



Universität Stuttgart

Evaluation of the 5th SADC MET Water PT

Evaluation Workshop Kampala 2008

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Evaluation and Assessment

- according to same procedure as in the last rounds
 - assigned value from the formulation of the samples (with an uncertainty budget)
 - calculation of standard deviation using Algorithm A from ISO 13528
 - but! – limitation of the standard deviation (as ‘fitness for purpose’ requirement)

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Limits for standard deviation

parameter	std limit	parameter	std limit
sulphate	10 %	manganese	20 % / 12 %
chloride	10 %	aluminium	30 %
fluoride	12 %	lead	40 % / 25 %
nitrate	15 %	copper	20 %
phosphate	10 %	zinc	20 %
calcium	10 %	chromium	25 %
magnesium	10 %	nickel	25 %
sodium	10 %	cadmium	30 %
potassium	10 %	arsenic	30 %
iron	20 % / 12 %	cobalt	20 %

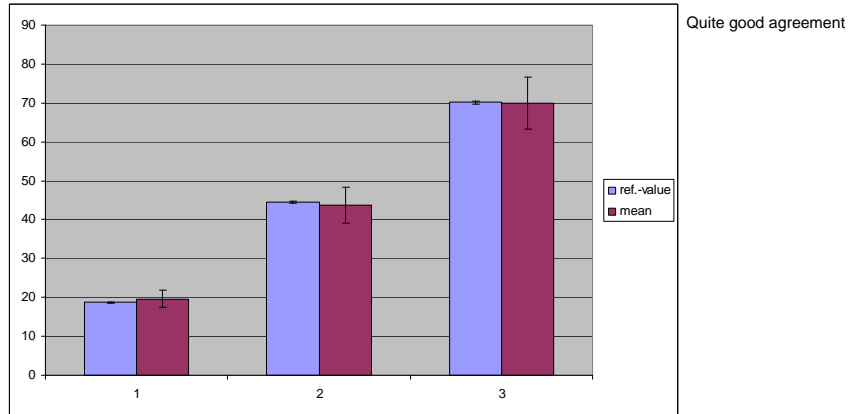
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Elimination of gross outliers

- Values $< \text{ref.-value}/8$ and $> \text{ref.-value} * 8$ have been excluded before applying statistical procedures

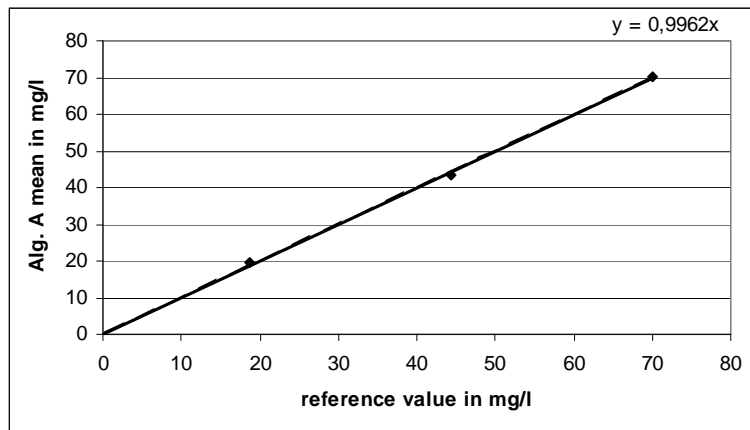
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Sulphate Alg.A mean and ref.-value from weighings



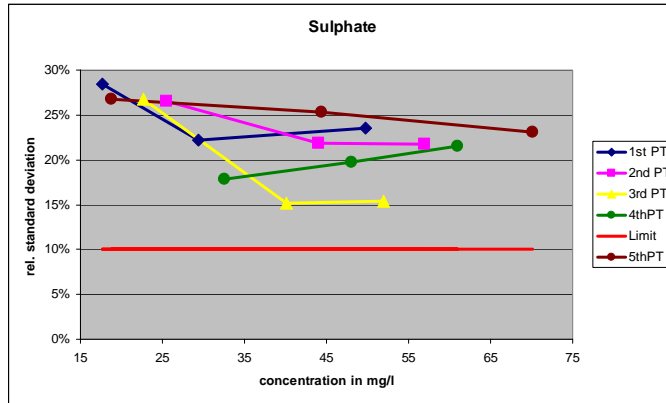
Exp. uncertainty of the Alg.A mean is calculated according to ISO 13528: $U_{c_{mean}} = 2 \cdot u_{c_{mean}} = 2 \cdot 1,25 \cdot \frac{s_R}{\sqrt{n}}$
 Exp. uncertainty of the ref.-value from an uncertainty budget

Sulphate mean vs. ref.-value



Average recovery: 99.6%; in 2007: 103.6%; in 2006: 106.5%

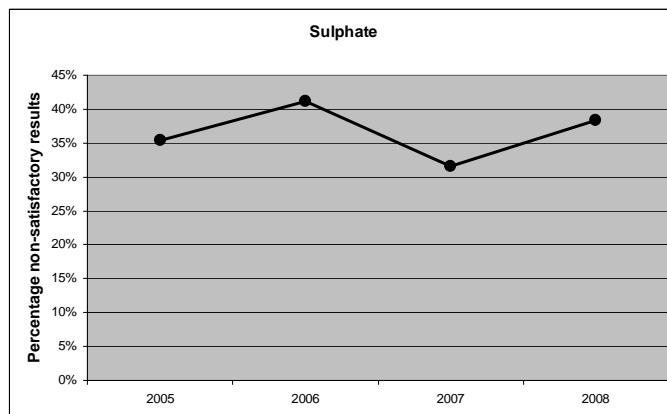
Sulphate calculated standard deviation and limit



No improvement over time

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Sulphate Percentage non-satisfactory results

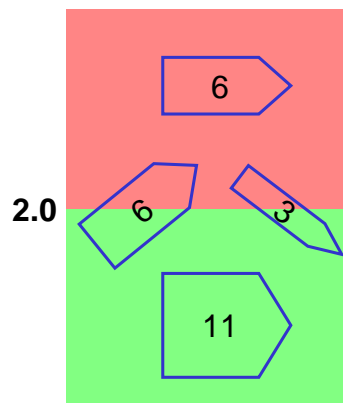
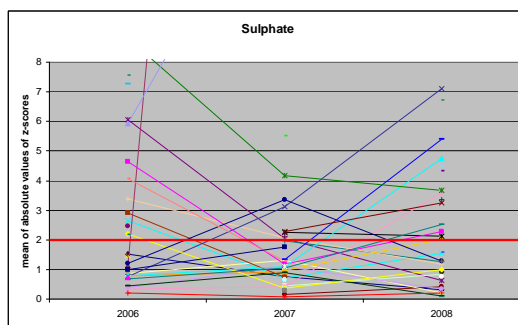


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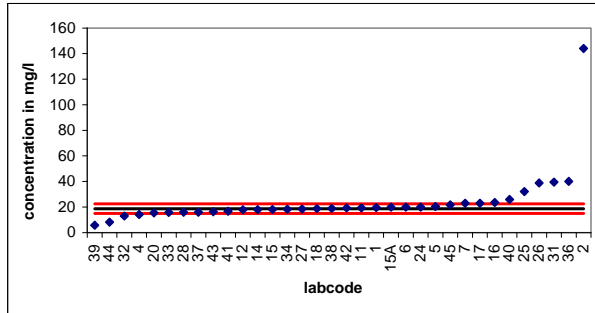
Individual performance development

- For all labs participating in 2008 and in 2007 (or 2006)
- Calculation of the mean of the absolute values of z-scores of the 3 values
- Graphical display
 - all values
 - How man labs are
 - Consistently lower than 2.0 (good)
 - Consistently higher than 2.0 (bad)
 - Improving from > 2.0 to < 2.0
 - Getting worse from < 2.0 to > 2.0

Sulphate Individual performance development

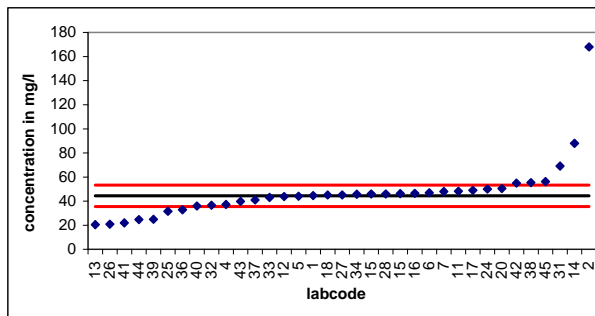


Sulphate 1



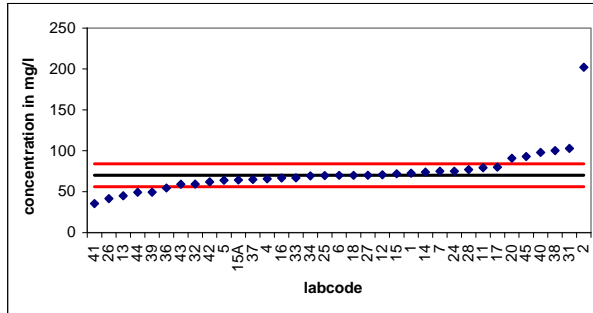
values:	35
removed:	1
mean:	19,66
ref.-value:	18,72
recovery:	105,0%
std:	5,016
rstd:	26,8%
std limit:	10%
upper limit:	22,47
lower limit:	14,98
too high:	9
too low:	5
outside limits:	14

Sulphate 2



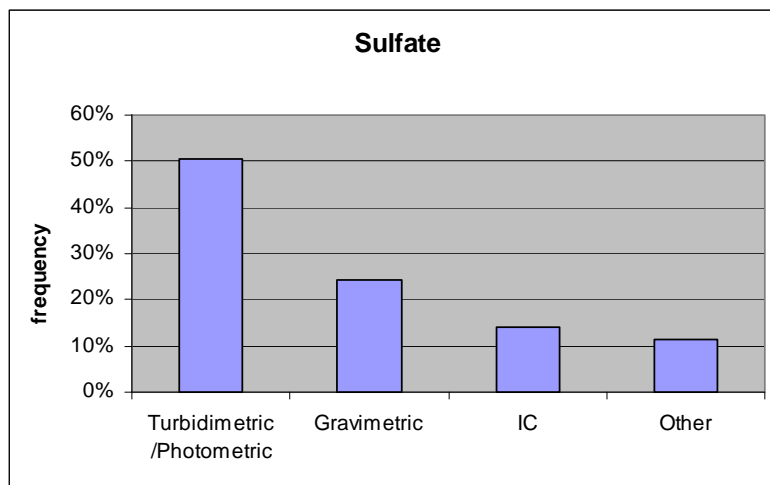
values:	36
removed:	1
mean:	43,61
ref.-value:	44,42
recovery:	98,2%
std:	11,227
rstd:	25,3%
std limit:	10%
upper limit:	53,30
lower limit:	35,54
too high:	6
too low:	8
outside limits:	14

Sulphate 3

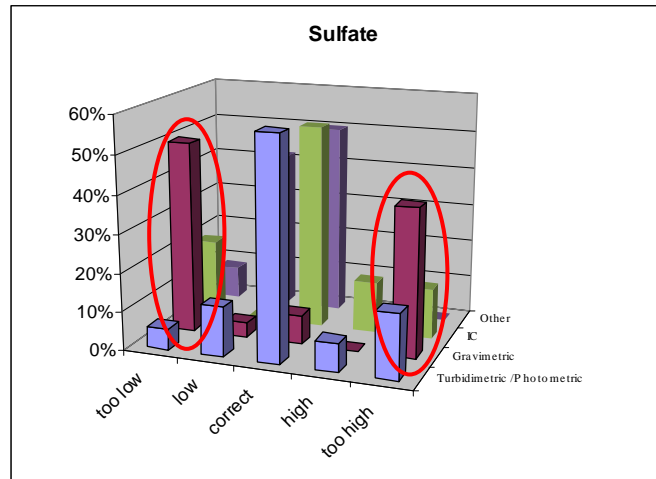


values:	36
removed:	1
mean:	70,00
ref.-value:	70,13
recovery:	99,8%
std:	16,184
rstd:	23,1%
std limit:	10%
upper limit:	84,15
lower limit:	56,10
too high:	6
too low:	7
outside limits:	13

Used methods



Comparison of methods



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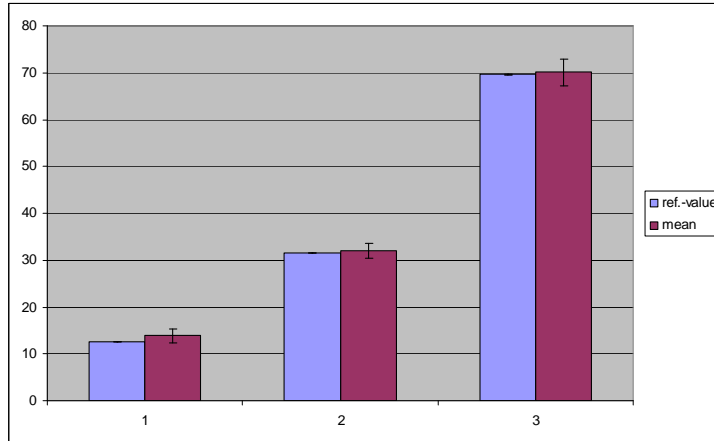
Summary Sulphate

- Good agreement between means and ref.-values
- Standard deviation constantly higher than limits
- High portion of outliers for the gravimetric method

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Chloride

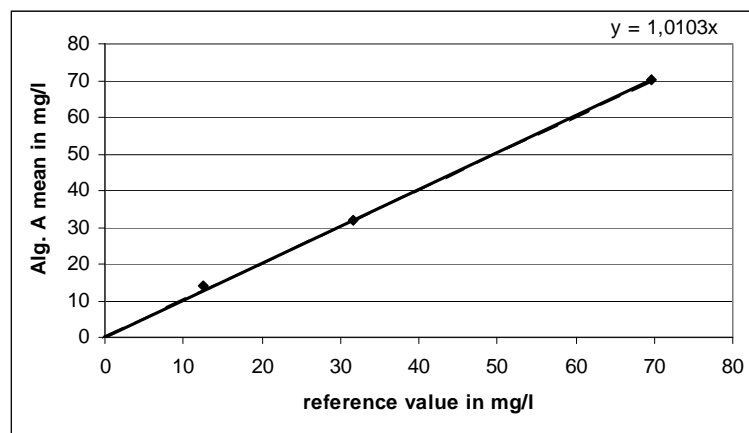
Alg.A mean and ref.-value from weighings



Similar to 2006 data: means a little bit higher than ref.-values

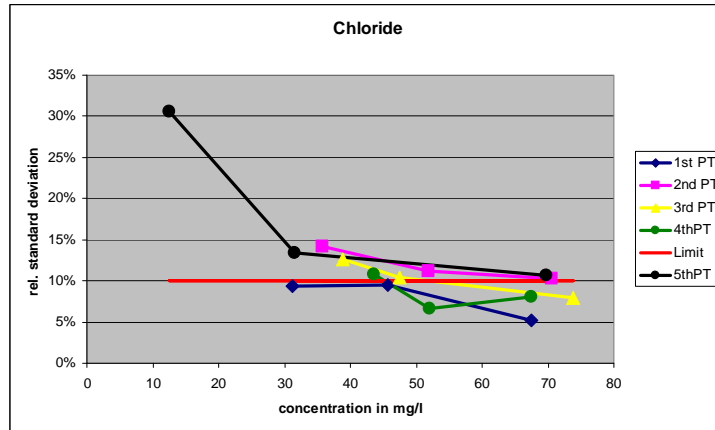
Chloride

mean vs. ref.-value



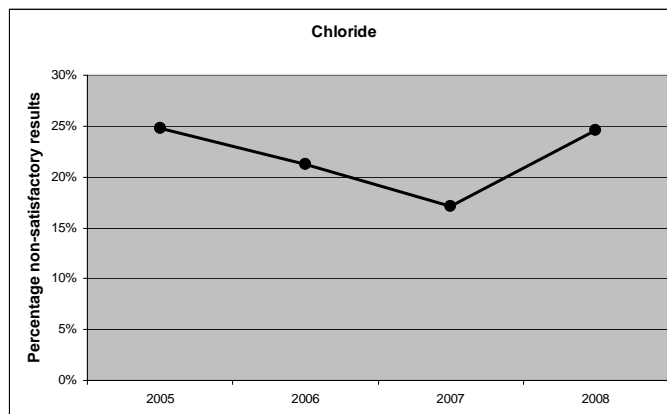
Average recovery: 101.0%; in 2007: 102.4%; in 2006: 101.6%

Chloride calculated standard deviation and limit



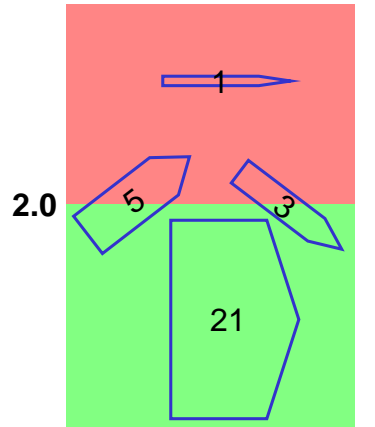
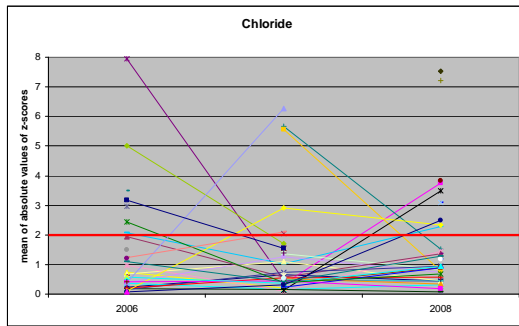
No improvement over time; standard deviation increases dramatically for low values

Chloride Percentage non-satisfactory results

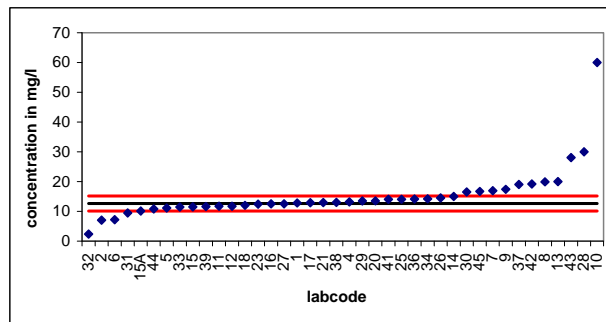


Chloride

Individual performance development

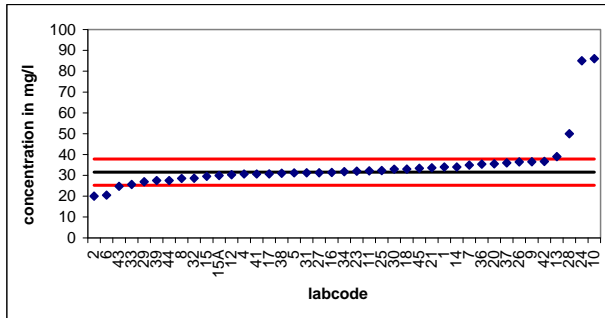


Chloride 1



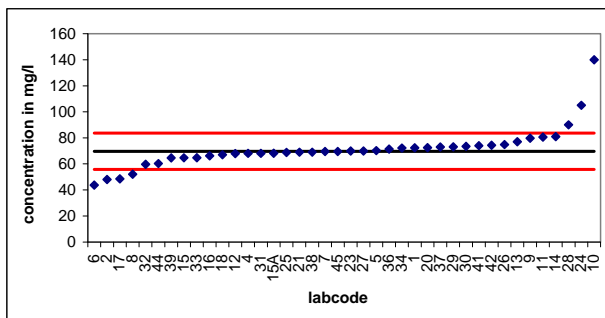
values:	41
removed:	1
mean:	13,86
ref.-value:	12,60
recovery:	110,0%
std:	3,857
rstd:	30,6%
std limit:	10%
upper limit:	15,12
lower limit:	10,08
too high:	12
too low:	4
outside limits:	16

Chloride 2



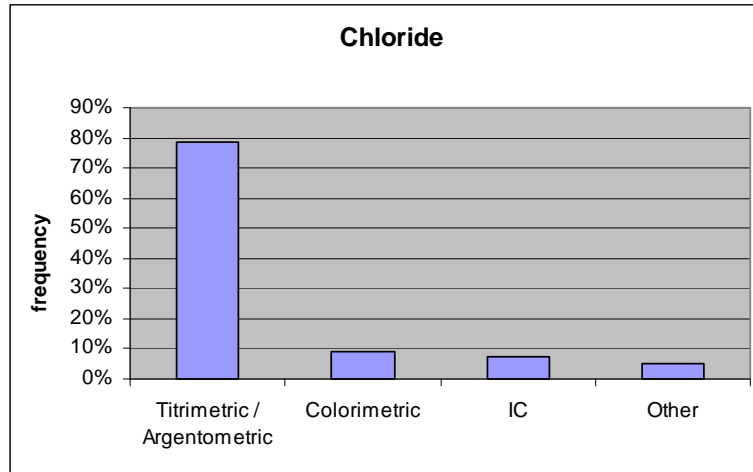
values:	41
removed:	0
mean:	32,05
ref.-value:	31,55
recovery:	101,6%
std:	4,235
rstd:	13,4%
std limit:	10%
upper limit:	37,86
lower limit:	25,24
too high:	4
too low:	3
outside limits:	7

Chloride 3



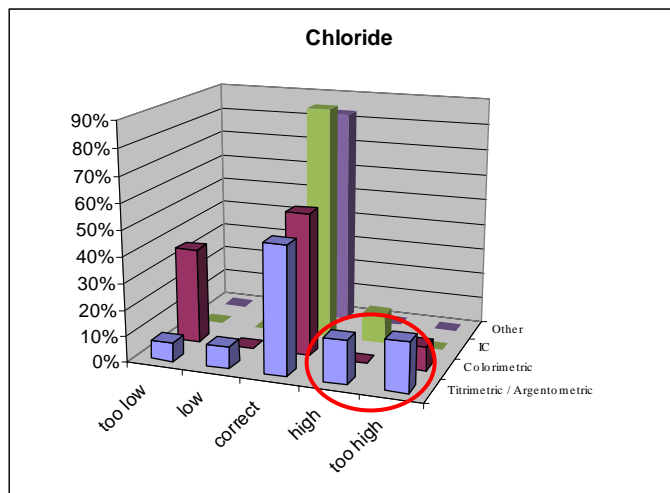
values:	40
removed:	0
mean:	70,10
ref.-value:	69,67
recovery:	100,6%
std:	7,456
rstd:	10,7%
std limit:	10%
upper limit:	83,61
lower limit:	55,74
too high:	3
too low:	4
outside limits:	7

Used methods



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Comparison of methods



Problems with endpoint detection?

