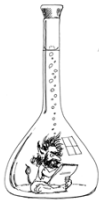


Reporting with high uncertainty

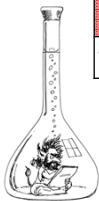
Eurachem workshop in Berlin 19-20 November 2019
Bertil Magnusson Eskil Sahlin and Thomas Svensson³



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What is high relative uncertainty (in this presentation)

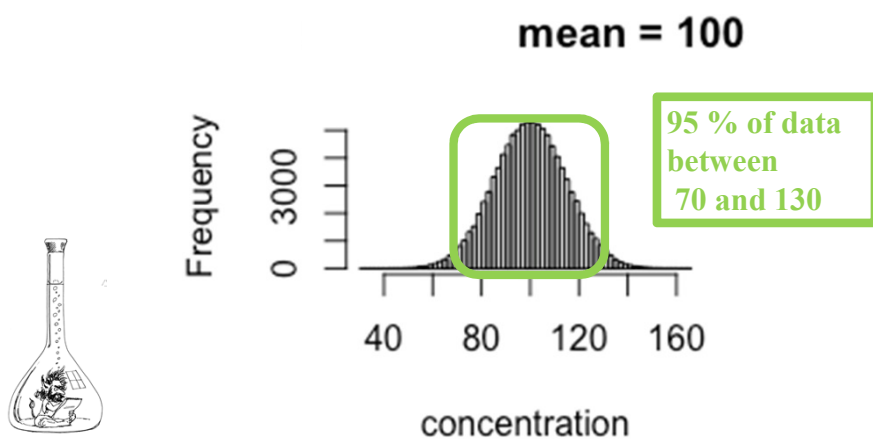
Uncertainty	u_c %	U %	Handling
"Low"	< 15	< 30	As usual
"Medium"	< 40	< 80	^F U or log(10)
"High"	> 40	> 80	^F U or log(10)
u_c is the standard combined uncertainty			



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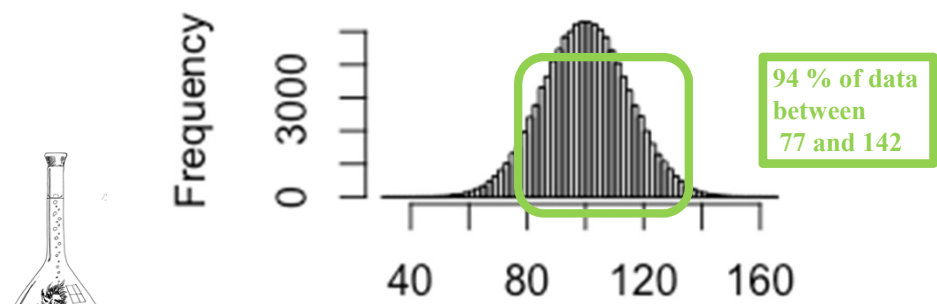
Problem when **relative** uncertainty is high

Our goal for correct reporting – 95 % of the results should include the “true” value



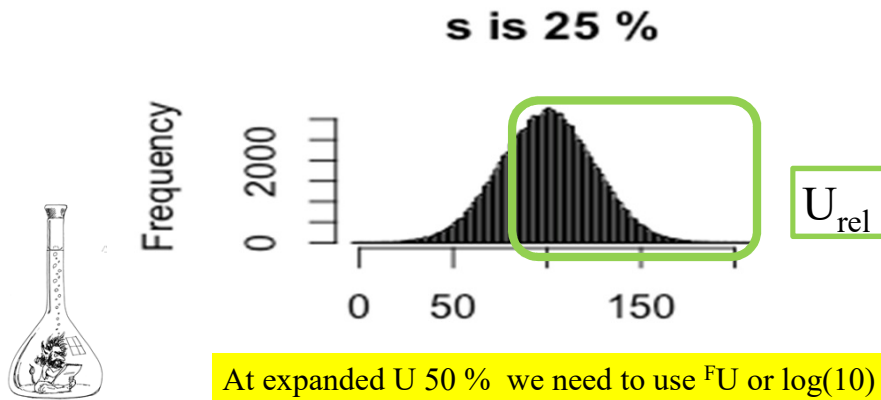
Results reported \pm U 30 % (expanded) that include the mean value

