FIRMS - Forensic Isotope Ratio Mass Spectrometry PT Scheme

Round: 221

Issue Number 1

Issued 31 October 2014

Scheme Information

Aims of Scheme

The primary aim of the Forensic Isotope Ratio Mass Spectrometry Proficiency Testing Scheme (FIRMS) is to enable laboratories performing isotope ratio analysis of a range of test materials to monitor their performance and compare it with that of their peers. The FIRMS scheme also aims to provide information to participants on technical issues and methodologies relating to isotope ratio analysis.

Further information on the scheme organisation, the test materials, and the statistical analysis of data are available in the FIRMS Scheme Description and the LGC PT General Protocol.

Performance Assessment

Once a PT round has closed, the results will be analysed and the assigned value determined for each analyte, according to the criteria provided in the Scheme Description. Information regarding the traceability of each calculated assigned value is also provided in the Scheme Description.

For quantitative data, the participant's result, x, (or $\log_{10} x$ for microbiological data) is converted into a z score using the following formula;

$$z = \frac{(x - X)}{SDPA}$$

X =   Assigned value
SDPA = Standard deviation for proficiency assessment

For quantitative data, the uncertainty of the assigned value is calculated to ensure that it would have a negligible effect on participants' performance scores. If the uncertainty of the assigned value is greater than 0.3 x SDPA, then this is not considered negligible. In this situation, a z' (z prime) performance score is automatically calculated rather than a z score, in order to take account of the measurement uncertainty of the assigned value. The z' score is calculated using the following formula;

$$z' = \frac{(x - X)}{\sqrt{(SDPA^2 + Ux^2)}}$$

X =   Assigned value
SDPA = Standard deviation for proficiency assessment
Ux = Uncertainty of the assigned value

Trend graphs will use a mixture of z and z' scores, i.e. the 'performance score' for the round.

For quantitative data, gross errors or blunders are removed from the data by removal of any results that are greater than the assigned value ± 5 x SDPA. These results are not used in the final calculation of the assigned value and other summary statistics and will be included in the number of 'Excluded Results'. All results, including excluded results, will be given a performance score.

For the purposes of performance assessment for a single round, z and z' scores are interpreted as follows:

z/z' score	Interpretation	Colour coding
$|z| \leq 2.00$	Satisfactory result	Green
$2.00 < |z|$ and < 3.00	Questionable result	Amber
$|z| \geq 3.00$	Unsatisfactory result	Red
No score given	See below	No colour coding

Performance scores will not be given for the following:

▪   For qualitative results, where satisfactory performance is based on the participants reporting the same result as the assigned result. e.g. detected, not detected. For these results, colour coding of green (satisfactory) or red (unsatisfactory) will apply.

▪   For results of zero; such a result is not normally appropriate and should not be reported, the result should be reported as less than the detection limit rather than zero.
      Note: for a very small number of analytes it may be appropriate to report a result of zero, depending on the type of measurement scale being used.

▪   For quantitative results where the analyte under test is present in the test material but participants report non-numerical results e.g. 0, <1, >300. In these cases, it is not possible to allocate a performance score and participants should assess their performance based on the assigned value and satisfactory range given.

▪   For quantitative results, for microbiological test materials, where the analyte under test is not present in the test material, the assigned value will be classified as 'Absent'. Results reported as 'less than' at or below the detection level for our method of confirmation will be assessed as satisfactory (green colour code). Results reported at a higher detection level will not be assessed and participants will need to use their own judgement to determine whether their result is fit for its intended use. Results reporting a positive count will be assessed as unsatisfactory (red colour code).

In some cases, performance scores may not be provided or may be provided but with colour coding suspended (indicating that scores need to be interpreted with caution). For example:

▪   For small data sets where less than 8 results have been submitted and the assigned value is derived using a consensus value from the participants' results. In these circumstances, there may be increased uncertainty of the assigned value, given the low number of participants, and performance scores will be given for information only.

▪   In cases where the distribution of the results gives cause for concern e.g. bi-modal data sets. These circumstances will be dependent on the statistical design that is in place.

▪   If the assigned value falls below a concentration threshold (only applies to some schemes).

In these or similar circumstances, further explanation as to the reasons for suspension of performance scoring or colour coding, and on the interpretation of results, will be given in the report.