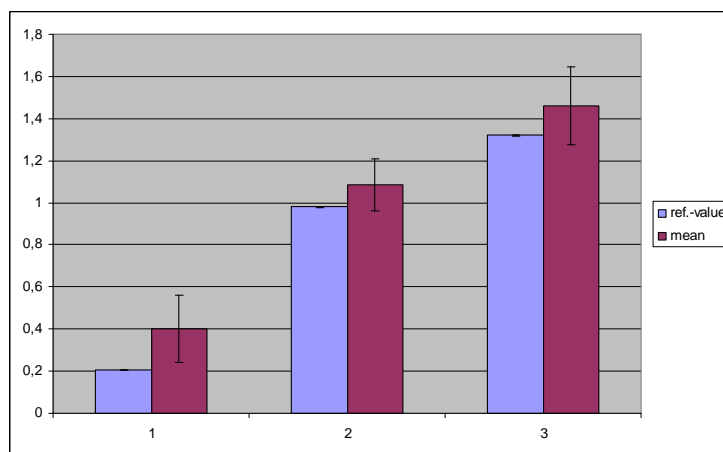
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Summary Chloride

- quite good agreement between mean and reference value
- standard deviation too high for low values – no improvement for higher values

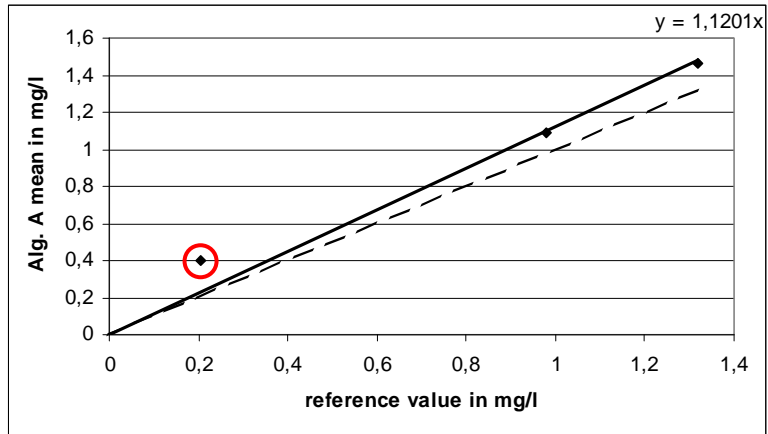
Fluoride

Alg.A mean and ref.-value from weighings



Means significantly higher than ref. Value, especially for low concentration

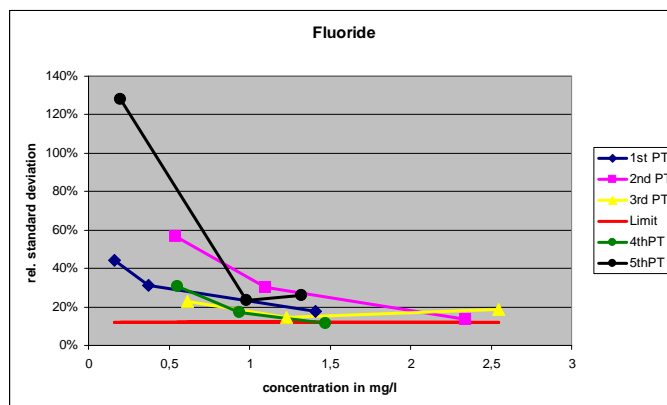
Fluoride mean vs. ref.-value



Average recovery: 112.0%; in 2007: 98.2%; in 2006: 107.7%

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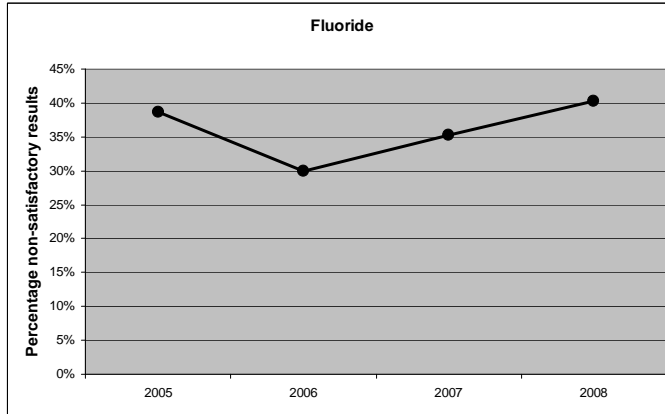
Fluoride calculated standard deviation and limit



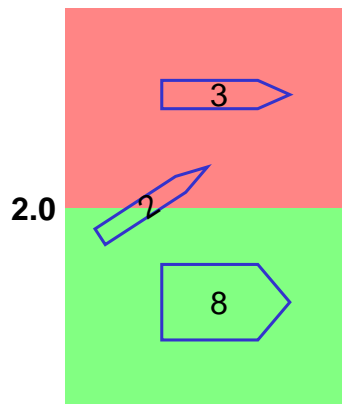
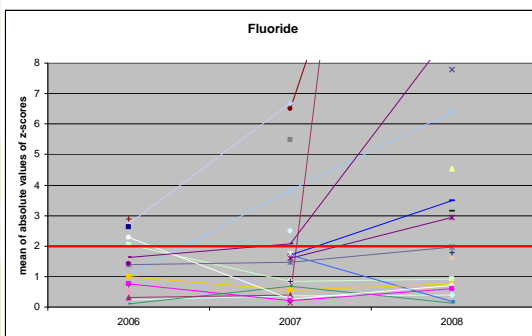
For level 1 very high standard deviation – no improvement

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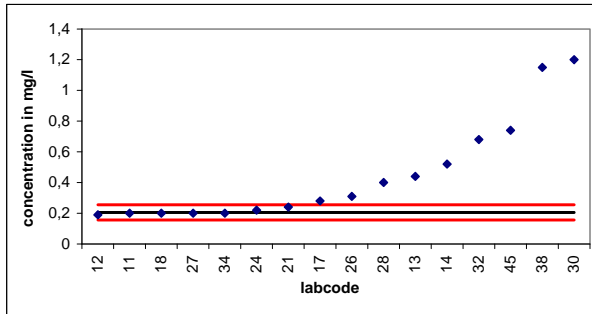
Fluoride Percentage non-satisfactory results



Fluoride Individual performance development



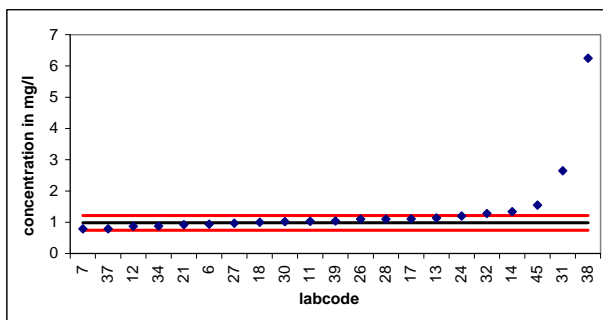
Fluoride 1



values:	20
removed:	4
mean:	0,40
ref.-value:	0,21
recovery:	195,1%
std:	0,263
rstd:	128,0%
std limit:	12%
upper limit:	0,25
lower limit:	0,16
too high:	11
too low:	2
outside limits:	13

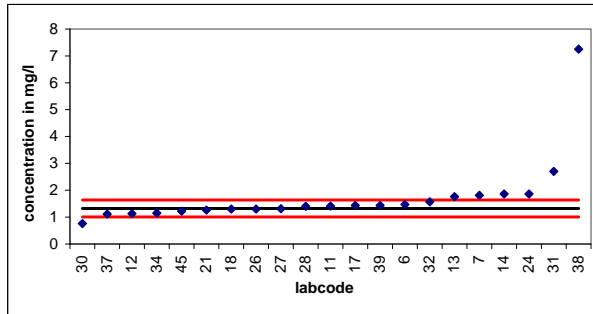
No real consensus between the participants

Fluoride 2



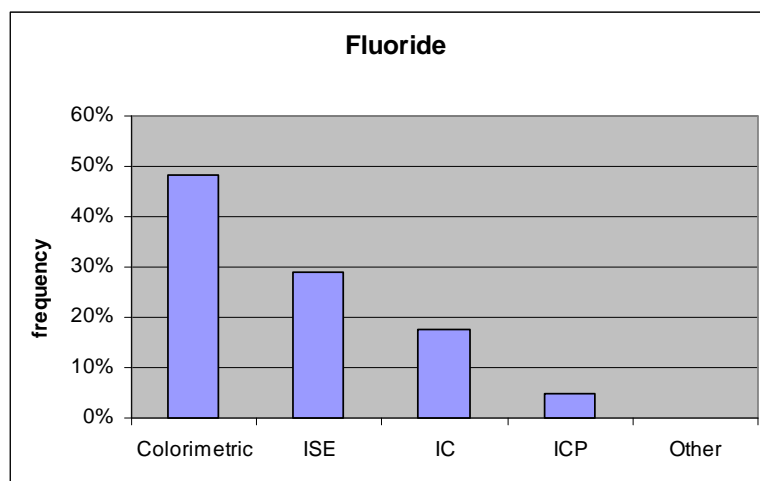
values:	21
removed:	0
mean:	1,09
ref.-value:	0,98
recovery:	110,8%
std:	0,229
rstd:	23,4%
std limit:	12%
upper limit:	1,22
lower limit:	0,75
too high:	5
too low:	0
outside limits:	5

Fluoride 3

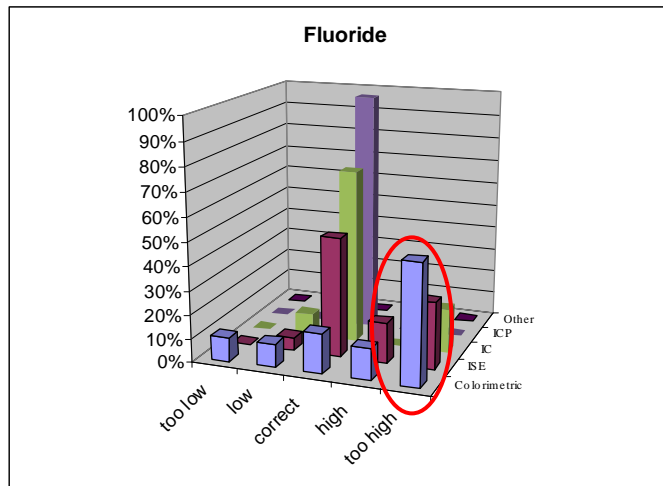


values:	21
removed:	0
mean:	1,46
ref.-value:	1,32
recovery:	110,7%
std:	0,346
rstd:	26,2%
std limit:	12%
upper limit:	1,64
lower limit:	1,00
too high:	6
too low:	1
outside limits:	7

Used methods



Comparison of methods



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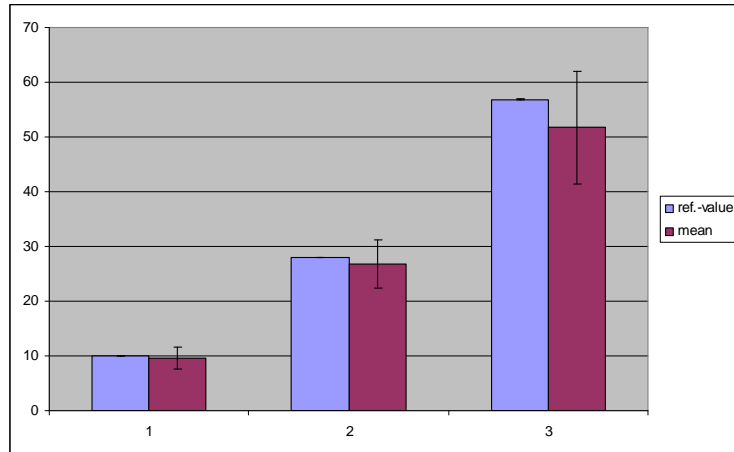
Summary Fluoride

- mean values higher than reference values
- standard deviations too high, especially for low concentrations – no improvement
- colorimetric values not reliable (as in the last years!)

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Nitrate

Alg.A mean and ref.-value from weighings

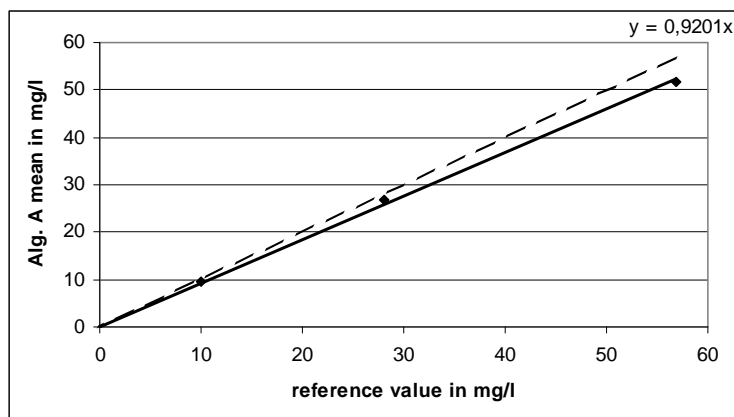


Means slightly lower than reference values

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Nitrate

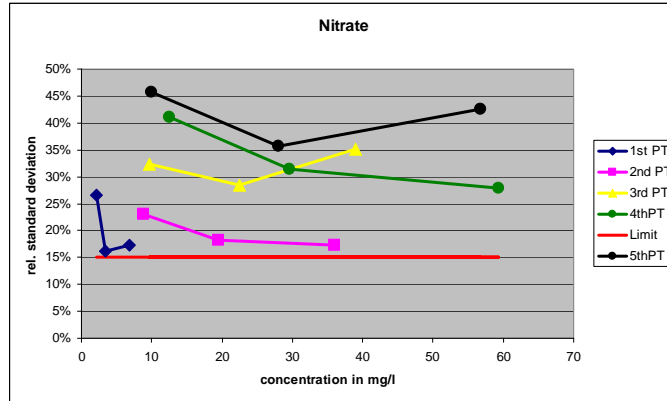
mean vs. ref.-value



Average recovery: 92,0%; in 2007: 85.9%; in 2006: 90.6%

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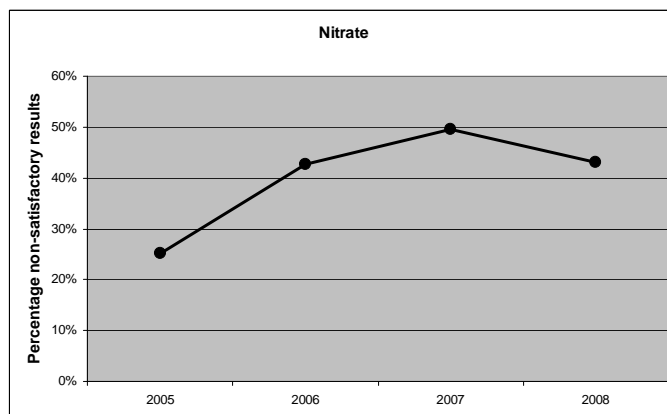
Nitrate calculated standard deviation and limit



Highest standard deviation ever!!

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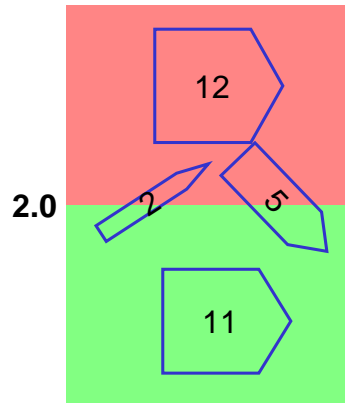
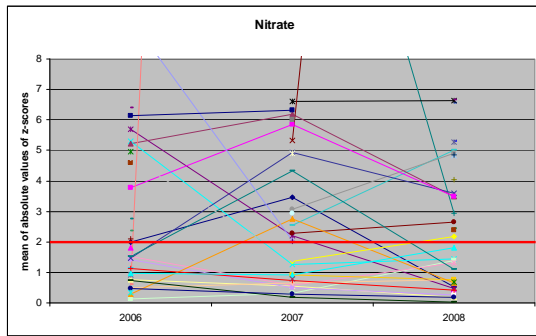
Nitrate Percentage non-satisfactory results



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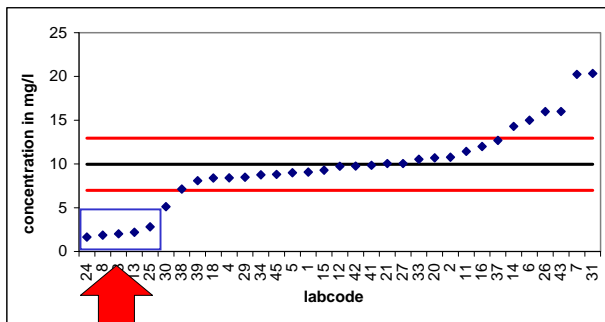
Nitrate

Individual performance development



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Nitrate 1

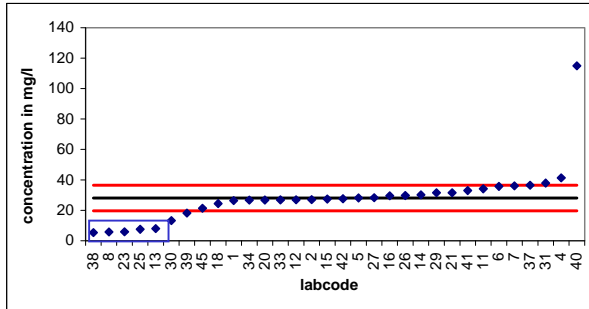


values:	37
removed:	4
mean:	9,58
ref.-value:	9,97
recovery:	96,1%
std:	4,559
rstd:	45,7%
std limit:	15%
upper limit:	12,96
lower limit:	6,98
too high:	7
too low:	9
outside limits:	16

most probably reported as NO₃⁻-N instead of NO₃⁻

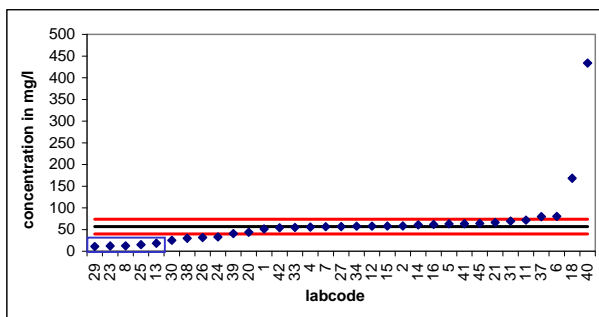
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Nitrate 2



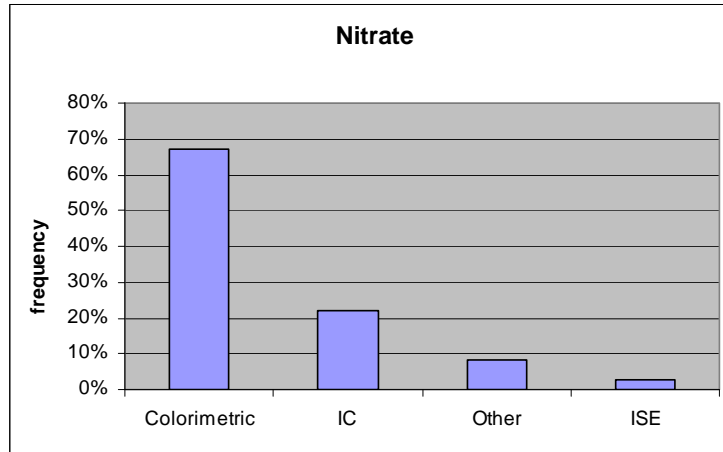
values:	36
removed:	4
mean:	26,77
ref.-value:	28,05
recovery:	95,4%
std:	10,001
rstd:	35,7%
std limit:	15%
upper limit:	36,47
lower limit:	19,64
too high:	4
too low:	11
outside limits:	15

Nitrate 3



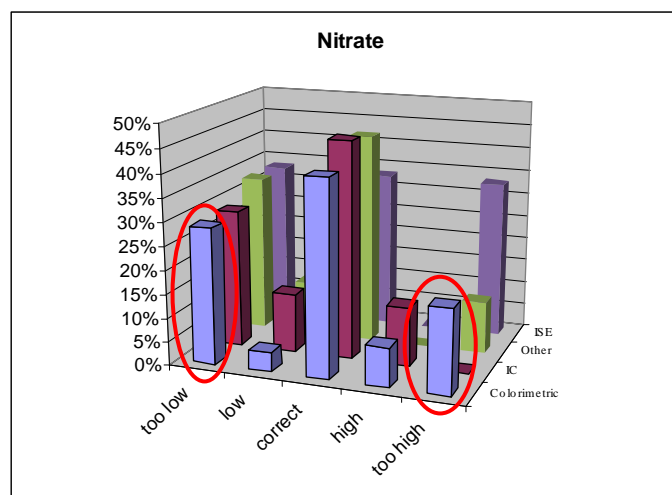
values:	36
removed:	3
mean:	51,74
ref.-value:	56,82
recovery:	91,0%
std:	24,121
rstd:	42,4%
std limit:	15%
upper limit:	73,87
lower limit:	39,78
too high:	4
too low:	12
outside limits:	16

Used methods



Many different methods hidden behind "colorimetric" – see separate presentation

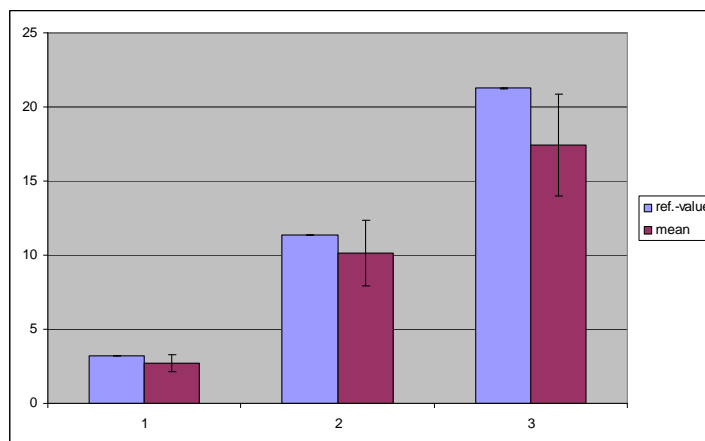
Comparison of methods



Summary Nitrate

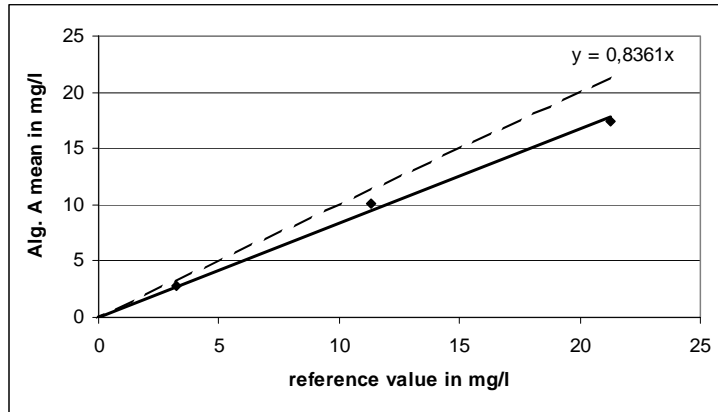
- some values obviously again reported in wrong units
- high number of outliers
- average quality is very bad! – no improvement!
- parameter needs more emphasis
- harmonization of methods?

Phosphate Alg.A mean and ref.-value from weighings



Means lower than reference values

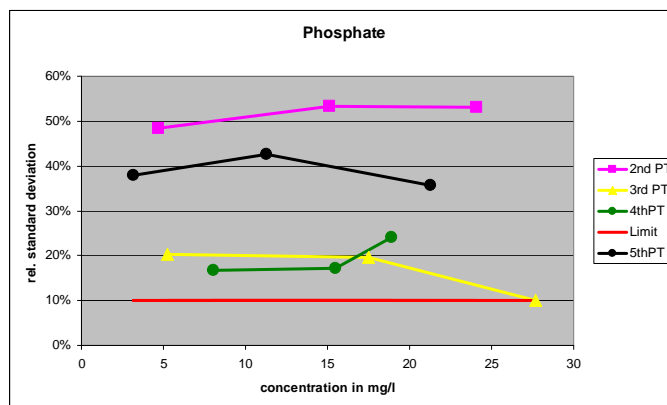
Phosphate mean vs. ref.-value



Average recovery: 83,6%; in 2007: 95,0%; in 2006: 96,1%

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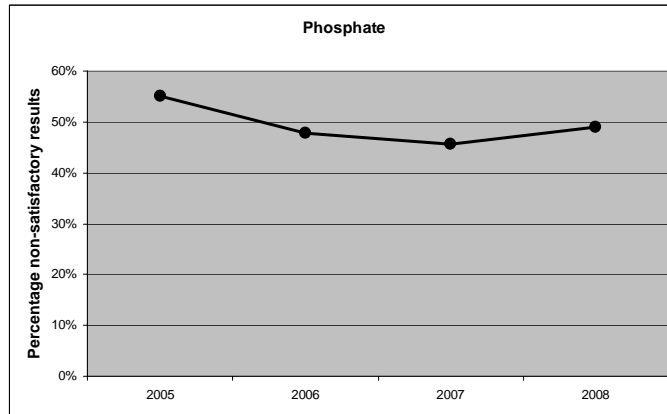
Phosphate calculated standard deviation and limit



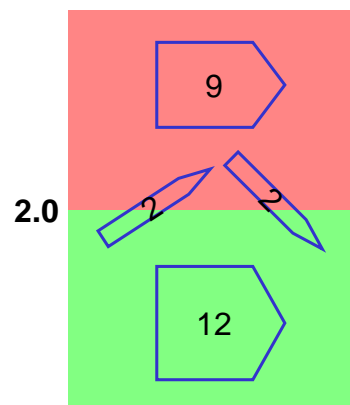
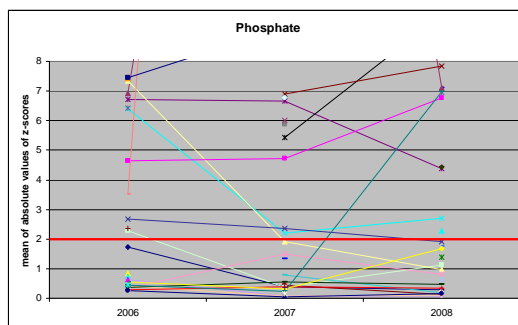
worse than in the last years

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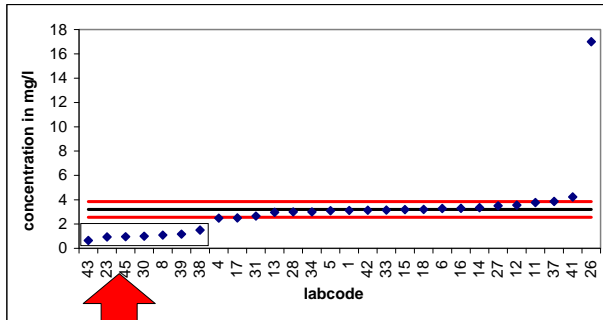
Phosphate Percentage non-satisfactory results



Phosphate Individual performance development



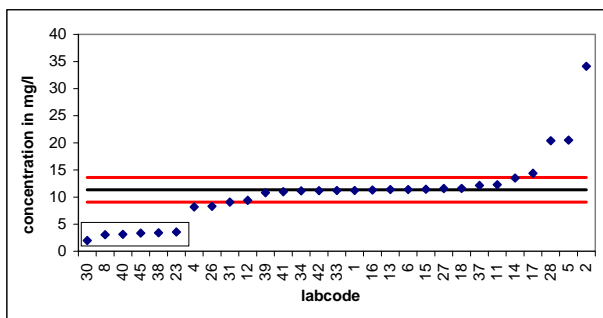
Phosphate 1



values:	32
removed:	4
mean:	2,73
ref.-value:	3,20
recovery:	85,3%
std:	1,212
rstd:	37,8%
std limit:	10%
upper limit:	3,84
lower limit:	2,56
too high:	4
too low:	12
outside limits:	16

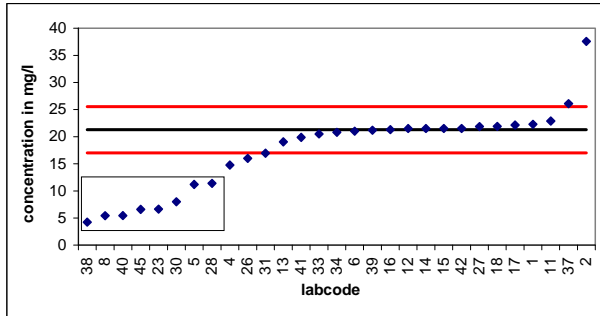
most probably reported in $\text{PO}_4^{3-}\text{-P}$ instead of PO_4^{3-}

Phosphate 2



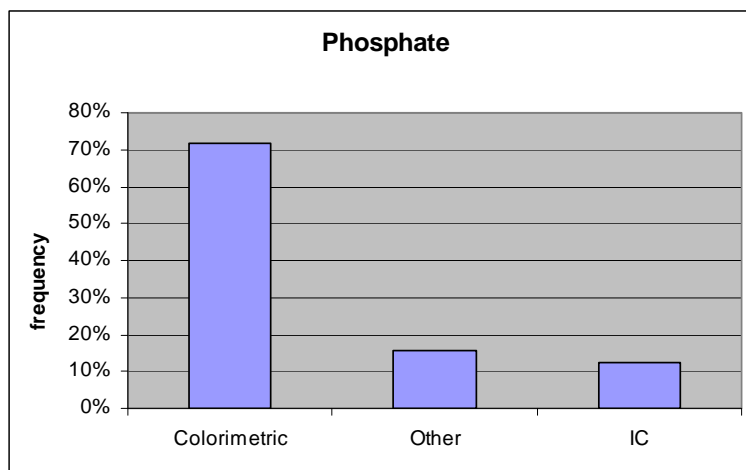
values:	32
removed:	3
mean:	10,14
ref.-value:	11,34
recovery:	89,4%
std:	4,817
rstd:	42,5%
std limit:	10%
upper limit:	13,61
lower limit:	9,07
too high:	4
too low:	11
outside limits:	15

