | | | | x | x | x | 1 December 2008 |
| 89 | | | x | | x | x | | 20 November 2008 |
| 90 | | | | | x | x | | 27 November 2008 |
| 91 | x | | | x | x | | | 15 December 2008 |
| 92 | | | | x | x | | | 1 December 2008 |
| 93 | | | | | | x | | 4 January 2009 |
| 94 | | | x | x | x | | x | 1 December 2008 |
| 95 | | | x | | x | | x | 24 November 2008 |
| 96 | | | x | | x | x | x | 15 December 2008 |
| 97 | | | | | x | | x | 25 November 2008 |
| 98 | | | | | x | x | | 1 December 2008 |
| 101 | x | | | | | | | 15 January 2009 |
| 102 | | | x | x | | | | 17 November 2008 |
| 103 | | | x | | | | | 4 November 2008 |
| 104 | | | | | x | | | 1 December 2008 |
| 105 | | | | | x | x | x | 8 December 2008 |
| 106 | x | x | | | x | x | x | 28 November 2008 |
| 107 | x | | x | x | x | | | 26 November 2008 |
| 108 | | | | | | x | | 23 December 2008 |
| 109 | x | | | x | x | | x | 27 November 2008 |
| 110 | | | | | x | | | 7 January 2009 |
| 111 | | | | | x | | | 1 December 2008 |
| 112 | | | | | | x | | 25 November 2008 |
| 113 | x | x | x | x | | x | x | 16 December 2008 |
| Total | **25** | **16** | **29** | **31** | **55** | **44** | **32** | **232** |