Note: Data displayed in the report will have been rounded to the required number of decimal places. However statistical calculations will have been performed on unrounded data. For this reason, there may appear to be differences between displayed data and calculated data, but this does not affect results in any way.

Confidentiality
A unique laboratory reference code is used to report results in order to ensure confidentiality.

Contact details
The Technical Scheme Coordinator is Matthew Whetton

Please contact **ptcustomerservices@lgcgroup.com** if you have any questions or comments regarding the scheme.

Authorisation

This report was authorised by Wayne Gaunt, Technical Manager on the 31 October 2014

Sample Details

Samples were despatched on 15 September 2014.
The reporting deadline was 24 October 2014.

The following samples were distributed in FIRMS Round 221:

1: 1 x 0.5g Nylon for the determination of delta 2H, 13C, 15N and 18O
2: 1 x 0.5g Hydrocarbon oil for the determination of delta 2H &13C

Further information regarding assigned values, performance assessment and technical comments can be found under the individual sample and analyte results.

Calculated within and between participant standard deviations

Sample 1 (Nylon)

Analyte	Within participant SD	Between participant SD
Delta 2H	0.8963	1.2060
Delta 13C	0.0677	0.0144
Delta 15N	0.1925	0.0407
Delta 18O	1.1170	0.1100

Sample 2 (Hydrocarbon oil)

Analyte	Within participant SD	Between participant SD
Delta 2H	4.5033	0.4416
Delta 13C	0.0975	0.0309

Quality Control

All homogeneity assessments have been conducted in accordance with the principles stipulated in ISO 13528 [1] and/or the IUPAC [2] Harmonized PT Protocol. Further details regarding the assessment of homogeneity can be found in the LGC Standards Proficiency Testing General Protocol.

Sample	Analyte/Test	Result (SD)	Assessment
1 (nylon)	delta 13C	-27.41 (0.05)*	Pass
2 (hydrocarbon oil)	delta 13C	-27.38 (0.04)*	Pass

*Results were scaled to the NBS19-LSVEC scale.

Analysis carried out for the purposes of homogeneity testing was sub-contracted by LGC to an external laboratory.

For quantitative testing in this round, a comparison of the standard deviation of the homogeneity results returned and the SDPA expected for the participant assessment was carried out. The samples were considered to be sufficiently homogeneous for use in the PT scheme, based on the values returned.

For qualitative testing, the target analyte must be detected in 100% of test materials analysed.

For any analyte which has not been proven to be sufficiently homogeneous, and any closely related analytes, the value set for the SDPA may be suspended in order to take account of any potential inhomogeneity. The actual value used for the standard deviation for proficiency assessment is shown at the foot of the results and z-score tables in this report.

Often a particular test material does not require homogeneity assessment prior to distribution. Such sample types include standard solutions and aqueous solutions.

[1] ISO 13528 (2005), 'Statistical methods for use in proficiency testing by inter-laboratory comparisons'.

[2] M Thompson, S L R Ellison, R Wood, 'International Harmonised Protocol for the Proficiency Testing of Analytical Chemistry Laboratories', *Pure Appl. Chem*., 2006, 78, 145-196.

Sample: 01 - FIRMS sample 1

Analyte: delta 2H (VSMOW)

Lab ID	Method	Result	z' score*
FM0002	Isotope Ratio Mass Spectrometry	-162.30	-0.15
FM0006	Isotope Ratio Mass Spectrometry	-160.89	0.00
FM0010	Isotope Ratio Mass Spectrometry	-161.53	-0.07
FM0011	Isotope Ratio Mass Spectrometry	-154.84	0.63
FM0014	Isotope Ratio Mass Spectrometry	-160.19	0.07
FM0015	Isotope Ratio Mass Spectrometry	-176.23	-1.60
FM0016	Isotope Ratio Mass Spectrometry	-150.94	1.04
FM0018	Isotope Ratio Mass Spectrometry	-156.72	0.43
FM0025	Isotope Ratio Mass Spectrometry	-170.30	-0.98
FM0027	Isotope Ratio Mass Spectrometry	-169.99	-0.95
FM0028	Isotope Ratio Mass Spectrometry	-148.30	1.31

