Calculation of results for uranium in water by alpha spectrometry

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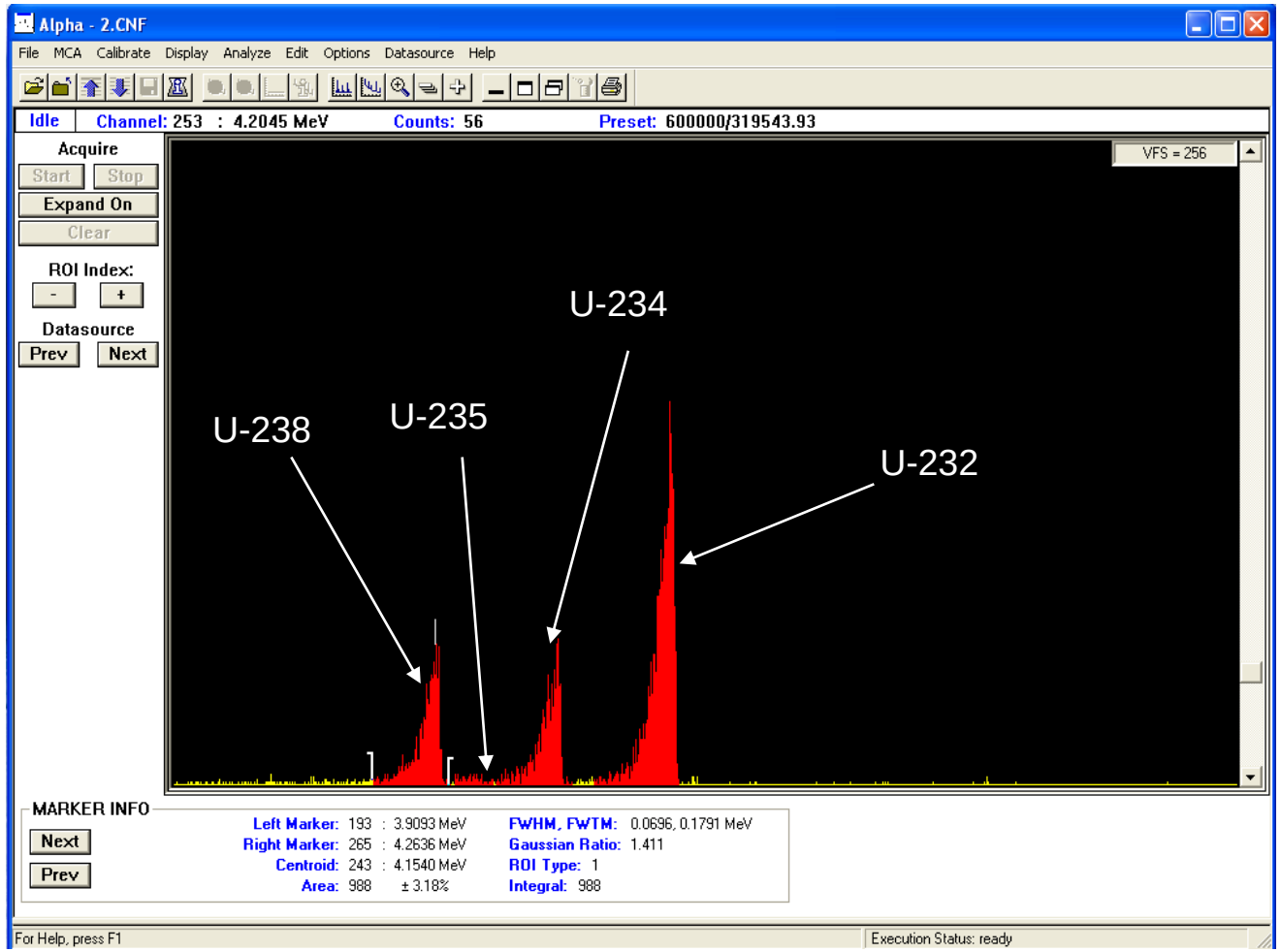
Uranium alpha spectrum



Calculation of results

$$A_{\mathrm{U-238}} = \frac{\left(R_{\mathrm{U-238}} - R_{\mathrm{b,U-238}}\right)A_{\mathrm{U-232}}}{\left(R_{\mathrm{U-232}} - R_{\mathrm{b,U-232}}\right)m_{\mathrm{U-232}}V_{\mathrm{s}}} \qquad (1)$$

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

$A_{\mathrm{U-238}}$ → activity concentration of $\mathrm{U-238}$ [Bq/L]

$R_{\mathrm{U-238}}$ → $\mathrm{U-238}$ count rate [1/s]

$R_{\mathrm{b,U-238}}$ → $\mathrm{U-238}$ background count rate [1/s]

$R_{\mathrm{U-232}}$ → $\mathrm{U-232}$ count rate [1/s]

$R_{\mathrm{b,U-232}}$ → $\mathrm{U-232}$ background count rate [1/s]

$A_{\mathrm{U-232}}$ → activity concentration of $\mathrm{U-232}$ tracer [Bq/g]

$m_{\mathrm{U-238}}$ → mass of $\mathrm{U-232}$ tracer added [Bq/g]

V_{s} → sample volume [L]

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]

Calculation of measurement uncertainty

$$u_{\mathrm{c,U-238}} = A_{\mathrm{U-238}} \sqrt{\left(\frac{u_{R_{\mathrm{U-238}}-R_{\mathrm{b,U-238}}}}{R_{\mathrm{U-238}} - R_{\mathrm{b,U-238}}}\right)^2 + \left(\frac{u_{R_{\mathrm{U-232}}-R_{\mathrm{b,U-232}}}}{R_{\mathrm{U-232}} - R_{\mathrm{b,U-232}}}\right)^2 + \left(\frac{u_{A_{\mathrm{U-232}}}}{A_{\mathrm{U-232}}}\right)^2 + \left(\frac{u_{m_{\mathrm{U-232}}}}{m_{\mathrm{U-232}}}\right)^2 + \left(\frac{u_{V_{\mathrm{S}}}}{m_{V\mathrm{S}}}\right)^2} \quad (3)$$

$$u_{R_{\mathrm{U-238}}-R_{\mathrm{b,U-238}}} = \sqrt{\left(u_{R_{\mathrm{U-238}}}\right)^2 + \left(u_{R_{\mathrm{b,U-238}}}\right)^2} \quad (4)$$

$$u_{R_{\mathrm{U-232}}-R_{\mathrm{b,U-232}}} = \sqrt{\left(u_{R_{\mathrm{U-232}}}\right)^2 + \left(u_{R_{\mathrm{b,U-232}}}\right)^2} \quad (5)$$

$$u_{R_{\mathrm{X}}} = \frac{1}{\sqrt{N_{\mathrm{X}}}} \quad (6)$$

$u_{\mathrm{c,U-238}} \rightarrow$ combined standard uncertainty for $\mathrm{U-238[Bq/L]}$

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

Reporting of the results

$$U_{\mathrm{U-238}} = k\, u_{c,U-238} \qquad (7)$$

$U_{\mathrm{U-238}}$ → expanded uncertainty for U-238 activity concentration [Bq/L]

k → coverage factor ($k = 2$ for 95% coverage)

$$A_{\mathrm{U-238}} = A_{\mathrm{U-238}} \pm U_{\mathrm{U-238}}$$

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