## Appendix G. Example Kiri plot

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

**Figure G1. Deviation plot example**

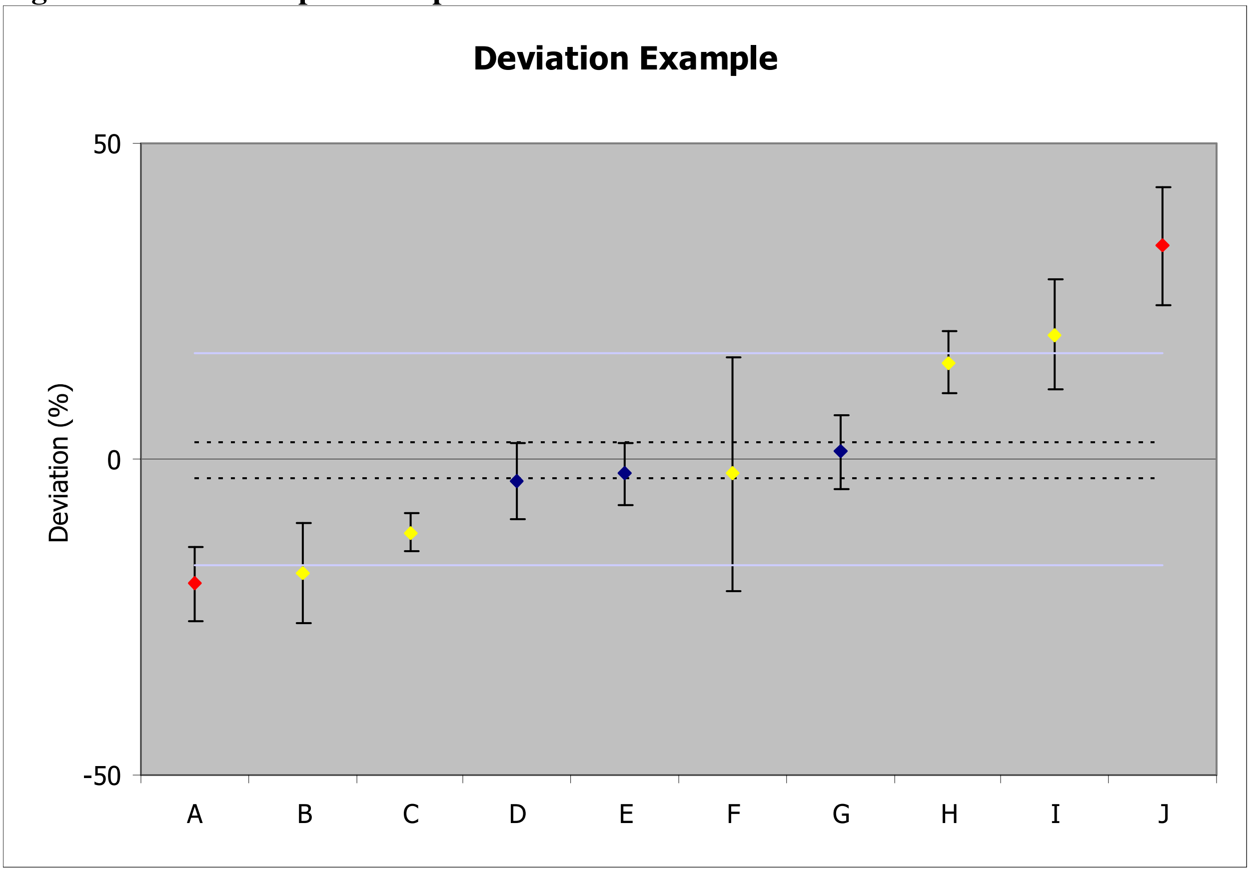


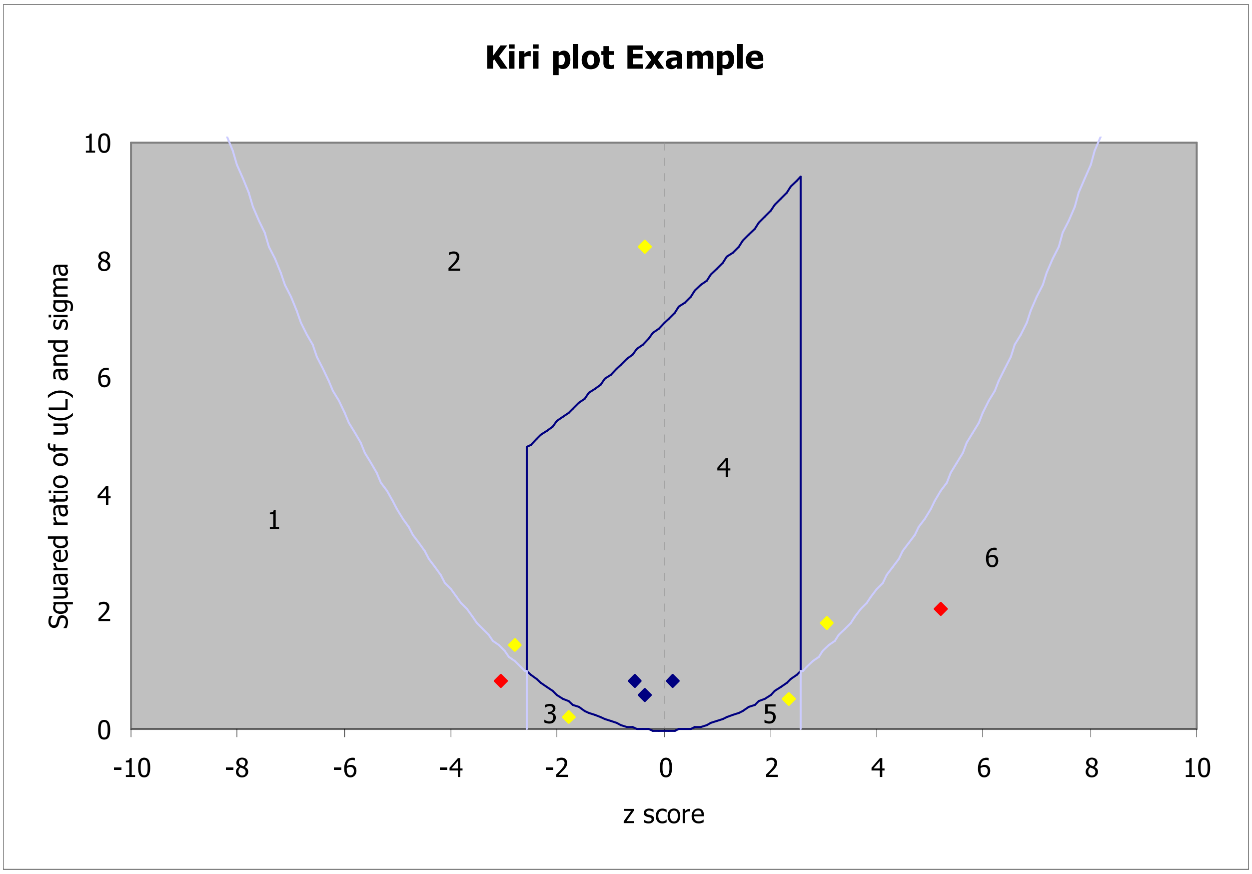

**Table G1 – Data classification**

| 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 will have a z score of 0 and ratio 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 test 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 G2 is shown below.

**Figure G2. 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 H. 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.

**Table H1 – Relative uncertainty outliers**

| Nuclide | Laboratory | Relative uncertainty (%) | Critical value (%) |
|---|---|---|---|
| $^{234}$U AL | 77* | 14.3 | 12.4 |
| $^{235}$U AL | 40* | 126 | 40.1 |
| $^{238}$Pu AL | 77 | 16.9 | 16.1 |
| $^{239}$Pu AL | 77 | 17.4 | 15.2 |
| $^{235}$U AH | 1* | 107 | 42.7 |
| $^{238}$U AH | 1* | 31.4 | 17.6 |
| $^{90}$Sr B2 | 26* | 28.0 | 26.3 |
| $^{22}$Na GL | 27* | 24.5 | 23.5 |