Phosphate 3

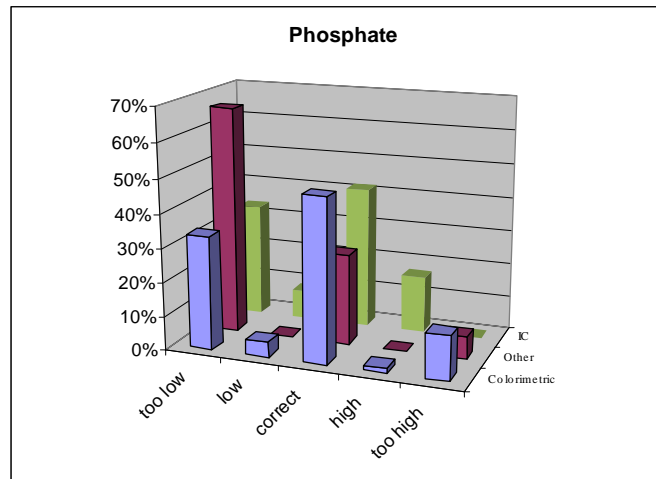


values:	32
removed:	3
mean:	17,43
ref.-value:	21,28
recovery:	81,9%
std:	7,590
rstd:	35,7%
std limit:	10%
upper limit:	25,53
lower limit:	17,02
too high:	2
too low:	14
outside limits:	16

Used methods



Comparison of methods

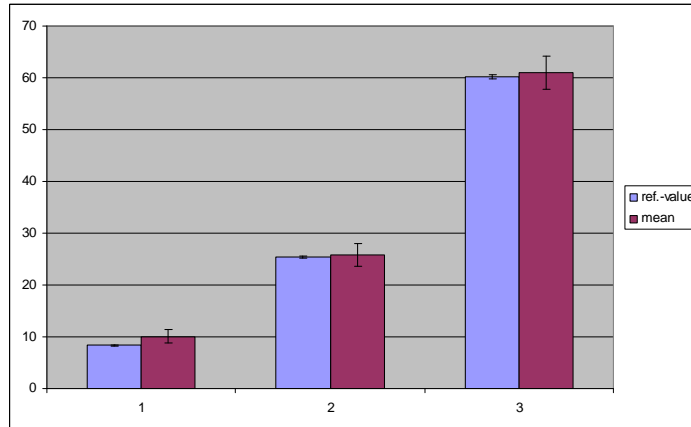


Summary Phosphate

- values in wrong units
- very high standard deviation

Calcium

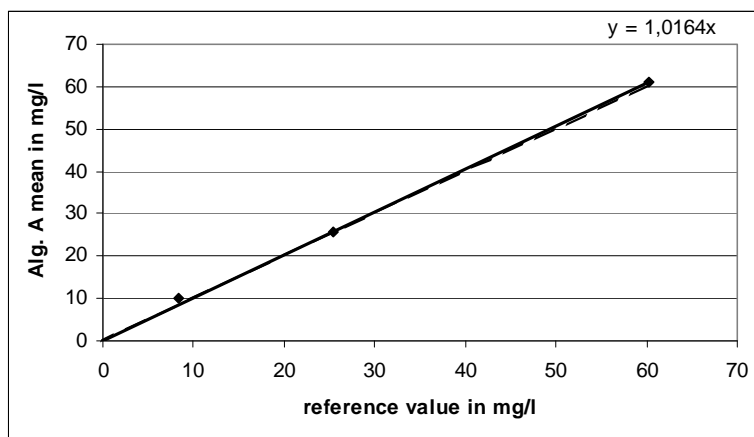
Alg.A mean and ref.-value from weighings



consensus mean close to ref.value

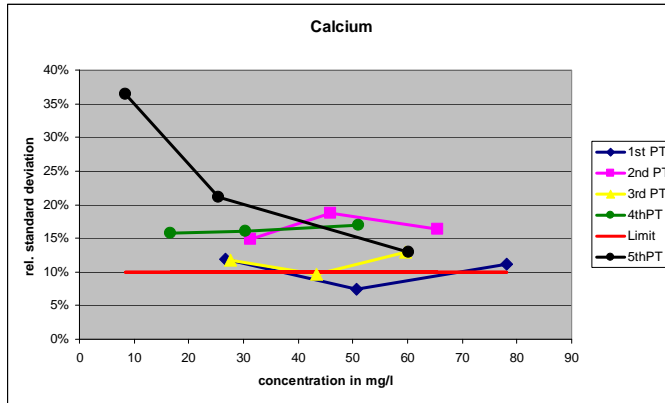
Calcium

mean vs. ref.-value



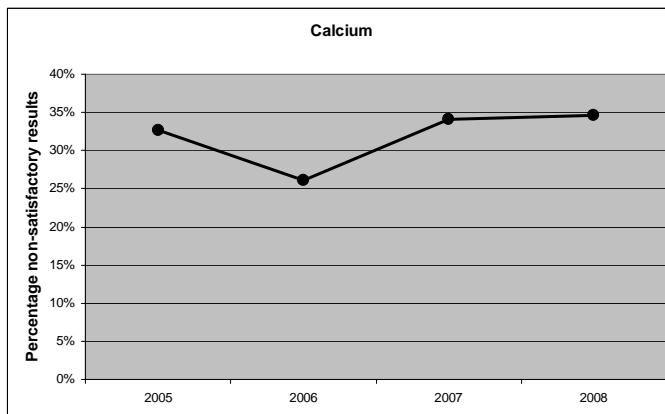
Average recovery: 101,6%; in 2007: 102,2%; in 2006: 97,2%

Calcium calculated standard deviation and limit



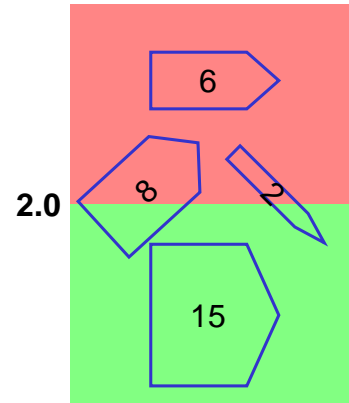
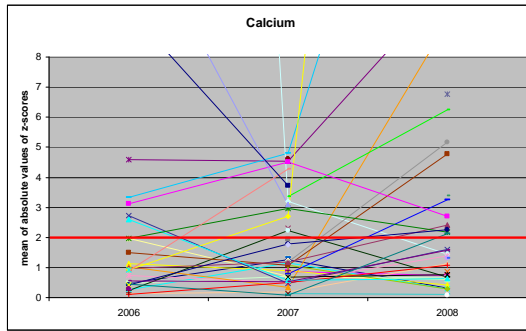
worse than in the last years, especially for low concentrations

Calcium Percentage non-satisfactory results

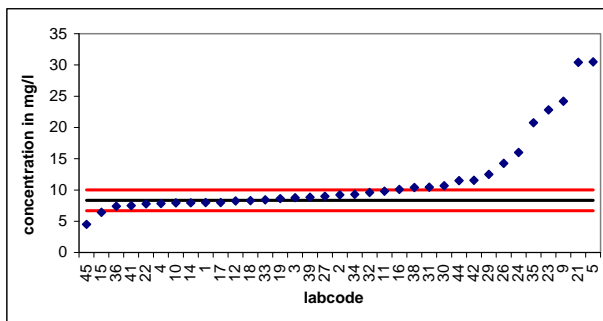


Calcium

Individual performance development

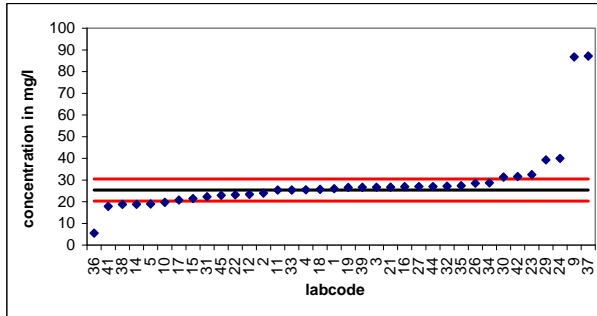


Calcium 1



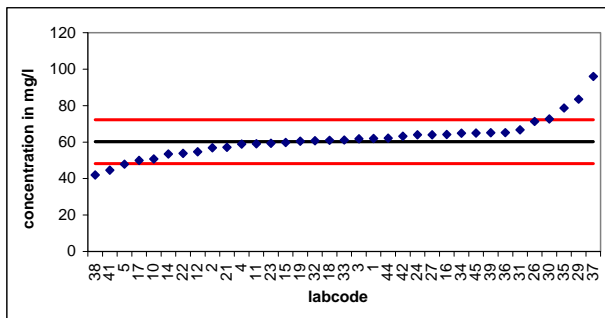
values:	36
removed:	1
mean:	10,05
ref.-value:	8,35
recovery:	120,4%
std:	3,044
rstd:	36,5%
std limit:	10%
upper limit:	10,01
lower limit:	6,68
too high:	15
too low:	2
outside limits:	17

Calcium 2



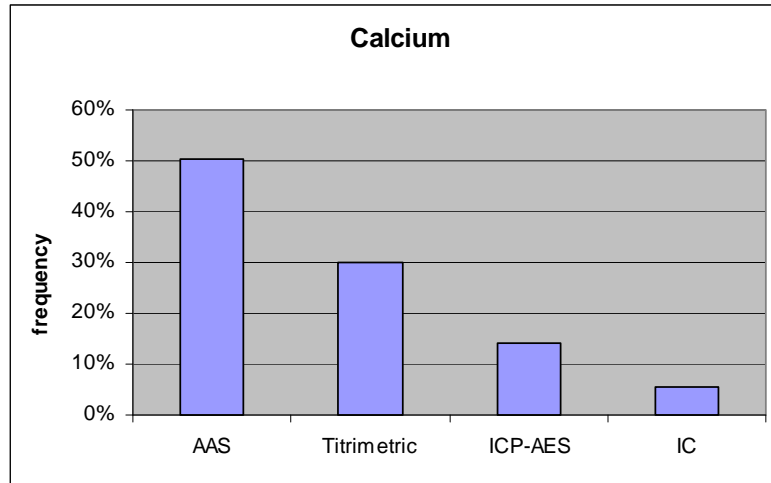
values:	36
removed:	0
mean:	25,80
ref.-value:	25,43
recovery:	101,5%
std:	5,375
rstd:	21,1%
std limit:	10%
upper limit:	30,51
lower limit:	20,34
too high:	7
too low:	6
outside limits:	13

Calcium 3

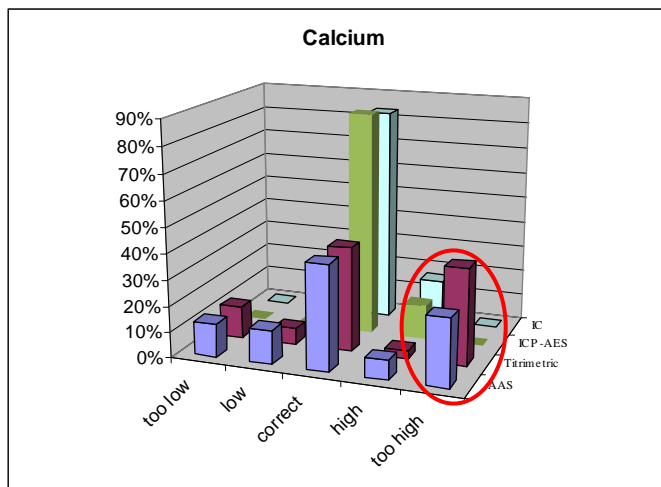


values:	35
removed:	0
mean:	61,02
ref.-value:	60,23
recovery:	101,3%
std:	7,832
rstd:	13,0%
std limit:	10%
upper limit:	72,28
lower limit:	48,19
too high:	4
too low:	3
outside limits:	7

Used methods



Comparison of methods

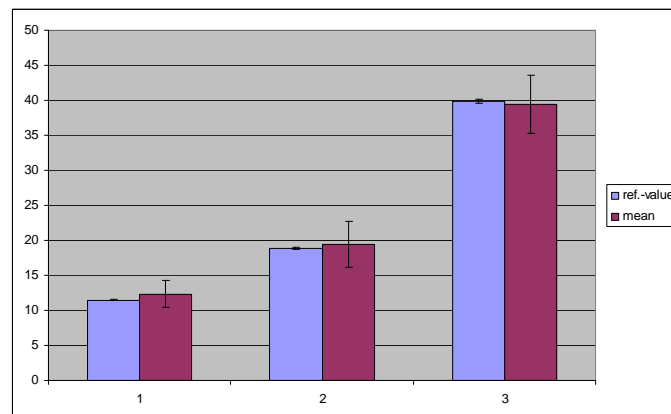


Summary Calcium

- mean values close to reference values
- standard deviations very high

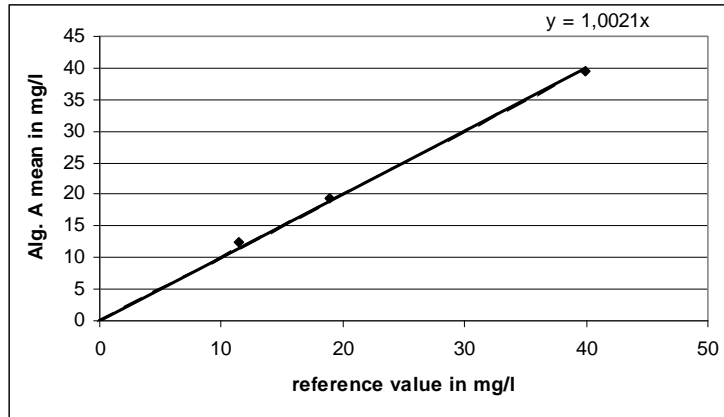
Magnesium

Alg.A mean and ref.-value from weighings



consensus mean close to ref.value

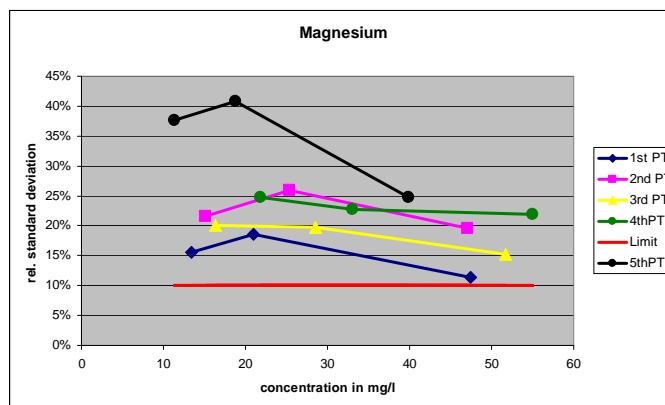
Magnesium mean vs. ref.-value



Average recovery: 100,2%; in 2007: 101.7%; in 2006: 99.6%

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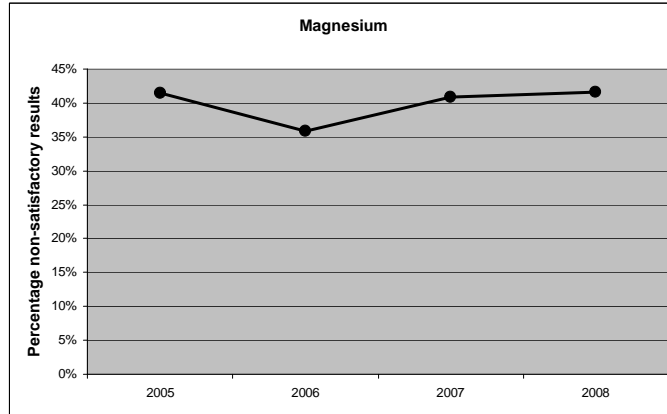
Magnesium calculated standard deviation and limit



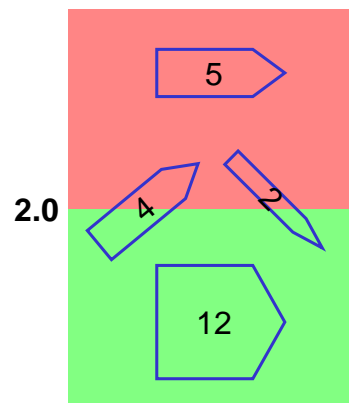
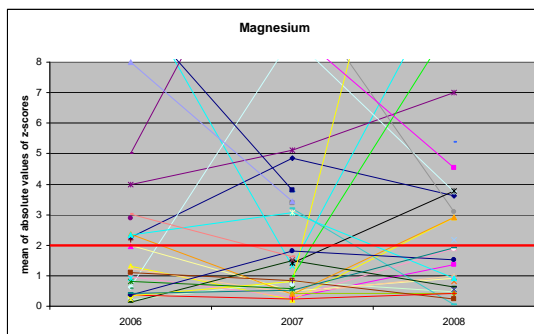
Much worse than in the last years

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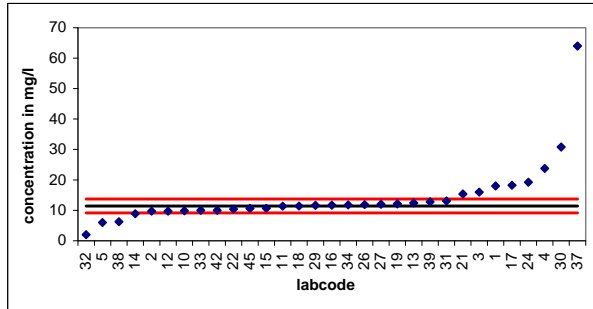
Magnesium Percentage non-satisfactory results



Magnesium Individual performance development

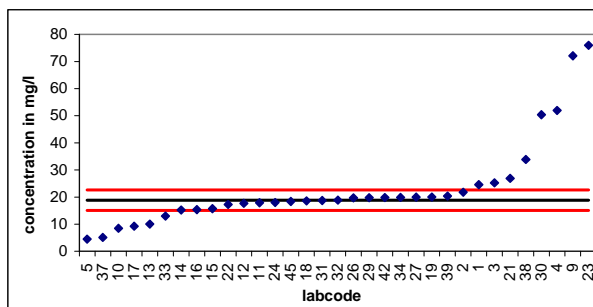


Magnesium 1



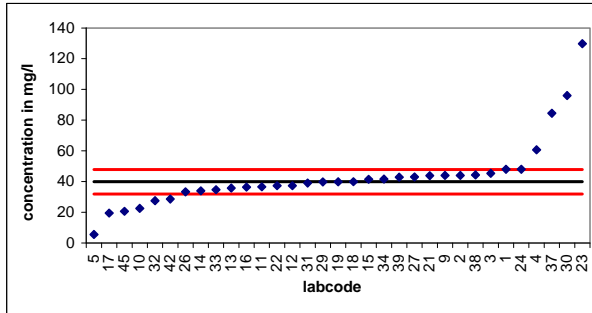
values:	33
removed:	2
mean:	12,35
ref.-value:	11,44
recovery:	108,0%
std:	4,303
rstd:	37,6%
std limit:	10%
upper limit:	13,73
lower limit:	9,15
too high:	9
too low:	5
outside limits:	14

Magnesium 2



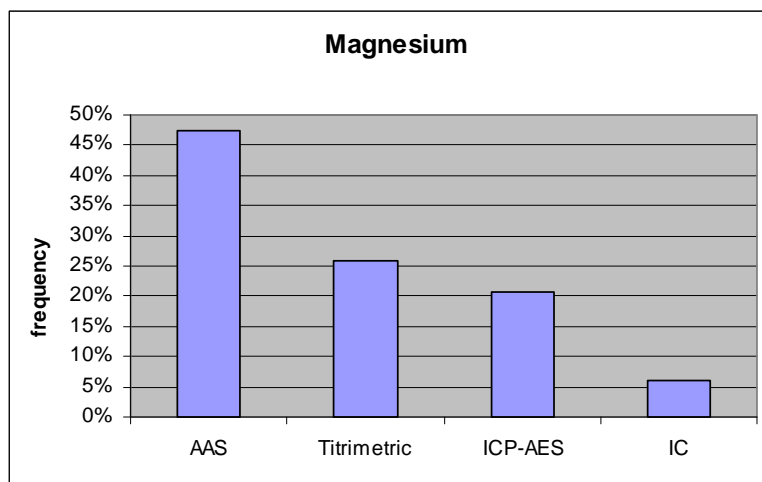
values:	34
removed:	1
mean:	19,44
ref.-value:	18,85
recovery:	103,1%
std:	7,693
rstd:	40,8%
std limit:	10%
upper limit:	22,62
lower limit:	15,08
too high:	8
too low:	7
outside limits:	15

Magnesium 3

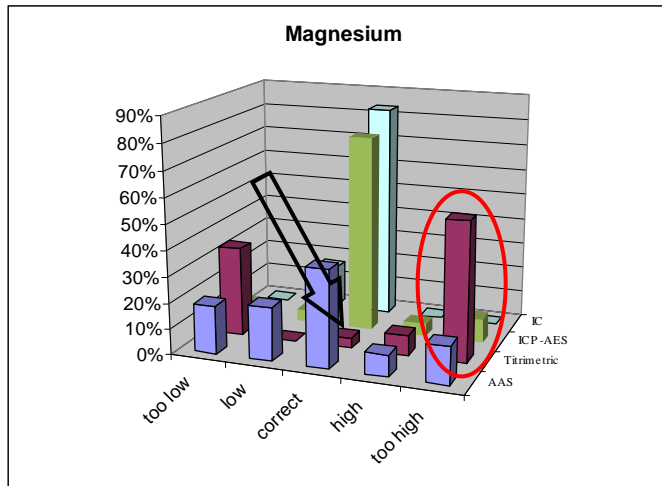


values:	34
removed:	1
mean:	39,44
ref.-value:	39,87
recovery:	98,9%
std:	9,843
rstd:	24,7%
std limit:	10%
upper limit:	47,85
lower limit:	31,90
too high:	6
too low:	7
outside limits:	13

Used methods



Comparison of methods



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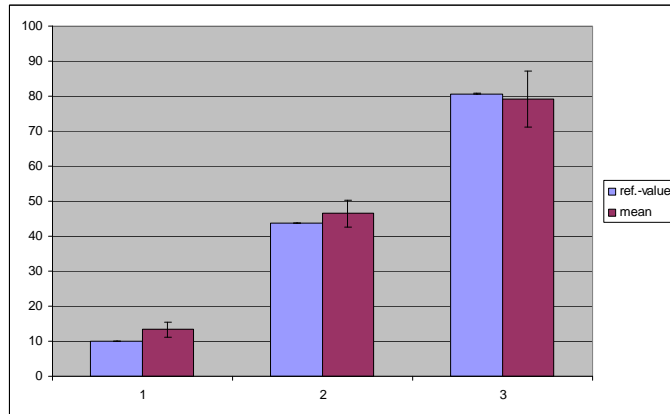
Summary Magnesium

- mean values around reference values
- standard deviations much too high
- titrimetric values not reliable

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Sodium

Alg.A mean and ref.-value from weighings

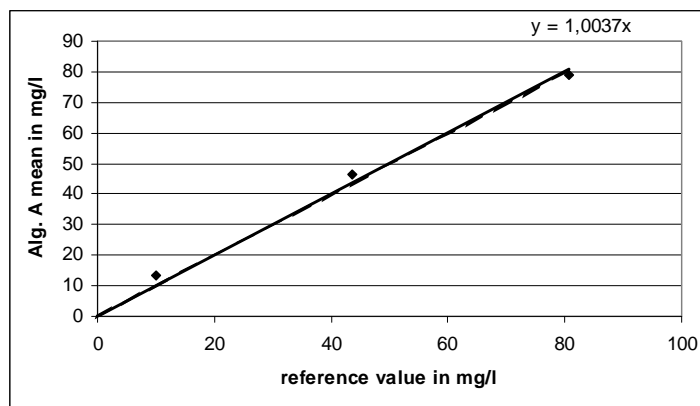


similar to 2007

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Sodium

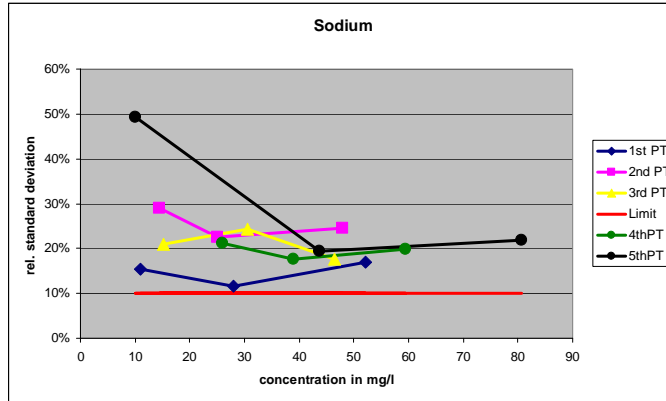
mean vs. ref.-value



Average recovery: 100,3%, but too high for low conc. and low for high conc.
 In 2007: 103,3%; in 2006: 104,4%

84 Koch, M.: PT evaluation – SADC MET PT Workshop 2008 Kampala

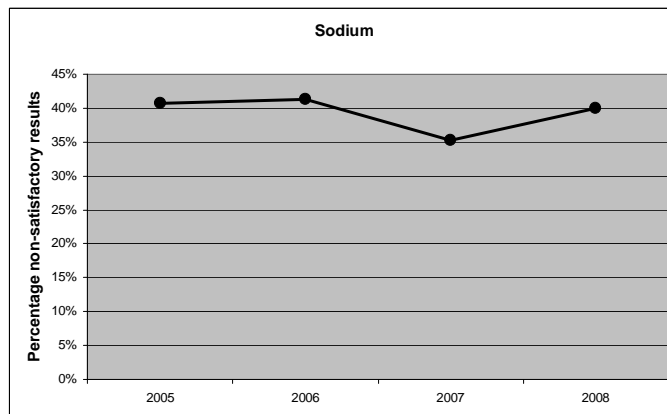
Sodium calculated standard deviation and limit



Very high for lowest conc.

