

GammaSem 2010

Working Group on uncertainties and detection limits

GammaSem 100928

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Work plan

- Submit a questionnaire regarding application of combined uncertainty calculation and budgeting and use of detection limits for gamma ray spectrometry in the Nordic and Baltic countries (achieved)
- Suggest/recommend the use of certain well-defined detection levels for common application among the Nordic laboratories (aka NKS-participants)?
- NKS-workshop in GUM and Currie limits?
 - Recommendations?

Outcome of questionnaire

Questions asked

- **Software (manual or automated assessment):** Type of software or analysis tool used most commonly used for the gamma spectrometry at Your laboratory/institute
- **Sources of uncertainties considered:** Combined uncertainty calculation and budgeting in Gamma Spectrometric measurements: Which sources of uncertainty associated with the processes given below are taken into account in the full report/assessment for the gamma spectrometry at Your laboratory/institute?
- **Confidence limits reported:** Which confidence limits, or coverage factors, do you apply on the reporting of measurement results?
- **Adaption to the GUM procedure:** To which extent have You adapted to the International Standardisation Organisation's guide to the Expression of Uncertainty in Measurement (GUM)?

Outcome of questionnaire

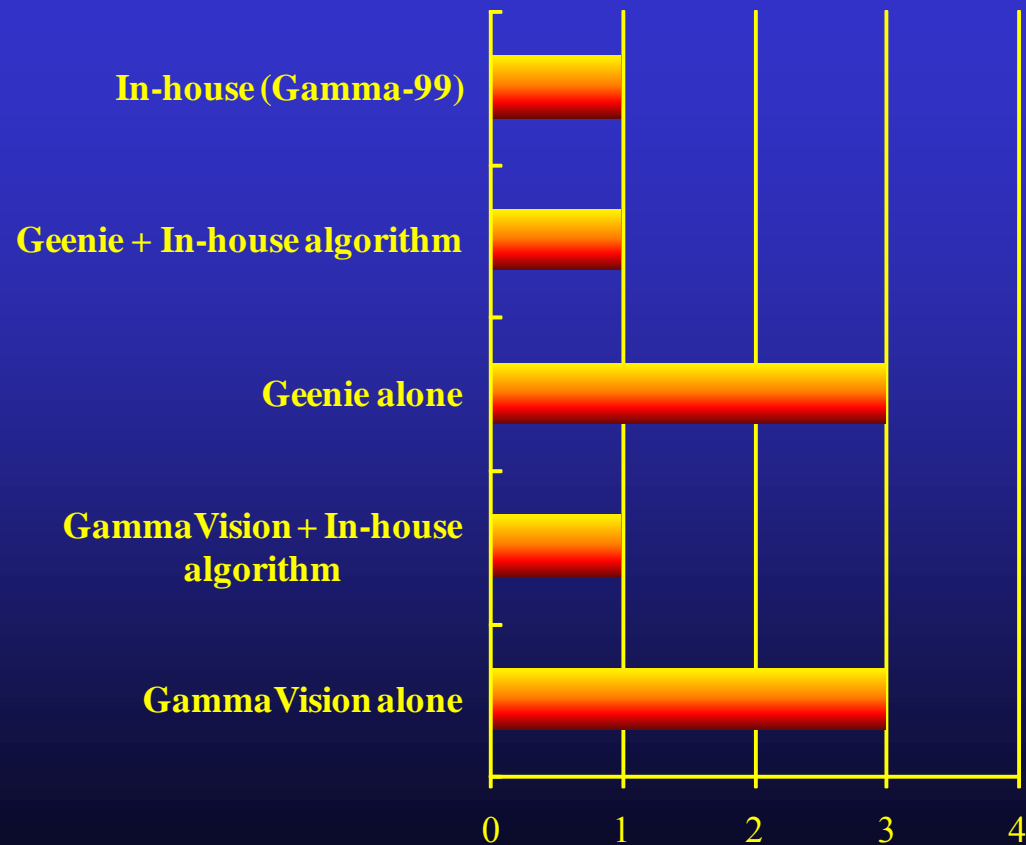
Questions asked (contd)

- Alternative approaches if not complying with GUM
- Use and definition of detection limit: Do You regularly use a definition of detection limit? If yes then specify.
- Use and definition of critical limit: Do You regularly use a definition of critical limit? If yes then specify.