s = 15 % mean = 100



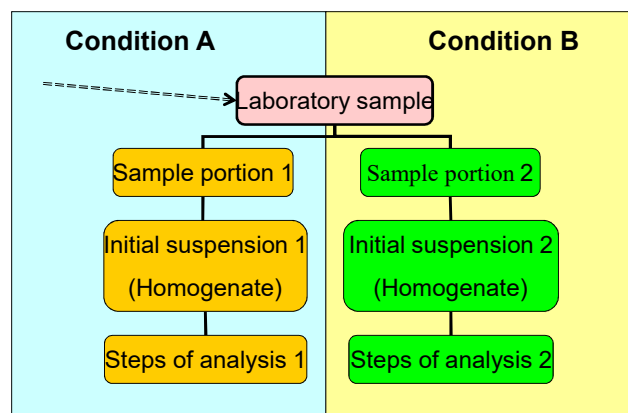
Problem start at U 20 -30 % – acceptance skewed

Results reported $\pm U$ 50 % (expanded)
that include the mean value



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U estimation in microbiology - lognormal
ISO/TS 19036 and ISO 29201



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6

U estimation in microbiology uncertainty calculated on \log_{10} values

Sample	C_1	C_2	$\log(C_1)$	$\log(C_2)$
1	5	8	0.6990	0.9031
2	15	11	1.1761	1.0414
3	11	19	1.0414	1.2788
4	21	39	1.3222	1.5911

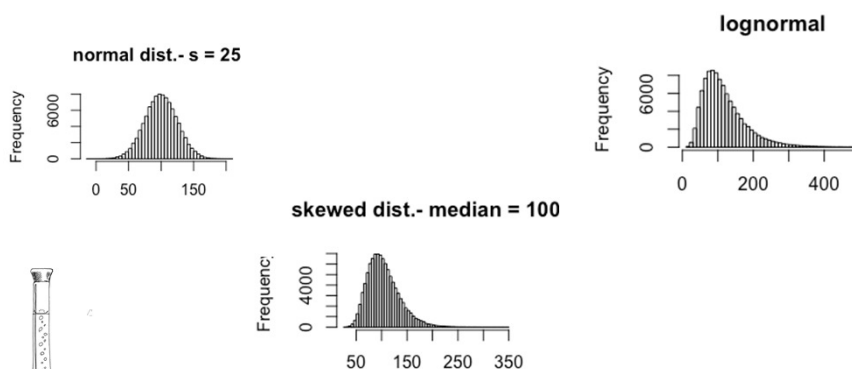


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Expanded uncertainty e.g. 0.3 in \log_{10}
Result 80 counts can be reported as
80 cfu/g [- 51 %; + 100 %]
NOTE [80/2 – 80 *2]

7

In chemistry the distribution is often somewhere between normal and lognormal



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At relative expanded uncertainty < 30 % the
distributions are very similar

8

We start looking at the normal distribution
U = 30 % and U = 50 % at a level of 100



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9

Absolute U 30 (expanded)

Mean value 100

Lower bound (2.5 %)

Result = 70, U = 30

Report 70 ± 30

Upper bound (97.5 %)

Report 130 ± 30

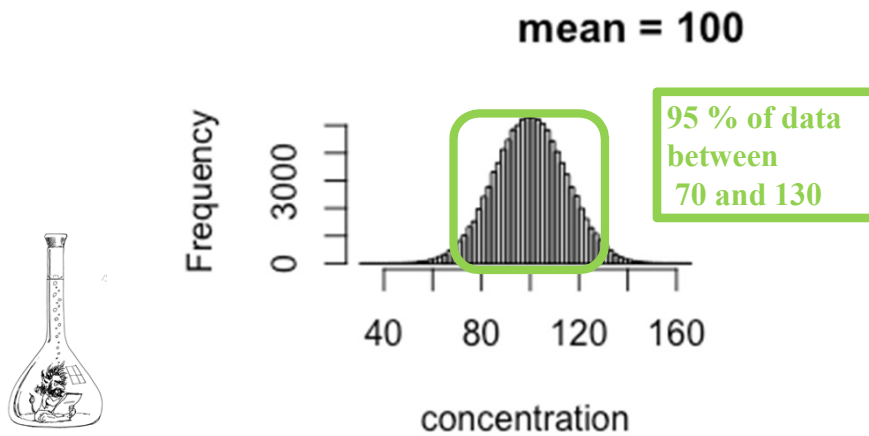


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95 % of the reported values will
include the mean value 100

10

Absolute U = 30 - results reported that include the mean value



Relative Expanded U 30 %

Mean value 100

Lower bound (2.5 %)

Result = 70, $U = 0.30 * 70 = 21$

Report 70 ± 21

Upper bound (97.5 %)

Report 130 ± 39

How man % of the reported values will include the mean value 100?



