



Canadian Nuclear
Laboratories

Laboratoires Nucléaires
Canadiens

OBT analysis through the lens of combined uncertainty.

by Alexi Shkarupin

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Scientific Uncertainty (u , s^r , σ , Δ)

- Degree of confidence or precision that scientists have in their understanding of a particular phenomenon or process
- Range of possible values within which the true value lies
- Effective way of communicating the limitation of scientific knowledge

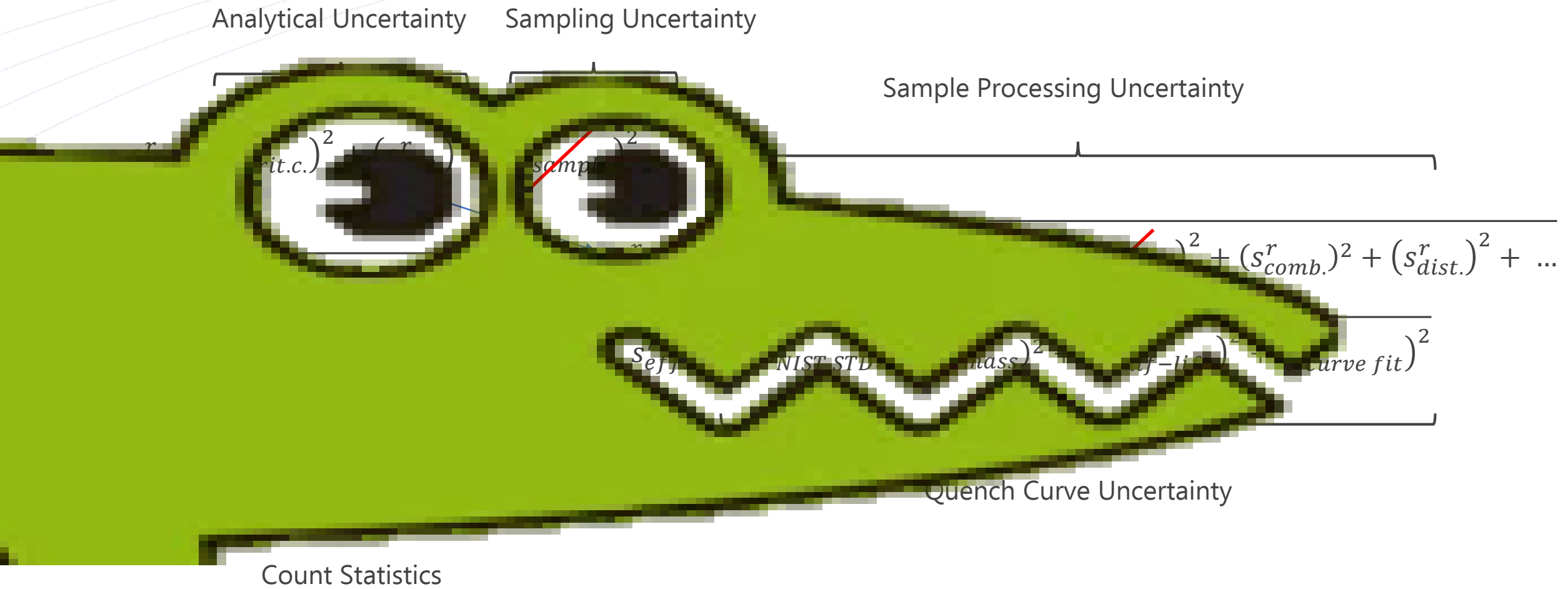
Tritium Half-life = 4500 ± 8 days

Lucas, Luzabelle. (2000). Comprehensive Review and Critical Evaluation of the Half-Life of Tritium. Journal of Research of the National Institute of Standards and Technology. 105. 10.6028/jres.105.043.