85 Koch, M.: PT evaluation – SADC MET PT Workshop 2008 Kampala

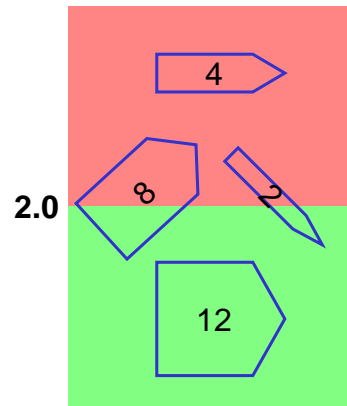
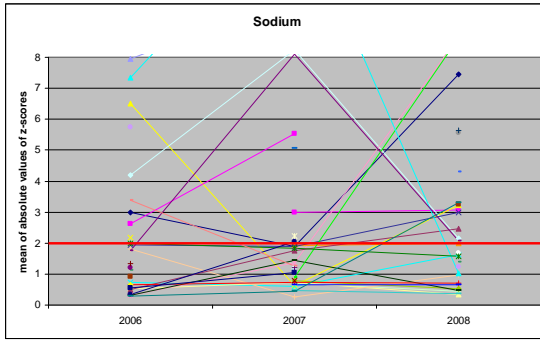
Sodium Percentage non-satisfactory results



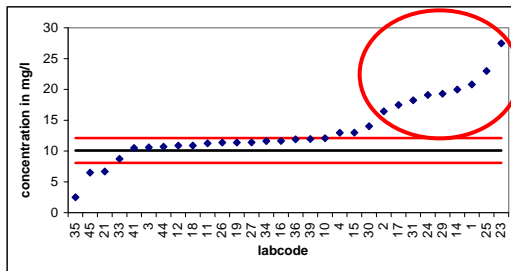
86 Koch, M.: PT evaluation – SADC MET PT Workshop 2008 Kampala

Sodium

Individual performance development

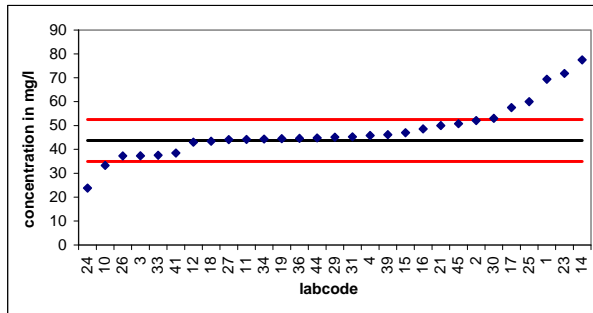


Sodium 1



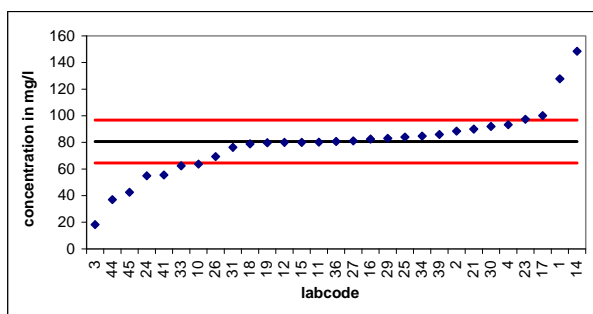
values:	30
removed:	0
mean:	13,29
ref.-value:	10,10
recovery:	131,7%
std:	4,987
rstd:	49,4%
std limit:	10%
upper limit:	12,12
lower limit:	8,08
too high:	12
too low:	3
outside limits:	15

Sodium 2



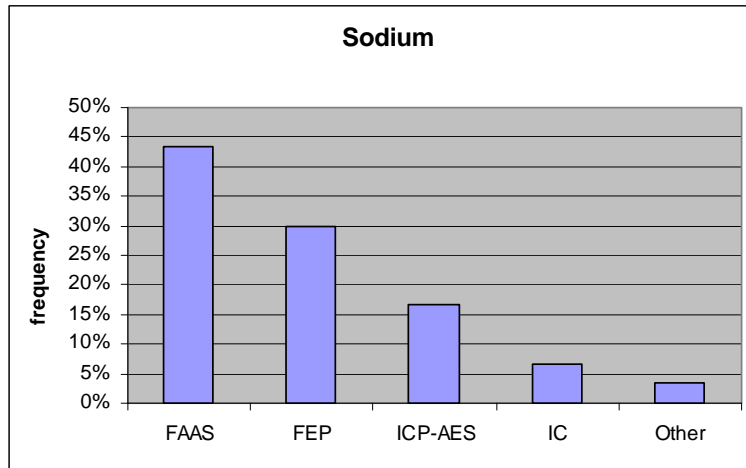
values:	30
removed:	1
mean:	46,54
ref.-value:	43,72
recovery:	106,4%
std:	8,489
rstd:	19,4%
std limit:	10%
upper limit:	52,46
lower limit:	34,98
too high:	6
too low:	3
outside limits:	9

Sodium 3



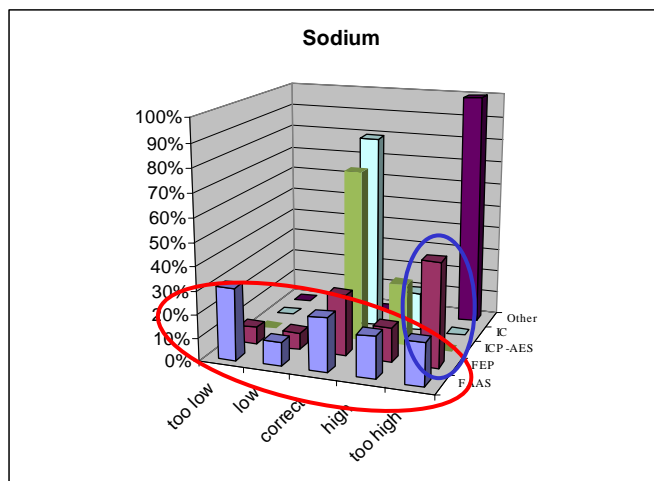
values:	30
removed:	1
mean:	79,06
ref.-value:	80,60
recovery:	98,1%
std:	17,567
rstd:	21,8%
std limit:	10%
upper limit:	96,72
lower limit:	64,48
too high:	4
too low:	8
outside limits:	12

Used methods



91 Koch, M.: PT evaluation – SADC MET PT Workshop 2008 Kampala

Comparison of methods



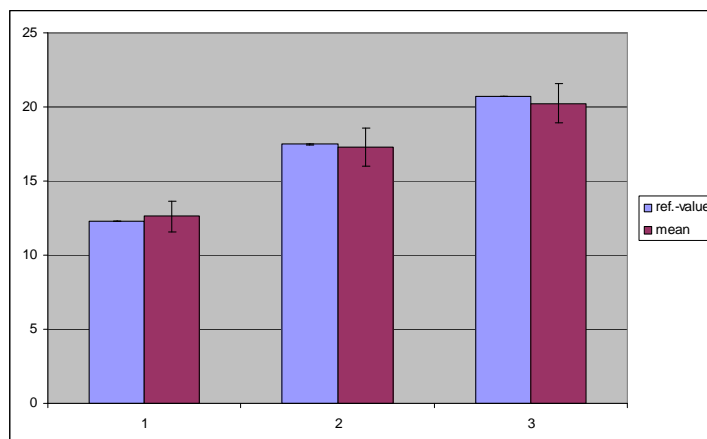
92 Koch, M.: PT evaluation – SADC MET PT Workshop 2008 Kampala

Summary Sodium

- consensus means close to ref.values
- standard deviations too high
- most probably calibration problems in some labs
- many too high values with FEP
- unreliable data with AAS

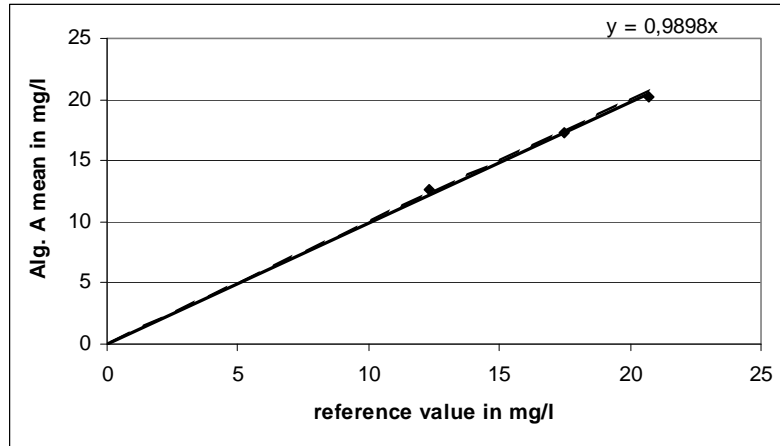
Potassium

Alg.A mean and ref.-value from weighings



consensus mean close to ref.value

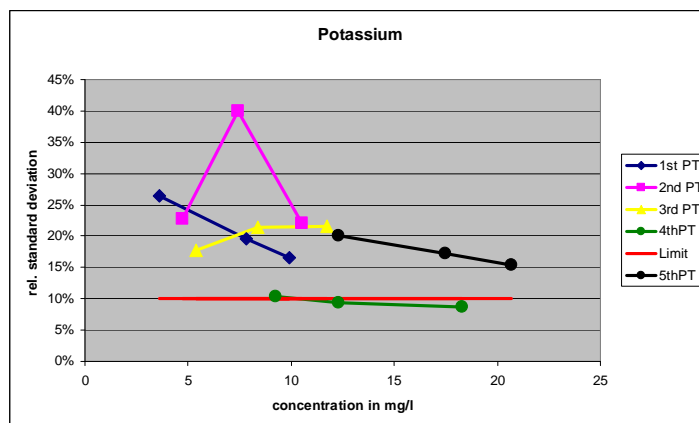
Potassium mean vs. ref.-value



Average recovery: 99.0%; in 2007: 98.5%; in 2006: 96.9%

95 Koch, M.: PT evaluation – SADC MET PT Workshop 2008 Kampala

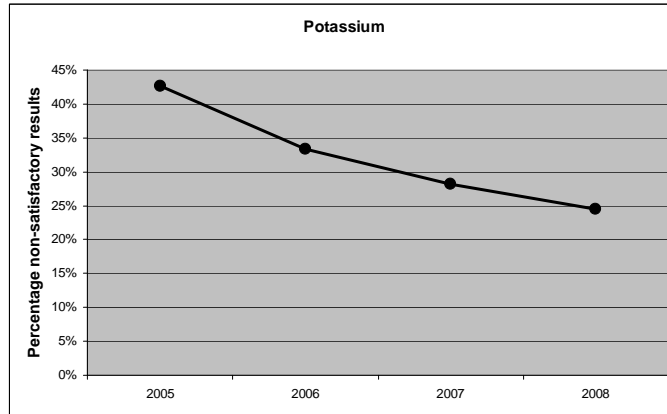
Potassium calculated standard deviation and limit



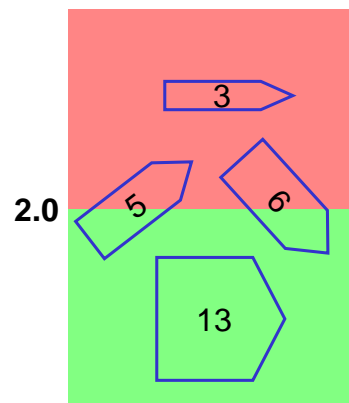
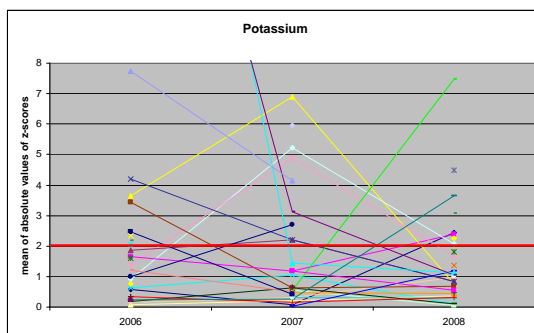
Standard deviations worse than in 2007

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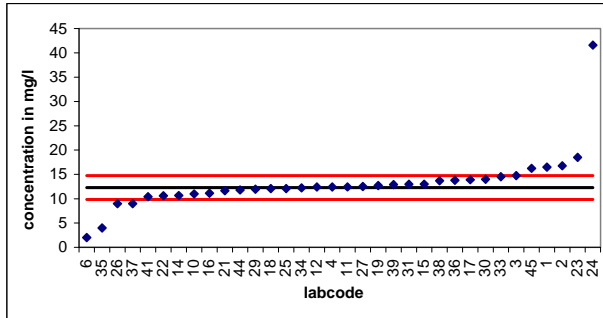
Potassium Percentage non-satisfactory results



Potassium Individual performance development

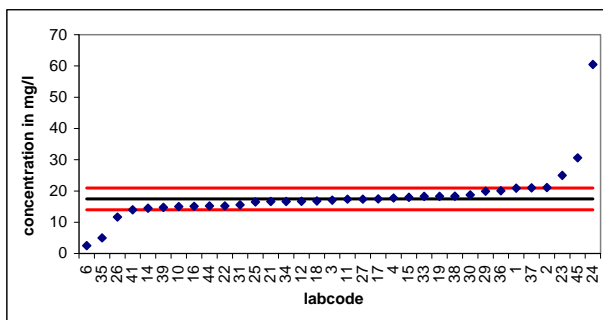


Potassium 1



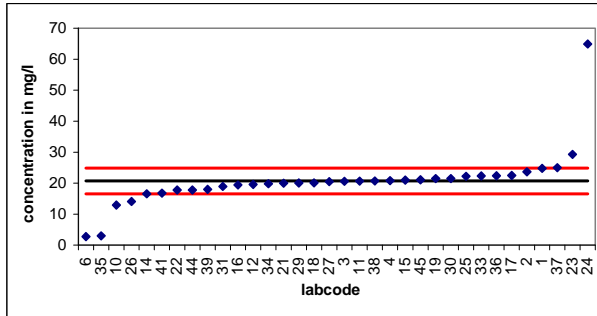
values:	34
removed:	0
mean:	12,62
ref.-value:	12,30
recovery:	102,6%
std:	2,478
rstd:	20,1%
std limit:	10%
upper limit:	14,76
lower limit:	9,84
too high:	5
too low:	4
outside limits:	9

Potassium 2



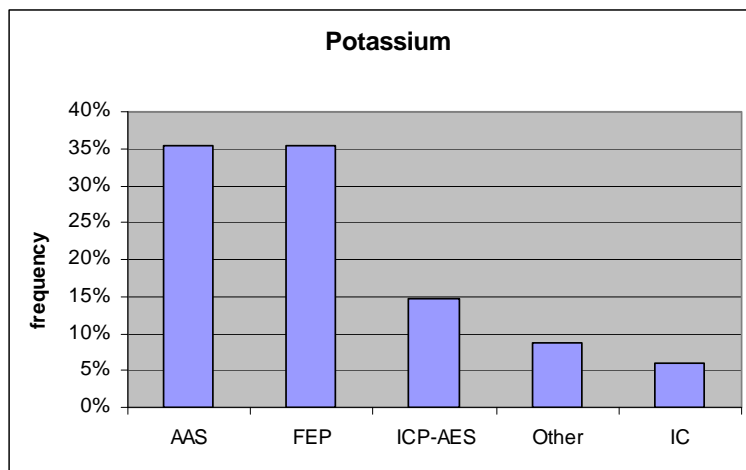
values:	34
removed:	0
mean:	17,30
ref.-value:	17,48
recovery:	99,0%
std:	3,024
rstd:	17,3%
std limit:	10%
upper limit:	20,97
lower limit:	13,98
too high:	5
too low:	3
outside limits:	8

Potassium 3

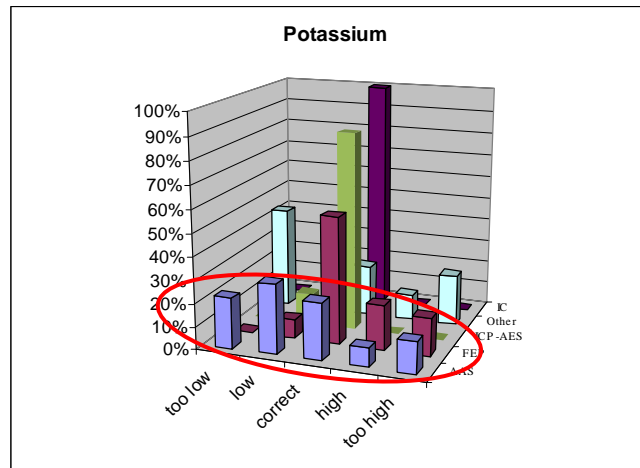


values:	34
removed:	0
mean:	20,24
ref.-value:	20,72
recovery:	97,7%
std:	3,191
rstd:	15,4%
std limit:	10%
upper limit:	24,86
lower limit:	16,57
too high:	3
too low:	5
outside limits:	8

Used methods



Comparison of methods



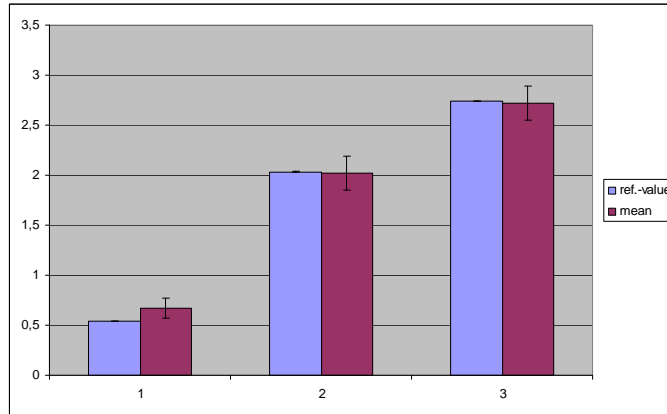
Summary Potassium

- Mean values close to reference values
- standard deviations higher than last year
- AAS values not reliable



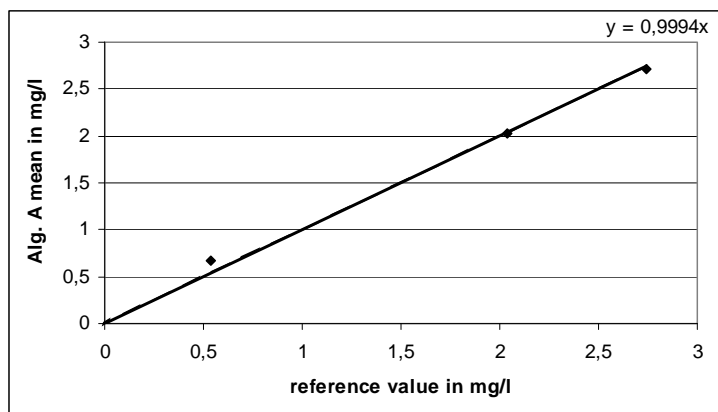
Iron

Alg.A mean and ref.-value from weighings



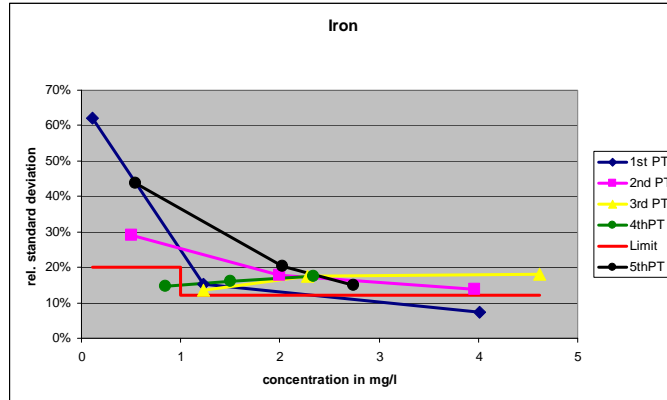
Iron

mean vs. ref.-value



Average recovery: 99.9%; in 2007: 92.9%; in 2006: 88.0%
But for lowest level mean a bit too high

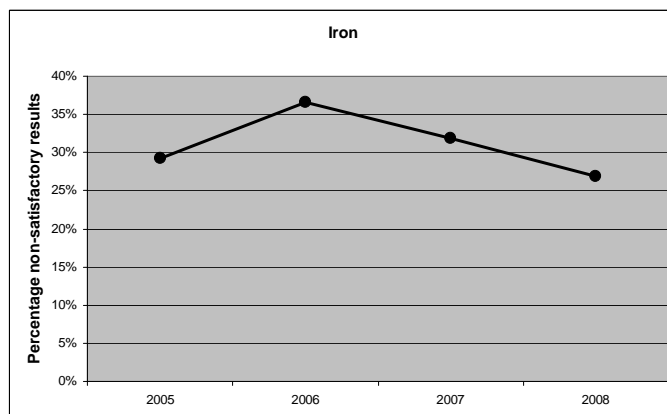
Iron calculated standard deviation and limit



higher than in last years

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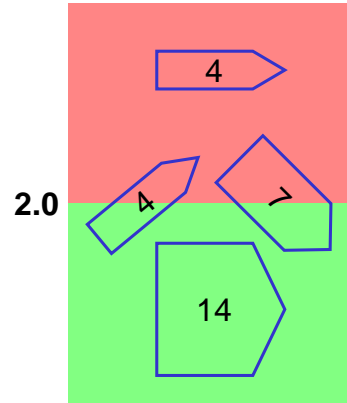
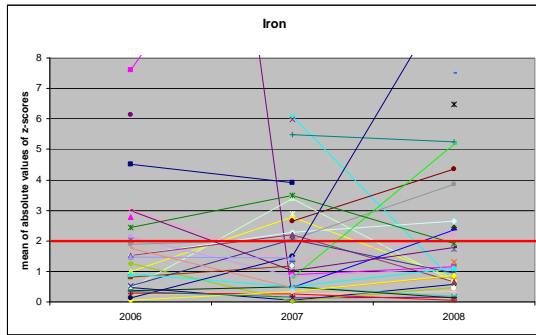
Iron Percentage non-satisfactory results



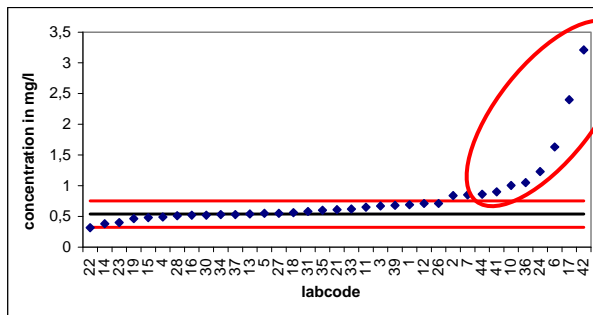
108 Koch, M.: PT evaluation – SADC MET PT Workshop 2008 Kampala

Iron

Individual performance development

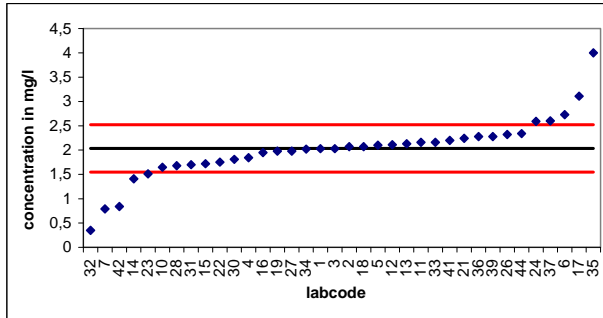


Iron 1



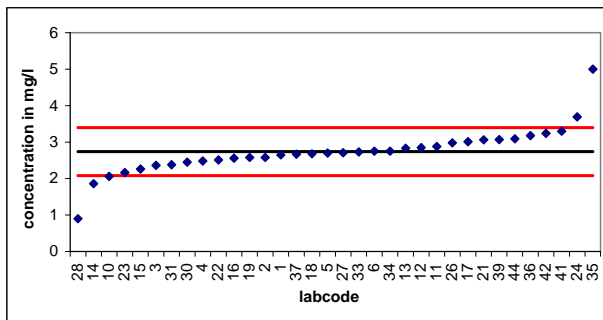
values:	36
removed:	1
mean:	0,67
ref.-value:	0,54
recovery:	124,4%
std:	0,236
rstd:	43,8%
std limit:	20%
upper limit:	0,75
lower limit:	0,32
too high:	10
too low:	2
outside limits:	12

Iron 2



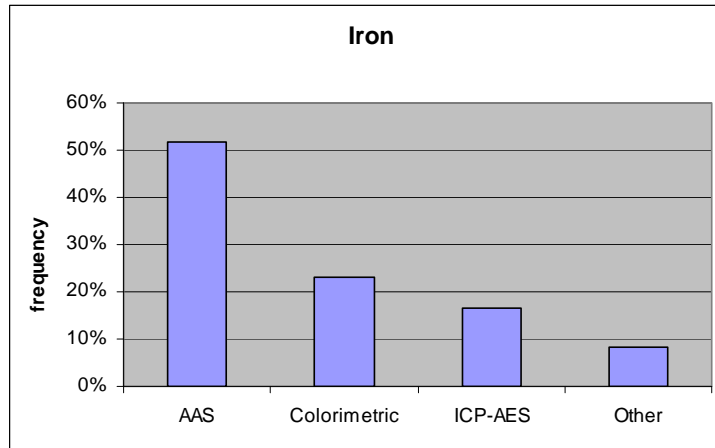
values:	36
removed:	0
mean:	2,02
ref.-value:	2,03
recovery:	99,5%
std:	0,416
rstd:	20,4%
std limit:	12%
upper limit:	2,52
lower limit:	1,55
too high:	5
too low:	5
outside limits:	10

Iron 3

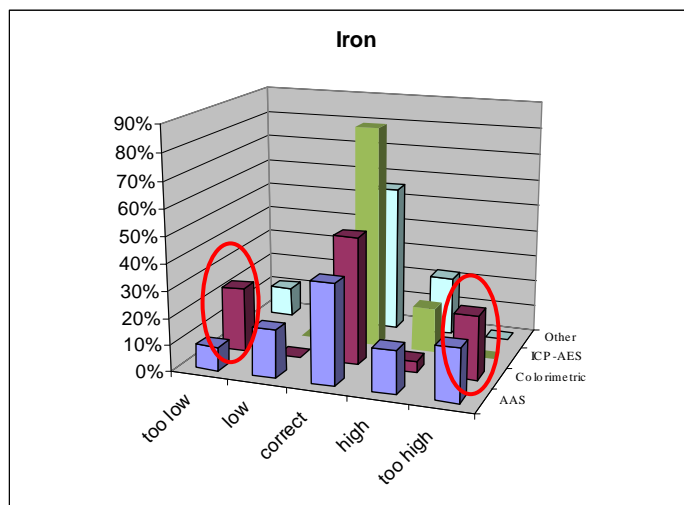


values:	36
removed:	2
mean:	2,72
ref.-value:	2,74
recovery:	99,2%
std:	0,410
rstd:	15,0%
std limit:	12%
upper limit:	3,40
lower limit:	2,08
too high:	2
too low:	5
outside limits:	7