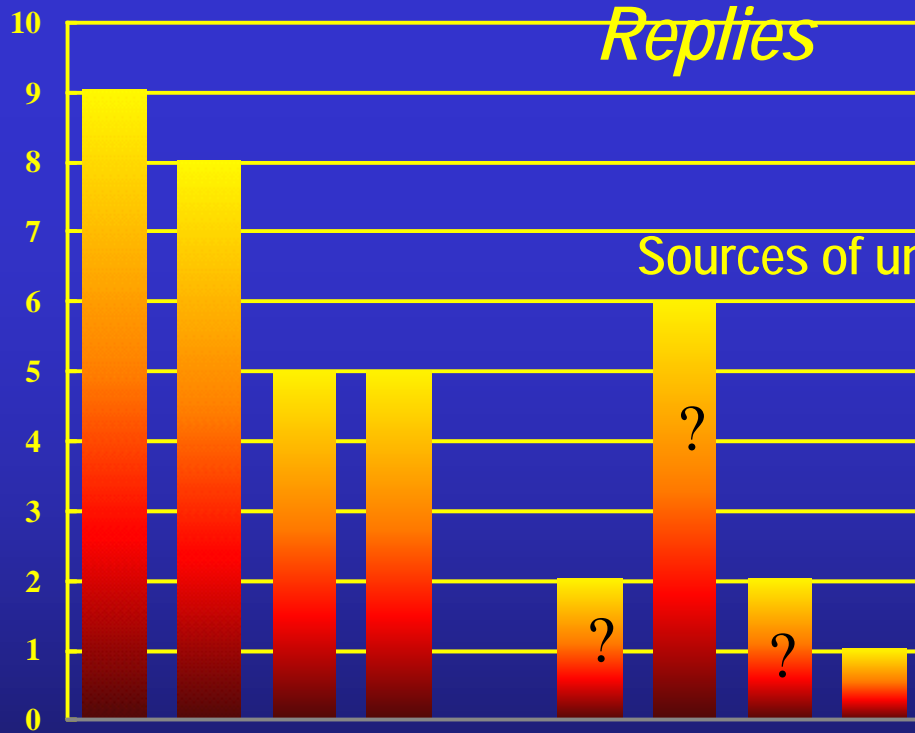
Outcome of questionnaire

Replies

Software (manual or automated assessment)



Outcome of questionnaire



Sources of uncertainties considered:

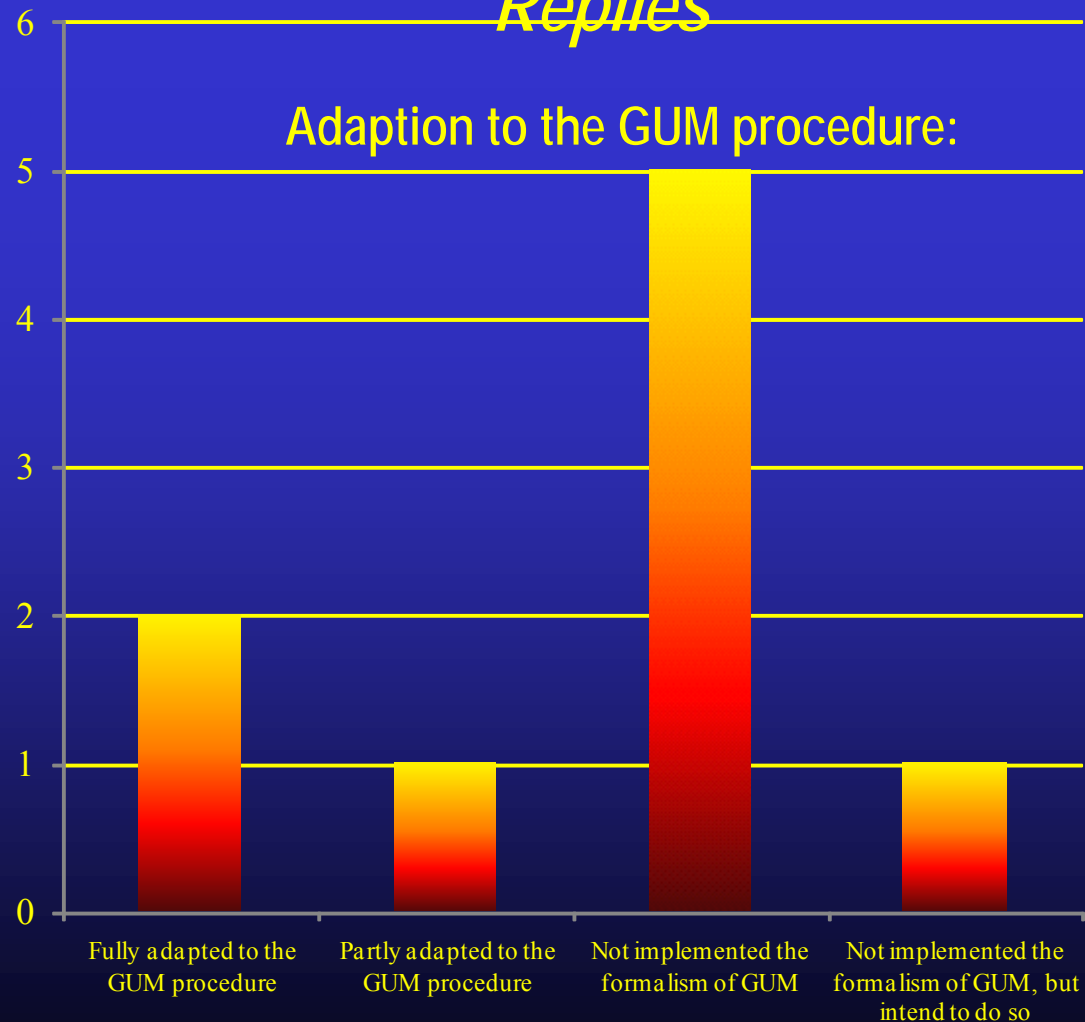
- *Counting statistics*
- *Decay*
- *Calibration*
- *Efficiency*
- *Absorption matrix (density)*
- *Coincidence*
- *Geometry*
- *Other*