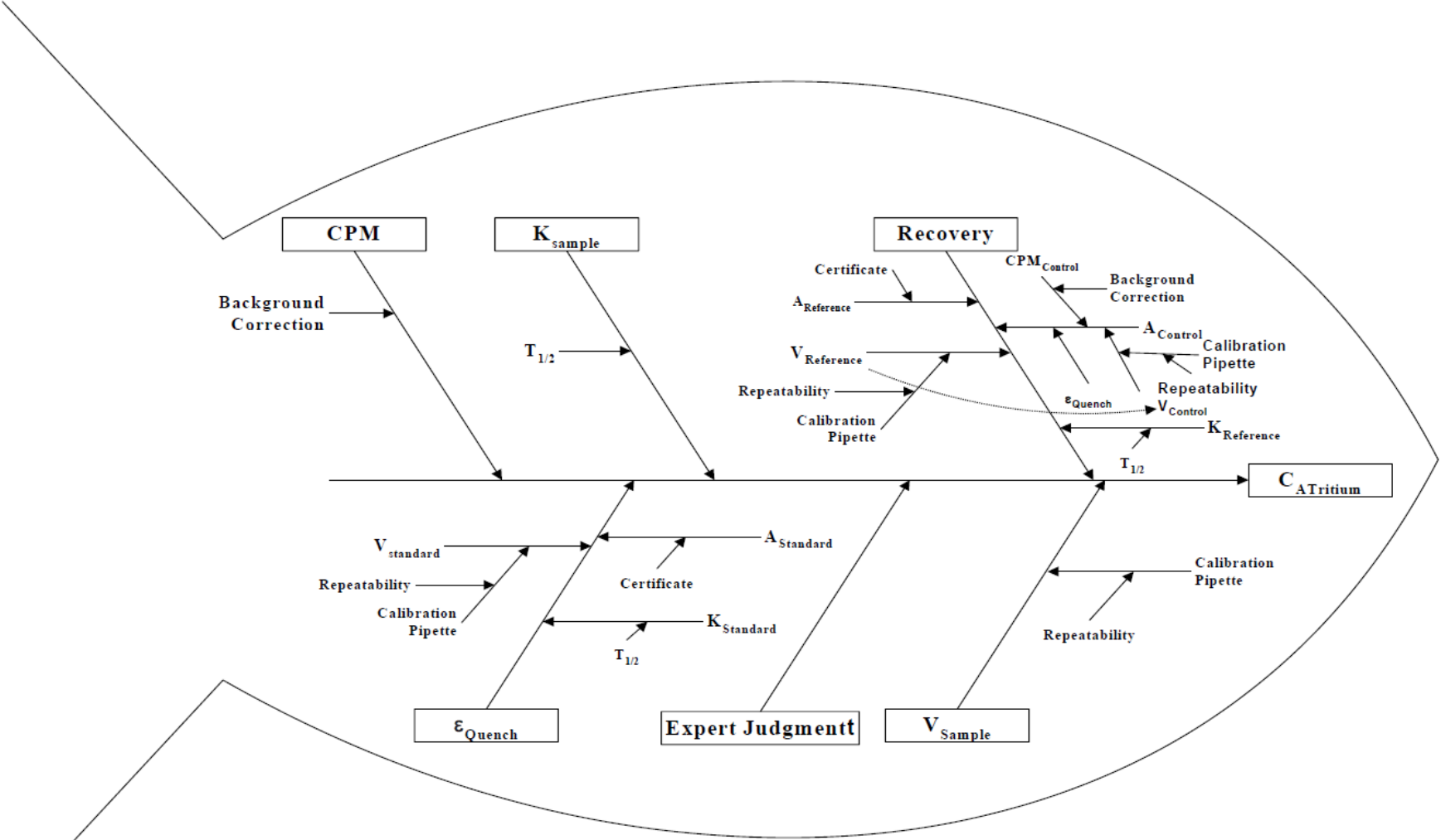


Propagation of uncertainty

$$s_{combined}^r = \sqrt{s_x^2 + s_y^2 + \dots}$$



Cause and effect diagram: Uncertainties in Tritium measurement (IAEA)



Discrepancies in OBT measurements



Fish (dry)

Discrepancies: 7.2 – 13 Bq/L



Venison (dry)

Discrepancies: 7.8 – 53 Bq/L



Moose (fresh)

Discrepancies: 9.0 - 25 Bq/L;

Fish (fresh)



Possible OBT results of the same fish_{fresh} samples

85 Bq/L

vs.