Used methods



Comparison of methods

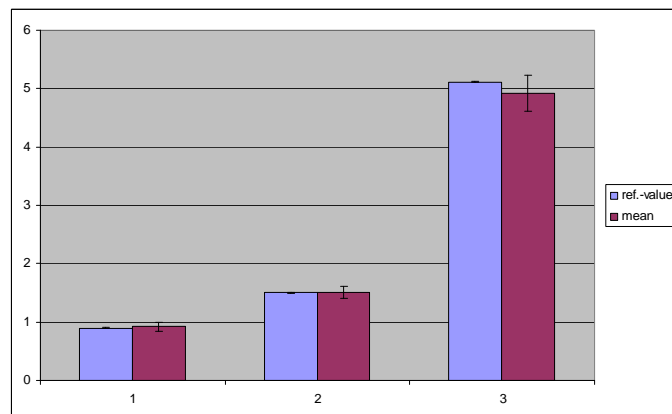


Summary Iron

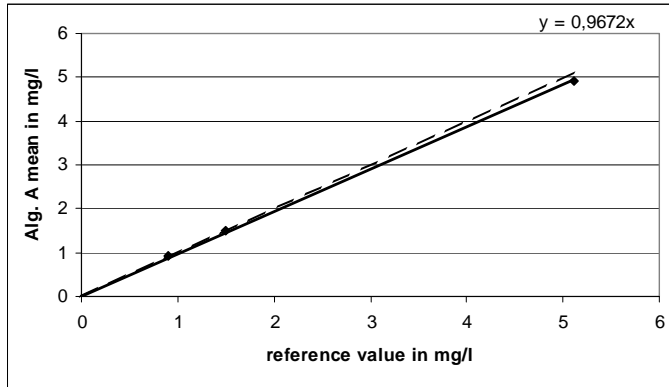
- means close to reference values
- standard deviations too higher
- many outliers with colorimetric method

Manganese

Alg.A mean and ref.-value from weighings

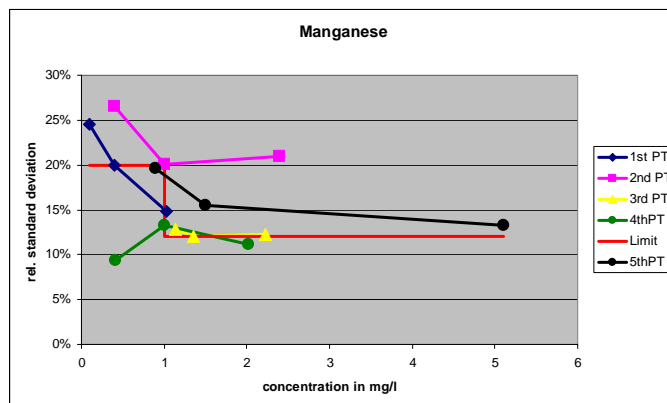


Manganese mean vs. ref.-value



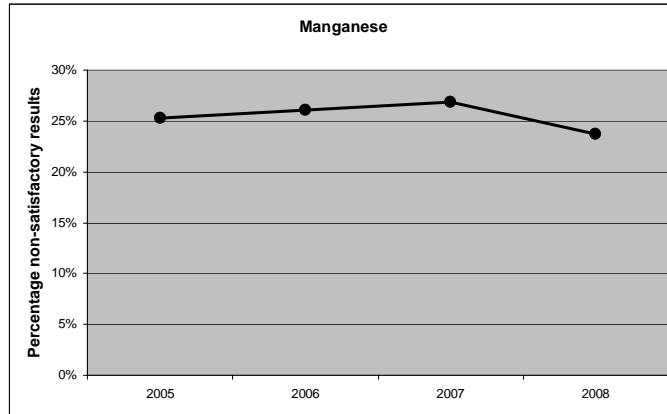
Average recovery: 96.7%, mostly caused by the highest level
in 2007: 96.0%; in 2006: 95.4%

Manganese calculated standard deviation and limit

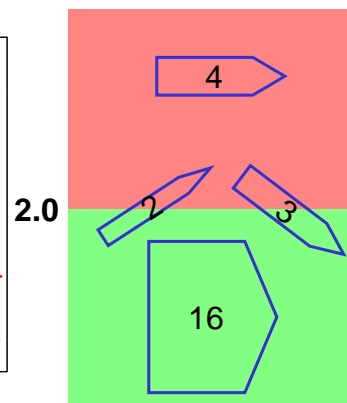
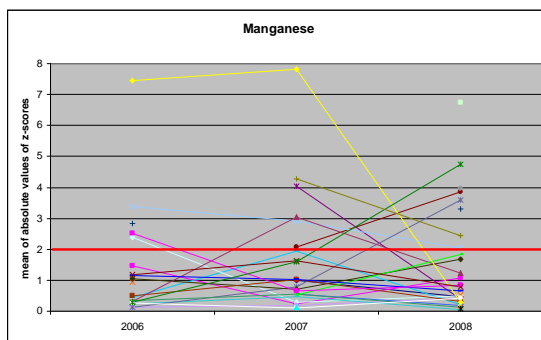


higher than in 2007

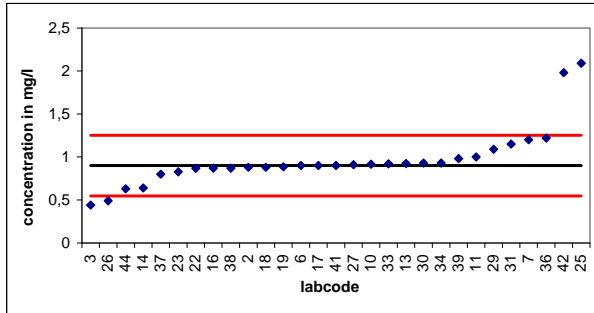
Manganese Percentage non-satisfactory results



Manganese Individual performance development

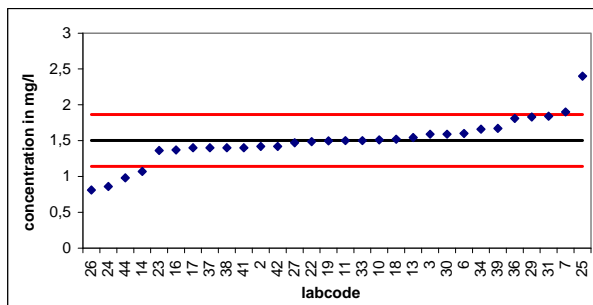


Manganese 1



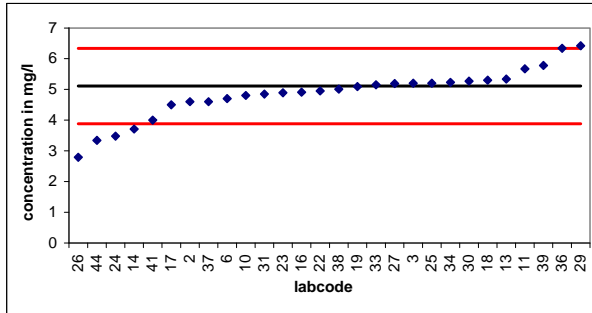
values:	31
removed:	2
mean:	0,92
ref.-value:	0,90
recovery:	102,4%
std:	0,176
rstd:	19,6%
std limit:	20%
upper limit:	1,25
lower limit:	0,55
too high:	2
too low:	4
outside limits:	6

Manganese 2



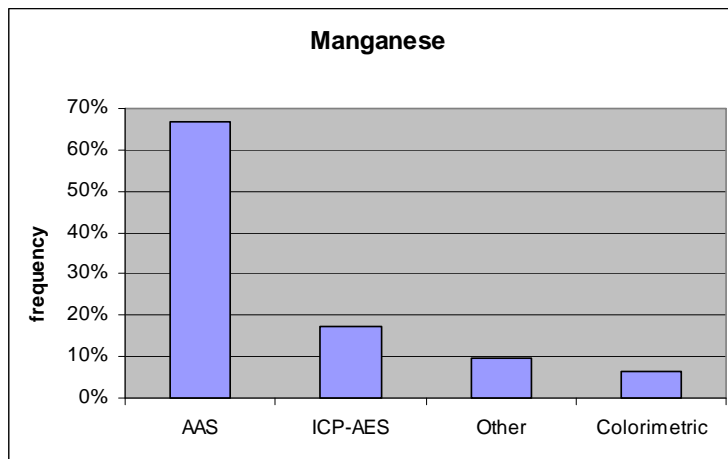
values:	31
removed:	1
mean:	1,50
ref.-value:	1,50
recovery:	100,1%
std:	0,232
rstd:	15,4%
std limit:	12%
upper limit:	1,86
lower limit:	1,14
too high:	2
too low:	5
outside limits:	7

Manganese 3

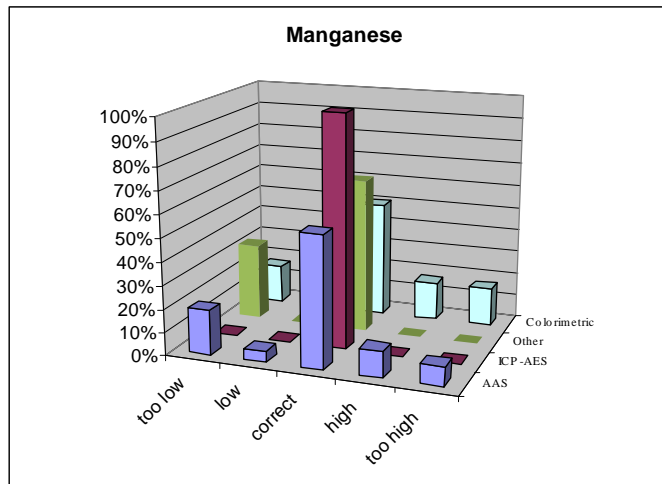


values:	31
removed:	3
mean:	4,92
ref.-value:	5,11
recovery:	96,2%
std:	0,680
rstd:	13,3%
std limit:	12%
upper limit:	6,34
lower limit:	3,88
too high:	2
too low:	7
outside limits:	9

Used methods



Comparison of methods



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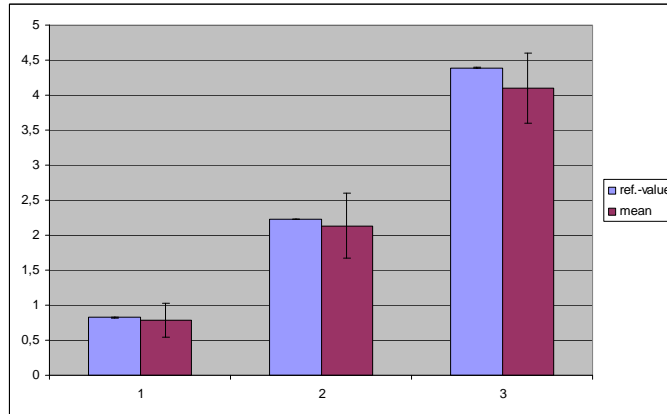
Summary Manganese

- mean values close to reference values
- standard deviation higher than in 2007

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Aluminium

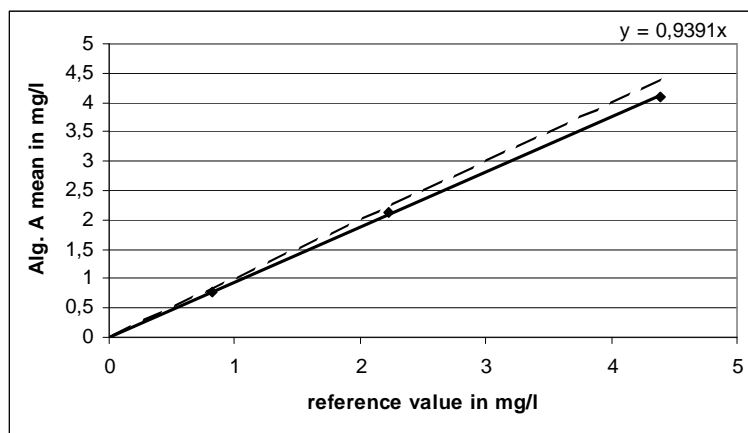
Alg.A mean and ref.-value from weighings



consensus means a bit lower than ref.-values

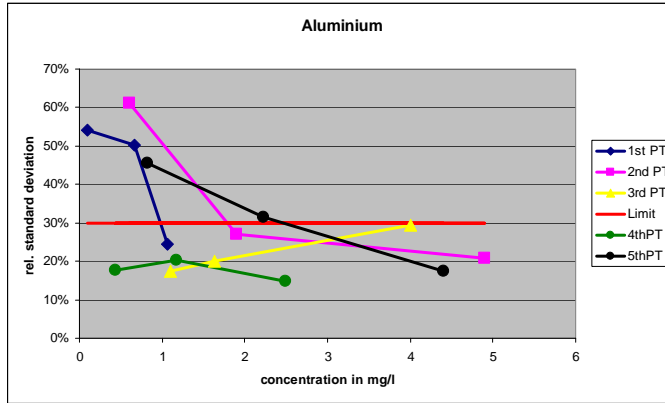
Aluminium

mean vs. ref.-value



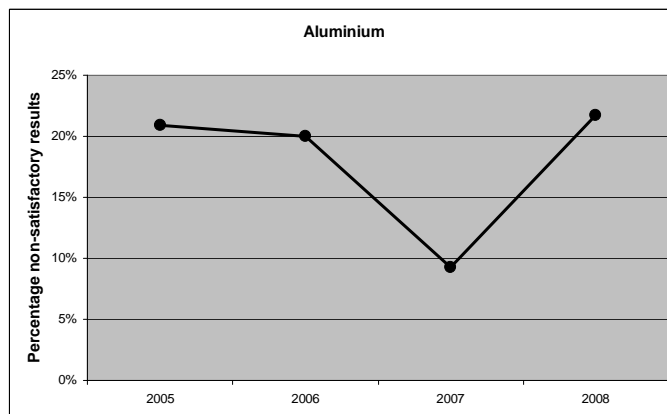
Average recovery: 93.9%; in 2007: 96.1%; in 2006: 85.7%

Aluminium calculated standard deviation and limit



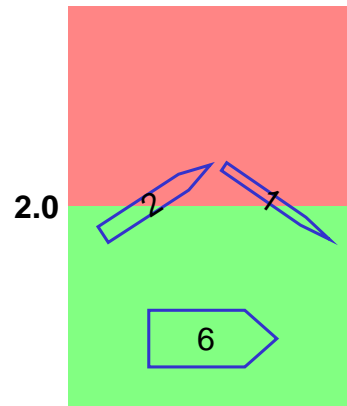
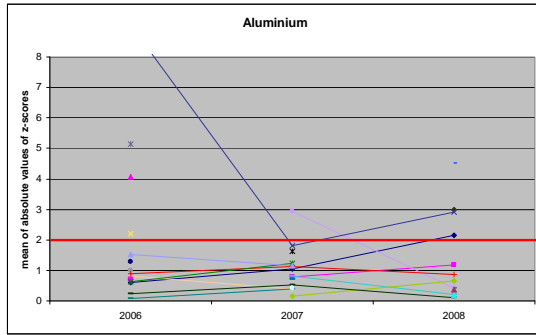
Standard deviation higher

Aluminium Percentage non-satisfactory results

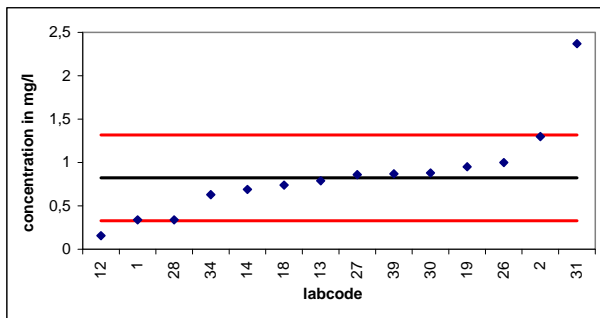


Aluminium

Individual performance development

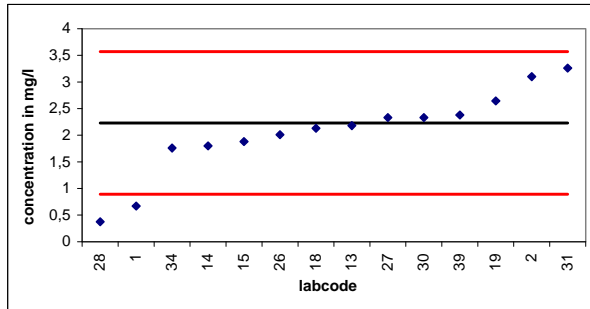


Aluminium 1



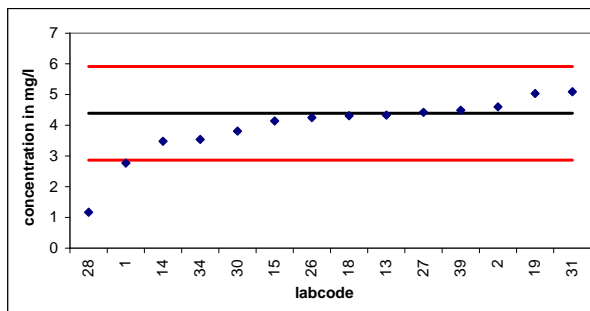
values:	15
removed:	1
mean:	0,78
ref.-value:	0,82
recovery:	95,0%
std:	0,375
rstd:	45,6%
std limit:	30%
upper limit:	1,32
lower limit:	0,33
too high:	1
too low:	2
outside limits:	3

Aluminium 2



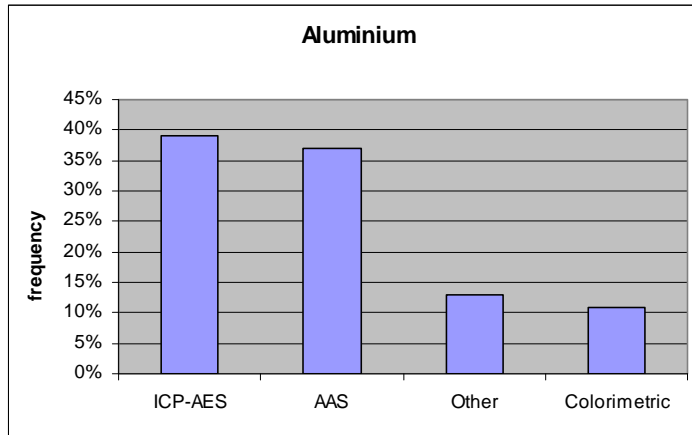
values:	15
removed:	1
mean:	2,14
ref.-value:	2,23
recovery:	95,7%
std:	0,703
rstd:	31,5%
std limit:	30%
upper limit:	3,57
lower limit:	0,89
too high:	0
too low:	3
outside limits:	3

Aluminium 3

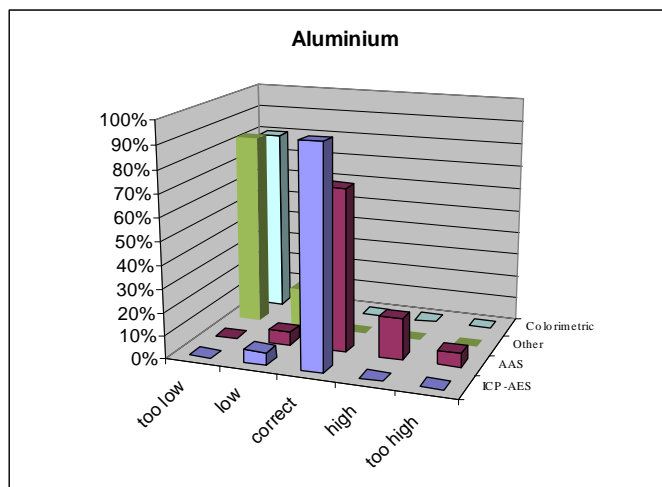


values:	16
removed:	2
mean:	4,10
ref.-value:	4,39
recovery:	93,4%
std:	0,762
rstd:	17,3%
std limit:	30%
upper limit:	5,91
lower limit:	2,87
too high:	0
too low:	4
outside limits:	4

Used methods



Comparison of methods

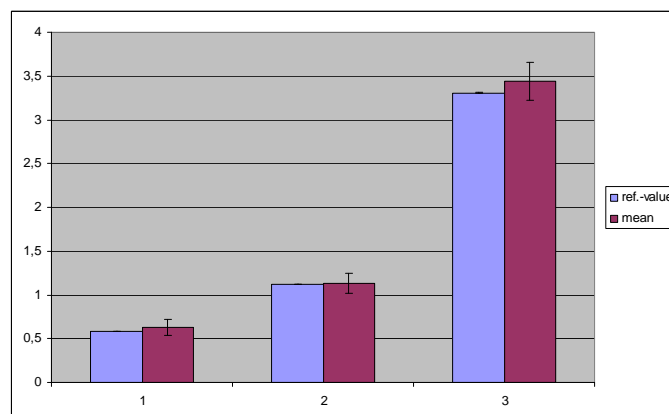


Summary Aluminium

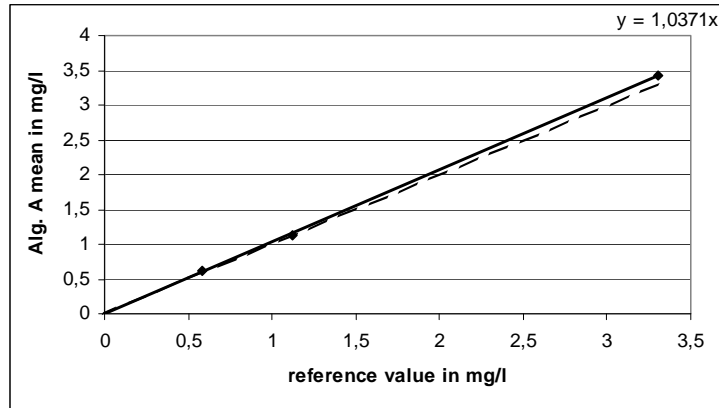
- small number of values
- mean values a bit below reference values

Lead

Alg.A mean and ref.-value from weighings



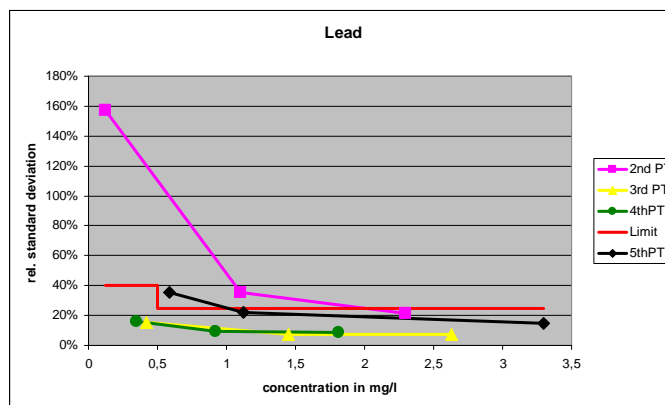
Lead mean vs. ref.-value



Average recovery: 103.7%; in 2007: 95.4%; in 2006: 95.6%

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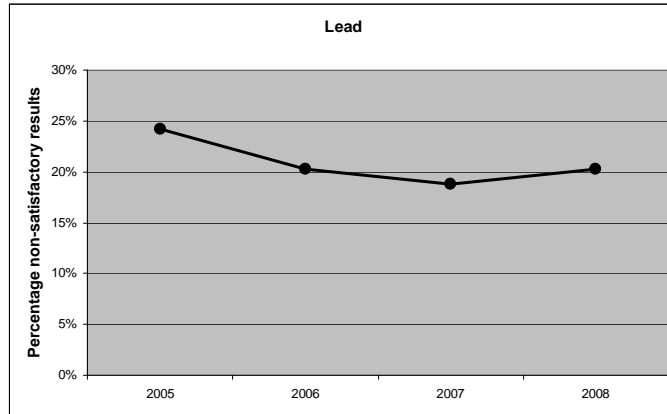
Lead calculated standard deviation and limit



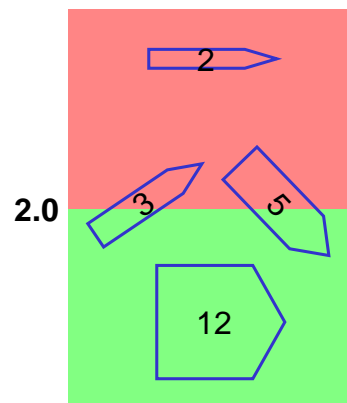
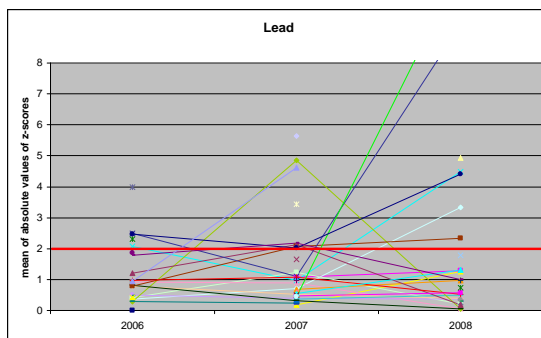
Higher than in last years

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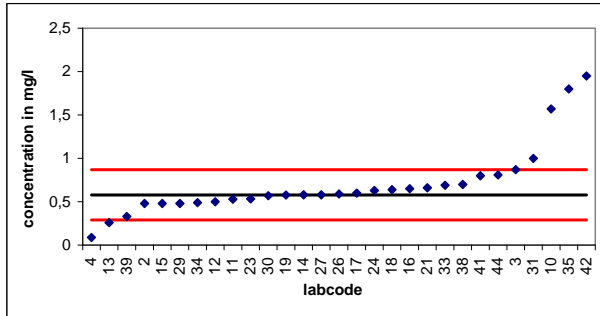
Lead Percentage non-satisfactory results