Data Statistics

	Value
Number of Results	11
Number of Excluded Results	0
Mean	-161.11
Median	-160.89
Standard Deviation	8.488
Robust Standard Deviation	8.972
Result Range	-176.23 to -148.30

Performance Statistics

	Value
Assigned Value	-160.89
Uncertainty of Assigned Value	3.38
SDPA	9.588
Satisfactory Range	-180.07 to -141.71
Satisfactory z' scores	100.0%
Questionable z' scores	0.0%
Unsatisfactory z' scores	0.0%
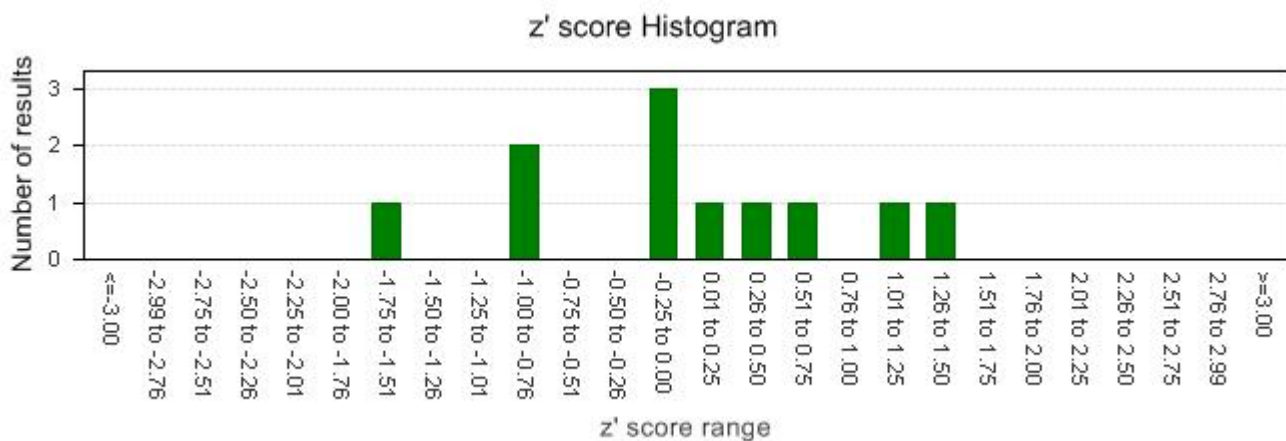
z' score Histogram

Methodology Summary

Method	Number of Results	Excluded Results	% of Total	Median	Robust SD	Range	Sat. %
Isotope Ratio Mass Spectrometry	11	0	100	-160.89	8.972	-176.23 to -148.30	100.0
All	11	0	100	-160.89	8.972	-176.23 to -148.30	100.0

Comments

The participants in the FIRMS scheme were allowed to report up to 10 results, for the purposes of calculating individual and group summary statistics, plus a mean result, which was used to calculate the summary statistics subsequently applied in the assessment of performance.

In this round most participants obtained satisfactory performance scores for most parameters; however performance scores are currently calculated using the robust standard deviation obtained from the data reported. For delta 2H this value was 9.588 which is 6% of the assigned value (-160.89).

In cases where the results returned are more varied, the robust standard deviation will also be larger and so a wider range of results will therefore be assessed as satisfactory. Participants are advised to consider the magnitude of the robust standard deviations used, and the absolute difference of their result from the assigned value, when interpreting their performance.

Sample: 01 - FIRMS sample 1

Analyte: delta 2H (VSMOW)

A fixed SDPA, which can also be a percentage of the assigned value, is being considered by LGC and the FIRMS advisory group.

*Please note, participant performance for this analyte has been assessed using a z' score, rather than a z score, in order to account for the measurement uncertainty of the assigned value which is not negligible when compared to the SDPA.