| $^{60}$Co GL | 17* | 20.4 | 20.2 |
| | 27* | 25.1 | 20.2 |
| $^{95}$Zr GL | 27 | 28.9 | 27.0 |
| | 17* | 30.0 | 27.0 |
| $^{95}$Nb GL | 92 | 31.1 | 25.6 |
| $^{133}$Ba GL | 27* | 26.8 | 21.8 |
| | 33 | 33.4 | 21.8 |
| | 17* | 38.7 | 21.8 |
| $^{137}$Cs GL | 27* | 23.1 | 21.0 |
| $^{22}$Na GH | 4* | 17.2 | 13.0 |
| | 27* | 21.1 | 13.0 |
| $^{60}$Co GH | 27* | 20.9 | 17.1 |
| | 112 | 25.1 | 17.1 |

continues

| continued | | | |
|---|---|---|---|
| $^{95}$Zr GH | 4* | 17.3 | 14.0 |
| | 27 | 21.1 | 14.0 |
| | 112 | 25.0 | 14.0 |
| $^{95}$Nb GH | 112 | 25.0 | 21.7 |
| | 7 | 30.7 | 21.7 |
| $^{133}$Ba GH | 4* | 14.1 | 13.0 |
| | 27* | 20.9 | 13.0 |
| | 112 | 25.1 | 13.0 |
| $^{134}$Cs GH | 27* | 21.0 | 16.0 |
| | 112 | 25.1 | 16.0 |
| $^{137}$Cs GH | 27* | 20.9 | 15.3 |
| | 112* | 25.1 | 15.3 |
| $^{152}$Eu GH | 4* | 14.0 | 13.8 |
| | 27* | 21.0 | 13.8 |
| | 112* | 25.0 | 13.8 |
| $^{60}$Co C | 105 | 46.2 | 25.0 |
| | 65 | 50.3 | 25.0 |
| $^{154}$Eu C | 4 | 40.0 | 36.5 |
| | 105* | 54.5 | 36.5 |