Lead Individual performance development

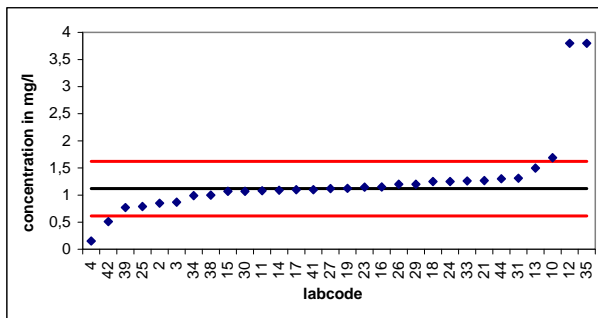


Lead 1



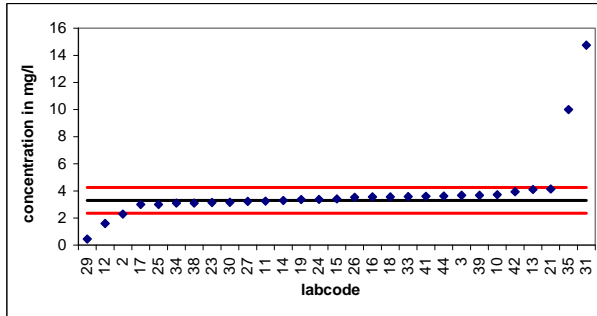
values:	29
removed:	0
mean:	0,63
ref.-value:	0,58
recovery:	108,0%
std:	0,206
rstd:	35,5%
std limit:	25%
upper limit:	0,87
lower limit:	0,29
too high:	5
too low:	2
outside limits:	7

Lead 2



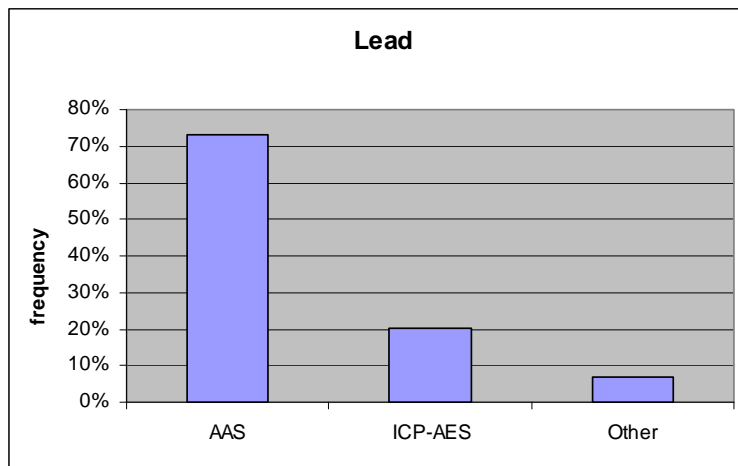
values:	30
removed:	0
mean:	1,13
ref.-value:	1,12
recovery:	100,9%
std:	0,251
rstd:	22,4%
std limit:	25%
upper limit:	1,62
lower limit:	0,62
too high:	3
too low:	2
outside limits:	5

Lead 3

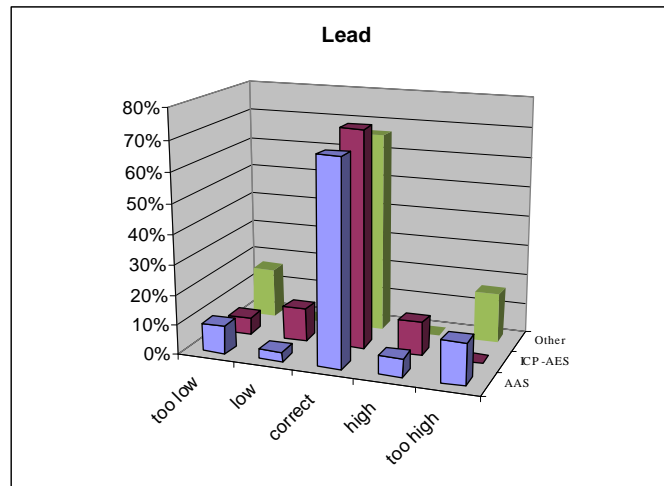


values:	30
removed:	1
mean:	3,43
ref.-value:	3,31
recovery:	103,9%
std:	0,477
rstd:	14,4%
std limit:	25%
upper limit:	4,26
lower limit:	2,35
too high:	2
too low:	4
outside limits:	6

Used methods



Comparison of methods



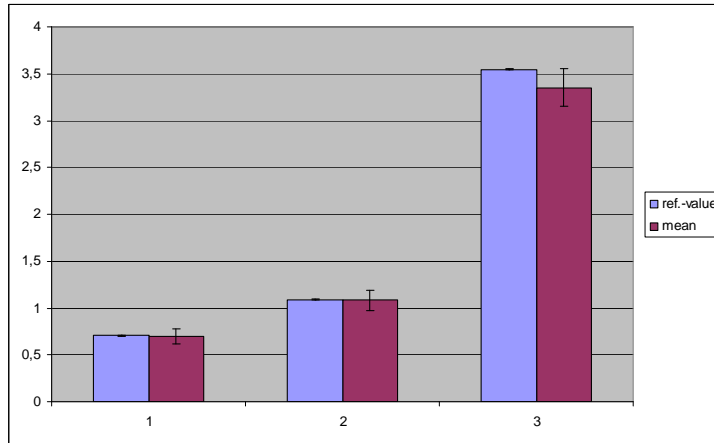
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Summary Lead

- mean values around reference values
- standard deviation higher than in last years

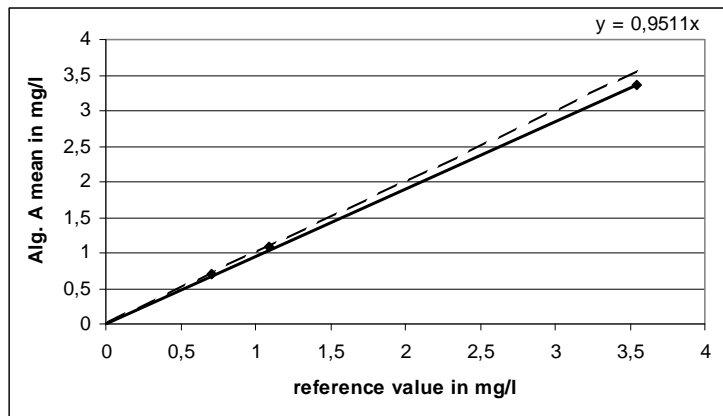
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Copper Alg.A mean and ref.-value from weighings



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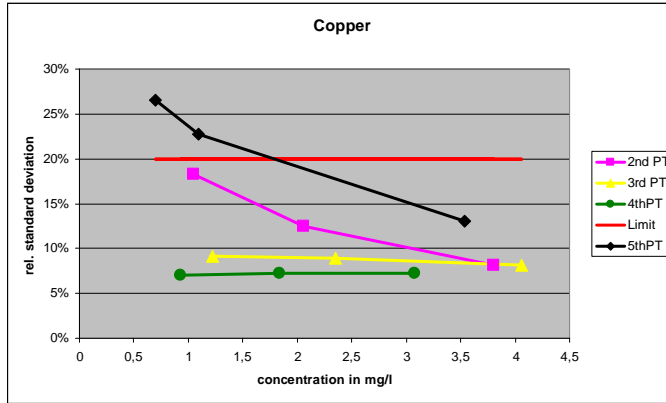
Copper mean vs. ref.-value



Average recovery: 95,1%, mainly caused by the highest level
in 2007: 97,5%; in 2006: 98,5%

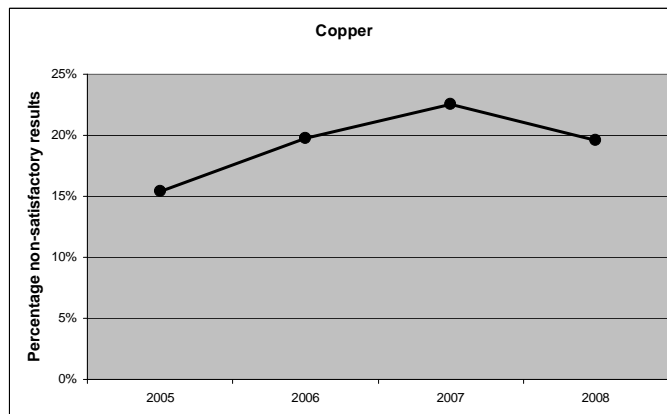
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Copper calculated standard deviation and limit

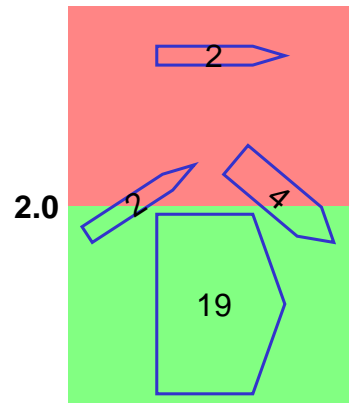
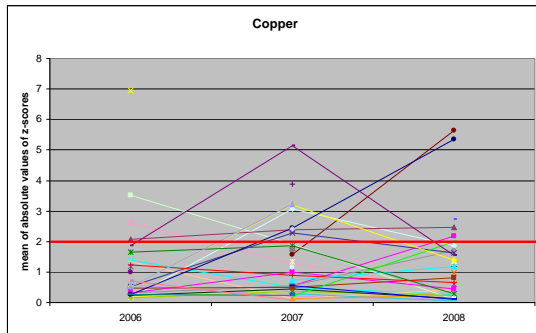


Much higher than in previous PTs; 1st time higher than limit

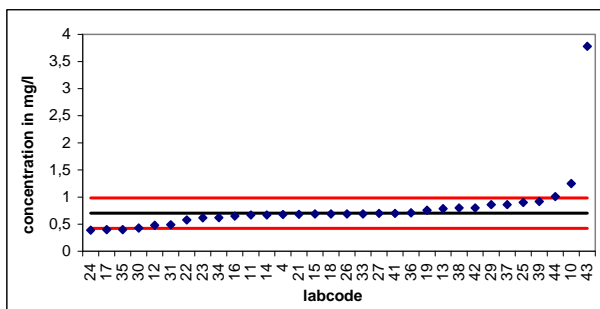
Copper Percentage non-satisfactory results



Copper Individual performance development

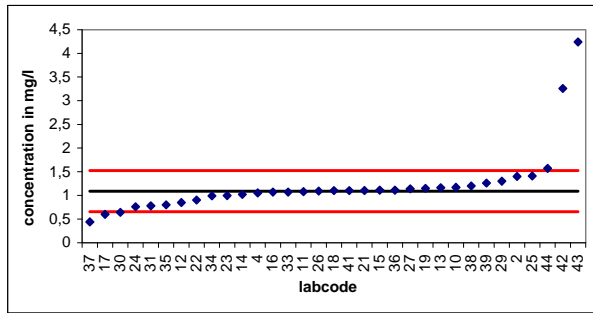


Copper 1



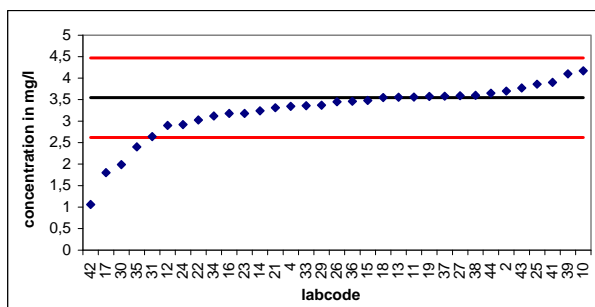
values:	34
removed:	2
mean:	0,70
ref.-value:	0,70
recovery:	99,1%
std:	0,186
rstd:	26,5%
std limit:	20%
upper limit:	0,98
lower limit:	0,42
too high:	3
too low:	5
outside limits:	8

Copper 2



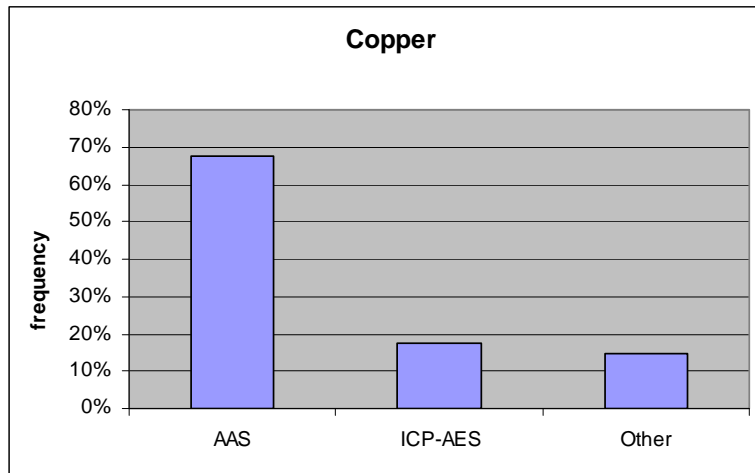
values:	34
removed:	1
mean:	1,08
ref.-value:	1,09
recovery:	99,2%
std:	0,247
rstd:	22,7%
std limit:	20%
upper limit:	1,53
lower limit:	0,65
too high:	3
too low:	4
outside limits:	7

Copper 3

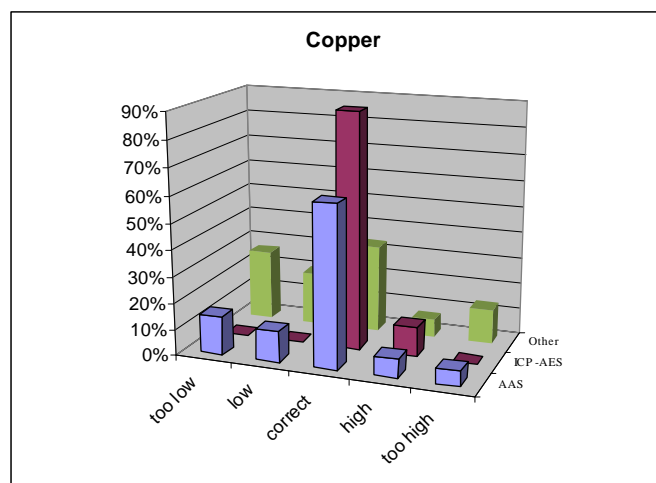


values:	34
removed:	1
mean:	3,35
ref.-value:	3,54
recovery:	94,6%
std:	0,462
rstd:	13,0%
std limit:	20%
upper limit:	4,47
lower limit:	2,62
too high:	0
too low:	5
outside limits:	5

Used methods



Comparison of methods

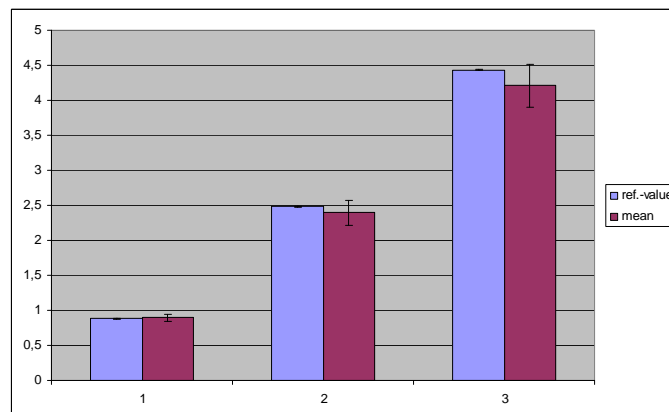


Summary Copper

- mean values in quite good agreement with reference values
- standard deviation higher than in previous years

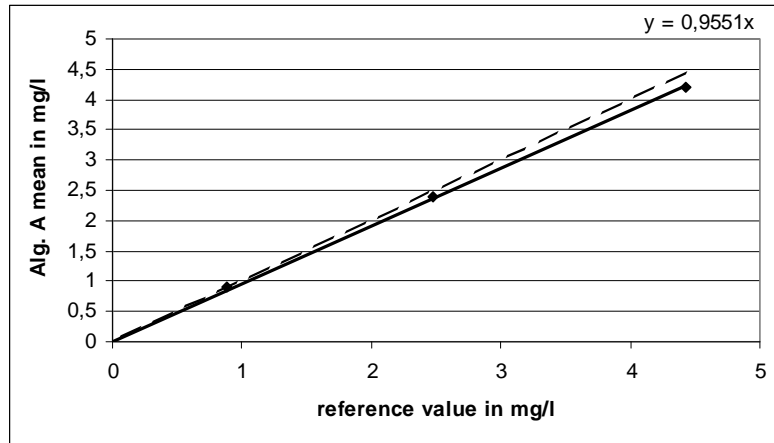
Zinc

Alg.A mean and ref.-value from weighings



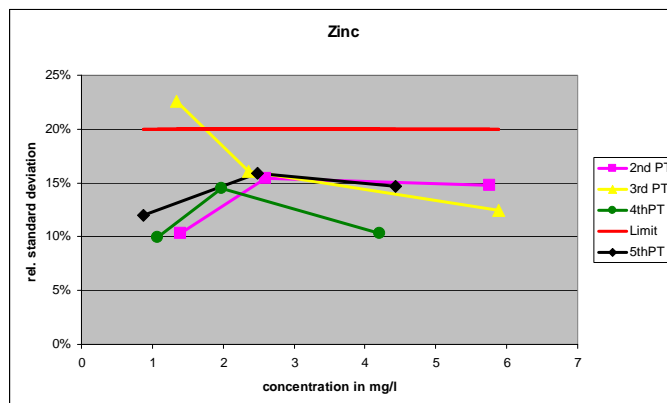
consensus means slightly lower

Zinc mean vs. ref.-value



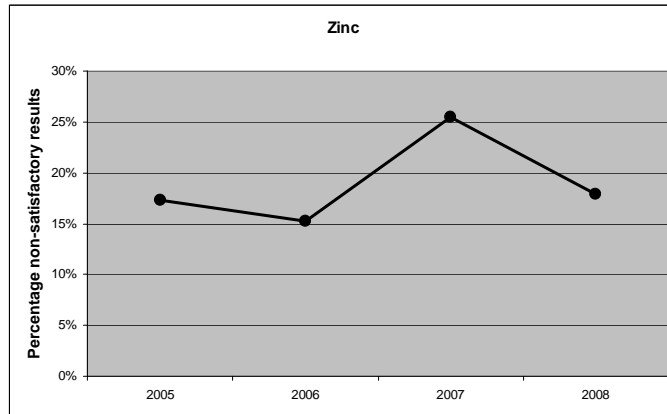
Average recovery: 95.5; in 2007: 93.0%; in 2006: 96.8%

Zinc calculated standard deviation and limit

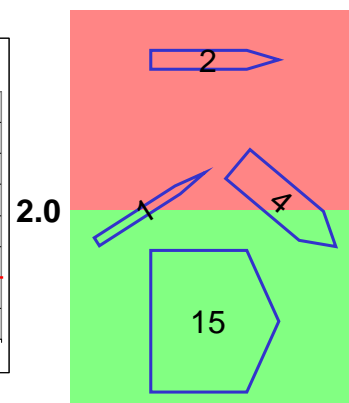
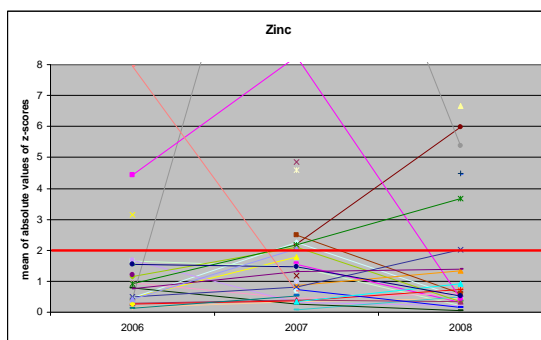


Similar to previous years

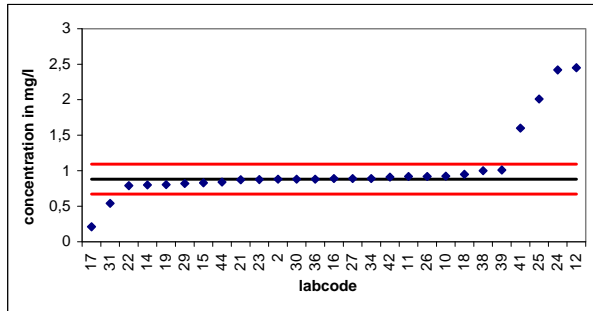
Zinc Percentage non-satisfactory results



Zinc Individual performance development

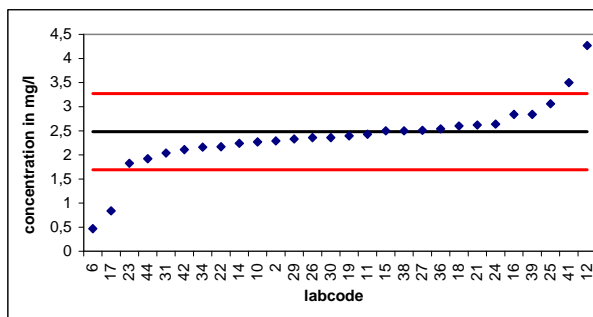


Zinc 1



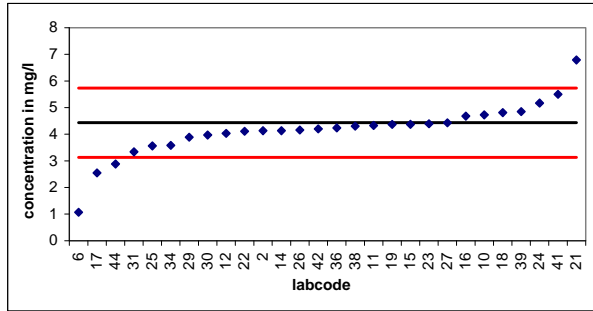
values:	28
removed:	1
mean:	0,90
ref.-value:	0,88
recovery:	102,1%
std:	0,106
rstd:	12,0%
std limit:	20%
upper limit:	1,09
lower limit:	0,67
too high:	4
too low:	3
outside limits:	7

Zinc 2



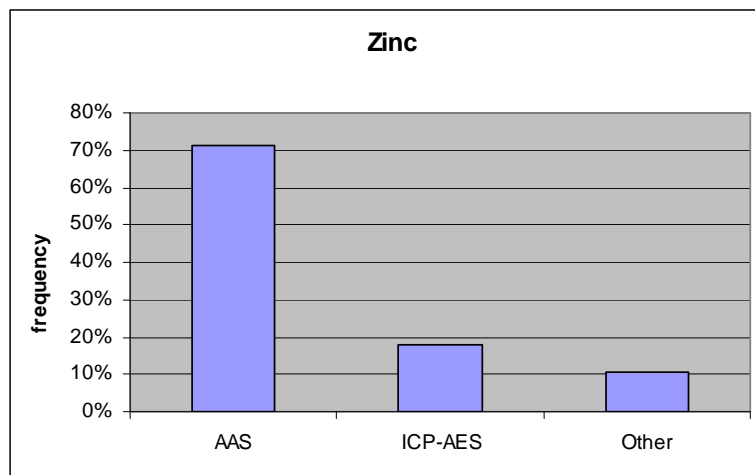
values:	28
removed:	0
mean:	2,40
ref.-value:	2,48
recovery:	96,5%
std:	0,396
rstd:	15,9%
std limit:	20%
upper limit:	3,27
lower limit:	1,69
too high:	2
too low:	2
outside limits:	4

Zinc 3

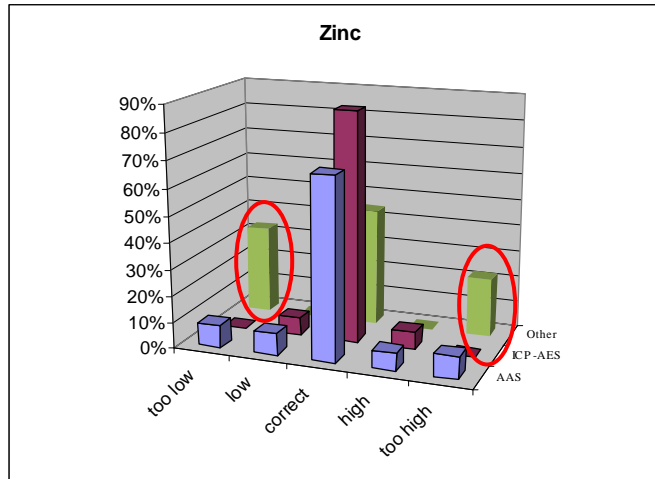


values:	28
removed:	0
mean:	4,21
ref.-value:	4,43
recovery:	94,9%
std:	0,651
rstd:	14,7%
std limit:	20%
upper limit:	5,74
lower limit:	3,13
too high:	1
too low:	3
outside limits:	4

Used methods



Comparison of methods



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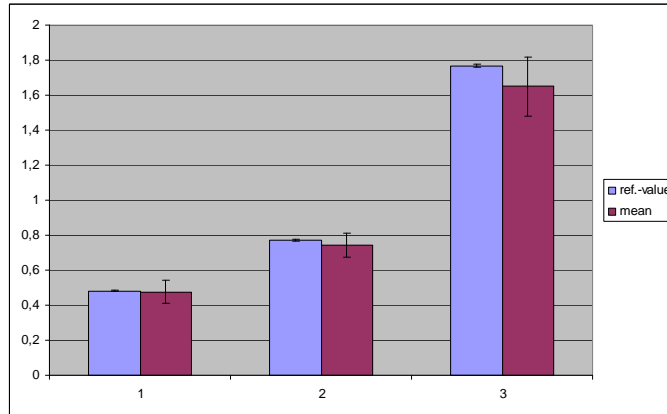
Summary Zinc

- mean values slightly lower than reference values
- standard deviation below limit

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Chromium

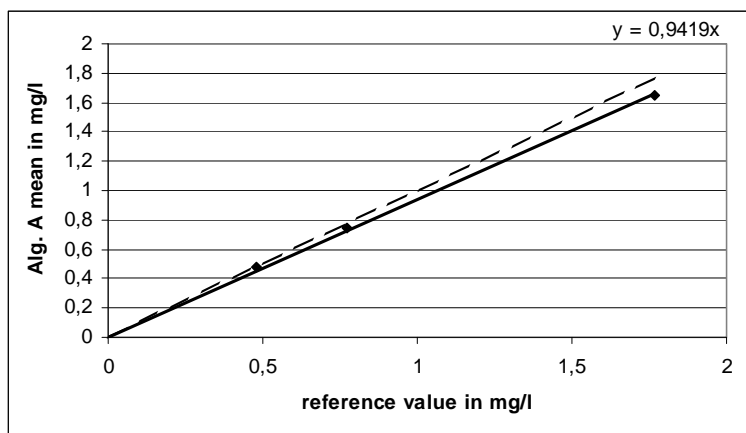
Alg.A mean and ref.-value from weighings