Sample: 01 - FIRMS sample 1

Analyte: delta 13C (VPDB)

| Lab ID	Method	Result	z' score*
FM0002	Isotope Ratio Mass Spectrometry	-27.50	0.48
FM0003	Isotope Ratio Mass Spectrometry	-27.64	-1.77
FM0006	Isotope Ratio Mass Spectrometry	-27.40	2.09
FM0009	Isotope Ratio Mass Spectrometry	-27.59	-0.96
FM0010	Isotope Ratio Mass Spectrometry	-27.52	0.16
FM0011	Isotope Ratio Mass Spectrometry	-27.50	0.48
FM0014	Isotope Ratio Mass Spectrometry	-27.59	-0.96
FM0015	Isotope Ratio Mass Spectrometry	-27.53	0.00
FM0016	Isotope Ratio Mass Spectrometry	-27.57	-0.64
FM0018	Isotope Ratio Mass Spectrometry	-27.42	1.77
FM0019	Isotope Ratio Mass Spectrometry	-27.38	2.41
FM0025	Isotope Ratio Mass Spectrometry	-27.53	0.00
FM0027	Isotope Ratio Mass Spectrometry	-27.50	0.48
FM0028	Isotope Ratio Mass Spectrometry	-27.62	-1.44
FM0031	Isotope Ratio Mass Spectrometry	-27.55	-0.32

Data Statistics

	Value
Number of Results	15
Number of Excluded Results	0
Mean	-27.52
Median	-27.53
Standard Deviation	0.077
Robust Standard Deviation	0.059
Result Range	-27.64 to -27.38

Performance Statistics

	Value
Assigned Value	-27.53
Uncertainty of Assigned Value	0.02
SDPA	0.062
Satisfactory Range	-27.65 to -27.41
Satisfactory z' scores	86.7%
Questionable z' scores	13.3%
Unsatisfactory z' scores	0.0%
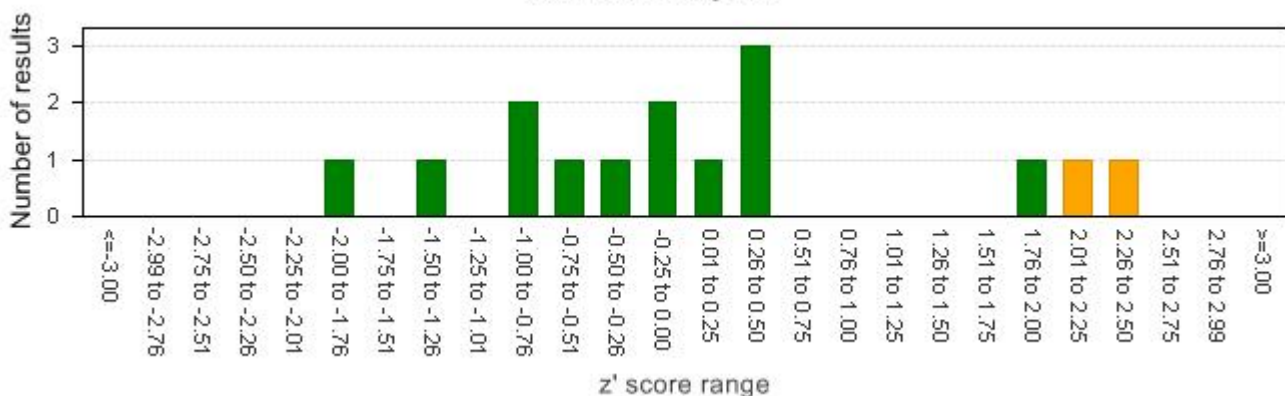
z' score Histogram

Methodology Summary

Method	Number of Results	Excluded Results	% of Total	Median	Robust SD	Range	Sat. %
Isotope Ratio Mass Spectrometry	15	0	100	-27.53	0.059	-27.64 to -27.38	86.7
All	15	0	100	-27.53	0.059	-27.64 to -27.38	86.7

Comments

*Please note, participant performance for this analyte has been assessed using a z' score, rather than a z score, in order to account for the measurement uncertainty of the assigned value which is not negligible when compared to the SDPA.

Sample: 01 - FIRMS sample 1

Analyte: delta 15N (AIR)

| Lab ID	Method	Result	z' score*
FM0002	Isotope Ratio Mass Spectrometry	2.78	1.08
FM0003	Isotope Ratio Mass Spectrometry	3.22	8.97
FM0006	Isotope Ratio Mass Spectrometry	2.57	-2.69
FM0009	Isotope Ratio Mass Spectrometry	2.71	-0.18
FM0011	Isotope Ratio Mass Spectrometry	2.74	0.36
FM0014	Isotope Ratio Mass Spectrometry	2.69	-0.54
FM0015	Isotope Ratio Mass Spectrometry	2.83	1.97
FM0016	Isotope Ratio Mass Spectrometry	2.76	0.72
FM0018	Isotope Ratio Mass Spectrometry	2.48	-4.31
FM0019	Isotope Ratio Mass Spectrometry	2.74	0.36
FM0025	Isotope Ratio Mass Spectrometry	2.73	0.18
FM0027	Isotope Ratio Mass Spectrometry	2.48	-4.31
FM0028	Isotope Ratio Mass Spectrometry	2.69	-0.54