2. affects the evaluation

## Appendix I. 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 J. Nuclear data

### Table J – Half-lives

| Nuclide | Half-life (d) | Reference |
|---|---|---|
| $^{3}$H | 4497(9) | DDEP |
| $^{14}$C | $2.082(11) \times 10^{6}$ | DDEP |
| $^{22}$Na | 950.6(4) | DDEP |
| $^{40}$K | $4.62(5) \times 10^{11}$ | DDEP |
| $^{41}$Ca | $3.7(3) \times 10^{7}$ | NuDat |
| $^{55}$Fe | 1003(3) | DDEP |
| $^{60}$Co | 1925.2(3) | DDEP |
| $^{63}$Ni | $3.60(9) \times 10^{4}$ | DDEP |
| $^{90}$Sr | 10520(30) | DDEP |
| $^{95}$Zr | 64.032(6) | DDEP |
| $^{95}$Nb | 34.991(6) | DDEP |
| $^{99}$Tc | $7.8(3) \times 10^{7}$ | DDEP |
| $^{133}$Ba | 3849.7(22) | DDEP |
| $^{134}$Cs | 753.5(10) | IAEA |
| $^{137}$Cs | 10976(30) | DDEP |
| $^{152}$Eu | 4939(6) | DDEP |
| $^{154}$Eu | 3141.5(14) | DDEP |
| $^{226}$Ra | $5.844(25) \times 10^{5}$ | DDEP |
| $^{234}$U | $8.967(22) \times 10^{7}$ | DDEP |
| $^{235}$U | $2.5706(18) \times 10^{11}$ | NuDat |
| $^{237}$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/
NuDat – NuDat – ENSDF data: www.nndc.bnl.gov/nudat2/

## Appendix K. 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 |
| $\infty$ | 2.576 |

## Appendix L. Standard deviation for proficiency assessment; NPL and ISO approach

For all samples in this exercise, except the C samples for which the LCS contained less than 75% of the results in the data set, the standard uncertainty for proficiency assessment is calculated according to:

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

For the C samples for which the LCS contained less than 75% of the results in the data set, the standard deviation for proficiency assessment is calculated according ISO 13528:2005:

$$\sigma_p = s^* \qquad \text{(see Section 2.7.2)}$$

In both cases 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 of the results themselves (as was done for some of the C samples), the product of median of the participant's 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 3.6% 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 differ for every exercise (although the values for the 2008 Exercise were in general very similar to the values obtained for the 2005 and 2007 Exercises). Table L1 lists the results of both approaches and shows the ratios between the ISO $\sigma_p$ and the NPL $\sigma_p$. 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., gross alpha (AL), $^{226}$Ra (AH) and $^{63}$Ni (B2)].

**Table L1 – Standard deviation for proficiency assessment; NPL and ISO approach**

| Nuclide | Number of results | $\sigma_p$ (NPL) | $\sigma_p$ (ISO 13528) | $\sigma_p$ (ISO) / $\sigma_p$ (NPL) Ratio |
|---|---|---|---|---|
| | | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | |
| $^{226}$Ra (AL) | 9 | **0.33** | 0.64 | 2.0 |
| $^{234}$U | 16 | **0.88** | 1.3 | 1.4 |
| $^{235}$U | 17 | **0.089** | 0.13 | 1.4 |
| $^{238}$U | 16 | **0.89** | 1.3 | 1.5 |
| $^{237}$Np | 8 | **0.97** | 1.4 | 1.5 |
| $^{238}$Pu | 17 | **0.67** | 0.79 | 1.2 |
| $^{239}$Pu | 17 | **0.59** | 0.58 | 1.0 |
| $^{241}$Am | 22 | **0.81** | 0.91 | 1.1 |
| $^{244}$Cm | 14 | **0.41** | 0.61 | 1.5 |
| gross alpha | 10 | **4.6** | 30 | 6.3 |
| | | (Bq g$^{-1}$) | (Bq g$^{-1}$) | |
| $^{226}$Ra (AH) | 9 | **0.38** | 1.2 | 3.2 |
| $^{234}$U | 11 | **0.50** | 1.2 | 2.4 |
| $^{235}$U | 13 | **0.056** | 0.088 | 1.6 |
| $^{238}$U | 14 | **0.57** | 0.84 | 1.5 |
| $^{237}$Np | 7 | **0.19** | 0.40 | 2.1 |
| $^{238}$Pu | 10 | **0.33** | 0.57 | 1.7 |
| $^{239}$Pu | 10 | **0.79** | 1.8 | 2.3 |
| $^{241}$Am | 15 | **0.15** | 0.25 | 1.6 |
| $^{244}$Cm | 11 | **0.24** | 0.47 | 1.9 |
| gross alpha | 7 | **3.3** | 9.6 | 2.9 |
| $^{3}$H (B1) | 28 | **0.053** | 0.079 | 1.5 |
| $^{14}$C | 22 | **0.042** | 0.11 | 2.5 |
| $^{99}$Tc | 14 | **0.092** | 0.12 | 1.3 |

