Calculation of results for tritium in water by liquid scintillation counter

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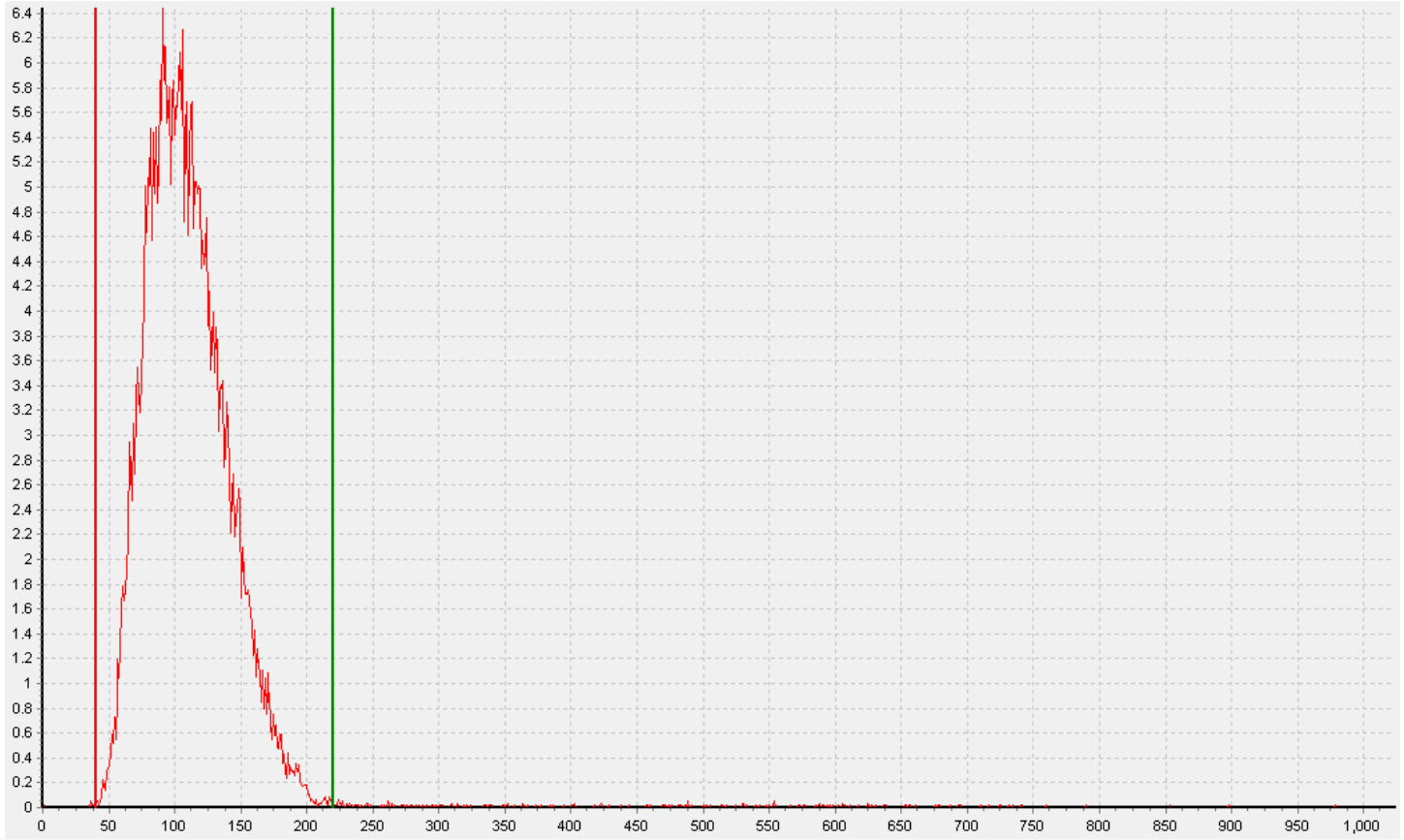
Tritium spectrum acquired by Quantulus 1220 liquid scintillation counter



Calculation of results

$$A_{\mathrm{H-3}} = \frac{(R_{\mathrm{s}} - R_{\mathrm{DW}})}{Z_{\mathrm{I}}\, \varepsilon_{\mathrm{H-3}}\, V_{\mathrm{s}} f} \quad (1)$$

$$R_X = \frac{N_{\mathrm{X}}}{t_{\mathrm{m}}} \quad (2)$$

$$Z_{\mathrm{I}} = e^{\left(\frac{PQ}{(m_s - m_f)F} ln \frac{m_s}{m_f}\right)} \quad (3)$$

$A_{\mathrm{H-3}}$ → activity concentration of $\mathrm{H-3}$ [Bq/L]

R_{s} → sample count rate [1/s]

R_{DW} → death water count rate [1/s]

Z_I → $\mathrm{H-3}$ electrolytical enrichment factor

$\varepsilon_{\mathrm{Pb-210}}$ → $\mathrm{H-3}$ detection efficiency

V_{s} → sample volume [L]

f → decay correction factor

R_{X} → count rate of radionuclide X or background [1/s]

N_{X} → number of counts of radionuclide X or background

t_{m} → measurement time [s]

P → average enrichment parameter for specific electrolytic cell

Q → electric charge [Ah]

m_{s} → starting mass of sample before electrolysis [g]

m_{f} → final mass of sample after electrolysis [g]

F → Faraday constant[Ah/g]]

Calculation of measurement uncertainty

$$u_{\mathrm{c,H-3}} = A_{\mathrm{H-3}} \sqrt{\left(\frac{u_{R_\mathrm{s}-R_{DW}}}{R_\mathrm{s}-R_{DW}}\right)^2 + \left(\frac{u_{Z_I}}{Z_I}\right)^2 + \left(\frac{u_{\varepsilon_{\mathrm{H-3}}}}{\varepsilon_{\mathrm{H-3}}}\right)^2 + \left(\frac{u_{V_\mathrm{s}}}{V_\mathrm{s}}\right)^2 + \left(\frac{u_f}{f}\right)^2} \tag{4}$$

$$u_{R_\mathrm{s}-R_\mathrm{DW}} = \sqrt{\left(u_{R_\mathrm{beta}}\right)^2 + \left(u_{R_\mathrm{b,beta}}\right)^2} \tag{5}$$

$$u_{R_\mathrm{X}} = \frac{1}{\sqrt{N_\mathrm{X}}} \tag{6}$$

$u_{\mathrm{c,H-3}} \rightarrow$ combined standard uncertainty for $\mathrm{H-3[Bq/L]}$

$u_\mathrm{X} \rightarrow$ standard uncertainty of X

Reporting of the results

$$U_{\mathrm{H-3}} = k\, u_{\mathrm{c,H-3}} \qquad (7)$$

$U_{\mathrm{H-3}} \rightarrow$ expanded uncertainty for $\mathrm{H-3}$ activity concentration [Bq/L]

$k \rightarrow$ coverage factor ($k = 2$ for 95% coverage)

$$A_{\mathrm{H-3}} = A_{\mathrm{H-3}} \pm U_{\mathrm{H-3}}$$

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