12

Relative U 30 %
Results reported $\pm U$ that include the mean value

Mean value 100

Lower bound (6 %)
Result = 77, $U = 0.30 * 70 = 23$
Report 77 ± 23

Upper bound (99.8 %)
Report 143 ± 39



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Ca 94 % of the reported values will include the mean value 100 but...

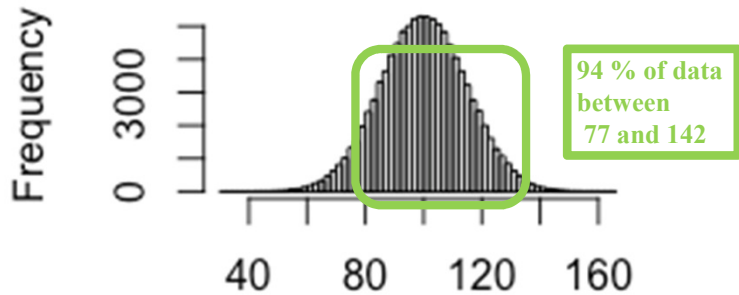
13

Relative U 30 % - results reported $\pm U$ that include the mean value

s = 15 % mean = 100



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Relative U 30 % Conclusions

With U 30 %

- we can still report $y \pm 30 %$
- with confidence interval close to 95 %
- not accepted
 - low levels 6 %
 - high levels 0.2 %

94 % of data
between
77 and 142



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At 30 % we see a problem coming ...
Lets try 50 %

15

Relative U 50 %

Mean value 100

Lower bound (2.5 %)

Result = 50, $U = 0.50 * 50 = 25$

Report 50 ± 25

Upper bound (97.5 %)

Report 150 ± 75



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How man % of the reported values will
include the mean value 100?

16

Relative U 50 %
Results reported $\pm U$ that include the mean value

Mean value 100

Lower bound (10 %)
Result = 67, $U = 0.5 * 67 = 34$
Report 67 ± 34

Upper bound (> 99.9 %)
Report 200 ± 100



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Ca 90 % of the reported values will include the mean value 100

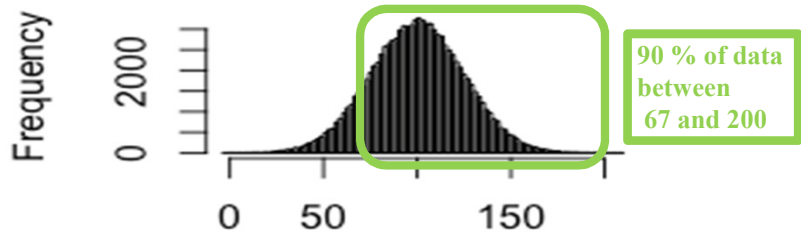
17

Relative expanded U 50 %
Results reported $\pm U$ that include the mean value

s is 25 %



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Relative expanded uncertainty 50 % Conclusions

With U 50 %

- we can not report $y \pm 50\%$ with confidence interval close to 95 %
- 10 % of the low results will not include the mean value

90 % of data
between
67 and 200



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With U 50 % we need to report differently

19

Use of uncertainty factor FU for U = 50

The Eurachem sampling guide proposes the use of the uncertainty factor FU when the distribution is approximately lognormal

For relative U = 50 %, $u_{rel} = 25\%$

The uncertainty factor FU (UF) $\approx e^{ku_{rel}}$

By modelling $-\log(e)$ we get a value of $s = 0.27$

$$^FU \approx e^{2 * 0.27} = 1.72$$



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20

Use of uncertainty factor FU for $U = 50$

The Eurachem sampling guide proposes the use of the uncertainty factor FU when the distribution is approximately lognormal