5.6 Bq/L



oven-drying result

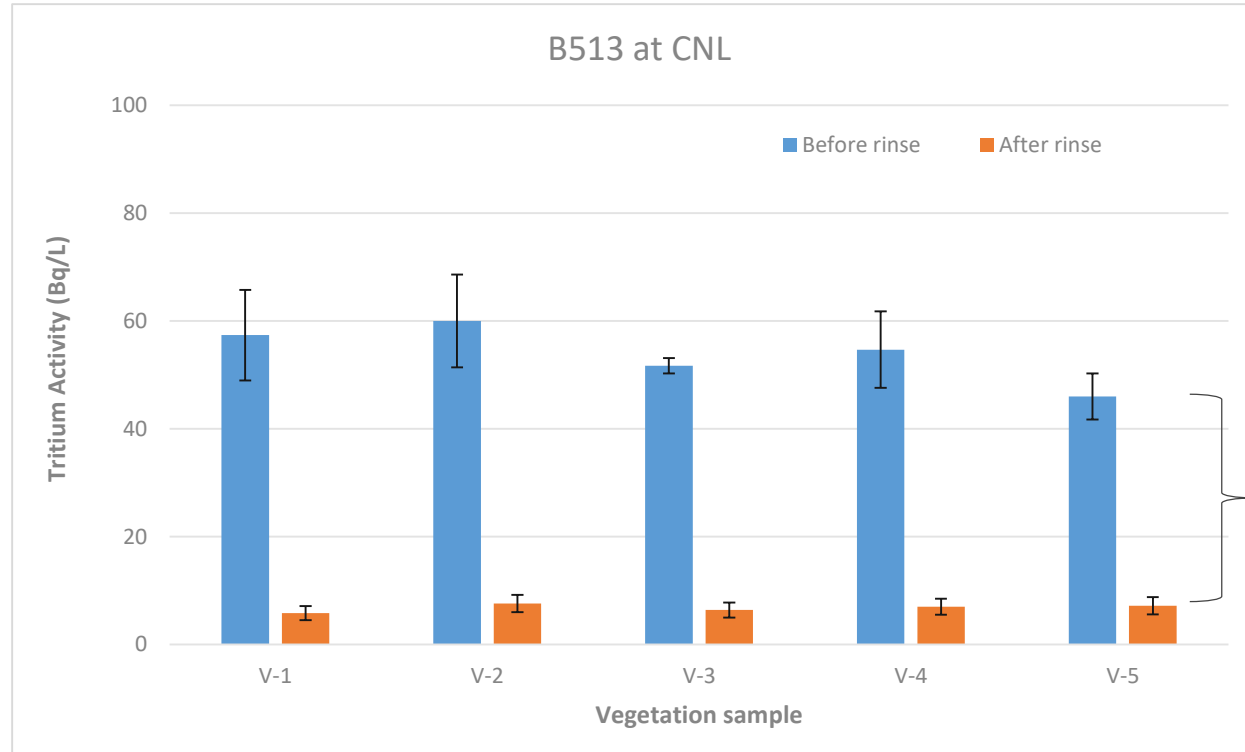


freeze-drying result



Example of background contamination in OBT measurements

Oven-drying of background samples in B513 on CNL site



$D = 39 \text{ Bq/L}$

Rinsing process was important to remove the exchangeable OBT

TRIC 2022 ³H Inter-comparison

Reference Value in TU

Sample	C(TU)	Unc.(TU)	σ_p (TU)
T40	135.500	0.670	4.10
T41	46.990	0.230	2.35
T42	600.10	2.90	12

Reference Value in Bq/L

C(Bq/L)	Unc. (Bq/L)	σ_p (Bq/L)
16.004	0.079	0.484
5.5495	0.027	0.278
70.872	0.342	1.417

CNL results in Bq/L

C(Bq/L)	1s (Bq/L)
17.09	0.35
6.296	0.24
71.86	0.68

Why so low?

Results evaluation in Bq/L

Sample	$D = x - x_a$	$D\% = 100(x - x_a)/x_a$
T40	1.08	6.77%
T41	0.75	13.5%
T42	0.99	1.39%

Accuracy Test

z-test
questionable
questionable
satisfactory

Uncertainty Test

ζ -test
unsatisfactory
unsatisfactory
satisfactory

$$S_{count} = \sqrt{\frac{CPM_0}{t_0} + \frac{CPM_s}{t_s}}$$

↓

t = 24 hrs

OBT Dilemma

- Multiple inter-comparison exercises have been performed within the Canadian Nuclear Industry. Further inter-comparisons have been paused until the discrepancies identified in previous exercises are resolved.
 - What is the best method for OBT sample processing and analysis to get the most accurate and reproducible results?
- Partial answer from 8th OBT workshop:
 - The OBT community expressed that they did not want to be mandated to use specific analysis equipment or a specific methodology. Eventually, a consensus on the most accurate option can be reached; in the meantime, laboratories prefer mastering their own methods and comparing results from those methods among one another
- Suggestion on how to answer the question:
 - Design an inter-comparison study focusing on evaluation and comparison of uncertainties of every step in the methods performed by different laboratories.



Conclusions:

- Different laboratories have different accuracy and precision requirements for OBT analysis.
 - Canadian Domestic OBT exercises showed acceptable variation in measured tritium concentrations for Canadian nuclear monitoring laboratories
 - The same variation would be extreme and unsatisfactory for high precision groundwater dating service.
- OBT sample processing has several optional steps that some labs may choose to follow. It can significantly affect the quality of final results.
- There is a need to understand different method performance criteria and limitations
- A study on different method's combined uncertainties can help with the posed OBT question.



Thank you





Question for you:

What do you like about your OBT method?