Means slightly lower

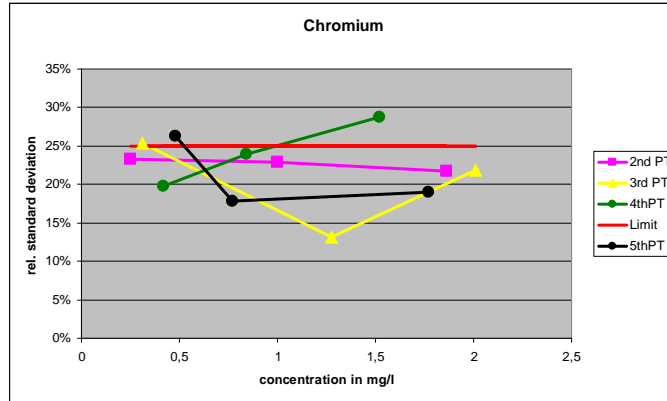
Chromium

mean vs. ref.-value



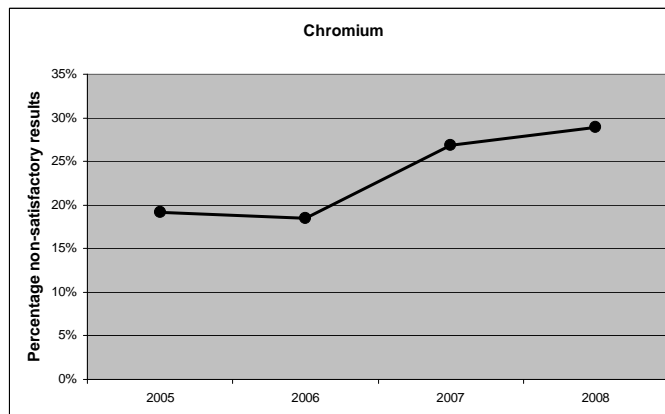
Average recovery: 94,2%; in 2007: 100.1%; in 2006: 97.4%

Chromium calculated standard deviation and limit



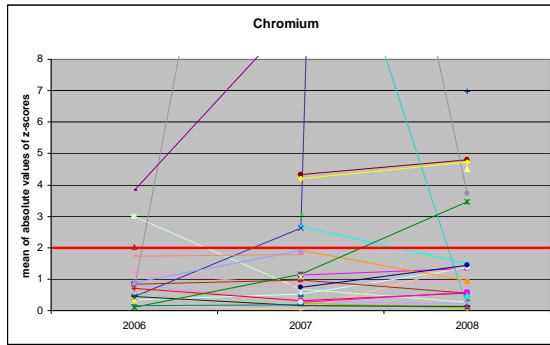
Similar to last years

Chromium Percentage non-satisfactory results

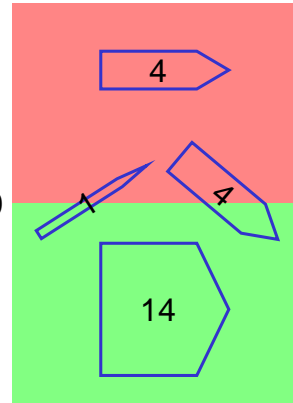


Chromium

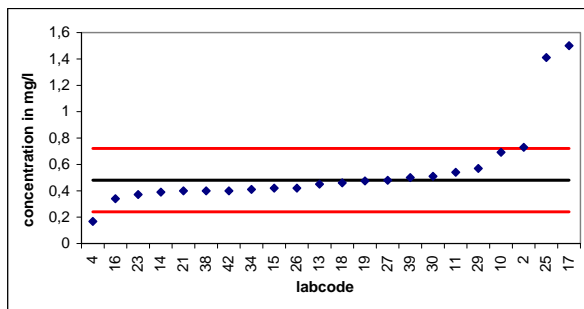
Individual performance development



2.0

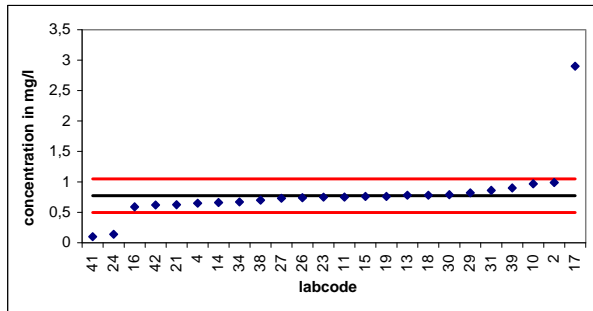


Chromium 1



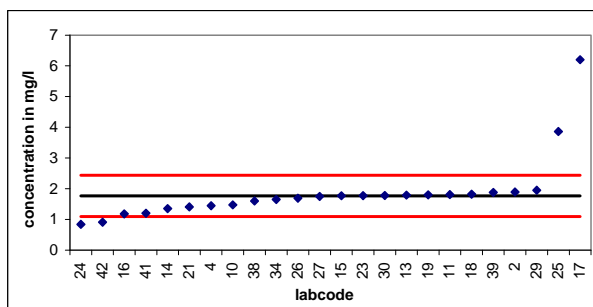
values:	28
removed:	6
mean:	0,48
ref.-value:	0,48
recovery:	99,2%
std:	0,126
rstd:	26,3%
std limit:	25%
upper limit:	0,72
lower limit:	0,24
too high:	4
too low:	6
outside limits:	10

Chromium 2



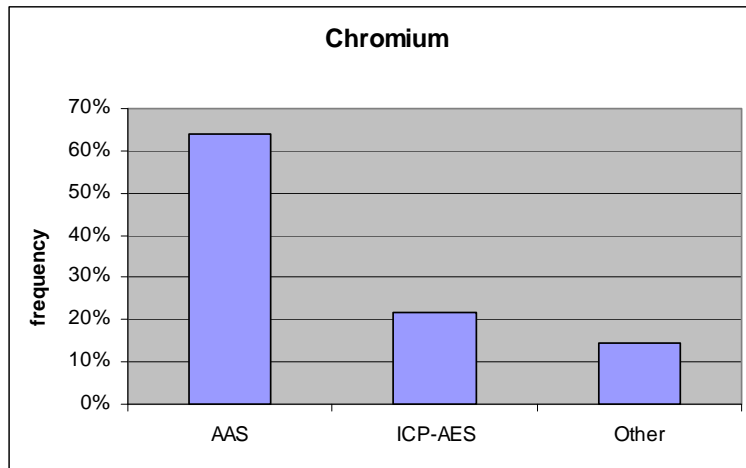
values:	27
removed:	3
mean:	0,74
ref.-value:	0,77
recovery:	96,3%
std:	0,138
rstd:	17,8%
std limit:	25%
upper limit:	1,05
lower limit:	0,50
too high:	1
too low:	5
outside limits:	6

Chromium 3



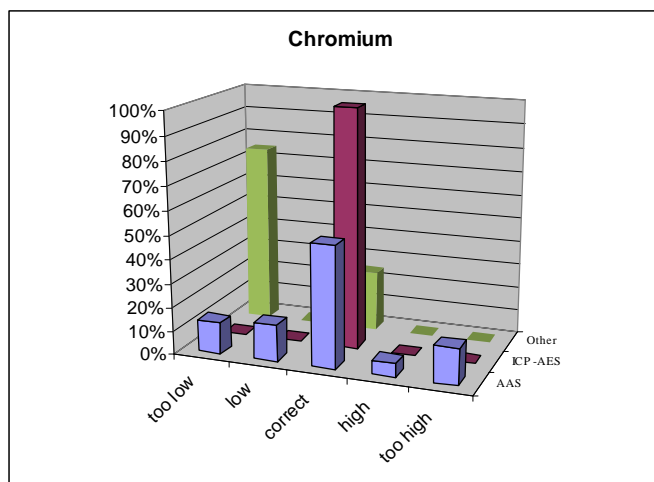
values:	28
removed:	4
mean:	1,65
ref.-value:	1,77
recovery:	93,4%
std:	0,336
rstd:	19,0%
std limit:	25%
upper limit:	2,44
lower limit:	1,10
too high:	3
too low:	5
outside limits:	8

Used methods



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Comparison of methods



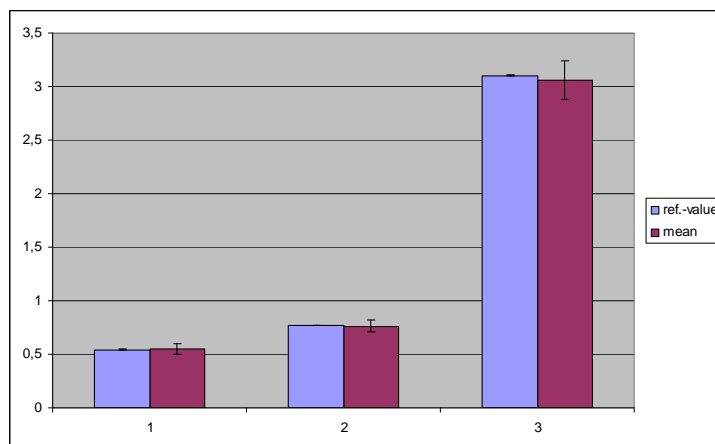
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Summary Chromium

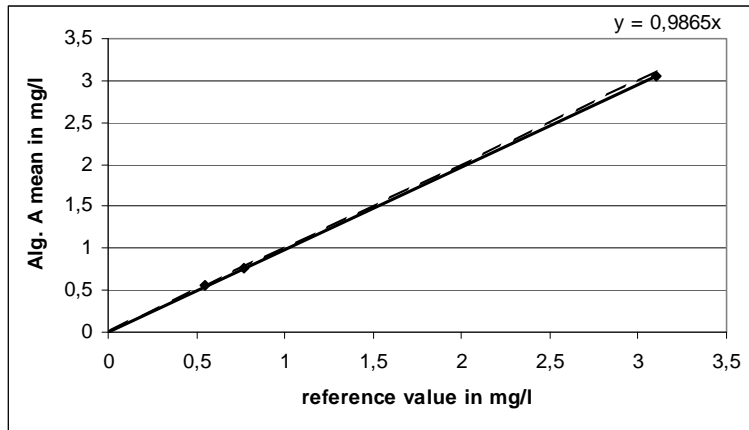
- mean values slightly lower than reference values
- standard deviation around limit

Nickel

Alg.A mean and ref.-value from weighings

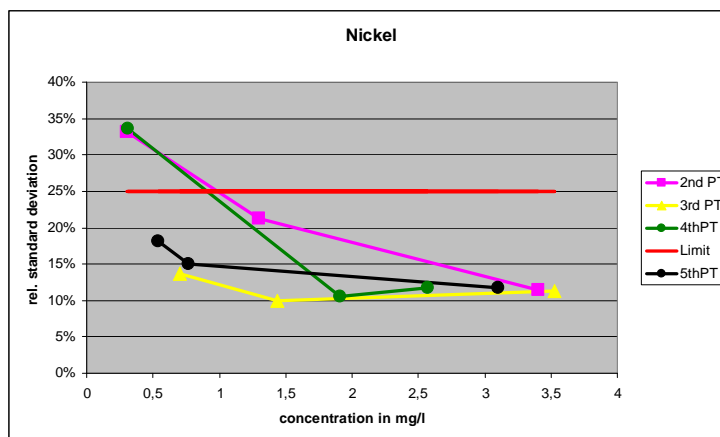


Nickel mean vs. ref.-value



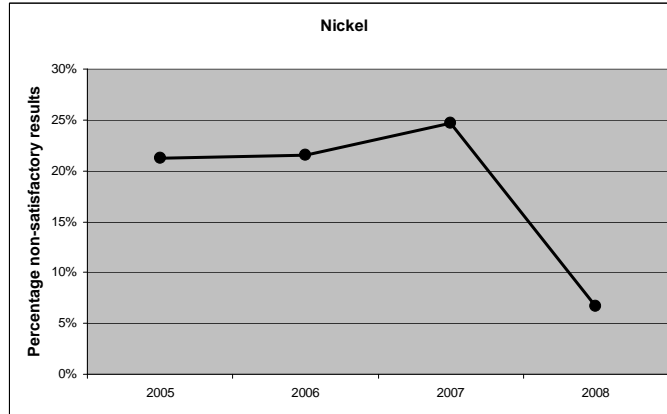
Average recovery: 98.7%; in 2007: 99.0%; in 2006: 94.6%

Nickel calculated standard deviation and limit

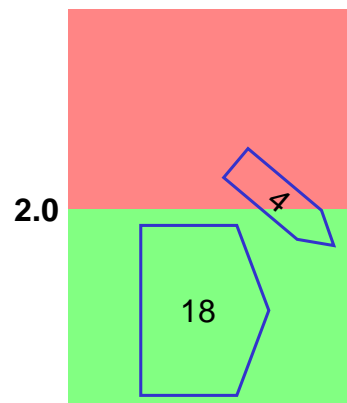
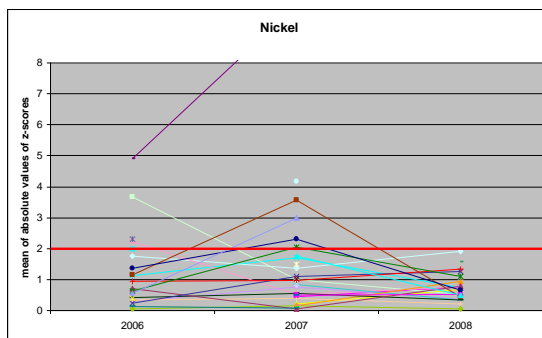


Standard deviation for low level better than last year

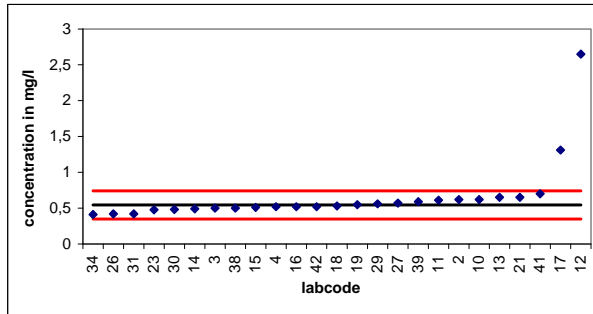
Nickel Percentage non-satisfactory results



Nickel Individual performance development

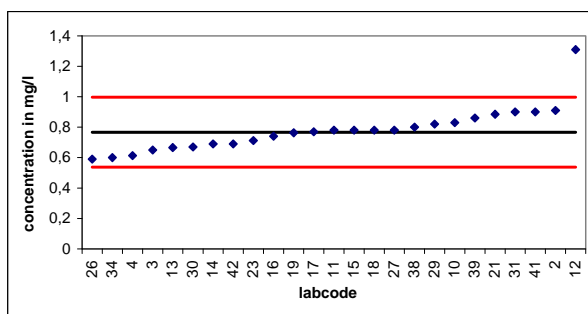


Nickel 1



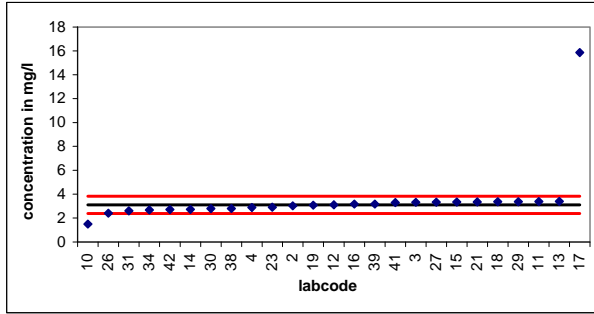
values:	25
removed:	0
mean:	0,55
ref.-value:	0,54
recovery:	101,5%
std:	0,098
rstd:	18,1%
std limit:	25%
upper limit:	0,74
lower limit:	0,35
too high:	2
too low:	0
outside limits:	2

Nickel 2



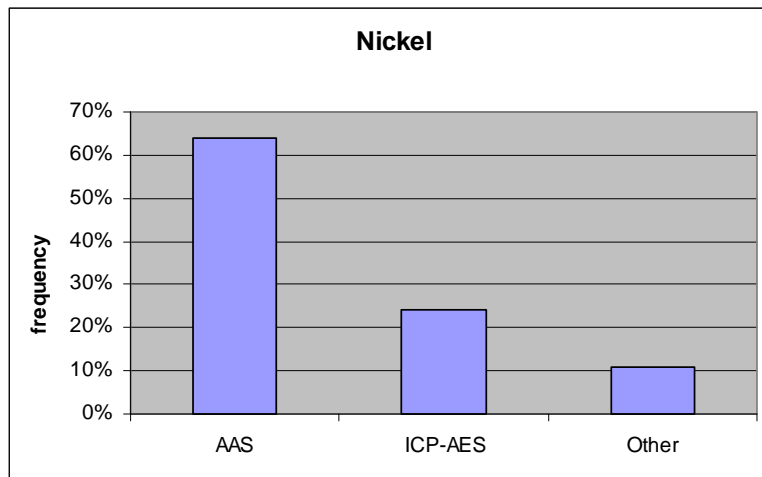
values:	25
removed:	0
mean:	0,76
ref.-value:	0,77
recovery:	99,7%
std:	0,115
rstd:	15,0%
std limit:	25%
upper limit:	1,00
lower limit:	0,54
too high:	1
too low:	0
outside limits:	1

Nickel 3

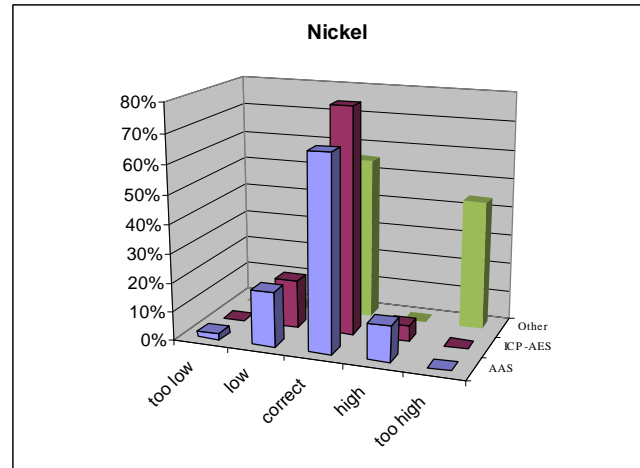


values:	25
removed:	0
mean:	3,06
ref.-value:	3,10
recovery:	98,5%
std:	0,365
rstd:	11,8%
std limit:	25%
upper limit:	3,83
lower limit:	2,37
too high:	1
too low:	1
outside limits:	2

Used methods



Comparison of methods



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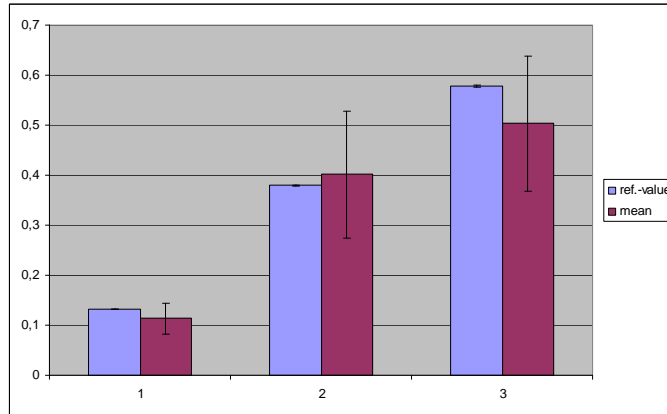
Summary Nickel

- mean values in quite good agreement with reference values
- standard deviation ok

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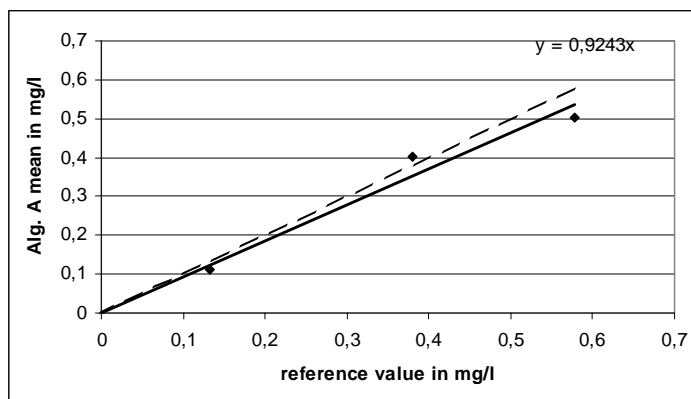
Arsenic

Alg.A mean and ref.-value from weighings



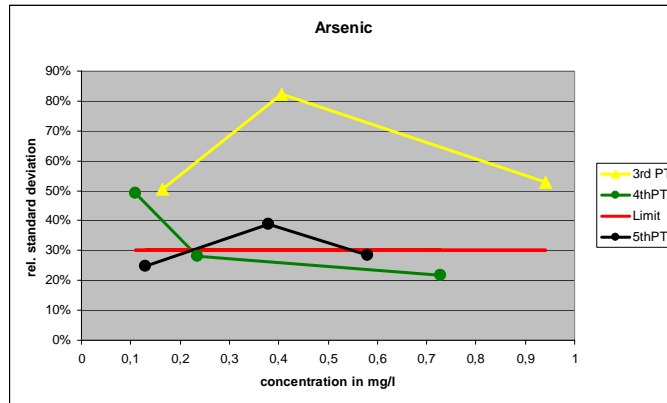
Arsenic

mean vs. ref.-value



Average recovery: 92.4%; mainly caused by the highest level
 In 2007: 96.6%; in 2006: 111.2%

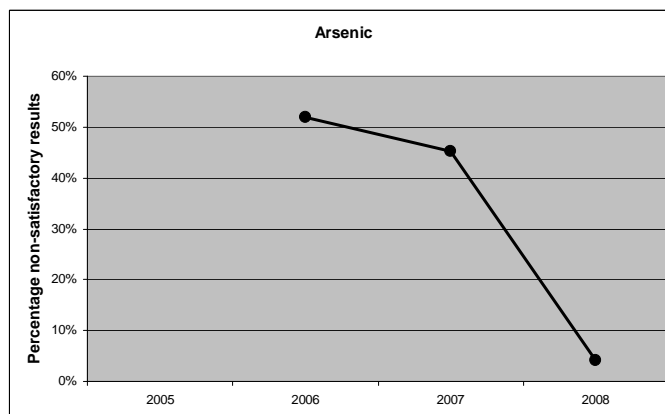
Arsenic calculated standard deviation and limit



Similar to 2007

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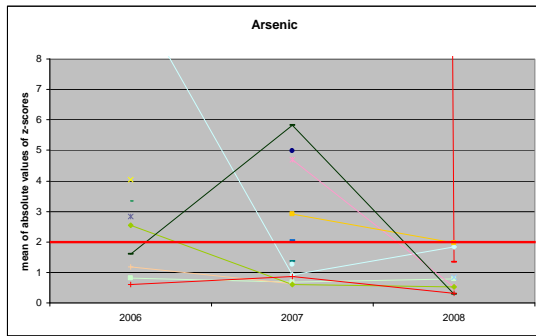
Arsenic Percentage non-satisfactory results



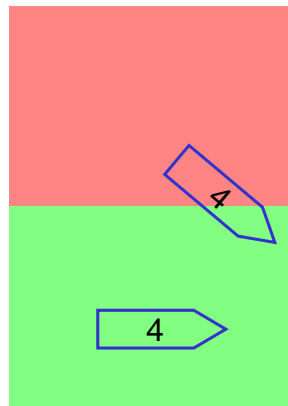
196 Koch, M.: PT evaluation – SADC MET PT Workshop 2008 Kampala

Arsenic

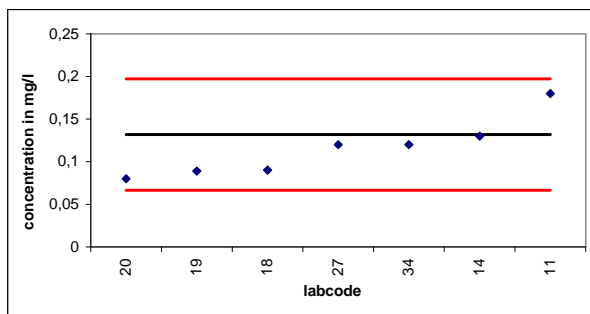
Individual performance development



2.0

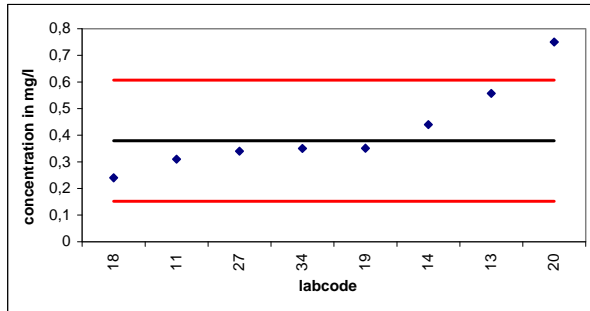


Arsenic 1



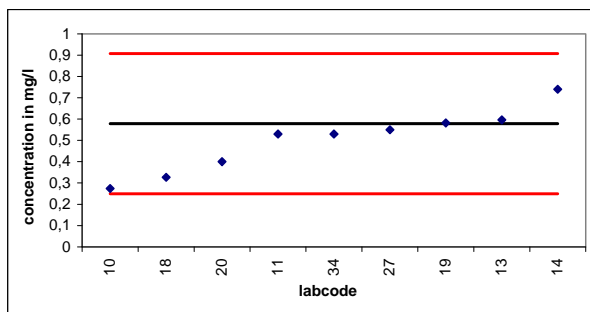
values:	7
removed:	0
mean:	0,11
ref.-value:	0,13
recovery:	85,7%
std:	0,033
rstd:	24,8%
std limit:	30%
upper limit:	0,20
lower limit:	0,07
too high:	0
too low:	0
outside limits:	0

Arsenic 2



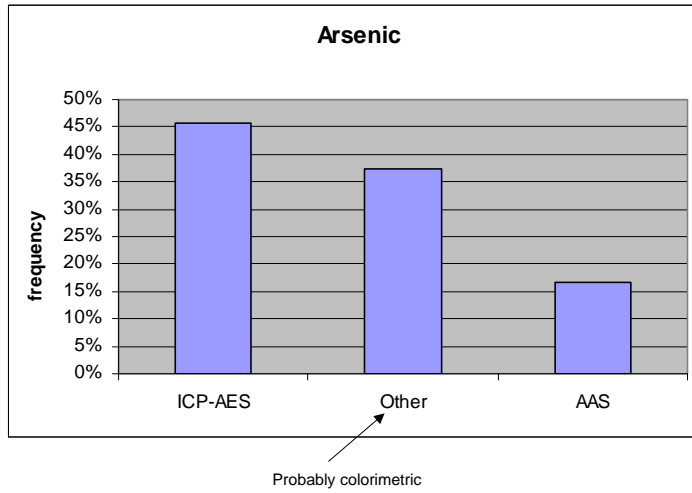
values:	8
removed:	0
mean:	0,40
ref.-value:	0,38
recovery:	105,8%
std:	0,147
rstd:	38,7%
std limit:	30%
upper limit:	0,61
lower limit:	0,15
too high:	1
too low:	0
outside limits:	1

