



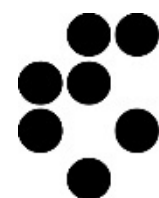
Augmented cooperation in education
and training in nuclear and radiochemistry

Calculation of results for Pb-210 in fish by proportional counter

Marko Štok, Jožef Stefan Institute



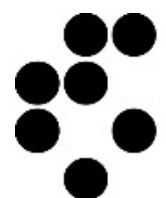
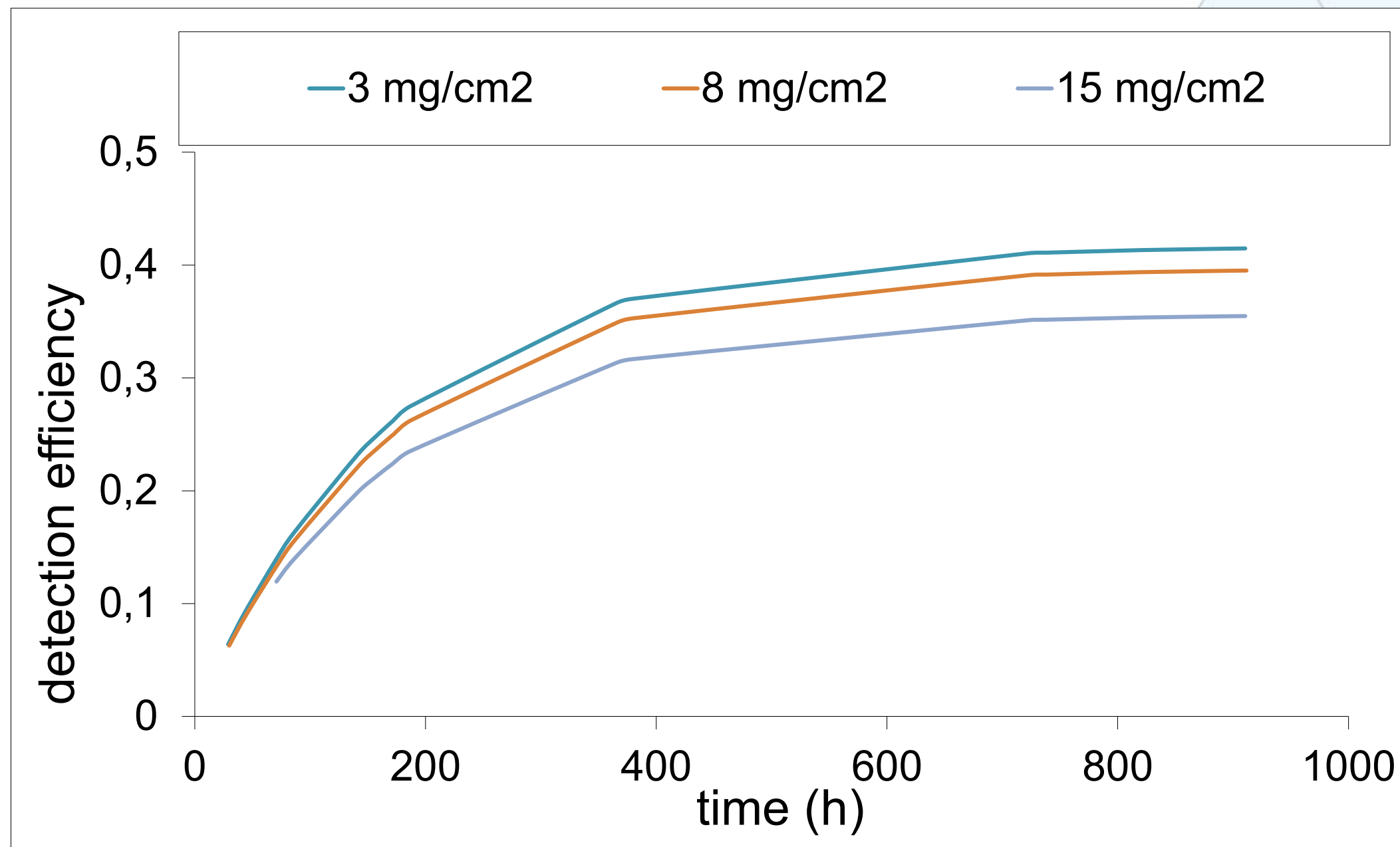
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Bi-210 in-growth from Pb-210 at different sample thickness



Calculation of results

$$A_{\text{Pb-210}} = \frac{(R_{\text{beta}} - R_{\text{b,beta}})}{\eta_{\text{Pb-210}} \varepsilon_{\text{Pb-210}} m_s} \quad (1)$$

$$\eta_{\text{Pb-210}} = \frac{m_{\text{PbSO}_4} M_{\text{Pb}}}{m_{\text{Pb}} M_{\text{PbSO}_4}} \quad (3)$$

$A_{\text{Pb-210}}$ → activity concentration of Pb – 210 [Bq/L]

R_{beta} → beta count rate [1/s]

$R_{\text{b,beta}}$ → beta background count rate [1/s]

$\eta_{\text{Pb-210}}$ → Pb – 210 chemical recovery

$\varepsilon_{\text{Pb-210}}$ → Pb – 210 detection efficiency

m_s → fresh sample mass [g]

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]

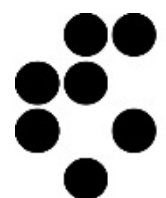
$$R_X = \frac{N_X}{t_m} \quad (2)$$

m_{PbSO_4} → mass of PbSO_4 on planchet after separation [g]

M_{PbSO_4} → molar mass of PbSO_4 [g/mol]

m_{Pb} → mass of added Pb carrier before separation [g]

M_{Pb} → molar mass of Pb [g/mol]



Calculation of measurement uncertainty

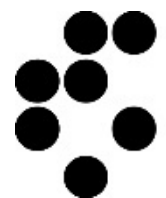
$$u_{c,\text{Pb-210}} = A_{\text{Pb-210}} \sqrt{\left(\frac{u_{R_{\text{beta}} - R_{\text{b,beta}}}}{R_{\text{beta}} - R_{\text{b,beta}}}\right)^2 + \left(\frac{u_{\eta_{\text{Pb-210}}}}{\eta_{\text{Pb-210}}}\right)^2 + \left(\frac{u_{\varepsilon_{\text{Pb-210}}}}{\varepsilon_{\text{Pb-210}}}\right)^2 + \left(\frac{u_{m_s}}{m_s}\right)^2} \quad (4)$$

$$u_{R_{\text{beta}} - R_{\text{b,beta}}} = \sqrt{(u_{R_{\text{beta}}})^2 + (u_{R_{\text{b,beta}}})^2} \quad (5)$$

$$u_{R_X} = \frac{1}{\sqrt{N_X}} \quad (6)$$

$u_{c,\text{Pb-210}}$ → combined standard uncertainty for Pb – 210[Bq/g]

u_X → standard uncertainty of X



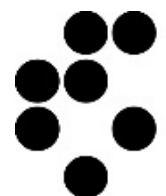
Reporting of the results

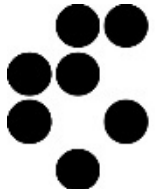
$$U_{\text{Pb-210}} = k u_{\text{c,Pb-210}} \quad (7)$$

$U_{\text{Pb-210}}$ → expanded uncertainty for Pb – 210 activity concentration [Bq/g]

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

$$A_{\text{Pb-210}} = A_{\text{Pb-210}} \pm U_{\text{Pb-210}}$$





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