?: Difference between correcting and consider the uncertainty in the correction!

1. Counting statistics - sample
2. Counting statistics - bkg
3. Efficiency curve
4. Calibration standard
5. Geometry
6. Absorption matrix
7. Decay
8. Coincidence
9. Other (specify)

Outcome of questionnaire

Replies



Outcome of questionnaire

Replies

Type A and Type B uncertainties:

- *“Until now we have made a rough estimate of total uncertainty including all components including types A and B, but we intend to quantify type A components in future.”*
- *“Type A: Unc. is calculated by the software. No repeated measurements are performed. Type B: Physical data from evaluated databases are registered in the software by the user, and then used by the software in the uncertainty calculation.”*
- *“No distinction is made”*
- *“Not considered in everyday use.”*

Outcome of questionnaire

Replies

Use and definition of detection limits

- 7 of 9 reported the use of detection level for *a priori* characterization of gamma detection sensitivity!!!
- 7 of 9 reported no or only occasional use of critical limit for *a posteriori* characterization of a gamma spectrometry assessment

Outcome of questionnaire

Replies

Use and definition of detection limit

What is the smallest amount of gamma emitting nuclide we can detect with given detection settings (acquisition times, measuring geometry, etc)?



Outcome of questionnaire

Replies

Use and definition of detection limit

Examples:

$$D_L = (2.7 + 4.65 \cdot \sigma_{Bkg}) / t_{Bkg} / \epsilon$$

$$CR_{mda} = \frac{\frac{100}{SENS} \times \left(\sqrt{2 * B_1 + \frac{2500}{SENS^2}} + \frac{50}{SENS} \right)}{LT}$$

$$1.6452 + 2 \cdot 1.645 \cdot SDBkg$$

Minimum Detectable Concentration =
 $3 * \sigma_{Bkg} / t_{Bkg} / (i, E) / p(i, E) / Q$

“Calculated from detector efficiency and critical limit calculated according to Nureg 4.16 Method.”

$$MDA = \left(\left(\left(L_d / t_{mät} \right) / \epsilon \right) / n_g \right); L_d = 2.71 + 3.29 \cdot \sigma_{PBkg} \cdot \sqrt{(t_{mät} / t_{bkg})}$$

Outcome of questionnaire

Replies

Use and definition of critical limit – a posteriori statement of a measurement

Did we detect something or not (aka
was the net signal significantly
($p > 0.05$) different from zero)?



Conclusions

Software:

- 2 dominating softwares – are we relying too heavily on their default expressions for detection limits?

Uncertainty analysis:

- Not all laboratories take the uncertainties associated with counting efficiency and calibration standard into consideration
- Even less consider the uncertainty of the density and coincidence correction

Detection limits:

- A flora of different expressions for the detection limit is used
- Almost no use of critical limits; for any laboratory commissioned with exemption measurements this is an urgent problem which needs to be addressed in the workgroup

What next?

Targets for the workgroup

- Has this questionnaire increased the awareness among the Nordic laboratories regarding the need for a complete uncertainty budgeting?
- Suggest expressions for detection and critical limits for gamma spectrometry?
- Nordic workshops in uncertainty propagation and detectability (similar to those given by at e.g. IRPA 12 in Madrid 2004)?