Data Statistics

	Value
Number of Results	13
Number of Excluded Results	1
Mean	2.68
Median	2.72
Standard Deviation	0.113
Robust Standard Deviation	0.052
Result Range	2.48 to 2.83

Performance Statistics

	Value
Assigned Value	2.72
Uncertainty of Assigned Value	0.02
SDPA	0.056
Satisfactory Range	2.61 to 2.83
Satisfactory z' scores	69.2%
Questionable z' scores	7.7%
Unsatisfactory z' scores	23.1%

z' score Histogram
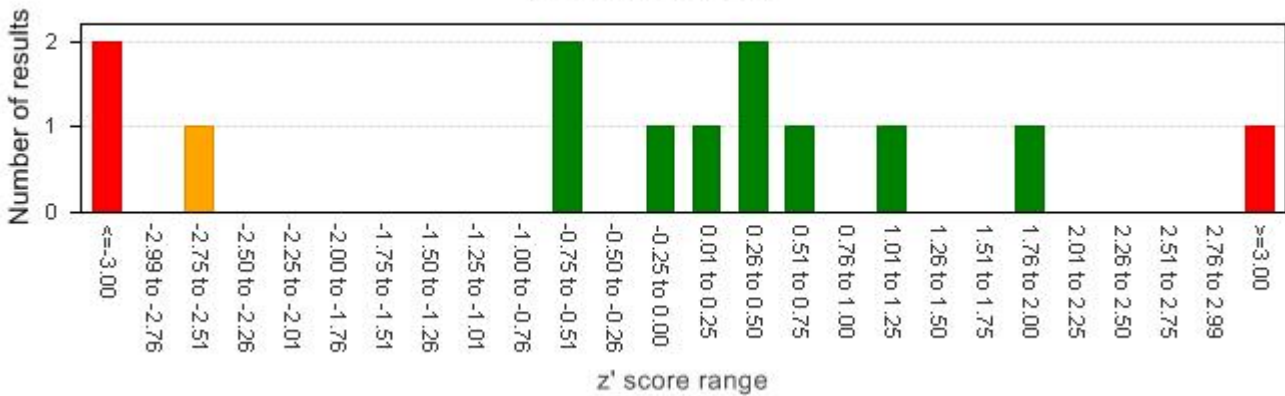
Methodology Summary

Method	Number of Results	Excluded Results	% of Total	Median	Robust SD	Range	Sat. %
Isotope Ratio Mass Spectrometry	13	1	100	2.72	0.052	2.48 to 2.83	69.2
All	13	1	100	2.72	0.052	2.48 to 2.83	69.2

Comments

*Please note, participant performance for this analyte has been assessed using a z' score, rather than a z score, in order to account for the measurement uncertainty of the assigned value which is not negligible when compared to the SDPA.

Sample: 01 - FIRMS sample 1

Analyte: delta 18O (VSMOW)

Lab ID	Method	Result	z' score*
FM0002	Isotope Ratio Mass Spectrometry	10.74	0.59
FM0015	Isotope Ratio Mass Spectrometry	10.74	0.59
FM0016	Isotope Ratio Mass Spectrometry	8.62	-2.41
FM0018	Isotope Ratio Mass Spectrometry	10.53	0.30
FM0025	Isotope Ratio Mass Spectrometry	10.10	-0.31
FM0027	Isotope Ratio Mass Spectrometry	9.73	-0.83

Due to the low number of results returned, performance scores are shown for information purposes only

Data Statistics

	Value
Number of Results	6
Number of Excluded Results	0
Mean	10.08
Median	10.32
Standard Deviation	0.816
Robust Standard Deviation	0.630
Result Range	8.62 to 10.74