continues

| continued | | | | |
|---|---|---|---|---|
| **Nuclide** | **Number of results** | **$\sigma_p$ (NPL)** | **$\sigma_p$ (ISO 13528)** | **$\sigma_p$ (ISO) / $\sigma_p$ (NPL) Ratio** |
| $^{3}$H (B2) | 29 | **0.021** | 0.034 | 1.7 |
| $^{55}$Fe | 13 | **0.11** | 0.27 | 2.5 |
| $^{63}$Ni | 14 | **0.035** | 0.14 | 3.9 |
| $^{90}$Sr | 23 | **0.042** | 0.052 | 1.2 |
| | | (Bq kg$^{-1}$) | (Bq kg$^{-1}$) | |
| $^{22}$Na (GL) | 51 | **0.43** | 0.63 | 1.5 |
| $^{60}$Co | 54 | **0.33** | 0.54 | 1.6 |
| $^{95}$Zr | 53 | **0.49** | 0.62 | 1.3 |
| $^{95}$Nb | 51 | **0.80** | 1.6 | 2.0 |
| $^{133}$Ba | 50 | **0.38** | 0.52 | 1.4 |
| $^{134}$Cs | 54 | **0.52** | 0.90 | 1.7 |
| $^{137}$Cs | 55 | **0.46** | 0.43 | 0.9 |
| $^{152}$Eu | 54 | **0.68** | 1.4 | 2.1 |
| | | (Bq g$^{-1}$) | (Bq g$^{-1}$) | |
| $^{22}$Na (GH) | 39 | **0.22** | 0.48 | 2.2 |
| $^{60}$Co | 43 | **0.17** | 0.23 | 1.3 |
| $^{95}$Zr | 43 | **0.29** | 0.47 | 1.6 |
| $^{95}$Nb | 42 | **0.67** | 1.2 | 1.8 |
| $^{133}$Ba | 44 | **0.12** | 0.23 | 1.8 |
| $^{134}$Cs | 44 | **0.18** | 0.29 | 1.6 |
| $^{137}$Cs | 44 | **0.36** | 0.42 | 1.2 |
| $^{152}$Eu | 43 | **0.69** | 1.4 | 2.0 |

**Table L2 – Standard deviation for proficiency assessment; NPL and ISO approach**

| Nuclide | Number of results | $\sigma_p$ (NPL) | $\sigma_p$ (ISO 13528) | $\sigma_p$ (ISO) / $\sigma_p$ (NPL) Ratio |
|---|---|---|---|---|
| | | (Bq g$^{-1}$) | (Bq g$^{-1}$) | |
| $^{3}$H total © | 14 | – | 7.7 | – |
| $^{3}$H leach | 5 | – | 2.9 | – |
| $^{3}$H fixed | 3 | not evaluated | – | – |
| $^{14}$C | 12 | – | 0.035 | – |
| $^{22}$Na | 1 | not evaluated | – | – |
| $^{36}$Cl | 1 | not evaluated | – | – |
| $^{40}$K | 7 | – | 0.060 | – |
| $^{55}$Fe | 5 | 0.0089 | 0.022 | 2.5 |
| $^{58}$Co | 1 | not evaluated | – | – |
| $^{60}$Co | 31 | 0.0055 | 0.011 | 2.0 |
| $^{63}$Ni | 6 | – | 0.024 | – |
| $^{133}$Ba | 15 | 0.00088 | 0.0015 | 1.8 |
| $^{137}$Cs | 1 | not evaluated | – | – |
| $^{152}$Eu | 31 | 0.11 | 0.21 | 1.9 |
| $^{154}$Eu | 28 | 0.0080 | 0.018 | 2.3 |
| $^{226}$Ra | 1 | not evaluated | – | – |
| $^{228}$Ra | 1 | not evaluated | – | – |
| $^{232}$Th | 1 | not evaluated | – | – |
| $^{238}$U | 1 | not evaluated | – | – |
| gross beta | 6 | – | 0.65 | – |

## Appendix M. Acknowledgements

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