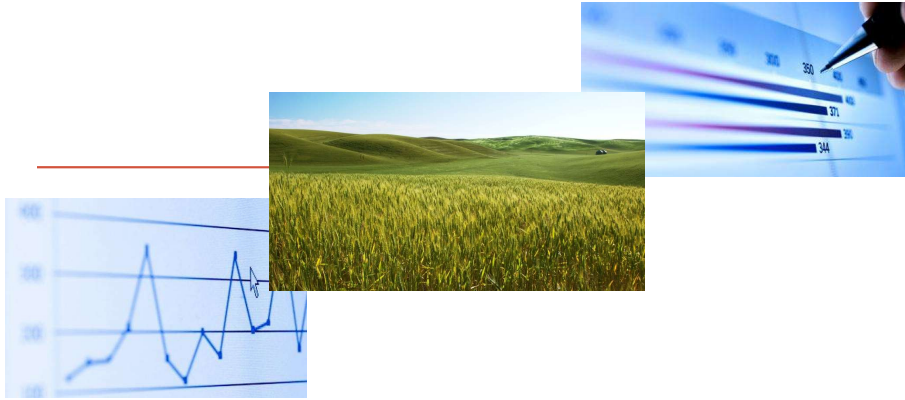


1


## MEASUREMENT UNCERTAINTY



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## What is Measurement Uncertainty (MU) ?

- When repeated measurements give different answers
- How widely spread are the values—wobble room
- Judge quality of measurement from the spread
- Measure AVERAGE and STDEV in EXCEL



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## Why does ISO 17025 care?



- Measurements are subject to errors.
- Measurements have uncertainty associated with it.
- Result is incomplete without a statement of MU.
- Without MU give wrong impression to customer

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## MU without Sample PREP



- Magruder 1107
- Run 40 X from Nov. 2013-April 2015
- AVER= 11.71%
- STDEV= 0.0595%
- **%RSD= 0.5085%**

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## MU with Sample PREP

- Design set of experiments
- 4 different samples
- Each sample: mass reduction to 4 splits
- Each split: 3 instrument measurements



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## MU with Sample PREP

- EXAMPLE: Sample 1
- Repeated for 4 Samples
- **AVG of 4 splits: 10.935**
- **SD of 4 Splits: 0.090492**
- **%RSD: 0.82755**
- **%RSD AVER of 4 samples= 1.132%**

Sample Split	Result: %Nitrogen	Average
Split 1	11.111	
	11.043	
	10.953	11.036
Split 2	10.899	
	10.903	
	11.022	10.941
Split 3	10.955	
	10.935	
	10.952	10.947
Split 4	10.915	
	10.775	
	10.757	10.816



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## Degrees of Freedom

- Degrees of freedom: number of measurements - 1
- For >20 values,  $k = 2.0$ , degrees of freedom =  $\infty$
- Tabulated values of  $k$  shown below:

n -1	1	2	3	4	5	6	7	8	9	10
$k_{(corr)}$	12.71	4.30	3.18	2.78	2.57	2.45	2.37	2.31	2.26	2.23
n -1	11	12	13	14	15	16	17	18	19	20
$k_{(corr)}$	<b>2.20</b>	2.18	2.16	2.15	2.13	2.12	2.11	2.10	2.09	2.09

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## Expand Uncertainty

- **Uncertainty:** 1.132%
- **Expand Uncertainty:**  $1.132 \times 2.2 = 2.4904\%$
- MU estimated to be 3.0% (95% CL,  $k=2$ )
- **True value:** 10.935%
- 3% of 10.935 % = 0.328%
- 95% confident result will be 10.607% - 11.263%
- YAHOO!!

## Conclusions

- Deriving measurement uncertainty is so doable!
- Standard protocol for determining uncertainty
- This is NOT a stumbling block for accreditation
- Practical approach—usable and manageable



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*“A person who never made a mistake  
never tried anything new.”*

*Albert Einstein*