Performance Statistics

	Value
Assigned Value	10.32
Uncertainty of Assigned Value	0.32
SDPA	0.707
Satisfactory Range	8.91 to 11.73
Satisfactory z' scores	83.3%
Questionable z' scores	16.7%
Unsatisfactory z' scores	0.0%

Methodology Summary

Method	Number of Results	Excluded Results	% of Total	Median	Robust SD	Range	Sat. %
Isotope Ratio Mass Spectrometry	6	0	100	10.32	0.630	8.62 to 10.74	83.3
All	6	0	100	10.32	0.630	8.62 to 10.74	83.3

Comments

Sample: 02 - FIRMS sample 2

Analyte: delta 2H (VSMOW)

Lab ID	Method	Result	z' score*
FM0002	Isotope Ratio Mass Spectrometry	-115.40	0.50
FM0003	Isotope Ratio Mass Spectrometry	-115.10	0.63
FM0006	Isotope Ratio Mass Spectrometry	-118.18	-0.71
FM0010	Isotope Ratio Mass Spectrometry	-116.81	-0.11
FM0011	Isotope Ratio Mass Spectrometry	-111.52	2.19
FM0014	Isotope Ratio Mass Spectrometry	-115.59	0.42
FM0015	Isotope Ratio Mass Spectrometry	-122.11	-2.42
FM0016	Isotope Ratio Mass Spectrometry	-113.04	1.53
FM0018	Isotope Ratio Mass Spectrometry	-116.55	0.00
FM0025	Isotope Ratio Mass Spectrometry	-117.30	-0.33
FM0027	Isotope Ratio Mass Spectrometry	-119.55	-1.31

Data Statistics

	Value
Number of Results	11
Number of Excluded Results	0
Mean	-116.47
Median	-116.55
Standard Deviation	2.917
Robust Standard Deviation	2.150
Result Range	-122.11 to -111.52

Performance Statistics

	Value
Assigned Value	-116.55
Uncertainty of Assigned Value	0.81
SDPA	2.298
Satisfactory Range	-121.15 to -111.95
Satisfactory z' scores	81.8%
Questionable z' scores	18.2%
Unsatisfactory z' scores	0.0%
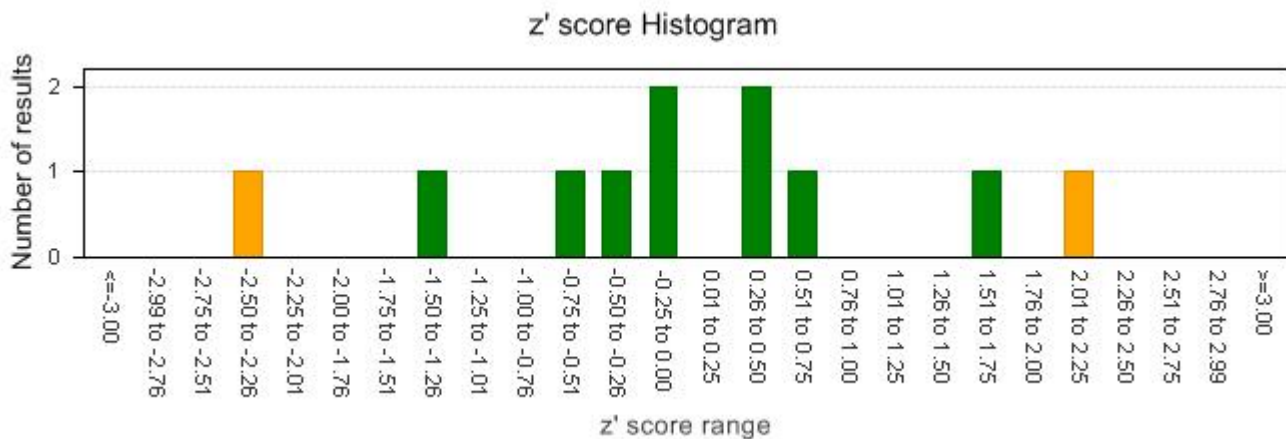
z' score Histogram

Methodology Summary

Method	Number of Results	Excluded Results	% of Total	Median	Robust SD	Range	Sat. %
Isotope Ratio Mass Spectrometry	11	0	100	-116.55	2.150	-122.11 to -111.52	81.8
All	11	0	100	-116.55	2.150	-122.11 to -111.52	81.8

Comments

Please refer to sample 1, delta 2H for report comments.

