Measurements of $^3\text{H}$ activity

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To check all details of activity measurement of a $^3$H solution using the TDCR method (before the international comparison)

To prepare a set of $^3$H standard sources for obtaining a quenching curve in the LS-spectrometer Wallac 1411
Sources for measurement

- $^3$H solution: the LNHB standard No H3-LNHB00, activity $A_{LNHB} = 144.5 \pm 1.1 \text{ kBq/g on 18-SEP-2000}$
- Ultima Gold liquid scintillator
- A set of 10 sources (No. 1 -10) in standard Packard vials
  A set of 5 sources (No. 11-15) in frosted vials
  Masses: from 7.7 mg to 85.5 mg
The discrimination level of each PM-tube is adjusted just below the single photoelectron peak.

The detection efficiency is decreased by defocusing of the PM-tube.

Computing codes: TDCRB-02 (Poisson model) TDCRB-2Q (Polya model)
Analysis of calculation results

Activity $A = \frac{N}{\varphi_{\text{theor}}}$ [kBq]

The reason for bad calculation results can be a bad model of phenomena in the LS-counter, or the TDCR system is not functioning properly or maladjusted.
Measurement of the set of $^3$H sources No. 1 - 10

Measurement times:
- each point: 6 min
- 10 sources: 6 h

Statistical model | $A$ [kBq/g] | $A - A_{LNHB}$
--- | --- | ---
d. Polya $L = 0.02$ | 96.09 | + 1.6%
d. Polya $L = 0.05$ | 94.46 | - 0.1%
d. Poisson | 93.38 | - 1.2%

Certified value: $A_{LNHB} = 94.54 \pm 0.72$ kBq/g
Measurement of the set of $^3$H sources
No. 11 - 15 in frosted vials

<table>
<thead>
<tr>
<th>Statistical model</th>
<th>$A$ [kBq/g]</th>
<th>$A - A_{LNHB}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>d. Polya $L = 0.02$</td>
<td>96.28</td>
<td>+ 1.8%</td>
</tr>
<tr>
<td>d. Polya $L = 0.05$</td>
<td>94.47</td>
<td>- 0.1%</td>
</tr>
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Certified value: $A_{LNHB} = 94.54 \pm 0.72$ kBq/g

The slope of the regression line through a set of counting points is lower than before.

The calculated mean activity value of this set of sources is nearly the same as before.
Test of influence of adjustment of discrimination level on the measurement result

Set of $^3$H sources in frosted vials

Sources No 12 - 14
Discriminator threshold $D_0 = -0.7$ V

Sources No 10 - 15
Discriminator threshold $D_1 = -1.0$ V

Source No 12
Discriminator threshold $D_2 = -2.0$ V

Too low discrimination level

Too high discrimination level

d. Poisson
93.74 kBq/g

d. Poisson
94.47 kBq/g

d. Poisson
93.38 kBq/g

d. Poisson
92.72 kBq/g
Conclusions

- The exact results of the $^3$H solution measurements can be obtained with the Polya model with the parameter $L = 0.05$. An estimated uncertainty of the TDCR method of the $^3$H standardization was ± 0.5%. (Obtained activity was consistent with the LNHB value)

- In the case of the Poisson model, the calculated mean value of activity was lower by about 1%.

- The slope of the regression line through a set of counting points was lower when frosted vials were used, but the value of activity was nearly the same as for normal vials.