Arsenic 3



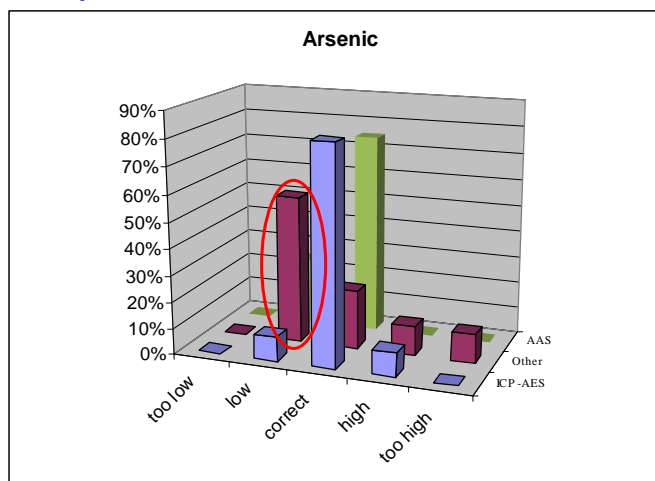
values:	9
removed:	0
mean:	0,50
ref.-value:	0,58
recovery:	87,0%
std:	0,165
rstd:	28,5%
std limit:	30%
upper limit:	0,91
lower limit:	0,25
too high:	0
too low:	0
outside limits:	0

Used methods



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Comparison of methods



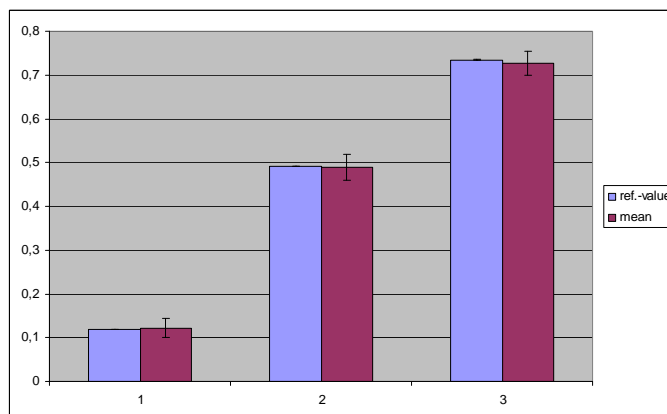
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Summary Arsenic

- low number of values
- standard deviation around limit

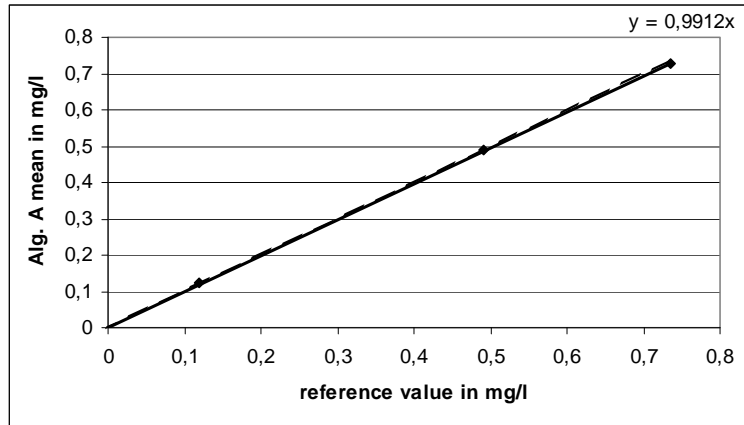
Cadmium

Alg.A mean and ref.-value from weighings



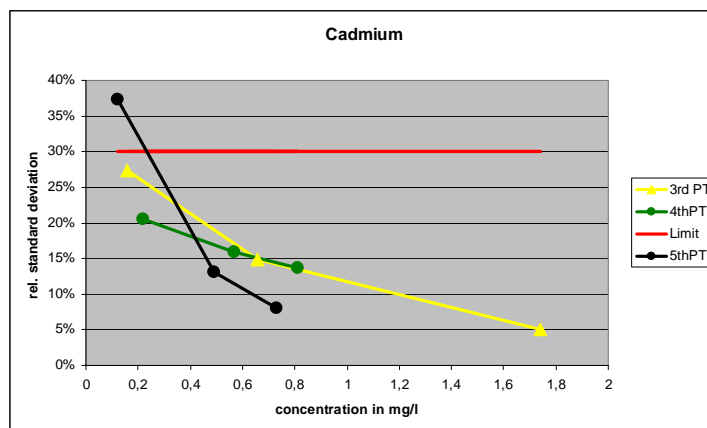
consensus means close to reference values

Cadmium mean vs. ref.-value

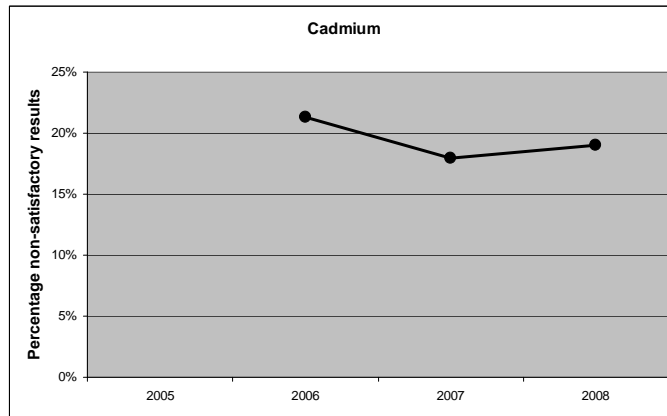


Average recovery: 99.1%; in 2007: 96.4%; in 2006: 96.6%

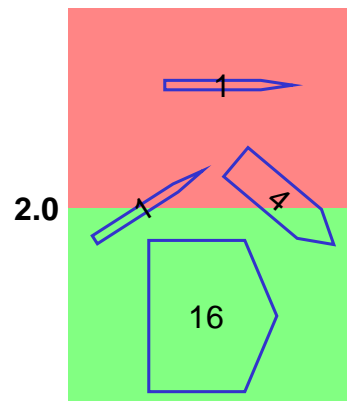
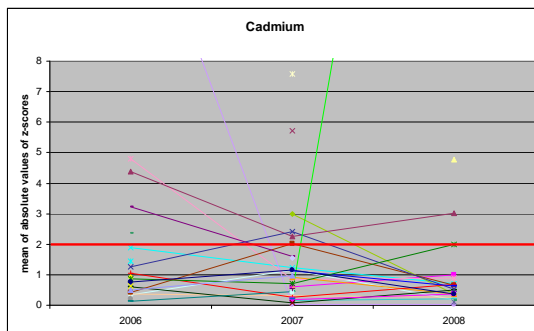
Cadmium calculated standard deviation and limit



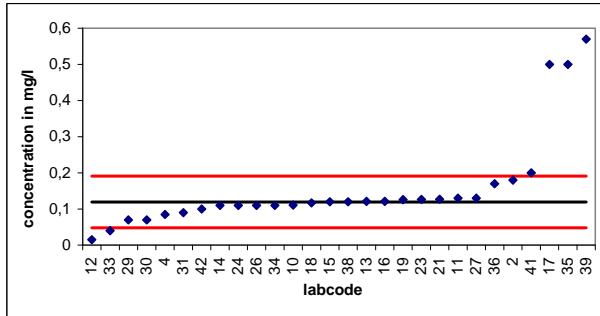
Cadmium Percentage non-satisfactory results



Cadmium Individual performance development

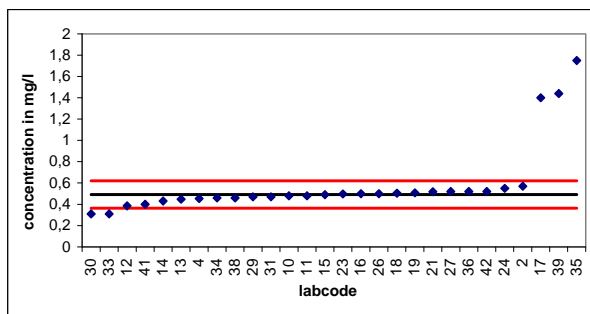


Cadmium 1



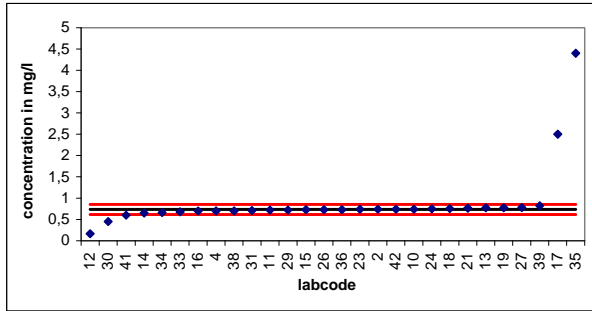
values:	28
removed:	0
mean:	0,12
ref.-value:	0,12
recovery:	102,2%
std:	0,045
rstd:	37,3%
std limit:	30%
upper limit:	0,19
lower limit:	0,05
too high:	4
too low:	2
outside limits:	6

Cadmium 2



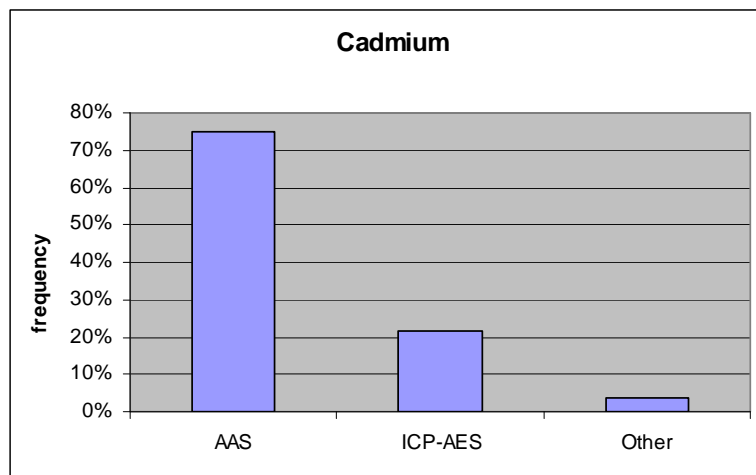
values:	28
removed:	0
mean:	0,49
ref.-value:	0,49
recovery:	99,4%
std:	0,065
rstd:	13,1%
std limit:	30%
upper limit:	0,62
lower limit:	0,36
too high:	3
too low:	2
outside limits:	5

Cadmium 3

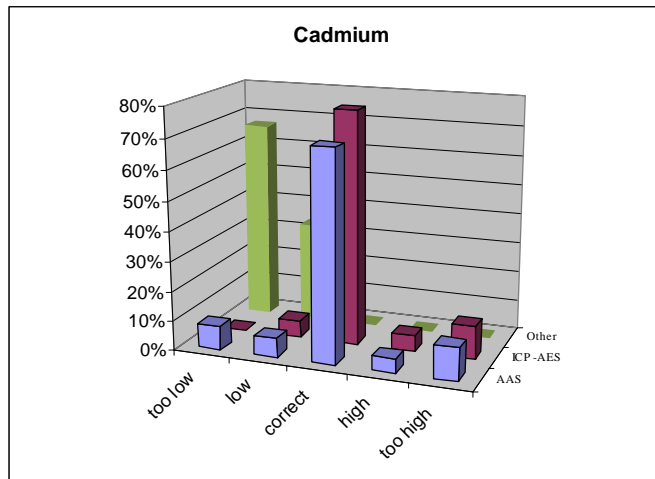


values:	28
removed:	0
mean:	0,73
ref.-value:	0,73
recovery:	98,9%
std:	0,059
rstd:	8,0%
std limit:	30%
upper limit:	0,85
lower limit:	0,62
too high:	2
too low:	3
outside limits:	5

Used methods



Comparison of methods



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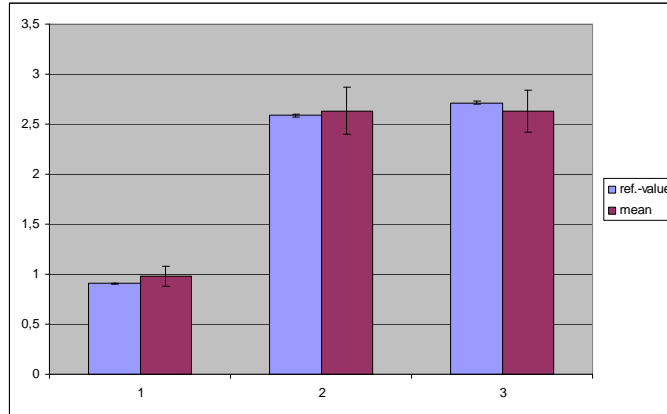
Summary Cadmium

- mean values in good agreement with reference values
- Standard deviation high for low concentration

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Cobalt

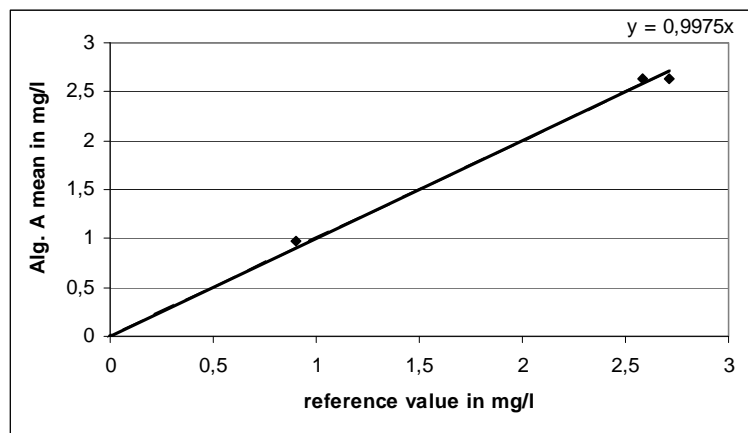
Alg.A mean and ref.-value from weighings



consensus means close to reference values

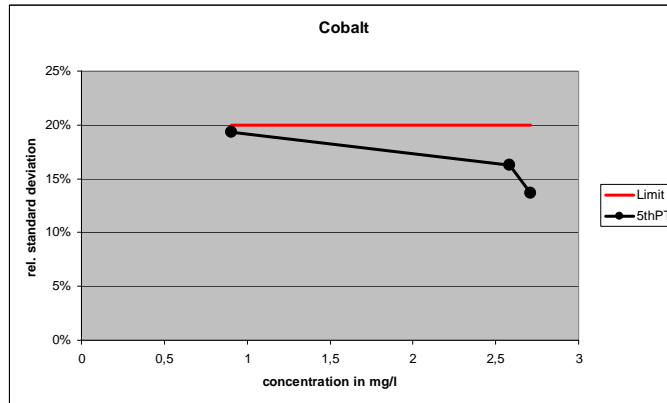
Cobalt

mean vs. ref.-value



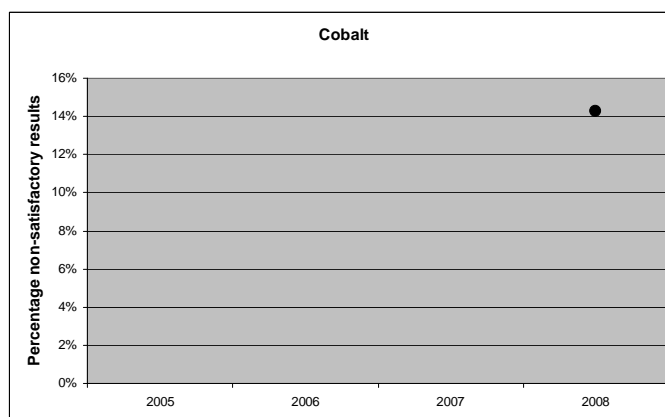
Average recovery: 99.8%

Cobalt calculated standard deviation and limit



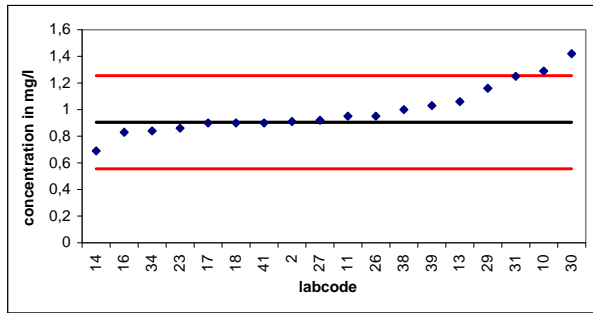
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Cobalt Percentage non-satisfactory results



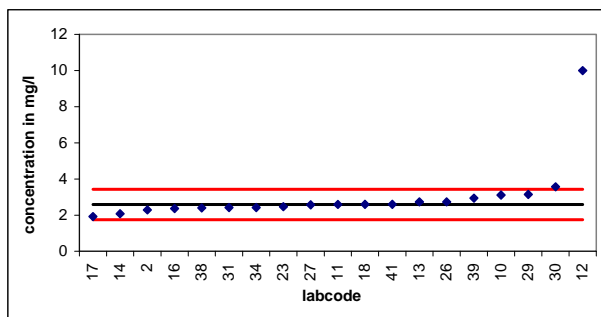
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Cobalt 1



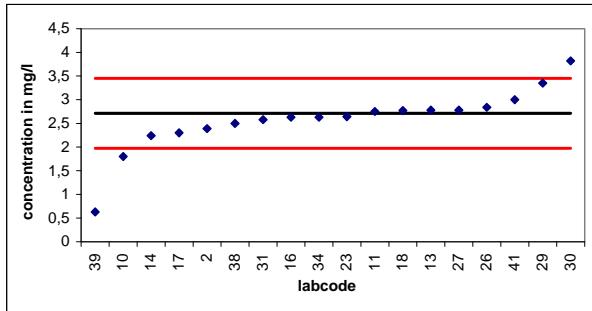
values:	19
removed:	1
mean:	0,98
ref.-value:	0,91
recovery:	108,4%
std:	0,175
rstd:	19,3%
std limit:	20%
upper limit:	1,25
lower limit:	0,56
too high:	3
too low:	0
outside limits:	3

Cobalt 2



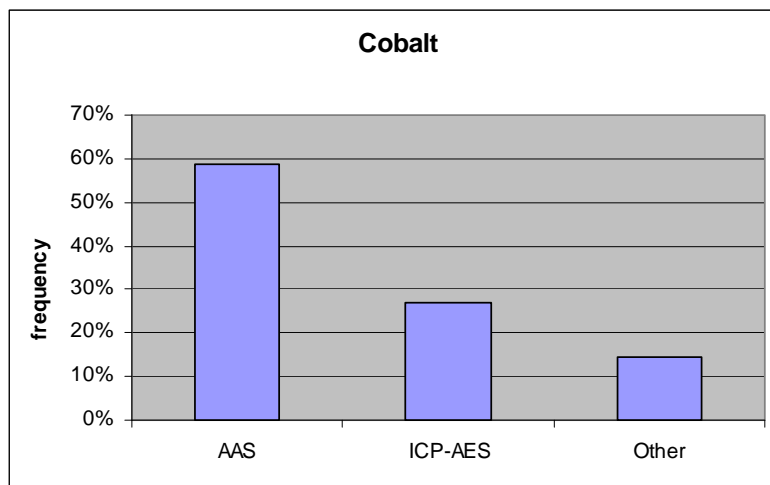
values:	19
removed:	0
mean:	2,63
ref.-value:	2,59
recovery:	101,7%
std:	0,420
rstd:	16,2%
std limit:	20%
upper limit:	3,43
lower limit:	1,75
too high:	2
too low:	0
outside limits:	2

Cobalt 3

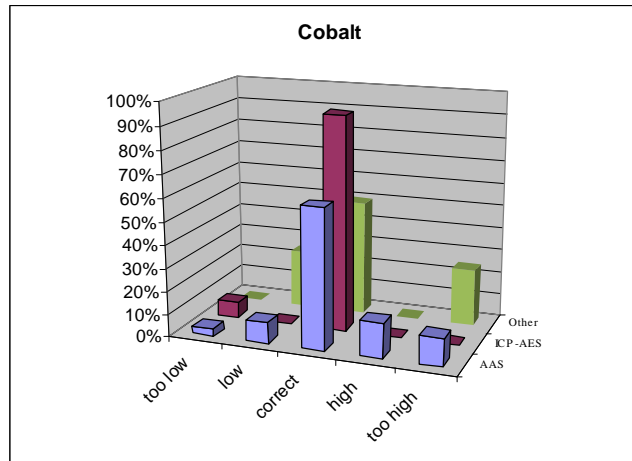


values:	18
removed:	0
mean:	2,63
ref.-value:	2,71
recovery:	97,0%
std:	0,370
rstd:	13,6%
std limit:	20%
upper limit:	3,45
lower limit:	1,97
too high:	1
too low:	2
outside limits:	3

Used methods



Comparison of methods



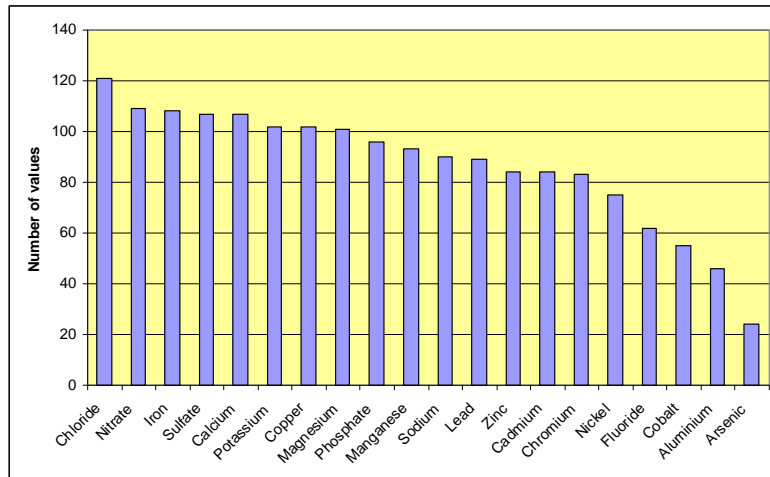
223 Koch, M.: PT evaluation – SADC MET PT Workshop 2008 Kampala

Summary Cobalt

- Consensus means close to reference values
- Standard deviation below limit

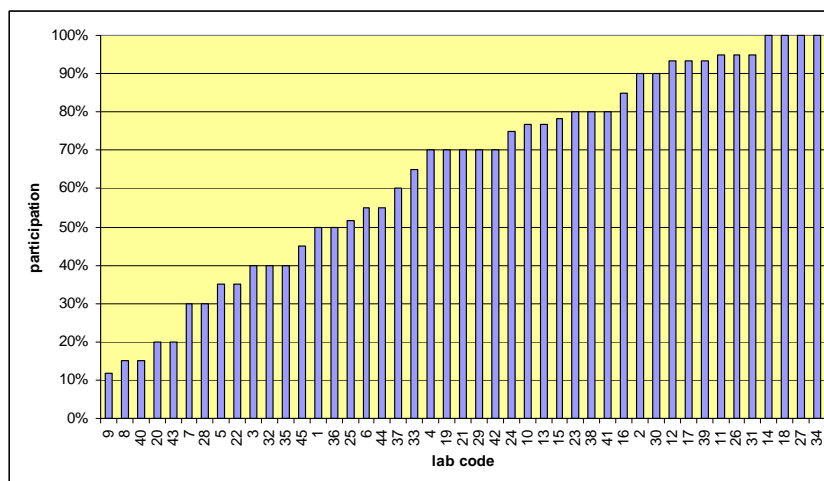
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Number of values per parameter



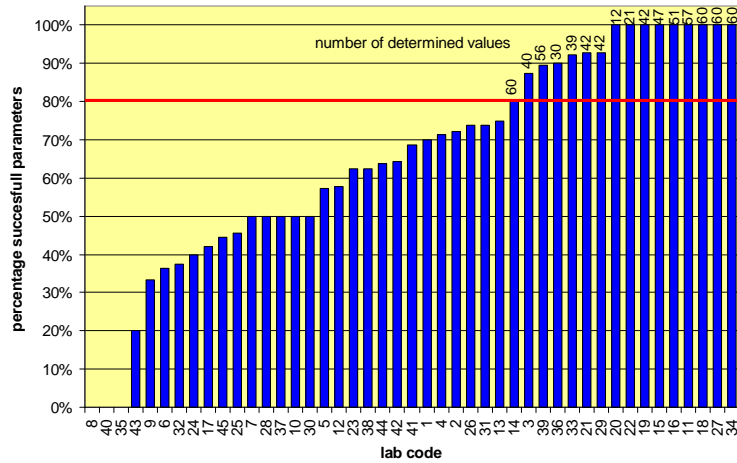
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Overview on participation

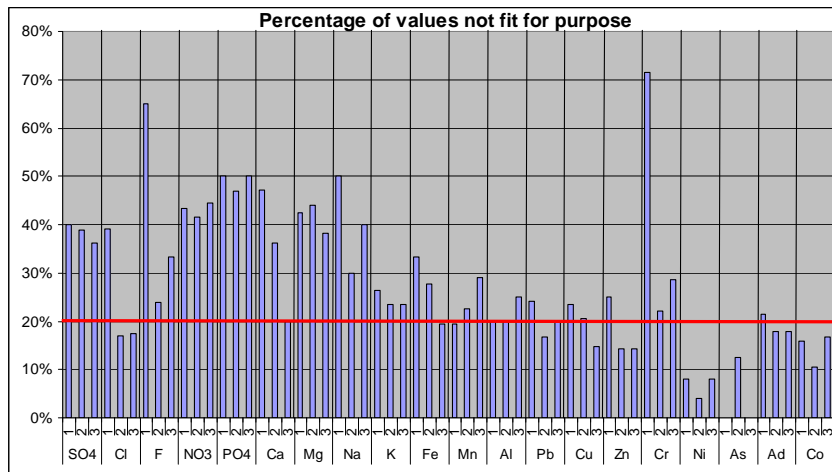


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Overview on participants' success



Values not fit for purpose





Conclusion

- The PT Provider did a very good job
- The evaluation and assessment procedure is fit for the purpose
- The SADC MET Water PT is a good possibility for the participants to compare with peers and with stated fitness-for-purpose criteria
- The results of many laboratories are still not satisfactory or getting worse
- More emphasis should be put on corrective actions after unsatisfactory participation