*Please note, participant performance for this analyte has been assessed using a z' score, rather than a z score, in order to account for the measurement uncertainty of the assigned value which is not negligible when compared to the SDPA.

Sample: 02 - FIRMS sample 2

Analyte: delta 13C (VPDB)

| Lab ID	Method	Result	z' score*
FM0002	Isotope Ratio Mass Spectrometry	-27.53	-0.64
FM0003	Isotope Ratio Mass Spectrometry	-27.13	3.62
FM0006	Isotope Ratio Mass Spectrometry	-27.25	2.34
FM0009	Isotope Ratio Mass Spectrometry	-27.53	-0.64
FM0010	Isotope Ratio Mass Spectrometry	-27.49	-0.21
FM0011	Isotope Ratio Mass Spectrometry	-27.51	-0.43
FM0014	Isotope Ratio Mass Spectrometry	-27.54	-0.75
FM0015	Isotope Ratio Mass Spectrometry	-27.39	0.85
FM0016	Isotope Ratio Mass Spectrometry	-27.37	1.06
FM0018	Isotope Ratio Mass Spectrometry	-27.37	1.06
FM0019	Isotope Ratio Mass Spectrometry	-27.43	0.43
FM0025	Isotope Ratio Mass Spectrometry	-27.48	-0.11
FM0027	Isotope Ratio Mass Spectrometry	-27.47	0.00
FM0031	Isotope Ratio Mass Spectrometry	-27.47	0.00

Data Statistics

	Value
Number of Results	14
Number of Excluded Results	0
Mean	-27.43
Median	-27.47
Standard Deviation	0.117
Robust Standard Deviation	0.089
Result Range	-27.54 to -27.13

Performance Statistics

	Value
Assigned Value	-27.47
Uncertainty of Assigned Value	0.03
SDPA	0.094
Satisfactory Range	-27.66 to -27.28
Satisfactory z' scores	85.7%
Questionable z' scores	7.1%
Unsatisfactory z' scores	7.1%

z' score Histogram
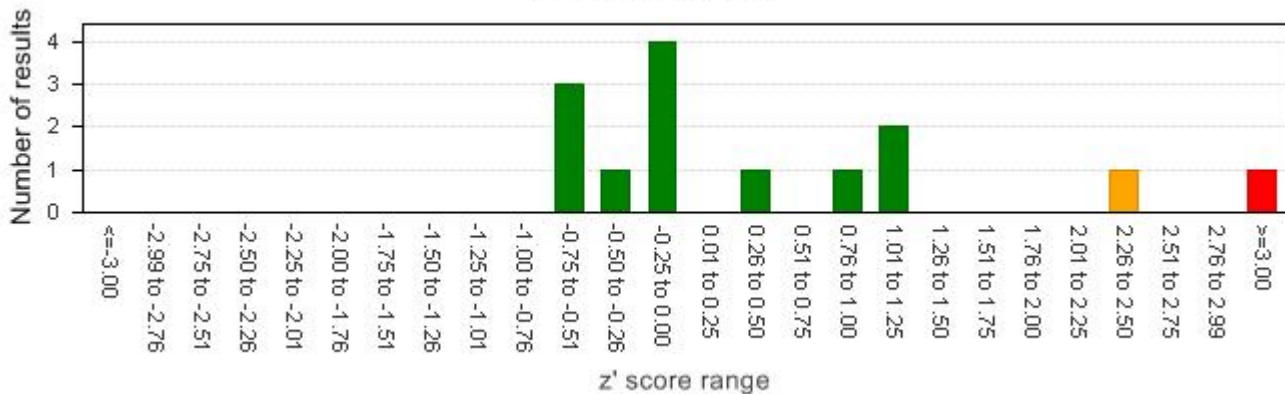
Methodology Summary

Method	Number of Results	Excluded Results	% of Total	Median	Robust SD	Range	Sat. %
Isotope Ratio Mass Spectrometry	14	0	100	-27.47	0.089	-27.54 to -27.13	85.7
All	14	0	100	-27.47	0.089	-27.54 to -27.13	85.7

Comments

*Please note, participant performance for this analyte has been assessed using a z' score, rather than a z score, in order to account for the measurement uncertainty of the assigned value which is not negligible when compared to the SDPA.