By modelling we get a value of

$$^FU \approx 1.72$$



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21

Relative U 50 % Results reported using FU that include the mean value

Mean value 100
 $^FU = 1.72$

Lower bound (4,6 %)
Result = 58, $U_+ = 100$

Upper bound (> 99.8 %)
Result = 172 $U_- = 100$

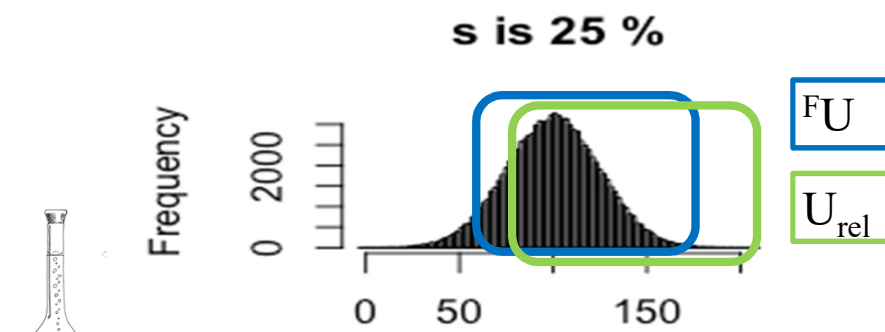


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Ca 96 % of the reported values will include the mean value 100

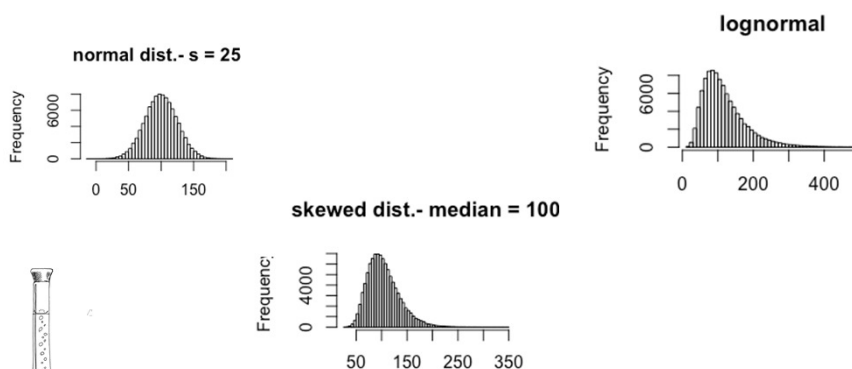
22

U 50 %
Results reported that include the mean value



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In chemistry the distribution is often somewhere between normal and lognormal



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Let's look at a skewed distribution

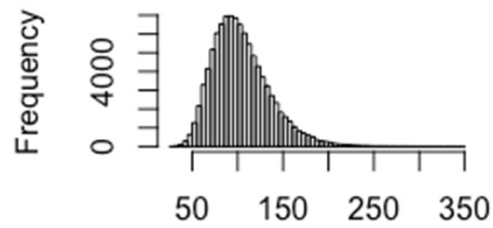
24

Skewed distribution

$$U_{\text{rel}} = 60 \%$$

skewed dist.- median = 100

$$^F U = 1.90$$



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25

Relative expanded uncertainty 50 %
Results reported using $^F U$ that include the mean value

Mean value 100
 $^F U = 1.84$

Lower bound (2.1 %)
Result = 53, $U_+ = 100$

Upper bound (> 98 %)
Result = 184 $U_- = 100$

96 % of the reported values will
include the mean value 100



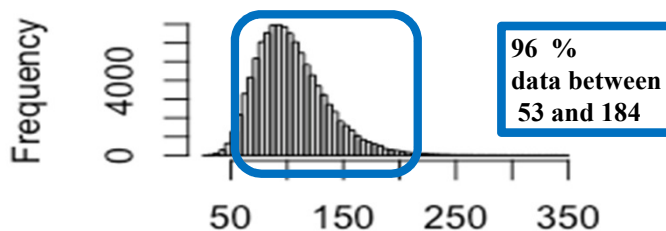
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26

Skewed distribution $U_{rel} = 60\%$
 Results reported using $^F U$ that include the mean value

skewed dist.- median = 100

$^F U = 1.84$



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27

High relative uncertainty

What we can do!

Uncertainty	u_c %	U %	Handling
"Low"	< 15	< 30	As usual
"Medium"	< 40	< 80	$^F U$ or log(10)
"High"	> 40	> 80	$^F U$ or log(10)

u_c is the standard combined uncertainty



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NOTE $^F U$ or log(10) is very similar
 $^F U$ can be calculated from relative s (CV%)

Thanks for listening

More info on quality issues also at
www.trollboken.se

NOTE Nordtest TR 604 on
sampling uncertainty will be
revised March-June 2020



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29